Western Society of Naturalists

100th Meeting Program

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Western Society of Naturalists
~ 2019 ~

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100TH ANNUAL MEETING
OCTOBER 31 - NOVEMBER 3 2019
IN ENSENADA, MEXICO

Welcome to the 100th Annual Meeting of the Western Society of Naturalists! WSN's roots can be traced back to 1910 when a group of biologists, concerned about the lack of scientific meetings on the west coast, formed the Biological Society of the Pacific (call this our larval phase). The BSP was intended to include "any person interested in scientific work of a research nature." In 1915, the American Society of Naturalists invited the BSP to join as a Pacific chapter under the ASN banner. Although the BSP voted in favor, the merger was eventually rejected by the ASN Executive Committee, who felt that we might not be sufficiently selective in admitting members. Through this process, the BSP formally metamorphosed into the Western Society of Naturalists in 1916.

The first annual meeting of the society that would become WSN featured four scientific presentations and a dinner. Since then, our meetings and our society have grown substantially, but we still proudly welcome *everyone* who is interested in scientific work of a research nature. This year, we celebrate our 100th meeting. We couldn't be more pleased to mark this milestone in Ensenada, which represents an excellent opportunity to advance our goals of extending the breadth and depth of our science, integrating diverse personal and cultural perspectives, and expanding our network of excellent scientists at all career stages.

Registration and General Information

The registration desk will be open Thurs 5:00 - 8:00 pm, Fri-Sat 7:30 am - 6:00 pm, and Sun 10:00-1:00. Registration packets will be available at the registration desk for attendees who have pre-registered. Those who have not pre-registered but wish to attend the meeting can pay for membership and registration anytime after 5:00 pm on Thursday ($200 Student/ $350 Regular) at the registration desk. **Very limited tickets for the Saturday night buffet dinner will be available at the meeting, but first come - first served because the hotel requires final counts of attendees well in advance**. The Attitude Adjustment Hour (AAH) is included in the registration price, so you will only need to show your badge or guest AAH ticket for admittance. WSN T-shirts and other merchandise can be purchased or picked up at the WSN Student Committee table.

Thanks to Student Travel Fund Donors

We are grateful to all of you who made donations to the Student Travel Fund when you registered; those funds are greatly appreciated by our many student members. Thank you!

Merchandise

Merchandise may be picked up during the following times:

- THURSDAY: 5:00 - 8:00 pm
- FRIDAY: 7:30 - 8 am, all coffee breaks, and 6:30 - 7:00 pm
- SATURDAY: 7:30 - 8 am, all coffee breaks
- SUNDAY: 8 - 8:30 am, 10 - 10:30 am

Auction: Proceeds from the silent auction and limited live auction will support the student travel fund. Please take items to the merchandise table for donation. Thank you!

SILENT AUCTION: Friday 11/1 @ 8 am through Saturday 11/2 @ 9:45 pm, following the live auction. Winners must pick up their items by Sunday 11/3 @ 10:30 am. Items not claimed by then will be forfeited to the second-highest bidder.

LIVE AUCTION: Saturday 11/2 @ 9 pm. We will host a limited live auction on Saturday 11/2 @ 9:00 pm following the Presidential Address. Please bring items of special personal and historical significance to be auctioned!

Día de Muertos (Day of the Dead) Gala

WSN invites you to respectfully participate in Día de Muertos at this year's gala. This Mexican holiday is a celebration of the life of friends and family that have passed and a chance for their loved ones to remember them. Traditionally, families build ofrendas (altars) upon which they place pictures, flowers, and decorations to honor their loved ones and represent their presence at the celebration. At this year's gala, we will have an altar set up to honor WSN members who have passed so they may celebrate with us – you are invited to contribute photos and mementos of people you would like remembered to our altar.

There will also be live music and professional make-up artists to paint traditional holiday sugar skull designs. In lieu of the typical WSN Olympics, we will also offer an Escape Room style activity to fundraise for student travel! To participate, teams of 6 must raise $150! You can sign up for your team starting Friday evening at the Student Committee table.

Diversity, Equity, and Inclusion

WSN is committed to creating and maintaining an environment in which all attendees can participate without harassment, discrimination, or violence of any type. In support of this goal, the society has established a Diversity, Equity, and Inclusion Committee, whose members include Corey Garza (Chair), Cheryl Barnes, Jennifer Burnaford, Alexandra Davis, Mike Gil, and Crystal Ng.

Western Society of Naturalists Meeting Code of Conduct

The Western Society of Naturalists (WSN) annual meeting is intended to foster the exchange of scientific ideas, provide participants with an opportunity to present research findings, establish and renew collaborations, facilitate recruitment of students and staff to laboratories and institutions, and to learn, teach, and network with an international community of scientists. WSN is committed to creating an environment in which all attendees can participate without harassment, discrimination, or violence of any type. This Code of Conduct applies to all events at the WSN annual meeting, including all meeting-related activities of participants. **All meeting participants must be treated with respect, regardless of race, gender, sexual orientation, gender identity/expression, ethnicity, ability, religion, language, professional status, institution or age. All meeting participants including, but not limited to, members, volunteers, attendees, vendors, exhibitors, contractors, and guests are expected to abide by this WSN Meeting Code of Conduct.**

Expected behavior includes (but is not limited to):

- Treating all participants and meeting facilities with respect and consideration.
- Communicating openly with respect for others, critiquing ideas rather than individuals.
- Avoiding personal attacks directed toward others.
- Respecting the rules and policies of the meeting venue, hotels, WSN contracted facility, or any other venue.
- Abiding by the principles of academic integrity and ethical professional conduct.

Harassment or discrimination by or of any meeting participant or of any type will not be tolerated.

Unacceptable behavior includes (but is not limited to):

- Behavior that implies or indicates that someone does not belong at the WSN meeting based on any personal characteristic or identity.
- Any unwanted attention, sexual advances, and comments about appearance.
- Verbal harassment, including comments, epithets, slurs, threats, and negative stereotyping that are offensive, hostile, disrespectful, or unwelcome.
- Non-verbal harassment, including actions or distribution, display, or discussion of any written or graphic material toward an individual or group that ridicules, denigrates, insults, belittles, or shows hostility, aversion, or disrespect.
- Bullying, intimidation, stalking, shaming, and assault.
- Retaliation for reporting harassment.
- Reporting an incident in bad faith.

Consequences: The WSN Secretariat reserves the right to enforce this Code of Conduct in any manner deemed appropriate. Anyone violating the Code of Conduct will first be asked to cease these behaviors. Failure to comply with requests can result in escalating consequences which may include, but are not limited to, (a) expulsion from the meeting, (b) prohibition from future meetings or (c) revocation of WSN membership.

Reporting: If you are the subject of unacceptable behavior or have witnessed any such behavior, please immediately notify a member of the WSN Secretariat. Notification can be done by contacting a member of the WSN Secretariat on-site or via e-mail to secretariat@wsn-online.org.

Thank-you

The secretariat gratefully acknowledges the support and commitment of members of our society to make the society a welcoming community and a great. We also deeply appreciate the hard work of the many people that make the annual meeting possible and a great success! This meeting provides a unique opportunity for naturalists to come together to share curiosity, inspiration, knowledge and experience. We are privileged to be a part of this! Special thanks to:

Student committee: Yaamini Venkataraman for coordinating the Thursday workshop, Cassandra Konecny for coordinating the Student Symposium, Theresa Burnham for coordinating the Gala, Erin Dillon for managing social media and the auction, Jason Toy for managing merchandise, and Amelia Hesketh for chairing the student committee and keeping the secretariat on task. The student committee is vital to WSN, *thank you for your hard work!*

***Judges*:** Each year, WSN recognizes outstanding student oral and poster presentations with awards. We thank the hard work by the judging coordinators Alison Haupt, Alicia Abadía-Cardoso and Jayson Smith, and the many volunteer judges that provide constructive feedback and assessments of student presentations.

Volunteers: Over a dozen students volunteer to help the meeting run smoothly. These students skip a session or a social event to operate the table, run around to find tape, and do countless other essential and often last minute tasks. We couldn't run the meeting without you!

And very special thanks to super volunteers Kaleigh Davis, Mairin Deith and Cassandra Knoecny who have worked hard for months on the website, registration and program. We appreciate your hard work and generous commitment of your time to our society!

SCHEDULE AT A GLANCE: MAIN EVENTS

THURSDAY, OCTOBER 31, 2019

1800-2015 THURSDAY WORKSHOP (Ensenada 1) - open to all
"Mental Health in Academia: How Can We Do Better?"

2015 - MIXER (Marina Grill Bar, Hotel Coral y Marina)

FRIDAY, NOVEMBER 1, 2019

0800-0950 STUDENT SYMPOSIUM (Ensenada 1-3)
"Learn the Past and Create the Future:
The Role of Natural History in a World of Innovation"

0950-1010 Coffee break

1010-1100 NATURALIST OF THE YEAR AWARD (Ensenada 1-3)
Diana Steller: "*Field Immersion: how curiosity, serendipity, and natural history led to ecological discoveries along the Californias*"

1100-1215 SPEED TALKS (Ensenada 1-3)

1215-1330 Lunch

1330-1530 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1530-1600 COFFEE BREAK

1600-1800 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1900-2100 POSTER SESSION & ATTITUDE ADJUSTMENT HOUR (AAH) (Ensenada 1-3)

SATURDAY, NOVEMBER 2, 2019

0800-1000 PRESIDENTIAL SYMPOSIUM (*Bridges Not Borders: Benefits of Building Across Boundaries*) (Ensenada 1-3)

1000-1030 Coffee Break

1030-1200 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1200-1330 LUNCH

1330-1530 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1530-1545 break

1545-1715 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1745-1900 ANNUAL BUSINESS MEETING. All members are welcome - come help shape the future of our society (Ensenada 1)

1900-2100 PRESIDENTIAL BUFFET AND ADDRESS: Brian Tissot (Terraza Coral)

2100-2400 DÍA DE MUERTOS GALA: AUCTION, GAMES, MUSIC, and ENTERTAINMENT (Terraza Coral)

SUNDAY, NOVEMBER 3, 2019

0800-0930 WSN Continental Breakfast (Terraza Coral) + Diversity, Equity and Inclusion (DEI) breakfast conversation (*open to all, find the designated area at breakfast*)

0930-1130 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1200-1250 SPECIAL PLENARY SPEAKER (Ensenada 1-3)
Dr. Hector Reyes Bonilla: "Marine Research in northwest Mexico: Past, Present, and Future"

1250 MEETING CLOSING

SPECIAL TOPICS:

Alongside our usual range of topics, the 2019 meeting will also include sessions of contributed talks focused on four **Special Topics**. For a summary of these sessions, please see page 33.

CONFERENCE FOOD AND MEALS:

FRIDAY NIGHT AAH: 7:00 to 9:00 pm. A complimentary buffet and a cash bar will be provided in the rooms Ensenada 1-3 Rooms, including vegetarian options.

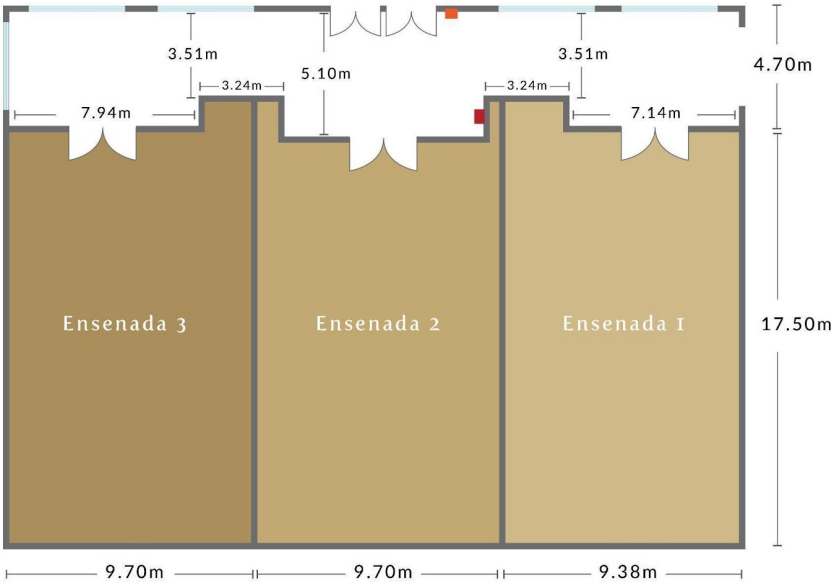
SATURDAY NIGHT PRESIDENTIAL BUFFET: 7:00 to 8:30 pm. The Presidential event will include a Tacos buffet served with complimentary Sangria and Margaritas from 7:00 to 8:00 pm at the Terraza Coral. A cash bar will also be available.

SUNDAY MORNING BRUNCH: 8:00 to 9:30 am. A complimentary Deluxe Continental breakfast/brunch buffet will be available at Terraza Coral.

Lunches will be on one's own. A list of local restaurants appears on page 35.

SALONES y FOYER

Hotel Coral & Marina



Salones
Altura 4.20 mts

Foyer
Ancho 3.51 mts | Largo: 29.90 mts

Hidrante
Extintor

Hotel Floor Plan

Lactation Room

There will be a room (Manzanilla) available from Thursday to Sunday. Please note the room will not be available on Sat. morning from 8 to 12, so plan accordingly.

THURSDAY, Oct 31, 2019 All attendees of WSN, *not only students*, are encouraged to attend!

1800 - 2015: THURSDAY WORKSHOP 2019: *"MENTAL HEALTH IN ACADEMIA: HOW CAN WE DO BETTER?"* Ensenada 1-2

Graduate students are facing a mental health crisis. A recent *Nature Biotechnology* study suggests that graduate students are six times more likely to experience anxiety or depression than the general public (Evans et al. 2018). Student identity (ex. race or gender) and mentorship quality were found affect mental health. Given that a healthy student population is integral to scientific institutions, mental health outcomes in graduate school may follow a student throughout their academic career, and that poor mental health is generally pervasive in academia, identifying gaps in mental health resources is crucial. This workshop will discuss the complexities of mental health in academia and identify possible solutions that institutions like the Western Society of Naturalists can implement in response.

Angelina Zuelow, MSc Student & Teaching Associate, CSU Fullerton. Angelina is the president of the SACNAS club at CSU Fullerton, which focuses on increasing diversity in science. As a teacher and president of a club geared towards undergraduates, Angelina has dealt with mental health issues in academia and collaborated with students to create solutions. For SACNAS specifically, Angelina and her colleagues have developed worksheets and conversation topics that they go over during monthly member meetings, creating safe spaces for members to ask questions and discuss their needs. Angelina has also dealt with mental health issues, such as imposter syndrome, and believes she has a lot to share that can positively affect others.

Sadie Small, Laboratory Manager, Bodega Marine Laboratory. Sadie Small works with Dr. Steven Morgan at BML, where her research broadly encompasses the effects of environmental factors on the early life history of marine organisms, ranging from seaweeds to invertebrates and fishes, through a lens of restoration, conservation, and mariculture. Her career in marine ecology has spanned many institutions and systems; she received her BSc at UC San Diego, worked as a technician with Dr. Paul Dayton at Scripps, and pursued her MS in seaweed ecophysiology at SDSU with Dr. Matthew Edwards. While in graduate school, Sadie gained valuable experience outside of academia – first via a US Navy fellowship culturing abalone with Dr. David Lapota at SPAWAR-SSC Pacific, then as an oyster hatchery technician at Carlsbad Aquafarms. Despite these accomplishments, Sadie's graduate school tenure was rocky due to problems both personal and systemic. This has led her to advocate for transparency and visibility around the ubiquitous issue of mental health in academia.

Dr. Laura Jurgens, Assistant Professor, Texas A&M Galveston. Dr. Laura Jurgens is an Assistant Professor in the Marine Biology Department at Texas A&M University Galveston (TAMUG) and a core faculty member in the Ecology and Evolutionary Biology Interdisciplinary Doctoral Degree Program at Texas A&M (College Station). Her research investigates processes supporting ecological stability from population to ecosystem levels, and from local site to latitudinal scales. She works largely in Pacific and Gulf ecosystems, emphasizing experimental field ecology and bio-physical interactions. Prior to her science career, she worked as a community organizer in social justice and environmental policy, and trained in multicultural conflict resolution and addressing racism and sexism in the workplace. In addition to research and mentoring in her current faculty role, she is committed to helping students learn to overcome perfectionism and imposter syndrome in academia.

Dr. Niyatee Sukumaran, Staff Psychologist, UC San Diego Counseling and Psychological Services
Niyatee is originally from Mumbai, India, has resided in different nations, and arrived in the US as an international student for graduate school. Niyatee is excited to empower clients via therapy, outreach and workshops to increase their self-understanding and improve their mental health and well-being. Her therapeutic framework is integrative, including a strengths-based approach that takes into consideration a student's individuality, cultural context and systemic issues. Niyatee actively engages in outreach/ consultations to work towards reducing stigma and increasing help-seeking among underrepresented groups (e.g., racial/ethnic minorities). At UCSD CAPS, she serves as a liaison to the South Asian, Asian American, and International Students Muslim Student Community. Some of the topics she addresses in therapy include adjustment & life transitions, acculturation, trauma and interpersonal difficulties; anxiety (general & social), depression, impostor syndrome, and self-compassion.

FRIDAY, NOVEMBER 1, 2019

STUDENT SYMPOSIUM (0800-0940) Ensenada 1-3

"Learn the Past and Create the Future: The Role of Natural History in a World of Innovation"

0800 **MEETING OPENING (**Secretariat**)**

0810 **INTRODUCTION** (Cassandra Konecny, WSN Student Committee)

0815 **Dr. Andrew Olaf Shelton**, Northwest Fisheries Science Center, NOAA
BUILDING NEW NETS FOR OLD QUESTIONS: THE HOPE, HYPE AND PRACTICE OF USING ENVIRONMENTAL DNA TO UNDERSTAND ECOLOGICAL COMMUNITIES

0845 **Dr. Loren McClenachan**, Colby College
HARNESSING HISTORICAL DATA FOR MARINE CONSERVATION

0915 **Dr. Kyle Cavanaugh,** University of California - Los Angeles
NATURAL HISTORY FROM ABOVE: CONFRONTING THE PROBLEM OF PATTERN AND SCALE IN ECOLOGY WITH REMOTE SENSING

0945 **PANEL DISCUSSION**

1000 **COFFEE BREAK**

1020 **NATURALIST OF THE YEAR AWARD** (presented by Chris Harley)
Diana Steller: "*Field Immersion: how curiosity, serendipity and natural history led to ecological discoveries along the Californias*"

1120 **SPEED TALKS** (Ensenada)

1230 **LUNCH BREAK**

1330 **CONTRIBUTED PAPERS** (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1530 **COFFEE BREAK**

1600 **CONTRIBUTED PAPERS** (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1800 **BREAK**

1900 **POSTER SESSION AND ATTITUDE ADJUSTMENT HOUR (AAH)** (Ensenada)

SPEED TALKS (1120-1230) - CHAIR: K. Boyer **Ensenada**

1120 **Harley, Chris** DOCUMENTING LONG-TERM, WIDESPREAD DECLINES OF LARGE INTERTIDAL HERBIVORES IN NEW ZEALAND IN RELATION TO RELATIVE THERMAL TOLERANCE

1126 **Boyer, Katharine** LIVING SHORELINES: WHAT'S NEW AND WHAT'S NEXT IN SAN FRANCISCO BAY

1132 **Carpizo-Ituarte, Eugenio de** CLIMATE-PROOFING AQUACULTURE SPECIES: A COLLABORATIVE 'PROOF OF CONCEPT' PROJECT ON OYSTERS

1138 **Cavanaugh, Katherine** VARIABILITY IN THE RECOVERY OF CALIFORNIA KELP FORESTS FOLLOWING A MARINE HEATWAVE

1144 **Delgadillo Nuño, Manuel Alejandro** SUDDEN DECREASE IN SEAWATER TEMPERATURE INCREASES EXPRESSION OF HSP70 IN CORALS OF THE MEXICAN PACIFIC

1150 **Henry, Amy** RISK ASSESSMENT OF ECOLOGICAL IMPACTS BY RANGE-EXPANDING MARINE SPECIES IN NORTH AMERICA

1156 **Lowe, Alexander** A MODERN SYM*PH*ESIS: SCALING OCEAN ACIDIFICATION FROM LOCAL TO GLOBAL SCALES

1202 **Neumann, Kyle** WATER-CORERS: LOW-COST, OPEN SOURCE WATER SAMPLERS DESIGNED TO STUDY ECOSYSTEM DYNAMICS IN NOVEL WAYS AND WITH HIGH RESOLUTION

1208 **Stubler, Amber** THIS PAPER IS SIMPLY MANURE: DOWNSTREAM EFFECTS OF UNPROFESSIONAL PEER REVIEW COMMENTS AMONG INTERSECTIONAL GROUPS IN STEM

1216 **McDonald, Meghann** YOUTH ENGAGEMENT - PARTICIPATORY BASED EDUCATION AS A TOOL FOR COMMUNITY BASED CONSERVATION IN BAHÍA DE LOS ÁNGELES

FRIDAY, NOV 1 1330-1530 † eligible for Best Student Paper Award

Time	Session 22: Ensenada 1 Fisheries Ecology I Chair: Dan Okamoto	Special Session 6: Ensenada 2 Transboundary Science Chair: Luis Malpaca Cruz	Special Session 7: Ensenada 3 Eco-evolutionary Dynamics in the Sea Chair: Gina Contolini	Session 23: Tent 1 Intertidal Ecology 1 Chair: Bernardo Broitman	Session 10: Tent 2 Community Ecology Chair: Matt Whalen
1330	† **Peake, Jonathan** COMMUNITY STRUCTURE AND DYNAMICS OF FORAGE FISHES IN THE EASTERN GULF OF MEXICO (1998-2017)	**Bell, Tom** KELPWATCH: A PUBLICLY AVAILABLE TOOL FOR VISUALIZATION AND ANALYSIS	**Aguirre, David** STRONG PHYLOGENETIC SIGNAL FOR MASS CORAL BLEACHING WITHIN REGIONS, BUT NO EVIDENCE FOR PHYLOGENETIC CONSTRAINTS BETWEEN REGIONS	**Broitman, Bernardo** BACK TO THE FUTURE: COASTAL PALAEOECOLOGY AND PALAEOCEANOGRAPHY OF THE ATACAMA DESERT (CHILE, 25°S) DURING THE HOLOCENE	† **Gabara, Scott** KELP FOREST DEFORESTATION LEADS TO COMMUNITY-WIDE DIETARY NICHE CONTRACTION
1345	**Nelson, Peter** COLLABORATIVE FISHERIES MONITORING IN THE YAP OUTER ISLANDS	**Lowe, Chris** THE IMPORTANCE OF TRANSBOUNDARY COLLABORATIVE RESEARCH ON HIGHLY MIGRATORY WHITE SHARKS	† **Beaty, Fiona** A SEARCH FOR LOCAL ADAPTATION IN A MARINE SNAIL REVEALS HIGH PLASTICITY, MALADAPTATION, AND LOW SURVIVAL IN SOUTHERN REGIONS	† **McIntire, Lily** CAN'T STAND THE HEAT? GET OUT OF THE TIDEPOOLS: EVALUATING TEMPERATURE REGULATION IN GUMBOOT CHITONS	† **Yeager, Mallarie** EFFECTS OF SPATIOTEMPORAL CHANGES IN CONSUMER FUNCTIONAL DIVERSITY ON ECOSYSTEM STABILITY AND FUNCTIONING
1400	† **Mansfield, Betsy** A REPORT ON THE CALIFORNIA SPINY LOBSTER FISHERY OF EL ROSARIO, BAJA CALIFORNIA: SUBLEGAL BYCATCH RATE, EFFORT, AND CATCH VARIANCE	**Micheli, Fiorenza** SOCIAL-ECOLOGICAL VULNERABILITY AND ADAPTATION TO A CHANGING OCEAN	† **Contolini, Gina** POPULATION-SPECIFIC DIFFERENCES IN THE EFFECTS OF ACIDIFICATION ON PREDATOR FORAGING TRAITS	**Díaz-Castañeda, Victoria** BENTHIC COLONIZATION OF AN ARTIFICIAL REEF LOCATED IN THE WEST COAST OF BAJA CALIFORNIA: A PLATE EXPERIMENTAL APPROACH.	† **Tedford, Kinsey** RESTORING VIRGINIA'S OYSTER REEFS: ENVIRONMENTAL CONTROLS ON OYSTER RECRUITMENT, GROWTH, AND SURVIVAL ACROSS SPATIAL SCALES
1415	† **Ferrer, Erica** THE CARBON FOOTPRINTS OF MEXICAN SMALL-SCALE FISHERIES REVEAL NEW INSIGHTS INTO MARINE RESOURCE TRADE-OFFS ON A CHANGING PLANET	† **Ricárdez-García, Víctor** A TRANSDISCIPLINARY STRATEGY FOR THE SUSTAINABLE DEVELOPMENT OF FISHING COMMUNITIES OF THE UPPER GULF OF CALIFORNIA	**Jacobs, David** EXTINCTION OF CALIFORNIA'S FLIGHTLESS DUCK IMPACTS OTTERS & ABALONE; COLORADO DELTA DESICCATION RISKS INTROGRESSIVE SPECIES LOSS.	† **Fields, Jennifer** A TALE OF TWO TIDE POOLS: EFFECT OF *MYTILUS* AND *PHYLLOSPADIX* REMOVAL ON ECOSYSTEM FUNCTION WITHIN OREGON ROCKY INTERTIDAL	† **Speare, Kelly** CORAL BLEACHING DISPROPORTIONATELY AFFECTS THE SMALLEST AND LARGEST INDIVIDUALS
1430	† **Cavole, Leticia** FISHES AS "MOBILE MONITORS" OF HYPOXIC CONDITIONS ACROSS OCEAN BASINS	† **Ramirez-Valdez, Arturo** MARINE CONSERVATION ACROSS POLITICAL BORDERS	† **Griffiths, Joanna** TRANSGENERATIONAL PLASTICITY AND PARENTAL GENOTYPE ALTERS THE CAPACITY TO ADAPT TO LOW SALINITY IN THE EASTERN OYSTER	**Hennessey, Shannon** EFFECTS OF PREY PREDICTABILITY ON THE FORAGING EFFICIENCY OF PREDATORY WHELKS	**Scott, Alexander** DEEP THOUGHTS: DOES SPONGE COVER INCREASE WITH DEPTH ON CARIBBEAN MESOPHOTIC REEFS?
1445	† **Boles, Sara** INTERACTIVE EFFECTS OF OCEAN	**Panel Discussion**	**Jones, Hollis** SYNERGISTIC EFFECTS OF TEMPERATURE AND	**Brownlee, Graham** TIDE POOL CONNECTIVITY INFLUENCES THE	† **Lima, Lais** MATHEMATICAL MODELING OF THE CORAL

	ACIDIFICATION AND WARMING ON DEVELOPING RED ABALONE (*HALIOTIS RUFESCENS*)		SALINITY ON THE GENE EXPRESSION AND PHYSIOLOGY OF CRASSOSTREA VIRGINICA	EFFECTS OF TEMPERATURE ON ROCKY INTERTIDAL ZONE GASTROPODS	MICROBIOME: THE INFLUENCE OF TEMPERATURE AND MICROBIAL NETWORK
1500	**† Early Capistrán, Michelle María** QUANTIFYING LOCAL ECOLOGICAL KNOWLEDGE TO RECONSTRUCT GREEN TURTLE ABUNDANCE IN THE GULF OF CALIFORNIA	**Panel Discussion**	**Swezey, Daniel** LOCAL ADAPTATION? OCEAN ACIDIFICATION DIFFERENTIALLY AFFECTS SURVIVAL OF TWO POPULATIONS OF RED ABALONE	**† Bolwerk, Ashley** TROPHIC AND ENVIRONMENTAL FORCING IN ALASKAN ROCKY INTERTIDAL ZONES	**† Glanz, Jessica** CRUSTOSE CORALLINE ALGAL MORTALITY AND MORPHOLOGY INFLUENCE ASSOCIATED EPIFAUNAL DIVERSITY IN MOOREA, FRENCH POLYNESIA
1515	**Okamoto, Dan** REDEFINING FISHERIES SUSTAINABILITY: ACCOUNTING FOR COMPLEX FEEDBACKS AMONG ECOLOGICAL, GOVERNANCE, AND SOCIOECONOMIC DYNAMICS		**† Venkataraman, Yaamini** INFLUENCE OF OCEAN ACIDIFICATION ON PACIFIC OYSTER DNA METHYLATION	**† Bedgood, Samuel** SEA ANEMONE MUTUALISM LEADS TO FACILITATION: COMPLEX INTERACTIONS INCREASE BIODIVERSITY IN THE ROCKY INTERTIDAL ZONE	**Whalen, Matthew** COMMUNITY-LEVEL RESPONSES OF INTERTIDAL SEAWEEDS TO A MARINE HEATWAVE IN CENTRAL BRITISH COLUMBIA
1530					**Edwards, Matt** THE IMPACTS OF VESSEL MOORING DISTURBANCES ON PRIMARY PRODUCTION IN CATALINA RHODOLITH BEDS

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FRIDAY, NOV 1 1600-1800 † eligible for Best Student Paper Award

Time	Special Session 3: Ensenada 1 Advancements in MPA Science Chair: Melissa Kent	Session 7: Ensenada 2 Applied Ecology Chair: Crow White	Session 17: Ensenada 3 Conservation and Restoration 1 Chair: Mark Hixon	Session 24: Tent 1 Intertidal Ecology 2 Chair: Cassandra Konecny	Session 29: Tent 2 Physiological Ecology Chair: DellaTorre, Melissa
1600	**Shears, Nick** LONG-TERM MARINE RESERVE PROTECTION UNEQUIVOCALLY DEMONSTRATES THE ECOSYSTEM-LEVEL CONSEQUENCES OF FISHING ON KELP FORESTS	**Angwin, Renee** ECOLOGICALLY RESTORATIVE AQUACULTURE OF PURPLE SEA URCHINS (STRONGYLOCENTROTUS PURPURATUS)	**† Norrie, Craig** MUSSELS, MODELS, AND MICROCHEMISTRY - LARVAL SUBSIDIES FROM AQUACULTURE MAY ASSIST WITH RESTORATION	**† Sellers, Andrew** SEASONAL UPWELLING INCREASES ALGAL COVER AND WEAKENS HERBIVORY ON PANAMANIAN ROCKY SHORES	**† DellaTorre, Melissa** DECOUPLED PHYSIOLOGICAL RESPONSES TO INCREASED TEMPERATURE – IMPLICATIONS FOR ADAPTATION POTENTIAL TO OCEAN CHANGE

1615	**† Gold, Zachary** COMPARISON OF ENVIRONMENTAL DNA TO UNDER WATER VISUAL CENSUS METHODS ACROSS THE SOUTHERN CALIFORNIA MARINE PROTECTED AREA NETWORK	**Bignami, Sean** KELP (*MACROCYSTIS PYRIFERA*) PRESERVATION TECHNIQUE IMPACTS THE GROWTH OF JUVENILE RED ABALONE (*HALIOTIS RUFESCENS)*	**Malpica-Cruz, Luis** CAN FISHING BE A TOOL TO CONTROL MARINE INVASIVE SPECIES?	**† Konecny, Cassandra** TO FRY OR TO SAUTÉ: INNOVATION IN TIDE POOL THERMAL MANIPULATION	**† Csik, Samantha** THE EFFECTS OF TEMPERATURE ON THE PHYSIOLOGY AND FORAGING ECOLOGY OF THE CA SPINY LOBSTER (PANULIRUS INTERRUPTUS)
1630	**† Hanns, Benn** MARINE RESERVE EFFECTIVENESS AND THE NEW ZEALAND ROCK LOBSTER JASUS EDWARDSII	**Osberg, Andrew** SPONGE FORAGING PREFERENCE BY THE HAWAIIAN TIGER COWRIE AND IMPLICATIONS FOR MANAGEMENT OF INVASIVE SPONGES IN KĀNEʻOHE BAY, OʻAHU	**Lee, Lynn** COLLABORATIVE COASTAL MARINE HABITAT RESTORATION WITHIN AN INDIGENOUS CO-MANAGEMENT CONTEXT IN GWAII HAANAS, HAIDA GWAII, CANADA	**Jeppesen, Rikke** EUTROPHICATION DECREASES SALT MARSH RESILIENCE THROUGH PROLIFERATION OF ALGAL MATS	**Borras-Chavez, Renato** SPATIAL VARIATION OF ALGINATE PROPERTIES AND A NUTRITIONAL QUALITY COMPARISON OF SIX KELP SPECIES FROM THE ALEUTIAN ARCHIPELAGO
1645	**† Deith, Mairin** SAVING SPACE FOR DINNER: CAN SPATIAL RESERVES PROMOTE SUSTAINABILITY EVEN WHEN DATA ARE SCARCE?	**Szuta, Dorota** LOGS FROM THE SEA OF CORTEZ: ESTIMATING DIET PREFERENCE OF HAWKSBILL SEA TURTLES FROM FORTUITOUS FECAL FINDS	**Hixon, Mark** CReME: CORAL RESILIENCE MODULE EXPERIMENT	**† Haas, Amanda** MODELING EFFECTS OF OCEAN ACIDIFICATION ON PREDATOR-PREY DYNAMICS IN THE ROCKY INTERTIDAL ZONE	**† Becker, Danielle** INVESTIGATING THE EFFECTS OF LAND-BASED POLLUTION ON CORAL THERMAL TOLERANCE IN A BRANCHING CORAL SPECIES
1700	**† Quennessen, Victoria** ACCOUNTING FOR POPULATION DYNAMICS IMPROVES THE USE OF NO-TAKE MARINE RESERVES FOR FISHERY MANAGEMENT	**White, Crow** TRADEOFF ANALYSIS INFORMS SPATIAL PLANNING OF OFFSHORE WIND ENERGY FARMS IN RELATION TO FISHERIES AND SEABIRDS	**Eckert, Ginny** APEX PREDATORS, SEAGRASS COMMUNITY STRUCTURE, AND BLUE CARBON: ARE SEA OTTERS KEYSTONE SPECIES IN ALASKAN SEAGRASS MEADOWS?	**Gravem, Sarah** BACK TO THE FUTURE: USING A LONG-TERM DATASET TO EXPLORE WHETHER ROCKY INTERTIDAL COMMUNITY STRUCTURE IS SENSITIVE TO CLIMATIC VAR	**† Bates, Eileen** IMPACTS OF OCEAN ACIDIFICATION AND WARMING ON THE SURVIVAL AND SETTLEMENT OF LARVAL PINTO ABALONE (*HALIOTIS KAMTSCHATKANA*)
1715	**† Ramírez-Ortiz, Georgina** ARE THE MARINE PROTECTED AREAS OF THE GULF OF CALIFORNIA RESILIENT?	**† Salinas, Hugo** DYNAMIC SIMULATION OF A ZOSTERA MARINA MEADOW	**Heineke, Marcella** DRAMATIC REPRODUCTION DEFEATS EFFORTS TO ERADICATE AN INVASIVE MARINE PREDATOR	**† Dickens, John** BURN IN SHELL: USING 3-D MAPS TO PREDICT MUSSEL BED DYNAMICS WITH RISING TEMPERATURES	**† Bardou, Remi** VARIABILITY IN THE FUNDAMENTAL AND REALIZED NICHES OF MANGROVES IN BAJA CALIFORNIA
1730	**White, Will** ESTIMATING FISHERY HARVEST RATES TO ASSESS THE EFFICACY OF MARINE PROTECTED AREAS IN THE SANTA BARBARA CHANNEL ISLANDS	**Beatty, Deanna** EFFECTS OF LOCAL MANAGEMENT AND MACROALGAE ON ANTI-PATHOGEN DEFENSES OF CORALS	**† Davis, Kaleigh** THE ECOLOGY OF EELGRASS IN JAMES BAY, QC	**† DeSantiago, Ric** NATIVE DIVERSITY AND BIOSECURITY: BLACK ABALONE DECLINES SHIFTED HERBIVORE COMMUNITIES TO THOSE THAT AVOID INVASIVE SARGASSUM	**† Alma, Lindsay** DOES IT MATTER WHERE MY PARENTS GREW UP? TRANSGENERATIONAL PLASTICITY OF OLYMPIA OYSTER LARVAE

1745	**Carr, Mark** GOT CRABS? RED ROCK CRABS MIGHT JUST CONTRIBUTE TO THE RECOVERY OF CALIFORNIA KELP FORESTS	**† Stockton, Lindsey** SPATIALLY AGGRESSIVE PEYSSONNELID ALGAL CRUSTS (PAC) CONSTRAIN CORALS TO DIADEMA GRAZING HALOS ON CARIBBEAN REEFS	**Tholan, Brittany** THE BIODIVERSITY OF FISHES AT ISLAS MARIAS, MEXICO AS DETERMINED BY BAITED REMOTE UNDERWATER VIDEO	**† Arboleda-Baena, Clara** THE COMPLEX INTERACTION BETWEEN MACROORGANISMS AND BIOFILM IN THE INTERTIDAL ROCKY SHORE: TROPHIC AND NON-TROPHIC PATHWAYS	**Long, Jeremy** SEABIRD SUBSIDIES TO A “LARGE” ISLAND SHIFT THE ISOTOPIC SIGNATURE OF PLANTS, ARTHROPODS, AND RATTLESNAKES IN BAJA CALIFORNIA

SATURDAY, NOVEMBER 2, 2019

PRESIDENTIAL SYMPOSIUM (0800-1000) Ensenada 1-3

"Bridges Not Borders: Benefits of Building Across Boundaries"

0800 **INTRODUCTION** (Dr. Brian Tissot)

0810 **Sergio A. Navarrete**, *Pontificia Universidad Catolica de Chile*
The Importance of Cultural Diversity for Sustainability and the Successful Development of Inter-Disciplinary Studies

0835 **Delisse Ortiz**, *National Oceanic and Atmospheric Administration*
A Pelagic Migration: One Scientist;s Journey Across the Boundary Between Research and Management

0900 **Rodrigo Beas,** *Universidad Autonoma de Baja California*
Oceans Don't Have Borders, Our Science Shouldn't Either

0925 **Noelani Puniwai,** *University of Hawaii at Manoa*
Aloha 'Aina; The Science of Loving Place and People

1000 **COFFEE BREAK**

1030-1200 **CONTRIBUTED PAPERS** (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1200-1330 **LUNCH**

1330-1530 **CONTRIBUTED PAPERS** (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1530-1545 **BREAK**

1545-1715 **CONTRIBUTED PAPERS** (Ensenada 1, Ensenada 2, Ensenada 3, Tent 1, Tent 2)

1745-1900 **ANNUAL BUSINESS MEETING**; all welcome and encouraged (Tent 2)

1900-2100 **WSN DINNER BUFFET AND PRESIDENTIAL ADDRESS: Brian Tissot** (Terrace DEL MAR)

2100-2400 **DÍA DE MUERTOS GALA: WSN AUCTION, GAMES, MUSIC, and ENTERTAINMENT** (Terrace DEL MAR)

405

SATURDAY, NOV 2 1030-1200 † eligible for Best Student Paper Award

Time	Special Session 2: Ensenada 1 Special Session: For the Love of Fish Chair: Dovi Kacev and Kerry Nickols	Special Session 4: Ensenada 2 Kelp Ecosystem Health and Sea Star Wasting Chair: Sarah Gravem and Rietta Hohman	Session 20: Ensenada 3 Evolutionary Biology Chair: Soren Huber	Session 8: Tent 1 Behavioral Ecology Chair: Felix Loaiza, Ana Carolina	Session 26: Tent 2 Ecosystem Assessment1 Chair: Reid-Wainscoat, Elizabeth
1030	**Kacev, Dovi** ORGANOCHLORINE CONTAMINANTS AS AN ECOLOGICAL TOOL TO EXPLORE NICHE PARTITIONING IN THREE SPECIES OF PELAGIC SHARK	**Abbott, Dan** VARIATION IN THE RESPONSE OF KELP FOREST ECOSYSTEMS TO ENVIRONMENTAL STRESSORS ALONG THE COAST OF CALIFORNIA	**† Garcia, Eric** GENOMIC ANALYSIS REVEALS DRIFT AND CONVERGENT SELECTION IN DISJUNCT MARINE FISH POPULATIONS OF THE PACIFIC AND SEA OF CORTEZ	**† Felix Loaiza, Ana Carolina** EFFECTS OF INVASIVE MACROALGAE ON RED SEA URCHINS *MESOCENTROTUS FRANCISCANUS*	**Reid-Wainscoat, Elizabeth** AN ASSESSMENT OF ECOSYSTEM HEALTH AND BIODIVERSITY IN LOS ANGELES COUNTY
1045	**Galloway, Aaron** FATTY ACIDS REVEAL LARGE-SCALE GEOGRAPHIC VARIATION IN THE TROPHIC NICHE OF LINGCOD	**† Arafeh-Dalmau, Nur** EXTREME MARINE HEATWAVES ALTER KELP FOREST COMMUNITY NEAR ITS EQUATORWARD DISTRIBUTION LIMIT	**† Wright, Daniel** CORRECTING THE COUNT: SPECIES RICHNESS REVISITED IN SOUTH AFRICA'S ROCKY INTERTIDAL	**† Flood, Ashley** GUT INSTINCTS: FEEDING BEHAVIOUR OF THE SOUTHERN ROCK LOBSTER, JASUS EDWARDSII	**Pentcheff, Dean** THE LOS ANGELES URBAN OCEAN EXPEDITION 2019
1100	**Anderson, James** QUANTIFYING RESIDENCY AND SPACE USE PATTERNS AT HOTSPOT LOCATIONS IN SOUTHERN CALIFORNIA JUVENILE WHITE SHARK NURSERY AREAS	**† Eisaguirre, Jake** TROPHIC REDUNDANCY AND PREDATOR SIZE CLASS STRUCTURE DRIVE DIFFERENCES IN KELP FOREST ECOSYSTEM DYNAMICS	**† Huber, Soren** *CORALLINA OFFICINALIS VAR. CHILENSIS* (CORALLINALES RHODOPHYTA) NOT A "VARIETY" AND DISCOVERED IN BOTH HEMISPHERES	**† Jarman, Cheyenne** GUTS OR GONADS? MESO-PREDATOR CHOICE BETWEEN STARVED AND GRAVID SEA URCHINS IN BARREN AND KELP FOREST HABITATS	**† Paz-Lacavex, Andrea** HISTORICAL DYNAMICS OF KELP FOREST BLUE CABRON CAPTURE IN ENSENADA, MEXICO
1115	**† Dillon, Erin** DERMAL DENTICLE ASSEMBLAGES REVEAL SHIFTS IN SHARK COMMUNITIES ON CORAL REEFS OVER THE LAST 7000 YEARS IN PANAMA	**Gehman, Alyssa** VARIATION IN SPECIES ABUNDANCE FOLLOWING SEA STAR WASTING DISEASE OUTBREAK IN CENTRAL BRITISH COLUMBIA, CANADA.	**Crandall, Eric** THE MOLECULAR BIOGEOGRAPHY OF THE INDO-PACIFIC: TESTING HYPOTHESES WITH MULTISPECIES GENETIC PATTERNS	**† Knight, Christopher** CONSPECIFIC CUES, NOT STARVATION, MEDIATE HABITAT-SPECIFIC RESPONSES OF URCHINS TO PREDATION RISK	**† McCarthy, Orion** IDENTIFYING THE DRIVERS OF STRUCTURAL COMPLEXITY ON HAWAIIAN CORAL REEFS USING STRUCTURE FROM MOTION
1130	**Ben-Aderet, Noah** UNDERSTANDING YELLOWTAIL (*SERIOLA DORSALIS*) MOVEMENT IN THE SOUTHERN CALIFORNIA BIGHT THROUGH ACOUSTIC AND CONVENTIONAL TAGGING	**† Hamilton, Sara** NOVEL USE OF SATELLITE IMAGERY REVEALS SURPRISING POPULATION TRENDS AND ENVIRONMENTAL DRIVERS IN NEREOCYSTIS LUETKEANA (BULL KELP)	**† Bachtel, Tiffany** EFFECTS OF HYDROSTATIC PRESSURE ON THE METABOLIC ENZYMES OF CTENOPHORE SPECIES FROM DIFFERENT DEPTH HABITATS	**† McHaskell, Danielle** BLACK HARE MAGIC: FEEDING RATES OF A LARGE SEA HARE, APLYSIA VACCARIA, ON BROWN ALGAE AND EXPLORATION OF POTENTIAL DRIVERS	**† da Silva, Nicholas** IMPACT OF TWO SEAGRASS SPECIES (ZOSTERA MARINA AND RUPPIA MARITIMA) ON ESTUARINE MACROINVERTEBRATE COMMUNITY COMPOSITION

1145	**† Blincow, Kayla** ADDRESSING KNOWLEDGE GAPS IN THE ECOLOGY OF GIANT SEA BASS (STEREOLEPIS GIGAS) USING TAGGING AND STABLE ISOTOPE ANALYSES.	**Hohman, Rietta** COLLABORATIVE STRATEGIES FOR BULL KELP RESTORATION IN NORTHERN CALIFORNIA	**† Williams, Megan** EFFECTS OF INTERSPECIFIC COMPETITION BETWEEN INCREASINGLY DOMINANT PEYSSONNELID ALGAL CRUST (PAC) AND SCLERACTINIANS	**† Smith, Nicola** BIOTIC RESISTANCE THROUGH FEAR OF PREDATORS ON CARIBBEAN CORAL REEFS	**Kumagai, Joy** BRIDGING MANGROVE RESEARCH AND GOVERNMENT ACTION TO SUPPORT CARBON ABATEMENT

SATURDAY, NOV 2 1330-1530 † eligible for Best Student Paper Award

Time	Special Session 3: Ensenada 1 Special Session: For the Love of Fish, cont. Chair: Dovi Kacev and Kerry Nickols	Special Session 4: Ensenada 2 Kelp Ecosystem Health and Sea Star Wasting Chair: Rietta Hohman	Special Session 5: Ensenada 3 Biological Physical Coupling in the Coastal Zone Chair: Lydia Ladah & Gerardo Fernández	Session 25: Tent 1 Population Biology and Ecology Chair: M. Castorani	Session 9: Tent 2 Community Ecology Chair: Emily Longman
1330	**Bernardi, Giacomo** CLIPPERTON ATOLL AS A MODEL TO STUDY SMALL MARINE POPULATIONS: ENDEMISM AND THE GENOMIC CONSEQUENCES OF SMALL POPULATION SIZE	**McHugh, Tristin** INDIRECT INTERACTIONS IN NORTHERN CALIFORNIA REEFS EXPERIENCING PHASE SHIFT FROM KELP FOREST TO URCHIN BARREN	**† Maldonado, Alejandra** VERTICAL DISTRIBUTION AND ABUNDANCE OF MEROPLANKTON INSIDE AND OUTSIDE OF A KELP FOREST DURING THE INTERNAL TIDE	**† Torres, Veronica** IS SOCIALITY CORRELATED WITH PARASITE BURDEN IN ACANTHURUS TRIOSTEGUS?	**† Girard, John** ANIMAL AND ALGAL FORESTS AND THEIR INFLUENCE ON COMMUNITY COMPOSITION AND CORAL PHOTOPHYSIOLOGY IN UNDERSTORY COMMUNITIES
1345	**† Garcia-Rodriguez, Emiliano** ECOLOGY AND FISHING INTERACTIONS OF JUVENILE WHITE SHARKS IN A NURSERY AREA FROM THE MEXICAN PACIFIC COAST	**† Murie, Kindall** KELP HELP: FRAGMENTED NEREOCYSTIS LUETKEANA FORESTS ALTER SEAWATER CHEMISTRY, MITIGATING OCEAN ACIDIFICATION	**† Fernández Aldecoa, Gerardo** DISTRIBUTION AND DELIVERY OF MEROPLANKTONIC LARVAE IN THE BAY OF TODOS SANTOS: THE ROLE OF INTERNAL TIDAL WAVES AND ONSHORE	**† Nicolas Chavez, Andrea** EFFECT OF ENVIRONMENTAL CONDITIONS ON THE RELATIVE ABUNDANCE OF MANTAS (*MOBULA BIROSTRIS*) IN REVILLAGIGEDO NATIONAL PARK.	**† Longman, Emily** USING HISTORICAL DATA TO TEST WHETHER SPECIES DIVERSITY HAS DECLINED IN MUSSEL BED COMMUNITIES IN NORTHERN CALIFORNIA
1400	**Crow, Karen** HOW THE DEVIL RAY GOT ITS HORNS: THE GENETIC BASIS OF BODY PLAN REMODELING IN MANTA RAYS AND THEIR RELATIVES	**Robinson, Jonathan** ARE WE THERE YET? A COAST WIDE LOOK AT THE RECOVERY OF KEYSTONE FUNCTION TO SSWD, FIVE YEARS IN.	**† Gonzalez, Abraham** OCEANOGRAPHIC CONDITIONS EFFECTS ON THE FISH COMMUNITY IN LOS PEÑASQUITOS LAGOON IN THE LAST 30 YEARS	**† Miller, Samantha** METAGENOMIC ANALYSIS OF MYXOZOAN PARASITES FROM AMAZONIAN FISHES	**† Rempel, Hannah** ECOLOGICAL DRIVERS AND LONG-TERM IMPACTS OF PARROTFISH PREDATION ON ENDANGERED ORBICELLA ANNULARIS CORALS
1415	**Saunders, Megan** NETWORK ANALYSIS OF LONG-DISTANCE MOVEMENTS IN THE GIANT MANTA RAY, MOBULA BIROSTRIS	**Rogers-Bennett, Laura** MAKING HOLISTIC KELP FOREST ECOSYSTEM AND ABALONE RESTORATION PLANS CLIMATE SMART	**† Bauer, Kristofer** IS THIS THE PLACE? CHEMICAL AND PHYSICAL SETTLEMENT CUES UTILIZED BY BARNACLE AND MUSSEL LARVAE	**† Marquardt, Alexandria** DISTRIBUTION, ABUNDANCE, AND HABITAT ASSOCIATIONS OF PISMO CLAMS, *TIVELA STULTORUM* IN CALFORNIA	**Rhoades, Olivia** MULTISCALE SPATIO-TEMPORAL VARIABILITY IN PREDATION AND HERBIVORY: A FISHY TALE

1430	**Sosa-Nishizaki, Oscar** PLANNING FOR THE CONSERVATION OF THE WHITE SHARK (*CHARCHARODON CARCHARIAS*) IN MEXICAN WATERS: HOW ARE WE DOING?	**Sánchez-Barredo, Mariana** EXTREME LIGHT REDUCTION IN THE UNDERSTORY OF GIANT KELP FORESTS CAN ACT AS A BARRIER FOR THE INVASIVE SEAWEED *UNDARIA PINNATIFID*	**† Munson, Calvin** THE COUPLED EFFECTS OF UPWELLING AND PREDATION ON BENTHIC COMMUNITY STRUCTURE IN THE GALAPAGOS SUBTIDAL	**† Lubinsky-Jinich, Denise** PACIFIC HARBOR SEAL (*PHOCA VITULINA* RICHARDII) MOVEMENTS IN WATERS AROUND TODOS SANTOS ISLAND, ENSENADA, BAJA CALIFORNIA	**White, Wendi** SARGASSUM HORNERI INVASIONS SHIFT GRAZING ONTO NATIVE BENTHIC SEAWEEDS IN INTERTIDAL COMMUNITIES RECEIVING KELP SUBSIDIES
1445	**Caselle, Jennifer** MOBILE MARINE PREDATORS: AN UNDERSTUDIED SOURCE OF NUTRIENTS TO CORAL REEFS IN AN UNFISHED ATOLL	**Selgrath, Jennifer** SHIFTS IN DOMINANT KELP FOREST SPECIES, MONTEREY BAY, CALIFORNIA	**† Obrist, Debora** MARINE SUBSIDIES DRIVE PATTERNS IN AVIAN ISLAND BIOGEOGRAPHY	**† Klingbeil, William** MAINTENANCE OF GENETIC DIVERSITY DESPITE LARGE-SCALE DISTURBANCE SUPPORTS RESILIENCE OF GIANT KELP IN SOUTHERN CALIFORNIA	**Rogers, Tanya** ENVIRONMENTAL DRIVERS OF TOP-DOWN AND BOTTOM-UP INTERACTIONS
1500	**Larson, Shawn** CHANGES IN FISH ASSEMBLAGES IN BOTTOMFISH SURVEYS IN THE STRAIT OF JUAN DE FUCA AND PUGET SOUND 2005-2019	**† Ryznar, Emily** EVALUATING MECHANISMS FACILITATING THE INVASION SUCCESS OF SARGASSUM HORNERI AND THE RESILIENCE OF MACROCYSTIS PYRIFERA	**† Ninokawa, Aaron** VARIABILITY IN HOW HETEROTROPHIC ECOSYSTEM ENGINEERS MODIFY SEAWATER CHEMISTRY	**† Gossard, Daniel** EPIPHYTE-HOST DYNAMICS BETWEEN *PYROPIA NEREOCYSTIS* AND *NEREOCYSTIS LUETKEANA* SOUTH OF MONTEREY BAY	**Wells, Christopher** DNA METABARCODING PROVIDES INSIGHTS INTO THE DIVERSE DIET OF THE GIANT PLUMOSE ANEMONE *METRIDIUM FARCIMEN*
1515	**† Fennie, Will** PREY TELL: QUILLBACK ROCKFISH EARLY LIFE HISTORY TRAITS AFFECT SURVIVAL IN PREDATION ENCOUNTERS WITH JUVENILE COHO SALMON	**† Spiecker, Barbara** EXPLORING SPATIOTEMPORAL VARIATION IN THE STRENGTH OF EL NIÑO ON OREGON INTERTIDAL KELPS	**† Harris, Lyda** THE EFFECT OF MICROPLASTIC ON MUSSEL BIODEPOSIT SINKING AND RESUSPENSION	**Castorani, Max** DISTURBANCE, RESOURCES, AND CLIMATE INTERACTIVELY SYNCHRONIZE KELP FORESTS ACROSS SCALES	**Lonhart, Steve** MARINE HEATWAVES IN CENTRAL AND SOUTHERN CALIFORNIA FROM 2013 TO 2018

SATURDAY, NOV 2 1545-1715 † eligible for Best Student Paper Award

Time	Session 13a: Ensenada 1 Community Ecology Chair: Sarah Joy Bittick	Special Session 4: Ensenada 2 Kelp Ecosystem Health and Sea Star Wasting Chair: Sarah Gravem	Special Session 5: Ensenada 3 Biological Physical Coupling in the Coastal Zone Chair: Lydia Ladah & Gerardo Fernández	Session 30: Tent 1 Reproduction, Dispersal, and Recruitment Chair: Adreani, Mia	Special Session 1: Tent 2 Marine Metapopulations Chair: Alison Dedrick and Katrina Catalano
1545	† **Velasco, Manuel** FISH ASSEMBLAGES IN SUBTROPICAL MESOPHOTIC ECOSYSTEMS ACROSS TWO DIFFERENT ECOREGIONS	† **Morton, Dana** SOMETHING ABOUT PARASITES IN KELP FOREST FOOD WEBS	† **Panos, Demetra** COMMUNITY CONTRIBUTIONS TO BENTHIC BIOGEOCHEMISTRY IN TEMPERATE ROCKY REEFS	† **Quinlan, Zacharuy** THE INFLUENCE OF CRUSTOSE CORALLINE ALGAE BIOFILMS AND EXOMETABOLITES ON CORAL LARVAL SETTLEMENT	†**Catalano, Katrina.** QUANTIFYING THE STOCHASTIC NATURE OF LARVAL CONNECTIVITY AMONG NEARSHORE MARINE POPULATIONS
1600	**Bittick, Sarah Joy** EFFECTS OF NUTRIENT ENRICHMENT ON SEAGRASS COMMUNITY STRUCTURE	**Teague, Christopher** ABALONE AND URCHIN POPULATION CHANGES ON SHALLOW ROCKY REEFS ALONG CALIFORNIA'S NORTH COAST	**Pineda, Jesus** IDENTIFYING PROCESSES AND SCALES IN NEARSHORE LARVAL TRANSPORT FROM SETTLEMENT AND HIGH RESOLUTION PHYSICAL MEASUREMENTS	† **Park, Sara** ASSESSING LIFE HISTORY PARAMETERS OF THE PISMO CLAM *TIVELA STULTORUM* ON PISMO BEACH, CALIFORNIA	**Dinsdale, Elizabeth** GLOBAL WHALE SHARK (*RHINCODON TYPUS*) MICROBIOME
1615	† **Khen, Adi** LONG-TERM STABILITY OF PALMYRA'S CORAL REEFS OVER 10 YEARS DESPITE TWO BLEACHING EVENTS	† **Weigel, Brooke** FROM MICRO TO MACRO: BACTERIAL COMMUNITIES AND NUTRIENT CYCLING ASSOCIATED WITH BULL KELP BLADES	**Reyns, Nathalie** LARVAL ACCUMULATION AND TRANSPORT IN THE NEARSHORE	† **Estrada, Alexis** QUANTIFYING POST-SETTLEMENT RECRUITMENT OF RECOVERING ABALONE (HALIOTIS SSP.) AT SANTA CATALINA ISLAND, CALIFORNIA	**Dedrick, Allison** METAPOPULATION PERSISTENCE IN A MARINE SYSTEM: THE CLOWNFISH CASE
1630	† **McConnell, Katie** REEF MICROBIOME VARIABILITY IN THE MO'OREA ISLAND SOCIO-ECOLOGIC AL SYSTEM	† **Wetmore, Lynne** A BEHAVIORALLY MEDIATED TROPHIC CASCADE PREDICTED BY SEA STAR WASTING DISEASE IN CALIFORNIA KELP FORESTS	† **Ryder, Abigail** EELGRASS BEDS OF SAN DIEGO BAY: CARBON SINK OR SOURCE?	**Denney, Christian** LIFE ON THE EDGE: THE PHENOLOGICAL RESPONSE OF A CRITICALLY-ENDANG ERED FISH TO A RAPIDLY CHANGING CLIMATE	**Ernisse, Douglass** ISLAND LIFE: WHAT TWO MOLLUSCAN ENDEMICS ON CALIFORNIA'S CHANNEL ISLANDS REVEAL ABOUT REPRODUCTIVE CONTRASTS IN MARINE ANIMALS
1645	† **Adamczyk, Emily** TRANSPLANT EXPERIMENT REVEALS INSIGHT TO SPECIFICITY OF EELGRASS BLADE MICROBIOTA	† **Smith, Joshua** A NEW HOPE? RECOVERY OF CENTRAL CALIFORNIA KELP FORESTS FOLLOWING DESTRUCTIVE SEA URCHIN GRAZING	**Traiger, Sarah** BIOLOGICAL CONTRIBUTIONS TO BIOGEOCHEMICAL VARIABILITY OF KELP FOREST HABITATS	† **Belak, Carolyn** SPATIOTEMPORAL VARIABILITY OF ROCKFISH RECRUITMENT AND SURVIVAL ON CALIFORNIA'S NORTH COAST IN RELATION TO HABITAT AVAILABILITY	**Schiel, David** LOSS OF ECOLOGICAL INFRASTRUCTURE AND RESILIENCE OF ALGAL COMMUNITIES FOLLOWING THE MW7.8 KAIKOURA EARTHQUAKE OF 2016

1700	**†Beckley, Billie** UNDERSTANDING THE MECHANISMS LEADING TO RECRUITMENT INHIBITION OF MACROCYSTIS PYRIFERA BY OPPORTUNISTIC UNDERSTORY ALGAE	**†Gratwohl, Robin** DO PURPLE SEA URCHINS ALTER THEIR MORPHOLOGY IN RESPONSE TO VARIATION IN PREDATOR ABUNDANCE AND RESOURCE AVAILABILITY?	**Vilas Fernandez, Cesar** ECOSYSTEM FUNCTIONING OF A TEMPERATE ESTUARY AND IMPLICATIONS ON PELAGIC FISHERIES MANAGEMENT: GUADALQUIVIR LTER 1997-2019	**Adreani, Mia** REPRODUCTIVE OUTPUT AND RECENT SHIFTS IN SIZE AT MATURITY AND SEX CHANGE IN CALIFORNIA SHEEPHEAD	**†Stark, Keila** BEYOND A SINGLE PATCH: LOCAL AND REGIONAL PROCESSES EXPLAIN DIVERSITY PATTERNS IN AN EPIFAUNAL SEAGRASS METACOMMUNITY

SUNDAY, NOVEMBER 3, 2019

0800-0930 WSN Continental Breakfast (Terraza Coral)

0930-1130 CONTRIBUTED PAPERS (Ensenada 1, Ensenada 2, Ensenada 3, tent 1, tent 2)

1200-1250 SPECIAL PLENARY SPEAKER (International Ballroom)
Dr. Hector Reyes Bonilla: "Marine Research in northwest Mexico: Past, Present and Future"

1250-1300 Meeting Close (Secretariat)

SUNDAY, NOV 3 0930-1130 † eligible for Best Student Paper Award

Time	Session 21: Ensenada 1 Fisheries Ecology 2 Chair: Frances Juanes	Session 13b: Ensenada 2 Community Ecology Chair: TBD	Special Session 16-17: Ensenada 3 Conservation and restoration Chair: TBD	Session 28: Tent 1 Physiological Ecology 2 Chair: Luke Miller	Session 27: Tent 2 Ecosystem Assessment 2 Chair: B. Ruttenberg
0930	**Burnham, Theresa** CLARIFYING REGIONAL POPULATION STRUCTURE OF THE CALIFORNIA SPINY LOBSTER (PANULIRUS INTERRUPTUS)	**† Sura, Shayna** A FUNCTIONAL GROUP MODEL DEMONSTRATES KEY HERBIVORE GUILDS SHAPE THE RESILIENCE OF CORAL REEF ECOSYSTEMS	**† Bauer, Jeremy** ABALONE MARICULTURE IN BAJA CALIFORNIA: A CONSERVATION AQUACULTURE PROJECT	**Low, Natalie** VARIABLE EXPOSURE TO COASTAL HYPOXIA ACROSS THE SOUTHERN CALIFORNIA CURRENT SYSTEM	**Wetzer, Regina** WHY STOP AT THE BORDER: SPHAEROMATID ISOPODS, A CASE STUDY
0945	**† Edwards, Jessica** ECOLOGY AND SUSTAINABILITY OF A CO-MANAGED COMMERCIAL GOOSENECK BARNACLE FISHERY	**† Payan, Juan Angel** EXTREME ARID CONDITION NARROW FUNCTIONAL TRAIT IN THE MANGROVE FISH COMMUNITY IN THE GULF OF CALIFORNIA	**† Allard, Henry** LONG TERM CHANGES TO REEF FISH ASSEMBLAGES IN NEW ZEALAND'S OLDEST MARINE RESERVE, AND THE GENERALITY OF RESERVE EFFECTS	**† Wang, Jason** PHYSIOLOGICAL PROCESSES UNDERLYING FOOD CONVERSION EFFICIENCY DURING GROWTH OF SEA URCHIN LARVAE	**Uyeda, Kellie** MONITORING LONG-TERM CHANGES IN LOW MARSH VEGETATION ASSOCIATED WITH SEDIMENT ACCRETION AT THE TIJUANA ESTUARY
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1 - **†Pierce, K. M.*, Neumann, K. C., Burkepile, D. E., Zubia, M. -** MACROALGAL SPECIES RICHNESS AS AN INDICATOR OF NUTRIENT ENRICHMENT ON FRINGING REEFS IN MO'OREA, FRENCH POLYNESIA

2 - **†Green, C. K.*, Underhill, W. J. -** LAND USE CHANGE AND EUTROPHICATION IN CORAL REEF ECOSYSTEMS ON MO'OREA FRENCH POLYNESIA

3 - **Giffard-Mena, I. *, Hernández-Montiel, A. , Pérez-Robles, J. , David-True, C. -** TOTOABA MACDONALDI; A HISTORY OF SALINITY ADAPTATION, ¿OR NOT?

4 - **†Bergman, C. N.*, Hovel, K. A. -** IMPACT OF OCEAN ACIDIFICATION AND CLIMATE CHANGE ON ZOSTERA MARINA AND ASSOCIATED FAUNA

5 - **†Barton, E. M.*, Hale, T. C., Rempel, H. S., Ruttenberg, B. I. -** ECOLOGICAL DRIVERS OF PARROTFISH CORALLIVORY ACROSS THE GREATER CARIBBEAN

6 - **†Hart, C. E.*, Lanphier, K. , Shields, M. , Eckert, G. L. -** SPATIAL AND TEMPORAL VARIATION OF PARALYTIC SHELLFISH TOXICITY IN THE COMMERCIAL GEODUCK CLAM FISHERY OF SOUTHEAST ALASKA

7 - **Merolla, S. M.*, Outcalt, A. M., Ricart, A. M., Sanford, E. D., Gaylord, B. P., Hill, T. M. -** EFFECTS OF SEAGRASS ON OYSTER CALCIFICATION IN AMBIENT AND OCEAN ACIDIFICATION CONDITIONS

8 - **†Hull, W. W.*, Bourdeau, B. E. -** BREAKING AND ENTERING: DISENTANGLING MULTIPLE PREDATOR EFFECTS OF CRABS AND SEA STARS ON CALIFORNIA MUSSELS

9 - **†Ayala, G. S.*** - EPIFAUNAL COMMUNITY RECOVERY IN SAN FRANCISCO ESTUARY EELGRASS (ZOSTERA MARINA) BEDS FOLLOWING A LOW SALINITY PERIOD

10 - **†Krier, L. E.*, Kensinger, S. , Haupt, A. J., Crandall, E. D. -** LARVA ME NOW OR LARVA ME NOT: IS CAPE MENDOCINO A BARRIER TO LARVAL DISPERSAL?

11 - **†Sugano, C. S.*, Hoshijima, U. , Hofmann, G. E. -** CYCLIC, EPISODIC, AND MACROPHYTE-DRIVEN ENVIRONMENTAL VARIABILITY IN THE CONTEXT OF OCEAN GLOBAL CHANGE

12 - **†Peria, J. N.*, Pernet, B. -** TOLERANCE TO SALINITY AND THERMAL STRESS BY LARVAE AND ADULTS OF THE SERPULID ANNELID *FICOPOMATUS ENIGMATICUS*

13 - **†Schouweiler, M. D.*, Bell, L. E., Kroeker, K. J. -** EFFECTS OF PH AND TEMPERATURE ON THE EXCRETION RATE AND NUTRITIONAL QUALITY OF KELP FOREST GRAZER FECES

14 - **Bursch, H. A.*, Goodman, A. Z., Mora, M. , Moreno, I. , Kerr, E. , Baer, J. , Lima, L. F., Dinsdale, E. A. -** DOES THE INVASIVE *SARGASSUM HORNERI* AFFECT THE PHOTOSYNTHETIC CAPACITIES OF THE NATIVE *MACROCYSTIS PYRIFERA*?

15 - **†Ton, V. T.*, Hamilton, S. L. -** PACIFIC HERRING (CLUPEA PALLASII) EXPERIENCE DETRIMENTAL EFFECTS OF OCEAN ACIDIFICATION AND HYPOXIA IN EARLY LIFE STAGES

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104 - **Sanchez, M. L.*, Ridder, E. -** USING TRACK SURVEYS AND CAMERA TRAPS TO ANALYZE MAMMAL MOVEMENTS AND USAGE OF SUBURBAN WILDLIFE CORRIDORS

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107 - **†Ren, X. *, Ormiston, J. T., Favoreto Jr., S. , McConnico, L. A. -** PATHOGENIC OR OPPORTUNIST? LABYRINTHULA SPP. ASSOCIATION WITH EELGRASS (*ZOSTERA MARINA*) IN MORRO BAY ESTUARY.

108 - **†Anderson, K. A.*, Bourdeau, P. E. -** PREDATOR IDENTITY, NOT PRIOR EXPOSURE HISTORY, AFFECTS TEGULA FUNEBRALIS ANTI-PREDATOR RESPONSE

109 - **†Waite, H. R.*, Sorte, C. J. -** DOES THE APPLE REALLY NOT FALL FAR FROM THE TREE? : PARENTAL EFFECTS ON LARVAL THERMAL TOLERANCE IN THE MUSSEL, MYTILUS TROSSULUS

110 - **Saavedra, J. J.*, Jackson, J. R., DeMaria, D. , Smith, D. *, Eckert, G. , Hughes, B. B. -** TESTING THE EFFECTS OF RECOVERING SEA OTTERS ON SEAGRASS ECOSYSTEMS IN SOUTHEAST ALASKA

111 - **Avila, M. * -** KNOWING YOUR CUSTOMERS: OBSERVING VARIATION BETWEEN FISH ASSEMBLAGES AND CLIENTELE OF THE HAWAIIAN CLEANER WRASSE

112 - **†Killeen, H. J.*, Dibble, C. D., Morgan, S. G., Susner, M. G., Largier, J. L. -** SMALL-SCALE NEARSHORE FRONTS CONCENTRATE ORGANISMS AND STRUCTURE COASTAL PLANKTONIC COMMUNITIES

113 - **†Vazquez-Alfaro, D. L.*, Eernisse, D. J., Lafarga-De la Cruz, F. -** PROTOCOL FOR MOLECULAR STUDIES OF *MEGATHURA CRENULATA* (SOWERBY, 1825)

114 - **†Soto González*, E.M., Valdés, L.R.E., Enríquez Paredes, L.R. -** LOW GENETIC DIVERSITY IN THE GULF CORVINA AND ITS IMPLICATIONS ON FISHERY MANAGEMENT

115 - **†Quan, J. R.*, De Leon Sanchez, E. E., Longman, E. K., Sones, J. L., Sanford, E. -** EFFECTS OF A RECORD-BREAKING HEATWAVE ON MUSSEL BED COMMUNITIES IN NORTHERN CALIFORNIA.

116 - **Chiachi, A. E.*, Bachhuber, S. M., Menge, B. A., Raimondi, P. T., Gravem, S. A. -** POPULATION DEMOGRAPHICS AND ZONATION OF FOUR ROCKY INTERTIDAL PREDATORS FROM CENTRAL OREGON TO SOUTHERN CALIFORNIA

117 - **Kopecky, K. L.*, Stier, A. C., Schmitt, R. J. -** EFFECTS OF PREDATION AND COLONY DENSITY ON CORAL GROWTH AND SURVIVAL

118 - **Stirling, B. S.*, Anderson, J. M., Lowe, C. G. -** IMPROVEMENTS IN PASSIVE ACOUSTIC TELEMETRY MONITORING: PERFORMANCE OF ACOUSTIC RECEIVERS

119 - **†Kalan, P. *-** PACIFIC LAMPREY AS COASTAL WATERSHED QUALITY IMPROVERS

120 - **†Slein, M. A.*, Kraskura, K. , Csik, S. , Hardison, E. A., Eliason, E. J. -** UNDERSTANDING THE EFFECTS OF HYPOXIA ON THE PHYSIOLOGY AND FORAGING ECOLOGY OF PANULIRUS INTERRUPTUS (CALIFORNIA SPINY LOBSTER)

121 - **†Primo, A. *, Pruitt, J. N., Osenberg, C. W., Stier, A. C. -** INTRASPECIFIC VARIATION IN AGGRESSION DRIVES VARIATION IN MARINE SYMBIOSIS

SPECIAL TOPICS FOR CONTRIBUTED TALKS

Alongside our usual range of topics, the meeting includes sessions of contributed talks focused on the Special Topics listed below. Please see the schedule for session times and locations.

1. Understanding marine metapopulations: what progress have we made and where do we go next? [Special Session #1, Saturday 1545 - 1715, Tent 2]

Contributed by Allison Dedrick and Katrina Catalano

After much development of models and theory for marine metapopulations, advances in genetic analyses and natural tags such as otoliths have made it easier to estimate dispersal patterns and demographic rates. We now have a collection of empirical estimates of persistence metrics for marine metapopulations and are starting to be able to test marine metapopulation theory in the field. The data are time-intensive to collect, however, and moving beyond model species like sedentary reef fish (e.g. clownfish) to more mobile species and those of interest to fisheries is challenging. In this session we will consider the progress we've made in understanding marine metapopulations empirically and next steps.

2. For the love of fish: using natural history to inform conservation of fishes and sharks; a session in honor of Michele Buckhorn, Ph.D. [Special Session #2, Saturday 1030 - 1200, 1330-1530, Ensenada 1]

Contributed by Dovi Kacev and Kerry Nickols

Fishes and sharks are ecologically and economically important and are under many threats from overfishing to habitat loss and climate change. They also are captivating organisms that inspire many to pursue a career in marine biology. Many fish and shark groups are data poor and knowing the natural history of different species can be key to addressing conservation challenges. This session will honor Michele Buckhorn, her passion for conservation, and her insatiable curiosity for all things fishes and sharks. Contributions about fish or sharks in Baja (Michele's favorite place) will be especially welcome.

3. Advancements in MPA science: Applications for managing a changing ocean (paired science talks with panel discussion) [Special Session #3, Friday 1600-1800, Ensenada 1]

Contributed by Melissa Kent

There is a breadth of literature on marine protected area (MPA) benefits to coastal ecosystems and communities, which has lead, in-part, to the embrace of MPAs along the west coast of North America. What are recent advancements in MPA science that can provide a better understanding of individual and protected-area network effects, including MPAs as tools for climate change resistance and resilience? How can that science be applied to inform ocean and coastal policy and management? This special session will pair talks on advancements in MPA science with a discussion panel of west coast MPA managers, policymakers, and other experts for insight into the current science/policy/management nexus and what's next for west coast MPAs.

4. Kelp Ecosystem Health and Sea Star Wasting Disease [Special Session #4, Saturday 1030-1200, 1330-1530, 1545-1715, Ensenada 2]

Contributed by Sarah Gravem and Rietta Hohman

The health of marine ecosystems depends on the health of its species. The Sea Star Wasting Task Force and the Kelp Recovery Program are teaming up to host a WSN special session followed by a lunchtime

mixer on Kelp Ecosystem Health and Sea Star Wasting. We intend to bring kelp ecosystem and sea star scientists closer together to encourage collaboration and mutual progress. We encourage those interested to submit their abstracts for this special session during WSN registration. During the informal mixer, we will identify research and management synergies. All are welcome to attend the WSN special session and the no-host lunchtime mixer on Saturday November 2nd. Details and RSVP for the mixer TBA.

5. Biological Physical Coupling in the Coastal Zone [Special Session #5, Saturday 1330-1530, 1545-1715, Ensenada 3]

Contributed by the Lydia Ladah and Gerardo Fernández

This biological-physical coupling session will focus on research with an important physics component that links with ecological processes. All aspects of research that can link biological and physical processes are welcome, from the molecular to the ecosystem level.

6. Transboundary science: needs, challenges and opportunities [Special Session #6, Friday 1330-1530, Ensenada 2]

Contributed by Luis Malpica and the Marine Ecology, Conservation and Natural Resource Management Research Group at MexCal https://mex-cal.org/

We would like to propose a special session to present and discuss research questions that are, can or need to be answered across international borders among Canada, US and Mexico. WSN 100th meeting in Ensenada is an opportunity to shed light on subjects that are of interest to the wide WSN community along the North West, from Alaska to Baja. The idea is to discuss the needs, challenges and opportunities that exist on these broad subjects and connect researchers interested in them. If available depending on session format and time a debate, roundtable, open discussion, or other group dynamic might be suitable to further increase session impact. We consider the current political landscape calls to be proactive and create synergies to tackle research and conservation needs that permeate political boundaries.

7. Eco-evolutionary Dynamics in the Sea [Special Session #7, Friday 1330-1530, Ensenada 3]

Contributed by Gina Contolini, Joanna Griffiths, Dan Swezey

An important synthesis between the fields of ecology and evolution rests on the idea that evolutionary processes can happen on the same timescales as ecological processes, allowing the two to interact. This leads to unidirectional and bidirectional effects of ecology and evolution on one another, termed “eco-evolutionary dynamics.” This field broadly includes any approach that links genetic or phenotypic variation to population dynamics, diversity, or ecosystem function, including topics like community genetics and niche construction. While eco-evolutionary dynamics may be critically important for maintaining diversity and stability of communities, the study of the bidirectionality between ecology and evolution has largely progressed only in freshwater and terrestrial systems. It is now time to push the frontier of eco-evolutionary dynamics into the marine realm, where scientists have more recently begun to appreciate the importance of intraspecific variation for communities and ecosystems.

MexCal Guide To Restaurants close to Hotel Coral y Marina

Hotel Restaurants:

MARINA GRILL: “Located on the waterfront in the Marina, this casual restaurant and bar serves fresh seafood, crunchy shrimp, burgers and more.”

BC BISTRO & CAVA: “Savor the delightful flavors of Baja California at our award-winning restaurant, BC Bistro & Cava. Our gourmet dishes are prepared in the region’s popular “Baja-Med” style, which blends typical Mexican entrees with locally sourced Mediterranean cuisine.”

POOL BAR: “Enjoy poolside cocktails, ceviche, seafood and more at our outdoor Pool Bar.”

CAPELLA CAFE AND BISTRO: Coffee bar with breakfast and lunch options.

Walking distance:

AL HORNO (300 meters): Empanadas…

TRANSPENINSULAR (300 meters): Brewery with lunch options…

CHILTEPINOS (300 meters): Sports bar with wings and pub food.

NAUFRAGO (450 meters): Pub/brewery with Mexican food

OSHO (600 meters): Mexican breakfast and lunch

LA FLOR DE CALABAZA (700 meters): “Healthy food and juices prepared entirely from locally-produced ingredients….”

ACUEDUCTO (800 meters): Hotel Lucerna restaurant

RIVIERA PACIFIC GRILL (800 meters): Hotel Lucerna restaurant

LA AZOTEA (800 meters): Hotel Lucerna restaurant

SANOS (900 meters): Restaurant and bar…

IRISH PUB (900 meters): Pub/brewery collective with Mexican an American food

PETE´S FOOD COURT/El Ramen Bar II (1,000 meters): Ramen and Asian options

PUNTA MORRO (1,000 meters): Hotel Punta Morro restaurant

Speed Talk

* indicates presenting author

† indicates eligibility for Best Student Paper/Poster Award

Boyer, Katharyn E. [1]*, Latta, Marilyn [2]

LIVING SHORELINES: WHAT'S NEW AND WHAT'S NEXT IN SAN FRANCISCO BAY

1 - Estuary & Ocean Science Center, San Francisco State University, 2 - California State Coastal Conservancy

Living shorelines are restoration design approaches that create intertidal and subtidal habitat while achieving physical shoreline protection goals. This concept is relatively new in California where hurricanes do not drive coastal management; however, accelerating sea level rise and increased flooding and storm surges resulting from climate change have fostered a developing interest in shoreline protections solutions, especially those that are "nature-based". An initial multi-partner collaboration of researchers and managers installed the first living shorelines project in San Francisco Bay in 2012 and since then additional projects with a wide range of climate change adaptation features have been implemented. Projects have consistently included an experimental approach, which is helping to build expertise and methodologies based on sound science. Results have led to reconfiguration of shoreline features including oyster reefs and eelgrass plantings, and the testing of new subtidal and intertidal species combinations and techniques that maximize traits to enhance shoreline protection and wildlife refuge during flooding. The ultimate goal is to use these developing methodologies to protect wetlands, wildlife, and human infrastructure on a larger scale; however, there is a need to first test and better understand optimal methods, timing, and outcomes for specific nature-based site approaches.

Cavanaugh, K.C.*, Cavanaugh, K.C., Pawlak, C.C.

VARIABILITY IN THE RECOVERY OF CALIFORNIA KELP FORESTS FOLLOWING A MARINE HEATWAVE

University Of California, Los Angeles

The geographical range and abundance of canopy-forming kelp (*Macrocystis pyrifera* and *Nereocystis luetkeana*) vary through time along the California coastline. Satellite data such as Landsat and Sentinel-2 provide a platform for studying the patterns and drivers of these distribution and productivity changes across a range of spatial and temporal scales, but resolution limits inhibit the detection of small or fringing beds that may serve as refuge populations after large disturbances. However, new sources of high-resolution satellite imagery may allow for fine-scale mapping of changes in kelp abundance. Between 2014 and 2016 the coast of California experienced a marine heatwave that led to large-scale declines in kelp cover. Using long-term Landsat satellite data, we identified regions in Northern and Southern California that experienced declines in kelp cover during this disturbance. We assessed the potential for

using 3m resolution Planet imagery to monitor recovery on fine spatial scales and identify remnant, persistent kelp beds. The response of kelp to this marine heatwave varied within and between sites, demonstrating spatial variability in recovery patterns to extreme warming. While small, dispersed kelp beds have persisted in Northern California, population abundance and extent have greatly decreased across the region. Southern California kelp populations, on the other hand, showed much greater resiliency.

Delgadillo-Nuño, M.A. [1*], Carpizo-Ituarte, E.J. [1], Liñán-Cabello, M.A. [2], Justel-Diez, M. [3], Delgadillo-Nuño, E. [3], Galindo-Sanchéz, C.E. [3]

SUDDEN DECREASE IN SEAWATER TEMPERATURE INCREASES EXPRESSION OF HSP70 IN CORALS OF THE MEXICAN PACIFIC

1 - Instituto De Investigaciones Oceanológicas, Universidad Autónoma De Baja California, 2 - Acuacultura / Biotecnología, Facultad De Ciencias Marinas, Universidad De Colima, 3 - Departamento De Biotecnología Marina, Centro De Investigación Científica y De Educación Superior De Ensenada

The greatest threats corals face is the growing climate crisis. One of the major concern regarding this crisis is warming trends and coral bleaching. Response to increasing water temperatures of reef-building corals (e.g. expression of hsp genes) has been extensively studied. However, cold-water bleaching due to upwelling events and other thermal anomalies has been less documented. Nevertheless, in the Mexican Pacific and Sea of Cortez cold-water bleaching has been reported several times in the past decade, mainly during the spring season. Then, to gain insight into the response to decreased temperatures, which are more frequent in this region, we conducted prospective samplings in a small but important coral community in the Mexican Pacific during the spring season on April (2016) and February and May (2017). We observe a sudden decrease in seawater temperature (= 20 ° C) in April 2016. Although this decrease in seawater temperature was only for a few hours, one day before we observe an increase of 5, 13 and 50 fold expression of hsp70 for *Pocillopora cf. capitata*, *P. cf. verrucosa* and *P. cf. damicornis* (respectively). This finding is in addition to another study, in which an HSP60 protein modulation was observed in the coral *Seriatopora caliendrum* following both short-term heat and cold shocks in laboratory experiments. We suggest that the molecular stress response in some reef-building corals is closely related to thermal short term oscillations, whether it is heat or cold and the long term response of each species is mediated by their accumulated thermal history

Eugenio Carpizo-Ituarte [1*], Gretchen Hofmann [2], Zaul Garcia Esquivel [1]

CLIMATE-PROOFING AQUACULTURE SPECIES: A COLLABORATIVE ‘PROOF OF CONCEPT’ PROJECT ON OYSTERS

1 - Universidad Autonoma De Baja California - Instituto De Investigaciones Oceanologicas, 2 - Marine Science Institute, University Of California Santa Barbara

Global change is changing the way species are coping with the altered environment around the oceans. Motile organisms are moving out of the actual range pushed by increasing temperatures, ocean acidification and low oxygen levels among other stressors. In contrast,

sessile organisms have to cope with the changes, in place, once they settle and metamorphose. The goal of this collaborative project is to explore whether an important aquaculture species, the Pacific oyster Crassostrea gigas, can be “climate-proofed”. Conceptually, our approach relies on transgenerational plasticity (TGP) as a means to “heat harden” early-stage oysters, with the idea that such priming of the progeny via adult conditioning will result in a hardier spat and juvenile oysters in an aquaculture setting in the future. On facilities at UABC, we will condition adult oysters to high temperatures, and then test whether their progeny are more tolerant of heat stress as embryos and larvae. Experimentally, our goal is to assess the performance of the progeny using methods that assess metabolism, growth and in addition, we plan to use molecular tools where we will ask whether the thermal history of the oyster broodstock is transferred to their offspring via an epigenetic response. The latter will be performed using a methylation-sensitive polymorphism amplification (MSAP) assay developed in the lab at UCSB. The aquaculture work along with physiological measurements will be conducted at UABC.

Harley, C.D.G. [1]*, Houweling, A.E.P. [1], Dunphy, B.J. [2], Shears, N.T. [2]

DOCUMENTING LONG-TERM, WIDESPREAD DECLINES OF LARGE INTERTIDAL HERBIVORES IN NEW ZEALAND IN RELATION TO RELATIVE THERMAL TOLERANCE

1 - University Of British Columbia, 2 - University Of Auckland

Global climate change is expected to result in dramatic ecological change. Although environmental warming and other aspects of climate change have already been proceeding for decades, we often have a poor understanding of how ecosystems have already begun to respond due to a lack of baseline data or, where such data exist, a lack of adequate comparative work through time. We took advantage of extensive published and unpublished data from northeastern New Zealand dating back as far as the 1960s to establish a baseline for intertidal species abundance. We then resurveyed the same sites, using the same methods, and where possible in consultation with the original authors, in order to assess ecological change through time. We documented substantial and consistent declines in large herbivores, particularly limpets (*Cellana radians* and *C. ornata*) and chitons (*Sypharochiton pelliserpentis*), across sites. These species are now considerably less abundant than in past decades, and the median size has decreased. Other herbivores, mainly coiled gastropods and siphonarian limpets, either did not change consistently across studies or, in the case of *Nerita melanotragus*, have increased in abundance. Predatory gastropods also declined in some areas, both in terms of abundance and maximum size. Patterns of change across taxa reflect the relative thermal tolerance of these species, where *Cellana* and *Sypharochiton* are the least thermally tolerant. We predict that continued warming will drive further change, with important consequences for intertidal food webs in New Zealand.

Henry, A.K.*, Sorte, C.J.B.

RISK ASSESSMENT OF ECOLOGICAL IMPACTS BY RANGE-EXPANDING MARINE SPECIES IN NORTH AMERICA

University Of California, Irvine

As ocean conditions change, many marine species have expanded their geographic ranges to track suitable conditions. Species introduced from distant locations (non-native species) have many well-studied impacts on ecosystems, such as predation on or competition with native species or habitat modification. Range-expanding species (species with expanded ranges contiguous to native ranges), have the potential to be similarly impactful, but are less well-studied, or even considered beneficial as ecosystems adapt to climate change. In this study, we compared range-expander impacts on populations of interacting species to a comparable subset of introduced species. We used a novel application of the EICAT (Environmental Impact Classification of Alien Taxa) assessment method, the IUCN-favored approach for assessing impacts of non-native taxa, to evaluate the impacts of range-expanders. Our preliminary results based on assessment of 28 species (15 non-native, 13 range-expanding) on the coasts of North America indicate that range-expanders have comparable impacts in their new ranges to introduced species. Impacts of range-expanders may be important to consider as resource managers make decisions about prioritizing range-expanders and non-native invaders for conservation or removal.

Lafferty, K. D. [1*], Benesh, K. C. [2], Mahon, A. R. [2], Jerde, C. L. [3], Lowe, C. G. [4]

DETECTING SOUTHERN CALIFORNIA'S WHITE SHARKS WITH ENVIRONMENTAL DNA

1 - Usgs, 2 - Cmu, 3 - Ucsb, 4 - Csulb

To improve ability to detect white sharks without the need for tags, or visual census, we developed a species-specific environmental DNA (eDNA) assay that targets a 163 bp fragment of the white shark (Carcharodon carcharias) mitochondrial cytochrome B gene on a digital droplet PCR (ddPCR) platform. We used this marker to detect white shark DNA in 250 ml water samples taken from across two sites in Santa Barbara, California (United States) frequented by juvenile white sharks. We did not detect white shark DNA in samples from two neighboring sites where sharks are presumably absent, suggesting that eDNA can indicate nearby white sharks. This marker development, testing, and opportunistic application in a region with known distributions of white sharks indicates that eDNA could be developed further to monitor white sharks, thereby informing conservation planning and public safety. With the potential increase in white shark populations due to decades of protection, there is a need for fishery independent methods for assessing white shark distributions, and eDNA may provide an ideal, non-intrusive tool for coastal assessments.

Lowe, A.T. [1*], Ruesink, J.L. [2], Miller, A.W. [1]

A MODERN SYM*PH*ESIS: SCALING OCEAN ACIDIFICATION FROM LOCAL TO GLOBAL SCALES

1 - Smithsonian Marinegeo, 2 - University Of Washington, Biology

Ocean acidification hot spots. OA refugia. Are these persistent climatological phenomena or two sides of the same ecological coin? A driving hypothesis in marine ecology is that ocean acidification is a uniform, global response to increasing atmospheric carbon dioxide concentration. This hypothesis has been supported by data from open ocean habitats – where seawater pH remains static on short time scales and largely responds to long-term changes in

air-sea gas equilibrium. Observations in coastal habitats have not supported this hypothesis, and singular phenomena have been applied to correct for the difference (e.g. upwelling, river input, eutrophication). I tested an alternative hypothesis that seawater pH is a dynamic response to multiple factors acting at local scales, including the balance of photosynthesis and respiration. Using research from the Salish Sea and a cross-system experiment in seagrass and adjacent nearshore habitats, I show that incorporating local biological processes was essential to describe pH variation at scales ranging from minutes to decades, and individual to ecosystem scales. The biological effects were mediated by physical factors leading to dramatic, yet ecologically predictable, spatial and temporal patterns of pH variation. Community metabolism led to a wide range of pH, including extreme highs and lows, highlighting the dynamic nature of seawater pH in coastal habitats. This framework is flexible to fit the spectrum of aquatic habitats and has important implications for understanding the role of pH in marine ecosystems.

Neumann, K.C.*, Burkepile, D.E., La, D., Yoo, H.M.

WATER-CORERS: LOW-COST, OPEN SOURCE WATER SAMPLERS DESIGNED TO STUDY ECOSYSTEM DYNAMICS IN NOVEL WAYS AND WITH HIGH RESOLUTION

Uc Santa Barbara

Marine and freshwater flora and fauna are highly sensitive to changes in water chemistry. Even small increases in the concentrations of compounds such as nitrogen (N) and phosphorus (P) can have drastic impacts on ecosystem health and community composition. N and P concentrations in nearshore ecosystems can vary by orders of magnitude on very small temporal (hours) and spatial (meters) scales. Therefore, to fully understand the cycling, fate and impacts of chemical compounds in the marine environment, it is critical to sample at the temporal and spatial scales at which they fluctuate. The two most common methods used to collect water chemistry data, spot sampling and in-situ analyzers, are severely limited in their spatial and/or temporal resolution. Increasing the resolution of these methods requires a sizeable monetary or labor investment. In response, we developed a low-cost (~$250), open-source water sampling system that is compact, waterproof to diver-depth, and relatively easy to construct with tools available on most college campuses. In the base configuration, the sampler provides an integrated picture of water chemistry over the deployment period (up to 24 hours). The sampler's design is easily modifiable to accommodate deeper and longer deployments, or to collect a time-series. We are currently using these samplers to collect data on organism derived nutrients that would otherwise be impossible due to the disturbance caused by the presence of divers. This is just one example of the extensive potential of this system.

Stubler, Amber And Silbiger, Nyssa*, Stubler, Amber And Silbiger, Nyssa

THIS PAPER IS SIMPLY MANURE': DOWNSTREAM EFFECTS OF UNPROFESSIONAL PEER REVIEW COMMENTS AMONG INTERSECTIONAL GROUPS IN STEM

Occidental College And California State University, Northridge

The peer review process is essential for protecting the quality and integrity of scientific publications. While most reviewers and editors aim to objectively evaluate manuscripts, there

are systemic and inherent biases that creep into the peer review process and undermine both the science and the scientists. Many of the inequalities and inequities of peer review outcomes have been well-studied; however, these studies have not specifically assessed the content of the reviews, and the downstream effects that unfair, biased, and *ad hominem* comments may have on authors. In an anonymous survey of 1100 international participants in STEM (science, technology, engineering, and mathematics) fields, we investigated the pervasiveness and long-term implications of receiving unprofessional comments as an author during peer review. We specifically evaluated impacts on four intersecting categories of gender and race/ethnicity, and found that all scientists, regardless of gender or race/ethnicity receive unprofessional reviews equally. However, traditionally underrepresented groups in STEM fields are more likely to report direct, negative impacts on their scientific aptitude, productivity, and career advancement after receiving an unprofessional peer review. These results indicate that unprofessional reviews likely have and will continue to perpetuate the gap in STEM fields for traditionally underrepresented groups in the sciences.

Contributed Posters

* indicates presenting author

† indicates eligibility for Best Student Paper/Poster Award

Abadía-Cardoso, A.*, Enríquez-Paredes, L. M.

PHYLOGENETIC ANALYSIS OF THE SCIAENIDAE FAMILY FISHED IN THE GULF OF CALIFORNIA, MEXICO

Uabc

The Gulf of California is recognized worldwide for its great biological diversity and productivity. Particularly, species of Sciaenidae Family, known as curvinas or croakers, represent an ecologically and economically important group of marine fish in the Gulf of California, including the Totoaba (*Totoaba macdonaldi*), whose fishery is among the most controversial in the world in recent years. Currently, there are no conclusive studies evaluating biological diversity and phylogenetic relationships among sciaenid species in the Gulf. In this work, I use molecular markers and analyzes to document the biodiversity of species of the Sciaenidae family that are fished in the Gulf of California, and define their genetic relationships. The analysis showed six phylogenetic groups: (a) *Umbrina roncador* and *Roncador sternsii*, b) *Totoaba macdonaldi*, c) *Micropogonias* (*M. altippinis, M. megalops, M. ectenes*), d) *Atractoscion nobilis*, e) *Cynoscion* (*C. othonopterus, C. xanthulus, C. reticulatus, C. parvippinis*) and *Isopisthus remifer*, and f) *Menticirrhus* (*M. undulatus* and *M. nasus*). These results are mostly consistent with those reported in previous studies, however, the species representing group e) did not show a separation between the two genus. In contrast, the individuals analyzed intercalate and show a high identity value. This study shows how genetic methods are necessary to document and understand biological diversity which translates in effective management strategies.

Akaka, K[*], Rodrigues, J.P, Puniwai, N.

RE-EMERGENCE OF INDIGENOUS SCIENCE IN HAWAIʻI

Uh MaNoa

While traditional western sciences provide great benefit to society, observations made towards these practices reveal a disconnect between modern science and indigenous scientific understanding. Hawaiʻi is in a unique position to bridge this gap due to having the advantage of a dominant indigenous culture. There is a great potential to expand scientific understanding through indigenous methods that still remain dormant. Throughout Hawaiʻi, there has been a recent emergence of traditional ʻaina (land) based programs in science, conservation, reforestation and restoration. Through the University of Hawaiʻi, certain classes have also been tailored to the introduction and implication of these said indigenous methods. As we cultivate the implementation of indigenous sciences and practices alongside western systems, we can introduce a solution for the disconnect from traditional indigenous learning which can enhance modern scientific methodology as well as create a more efficient way of learning.

Amador, D. [1*], Reyes-Bonilla, H. [1], Jaume-Schinkel, S [2]

HISTORICAL CHANGES (2005-2017) IN THE FUNCTIONAL GROUPS OF ECHINOIDS IN THE ESPIRITU SANTO ARCHIPELAGO NATIONAL PARK, MEXICO

1 - Universidad Autónoma De Baja California Sur, 2 - Sociedad De Historia Natural Niparajá

Echinoids are among the most abundant macroinvertebrates in coral and rocky reefs of the Gulf of California, and they play an important role within these ecosystems due to their regulatory role in marine communities. In tropical reefs echinoids feeding on macroalgae is avoid the phase shift phenomenon and favor to bioerosion high rates. The objective of this study was to observe changes of functional diversity of Echinoidea at Espiritu Santo Archipelago National Park from 2005 to 2017, using data from the official monitoring program of the marine protected area. To determine species richness and abundance, census of sea urchins were conducted in belt transects 30 x 2 m, and these data were combined with a series of 13 not correlated morphological traits of the 6 observed species, to define morphofunctional diversity at each transect. The results showed statistically significant differences for abundance, and functional richness, evenness and diversity in the years 2015, 2016 and 2017 in relation to 2006 and 2007, being lower in recent years. Although urchin abundance was higher in 2007. Also, the temporal trend obtained by a linear regression showed a decrease in the index. The pattern of sea urchin decrease has previously been detected in marine protected areas, and results from an increase in the biomass of predatory fish when regulation of fishing activities is implemented, and due to trophic cascade effects they regulate and decrease the echinoids community. Under this view, the protection of species of carnivorous fish has negatively affected the invertebrate fauna

Anderson, K.A. [1*], Bourdeau, P.E. [2]

PREDATOR IDENTITY, NOT PRIOR EXPOSURE HISTORY, AFFECTS TEGULA FUNEBRALIS ANTI-PREDATOR RESPONSE

1 - Humboldt State University And California Polytechnic State University San Luis Obispo, 2 - Humboldt State University

Predators in the rocky intertidal can regulate prey behavior, which ultimately affects community structure. Although predators do not always consume prey, they can elicit non-consumptive effects (NCEs), as prey change behaviors to avoid predators, and allocate resources to defend against predation. By spending more time avoiding predators, prey spend less time foraging, which impacts basal resources, known as trait-mediated indirect interactions (TMIIs). Prey populations that experience greater predation pressure should have stronger NCEs and TMIIs, a hypothesis I tested with *Tegula funebralis*, which are known to respond behaviorally to their primary predators, including *Pisaster ochraceus*, *Romaleon antennarium*, and *Octopus rubescens*. I collected snails from four different populations (Belinda Point, Fort Bragg; Devil's Gate, Cape Mendocino; Baker Beach, Trinidad; and Pt. St. George, Crescent City) which all vary in abundances of *Tegula's* main predators. Over a 28-day experiment, I measured avoidance behavior, shell growth, and total growth to measure NCEs, and kelp consumption to measure TMIIs. I observed significant behavioral differences between treatments, however, I did not observe any significant growth differences between treatments. Finally, I observed a significant difference in kelp consumption among sites, with *Pisaster* cue treatment being the only treatment eliciting significantly lower feeding rates at all sites. Overall, I found that *Pisaster*, regardless of *Tegula* source population, are the only predator that induces NCEs and TMIIs.

Avila, Mariel*

KNOWING YOUR CUSTOMERS: OBSERVING VARIATION BETWEEN FISH ASSEMBLAGES AND CLIENTELE OF THE HAWAIIAN CLEANER WRASSE

Sfsu

In nature, certain animals within assemblages provide especially vital roles in the overall health of the community. Cleaning symbiosis has many benefits for both client and cleaner. The Hawaiian cleaner wrasse, Labroides phthirophagus , is an endemic species with little known about their ecological roles compared to others obligate cleaners. Other studies showed they had preference towards some species, but these results were found in aquaria. Through various observations of what species being clean and running transects for sites abundance, we get to compare whether they have a preference. The results show that Hawaiian cleaner wrasse does have a preference on who they clean. Cleaning organisms have specialization on how and what is being cleaned. Observing these individuals led to finding behavioral patterns that could be helpful on helping further research to better understand their ecological role and impact on their habitats.

Ayala, G.S.*

EPIFAUNAL COMMUNITY RECOVERY IN SAN FRANCISCO ESTUARY EELGRASS (ZOSTERA MARINA) BEDS FOLLOWING A LOW SALINITY PERIOD

San Francisco State University

Severe weather events are predicted to increase in intensity and frequency in the future, and their effects on community composition and functioning in estuaries is poorly understood. The

San Francisco Estuary (SFE) experienced a historically wet winter in 2017 when heavy rainfall reduced surface salinities drastically for several months, but the impact of this extended period of low salinity on organisms in the shallow subtidal region of the central bay is unknown. Eelgrass (*Zostera marina*) is an important habitat-forming species worldwide, hosting a diverse community of epifaunal invertebrates. I conducted quarterly surveys in six SFE eelgrass beds beginning in July 2017 to quantify shoot density, epiphyte biomass, invertebrate community composition, sediment characteristics, and other factors. Following the low-salinity period, I observed large changes in the invertebrate community compared to pre-2017 data, including the disappearance of two key native species, Taylor's sea hare (*Phylapllysia taylori*) and the isopod *Pentidotea resecata*. These ecologically important species feed on eelgrass epiphytes, increasing light availability to eelgrass and linking primary production to higher trophic levels. At the same time multiple invasive invertebrates became abundant. These findings reinforce a need to understand weather-related shifts in epifaunal community composition and distribution, as these may critically affect the conservation of critical foundational habitats, especially as climate changes intensify.

Barton, E.M.*, Hale, T.C., Rempel, H.S., Ruttenberg, B.I.

ECOLOGICAL DRIVERS OF PARROTFISH CORALLIVORY ACROSS THE GREATER CARIBBEAN

Cal Poly Slo

Parrotfishes are important herbivores that indirectly facilitate coral recruitment and growth by grazing algae on coral reefs. However, some species of parrotfishes also prey on coral, which can cause partial to total mortality, and reduce growth and reproduction of corals. The ecological drivers of parrotfish corallivory and the degree to which parrotfish scale back the predation intensity on corals in response to changes in reef community composition remain poorly understood. The objective of this study is to compare the intensity of parrotfish predation on reef-building corals across a gradient of parrotfish biomass, algae cover and coral cover on reefs in St. Croix and Bonaire. At each site, we surveyed: (1) parrotfish biomass and species composition, (2) the abundance and size distribution of bite scars on coral colonies in relation to coral species and size, and (3) percent cover of coral, algae and other food items targeted by parrotfish. We used a linear mixed effects model to compare the intensity of parrotfish predation on corals in response to differences in parrotfish biomass, algae cover and coral cover. Additionally, we compared patterns of predation at the coral-species level. We found that the intensity of parrotfish corallivory varied regionally and with a number of local factors. This analysis improves our understanding of how changes in coral reef community composition on increasingly impacted reefs alters the intensity of parrotfish corallivory, as well as species-specific differences in corallivory rates.

Bell, L.E.*, Kroeker, K.J.

EFFECT OF SPAWN SUBSTRATE ON PACIFIC HERRING ROE DEVELOPMENT UNDER PROJECTED OCEAN ACIDIFICATION AND WARMING

University Of California Santa Cruz

Our ability to predict the emergent effects of climate change on vulnerable life stages of marine species requires information about environmental heterogeneity as well as potential refuge habitats. In the Gulf of Alaska, Pacific herring (*Clupea pallasii*) deposit adhesive eggs on a variety of marine vegetation during their spring spawn, where the fertilized roe develops until hatching. Many photosynthesizing species used as spawn substrates can modify the pH of their boundary layer environments during local drawdown of inorganic carbon. The goal of this experiment was to investigate whether a photosynthesizing spawn substrate can mitigate the effects of elevated pCO_2 and temperature on embryonic development and condition of newly hatched Pacific herring. We raised roe on either *Macrocystis pyrifera* blades or silicone strips under a factorial cross of current spring temperature and pH (pH 7.8, 7°C) and projected end-of-century (pH 7.5, 11°C) conditions in Sitka Sound, AK. Preliminary results indicate that effects of temperature are more pronounced than pH, with warmer temperatures increasing egg respiration and negatively affecting the nutritional status of larvae at hatch. Eggs fertilized on giant kelp blades experienced significantly lower fertilization success than eggs on non-photosynthesizing silicone; however, further assessment of substrate effects were complicated by poor retention of eggs on the blades. The findings of this study inform the developmental vulnerability of this culturally and economically important forage fish species in a changing North Pacific.

Berger, A.N*, Clark, C.J.

TO SING IN TWO WAYS A ‘TAIL’ OF CONVERGING ACOUSTIC MATING DISPLAYS

University Of California, Riverside

Male Anna’s and Costa’s Hummingbirds *(Calypte anna* and *C. costae*) produce acoustic mating signals both with tail feathers, and vocally with the syrinx. These signals converge in form– the vocalizations of each species acoustically resemble sounds of their own dive displays. The vocal signals are produced as a static display in which the male does not move with respect to the female, whereas the dive display signals are produced when the male’s dive velocity causes a Doppler shift in frequency by up to 8%. Since the male does not hear the effect of the Doppler shift, the sound that they produce is perceived differently by the recipients than by the male transmitters. I compare temporal and frequency characteristics between recorded dives, and songs characterizing the degree of temporal and frequency correspondence between these sounds to determine whether or not the male vocalizations suggest or mimic the Doppler shifted version of his dive sound. The results of these analyses imply novel questions in the evolution of auditory mating displays.

Bergman, C.N [1*], Hovel, K.A [2]

IMPACT OF OCEAN ACIDIFICATION AND CLIMATE CHANGE ON ZOSTERA MARINA AND ASSOCIATED FAUNA

1 - Ms., 2 - Dr.

Increasing input of carbon dioxide (CO2) into the oceans elevates seawater temperatures and lowers pH. These changes may have profound effects on seagrasses due their narrow thermal tolerances and carbon limitation. We tested how elevated temperature and carbon dioxide affect

(1) the growth of eelgrass (*Zostera marina*), (2) the growth of epiphytic algae that competes with eelgrass, and (3) the ability a crustacean herbivore (the grass shrimp *Hippolyte californiensis*) to graze on epiphytic algae. We factorially varied temperature (ambient vs. elevated), CO2 (ambient vs. elevated, based on IPCC predictions), and the presence of grass shrimp in laboratory mesocosms. Trends across all of the trials show that elevated CO2 increased epiphyte growth, while elevated temperature decreased eelgrass growth. We did not find a negative correlation between epiphyte growth and eelgrass growth. Grazing impact by *H. californiensis* was driven by the combination of increased temperature and elevated CO2 levels. Increased temperature appears to lower grazing rates compared to ambient temperature conditions, but the negative effect of elevated temperature on grazing impact was lessened by elevated CO2 levels, suggesting that elevated CO2 may mitigate detrimental effects of warming water on herbivory. However, this effect was reduced under high ambient seawater temperatures, suggesting a temperature threshold for the system. Our results suggest that interactive effects of different stressors should be evaluated and that the impact of climate change on eelgrass communities may be complex.

Bierzychudek, A.T. [1*], Uyeda, K [2], Greer, K [1], Crooks, J [3]

USING HISTORICAL AERIAL PHOTOGRAPHS TO DETERMINE LONG-TERM IMPACTS OF ANTHROPOGENIC FRESHWATER RUNOFF ON LOS PEÑASQUITOS LAGOON

1 - Tijuana River National Estuarine Research Reserve, 2 - San Diego Association Of Governments

Many areas of northern San Diego County experienced a population boom in the later part of the 20th century. This increase in population resulted in the urbanization of watersheds. As the landscape of these watersheds changed, so too did the coastal ecosystems they fed. Analyses in one-sub watershed of Los Peñasquitos Lagoon through 1999 revealed that this anthropogenic input resulted in marine-associated habitats being replaced by those associated with freshwater. Our current work extends the spatial and temporal coverage of freshwater input and habitat change in the lagoon. Vegetation within the other two sub-watersheds was mapped from 1986-2018 using aerial images and historical data. This was then analyzed for change in relation to urbanization as determined from San Diego Association of Government Land Use mapping. A shift from saltwater-associated vegetation to freshwater-associated vegetation continues to suggest decreasing salinity in the upper lagoon, and this increased freshwater correlates with increasing urbanization within the watersheds. The change in this vegetation has the potential to impact the fauna within the lagoon and change how the ecosystem, as a whole, functions.

Bogan, S.N. [1*], Kozal, L.C. [1], Meneses, M.J. [1], Albrecht, A.M. [2], Hofmann, G.E. [1]

ECO-EVOLUTIONARY AND MOLECULAR UNDERPINNINGS OF PLASTICITY IN THERMAL TOLERANCE AMONG POPULATIONS OF TIGRIOPUS CALIFORNICUS

1 - University Of California Santa Barbara, Department Of Ecology, Evolution And Marine Biology, 2 - Vassar College, Department Of Biology

Physiological plasticity is a key component of long-term acclimation to environmental change and can vary within a species for a given trait. However, the ecological and evolutionary processes that contribute to variation in physiological plasticity are poorly understood. Here, we used the intertidal copepod *Tigriopus californicus* as a system for examining intraspecific variation in plasticity. Developmental plasticity in thermal tolerance among populations of *T. californicus* is negatively correlated with latitude across North America's Pacific coast, increasing in southern populations that are adapted to warmer temperatures. By tracking thermal tolerance in different populations over time and rearing multiple generations under a common garden, we found evidence of *in situ* variation in the plasticity of thermal tolerance between northern and southern populations of *T. californicus* experiencing similar rates of seasonal warming. We measured additional traits associated with thermal physiology and found that sex-specific differences in mature body size and respiratory rate under temperature stress increased at higher latitudes. Our results suggest that distinct eco-evolutionary processes may differentially contribute to variation in thermal tolerance between southern and northern populations of *T. californicus*. Moving forward, we are broadening the scope of this study to (i) increase its resolution of time and biogeography and (ii) investigate the relationship between epigenetic variation in DNA methylation and plasticity.

Boone, X.K. [1]*, Ritger, A [2], Stier, A [2]

URCHIN STARVATION STATE MAY AMPLIFY THE POSITIVE INTERACTION BETWEEN CORYNACTIS CALIFORNICA AND MACROALGAE

1 - University Of California, Davis, 2 - University Of California, Santa Barbara

Associational refuges provide a critical defense to organisms under high herbivory stress and are important in determining community structure. There is little known about how the physiological state of the herbivores involved influences such interactions, and there are limited studies concerning the refuge provided by strawberry anemones (*Corynactis californica*) to macroalgae from benthic grazers. In this study, we analyzed how starvation state of purple urchins (*Stronglyocentrotus purpuratus*) affects the ability of *C. californica* to deter urchins from foraging. We found that the effect of *C. californica* on kelp consumption by fed urchins is not significant ($P = 0.4721$), yet there is a trend ($P < 0.07$) among starved urchins, which on average, eat 10% less kelp in the presence of C. californica. In addition, we found that, on average, starved urchins interact with the C. californica significantly less frequently, ($P < 0.001$) and are deterred from foraging significantly more ($P < 0.01$) than their fed counterparts. Our findings suggest that starvation of the urchins amplifies the deterrent effect of *C. californica*, highlighting the importance of environmental context when determining the outcome of positive interactions.

Boudinot, K.*, Dimarco, D.

PURIFICATION AND ANALYSIS OF MICROPLASTICS

Seattle University

Microplastics are widespread aquatic pollutants that contaminate waterways and originate from human sources, such as packaging or cosmetics. They are manufactured plastics (primary), or

environmentally degraded plastics (secondary), that are smaller than 5.0mm. Concerns about the potential impacts of microplastics, through chemical pollutant absorption, marine organism ingestion, and biomagnification indicate the importance of further investigation into the presence and types of microplastics in the Puget Sound. An initial visual analysis used light microscopy to identify plastics and suggested their presence in sediment and surface water. An improved plastic extraction method and chemical analysis procedure was developed. Samples were filtered through a series of sieves and vacuum filters followed by an adapted enzymatic digestion by proteinase-K in SDS, and density separated using zinc chloride prior to ATR FT-IR analysis. Spectra from these various locations were then analyzed to determine microplastic type. This filtration method paired with ATR FT-IR analysis is an efficient method that avoids plastic degradation and bias of manual sorting, and aids in the identification of microplastic polymers. This allows for increased confidence when making comparisons between identified microplastics.

Boudinot, K.*, Dimarco, D.

PURIFICATION AND ANALYSIS OF MICROPLASTICS

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Buchbinder, M.V.*, Patten, M.V., Boyer, K.E.

LIVING SHORELINES IN SAN FRANCISCO BAY: EARLY LESSONS FROM EELGRASS RESTORATION

Estuary & Ocean Science Center, San Francisco State University

Living shorelines projects (LSPs) seek to create biologically rich and diverse subtidal and low intertidal habitats that restore ecological function while protecting shorelines. The Giant Marsh LSP on the Richmond shoreline of San Francisco Bay (Point Pinole Regional Park) is a multi-partner collaboration building on lessons learned from a previous LSP sited across the bay in San Rafael. The project incorporates an experimental design in which eelgrass (*Zostera*

marina) has been planted alone and either bayward or shoreward of native oyster substrate (reef balls topped with Pacific shell bags), which was shown in San Rafael to attenuate flow by up to 30%. The experiment also addresses whether the density of plantings affects success of eelgrass establishment. Oyster reefs were installed in April 2019, and eelgrass was planted in two periods in May and June 2019. A heat wave that occurred right after the second period led to high mortality of transplants from that period. Thus, early monitoring results show the importance of planting date over our other experimental manipulations on initial eelgrass establishment. Supplemental planting early in spring 2020 will re-create our planned treatments and permit evaluation of their effects over time, including on related functions and services such as fish and invertebrate habitat, ocean acidification, and carbon storage. In the meantime, these results contribute to our developing understanding that increasing occurrences of heat waves and other climate-related stresses must be central to restoration planning and execution.

Burch, B. [1*] **, Sabety, J.** [2] **, Diesel, J.** [3] **, Deweese, K.** [3] **, Nuzhdin, S.** [3]

INVESTIGATING THE INFLUENCE OF PYTOHORMONES ON THE GROWTH OF MACROCYSTIS PYRIFERA

1 - Temple University, 2 - University Of California, Davis, 3 - University Of Southern California

This research explores the effects that four phytohormones have on *Macrocystis pyrifera* (giant kelp), a commercially important organism used as a food source and as animal feed. Phytohormones are chemical molecules produced in plants that control growth and development, they are used extensively in agriculture to manage crops and increase crop yields. Despite being grown commercially for decades, there has been little research conducted into the effect that phytohormones have on giant kelp. As the demand for kelp grows, investigating the potential for decreasing production time and increasing yield will be essential to helping this industry. Macrocystis apical meristems were grown in water containing four phytohormones present in both plants and algae: auxin, cytokinin, gibberellin, and abscisic acid. Over four weeks both size and physiology (length, width, etc) were measured in order to determine how these hormones influence kelp growth. In the future, the knowledge gained from this experiment may be applied in commercial aquaculture of Macrocystis pyrifera in order to make it more efficient and perhaps more cost effective.

Bursch, H.A.*, Goodman, A.Z., Mora, M., Moreno, I., Kerr, E., Baer, J., Lima, L.F.O., Dinsdale, E.A.

DOES THE INVASIVE *SARGASSUM HORNERI* AFFECT THE PHOTOSYNTHETIC CAPACITIES OF THE NATIVE *MACROCYSTIS PYRIFERA*?

San Diego State University

The invasive alga *Sargassum horneri* has been challenging *Macrocystis pyrifera* (kelp) for benthic space along California coastline, particularly on Santa Catalina Island. Major drivers contributing to the competitive advantage of Sargassum over kelp remain unknown. In this study, we investigated if kelp has a lower photochemical efficiency when directly interacting with Sargassum. We measured the maximum photochemical efficiency of PSII (Fv/Fm) on dark-acclimated tissue of both species via pulse-amplitude modulated fluorometry. Along

benthic transect surveys, blades were collected from both species. We collected our samples from two sites that exhibited species interaction, and one site exhibiting complete cover by Sargassum. Our results indicated that Sargassum was significantly more abundant at the Intake Pipes site (ANOVA; $p<0.01$), and that kelp was significantly more abundant at the Chalk Cove site (ANOVA; $p<0.02$). At the Cherry Cove site, benthic cover was exclusively Sargassum. Photochemical efficiency remained high in both species (Fv/Fm: 0.767 +/- 0.008) when interacting but was significantly lower at the Sargassum exclusive site Cherry Cove (ANOVA; $p<0.01$) and associated with algal senescence. Therefore, Sargassum is not negatively affecting the photochemical efficiency of kelp at sites of interaction, and the longevity of Sargassum may be increased in the presence of kelp. The ability of Sargassum to exclude kelp is not associated with the loss of photosynthetic capacity of the adults.

Cates R.J. [1*], Domke, L. [1], Raymond, W.W. [1], Eckert, G.L. [1], Noel, B. [2], Waldschmidt, A. [2]

GOOD EATING: CRAB ABUNDANCE AND SIZE DISTRIBUTION ALONG A SEA OTTER GRADIENT IN SOUTHEAST ALASKA

1 - University Of Alaska-Fairbanks, 2 - University Of Alaska Southeast

Once locally extinct in Southeast Alaska, sea otters (Enhydra lutris) were reintroduced in the 1960s creating a natural experiment in which sea otters gradually recolonized, with resultant decreases in shellfish important for commercial and subsistence fisheries. Crabs are highly vulnerable to sea otter predation, and Dungeness crab (Metacarcinus magister) is an essential resource to fisheries and communities in Southeast Alaska. To date trophic linkages among sea otters, eelgrass communities and intermediate predators like crabs result in indirect positive effects on eelgrass mediated through sea otter predation on crabs. Through investigation of crab abundance along a sea otter gradient from 2017-2019, we find that crab abundance and size distribution decreases with increasing sea otter occupation. Larger crabs are completely absent in the presence of sea otters, but interestingly the diversity of crab species increases in the presence of sea otters. Our future studies will examine variation in recruitment as well as explore species interactions among crab species along this sea otter gradient. By developing a baseline of crab abundance and identifying size and abundance changes over time, we can further analyze the relationship between crabs and sea otters within this trophic cascade, with the ultimate goal to support ecosystem based management that may account for the coexistence of sea otters and fisheries.

Charendoff, Ja [1*], Edwards, Cb [1], Pedersen, N [1], Petrovic, V [2], Zgliczynski, B [1], Sandin, Sa [1], Smith, Je [1]

EVIDENCE FOR PARROTFISH_MEDIATED BENTHIC SUCCESSION TOWARDS REEF CALCIFIERS ON PALMYRA ATOLL USING LARGE-AREA IMAGERY

1 - Scripps Institution Of Oceanography, 2 - California Institute For Telecommunications And Information Technology, Uc San Diego

Parrotfish in select trophic guilds leave scars on reef structures thought to create valuable open space for recruitment and growth of benthic organisms. While prior studies have attempted to quantify the role of parrotfish grazing scars in reef communities in the short-term (days/weeks

after grazing events), benthic succession towards calcifying organisms can take months to years. Here, we assess the benthic succession of parrotfish bite scars across the reefs of Palmyra Atoll. We used a large-area imaging technique to create 3D models using Structure from Motion to virtually archive reef communities, and considered benthic change between September 2015 and September 2016. Across 4 200m2 reef plots, over 2000 parrotfish bite scars were identified and mapped onto the benthos so that the surrounding benthic cover could be identified to the nearest functional group. Mapped bite scars were re-identified in the subsequent time points, and the benthic composition of those areas were identified to functional group. Within the bite scars, crustose coralline algae (CCA) increased on average by 11.5% with a corresponding decrease in percent cover of turf algae. While coral recruits have been shown to prefer CCA as a settlement substrate, only one coral recruit was observed to settle on bite scar spaces across the duration of this study. Feeding selectivity of parrotfish bite scars showed highest preference for turf and calcified macroalgae. Understanding the fate of these bite scars can give important insight into the role of parrotfish in the present and future of reef recovery.

Chiachi, A.E. [1*], Bachhuber, S.M. [1], Menge, B.A. [1], Raimondi, P.T. [2], Gravem, S.A. [1]

POPULATION DEMOGRAPHICS AND ZONATION OF FOUR ROCKY INTERTIDAL PREDATORS FROM CENTRAL OREGON TO SOUTHERN CALIFORNIA

1 - Oregon State University, 2 - University Of California, Santa Cruz

Climate change has already begun to alter population and species' ranges. Current patterns in latitudinal ranges, demography, and vertical distributions of intertidal species can provide insight for future responses to climate change and sea level rise. In this study, we aimed to better understand population demographics and latitudinal shifts in vertical intertidal distribution of four predator species (*Nucella canaliculata*, *Nucella ostrina*, *Pisaster ochraceus*, and *Leptasterias spp.*) at 33 sites from central Oregon to Los Angeles County. We analyzed whether densities, mean and maximum sizes, size distributions, and vertical distributions varied by site and latitude in 2018. The densities of all four species were higher in Oregon than in California, which was driven by a high abundance of juveniles in three out of four of our species. This suggests that Oregon populations have higher rates of reproduction, may have higher survival rates, and thus may be more resilient to rapid changes than California populations. However, toward southern latitudes, the maximum size of both *Nucella* species increase, which may be due to decreased direct and indirect competition at southern sites. We also compared vertical distributions and within-species size distributions in the zone they inhabit. This detailed inventory of size-specific zonation and latitudinal distribution enables us to establish a baseline understanding of intertidal species distribution and to investigate and predict the response of predator populations as the climate warms and sea levels rise.

Clark, N.M.[*], Maietta, E.G., Marquardt, A.R., Ruttenberg, B.I.

AGE AND GROWTH OF THE PISMO CLAM (*TIVELA STULTORUM*) IN CALIFORNIA

California Polytechnic State University

Pismo clams (*Tivela stultorum*) are an iconic fishery species in California which once supported a thriving commercial and recreational fishery. However, this species has suffered from

overharvest and a shortage of fisheries management relevant data, contributing to a collapse of the commercial fishery and substantial reduction in recreational landings. One key parameter incorporated into shellfish stock assessment models is a growth curve derived from the age/length relationship. Our study aims to elucidate the relationship between age and length of Pismo clams within their range in California. Additionally, we investigated whether there were spatial differences in the length/age relationship from clams north of Point Conception relative to south of Point Conception. We collected clams at sites north of Point Conception and sites south of Point Conception during 2018-2019. We measured the length of each individual clam and determined age by counting annual growth rings. We developed a statewide growth curve using the age/length data from Pismo clams collecting north and south of Point Conception. Additionally, we assessed whether there are spatial differences in growth curves between clams north of Point Conception relative to clams south of Point Conception. Collectively, these data may be used to improve stock assessments and guide resource management decisions for this socioeconomically important species.

Cohn, B.C.*, Nickols, K.J.

EFFECTS OF AN EPIPHYTIC BRYOZOAN ON THE GROWTH AND PHOTOSYNTHETIC PRODUCTION OF THE GIANT KELP MACROCYSTIS PYRIFERA

California State University, Northridge

Giant kelps of temperate coastal regions are among the most productive marine macrophytes and play an important role in the blue carbon cycle. *Macrocystis pyrifera* is the dominant kelp species on the North American Pacific coast. Encrusting bryozoans of the genus *Membranipora* are a common epiphyte throughout *M. pyrifera's* range and form a crustose, opaque layer on kelp blades. Reduction of incident light by this layer may negatively affect photosynthesis thus reducing primary production. This could have implications for kelp growth and surface water chemistry within kelp forests. Effects of bryozoan encrustation on primary production were measured using *in situ* growth surveys and photosynthesis/respiration (P/R) trials from June–August, 2019 in Monterey, CA. Tagged surface blades were measured weekly using a hole-punch method. P/R trials were conducted during the day and night with blades of varying levels of bryozoans inside sealed plastic bags with an oxygen probe. Growth surveys revealed that most blades were no longer growing by the time they were colonized by bryozoans, but encrusted blades showed a slightly higher decline in blade length. Unencrusted blades showed marginally significant higher rates of daytime O_2 production ($F_{1,14} = 4.78$, $p = 0.046$). Recent studies have shown a positive correlation between warming ocean temperatures, recruitment of *Membranipora*, and deforestation of kelp beds. As the oceans continue to warm, outbreaks of this bryozoan could be detrimental to kelp forests and the ecosystem services they provide.

Cooper, A. A.*, Lewis, L. S., Willmes, M., Hobbs, J.A.

BABIES ON BABIES: EVIDENCE FOR MULTIPLE BROODS AND EARLY GAMETIC PRODUCTION IN THE THREATENED LONGFIN SMELT

University Of California, Davis

Longfin Smelt were once an abundant native species of commercial and ecological significance in the San Francisco Estuary (SFE). Over the last 50 years, this distinct population has collapsed to less than 1% of its historic abundance, and a gap in our understanding of their population biology is likely limiting our ability to identify causes of decline. Longfin Smelt are believed to have a 2-year semelparous (single spawning) life history strategy; however, detailed studies of Longfin reproductive biology are limited. Determining maturation, batch fecundity, and lifetime fecundity is likely critical to understanding population dynamics and informing conservation. Here, we collected adult Longfin Smelt from South San Francisco Bay during the 2018-2019 winter spawning season and assessed gonad development (gonadosomatic index, GSI) and egg development (stage) as functions of length. Observations of GSI indicated that gonad development may occur in individuals at younger ages or smaller sizes than previously thought, and microscopy of eggs revealed instances of two distinct developmental stages of eggs within individual gonads. Earlier reproductive maturity and greater lifetime fecundity have implications for the population's ability to rebound and thus remain important considerations for further studies to inform and enhance conservation efforts for this threatened species.

Dale, K.E.[*], Mehta, R.S., Tinker, M.T.

PREDICTING SPATIO-TEMPORAL SHIFTS IN LARVAL FISH ABUNDANCE IN THE EASTERN PACIFIC USING HIERARCHICAL MODELING

University Of California, Santa Cruz

For many marine fishes, dispersal occurs via a planktonic larval form that resides in the surface layer of the ocean for a period of days to months before moving to juvenile habitats. Dispersal of larvae is influenced by environmental factors (e.g., climate oscillations, temperature, and currents) as well as biotic factors (e.g., pelagic larval duration time, feeding behavior, and swimming ability). Few studies have utilized long-term, spatially-explicit models to examine factors driving larval distributions across years. Yet developing predictive frameworks and integrating multiple stressors in a spatial context has been cited as an important area for future research. Spatial data in the form of larval fish catch data presents additional sources of sampling error, observation error, and spatial autocorrelation that can be difficult to account for in traditional analytical approaches. However, Bayesian methods can easily incorporate error and correct for autocorrelation while still providing estimates on actual parameter values that can be used for predicting larval abundances at a specific point in space and time. Here, we present preliminary results from a hierarchical, Eulerian-framed Bayesian model that combines long-term empirical CalCOFI catch data with environmental and biotic data to identify how larval distributions vary in space and time from southern Baja to southern California from 1951-2019. We focus our efforts on a few target species which vary in pelagic larval duration.

Delgadillo-Anguiano, C. [1*], Lafarga-De La Cruz, F. [2], Lorda, J. [1], Abadía-Cardoso, A. [1]

EVALUATION OF CANDIDATUS XENOHALIOTIS CALIFORNIENSIS (CXC) AND ITS ASSOCIATED PHAGE PCXC IN BLACK ABALONE OF BAJA CALIFORNIA

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Candidatus Xenohaliotis californiensis (*C*Xc) is a parasitic gastrointestinal bacterium that causes a chronic disease known as Withering Syndrome (WS) in abalone. This disease can cause atrophy of the foot muscle and digestive gland degeneration, which prevents nutrient absorption during feeding, causing the death of its host. The WS was first detected in black abalone, *Haliotis cracherodii*, populations in the Channel Islands, California, USA in the mid 80's, and since has extended progressively to other populations along the coast of United States and Mexico. Withering Syndrome has caused mass mortalities of abalone, resulting in the collapse of the fisheries. In 1993, commercial and recreational black abalone fisheries were closed in California and, in 2009, the National Marine Fisheries Service enlisted it in the Endangered Species Act. In recent years, a slow recovery of black abalone populations has been detected in both California and Baja California, however, these populations are still at risk of being affected by the WS, especially due to the stress caused by recent drastic environmental changes. For that reason, it is crucial to evaluate the occurrence of *C*Xc in some of the remaining populations in Baja California. On the other hand, the presence of a phage hyper parasite associated to the *C*Xc called Xenohaliotis phage (p*C*Xc) has been detected in recent years. This phage attacks the bacteria and reduces its pathogenicity. Therefore, we will use a non-lethal sampling and qPCR amplification method to determine the presence of both the bacteria and phague.

Doughty, C.L.*, Cavanaugh, K.C.

INVESTIGATING COASTAL WETLAND BIOMASS DYNAMICS WITH UAVS

Ucla

Climate change poses a significant threat to coastal ecosystems worldwide. How salt marshes will respond depends on their ability to actively build elevation, which is determined by plant productivity and biomass. Yet, salt marsh productivity and biomass are not well-characterized across broad spatial scales or continuously in time. We combined seasonal field surveys and high-resolution unmanned aerial vehicle (UAV) multispectral imagery from the Carpinteria Salt Marsh Reserve to investigate the patterns and drivers of salt marsh biomass in the southern California region. We validated the UAV imagery using canopy reflectance captured in situ and found that UAV reflectance correlated highly (r2>0.86) to field measurements. UAV imagery was then used to test a suite of vegetation indices in their ability to predict aboveground biomass. NDVI provided the strongest correlation to aboveground biomass for each season, and when seasonal data were pooled (r2=0.44; rmse=451 g/m2). The NDVI aboveground biomass estimation model (AGB=2657.3*NDVI–59.1) was then used to create maps of biomass for each season. We found that spring exhibited higher average aboveground biomass (1150 g/m2) and total site-wide aboveground biomass in spring was estimated to be 192 Mg, approximately 50 Mg higher than all other seasons. Aboveground biomass peaks highest in spring at elevations ranging from 1.6 – 2.0 m NAVD88, and exhibits sharp declines at higher elevations, especially during summer. Our approach utilizes UAVs to characterize the relationship between salt marsh biomass and remotely-sensed indices

Eagleton, J.L.*

HABITAT SPECIFIC VARIATION IN DIET COMPOSITION AND ASSOCIATED LIFE HISTORY TRAITS OF GARIBALDI IN CALIFORNIA

Cal Poly Pomona

Variation in diet composition within a fish species has been associated with spatial variation in life history characteristics. Factors effecting diet composition include environmental conditions as well as habitat qualities such as substrate type and reef structure. An analysis of diet composition comparing multiple types of reefs with differing environmental conditions may inform or be indicative of habitat value for a fish species. In the Southern California Bight (SCB), habitat provided by manmade (harbor breakwaters) and natural reefs exist in close proximity to one another and over a range of varying oceanographic conditions. One fish commonly found on both breakwaters and natural reefs in the SCB are Garibaldi (Hypsypops rubicundus), a fish protected from fishing since 1971. Garibaldi are a territorial damselfish with high sight fidelity. To compare the habitat value of manmade and natural structures for Garibaldi the diet composition of 835 fish collected by divers from 2013-2019 are being analyzed from paired breakwater and natural reefs along a range of environmental conditions within its southern California range. For this study, morphometric measurements were taken and otoliths were sectioned to determine growth rates and somatic length-weight relationships for Garibaldi collected from each area. Diet composition analysis is revealing differences between habitat types, sex and life stages.

Elizabeth Maricza Soto González [1]*, Luis Rodrigo Arce Valdés [2], Luis Manuel Enríquez Paredes [1]

LOW GENETIC DIVERSITY IN THE GULF CORVINA AND ITS IMPLICATIONS ON FISHERY MANAGEMENT

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From an economic and social perspective, the Gulf Corvina (“Cynoscion othonopterus”) stands as the most important fin fishery of the Upper Gulf of California (UGC). Even when the catch of this marine resource is carried out under a regulated quota scheme, in order to ensure sustainability, its is currently classified as “vulnerable” by the IUCN. The Gulf Corvina fishery has been always directed to the breeding aggregations, during the migration of mature individuals to the UGC, so the low genetic diversity revealed by some early studies raised up the concern on the conservation status of this endemic species. A more recent study pointed out that even when the species went into a population bottleneck before the onset of the fishery, the effective population size is large enough and do not compromise its persistence on the short-term. To confirm this demographic scenario and infer the trends on population abundance we analyzed 1,506 individuals collected over the last decade to test for changes in the frequency and number of maternal lineages (maternal haplotypes). Our results do not show significant differences in genetic diversity between the 2009 and 2019 fishing seasons, but confirmed that the Gulf Corvina has lower genetic diversity than other Corvina species that inhabit the UGC and even less that in the Totoaba, another endemic species of the UGC considered as critically endangered. This controversy raises the need to reconsider the management strategies and fishing potential of these two species.

Fajardo-Yamamoto, A.*, Sosa-Nishizaki, O., Sepulveda, C. A.*, Aalbers, S. A.

INSIGHTS INTO THE TRANSBOUNDARY STOCK STRUCTURE OF WHITE SEABASS, A. NOBILIS, ALONG THE COAST OF CALIFORNIA AND BAJA CALIFORNIA

No affiliation[s] given

The white seabass WS (*Atractoscion nobilis*) remains an important fishery resource throughout its distribution along the coast of California (Cal), USA and the Baja California Peninsula (BCP), Mexico. Although various studies have recently been conducted to improve our understanding of WS biology and movement patterns, some uncertainty remains regarding their stock structure. The objective of this study is to better identify WS stock structure along the coast of Cal and BCP through: reconstructing landing statistics within Mexican waters; comparing size-at-maturity estimates between distal regions of southern BC and Cal; and assessing the horizontal movements of adult white seabass using archival tags. Here we present preliminary results from ongoing studies using various data sources to reconstruct WS catch statistics in Mexico. To date, 93 gonad samples have been collected in southern BC for histological examination upon collection of additional samples. Data on the movement patterns of more than 100 adult WS have been collected from recovered electronic tags that have been at liberty for periods of up to 5 years. Although mean displacement distances between tag deployment and recovery locations was only 165 km, annual migrations exceeding 2,000 km have been estimated from the recovery of 35 geolocating archival tag returns, with transboundary movements across the U.S.-Mexico border. Bi-national data on fishery landings, biological characteristics and movement patterns will assist in the comprehention the stock structure and enhance the stock assessment of this resource.

Feliciano, K.T.*, Valdes, A.A.

A PHYLOGENETIC ANALYSIS OF THE SUPERFAMILY ACTEONOIDEA WITH AN EMPHASIS ON THE SYSTEMATICS OF BULLINA AND MICROMELO

Cal Poly Pomona

Acteonoidea is a superfamily of shelled sea slugs which includes the families Acteonidae, Aplustridae and Bullinidae. Members of Acteonoidea have been traditionally classified based on morphological features, resulting in their original placement in Cephalaspidea because of the presence of a headshield. However, recent molecular studies have indicated that their morphology may be homoplastic and have reclassified Acteonoidea into a more basal group sister to Nudibranchia. Few detailed taxonomic studies have addressed the relationships between families and genera in this group. This study will build a molecular phylogeny based on a number of specimens from localities around the globe using two mitochondrial genes (16S and CO1) and one nuclear gene (H3). The goal of this analysis is to attempt to reconcile molecular and morphological data and determine the relationships among members of Acteonoidea. Specifically, it will examine whether Bullinidae is a valid family or is a member of Aplustridae. Preliminary data shows *Bullina* to be nested within Aplustridae and as a sister group to *Micromelo*. A second goal of this study is to determine whether *Micromelo undatus* is truly a circumtropical species or if there is undescribed cryptic diversity. Preliminary results indicate a species complex within *Micromelo undatus*. Molecular data will be supplemented with a morphological examination of radulae, shells, and other anatomical details.

Fieber, A.M.*, Bourdeau, P.E.

IMPACTS OF OCEAN ACIDIFICATION ON INTERTIDAL MACROALGAE AND ALGIVORE PREFERENCE

Humboldt State University

As the world's oceans absorb elevated atmospheric carbon, algal growth patterns are expected to change, and marine algivores can face altered resources that influence shifts in feeding behavior. To examine this relationship, I grew five common species of red and brown intertidal macroalgae under elevated CO_2 in laboratory mesocosms and observed them in feeding preference trials with two common intertidal grazers, the Northern kelp crab *Pugettia producta* and the black turban snail *Tegula funebralis*. Both grazers demonstrated a strong preference for brown algae, particularly *Egregia menziesii*, that were grown under elevated CO_2, despite showing no preference among untreated algae. When offered an assemblage of conspecific algae exposed to a gradient of CO_2 concentrations, *P. producta* exhibited preference for the treatment that yielded the greatest algal growth in each species (moderate exposure for *E. menziesii* and high exposure for *Laminaria setchellii*). These results suggest that choice is related to experimentally induced changes in algal biochemistry, and further work will examine nutritional and phenolic contents of treated algae to determine the mechanisms underlying the effects of CO_2 exposure on algal palatability. Elucidating such pathways will lend further support to the findings from these laboratory preference trials, which indicate that ocean acidification has the potential to influence interactions between multiple intertidal grazers and macroalgae.

Gammie, S.A.*

CORAL DISEASE AND OUTPLANT SITE SUCCESS ON LITTLE CAYMAN ISLAND

1) Humboldt State University 2) Central Caribbean Marine Institute

Coral disease has been documented to cause high levels of mortality in the Cayman Islands. How this increasing prevalence of disease is impacting coral restoration is still unknown. In addition, efforts to restore coral reefs through nursery outplanting are becoming increasingly common, necessitating information on where coral outplants would have the best chance at survival. We studied seven *Acropora cervicornis* outplants from four restoration sites around Little Cayman Island to better understand whether young corals grown in nursery settings were surviving once restored to the wild, and if spatial patterns in their survival were apparent. Presence of disease in the surrounding wild coral reef at these seven restoration sites was also assessed by transect and quadrat based surveys to document the prevalence and type of diseases present at the sites. We found that in spite of the pristine coastal reef ecosystem surrounding Little Cayman Island, outplanted *Acropora cervicornis* were more likely to thrive in deeper fore reef sites than shallower back reef areas. We hypothesize that this spatial pattern in survival among outplants results primarily because there is less algal competition at lower depths due to the lower concentrations of shore derived nutrients and sunlight penetration. The diseases identified among nearby coral reef genera provides a baseline for comparison with other reefs that are more heavily impacted by human activities to parse natural and direct human impacts on coral reef health.

Gavriel, D. [1]*, Samara, Y. [2], Ogburn, M.B. [3], Breitburg, D.L. [3], Donelan, S.C. [3]

EFFECTS OF CULTURE METHOD ON SEX RATIOS OF EASTERN OYSTER (CRASSOSTREA VIRGINICA) IN OYSTER FARMS AND REEFS OF THE CHESAPEAKE BAY.

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Populations of the Eastern Oyster (*Crassostrea virginica*) in the Chesapeake Bay have drastically declined from historical levels. Eastern Oysters are essential ecosystem engineers. Thus, efforts to restore Eastern Oyster populations in the Chesapeake Bay serve to benefit the entire ecosystem as well as local fisheries and aquaculture. While aquaculture facilities often grow non-reproductive triploid oysters, some farms also grow diploid oysters, which produce gonad and hence can reproduce, in an effort to contribute to natural populations. The ability of diploid oysters grown in aquaculture to contribute to natural populations, however, may depend on their growing conditions. Eastern oysters change sex during their lifetime based on local environmental conditions. However, we have no knowledge of whether the method of growing oysters in aquaculture influences their growth and sex. In Maryland, oyster farmers grow oysters in cages that rest on the bottom of shallow estuaries or in surface floats that are suspended higher in the water column. This experiment aims to test whether the depth at which oysters are raised affects their sex ratios and growth. Using oysters collected from natural reefs and farms throughout Maryland, we found that oyster sex ratios were not affected by culture method; however, culture method affected how males and females grew and allocated energy, including toward reproduction. Considering culture method may, therefore, be a key component in predicting the potential of farmed oysters to contribute to natural populations.

Giffard-Mena, Ivone*, Hernández-Montiel, Alvaro, Pérez-Robles, Javier, David-True, Conal

TOTOABA MACDONALDI; A HISTORY OF SALINITY ADAPTATION, ¿OR NOT?

Universidad Autónoma De Baja California, Facultad De Ciencias Marinas

Among all histories about *Totoaba macdonaldi*, the endemic fish from the Gulf of California, salinity adaptation is a very controversial one. To this date, it is considered an endemic species and the almost extinction cause of the marine porpoise vaquita marina (*Phocoena sinus*) due to Illegal fishing. To explore its osmoregulatory capabilities, we exposed totoabas to different salinity conditions (from 3 to 40 psu) under laboratory trail. Several developmental stages from eggs, larva and juvenile confirm that this fish had an euryhaline behavior from juvenile. However, larval stages are very dependent on external media salinity concentration. The pattern of adaptation that we registered, and shifts in survival, are very related to its migratory strategy which can have important ecological consequences.

Goin, G*, Puniwai, N

E HOʻI I KA PONO LAWAIʻA (RETURN TO RIGHTEOUS FISHING)

Uh MaNoa

For our Hawaiian kupuna there was no room for error when it came to survival. The resources that Hawai‘i had to offer were utilized by our ancestors with the utmost importance, respect, and care. More than a limited amount of resources, using their cultural lens they understood that we are related to these resources through ancestral ties. We lost our way doing the practice and protocols of our kupuna and now many fishermen are focused on the biggest fish or having the greatest catch, not remembering that it takes time for a resource to grow. Enforcing size and bag limits within the community was the “pono” way of fishing. To return back to righteous fishing is to look to the past, so that we can provide the answers for the future of these precious resources for the generations to come.

Gomez, J.B.[*], Bell, L.E., Kroeker, K.J.

DIFFERENCES IN SEASONAL GROWTH RATE OF HIGH-LATITUDE CORALLINE ALGAE

University Of California Santa Cruz

Coralline algae are important reef-building algae, providing habitat and food for many marine species. Their calcium carbonate structure makes them highly susceptible to carbonate chemistry fluctuations. To better understand coralline algal response to climate change projections, it is important to understand how they are already coping with seasonal fluctuations in seawater pH and temperatures. We investigated the natural seasonal growth rates of two morphologically different coralline algal groups from Sitka Sound, Southeast Alaska. In winter and summer of 2018, 76-80 coralline algal samples were collected from the field, stained with Calcein, and outplanted for 2-3 months at the same field site. Once recovered, specimens’ growth rates were quantified using fluorescence microscopy to image linear extension from stained meristematic tissue. In both seasons, the length extension of articulated coralline algae ($\bar{x}_{W18}$=0.18 ± 0.14 mm/month; $\bar{x}_{S18}$=0.22 ± 0.15 mm/month) was greater than that of crustose coralline algae ($\bar{x}_{W18}$=0.13 ± 0.06 mm/month; $\bar{x}_{S18}$=0.10 ± 0.09 mm/month). We estimate slightly more articulated coralline algal biomass added during summer ($\bar{x}$=1.19 ± 0.04 mg/month) than winter ($\bar{x}$=1.16 ± 0.04 mg/month), but we were unable to accurately estimate added biomass for crustose forms given our methods. Given the seasonal swings in pH and temperature in this region, this baseline life-history information of a very common habitat-forming algal group will help us better anticipate the potential effects of ocean warming and acidification on these species’ growth.

Gonzalez-Vera, C.G. [1*], Bello-Bedoy, R. [2], Arteaga-Uribe, M.C. [1]

GENETIC VARIATION IN TOTAL PHENOLIC CONTENT AND TRICHOME DENSITY ASSOCIATED TO DEFENSE IN CAPSICUM ANNUUM VAR. GLABRIUSCULUM

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Plant species with a wide geographic distribution are exposed to different environments throughout their distribution, which in turn affects the different biological interactions and defensive strategies of the plant. *Capsicum annuum* var. *glabriusculum*, wild chili, has a wide distribution in Mexico, and it is expected that those populations that are closer to each other, are

more similar both genetically and in the production of defensive traits. A common garden experiment was conducted to evaluate the variation in defense and induction in 31 dam lines of wild chili. As an indicator of the production of chemical defenses total phenolic content (TPC) was used, and for physical defenses, foliar trichome density was used. To evaluate the induction of defense, two treatments were used: mechanical damage, and mechanical damage adding oral secretions of the herbivore *Lema daturaphila* (Coleoptera:Chrysomelidae). Considerable variation was found in both constitutive and induced defense in wild chili, which suggests genetic variability in relation to defensive traits. Damage treatments had different effects on chemical and physical defense, and it was observed that the response to damage treatments was different from control only in the case of trichome density. This suggests that for wild chili, chemical and physical defenses have the capacity to evolve independently.

Goodmanlowe, G.D. [1*], Harris, M. [2], Mcwilliams, L.J. [1], Smith, T.A. [1], Lowe, C.G. [1]

THAT'S A LOAD OF BULL (SHARK): THE MISIDENTIFICATION OF IMPORTED SHARK JAWS FROM TAIWAN

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A total of 6428 shark jaws contained within three shipments, all labeled as bull shark (*Carcharinus leucas*), were either confiscated by the USFWS or relinquished to them between April 2018 and May 2019. Visual identification of each jaw was based on tooth morphology, jaw morphology, and overall size. For sexually dimorphic species, sex was also determined using differences in tooth morphology. Overall body size was estimated using upper jaw quadrate length and total jaw width (cm). A total of 23 species of sharks were identified, which included five CITES species: *Alopias pelagicus* (pelagic thresher), *A. superciliosus* (bigeye thresher), *Carcharinus falciformis* (silky shark), *Sphyrna lewini* (scalloped hammerhead), and *S. zygaena* (smooth hammerhead). Only 0.12% of the jaws were identified as *C. leucas* (bull shark), while the majority of jaws (63%) were identified as *C. sorrah* (spottail shark). These shipments represent a small percentage of shark jaws that enter the US each year, many of which are not flagged for containing CITES species. Developing methods to more rapidly identify shark jaws to species will help USFWS officers in enforcing CITES regulations for protected species.

Gorra, T.R.[*], Garcia, S.C.R., Langhans, M.R., Estes, J.A., Raimondi, P.T., Kroeker, K.J.

TEMPORAL AND SPATIAL TRENDS OF SOUTHEAST ALASKAN KELP FORESTS

Uc Santa Cruz

Predators directly influence lower guild species and can indirectly influence primary producers via trophic cascades. The approaches used to study trophic cascades are primarily opportunity-driven, and as such, are often limited in scale. We discuss our understanding of how primary producer density relates to the abundance of predators within an ecosystem, and whether trophic interactions are similar or different across varying scales and conditions as predator populations fluctuate. In this study, we used temporal and spatial trends of herbivore population dynamics and benthic community structure to evaluate a well-known trophic interaction between otters, urchins, and kelp in Southeast Alaska. We measured the probability

of otter presence, sunflower star presence, kelp density, and urchin abundance and size structure at 14 sites in Sitka Sound, AK. We compared these data points to those collected using similar methods in 1988 (otters absent) and 2009 (otters present) by Estes et al. (1995). We found that an increased probability in otter presence contributed to a decrease in urchin populations and an increase in kelp observed over time (1988, 2009), and space (2018). Yet, the species assemblage has altered from 1988 to 2018. Our results imply that the ecosystem state in 2018 is departing from a 'two-state' view (i.e., sea urchin barrens in 1988, kelp forests in 2009, intermediate in 2018). While sea otters remain a crucial species in structuring kelp forest communities, we reevaluate our current understanding of the otter-urchin-kelp interaction and why it may vary.

Green, C.K.[*], Underhill, W.J

LAND USE CHANGE AND EUTROPHICATION IN CORAL REEF ECOSYSTEMS ON MO'OREA FRENCH POLYNESIA

University Of California Santa Barbara

The health of coral reefs in much of the world's oceans are at risk due to anthropogenic eutrophication, whereby nutrients are added to water bodies as a result of human activity. Nutrient addition affects the health of corals directly, and also encourages the growth macroalgae which compete with corals for space and resources. Many coral reefs experiencing the effects of eutrophication are adjacent to islands with growing populations and expanding agricultural development. Mo'orea, French Polynesia, is an example of an island which has experienced large population growth and development in the past few decades. One result of this growth has been the conversion of forest to pineapple plantations in some of the island's major watersheds. To assess the effects of land use on coral reef ecosystems we created a time series of land cover change using remote sensing techniques to correspond with time series of coral cover, algal cover and dissolved nutrients collected in the field by the Mo'orea Coral Reef Long Term Ecological Research (MCR LTER) program. Our analysis found that reefs with high cover of macroalgae as detected by MCR LTER were located near the outlets of watersheds with significant agricultural development. Pairing in-situ readings of stream and reef health with land cover change satellite data will help us gain a better understanding of the effects of runoff on corals, and reveal the links between agricultural development on Pacific islands and the depletion of coral reefs.

Griffin, J.E. [1*], Hovel, K.A. [2]

INTERACTIVE EFFECTS OF HABITAT DISTURBANCE AND ASIAN MUSSEL (*ARCUATULA SENHOUSIA*) INVASION ON EELGRASS INFAUNA

1 - Uc Davis And San Diego State University, 2 - San Diego State University

Seagrass communities are undergoing significant change as a result of human activities like habitat destruction and introduction of non-native species. While impacts of habitat loss and invasive species on seagrass communities are well-studied, few have considered their combined effects. However, these impacts often co-occur in urban estuaries, and it is unknown whether their effects on seagrass communities interact. To address this knowledge gap, we

conducted an experiment to assess the combined effects of seagrass habitat loss and invasive Asian mussels (*Arcuatula senhousia*) on infauna communities, as well as the potential for predators to modify *A. senhousia* impacts. We hypothesized that infauna diversity would be lowest in plots with both seagrass disturbance and *A. senhousia* presence due to synergistic effects of habitat loss and competition. We also hypothesized that predators would reduce *A. senhousia* impacts on infauna diversity. We factorially varied disturbance, mussel presence, and predator access in plots in Mission Bay, San Diego in summer 2019. Results to date suggest a trend for lowest diversity in plots with both seagrass loss and Asian mussels; however, diversity was only marginally lower than in plots with seagrass loss only, suggesting that effects of Asian mussels on diversity were limited. Also, diversity was higher in plots with predator access, suggesting that predator effects are stronger than effects of Asian mussel competition. Our study broadens our understanding of stressor interactions in seagrass communities, especially in urban areas.

Hammond, C.R.*, Tomassetti, C., Karam, S., Soper, R.

URBANIZATION AFFECTS WESTERN BLUEBIRD (*SIALIA MEXICANA*) NESTING BEHAVIOR AND SUCCESS

Department Of Biology, School Of Arts And Sciences, Concordia University Irvine, Ca

Western Bluebird (*Sialia mexicana*) habitat has been in decline due to increased development and urban sprawl. Placement of artificial nest boxes has contributed to increased nesting activity in urban areas, leading to Bluebirds using “foreign debris” (e.g. plastic) as nesting material, a phenomenon not well described in the literature. The purpose of this study was to describe the use of foreign debris by nesting Western Bluebirds in areas of varying urban development, and measure potential impacts of this behavior on reproductive success. Fifty-seven nest boxes were deployed across areas of vary urbanization (i.e. low, medium, high) and monitored weekly for nesting activity, number of eggs, number and developmental stage of hatchlings, mortality, and foreign debris. At the end of the nesting season, we quantified and categorized all foreign nesting material. Of the nests analyzed to date, 90-100% included at least 1 piece of foreign debris regardless of urbanization level. Nests in areas with low urbanization had an average of 4.7 +/- 1.3 pieces of foreign debris, compared to 14.2 +/- 1.2 pieces and 18.4 +/- 1.6 pieces in areas with medium and high urbanization, respectively. Preliminary analysis also indicates foreign debris may negatively affect fledging success, but results will not be conclusive until all nesting is complete. As human interaction with songbird habitats continues, additional deleterious effects may be observed. This type of investigation allows us to investigate and mitigate these impacts long term.

Hannibal, K.N.*, Dudgeon, S.R

THE EFFECTS OF DASYSIPHONIA JAPONICA ON MYTILUS EDULIS’ GROWTH, SETTLEMENT, AND SURVIVORSHIP.

California State University, Northridge

Mytilus edulis, an ecologically important species that facilitates biodiversity, has been disappearing from its native range in the Gulf of Maine (GOM). Recent studies have focused on

ocean acidification, warming, and predation from invasive invertebrates as main drivers for this disappearance. As critical as these may be, few studies have focused on algal invasives as an impetus for *M. edulis* loss. Current studies document the presence of *M. edulis* in the interstitial space provided by *Dasysiphonia japonica*, an invasive alga that has spread through the GOM since 2010, but few focus on the direct effects it has on the larval stage of *M. edulis*. We conducted an *in situ* settlement choice experiment and a continuous growth experiment in Nahant, MA to quantify *M. edulis* growth, settlement, and survivorship within *D. japonica*. Results suggest a complex relationship: Preliminary results show *M. edulis* settles within *D. japonica* more than in a native algal species. We observed a significant interaction between time and algal species as well. *M. edulis* grew slower in *D. japonica* when compared to a native alga. Survivorship of *M. edulis* was significantly higher in *D. japonica* individuals compared to a native alga. These results show *M. edulis'* dispersal throughout its native range has been negatively impacted by *D. japonica*. Our research provides insight into the relationship of *M. edulis* with *D. japonica* and can serve as the foundation for *M. edulis* conservation and understanding the role of *D. japonica's* in the hard substrate of the GOM.

Hardison, E.A.*, Kraskura, K.K., Van Wert, J.C., Csik, S., Eliason, E.E.

DIET EFFECTS ON THE ENERGETICS OF GIRELLA NIGRICANS

University Of California, Santa Barbara

The temperate omnivorous fish, Girella nigricans (opaleye), is known to vary its diet depending on its geographic location. While it is clear that diet varies significantly across the geographic range for opaleye, the mechanisms that drive these diet shifts are unknown. To better understand the consequences of diet shifts on opaleye physiology, we tested the hypothesis that diet affects metabolic performance in opaleye. We acclimated wild-caught juvenile opaleye to 20°C and fed them one of three diets (herbivorous, omnivorous, and carnivorous; consisting of Ulva and/or Artemia). We then used an intermittent flow respirometry system to measure maximum and standard metabolic rate (MMR, SMR), excess post-exercise oxygen consumption, and aerobic scope. Additionally, we measured growth. We found that diet had significant effects on metabolic performance and growth, with carnivorous diets displaying the highest growth, omnivorous diets conferring the highest SMR and intermediate growth, and herbivorous diets displaying the lowest SMR and no detectable growth. Our results indicate that opaleye may alter their diet strategy to change their metabolic performance.

Harrison, L.N.*, Anderson, T.W.

CHANGES IN WRACK-ASSOCIATED BEACH COMMUNITIES DRIVEN BY AN INVASIVE MACROALGA, SARGASSUM HORNERI

Department Of Biology And Coastal & Marine Institute, San Diego State University

Biological invasion is a major concern for numerous reasons, including the ability of invasive species to disrupt and alter subsidy flow between ecosystems. Sandy beaches, characterized by low primary productivity, are dependent on marine-derived subsidies. Stranded patches of kelp, algae, and seagrasses, referred to as “wrack”, can support diverse invertebrate beach communities that rely on these resources for survival. These communities have been shown to

utilize wrack patches differentially in response to a suite of morphological and physiochemical factors that ultimately influence species composition and abundance. To examine changes in beach invertebrate communities driven by the invasive alga, *Sargassum horneri*, wrack and invertebrate surveys were conducted in San Diego during the summer of 2019 and will be conducted again in the spring/summer of 2020. An experimental wrack deployment was also conducted in the summer of 2019 and will be repeated in 2020. Beach hoppers (*Megalorchestia* spp) are dominant wrack grazers and are therefore being treated as a focal group. Differences between communities found in wrack composed of the native *Macrocystis pyrifera* versus *S. horneri* may occur across southern California as the occurrence of *S. horneri* is expected to increase. Beach communities are already exposed to other anthropogenic stressors, resulting in multiple species experiencing regional declines and localized extirpations, further emphasizing the need to understand how *S. horneri* affects sandy beach systems.

Hart, C.E. [1*], Lanphier, K. [2], Shields, M. [3], Eckert, G.L. [1]

SPATIAL AND TEMPORAL VARIATION OF PARALYTIC SHELLFISH TOXICITY IN THE COMMERCIAL GEODUCK CLAM FISHERY OF SOUTHEAST ALASKA

1 - University Of Alaska Fairbanks, 2 - The Sitka Tribe Of Alaska Environmental Research Lab, 3 - University Of Alaska Southeast

In Southeast Alaska, the commercial geoduck harvest is a small but lucrative wintertime fishery with annual ex-vessel value averaging US$4.7 million (2010-2018). In recent years, this fishery has been hampered by paralytic shellfish toxins (PSTs); failed PST tests causes substantial economic loss to the geoduck fishery through increased sampling costs and by delaying or closing harvests. In the most recent commercial season, 25% of harvestable biomass was left in the ground due to PST closures. Clam toxicity within a harvest area varies substantially from week-to-week, fluctuating well above and below the regulatory limit. Geoduck clams (*Panopea generosa*) are filter feeders and can acquire PSTs by ingesting the toxin-producing phytoplankton, *Alexandrium* sp. Like many dinoflagellate species, *Alexandrium* alternates between a dormant, benthic stage, and a motile vegetative cell. The dormant cyst-stage persists in sediment during commercial clam harvests and we suspect they may influence wintertime toxicity in clams. To better understand the variation of geoduck toxicity, we are investigating spatial and temporal patterns of *Alexandrium* abundance through cyst-mapping. In collaboration with our partners, we collect sediments and clams and have counted high concentrations of cysts (>3000 cysts/cc sediment) in or near harvest areas with recent PST-related closures, as well as directly in the visceral mass of some clams. Uncovering these spatial and temporal patterns of cysts may provide valuable data to managers so that they may mitigate toxicity in commercial clams.

Hicks, P.[*], Bignami, S.

INDUCED SPAWNING OF THE PISMO CLAM (*TIVELA STULTORUM*)

Department Of Biology, School Of Arts And Sciences, Concordia University Irvine, Ca

Pismo clam (*Tivela stultorum*) populations along the California coast are sparse compared to historic levels, raising interest in the possibility of captive spawning and rearing for the purpose

of conservation, research, or consumption. However, procedures to induce spawning or support larval rearing of Pismo clams are limited in the literature, in contrast to a broad scope of knowledge for other successfully aquacultured bivalve species. The goal of this study was to examine the effectiveness of techniques known to induce spawning in other bivalve species, but previously unexplored or described only anecdotally in Pismo clams. Multiple methods to induce spawning were tested, including heat stress, exposure to dissected gonadal tissue, and exposure to extracted sperm. Preliminary results indicate the greatest spawning success was achieved by exposure to extracted sperm. If consistent spawning of Pismo clams becomes possible this will allow for in-vitro fertilization trials, description of the stages of larval development, and larval rearing trials.

Houghton, G.E.*, Bell, L.E., Kroeker, K.J.

NUTRIENT EXCRETION RATES OF HIGH LATITUDE KELP FOREST CONSUMERS UNDER TWO PH REGIMES

University Of California Santa Cruz

Grazers in the invertebrate community are known to impact *Macrocystis pyrifera* growth and survivorship via direct consumption. However, recent studies on consumer-mediated nutrient dynamics (CND) have shown that higher trophic level species, such as invertebrate grazers and fish, contribute nutrients via nitrogenous excretion, which can have a positive impact on macroalgal growth. As prior studies have shown metabolism to be negatively impacted by hypercapnia, projected increases in pCO_2 associated with ocean acidification may limit excretion rates of kelp forest associated species. This experiment investigated the relative nutrient excretion rates of several grazer species and one fish species common within giant kelp forests of Southeast Alaska, where pH levels are expected to decrease by 0.4 units by 2100. Multiple individuals of *Strongylocentrotus franciscanus, Strongylocentrotus droebachiensis, Tegula pulligo, Margarites* sp., *Haliotis kamtschatkana, Pagarus* sp., and *Brachyistius frenatus* (N=8/group) were collected from Sitka Sound, AK and incubated in closed containers of UV-sterilized seawater at pH 7.8 and 7.6. Seawater was frozen and analyzed for relative concentrations of ammonium, nitrate, and urea, which were standardized to shell-free dry weight for calcified species and biomass for fish. Here we present the first data from a high-latitude giant kelp forest ecosystem on species-specific excretion rates at different pH levels, which will help inform how the excretion of consumers might balance their direct consumption under future ocean conditions.

Hudson, H.A*, Dibble, C.D, Satterthwaite, E.V, Killeen, H.J, Small, S.L, Morgan, S.G

VARIATION IN GROUND FISH SPECIES RESPONSES TO MARINE PROTECTED AREAS

Uc Davis Bodega Marine Laboratory

The California Collaborative Fisheries Research Program (CCFRP) is a statewide effort to collect robust fisheries-independent data through catch and release fishing in marine protected areas and reference sites in collaboration with volunteer anglers and commercial fishing vessels. Fishes were randomly sampled in each MPA and comparable reference site containing rocky reef habitat and similar depth range, and fishing time was recorded in each grid cell to

measure effort. Standardized fishing methods allowed for comparisons of ground fish populations throughout the state and over time. We report results from two pairs of marine reserves and reference sites that we surveyed since 2017 along the northcentral coast, including mean length, biomass-per-unit-effort and catch-per-unit-effort (CPUE). We addressed two questions: 1) Does reserve designation impact fish populations? 2) Which species'-specific responses were strongest? After just three years, fish biomass was generally greater in the Bodega Head and Stewarts Point State Marine Reserves than in paired reference sites, though abundance and biomass gains varied by species, site, and year. Effects on CPUE and mean length were similar in magnitude and direction for some sites and species, but we found neutral or negative trends in one metric with positive trends in the other metric for other species. Initial reports indicate that similar trends may be occurring at other pairs of reserves and reference sites surveyed by CCFRP.

Hull,W.W.*, Bourdeau,B.E.

BREAKING AND ENTERING: DISENTANGLING MULTIPLE PREDATOR EFFECTS OF CRABS AND SEA STARS ON CALIFORNIA MUSSELS

Humboldt State University

Competing predators can have additive or synergistic effects on prey through interactions with each other, however most studies do not consider how competitor proximity and the role of physical versus chemical competitor cues influence these multiple predator effects. In rocky shore systems, predatory sea stars and rock crabs are sympatric predators of California mussels. To examine the effects of these predators on mussels, we combined a field and laboratory experiment to determine (1) the individual and combined effects of crabs and sea stars on mussel mortality, and (2) the effects of the physical and chemical presence of each predator on each other's feeding behavior. Across three sites varying in predator abundance, the combined effects of crabs and sea stars on mussel mortality did not differ from that of crabs alone. Lab experiments validated our field results in that physically interacting crabs and sea stars did not consume more mussels than crabs alone; suggesting that the physical presence of competitors affected mussel consumption. However, whereas the chemical presence of sea stars had no effect on crabs, we found that the chemical presence of crabs increased the feeding rate of sea stars. Taken together, these results suggest that mussel mortality should be greater in environments where crabs are present versus environments where they are rare or absent, as crabs not only contribute to overall mussel mortality via consumption, but also by increasing the feeding rate of sea stars.

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BLACK ABALONE STATUS IN BAJA CALIFORNIA, MEXICO. IDENTIFYING CRITICAL SITES TO PROMOTE ITS RECOVERY

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De Baja California, 4 - Facultad De Ciencias. Universidad Autonoma De Baja California, 5 - Cicese

The black abalone (Haliotis cracherodii) occurs in intertidal and shallow subtidal rocky reefs from southern Oregon, USA to Punta Prieta, Baja California Sur, Mexico. In USA it has the maximum regulatory protection under both federal and state law. In Mexico, It has been commercially harvested since the 70´s, and it represents 2% of the total abalone harvest only. Although cooperatives have permits, since 1996, an evaluation is required before fishing quotas can be issued. In 2004, an assessment found 0.003 ind/m2 in BC, and 0.38 ind/m2 in BCS; however a more recent evaluation is lacking. This work aims to assess black abalone status in Baja California to identify critical sites where populations are in good condition. From February 2018 to May 2019, we surveyed 26 sites from the Tijuana border to Faro San José. Preliminary results show cero abalones in 38.5% of the sites, being mainly the northern sites the ones with abalone. Densities were lower than 0.25 abalone/m². Juveniles (< 50mm) and sub-adults (60-90mm) were more abundant, and were found from cero to 1m apart. In contrast, adults (91-120mm) and harvestable size abalones (> 120mm) were very low, and the distance among individuals was > 1m. We found higher densities associated with a moderate habitat. This study is useful to identify critical sites to promote black abalone recovery. We suggest that caution should be taken to avoid granting quotas without a strict evaluation of the site.

Jackson, J.R. [1*], Tomoleoni, J. [2], Becker, B. [3], Hughes, B.B. [1]

EXPLORING NOVEL FOOD WEBS PRIOR TO TOP PREDATOR RECOVERY

1 - Sonoma State University, 2 - United States Geological Survey, 3 - Point Reyes National Park Service

Anthropogenic effects on marine ecosystems are an ever-present disturbance to the natural state of an environment. These alterations can change species diversity and abundance, as well as present unfavorable conditions for recovering species. Estuaries in northern California have an extensive history in oyster mariculture, particularly the non-native *Crassostera gigas*. One estuary (Drakes Estero) was used primarily as an oyster farm until 2014 when it closed, and another (Tomales Bay) has active oyster farms. The goal of our study is to determine the consequences, if any, these farms have on native invertebrate populations. This study focuses on larger benthic invertebrates (crab, clam and oysters), and determine how these estuarine communities will change if sea otter (*Enhydra lutris*) recovery were to occur. Here we present preliminary data that explores these novel food webs. Clam surveys were conducted by digging 50 cm x 50 cm quadrats at ~30cm deep throughout Drakes Estero mudflats. Crab traps were deployed at randomly selected coordinates in the estuary within three location: lower (closest the mouth), middle, and high (farthest from the mouth) and were sampled in two habitats: bare sediment and seagrass (*Zostera marina*). The traps soaked for 24 hours before collection/measurement. Preliminary results suggest that clams in areas of recent oyster farming have not recovered, with little impact of oyster farming on native crab populations. Our research will continue by sampling estuaries with varying levels of mariculture to further explore these novel food webs.

Jannot, J.E.[*], Good, T.P.

INSIGHTS INTO BLACK-FOOTED ALBATROSS BYCATCH IN US WEST COAST FISHERIES USING BAYESIAN MODELS

NOAA

Globally, seabird populations are declining due to factors such as pollution, climate change, introduction of predators, and interactions with fisheries. Incidental bycatch in U.S. West coast longline fisheries significantly contributes to the mortality of the black-footed albatross (BFAL). BFAL populations are stable but predicted to decline over the next half century. My project focuses on testing multiple Bayesian time series models to understand the factors that contribute to BFAL bycatch in a U.S. West Coast longline fishery. We tested model performance assuming two different distributions of the bycatch (negative binomial, Poisson), and examined constant versus non-constant bycatch rates. We also incorporated combinations of seven unique covariates to determine if a relationship exists between these covariates and the bycatch rate. We used leave-one-out cross validation to quantitatively evaluate the models. Results indicated that the best model of seabird bycatch used a negative binomial distribution with a constant bycatch rate. These results suggest that the distribution of bycatch is dispersed and that the underlying bycatch rate from year to year remains relatively constant. Of the covariates used, streamer lines, season, and floated longlines had the most predictive results this indicates that these covariates all have the capacity to affect the bycatch rate. The results of our work demonstrate clear improvements over previous methods of bycatch modeling and suggest factors that managers might use to reduce seabird bycatch.

Johnson, C.J. [1*], Doane, M.P. [2], Goodman, A.Z. [1], Quinlan, Z.A. [1], Moffat, J. [3], Torres, M. [3], Nosal, A.P. [4], Pien, C. [5], Ebert, D.A. [5], Kerr, E. [1], Reed, M.B. [6], Turnlund, A.C. [1], Peterson, M.H. [1], Johri, S. [1], Dinsdale, E.A. [1]

EPIDERMAL MICROBIOME STRUCTURE OF LEOPARD SHARKS (TRIAKIS SEMIFASCIATA) ACROSS SPATIAL AND TEMPORAL SCALES

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The group of micro-organisms that reside on or in the body of an organism, known as a microbiome, are vital for its health. A core microbiome is the set of microbes which can be found within the microbiome of all healthy organisms within a species; identifying these core microbiomes are important to better understand the effect of abiotic factors. We characterized the taxonomic and functional gene structure of the leopard shark (*Triakis semifasciata*) epidermal microbiome over multiple years and locations to identify a core microbiome, determine the ß-diversity between individual leopard sharks, and describe the functional stability of the epidermal microbiome. 32 total samples have been collected from La Jolla, CA (2013, 2015, 2017), Moss Landing, CA (2015), the Birch Aquarium (2018 & 2019), and the Scripps Institute of Oceanography Aquarium (2016). DNA has been extracted, prepared for sequencing, shotgun sequenced, and annotated. It produced 28,418,189 metagenome sequences. We discovered a core microbiome of 10 genera present in 78.12% of the samples. The ß-diversity described as a Bray-Curtis similarity index shows the sharks sharing 52.91% of genera. A

PERMANOVA with a Benjamini-Hochberg correction revealed the functions of the microbiome did not remain stable across a temporal scale in La Jolla (p=0.001). Although we have identified a core microbiome, the genetic potential within this core varies over time. We hypothesize that this is an adaptation of the microbiome's response to varied abiotic conditions. This maintains a core microbiome and health of the shark.

Kalan, Parker*

PACIFIC LAMPREY AS COASTAL WATERSHED QUALITY IMRPOVERS

California Polytechnic University San Luis Obispo

Many watersheds, particularly those with urban influence, have elevated levels of bacteria associated with fecal coliform, creating a health risk for humans and a degraded ecosystem for other organisms. Pacific lamprey (*Entosphenus tridentatus*) is an endemic, anadromous eel species in west coast watersheds, hypothesized to remove detritus and bacteria including Escherichia coli from the water column during the lamprey's larval filter-feeding stage. We propose testing this hypothesis using a controlled laboratory experiment conducted on wild-collected, laboratory-acclimated larval lamprey. Lamprey populations in replicate aquaria will be exposed to water of various E. coli concentration levels, and we will test for changes in E. coli levels before, during, and after the exposure period. Our full factorial experimental design will enable us to test independent and interactive effects of the concentration of E. coli, the density of Lamprey, and the duration of treatments on the rate of reduction in E. coli concentration. Ultimately, we expect our research to determine the efficacy of Pacific lamprey populations in reducing E. coli from contaminated water, providing guidance for ecosystem management of urban watersheds polluted with bacteria.

Kaslly, N.A.*

DO ZOOPLANKTON RESPOND TO DISTINCT BIO-ACOUSTIC SOUNDSCAPES?

San Francisco State University: Crow Lab

Sound is used broadly throughout marine environments by many different species for communication, orientation, reproduction, and navigation. The depth of research demonstrating dependence on sound varies among taxonomic groups. For example, whales and fishes have been researched extensively while zooplankton have been largely ignored. Zooplankton, the base of the food web and an integral component of ecosystem function, have only recently become a focal point. While adult and larval zooplankton respond to sound cues, to our knowledge this is the first study that examines spatial orientation in response to sound. We tested three different sound treatments (home reef playback, foreign reef playback, and no sound) on two sites (Sites A and B) and collected the zooplankton in a light trap. They were then separated into five general categories: copepods, copepodites, mysids, crab larvae, and ostracod larvae. Our results suggest that adult copepods show significant deterrence from their home reef sound on Site B, and that mysids are attracted to sound with a suggestive trend toward preferring their home reef sounds. We also found a greater abundance of larvae at Site B, the louder of the two sites, which may be indicative of larvae's reliance on sound cues for orientation.

Kerr, E.N. [1]*, Haggerty, M. [2], Johnson, C.J. [1], Goodman, A.Z. [1], Johri, S. [1], Doane, M.P. [3], Morris, M. M. [4], Lima, L.F.O. [1], Turnlund, A.C. [1], Livingston, I.G. [1], Peterson, M.H. [1], Bursch, H.A. [1], Dinsdale, E.A. [1]

SKIN MICROBIOME OF THE ROUND STINGRAY *UROBATIS HALLERI*, IN SOUTHERN CALIFORNIA

1 - San Diego State University, 2 - California Department Of Fish And Wildlife, 3 - Sydney Institute Of Marine Science, 4 - Stanford University

Microbiomes, or all microorganisms associated with an organism, provide insight into the health of an organism. Rays are part of the class Chondrichthyes and have several features that may affect the structure of the skin microbiome, including mucus production and benthic lifestyles. Here we describe the skin microbiome composition of the round stingray, *Urobatis halleri* using shotgun metagenomics. The skin microbiome of fifteen rays was collected from five California locations including Long Beach, San Onofre, Oceanside, San Diego Bay (2019), and Mission Bay (2017). To date, five metagenomes have been sequenced on Illumina and annotated using Focus and Superfocus, two kmer based programs. Preliminary results show Clorobia and Planctomycetia are more abundant on the skin of *Urobatis halleri* than in the water column. At the Class level Gamaproteobacteria are the most abundant on all stingray samples, but there is considerable variation between samples. The proportion of Gamaproteobacteria varies between 36 and 81 % of the metagenome across sting ray microbiomes. In the future, the microbiome from rays will be compared to the microbiomes of sharks and teleost fish. While sharks and rays are related, sharks are covered in dermal denticles with minimal mucus, whereas stingrays have a layer of mucus on their skin, which is a trait more similar to teleost fish. Therefore, we will analyze whether the microbiomes of the two phylogenetically related groups (sharks and rays) is more similar than the two unrelated groups, rays and fish that have a similar mucus-covered skin.

Killeen, H.J.*, Dibble, C.D., Morgan, S.G., Susner, M.G., Largier, J.L.

SMALL-SCALE NEARSHORE FRONTS CONCENTRATE ORGANISMS AND STRUCTURE COASTAL PLANKTONIC COMMUNITIES

Coastal Marine Sciences Institute, Uc Davis

Fronts are boundaries between distinct water masses that often aggregate flotsam, detritus, and zooplankton. Studies of large-scale (100-1000 m) offshore fronts show that these aggregations affect ecological interactions by concentrating prey for fish, sea birds, marine mammals, and other planktivores. Less is known about the small-scale (1-10 m) fronts that are ubiquitous in nearshore environments, yet these features may have outsized importance for the many animals that utilize exclusively nearshore environments. We present findings from a study of one small-scale front that forms nearshore, north of Bodega Bay, on the north-central coast of California. We used a Tucker trawl plankton net, CTD profiler, ADCP, satellite imagery, and time-lapse photography to characterize water circulation patterns and plankton distributions within and around the front. Prior work has shown that nearshore topographically-generated fronts provide high-quality feeding patches and enhance larval retention during upwelling. The front we sampled formed only under relaxation conditions and is affected by a collection of

physical processes, including flow-separation, beach circulation, and thermal stratification. Plankton accumulated at the front often in concentrations orders of magnitude greater than in nearby waters. These findings suggest that small-scale nearshore fronts are capable of concentrating planktonic organisms under relaxation conditions, likely altering ecological interactions, facilitating larval retention, and creating high-quality feeding environments for nearshore planktivores.

Kopecky, K. L.*, Stier, A. C., Schmitt, R. J.

EFFECTS OF PREDATION AND COLONY DENSITY ON CORAL GROWTH AND SURVIVAL

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Coral colony density varies both spatially and temporally, but how this variability influences coral vital rates (e.g., growth, survival, settlement, and recruitment) is not yet well understood. There is mounting evidence for the importance of natural enemies (i.e., pathogens and predators) in modifying density dependent vital rates in coral populations, yet the regulatory role of coral predators has rarely been investigated. We conducted a field experiment in Moorea, French Polynesia to explore the effects of predation and colony density on coral growth and survival. We found a negative, density independent effect of predators on coral survival, and a positive, density dependent effect of colony density on coral growth in the absence of predators, but no interaction between these factors. Our study provides insight to the role of predation and colony density in influencing coral vital rates, furthering our understanding of how variable colony density affects coral population dynamics.

Korabik, Angela R*, Grosholz, Ted

UNDARIA PINNATIFIDA GAMETOPHYTE RESPONSES TO SALINITY

University Of California Davis, Bodega Marine Laboratory

Climate change is likely to impact the process of species invasions around the world. This past year, California experienced above normal levels of rainfall, which coincided with verbal reports of decreased *Undaria pinnatifida* presence in Monterey Harbor and San Francisco Bay. To address the question of whether increased rainfall in California during early 2019 impacted the presence of *Undaria pinnatifida*, we conducted a laboratory culturing experiment that examined the responses of *Undaria pinnatifida* gametophytes to lowered salinity levels. Mature, reproductive adults of *Undaria pinnatifida* were sourced from two locations in California, Monterey Bay and Bodega Bay, and brought back to the Bodega Marine Laboratory where individuals from the two populations separately released spores. Ten replicates of each population's spore slurry were exposed to five different salinity levels (30, 25, 20, 15, and 10 psu) over a two-month period. We ultimately found differences in growth rates in response to experimental salinity treatments. Climate change projections for California suggest that there will be increasing frequency of extreme wet and dry years, so these results have important implications for the fate of *Undaria pinnatifida* invasions.

Kriegmont, Zoey, E*

COMPUTATIONAL ANALYSIS OF LANGUAGE RELATIONSHIPS: NATIVE NORTHWEST COAST OF NORTH AMERICA

American Museum Of Natural History

A long-standing problem within the field of linguistics is the tendency of subjective results. The purpose of this project was to mitigate this issue by employing a novel computational approach to analyzing language relationships. We focused on 5 different families of Native Northwest Coast of North America languages, which are important due to their critically endangered and extinct statuses. We compiled a database of a pre-established list of 100 common words (the Swadesh 100 list) in the languages' respective orthographies, then used a coding system to translate each word into its International Phonetic Alphabet (IPA) equivalent. The translated words are treated analogously to DNA sequences; instead of strings of ACGT, we have strings of individual sounds (known as phonemes). The programming system compiles the data to construct phylogenetic trees of the languages. Analysis of the trees may help us to understand how these cultures interacted in the past and to assist with modern day language revitalization efforts. Our preliminary results support known relationships between the languages and have exposed previously unknown relationships. Future research on these languages, in combination with other related data (e.g. genetic and/or geographic), may support the use of this novel computational approach in order to achieve more objective results in the field of linguistics.

Keywords: Swadesh, Moris. Whiteley, Peter. Wheeler, Ward. International Phonetic Alphabet. IPA. Phylogeny. Cladistics. Linguistics. Anthropology. Native Northwest Coast.

Krier, L.E. [1*], Kensinger, S. [1], Haupt, A.J. [2], Crandall, E.D. [1]

LARVA ME NOW OR LARVA ME NOT: IS CAPE MENDOCINO A BARRIER TO LARVAL DISPERSAL?

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Processes that influence the biogeographic distribution of species are also expected to impact the phylogeographic distribution of genetic diversity within a species. Cape Mendocino projects far into the Pacific Ocean, creating strong upwelling and an associated eddy that can potentially force the drifting larvae of intertidal species offshore. In addition, a large sandy stretch of coastline to the north of the Cape gives no opportunities for successful settlement by larvae of rocky intertidal species. The Cape has been identified as a biogeographic break for species with planktonic larval development, but not for direct developers. We first reviewed the literature, finding evidence of phylogeographic structure in 24 out of 46 species that have been sampled across the Cape. We then compared genetic structure across Cape Mendocino in two synchronously diverging, co-distributed intertidal gastropod species: one with planktonic larvae - *Lottia digitalis* - and another with direct development - *Nucella ostrina.* We hypothesized that if the Cape is a barrier to larval dispersal, *L. digitalis* populations to the north and south of the Cape will show significant genetic divergence, with F_{st} values and divergence times comparable to those found in the non-dispersive *N. ostrina.* Furthermore, populations pairs that do not span the Cape will have F_{st} values close to zero. If Cape Mendocino is a barrier to gene flow for

planktonically dispersing species, it could directly affect the way that conservation management policy is implemented.

Kuntz, J.P.[*], Lewis, L.S., Willmes, M., Hobbs, J.A.

HABITAT USE AND DIET COMPOSITION OF LEOPARD SHARKS (TRIAKIS SEMIFASCIATA) IN THE SAN FRANCISCO ESTUARY

University Of California, Davis

The Leopard Shark (*Triakis semifasciata*) is one of the most common elasmobranchs in the San Francisco Estuary (SFE), yet how these benthic mesopredators utilize different habitat types throughout this ecosystem is not well understood. We assessed Leopard Shark abundance throughout the estuary using field survey data (otter trawl catch) collected by the California Department of Fish and Wildlife's long-term monitoring program (San Francisco Bay Study) from 1980 to 2015. Leopard Shark catch per unit effort (CPUE) exhibited an overall decline during the study period, as well as seasonal variation. We modeled habitat suitability using Generalized Additive Models of CPUE as a function of region, salinity, and temperature. We also examined Leopard Shark diet composition in the southern SFE using gastric lavage to determine the relative feeding importance of different prey types.

Lafarga-De La Cruz, F. [1*], Re-Araujo, A.N. [2], Díaz, F. [2]

THERMOREGULATORY STUDY IN THE BLACK ABALONE *HALIOTIS CRACHERODII*

1 - Departamento De Acuicultura, Cicese, 2 - Departamento De Biotecnología Marina, Cicese

Haliotis cracherodii is the only abalone species listed as critically endangered (IUCN Red List) as population significantly decreased in the '90s. In México there is a lack of ecological data, although it is a highly-valuable fisheries resource. The objective of this study was to study the thermoregulation of the black abalone, stablishing the preferred and critical thermal maximum, with the final goal. Forty-five juvenile abalones were obtained from Ensenada, Baja California with an average size of 2.48 cm (0.206 g) and kept at 16°C. The preferred temperature was measured with the gravitational method. Ten organisms were introduced to the gradient at 16°C. Two evaluations each 24-hour were made and their location recorded every hour; obtaining a preferred temperature of 13.8°C. Additionally, to evaluate the CTMax, a glass aquarium (40 L) was used that contained seawater at 16°C, an aeration stone and a 1000-watt heater. Two groups of 10 marked organisms were used to determine their thermotolerance. To assess the exact temperature and the point of detachment from the substrate, we used a methodology of tenacity they were on, a nylon thread was joined to the shell and a lead weight (same weight of each organism was used). The experiment started at 16°C and the temperature increase was 1°C every 15 minutes. The first abalone detached from the substrate was at a temperature of 25.4°C and the last one at 31°C; CTMax of 50% was at 29.7°C. This data will allow us to maintain and conditioning the black abalone in captivity for reproduction studies to produce seed for restocking

Lamore, R.J.[*], Rempel, H.S., Vanderbloomer, P.D., Ruttenberg, B.I.

CONTEXT DEPENDENT VARIATION IN PARROTFISH CORALLIVORY ON ENDANGERED ORBICELLA ANNULARIS CORALS ACROSS CARIBBEAN REEFS

Cal Poly Slo

Parrotfishes are major herbivores on Carribean reefs that indirectly benefit corals, yet some species are also corallivores and thus have direct negative impacts on coral growth and survivorship. Parrotfishes target multiple coral species, but have high rates of focused predation on *Orbicella annularis*, an important reef building coral and endangered species. Larger bite scars have far less healing compared to smaller bites; thus greater focused predation leads to greater declines in cover of *O. annularis*. However, it is unclear how reef community composition influences the intensity of predation. The objective of this study is to examine the how the standing stock of bite scars on *O. annularis* corals scales in response to variation in parrotfish biomass and relative corallivore density, total coral cover and relative *O. annularis* cover, and well as algae community composition. We surveyed: 1) the size and abundance of bite scars in relation to *O. annularis* cover, 2) the relative cover of coral species, macroalgae species and other functional groups commonly targeted by parrotfishes using benthic photoquadrats, and 3) the biomass and community composition of parrotfish species using roving diver surveys. Preliminary results show that the intensity of corallivory changed in response to site-level differences in the community composition of parrotfishes and benthic cover. This research helps to inform managers how changes in parrotfish and benthic communities on increasingly impacted reefs may affect the cover of endangered *O. annularis* corals.

Larios, Mariana *

No affiliation[s] given

Laroche, N.L. [1] *, **King, S.L.** [2], **Eckert, G.L.** [1], **Rogers, M.** [3], **Pearson, H.C.** [4]

SEA OTTER SEASONAL DIET COMPOSITION IN SOUTHERN SOUTHEAST ALASKA

1 - University Of Alaska Fairbanks, 2 - University Of Wisconsin Green Bay, 3 - NOAA Fisheries, Alaska Fisheries Science Center, Auke Bay Laboratories, 4 - University Of Alaska Southeast

Sea otter foraging studies throughout the Pacific coast range have shown that sea otters will reduce invertebrate prey biomass when recolonizing an area. By quantifying sea otter diets and caloric intake according to recolonization patterns, we can better understand the ecosystem impacts of sea otter population increase and range expansion. We hypothesized that sea otter diet will vary according to age, reproductive class, seasonality, and time since recolonization. Foraging data was collected around Prince of Wales Island to determine diet composition during the summer. Sea otter vibrissae were obtained from subsistence hunters to assess seasonal changes in sea otter diets by using bulk stable isotope analysis. Sea otter prey items were collected in three seasons (spring, summer, and winter) to measure caloric value and stable isotopes of carbon (d13C) and nitrogen (d15N). Sea otter diets show variation over various metrics, but the overall population-level diet composition consisted of 69% of the biomass from clams, with butter clams as the main clam species. The results of this study aids in the future management of shellfisheries, subsistence hunting, and co-management of a protected species by providing quantitative diet composition data for stakeholders. This work is a part of a

large-scale project examining how the recovery of sea otters structures nearshore marine ecosystems, provides ecosystem services, and affects community sustainability.

Leonard, S.J. [1*], Selgrath, J.C. [1], Pearse, J.S. [2], Carlton, J.T. [3], Watanabe, J.M. [1], Glynn, P.W. [1], Elahi, R. [1], Micheli, F. [1]

LONG-TERM CHANGE IN AN INTERTIDAL COMMUNITY

1 - Stanford University, 2 - Uc Santa Cruz, 3 - Williams College

As the pressures of global change grow, it is critical to understand how the species composition of ecological communities is impacted. However, we often lack baseline information that allow us to evaluate change over multi-decadal time scales. Using a unique historic dataset from a biodiversity survey conducted in 1959-1961 as a baseline, we resurveyed the community in the upper intertidal zone (*Endocladia muricata* zone) at Hopkins Marine Station, Monterey Bay, CA. By examining how all plant and animal species in this community have changed over 50+ years, we gained a uniquely high resolution, long-term perspective of ecological change in a biodiverse coastal region. Using quantitative data on 59 species, we found significant trends including: declines in 19 species (mean decline: 92.8%); significant increases in 8 species (mean increase:171.4%); the disappearance of 19 species detected in the original study; and the presence of 12 species not detected in the original study. The substantial, community-wide changes we found emphasize the need to track whole communities – including species that are difficult to identify and cannot be quantitatively surveyed in the field – over long periods of time.

Leonardi, N.D. [1*], Thuesen, E.V. [1], Haddock, S.H.D. [2]

MORPHOMETRIC ANALYSIS OF COLLOBLASTS IN NINE FAMILIES OF THE PHYLUM CTENOPHORA

1 - The Evergreen State College, 2 - Monterey Bay Aquarium Research Institute

Ctenophores utilize colloblasts, specialized glue-secretion cells, for predation. Located on the tentacles, tentilla, or oral pads, colloblasts are only found in the phylum Ctenophora. Specimens were collected from the epipelagic to bathypelagic zones off the coast of Monterey Bay, CA and the Hawaiian Islands using blue-water divers and remotely operated vehicles. Tentacle samples were immediately fixed in a 4% formalin solution at sea, and then prepared for scanning electron microscopy in the lab. Diversity of ultrastructural characteristics were observed using a JEOL JSM-6480LV SEM and morphometrics of the collospheres, external granules, and helical threads were recorded for 18 species, among 9 families, including 5 undescribed species. Morphometry of colloblasts reveals three main forms of collospheres: ellipsoid, spherical, and indistinct. The growth patterns of the external granules were also noted to vary among species. These patterns were designated as either clustered growth or a pattern- oriented growth. These findings are being analyzed to describe the functional diversity of the interesting, and controversial, phylum Ctenophora.

Lim, E.G. [1*], Ens, N.J. [2], Howard, B.R. [3], Eastham, T.M. [1]

A COMPARISON OF THE PREDATORY IMPACTS OF INVASIVE AND NATIVE CRAB SPECIES USING A FUNCTIONAL RESPONSE APPROACH

1 - Bamfield Marine Sciences Centre, 2 - University Of Victoria, 3 - Fisheries & Oceans Canada, Pacific Biological Station

Invasive species are known for consuming more resources than native conspecifics, especially when those impacts affect industry. The European green crab (*Carcinus maenas*) is invasive on the west coast of British Columbia, Canada, and has the potential to impact shellfish aquaculture in the area by consuming product. We conducted a feeding experiment to determine whether *C. maenas* modifies its predatory behaviour when exposed to the effluent of the native red rock crab *Cancer productus*, which is a known predator and competitor. To determine whether *C. maenas* could have a disproportionate effect on cultured Pacific oysters (*Crassostrea gigas*) over a native predator, we also used functional response experiments to compare the predatory behaviour of *C. maenas* and *C. productus*. We found no effect of effluent on the feeding rate of *C. maenas*, suggesting that any exclusion by *C. productus* is not a result of chemical cues. We also found that predation by *C. maenas* increased asymptotically (Type II functional response) when fed increasing densities of *C. gigas*, while *C. productus* displayed a sigmoidal (Type III) response. Thus, at high prey densities we expect these two species will have comparable predation effects on *C. gigas* populations, despite *C. productus*'s considerably larger size. We predict that *C. maenas* will have a larger, potentially destabilizing, impact on low densities of *C. gigas*. If these results are consistent across prey species, this could negatively impact the native Olympia oyster (*Ostrea lurida*), which is of special concern.

Livingston, I.G.[*], Tiwari, A., Moreno, I.Y., Busch, A.R., Mora, M.F.[*], Dinsdale, E.A., Johri, S.

ASSESSMENT OF CHONDRICHTHYAN BIODIVERSITY IN WESTERN INDIA

No affiliation[s] given

Chondrichthyes (sharks, rays, skates, and chimaeras), one of the most diverse classes of extant vertebrates, are critical to top-down regulation of trophic interactions in marine ecosystems. Demand for chondrichthyan products has increased fishing pressure, threatening ~30% of species with extinction. Additionally, ~46% of species are data deficient, posing challenges to conservation of remaining populations. India is the second largest contributor of chondrichthyan landings globally. Among the species found in India, ~30% are threatened, and 37% are data deficient. Providing data for distribution and population numbers for these species is critical for conservation efforts. Here, we use biodiversity surveys of landing sites in western India to determine species being targeted by fisheries. Sampling was done at four primary chondrichthyan landing sites along the western coast of India -Okha, Veraval, Mangrol, and Porbandar. Chondrichthyan specimen samples from these sites were analyzed to determine taxonomic identities using morphological and molecular parameters. 102 samples were uploaded to the iNaturalist species identification database, where 31 species were identified. Possible range extensions were discovered for 3 species: Spotted Guitarfish (*Rhonobatos punctifer*), Gulf Torpedo (*Torpedo sinuspersici*), and the Spot-tail Shark (*Carcharhinus sorrah*), by comparing landing site locations and known geographic ranges from the IUCN Red List database. Data from these studies will reduce data deficiency affecting Chondrichthyes, and will inform conservation measures.

Mandy L. Hansen*

INVASIVE MANGROVES REDUCE HABITAT FOR BURROWING SHRIMP AND GOBY PAIRS IN KANEOHE BAY

San Francisco State University

Hawaii is a unique environment because it is so isolated. Many species that are native are also endemic. Hawaii ecosystems are venerable to invading species. Two invasive species including the red mangrove, (Rhizophora mangle) and the alga, (Gracilaria Salicornia) seem to be disrupting the habitat for the burrowing shrimp, (Alpheus rapax), and their mutualistic goby, (Psilogobius mainlandi). Although mangroves have been appreciated globally, they have caused problems for species in Hawaii by altering habitat features. Endemic species of Hawaii have not utilized the mangrove habitat. Shrimp/goby burrows appear to be abundant in sandy habitats. However, habitat utilization by the shrimp goby under the mangroves has not been evaluated. To determine if there was a difference in burrow density based on distance from mangroves, we compared burrow density by distance and then tested the effect of mangrove cover removal. There are significantly fewer burrows inside the mangrove area, and removal of mangrove cover resulted in increased burrow density.

Martone, M.A*, Traiger, S.B., Cohn, B.C., Panos, D.A., Nickols, K.J.

PHYTOPLANKTON COMMUNITY COMPOSITION INSIDE AND OUTSIDE KELP FORESTS

California State University Of Northridge

Coastal ocean primary producers, including phytoplankton and macroalgae, contribute to biogeochemical patterns by uptaking carbon dioxide and producing oxygen. Primary producers respond to changing oceanic conditions and may compete with each other for light and nutrients. We investigated phytoplankton community composition over time and space to contextualize productivity data inside and outside of kelp forests in coastal Monterey Bay. Using a 60 um plankton net, we collected phytoplankton from the upper 5 meters of the water column twice a week for 10 weeks at 2 sites during the summer of 2018 and at 2 sites during the summer of 2019. Site differed in wave exposure supplies different levels of oceanic properties to the community. Phytoplankton were identified to the lowest taxonomic level possible and relative abundance was estimated. We found that phytoplankton communities were similar in all kelp forests. There was also a transition from diatoms to dinoflagellates that corresponded with changes in upwelling patterns. While community composition was similar the abundance of phytoplankton was different inside and outside the kelp forests. This was indicated by higher amounts of chlorophyll a and particulate organic carbon (POC) outside of the kelp forest. When similar levels of productivity are observed inside and outside of kelp forests, they are likely driven by different primary producers. Understanding theses microscopic organisms will provide a necessary perspective for the processes affecting this ecosystem.

Matthews, A.M.*, Rempel, H.S., Ruttenberg, B.I.

IMPACTS OF MAJOR HURRICANES ON BENTHIC COMMUNITY COMPOSITION ON A CARIBBEAN CORAL REEF

Cal Poly Slo

Over the past few decades, the frequency of high-intensity hurricanes in the Greater Caribbean is increasing, contributing to the ecological stressors on coral communities. Hurricanes can greatly reduce coral cover, alter benthic community composition, and catalyze shifts from coral to algae dominated communities on less resilient reefs. In September of 2017, two successive category 5 hurricanes, Irma and Maria, struck the US Virgin Islands and caused major damage to St. Croix, USVI. The objective of this study is to compare changes in benthic community composition before and after hurricane damage on the main island of St. Croix and on the Buck Island Reef National Monument, a well enforced no-take marine reserve 2.5km off St. Croix's Northeastern coast. We compared four sites on St. Croix and three sites on Buck Island in July 2017 and July 2018. In order to quantify benthic community composition, we photographed twelve 0.5 x 0.5 m quadrats along 30m transects. Using CPCe, we classified coral and macroalgae to the genus or species level and identified functional groups of other organisms such as crustose coralline algae, turf algae, sponges and gorgonians. This study provides insight on the effects of a severe hurricanes on benthic community composition and compares differences in impact between fished reefs and no-take marine reserves.

Mcnealy, J.L.*, Aquilino, K.M.

SURVIVORSHIP OF CAPTIVE BRED WHITE ABALONE VARIES ACROSS AGE, LINEAGE, AND COHORT

Bodega Marine Laboratory, University Of California, Davis

SURVIVORSHIP OF CAPTIVE BRED WHITE ABALONE VARIES ACROSS AGE, LINEAGE, AND COHORT McNealy, J.L.1*, Aquilino, K.M. 1 1 – Bodega Marine Laboratory, University of California, Davis White abalone (*Haliotis sorenseni*) was the first marine invertebrate listed as endangered via the US Endangered Species Act. To recover this species, a consortium of partners led by UC Davis Bodega Marine Laboratory (BML) breeds white abalone in captivity for outplanting in the wild. BML's Captive Breeding Program has increased production of animals to outplanting size from merely a few dozen animals to thousands of animals annually in the past six years. However, production is at least an order of magnitude behind of what is necessary to save this species. In order to increase production, it is critical to understand variation in survival. The highest mortality in captive-bred abalone occurs in the first three months. Most effort has been dedicated to increasing survival at that stage; however, little attention has been given to mortality at older life history stages. Insights about mortality at these stages would optimize culture operations and inform stocking strategies. We investigated the mortality of 1- to 3-year-old white abalone grown at BML from 2016-2019. Mortality varied by animal age, spawning year, and parentage. These results can be used to identify strategies for increasing captive white abalone production for outplanting, expediting species recovery.

Merolla, S.M.*, Outcalt, A.M., Ricart, A.M., Sanford, E.D., Gaylord, B.P., Hill, T.M.

EFFECTS OF SEAGRASS ON OYSTER CALCIFICATION IN AMBIENT AND OCEAN ACIDIFICATION CONDITIONS

Bodega Marine Laboratory - University Of California, Davis

Ocean acidification (OA) is a substantial threat to marine calcifiers, such as shellfish that serve important roles in ecosystem habitat formation and in aquaculture. However, recent literature has suggested that photosynthetic organisms including macroalgae and seagrass could provide refugia for shellfish by modifying seawater chemistry, thus buffering the effects of OA. In this study the Pacific oyster *Crassotrea gigas* was incubated in laboratory chambers in the presence and absence of the seagrass *Zostera marina*. Incubations were conducted with both ambient (400 µatm) and elevated CO_2 seawater (1200 µatm) and ran in both light and dark periods. Rates of calcification for oysters were measured using changes in seawater total alkalinity. The presence of seagrass appeared to enhance calcification of the oysters in ambient seawater and light treatments. However, in contrast to our hypothesis and previous studies, seagrass did not increase calcification in the elevated CO_2 treatments. Changes in seawater chemistry produced by seagrass may not have been sufficient to counteract the negative effects of OA on oyster calcification, therefore additional analyses are planned that will investigate this possibility. Results from this study enhance our understanding of how seagrasses influence the performance of calcifying organisms, but more research is needed to elucidate the buffering capability of seagrass in response to future climate change.

Moffat, J.J.[*], Terhorst, C.P.

THERMAL STRESS RESPONSES OF MULTIPLE MICROALGAL ENDOSYMBIONT STRAINS

California State University, Northridge

Evolutionary rescue of a population can occur when selection for individuals with adaptive traits increase the frequency of those traits in a declining population. Rapid climate change can induce this type of eco-evolutionary response, however there must be standing genetic and phenotypic variation for selection to act upon. We tested whether different strains of an important microalgal endosymbiont, *Symbiodinium microadriaticum*, responded differently to environmental stress. We cultured five strains of *S. microadriaticum* at three temperatures, 26°C, 30°C, and 32°C, and measured growth rate, respiration, and photosynthesis. Strains responded differently to thermal stress, suggesting existing standing variation that could allow for evolutionary rescue. This is a preliminary investigation into the potential for evolutionary rescue by association in cnidarian-dinoflagellate obligate mutualisms. Most work on evolutionary rescue considers a single species, however, species interactions need also be considered when investigating evolutionary responses to climate change. Specifically, evolutionary rescue by association could occur if a mutualist is able to rapidly evolve and rescue the holobiont, without necessitating evolution in the host itself. Ongoing research will involve inoculating a cnidarian host, *Cassiopea xamachana*, with these symbiont strains to test if differential responses to thermal stress in culture are maintained in symbiosis and how these differences affect holobiont fitness.

Mora, M.F.[1*], Johri, S.[1], Pham, A.[2], Wong, A.[3], Chen. E.[4], Edwards, R.[1], Gersberg, R.[2], Verbyla, M.[3], Dinsdale, E.A.[1]

A METAGENOMIC LOOK AT THE NORTH CITY WATER RECLAMATION PLANT

1 - San Diego State University, Department Of Biology, 2 - San Diego State University, Department Of Public Health, 3 - San Diego State University, Department Of Environmental Engineering, 4 - Trussell Technologies Incorporated

San Diego's dependence on imported water has increased dramatically over the years. Currently, 85% of San Diego's water supply is imported at a cost which has tripled in the last fifteen years. In efforts to reduce such dependence, wastewater at the North City Reclamation Plant (NCWRP) is treated in order to produce reclaimed water that can be used for non-potable purposes and then treated at the North City Pure Water Facility to produce safe drinking water. A concern of the process is the types of microbes that may remain in the potable water. Here, we used metagenomics to describe the microbial communities present after each step in the treatment process. To do this, approximately 70-100 L of water from several of the steps in the treatment were collected. Each water sample was concentrated using tangential flow filtration and the microbial cells were collected using 0.2-µm Sterivex filters. The samples were prepared for DNA extractions and sequenced using the Illumina MiSeq. Upon sequencing, the raw data was checked for quality control and using bioinformatics software, we were able to look at the organisms present in our samples. The data showed there was a substantial difference among the microbial communities in each of the treatment steps. Medically relevant microbes such as Clostridia were removed by the process and other microbes such as Chlamydia showed intermittent presence during the process suggesting a succession of species.

Parsons-Field, A.B.[*], Caselle, J.E., Blanchette, C.A.

TEMPORAL PATTERNS OF CHANGE FOR INTERTIDAL SEA STAR AND BLACK ABALONE POPULATIONS AT SANTA CRUZ ISLAND FOLLOWING A MARINE HEATWAVE

Uc Santa Barbara

Sea star populations along the entire Northern American Pacific coast were decimated in 2013/14 as a result of Sea Star Wasting Syndrome (SSWS), including populations of the ochre sea star, *Pisaster ochraceus*, which plays an important role as a keystone predator in rocky intertidal systems. In California, this habitat is also home to the federally endangered black abalone, *Haliotis cracherodii*, an important herbivorous gastropod whose populations suffered from withering syndrome related mass-mortality in the 1980s. At five sites on Santa Cruz Island, CA, intertidal populations of both species were monitored annually in permanent survey plots from 2014 to 2019. Coincident with observed coast-wide mass-mortality, densities of *P. ochraceus* fell to zero or near zero at all five study locations by mid 2014, with negligible recovery and no evidence of significant recruitment over the next five years. Over the same time period, *H. cracherodii* populations fluctuated differently at each study location. Densities at three sites decreased in 2015 due in part to mortality as corroborated by direct observation of dead and dying abalone found washed ashore at one site. Densities increased at the two Western-most sites, especially from 2016-2019. Size structure data provides evidence of consistent recruitment of black abalone at Western sites with near zero recruitment observed at Eastern sites.

Patten, M. V. [1*], Buchbinder, M.V. [1], Merkel, K. [2], Boyer, K.E. [1]

MIX OR MATCH? MULTIPLE SOURCES OF EELGRASS IN RESTORATION MAY HEDGE BETS IN HIGHLY VARIABLE SAN FRANCISCO BAY

1 - San Francisco State University, 2 - Merkel & Associates

Eelgrass (Zostera marina) is valued in temperate estuaries throughout the world for services including stabilizing sediment and providing habitat for invertebrates, fishes, and birds. Eelgrass beds in San Francisco Bay have been damaged due to fill, boating, and pollutants. We have been conducting experiments to determine how best to restore eelgrass. Restoration efforts beginning in 2014 were designed to include experimental tests of donor source, replicated across sites and years. Following site selection using a habitat suitability model, we use small “test plots” to test site suitability, then expand plantings into multiple half-acre plots in which rows of transplants differ by donor (natural eelgrass beds where the plants were collected), or contain a mix of all donor sources. Preliminary results show strong effects of both donor source and year. At a site near Sausalito, plants from the closest natural bed have resulted in the greatest spatial coverage in some years. However, in other years, a further source gives the greatest coverage, suggesting that conditions in a particular year (e.g., temperature and salinity) matter. Interestingly, the mixture of sources is proving best at hedging bets, as it always contains the source that is most successful in a given year. In addition to spatial metrics, we are evaluating whether source and year interact to influence other characteristics, including densities, flowering rates, and invertebrate use. These data will inform future recommendations on whether to mix or match donors with site conditions in eelgrass restoration.

Peria,J.N. [1*], Pernet,B. [2]

TOLERANCE TO SALINITY AND THERMAL STRESS BY LARVAE AND ADULTS OF THE SERPULID ANNELID *FICOPOMATUS ENIGMATICUS*

1 - California State University, Northridge, 2 - California State University, Long Beach

The serpulid annelid *Ficopomatus enigmaticus* is a widely distributed invader of shallow-water, brackish habitats in subtropical and temperate regions, where it has numerous damaging ecological and economic effects. Its distributional pattern suggests that temperature and salinity play important roles in limiting its distribution. However, because other factors often covary with temperature and salinity, drawing strong conclusions from these patterns is difficult. In an effort to more clearly identify the effects of these factors, we examined tolerance to acute thermal (16-28°C) and salinity (0-35 psu) stress by larvae (5-day exposure, unfed) and adults (14-day exposure, unfed) of *F. enigmaticus* in laboratory experiments. Larvae showed higher mortality at the highest temperature tested, 28°C; adult survival was unaffected by temperature. Neither larvae nor adults survived exposure to pure freshwater (0 psu), but survived well at salinities ranging from 3.5-35 psu. In addition, high salinity did not slow tube growth in adults. These results suggest that salinity stress, in particular, is not directly responsible for the frequent limitation of *F. enigmaticus* to low-salinity habitats. Experimental work on the causes of the distribution of *F. enigmaticus* is uncommon in the literature, but is likely needed to identify the abiotic or biotic factors that limit the distribution of this frequently invasive species.

Perog, B.D.[*], Bowers, C.M., Lopez, C.Y., Torres, R.F., Zacherl, D.C.

EFFECTS OF SURFACE SHELL COVER AND TEXTURE ON THE RECRUITMENT OF NATIVE AND NON-NATIVE OYSTERS TO CONCRETE TILES IN SAN DIEGO BAY

California State University, Fullerton

Living Shorelines slow coastal erosion by promoting the growth of native foundation species that accumulate sediment and attenuate wave action. Oysters are historically abundant animals that are commonly targeted for Living Shorelines for their added benefit of filtering water. Concrete mixed with natural materials, such as shell, formed into a dome-shape structure with holes, called a reef ball, can be used as hard substratum to promote the growth and recruitment of oysters. We are investigating whether modifying the concrete shell composition and surface texture can preferentially recruit and promote the growth of native Olympia oysters, *Ostrea lurida*, and discourage the recruitment and growth of non-native Pacific oysters, *Crassostrea gigas*. We deployed four treatment types with surface shell (crushed and full shell) or without shell (smooth and rough concrete). The full shell and rough concrete surface had added surface texture to investigate the effect of rugosity on the recruitment of oysters. Seven replicates per treatment were deployed in San Diego Bay, CA, at 0 m MLLW from May to September 2018. We measured oyster growth and recruitment and found that *O. lurida* recruited in higher numbers than *C. gigas* on all treatments, but *C. gigas* had a higher percent cover than *O. lurida* on all treatments due to its larger size. Neither species showed a treatment preference. Restoration practitioners should decide whether percent cover or number of oysters is more important for Living Shorelines efforts aimed at restoring Olympia oysters with reef balls.

Pierce, K.M. [1*], Neumann, K.C. [1], Burkepile, D.E. [1], Zubia, M. [2]

MACROALGAL SPECIES RICHNESS AS AN INDICATOR OF NUTRIENT ENRICHMENT ON FRINGING REEFS IN MO'OREA, FRENCH POLYNESIA

1 - Uc Santa Barbara, 2 - Université De La Polynésie Française

Many of the fringing reefs around the island of Mo'orea, French Polynesia, lie near the mouths of streams and rivers, making them susceptible to degradation from terrestrial nutrient and sediment runoff. The topography of the island creates distinct watersheds, each of which flows out onto a distinct fringing reef area. The island's population and agricultural activities lie mainly in watersheds on the north shore, leaving the east and west shore of the triangular island less developed. This creates a unique opportunity to study and compare the effect of a range of land use, and subsequent watershed health, on the structure of fringing reef communities. To do this we collected dissolved inorganic nitrogen, phosphate, and total suspended solids data from 2017 to 2019 for nine nearshore watersheds in rainy and dry seasons. In August 2019, we conducted transects at fringing reef sites near the river mouths of these watersheds. These transects were conducted from the river mouth outwards, along a gradient of river plume exposure. Along these transects, we created an inventory of macroalgae species. With this inventory, we have examined macroalgal species richness at each site in comparison to river nutrient and sediment data. Using this relationship, we investigated macroalgae as a possible bioindicator of nutrient enrichment and identified species associated with higher nutrient levels in the adjacent river.

Pontier, O [1]*, Okamoto, D.K [2], Burt J.M [3], Hessing-Lewis, M. [1]

FACTORS INFLUENCING NEREOCYSTIS LUETKEANA SPATIAL AND TEMPORAL PRODUCTIVITY DYNAMICS ON THE CENTRAL COAST OF BRITISH COLUMBIA

1 - Hakai Institute, 2 - Florida State University, 3 - Nature United

Nereocystis luetkeana kelp forests are abundant contributors to primary production in the Northeast Pacific. *Nereocystis* forms a complex three-dimensional habitat that supports a diversity of fish and invertebrates. Unlike many other kelp species, *Nereocystis* is an annual species that shows high seasonal and interannual variability, with recruitment, growth and survival influenced by multiple abiotic and biotic drivers. To understand the interannual dynamics of *Nereocystis*, we've developed a monitoring program with three objectives: 1) empirically quantify *Nereocystis* productivity, 2) determine the morphometric properties driving productivity, and 3) understand the abiotic and biotic drivers of *Nereocystis* productivity in space and time.The measurements for *Nereocystis* are new and parameter standards, to date, have not been established. We present trends from three years of seasonal surveys at three sites on the Central Coast of British Columbia. First, multiple *Nereocystis* demographics exhibit seasonal trends and inform modelled estimates of productivity. Second, dynamics of *Nereocystis* blades and stipes both contribute substantially to productivity. Finally, abiotic conditions (e.g. temperature and nutrients) contribute differentially to *Nereocystis* dynamics across months, years and sites. With knowledge of the drivers influencing physiological and population dynamics, our ultimate goal is to be able to make predictions about kelp habitats in response to shifts in environmental conditions associated with climate change and human harvest.

Primo, A [1]*, Pruitt, J.N. [2], Osenberg, C.W. [3], Stier, A.C. [1]

INTRASPECIFIC VARIATION IN AGGRESSION DRIVES VARIATION IN MARINE SYMBIOSIS

1 - University Of California, Santa Barbara, 2 - Mcmaster University, 3 - University Of Georgia

Animals vary widely in their morphological and behavioral traits and this variation can have tremendous consequences for the dynamics and function of ecosystems. Historically ecologists have focused on variation in traits among species; however, more recent studies have documented that variation in traits within a species can meet or exceed the effects of variation among species. While the consequences of intraspecific variation are mainly researched when documenting such consequences in predator-prey interactions, this intraspecific variation is not as well-studied when considering its effects on mutualisms between species. Here we study how intraspecific variation in a coral-guard crab (*Trapezia serenei*) affects its capacity to defend *Pocillopora* corals from predatory sea stars. We subjected guard crabs to a series of behavioral tests to catalog variation in aggressive behavior among individuals and then used a mesocosm study to estimate how intraspecific variation in aggressive behaviors were linked to their capacity to deter coral predation. We found that behavioral variation in *T. serenei* significantly affected the intensity of coral predation where corals containing crabs with more aggressive temperaments lost less coral tissue to predation. This study successfully shows the importance of considering individual trait variation in mutualisms and indicates that including intraspecific

variation in our studies of mutualisms can allow us to explain variation that has historically been considered noise.

Pyles, A.M.[*], Claisse, J.T.

HABITAT USE PATTERNS OF GARIBALDI (HYPSYPOPS RUBICUNDUS) ON NATURAL AND ARTIFICIAL REEFS IN SOUTHERN CALIFORNIA WITH POTENTIAL IMP

California State Polytechnic University, Pomona

In southern California there is a need to understand the ecological variation between natural reefs and artificial reefs, and how this relates to their physical structural differences. The Los Angeles Harbor breakwall is an artificial reef that provides a high relief rocky reef structure which has relatively consistent habitat features across a depth gradient from the surface typically down to 15 or 20 meters where the quarry rock meets a sandy bottom. Garibaldi (Hypsypops rubicundus) is a protected marine damselfish found in southern California from 0-25m in depth. Territorial males prepare and defend a nest consisting of different red algae to attract females. Previous studies have indicated that females prefer nests with higher area of dense turf algae. Here we examine depth specific patters of Garibaldi habitat use and nest characteristics, as an initial part of an investigation of habitat quality of natural and artificial rocky reefs. We used a scuba diver operated stereo-video system to collect data on fish size structure, density, nest, and habitat characteristics across a depth gradient, and to determine if there is a correlation between male body size and nest area. We also used more traditional scuba-based survey methods to sample nest algal composition, and other nest and general habitat characteristics to compare techniques to quantify reef characteristics. Data from Los Angeles Harbor breakwall indicates that Garibaldi size structure varies with depths, and that these differences are correlated with multiple nest characteristics.

Quan, J.R. [1*], De Leon Sanchez, E.E. [1], Longman, E.K. [1], Sones, J.L. [2], Sanford, E. [1]

EFFECTS OF A RECORD-BREAKING HEATWAVE ON MUSSEL BED COMMUNITIES IN NORTHERN CALIFORNIA.

1 - Bodega Marine Laboratory, University Of California, Davis, 2 - Bodega Marine Reserve, University Of California, Davis

Heatwaves and other extreme events are projected to increase in frequency due to anthropogenic climate change. Past studies indicate that these disturbances can trigger mass mortality of intertidal invertebrates, including important sessile foundation species such as mussels. However, little is known regarding how mortality of mussels influences the diverse communities that live within mussel beds. In this study, we documented the extent and community consequences of mass mortality of California mussels (*Mytilus californianus*) in association with a record-breaking heatwave that struck northern California during June 2019. We surveyed the percentage of mussel mortality in randomly placed quadrats in Bodega Marine Reserve and compared the abundance and composition of invertebrates within plots with a low versus high percentage of dead mussel shells. Mean mortality of mussels in the upper layer of the bed was 30.4% in the high zone, and 24.1% in the mid zone. The Shannon-Wiener diversity index did not differ between plots with a high percentage of dead mussels and those with a low

percentage of dead mussels; however, the plots with a high percentage of dead mussels had a lower species richness and a lower total abundance of invertebrates. These results demonstrate that heatwaves can have immediate, negative effects on mussel bed communities, although additional research is needed to examine rates of recovery and the longer-term impacts of these extreme events.

Raemer, D.R.[*], Cass, C.J., O'Shea, D.C.

QUANTIFICATION OF MICROPLASTIC CONTENTS IN BIVALVES FROM HUMBOLDT BAY, CALIFORNIA USING ENZYMATIC DIGESTION METHODS

Humboldt State University

Microplastic (MP) contents of commercially cultured Pacific oysters (*Crassostrea gigas*) and wild mussels (*Mytilus edulis*) from Humboldt Bay (HB), California were evaluated. Mussels were collected from three locations in HB: North Bay (NB), Entrance Bay (EB), and South Bay (SB). Oysters were purchased from a commercial oyster farmer who cultivates them in the NB. Bivalves were digested with proteolytic enzyme complexes, vacuum filtered, and MP were quantified by microscopic examination of filters. All samples contained MP, with plastic fibers being the most abundant items. Significantly different concentrations of MP (plastic particles/g tissue wet mass) were found between mussels collected from different locations and from the cultured oysters ($p = 0.000$). Mussels from NB contained the highest average concentration of MP and were significantly different from all other groups. MP concentrations in EB and SB mussels were intermediate, and oysters contained the lowest concentrations. Half of the samples from each location were digested using the enzyme complex Corolase 7089, and the other half were digested with Corolase 8000. No significant difference in MP recovery was found between the two treatments ($p=0.253$). All samples treated with Corolase 8000 digested completely, whereas some of the samples treated with Corolase 7089 did not achieve complete digestion, suggesting that Corolase 8000 is more efficient for this purpose. This study is the first known evaluation of MP contents in bivalves from HB and demonstrates the use of low-cost industrial enzymes in the process.

Reed, K [1*], Forrester, G [2], Chille, E [2], Nickles, K [2]

BEHAVIORAL MECHANISMS UNDERLYING PARASITE-MEDIATED COMPETITION FOR REFUGES IN A CORAL REEF FISH

1 - California State University, Northridge, 2 - University Of Rhode Island

Parasites have been increasingly recognized as contributors to indirect ecological interactions, mainly through the process of host-manipulation. In our study system, the bridled goby host species (Coryphoptererus glaucofraenum) is infected by a parasitic copepod (Pharodes tortugensis) that attaches to its gills. We tested for a trait-mediated indirect interaction (TMII) where predator-prey contact between Coryphoptererus glaucofraenum and predatory fish is modified by Pharodes tortugensis. Because this particular parasite is not trophically transmitted via host manipulation, the altered behaviors in parasitized gobies are instead likely coincidental to infection. Gobies compete for crevices in the reef to avoid predation and it has been previously shown that goby mortality increases more rapidly with refuge shortage for parasitized

gobies than for their parasite-free counterparts. We found interactive effects of refuge shortage and parasitism on two behaviors we predicted might be associated with parasite-mediated competition for refuges. First, as refuges became scarce, the rate of aggression among gobies increased and parasitism intensified this interaction. Second, as refuges became scarce goby proximity to them increased, but parasitism nullified this response. In combination, these parasite-induced behavioral alterations may explain why parasitized gobies are poorer competitors for refuges.

Ren, X.*, Ormiston, J.T., Favoreto Jr., S., Mcconnico, L.A.

PATHOGENIC OR OPPORTUNIST? LABYRINTHULA SPP. ASSOCIATION WITH EELGRASS (*ZOSTERA MARINA*) IN MORRO BAY ESTUARY.

Cuesta College

Labyrinthula is linked to wasting disease and was associated with pandemic eelgrass declines in the 1930's and 1980's. Necrotic leaf tissue indicative of wasting disease is present throughout the Morro Bay Estuary, CA and the local eelgrass population (*Zostera marina*) has declined by 97%. Field and lab work (June 2018/2019) were done to determine the slime mold's presence in Morro Bay and to evaluate if it acts as a primary pathogen or opportunist. We collected "healthy" (green) and "necrotic" (green with black/ brown lesions) blades from the fore, mid and back bay (n=10 each site/blade type). In the lab, half of each blade was cultured on SSW media to detect *Labyrinthula* spp., and the other dried for DNA extraction and qPCR to quantify *Labyrinthula* spp. Excess Green Index (EGI) image analysis was used as a proxy for plant health. Both "healthy" and "necrotic" blades were positive for *Labyrinthula* spp. in culture at all three sites. qPCR results (2018 samples) also confirmed *Labyrinthula* spp. on both blade types at all sites, with the greatest concentration observed in the back bay. EGI analysis showed no consistent correlation between number of parasites and severity of lesions. The ubiquitous distribution and EGI results suggest that the *Labyrinthula* spp. in Morro Bay Estuary may not be a primary pathogen, but instead is an opportunist. Ongoing investigation will allow for an assessment of the slime mold's persistence and infection patterns. This work pioneers the research of *Labyrinthula* spp. in Morro Bay Estuary.

Reshitnyk, L.Y.*, Pontier, O., Mcinnes, W.S., Hessing-Lewis, M.

USING MULTIPLE REMOTE SENSING TECHNOLOGIES AND IN SITU DATA TO MAP THE EXTENT AND BIOMASS OF CANOPY-FORMING KELP

Hakai Institute

The use of remote sensing (RS) technologies is critical for mapping and monitoring of canopy-forming kelp (*Nereocystis luetkeana* and *Macrocystis pyrifera*). Ongoing work at the Hakai Institute is focused on using RS at different spatial scales (local, regional and coastal) to map the extent and biomass of kelp in British Columbia (BC). During the summer of 2019, paired SCUBA and drone surveys were conducted at *N. luetkeana* sites (n = 17) and *M. pyrifera* sites (n = 11) to compare methods for biomass estimation. Multi-tide surveys were conducted at annual monitoring sites (n=6) of both species to examine the effect of tide height on canopy extent. For regional mapping efforts, WorldView-2 imagery (2m) was collected across the BC

coast. These data will be used to examine species distribution and groundtruth coast-wide mapping efforts. At a coast-wide scale, we are continuing to develop a Google Earth Engine kelp mapping tool to integrate Sentinel imagery (10 m) as well as Landsat (30 m) imagery to produce coast-wide kelp extent datasets. The long-term goal is to develop a time series dataset on the extent and biomass of canopy-forming kelp to examine drivers of change for kelp and fill a significant gap in the spatial data needed for marine planning and resource management in nearshore ecosystems in BC. Next steps for this research are focused on expanding this work geographically in partnership with a growing community of kelp ecologists and mappers, including university scientists, government agencies and a field teams of community-based and Indigenous steward

Rex, P.T.[*], Lowe, C.G.

DRONING ON: USING UAVS TO QUANTIFY MARINE RECREATION AND JUVENILE WHITE SHARK ENCOUNTER RATES IN SOUTHERN CALIFORNIA

California State University Long Beach

There is evidence of population increase for white sharks, *Carcharodon carcharias*, in the Northeastern Pacific, coincidentally there has also been an increase in recreational beach activities. Southern California beaches serve as a juvenile white shark nursery habitat, and year-round human recreation areas. Evidence of increasing white shark population in northeastern Pacific Ocean, along with rising popularity of beach-related recreation may increase human-shark encounter probability. Although white shark bite rates have not risen, increased sightings and public fear of white sharks can negatively affect coastal tourism. Developing an understanding of nearshore recreation distributions, and quantification of human-white shark encounter rates may reduce beach safety concerns. Drone surveys are a cost-effective tool for gathering georeferenced census data for marine recreation groups and white sharks. They also provide a method to track sharks with high-resolution GPS and video to capture human-shark encounter location, and duration data. To date, 252 drone surveys have been flown across Southern California to quantify near-shore abundance, distributions, and interactions for sharks and 5 groups of marine recreation (waders, swimmers, bodyboarders, surfers, and stand-up paddlers). Shark-human encounters occurred during only 16 surveys, at 5 of 26 survey locations, with surfers having the most encounters to date. Additional aerial surveys via helicopter and deep-learning AI engines will be used in future analyses to quantify distance from shoreline and wave break.

Richardson, P.J. [1*], Walker, J.K. [2], Long, J.D. [1]

INCOMPLETE RECOVERY OF SALT MARSHES ONE YEAR AFTER EXPERIMENTAL MANIPULATIONS AND OBSERVER DISTURBANCES

1 - Sdsu, 2 - Sdsu/Uc Davis

Decisions about permit issuance for research in sensitive habitats should be determined by the ability of a habitat to recover from the specific disturbances the research will inflict. For example, manipulation of burrowing crabs in salt marshes could have legacy effects if manipulations persist after experiments. Similarly, the nature of the disturbance (e.g. vegetation removal

versus trampling by observers) could influence community recovery. Currently, however, our understanding of the lasting effects of experiments is lacking. We followed the recovery of experimental plots after the aboveground biomass was harvested at the completion of a 3-year manipulation of burrowing crabs in two southern California salt marshes. We surveyed crab burrows and vegetation in four plot types: 1) crab exclosures, 2) crab enclosures, 3) trampled areas surrounding exclosures/enclosures, and 4) undisturbed controls. At both marshes, burrow densities differed between treatments 1 & 2 even one year after cage removal. However, this did not translate into differences in the recovery of vegetation between these plots. Also, trampling decreased burrow density, perhaps because it shifted the community towards mud with a greater water content. But these trampling impacts were only seen at one marsh. Importantly, even after one year, experimental and trampled plots were less vegetated than controls. Thus, the recovery of salt marshes following experimental manipulations that included harvesting aboveground plant biomass may take longer than one year.

Ritger, A.L.*, Stier, A.C.

THE ROLE OF INTRASPECIFIC TRAIT VARIATION IN THE INTERACTION BETWEEN A CLONAL CORALLIMORPHARIAN AND PURPLE URCHIN

University Of California, Santa Barbara

Organisms often reduce their susceptibility to biotic and abiotic stressors by associating with other species, yet the role of intraspecific variation in determining the outcome of these positive interactions remains unclear. In temperate reefs along the California coast, the clonal corallimorpharian *Corynactis californica* provides an associational refuge to macroalgae from benthic grazers such as sea urchins. *C. californica* exhibit striking variation amongst colonies – in color, morphology, physiology, and behavior – and yet we have a limited understanding of how such variation may influence the ability of *C. californica* to defend macroalgae from grazing pressure. Here, I studied how trait variation among *C. californica* colonies influences purple urchin (*Stronglyocentrotus purpuratus*) foraging on giant kelp (*Macrocystis pyrifera*). I placed urchins in aquaria with one of three color morphs of *C. californica* and measured kelp consumption as well as urchin behavior. Overall, the presence of *C. californica* reduced kelp consumption by urchins and increased the time it took urchins to reach kelp. While urchins were least likely to consume kelp in the presence of red color morphs, the strength of the effect of *C. californica* on urchin behavior differed amongst color morphs. These findings suggest the role of intraspecific trait variation in positive interactions between *C. californica* and macroalgae may be subtle and warrants further study.

Rivera Larrea, I.A.*, Dr. Talley, D.M.

ASSESSMENT OF *FEROCACTUS GATESII* POPULATIONS IN BAHIA DE LOS ANGELES USING MANUAL COLLECTION AND UAVS

University Of San Diego

Bahia de los Angeles is an archipelago consisting of 16 islands with diverse cactus populations (West 2002). Restricted to a subset of these islands is an endemic cactus, the Bahía de los Ángeles biznaga (*Ferocactus gatesii*). Despite its rarity, and loss of individuals due to illegal

harvesting, there have been no quantitative surveys of this population, and little is known about their recruitment or ecology (West 2002). The goal of this study was to assess the *F. gatesii* populations in Bahia de los Angeles using both terrestrial and Unmanned Aerial Vehicle (UAV) methodologies, to assess the accuracy and effectiveness of UAV census for this species. From a total of 16 islands in Bahia de los Angeles, a subset of three islands were selected for this study. Dronedeploy was used to capture images, stitch them together, and form a high-resolution image of the island. These images were used to identify individual *F. gatesii*, and each was measured ("trunk" diameter) and assessed for reproductive status. The same parameters were collected on the ground. Surveyors walked the entirety of the islands and identified individual cactus. All parameters collected through field work were compared to those collected using UAVs. Preliminary analysis shows UAVs can correctly identify 100% of *F. gatesii* greater than 18 cm in diameter, while also identifying reproductive status. This suggests that, for monitoring adult populations of this threatened endemic, UAV surveys provide a rapid and effective method, but that there may be limitations in identifying newly-recruited individuals.

Saavedra, J.J.[*], Jackson, J.R, Demaria, D, Smith, D[*], Eckert, G, Brent, H.B

TESTING THE EFFECTS OF RECOVERING SEA OTTERS ON SEAGRASS ECOSYSTEMS IN SOUTHEAST ALASKA

No affiliation[s] given

Over time, the loss of a top predator can alter communities, ecosystem function and resilience. The purpose of this study is to investigate how the recovery of sea otters (*Enhydra lutris*), as top predators, effect their invertebrate prey within a seagrass (*Zostera marina*) ecosystem in southeast Alaska. Previous work in southeast Alaska has determined that sea otters and seagrass are positively associated, but what is unknown are the trophic mechanisms underlying this relationship. We conducted a reciprocal transplant experiment to test for the effects of sea otters on eelgrass communities. By moving seagrass in areas with low sea otter abundance to high sea otter abundance, and vice versa, we aim to determine the drivers of associations between sea otters and eelgrass. This experimental design allowed for a cage-free design in order to minimize cage artefacts. We also conducted benthic invertebrate surveys of crab and clams in eelgrass communities within our transplant experiments and adjacent seagrass beds to quantify trophic interactions. Here we present our preliminary results testing for the trophic effects of sea otters in eelgrass communities. Future efforts will aim to synthesize sea otter impacts to seagrass systems across their entire range.

Sanchez, M.L [1*], Ridder, E. [2]

USING TRACK SURVEYS AND CAMERA TRAPS TO ANALYZE MAMMAL MOVEMENTS AND USAGE OF SUBURBAN WILDLIFE CORRIDORS

1 - California State University San Marcos, Sonoma State University, 2 - California State University San Marcos

Rapid urban development can create habitat fragmentation, posing a threat to local wildlife. Wildlife corridors serve as linkages between habitats and can be an essential tool in protecting wildlife population viability. Three wildlife tunnels were built over a decade ago underneath

Valley Center Road, a busy highway next to the Daley Ranch conservation area in Escondido, CA. These tunnels serve as a corridor between Daley Ranch and Lake Wohlford, two habitats that provide essential resources to the local wildlife. The San Diego Tracking Team (SDTT) has performed quarterly surveys of wildlife observations within these tunnels since 2010. We have analyzed the results of these surveys to analyze how wildlife observations in the tunnels have changed from 2010 - 2018, and if wildlife tended to prefer one tunnel over the other tunnels. It was found that there was no significant difference in the quantity of observations of each species between the three tunnels. There was, however, a significant difference in the quantity of observations of each species from year to year. Although track surveys provide insight into wildlife use of the tunnels, there are several limitations with this method. We propose the use of camera traps in the tunnels to gain a better understanding of how wildlife behave in the tunnels, when they use the tunnels, and how many individuals use the tunnels. We also hope the camera traps will provide further insight as to how often humans are present in the tunnels. Cameras are currently placed throughout the Daley Ranch reserve to analyze wildlife movements.

Schouweiler, M.D.*, Bell, L.E., Kroeker, K.J.

EFFECTS OF PH AND TEMPERATURE ON THE EXCRETION RATE AND NUTRITIONAL QUALITY OF KELP FOREST GRAZER FECES

University Of California Santa Cruz

Herbivorous invertebrate species are the primary consumers of macroalgae in kelp forest environments. These species excrete large quantities of digested, nutrient-rich material as feces, creating a nutritional subsidy for benthic detritivores that are unable to directly consume larger, intact material. As ocean environments are predicted to become warmer and more acidic, this fecal supply may decrease as the primary grazers extract nutrients more efficiently to cope with changing conditions. This study focused on the fecal output of three common species of grazers in Southeast Alaska's giant kelp forests: green and red urchins, (*Strongylocentrotus droebachiensis* and *Strongylocentrotus franciscanus*) and pinto abalone, (*Haliotis kamtschatkana*). Twelve individuals from each species were collected from Sitka Sound, AK, placed in separate tanks with flow-through seawater and fed a diet of fresh *Macrocystis pyrifera* to satiation. Consumption and excretion rates for each invertebrate were quantified in ambient conditions (12°C, 8.0 pH) and in increased temperature and acidity (15°C, 7.6 pH). Algal and fecal samples collected during both trials were analyzed for differences in caloric content and carbon:nitrogen ratios to quantify relative nutritional quality. Preliminary analysis revealed no significant changes in consumption or excretion rates under different conditions. However, further analysis of the collected samples may demonstrate how an underappreciated food subsidy within kelp forest communities might respond to future ocean conditions.

Segui, L.M.*

DIASPORA AND DETRITUS: NON-NATIVE CRAYFISH IMPACT LEAF LITTER BREAKDOWN BUT NOT BENTHIC INVERTEBRATE COMMUNITY STRUCTURE

No affiliation[s] given

Species introductions can alter the relationship between trophic interactions and ecosystem processes. Often, introduced species reduce the abundance and diversity of biota in recipient food webs. However, ontogenetic diet shifts in the introduced species can alter the presence, degree or direction of these impacts on native species, making it difficult for scientists and managers to predict the ecological consequences of species introductions. I conducted a manipulative field experiment to assess the effects of crayfish species identity and ontogenetic stage on benthic invertebrate composition and abundance as well as leaf litter breakdown by native signal crayfish (*Pacifastacus leniusculus*) and introduced ringed crayfish (*Faxonius neglectus neglectus*). Treatments with signal crayfish and adult crayfish had higher reductions in leaf litter relative to treatments with introduced crayfish and juvenile crayfish. Alpha and beta diversity of benthic invertebrates was similar among treatments, but there were fewer shredders in treatments with adult crayfish. Thus, I show that ontogenetic stage and native vs. non-native status both matter for understanding the impact of species introductions on local ecological communities and ecosystem processes.

Slein, M.A. [1*], Kraskura, K. [2], Csik, S. [2], Hardison, E.A. [2], Eliason, E.J. [3]

UNDERSTANDING THE EFFECTS OF HYPOXIA ON THE PHYSIOLOGY AND FORAGING ECOLOGY OF PANULIRUS INTERRUPTUS (CALIFORNIA SPINY LOBSTER)

1 - Department Of Biology, Reed College, 2 - Department Of Ecology, Evolution, And Marine Biology, University Of California, Santa Barbara, 3 - Marine Science Institute And Department Of Ecology, Evolution, And Marine Biology, University Of California, Santa Barbara

Changing ocean environmental conditions (e.g. temperature, dissolved oxygen, pH) are imposing pronounced effects on coastal marine systems, including kelp forests. Kelp forests may provide refuge for organisms experiencing upwelling, characterized by low oxygen content and cold temperatures. As the climate continues to change, these upwelling events are predicted to intensify, thus raising concerns and questions about how organisms will respond to these new conditions. Here, we tested the effects of hypoxia on the heart rate (which can be used as a proxy for metabolism) and consumption rate of Panulirus interruptus (California Spiny Lobster). We exposed lobsters to either hypoxic (<50% air saturation (AS)) or normoxic (>90% AS) conditions for 24 hours and measured its effects on lobster 1) consumption rate of local mussel, Mytilus spp. and 2) heart rate. Hypoxia caused a noticeable decrease in consumption rate (of mussels over 24 hours) across all individuals as compared to individuals held in normoxic conditions. Preliminary results suggest that there was little difference in heart rate across individuals exposed to hypoxia versus individuals exposed to normoxia. These results suggest that severe upwelling and climate change associated hypoxia events may alter the feeding behavior of California spiny lobsters. Understanding how physiological processes, including metabolism, change in response to environmental conditions is key in determining potential ecological impacts.

Smith, J.R. [1*], Gilbane, L. [2], Ambrose, R.F. [3], Bell, C.A. [4], Burnaford, J.L. [5], Gaddam, R. [4], Miner, C.M. [4], Raimondi, P.T. [4], Whitaker, S.G. [6], Parsons-Field, A. [7], Multiple Marine Partners [8]

LONG-TERM COASTAL MONITORING BY THE MULTI-AGENCY ROCKY INTERTIDAL NETWORK (MARINE)

1 - California State Polytechnic University, Pomona, 2 - Bureau Of Ocean Energy Management, 3 - University Of California, Los Angeles, 4 - University Of California, Santa Cruz, 5 - California State University, Fullerton, 6 - Channel Island National Park, 7 - University Of California, Santa Barbara, 8 - Multi-Agency Rocky Intertidal Network

The Multi-Agency Rocky Intertidal Network (MARINe) monitoring program is the largest and longest-running project of its kind with more than 200 sites stretching from Alaska to Mexico, some being sampled for 30+ years (pacificrockyintertidal.org). MARINe conducts two survey types at different frequencies that, together, provide valuable information on spatial and temporal trends for rocky intertidal species. Coastal Biodiversity Surveys (CBS) sample all species to assess community similarities among sites and regions, and documents within- and among-site community change over time. Core Long-Term Monitoring (LTM) target specific assemblages and special interest species (ochre sea stars and endangered black abalone) to assess temporal changes. These long-term surveys allow us to detect changes in species abundances and distributions that deviate from “normal” and have been essential for: Natural Resource Damage evaluations; assessing impacts of urban runoff and human use; providing a baseline for designing and evaluating California Marine Protected Areas; evaluating Areas of Biological Significance; documenting the presence and spread of invasive species and disease outbreaks; examining ecosystem resilience; assessing populations for fisheries management; analyzing biogeographic patterns, and detecting species range shifts and alterations in community structure associated with climate change. The MARINe partnership of over 35 agencies and universities has proven to be a successful model for responsibly informing management and preservation of our coastal ecosystem.

Smith, L.S.*, Ryznar, E., Fong, P.

DO HIGH TEMPERATURE EXCURSIONS FACILITATE *SARGASSUM HORNERI* EXPANSION BY MAINTAINING GROWTH DURING KELP DECLINES?

Ucla

As climate change increases global temperatures, cold-intolerant invasive species have expanded poleward, making evaluation of the relationship between temperature and growth of invasives critical to predicting spread and evaluating impact. Concurrent with elevated water temperature during the recent ENSO in southern California, *Sargassum horneri*, an invasive brown alga, increased dramatically. To determine if growth of *S. horneri* varies with temperature and if this variation can be masked by herbivory, we are monitoring temperature and thalli growth +/- access to herbivores on Catalina Island. Twice a month we collect 20 *S. horneri* in each of 3 size classes (=10cm, >10cm & =100cm, and >100cm), weigh and measure height, attach half inside cages and leave half open to herbivory. Algae and a temperature logger are deployed for 5 days then collected, remeasured, and reweighed. Deployments will be repeated September-April to capture a wide range of temperatures. We will evaluate the relationship between temperature and growth both with and without herbivores. We expect *S. horneri* will maintain growth above temperatures known to result in *Macrocystis pyrifera* decline (20ºC), but this growth can be masked by herbivory. Preliminary results for September show *S. horneri*

=10cm grew taller when caged, but did not change weight. *S. horneri* between 10 & 100cm had grew in weight and height, with no difference between herbivore treatments. Daily average temperature was 20.9ºC, which indicates *S. horneri* can maintain growth above temperatures which cause decline in kelp.

Stirling, B.S.*, Anderson, J.M., Lowe, C.G.

IMPROVEMENTS IN PASSIVE ACOUSTIC TELEMETRY MONITORING: PERFORMANCE OF ACOUSTIC RECEIVERS

California State University, Long Beach

Passive acoustic telemetry is an important tool used to track the movements of marine and freshwater animals. Mounting position of acoustic receivers in the water column can impact detection efficiency due to factors such as refraction and reflection of the transmitted signal. A limitation of passive acoustic telemetry is often the rate at which data is obtained. Because subsurface-mounted receivers must be removed from their moorings and downloaded on the surface, time of data acquisition intervals may be months or more. Vemco real-time receiver buoys address this issue by providing real-time data via cell-networks. To have a rugged design that can withstand a potentially harsh marine-deployment, receivers must be mounted directly to the subsurface frame of a buoy. Cabled, digital receivers (VR2Rx) mounted to buoys were tested for detection efficiency and range in comparison with subsurface VR2W receivers. Range tests suggest that despite the buoy-mounted receiver being located near the surface (1 m) and VR2AR/VR2W receiver at depth (6 m), the performance between receivers was not significantly different. Subsurface receivers performed marginally better at close range (200-305 m), while the VR2Rx performed marginally better at far range (410, 565 m). Given the added benefit of real-time data combined with minimal reductions in detection efficiency, real-time buoys appear to be an important new tool in the field of acoustic telemetry. Because data acquisition is recorded and stored in real-time via cloud service, these systems are more cost and data efficient than VR2Ws.

Sugano, C.S.*, Hoshijima, U., Hofmann, G.E.

CYCLIC, EPISODIC, AND MACROPHYTE-DRIVEN ENVIRONMENTAL VARIABILITY IN THE CONTEXT OF OCEAN GLOBAL CHANGE

University Of California, Santa Barbara

The collection and utilization of long-term environmental data underlies our ability to forecast and manage the impacts of global change on marine ecosystems. While long-term time series of open ocean conditions exist, there is a paucity of long-term and high frequency environmental data for coastal marine ecosystems, which experience more dynamic fluctuations in seawater chemistry and temperature. In collaboration with the Santa Barbara Coastal Long Term Ecological Research program, we utilize oceanographic time series data collected from nearshore giant kelp forests to quantify environmental variability in the context of (1) the 2014 - 2015 marine heat wave in which the highest monthly mean temperature in the 17-year dataset was ~ 21.5˚C; (2) diel pH fluctuations and a strong upwelling event that reduced seawater pH by 0.2 - 0.3 pH units for nearly 11 days in the late spring of 2019; and (3) distinct dissolved oxygen

and pH dynamics inside and outside of a kelp forest. Overall, these and similar high-resolution time series highlight the spatiotemporal variability that coastal marine biota experience, and can help identify seasons and environments that may buffer or amplify the impacts of global change.

Switzer, Ethan.R [1*], Helaina Lindsey [2]

EFFECTS OF HYPOXIA ON VENTILATION RATE IN ENGLISH SOLE, PAROPHRYS VETULUS

1 - Csu Monterey Bay, 2 - Moss Landing Marine Labs

English sole(Parophrys vetulus) is a right-eyed flatfish commonly found along the west coast. Juvenile English sole use coastal estuaries as a nursery habitat, which unfortunately is susceptible to anthropogenic stressors, such as eutrophication. Hypoxia, the deficiency of oxygen, causes an increase in ventilation rate. This increase can result in vulnerability to predators and an increase in energy exertion, which negatively affects its survivability. Six treatments of dissolved oxygen(DO) were set up in twelve tanks containing ten fish each. After two weeks, the acclimated fish(n=60) were tested in trials of two tanks per treatment with five fish per tank in an array of ten experimental chambers made of 1.5cm thick polypropylene sheet. By counting operculum movements on GoPro footage, the ventilation rate is estimated from averaging between three one-minute measurements from start, halfway, and finish of the 30-minute recording. We expect to see a linear pattern of increased ventilation rate as DO decreases. Alternatively, the ventilation rate may stay constant and rapidly increase at a lower standard. This data will serve as a reference in determining the long-term effects hypoxia has on English sole population and how its nursery habitat can be protected from anthropogenic stressors.

Talley, D.M. [1*], Vanderplank, S. [2], Zatarain-Gonzalez, J. [3]

WINNERS AND LOSERS: CITIZEN SCIENCE COLLABORATION DETECTS CHANGES IN THE FLORA OF DESERT ISLANDS IN THE GULF OF CALIFORNIA

1 - University Of San Diego, 2 - Botanical Research Institute Of Texas, 3 - Comisión Nacional De Áreas Naturales Protegidas

The archipelago of Bahía de Los Àngeles (BLA), an International Biosphere Reserve and UNESCO World Heritage Site, comprises some of the floristically least-studied islands of the Baja California peninsula. In 2002, the floristic diversity and abundance on these islands was documented extensively by P. West. Working with a group of underrepresented minority high school students in the BAHIA program of Ocean Discovery Institute (ODI), we re-surveyed abundance data and assessed floristic change in the summer of 2016. Abundance was calculated using the ordinal abundance scale used by West for all perennial plant species of nine small islands in the archipelago. Island biogeographical patterns were assessed for island size and percentage of guano (which significantly affects floristic composition). Two of the islands have experienced significant losses in perennial species diversity over the last 14 years, but species such as the Cardón (*Pachycereus pringlei*) had increased in abundance on several islands. The number of non-native taxa on the islands was also assessed and has been seen to

decline, thanks to the efforts of the Mexican National Park Service (CONANP). Ice plant (*Mesembryanthemum crystallinum*) was only recorded on one of the islands visited.

Tettelbach, C.R.H. *

ACIDIFICATION AND ARDUINO: A COST EFFECTIVE APPROACH TO CLIMATE CHANGE MESOCOSM EXPERIMENTS

Estuary & Ocean Science Center, San Francisco State University

Mesocosms are a common tool used to study the effects of climate change on individual species, as well as on community responses. These systems attempt to mimic real-world conditions while altering variables such as temperature and pH in order to simulate climate change in a controlled setting. While mesocosm experiments represent a viable approach to this area of research, their implementation is often quite costly and can be inaccessible to those without substantial funding. One particularly expensive aspect is the control of experimental treatments using high-cost sensors and controller units. This project highlights a cost-effective solution for monitoring mesocosm treatments (temperature and pH, in a study of eelgrass and grazing response) through the use of DIY Arduino micro-controllers. Controllers were programmed to monitor and maintain the temperature and pH of four 55-gal header tanks at set intervals above or below the incoming seawater (+3^oC above ambient/-0.3 pH units below ambient). This allows treatment tanks to experience the same daily fluctuations as the ambient seawater, while common controllers are often restricted to static treatment values. Due to their low cost, accuracy (+/- 0.002), and general flexibility, controllers built using Arduino and accessory components are a viable way of reducing the overall cost of mesocosm experiments focused on climate change. This can in turn make studies of this nature more accessible, while maintaining highly accurate treatment levels.

Thomasdotter, A.O. [1*]**, Marks, L.** [2]**, Neuman, M.** [2]**, Beltran, N.** [3]

BEHAVIORAL RESPONSES OF CULTURED WHITE ABALONE (HALIOTIS SORENSENI) TO PREDATORY SEA STARS IN A LABORATORY EXPERIMENT

1 - San Jose State University, 2 - National Oceanic And Atmospheric Administration, National Marine Fisheries Service, 3 - University Of California, Santa Barbara

White abalone (*Haliotis sorenseni*) was listed as federally endangered in 2001. Current conservation efforts include outplanting cultured abalone to enhance wild populations. However, one challenge to the success of these efforts is the high risk of predation on captive-bred abalone, which are naïve to predators. This study aimed to investigate whether cultured white abalone exhibit defense responses when exposed to a predator, if those defenses allow the abalone to escape, and whether the abalone escape more quickly after multiple encounters. In a laboratory experiment, cultured white abalone were exposed to a predator, the Giant Spined Star (*Pisaster giganteus*), over three consecutive five-minute trials. The type and duration of abalone behaviors were recorded throughout each trial, and then compared to those observed during a control trial where abalone were touched by a non-biological sponge, as well as a baseline trial with no stimulus applied. The abalone altered their behavior when exposed to *P. giganteus* relative to control and baseline trials, effectively breaking contact with the sea star by

twisting (i.e., successive rotation of the shell) and galloping (i.e., rapid directional movement). They also escaped more quickly after the initial trial. These results indicate that cultured white abalone have an innate ability to recognize and respond to predators, and they can learn to escape more effectively through repeated encounters with predators. Predator exposure in the laboratory prior to outplanting may thus improve their survival in the wild

Ton, V.T.[*] , Hamilton, S.L.

PACIFIC HERRING (CLUPEA PALLASII) EXPERIENCE DETRIMENTAL EFFECTS OF OCEAN ACIDIFICATION AND HYPOXIA IN EARLY LIFE STAGES

Moss Landing Marine Laboratories

Climate change along the U.S. West Coast is altering ocean chemistry, and it has been predicted that oceanic conditions will become more acidic and hypoxic by the end of the century. Pacific herring (*Clupea pallasii*) are a forage fish that supports marine food webs, as a lower trophic level prey species, and provides sustenance to humans through important commercial and recreational fisheries throughout the northeast Pacific Ocean. This species may be vulnerable to changes in ocean chemistry, especially during embryo development and early life stages. To investigate the potential effects of ocean acidification and hypoxia on reproduction and development, *C. pallasii eggs* were collected at 2 sites Point Bolin and Discovery Bay, Washington and reared in 5 experimental single stressor treatments, simulating changes in pH and dissolved oxygen (DO): pH = 7.5, pH = 7.3, DO = 4 mg L^-1, DO = 2 mgL^-1 DO, and a control at ambient conditions. Once hatched, herring larvae were subsampled to compare differences in morphometrics (total length, yolk sac area, and eye diameter). Following hatching, larvae were sampled at Day 1 and 4 post-hatch to measure differences in heart rates, metabolic performance, and larval survivorship. We found that heart rates and survivorship significantly decreased under the low pH and DO treatments. Larvae from Discovery Bay were more tolerant than those from Point Bolin.

Tonra, K.J. [1*], Lasker, H.R. [2], Wells, C.D. [2]

PREFERENTIAL SETTLEMENT AND DECREASED SURVIVAL OF OCTOCORAL POLYPS ON ALGAL CRUSTS

1 - Oberlin College, 2 - University At Buffalo

In marine ecosystems, algal crusts provide a settlement cue and recruitment substratum, but can also aggressively compete via overgrowth and allelopathy with structure-building invertebrates such as corals, sponges, and worms, and inhibit settlement. We studied the impacts of crustose coralline algae (CCA), a known promoter of coral settlement, and the encrusting brown alga *Ramicrusta textilis*, an aggressive space competitor, on settlement and subsequent survival of a Caribbean gorgonian *Plexaura homomalla*. Planulae were given six days to choose between three pieces of coral rubble, which were mostly covered with CCA or *Ramicrusta* (“CCA” or “Ram”), or mostly not covered with algae (“Bare”). Settlement was greatest on CCA rubble, lower on Ram rubble, and lowest on Bare rubble. Within patches on each piece of rubble, polyps highly preferred CCA patches, showed no preference or avoidance for bare patches, and strongly avoided *R. textilis*. Survival was not different between rubble

types but was significantly different between patch types. After 20 days, survival was highest on bare patches (79%), lower on CCA patches (61%), and lowest on *R. textilis* patches (41%). Presence of crust encourages nearby settlement, regardless of crust type, but patch type is a more important factor in determining subsequent survival. These algal crusts may have defenses (e.g., shedding of epidermal cells) against settling octocoral larvae, which may result in a community composition shift in places where *Ramicrusta* continues to overgrow reefs.

Tripp-Valdez, M. A.[*], Cicala, F., Chacón-Ponce, K. D., López-Landavery, E.A., Galindo-Sanchez, C.E., Lafarga-De La Cruz, F.

GROWTH AND TRANSCRIPTOMIC PROFILE OF WARM-ACCLIMATED HYBRID ABALONE (HALIOTIS RUFESCENS X HALIOTIS CORRUGATA)

Centro De Investigación Científica y De Educación Superior De Ensenada, Ensenada, Mexico

Culture of red abalone (*Haliotis rufescens*) constitutes a prolific and rapidly growing activity. However, the low growth rate and sensitivity to high water temperatures still represent important bottlenecks in the production. Interspecific hybridization between abalone species with different thermal windows has the potential to overcome these limitations, improving growth rates even at high temperatures. In this regard, RNA-seq data provide a valuable resource to identify the physiological mechanism underlying the better performance of hybrids. In this study, we describe the growth in juveniles of pure *H. rufescens* (RR) and a hybrid cross of RR with *H. corrugata* (RAm) following three months acclimation at 18°C and 22°C. To evaluate the gene expression patterns, we constructed a reference transcriptome assembly using RR and RAm samples from each temperature. Our results show a lower growth rate of RR at 22 °C than at 18 °C, whereas RAm growth was similar in both temperatures and to RR at 18 °C. The RNA-seq data confirms different expression patterns between warm-acclimated RR and RAm. However, a differential expression analysis between the 22 °C and 18 °C treatments from each cross evinced that RAm presented a higher proportion of down-regulated genes involved in catalytic activity and cellular metabolic processes. Together, these results suggest that hybrid abalone can compensate for increased temperature following different gene regulation strategies than the pure cross, allowing it to sustain growth performance even after three months of warm acclimation.

Valenzuela-Apodaca, E. A.[1*], Bello-Bedoy, R.[2], Arteaga-Uribe, M. C.[1]

DEFENSIVE RESPONSE TO MECHANICAL DAMAGE AND HERBIVORE RESISTANCE IN DOMESTICATED AND WILD CHILI CAPSICUM ANNUUM VAR. GLABRIUSCULUM

1 - Centro De Investigación Científica y De Educación Superior De Ensenada, 2 - Universidad Autónoma De Baja California

Domestication has drastically changed phenotype of cultivated plants. Evidence indicates that life-history and morphological traits differ between domesticated and wild relatives. In relation to defense to herbivores, cultivated plants are expected to show lower resistance and tolerance to herbivores than wild relatives, because of a reduction in the strength of selection on these traits. We examined whether resistance and tolerance decreased in cultivated chilies serrano and poblano, in relation to wild chiltepín chili. To examine tolerance, we inflicted damage of 0%, 25%

and 50% on leaves of wild and domesticated chilies. Tolerance was quantified as relative growth rate (RGR), chlorophyll and biomass allocation. Resistance measurements were leaf total phenolic content, trichomes density and survival and performance of an herbivore larval. Wild chili showed no changes between treatments on tolerance traits indicating full tolerance, whereas plants with 50% damage declined heterogeneously on RGR and fruit biomass on serrano and poblano plants, respectively. Resistance was higher in wild than in cultivated varieties. Larvae fed with wild chili leaves had a 0% survival, while a 73.33% survival was found on larvae fed with domesticated varieties. A reduction of total phenolic content was observed on 50% damaged plants of wild and poblano chili. Leaf trichome density increased only in serrano with 50% damage. Overall, resistance and tolerance were higher in the wild than in the cultivated chilies, supporting the notion that domestication reduces plant defense.

Vargas-Peralta, C.E.[*], Del Río-Portilla, M.A., Lafarga De La Cruz, F., Barón-Sevilla, B., Farfán, C.

COMPLETE MITOCHONDRIAL GENOME OF PARALICHTHYS CALIFORNICUS

Cicese

The California halibut *Paralichthys californicus* is a highly prized flatfish due to its size, meat quality and market price. Within the finfish category, in Baja California the flatfish fishery ranks sixth in terms of average annual production value. This fishery is multispecific, but commercially, *P. californicus* stands out in the domestic and export markets. Given the demand, variability in flatfish landings during the last decade and decrease to 246 ton in 2018 (CONAPESCA, 2018), value close to the reference point of sustainability issued by INAPESCA for flatfish fisheries, it is important to generate biological and genetic information to potentiate its cultivation and provide genetic tools to develop fishery management strategies. This work presents the complete mitochondrial genome of *P. californicus*. Total DNA from gill tissue was extracted and sequenced using MiSeq by Illumina. Reads were cleaned, trimmed and de novo assembled with the CLC Genomics Workbench 6.5 software and annotated with DOGMA (Wyman et al. 2004), and MITOS (Bernt et al., 2013) programs. Protein translation was verified with ExPASy (http://www.expasy.org) and the phylogenetic analysis with MEGA software (Tamura et al., 2013).

The obtained nucleotide reads, after trim, were of 3,243,808. The mitogenome was found in a single contig 16,858 bp in length coding 13 protein genes, 22 tRNAs and two rRNAs. Compared to the mitogenome of other flatfishes *P. californicus* mitogenome was most similar to *P. olivaceous*.

Vazquez-Alfaro, D.L. [1*], Eernisse, D. J. [2], Lafarga-De La Cruz, F. [3]

PROTOCOL FOR MOLECULAR STUDIES OF *MEGATHURA CRENULATA* (SOWERBY, 1825)

1 - Facultad De Ciencias Marinas. Universidad Autónoma De Baja California, 2 - Department Of Biological Science, California State University, Fullerton, 3 - Departamento De Acuicultura. Centro De Investigación Científica y De Educación Superior De Ensenada, B.C.

Megathura crenulata also known as keyhole giant limpet is a gastropod outstanding for the immunological use of its KLH protein, otherwise, its genetic information is limited. The molecular

studies have been widely applied to several species of commercial importance, however, there are some species of biomedical, nutritional and ecological importance that don't have a consistent and continuous register of fishery, as *M. crenulata*.

The aim of this study is to standardize a protocol for DNA extraction from *M. crenulata´s* hemolymph, a non-destructive genetic sampling method. So, hemolymph from six limpets were collected following the US #6,852,338 B2 protocol. Total DNA was extracted using two commercial kits: QIAGEN DNeasy Blood and Tissue, and KingFisher Cell and Tissue DNA. Different volumes of sample, lysis times and centrifugation were tested. PCR amplification of species-specific 16S primers (unpublished) was performed to discard inhibitors presence in the DNA extracted.

Results shown that it is possible to get a good quality DNA from 100 µL of hemolymph with both kits and DNA concentration, integrity and purity was suitable for PCR amplification. This protocol will allow to perform diverse molecular studies related to phylogenetic, population genetics and parental analysis using molecular markers.

Waite, H.R.[*], Sorte, C.J.B.

DOES THE APPLE REALLY NOT FALL FAR FROM THE TREE? : PARENTAL EFFECTS ON LARVAL THERMAL TOLERANCE IN THE MUSSEL, MYTILUS TROSSULUS

University Of California Irvine

Under climate change conditions, marine organisms will need to cope with or adapt to increasing temperatures in order to persist. Parental effects, where offspring responses to environmental change are influenced by environments experienced by parents, may include mechanisms of coping with thermal stress. This study evaluated the degree to which thermal tolerance of larvae of the mussel, *Mytilus trossulus*, is influenced by parental environments. Adult mussels were collected from two sites of varying thermal stress on San Juan Island, WA: Friday Harbor Laboratories dock (FHL; low stress subtidal population) and False Bay (FB; high stress intertidal population). Air, water, and body temperatures were recorded in the field, and LT_{50} thermal tolerance (temperature lethal to 50% of individuals) trials were conducted on field-collected adults and their veliger larvae raised in the laboratory. Environmental temperatures and in situ mussel body temperatures were higher at False Bay (Mann-Whitney: $p<0.001$). Thermal tolerance was slightly higher in adults from the high stress environment than those from the low stress site. Despite predictions that larvae are more vulnerable and rarely experience such high temperatures in the water column, larval tolerances were surprisingly high when exposed to only one hour of elevated temperatures. In addition, larval tolerances were not significantly different between sites (T-Test; $p=0.2424$). These results raise questions about the role of parental effects in thermal tolerance and vulnerability to thermal stress across ontogeny.

Waldschmidt, A.J. [1*], Bolwerk, A.T. [2], Eckert, G.L. [2]

PINTO ABALONE CRYPTIC BEHAVIOR IN RELATION TO THEIR SIZE AND HABITAT COMPLEXITY IN SOUTHEAST ALASKA

1 - University Of Alaska Southeast, 2 - University Of Alaska Fairbanks

Pinto abalone (*Haliotis kamtschatkana*) abundance declined drastically in Southeast Alaska, largely as a result of overharvest during commercial fisheries in the 1980s and 1990s. These declines reduced abalone abundance so much that abalone are no longer found at their traditional harvesting sites. We were interested to explore abalone cryptic behavior, as it may reflect how susceptible they are to predation and may change with variation in resource availability and substrate type. We worked with a local Alaska Native tribe, the Hydaburg Cooperative Association, and local harvesters, who identified 18 traditional harvest sites with historically high abalone abundances in their region. At each site we surveyed one 20 x 2 m transect within the depth where traditional harvest occurs (1 m) and one below the reach of most traditional harvesters (3 m), but within the optimal abalone depth range. We quantified abalone density and scored each abalone's cryptic behavior on a scale from very hidden to completely exposed. We categorized primary and secondary substrate types and calculated an overall complexity score for each transect. Because large abalone are harder to remove from the rocks making them less susceptible to predation, we hypothesize that larger abalone would be more exposed than smaller abalone. If abalone prefer to seek out resources rather than hide from predators, then abalone should be found to be exposed no matter the substrate complexity. We plan to share our results with local harvesters to provide information on the status of this valuable resource.

Weinstock, J.B. [1*], Reyns, N.B. [2], Pineda, J. [1], Swiderski, M. [2], Flerchinger, D. [2]

LUNAR AND TIDAL CYCLES IN BARNACLE (*CHTHAMALUS* SPP.) TIMING OF REPRODUCTION AND SETTLEMENT

1 - Woods Hole Oceanographic Institution, 2 - University Of San Diego

Barnacles are important competitors for space in intertidal habitats, and the timing of their reproduction and settlement plays a major role in determining their potential dispersal and ultimate recruitment. Our goal was to monitor *Chthamalus* spp. in coastal Southern California over multiple years to test whether lunar and tidal cycles play a role in local timing of reproduction and settlement. We collected 100 adult barnacles daily from June to November 2016 and May to August 2017 at Bird Rock, San Diego. We inspected individuals under a stereomicroscope and categorized them by reproductive stage, ultimately calculating the proportion of each stage per sampling date. Settlement plates were also collected and replaced daily from April to July 2014, October 2014 to January 2015, April to August 2015, September to December 2015, and April to July 2016. The number of settlers were counted and normalized by suitable settlement area. Sea level data were obtained from a NOAA tide station at La Jolla, CA, and temperature data were collected near the settlement plates. For all biological, sea level, and temperature data, we calculated and assigned each sampling date to a lunar day. We then used a randomization test to evaluate the periodicity of reproduction and settlement. Our results revealed significant periodicity corresponding to lunar and tidal cycles in *Chthamalus* spp. reproduction, but not in settlement, indicating that these patterns exist in reproduction but potentially break down during dispersal.

Woods, M.B. [1*], Brown, N.A.W. [2], Balshine, S. [3], Juanes, F. [1]

SHIPS AND MIDSHIPMAN FISH: HOW BOAT NOISE AFFECTS AGGRESSION AND PARENTAL CARE OF THE PLAINFIN MIDSHIPMAN FISH

1 - University Of Victoria, 2 - Mcmaster University, University Of Victoria, 3 - Mcmaster University

Many fishes are largely reliant on sound for communication, prey and predator detection, and navigation. Over the last century, rising levels of anthropogenic noise have been introduced into the ocean, greatly altering the underwater soundscape. The highly vocal plainfin midshipman fish, *Porichthys notatus*, has a long and energetically-costly parental care period, during which a male guards a nest and cares for his eggs. *P. notatus* relies on sound production and reception for mate attraction and agonistic encounters, including nest defence; therefore, alteration of the environmental soundscape has the potential to affect reproductive behaviour, including nest-guarding and parental care. We are conducting a two-part study to investigate the effect of boat noise on the behaviour of *P. notatus* guarder males during nest defence. Using a within-subjects design, we exposed guarder males to a nest-invading crab threat stimulus in the presence and absence of boat noise. We first conducted these experiments using fish housed in individual tanks; the captive fish exhibited more aggressive behaviours in trials during boat noise playback compared to trials with only ambient conditions. We then repeated the experiments *in situ* at an intertidal breeding site. Our results will help explain how boat noise affects fish behaviour and mediates parental care. As anthropogenic noise continues to increase, understanding how it affects aquatic organisms is crucial in order to appropriately mitigate such effects.

Wu, M.L.V.*, Paig-Tran, E.W.M., Forsgren, K.L., Zacherl, D.C.

EFFECT OF SHELL AND MUSCLE CONTRACTION BEHAVIOR ON GAMETE PLUMES AND EGG VELOCITIES OF THE RED ABALONE, *HALIOTIS RUFESCENS*

California State University Fullerton

Abalones and other free-spawning marine invertebrates require dense aggregated populations for successful fertilization. Due to a long history of anthropogenic impacts, most Southern California abalone populations exist in low density aggregations. Reduced adult aggregations that are few and far apart may impact fertilization success. Abalones have evolved specific reproductive strategies to assist with fertilization success such as synchronized spawning and conspecific sperm chemotaxis. Abalones have also been observed to contract their muscular bodies while spawning, which may be a mechanism as yet unquantified that could assist with successful fertilization. We are examining the effects of bodily muscular contractions on gamete plume heights and gamete velocities in the red abalone, *Haliotis rufescens*. We hypothesize that the heights of ejected gamete plumes will increase with increasing contractile force, but that the gamete velocities are more density dependent. We measured the force of spawning red abalone contractions with a force transducer, while simultaneously recording the heights of the resultant gamete plumes with a GoPro, and capturing the egg particles as they exit the respiratory pores in high-speed frames of an Edgertronic camera. We measured the parameters of the plumes and gametes on Kinovea and compared them to the force data. Our novel research will enhance our knowledge of evolved abalone behaviors that assist in fertilization success and help guide out-planting strategies for on-going and future abalone reintroductions.

Zellmer, A.J. [1]*, Claisse, J.T. [2], Williams, C.M. [2], Schwab, S. [3], Pondella, D.J. [1]

PREDICTING OPTIMAL SITES FOR ECOSYSTEM RESTORATION USING STACKED-SPECIES DISTRIBUTION MODELING

1 - Vantuna Research Group, Occidental College, Los Angeles, Ca, Usa, 2 - California State Polytechnic University, Pomona, Ca, Usa, 3 - University Of California, Riverside, Ca, Usa

Habitat restoration is an important tool for managing degraded ecosystems, yet the success of restoration projects depends in part on adequately identifying preferred sites for restoration. Species distribution modeling using a machine learning approach provides novel tools for mapping areas of interest for restoration projects. Here we use stacked-species distribution models (s-SDMs) to identify candidate locations for installment of manmade reefs, a useful management tool for restoring structural habitat complexity and the associated biota in marine ecosystems. We created species distribution models for 21 species of commercial, recreational, ecological, or conservation importance within the Southern California Bight based on observations from long-term reef surveys combined with high resolution geospatial environmental data layers. We then combined the individual species models to create a stacked-species habitat suitability map, identifying over 800 km^2 of potential area for reef restoration within the Bight. Our results demonstrate that the existing manmade reefs included in our study on average are located in regions with habitat suitability that is not only less suitable than natural reefs, but also only slightly significantly better than random, demonstrating a need for more biologically informed placement of manmade reefs. The stacked-species distribution model provides insight for marine restoration projects in southern California specifically, but more generally this method can also be widely applied.

Contributed Talks

* indicates presenting author

† indicates eligibility for Best Student Paper/Poster Award

Abbott, D.*, Freiwald, J., Mchugh, T., Mcmillian, S.

VARIATION IN THE RESPONSE OF KELP FOREST ECOSYSTEMS TO ENVIRONMENTAL STRESSORS ALONG THE COAST OF CALIFORNIA

Reef Check Foundation

From 2013 to 2015 kelp forest ecosystems along the California coast north of Point Conception underwent a series of environmental stressors, including the loss of sea star species due to Sea Star Wasting Disease; warm water events, including the warm water “blob” (2014 & 2015) and the warmest El Niño on record (2015/2016); and a large recruitment pulse of purple sea urchins. These events have caused many of the state’s kelp forest ecosystems to undergo dramatic changes. However, areas along the coast responded differently to these events both due to differences in the severity of the events and due to differences in the structure of the kelp forest

communities themselves. While these events have caused dramatic phase shifts to urchin barrens in many kelp forests, other sites have remained stable. Data from 52 sites collected by Reef Check volunteer scuba divers from 2006 to 2019, as part of a statewide kelp forest monitoring program, were used to compare how these events have affected kelp forest ecosystems in different regions. North of San Francisco, a transition from kelp forest to urchin barren has been widespread and persistent. South of Point Sur, kelp forests have remained stable despite the loss of a major urchin predator, the sunflower star, and in the Monterey/Carmel Bay area outcomes have varied dramatically. Some reefs have shifted to persistent barrens, others remain kelp forests, some have oscillated between the two states, while still others shifted from a giant kelp dominated ecosystem to an urchin barren and eventually to a bull kelp dominated forest.

†Adamczyk, E.M.*, O'Connor, M.I., Wegener Parfrey, L.

TRANSPLANT EXPERIMENT REVEALS INSIGHT TO SPECIFICITY OF EELGRASS BLADE MICROBIOTA

University Of British Columbia

Eelgrass (*Zostera marina*) is a foundation species that provides habitat for diverse species of fish, crustaceans, mollusks, algae, and microbes, which enhance productivity and stabilize eelgrass ecosystems. It is increasingly apparent that the functions provided by the eelgrass microbiome can support host health through nitrogen fixation, sulfide detoxification, and producing agarases that prevent epiphytic algae overgrowth. However, there is a knowledge gap for how bacterial communities colonize eelgrass blades and how established communities persist. We hypothesize that eelgrass is a passive surface for bacteria colonization. We reciprocally transplanted eelgrass shoots and eelgrass analogues among four meadows with different environmental conditions. Our three treatments included: live eelgrass, dead/sterile eelgrass, and artificial seagrass units. We determined: 1) Turnover of eelgrass microbiota when shoots were introduced to a meadow with a different microbial pool, and 2) Composition of eelgrass microbiota compared to microbes that colonize sterile/dead eelgrass and passive marine surfaces. We found that a proportion of the original bacterial community remained the same following transplanting, while some species were replaced by others, indicating that eelgrass may be selecting for specific bacteria. We also found that the microbiota on live eelgrass was different from microbiota colonizing the dead and artificial blades. These results suggest that some of the eelgrass blade microbes have a strong relationship with their host and may influence eelgrass health.

Adreani, M.S.*, Steele, M.A.

REPRODUCTIVE OUTPUT AND RECENT SHIFTS IN SIZE AT MATURITY AND SEX CHANGE IN CALIFORNIA SHEEPHEAD

California State University Northridge

The California sheephead, *Semicossyphus pulcher*, supports a commercial fishery and is a valued target of recreational fishers in southern California USA and Baja California, Mexico. It is also ecologically important in kelp forests where it plays a key role in controlling populations of

sea urchins, which can locally eliminate kelp. Despite the importance of this species, its reproductive rates are poorly known, hampering effective management. For 10 years, we have collected female sheephead to characterize the duration of the spawning season, the frequency of reproductive bouts, batch fecundity, and annual fecundity of females. We also evaluated size and age at maturity for females in this protogynous species during their nearly 4-month-long spawning season. At our southern California study sites, which span from San Clemente to Oceanside, CA, there is persistent and heavy fishing pressure by recreational anglers and spearfishers. During the recent years of our study, we have noted a decrease in mature females and an increase in transitional individuals and early stage males. This indicates a shift to becoming male at an earlier size and age and even a transition prior to ever reproducing as a female. This is likely a combination of very successful recruitment during the recent warm water years, producing more females than can successfully reproduce and a heavily skewed male:female sex ratio on those reefs.

Aguirre, J.D. [1*], Muir P.R. [2], Done, T. [3]

STRONG PHYLOGENETIC SIGNAL FOR MASS CORAL BLEACHING WITHIN REGIONS, BUT NO EVIDENCE FOR PHYLOGENETIC CONSTRAINTS BETWEEN REGIONS

1 - Massey Univeristy Auckland, Auckland, New Zealand, 2 - Queensland Museum, Townsville, Queensland, Australia, 3 - Australian Institute Of Marine Science, Townsville, Queensland, Australia

Mass coral bleaching events related to unusually high sea temperatures have caused high mortality of corals over extensive geographic areas, and are widely predicted to increase in frequency and severity in the near future. Despite the devastating effects that mass bleaching events have on corals, associated biodiversity and human populations, little data exist on the bleaching susceptibility of individual corals identified to the species level, and for a large proportion of the reef building coral community, limiting our potential to predict the impacts of these events at large-scales. Here, we quantify individual variation in bleaching susceptibility for some of the most common Indo-Pacific corals in two of the world's most diverse coral reef systems: Ari atoll, Republic of the Maldives and Great Barrier Reef, Australia. We found that phylogenetic effects strongly influenced bleaching susceptibility in each region; however, the most bleaching susceptible clades differed between regions. Moreover, processes operating over shorter time-scales such adaptation and acclimatisation modified phylogenetic contributions to bleaching susceptibility. Overall, our data indicate that assessments of species' bleaching susceptibility and extinction risk cannot be applied over wide geographic areas and suggest that phenotypic responses to mass bleaching are occurring over relatively short time scales.

†Allard, H. [1*], Haggitt, T. [1], Ayling, T. [1], Shears, N. [2]

LONG TERM CHANGES TO REEF FISH ASSEMBLAGES IN NEW ZEALAND'S OLDEST MARINE RESERVE, AND THE GENERALITY OF RESERVE EFFECTS

University Of Auckland

Marine reserves can increase the abundance and size of targeted fish species, but the long-term effects of protection on the wider fish assemblage are less understood. New Zealand's oldest no-take marine reserve was opened at Leigh in 1977, and the benefits for target species like the sparid snapper *Chrysophrys auratus* were described soon after. In the decades of reserve status since, a trophic cascade has been described: the recovery of targeted predator species has suppressed sea urchin grazing, leading to the loss of heavily grazed "urchin barrens" and dominance of kelp forests. The long-term effect of these changes on the wider reef fish assemblage is largely unknown. A number of flow-on indirect effects have been hypothesised, although field studies testing these are rare. We investigated how reef fish assemblages within the Cape Rodney-Okakari Point (Leigh) Marine Reserve have changed after 40 years of reserve protection (1978 and 2018). We also investigated the generality of reserve effects in three northern NZ marine reserves.

We provide further evidence for the positive direct effects of protection and habitat changes in Leigh marine reserve, and describe several potential indirect effects. These include an increase in biomass of herbivorous silver drummer *Kyphosus sydneyanus* with the proliferation of kelp forests and a decline in spotted wrasse *Notolabrus celidotus*, perhaps in response to predatory fish recovery. We describe how the direct effects of protection were ubiquitous across three marine reserves, but indirect effects are largely localised.

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DOES IT MATTER WHERE MY PARENTS GREW UP? TRANSGENERATIONAL PLASTICITY OF OLYMPIA OYSTER LARVAE

1 - University Of Washington, 2 - Puget Sound Restoration Fund

Transgenerational plasticity can play an important role in the adaption of marine species to climate change. To test the potential for transgenerational effects in the Olimpia oyster (*Ostrea lurida*), we outplanted adult oysters to four sites in Puget Sound, Washington (for six-months) and determined if in situ conditions have the potential to affect the success and fitness of their offspring. Puget Sound's unique and variable oceanography serves as an exceptional "natural laboratory" to examine in a field setting the effects of seasonal anoxia, ocean acidification, extreme warming, algal blooms, and seasonal shifts in the pycnocline. Oceanographic conditions were coupled with biological measurements by placing shellfish cages onto the mooring line of Oceanic Remote Chemical Analyzer (ORCA) buoys. Higher growth in outplanted oysters was associated with high temperatures and thermal variability in the field. Larvae from parents outplanted to different sites did not show differences in growth when reared at 14°C but larvae whose parents experienced warmer temperatures grew up to 66% larger at 20°C. For all sites, larvae held at 20°C had better survival than at 14°C. Strong parental effects were observed in larval respiration. Short-term experiments revealed that larvae from parents exposed to the lowest thermal variation in the field (9-14°C) had higher respiration rates at 20°C (the thermal optimum). Our results show that larval thermal tolerance is a dynamic trait under the parental influence which has important implications for restoration and mitigating the effects of cl

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QUANTIFYING RESIDENCY AND SPACE USE PATTERNS AT HOTSPOT LOCATIONS IN SOUTHERN CALIFORNIA JUVENILE WHITE SHARK NURSERY AREAS.

1 - California State University Long Beach, 2 - Monterey Bay Aquarium

Evidence gathered from satellite telemetry studies over the last decade has pointed towards the Southern California Bight serving as important nursery habitat for Young of the Year (YOY < 175 cm TL) and juvenile (<200 cm TL) white sharks (JWS) (*Carcharadon carcharias*). While these studies have provided important insight into movement behaviors and their drivers, information regarding core use areas, and potential critical habitat is relatively scant. Between 2010 and 2018, 51 YOY & JWS were outfitted with ultrasonic transmitters, and their movements passively monitored via a stationary acoustic receiver array along coastal beach areas stretching from Santa Barbara to San Diego. Acoustic monitoring data support previous fishing records of reported catch of JWS. Nursery hotspots have been identified, with tagged individuals remaining in the detection range of a receiver for periods ranging from several days to several weeks. Here, we characterize these hotspots, and provide quantification of residency and space-use patterns during periods of beach residency.

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EXTREME ARID CONDITION NARROW FUNCTIONAL TRAIT IN THE MANGROVE FISH COMMUNITY IN THE GULF OF CALIFORNIA

Ipn-Cicimar

Although mangroves are important for associated fishes, few studies have addressed this habitat in arid conditions. The present study analyzed the functional and taxonomic diversity of arid mangroves in northwest Mexico to identify region-level consistency. We implemented field surveys and gathered available scientific information from three sites within the Gulf of California and from one site outside of the gulf with estuarine conditions to compare the results. With a morpho-structural analysis, we obtained 13 functional traits and calculated functional richness, dispersion, and redundancy. We also computed the taxonomic distinctness and the variation in taxonomic distinctness. We found functional convergence in the community traits due to the similarities in the environmental conditions, with no significant differences among sites (Anosim, R: 0.001824, P: 0.4648), because ecological efficiency should be operating at a similar trophic level in every locality due to the transitory conditions of the habitat. In particular, northern sites within the Gulf of California had higher values for all functional indices and lower functional redundancy than the outside location of Nayarit due to a higher percentage of species with a more specialized morphology. The taxonomic diversity showed a latitudinal gradient, and significant statistical variation was found across localities within the Gulf of California (although Sinaloa leaves the probabilistic tunnel), but the position of Nayarit had a higher variance. Further analysis should focus on the seasonal variation of environmental f

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ECOLOGICALLY RESTORATIVE AQUACULTURE OF PURPLE SEA URCHINS (STRONGYLOCENTROTUS PURPURATUS)

1 - San Diego State University Coastal And Marine Institute, 2 - San Diego State University Coastal And Marine Institute & Dept Of Biology

Over the last decade, the rapid expansion of urchin barrens along the coast of California has created an overabundance of purple urchins that exert destructive grazing pressure on essential kelp forest habitat. Although the harvesting of several urchin species has led to high-value fisheries worldwide, purple urchins presently have little to no commercial value, especially in a malnourished, barren condition. By harvesting purple urchins from barrens and enhancing their roe through aquaculture, we can transform these destructive grazers into high-quality seafood that also benefits ecological restoration of kelp forests. We collected purple urchins from barrens and fed them natural kelp or two different formulations of artificial feed in a recirculating aquaculture system. The gonad index (GI) of urchins fed the two artificial diets doubled in 6 wk, increased from a barren condition to a marketable yield (GI > 15%) in 9 wk, and was significantly greater than the GI of urchins fed kelp. Analyses of amino acids in gonad tissue also revealed important differences among the three diets. In particular, concentrations of glycine, which correlates with sweet tasting roe, and tyrosine, which correlates with bitterness, differed between the two artificial feeds, suggesting one feed has greater commercial potential. These results highlight an untapped potential to quickly produce a highly valued, consistent seafood product from seemingly low-value purple urchins. Echinoculture may thereby serve as a tool to stimulate urchin industries and restore kelp forests from urchin barrens.

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THE COMPLEX INTERACTION BETWEEN MACROORGANISMS AND BIOFILM IN THE INTERTIDAL ROCKY SHORE: TROPHIC AND NON-TROPHIC PATHWAYS

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The rocky intertidal shore of central Chile is one of the most studied marine ecosystems in the world. The rich information gathered there has allowed the construction of one of the most complete ecological networks. However, these studies have ignored the microbial component of these networks, precluding a holistic insight on the functioning of this ecosystem. Here, we attempt to disentangle the ecological interactions between the macro- and microscopic marine organisms, focusing on both trophic and non-trophic interactions in the rocky intertidal shore. We first characterized the assemblage of grazers, showing that *Fissurella crassa*, *Scurria araucana*, *Chiton granosus*, *Siphonaria lessoni*, and *Echinolittorina peruviana* have the highest potential to impact biofilms, according to abundance, body size, radula characteristics, and the foot mucus production. Our results showed significantly different negative effects between the mucus of *F.crassa and* S.lessoni on the coverage of photosynthetic epilithic biofilms. Grazing by *F.crassa and* C.granosus had the most significant negative impact on biofilms, and the other three species had no effects. After characterizing the microbial community by microscopy and

molecular approaches, we found intertidal zones differences. Finally, our study allows us to classify intertidal grazers into functional groups according to their impacts on biofilm and the differences in their trophic and non-trophic effects on the microbes are starting to unveil the myriad of interaction pathways connecting macro and microscopic marine organisms

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EFFECTS OF HYDROSTATIC PRESSURE ON THE METABOLIC ENZYMES OF CTENOPHORE SPECIES FROM DIFFERENT DEPTH HABITATS

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To better understand biochemical adaptations to high hydrostatic pressure in deep-sea animals, enzymatic rates from the phylum Ctenophora were investigated since phylogenetically distant species have independently evolved to inhabit the deep sea. Shallow and deep-sea ctenophore species were examined to explore the enzymatic constraint of depth ranges. Native enzymes from different ctenophore species were assayed at 1, 200, 400, and 600 atmospheres; after undergoing pressure treatment, the enzymes were assayed at 1 atmosphere (recovery). Maximum rates of enzyme reactions (Vmax) were recorded during each pressure treatment and recovery to investigate the effects of pressure. The glycolytic enzyme pyruvate kinase (PK) has exhibited adaptive pressure resistance in deep-sea fishes, and was initially targeted for comparison; malate dehydrogenase (MDH) and creatine kinase (CK) were also assessed for pressure tolerances. When saturated withsubstrate, both PK and MDH showed decreasing pressure inhibition with habitat depth, though pressure's effect on PK was more pronounced. Extremely deep species living below 2000 m disrupted this relationship in a manner consistent with historic data collected from vertebrates. Our initial results support two intriguing hypotheses: (1) that relationships between environmental conditions and enzyme volume change parameters are consistent across the longest branches of the animal tree of life, and (2) that pressure inactivation of an enzyme under saturating conditions is set by selective forces other than hydrostatic pressure of the habitat.

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VARIABILITY IN THE FUNDAMENTAL AND REALIZED NICHES OF MANGROVES IN BAJA CALIFORNIA

1 - University Of California, Los Angeles, 2 - Smithsonian Environmental Research Center, Smithsonian Institution

Mangroves are expanding into salt marshes in many coastal wetlands near tropical-temperate transition zones. Previous work identified freezes as the primary factor setting mangrove range on the Atlantic coast of North America. However, on the Pacific coast, the range limit for mangroves occurs in Baja California (BC), an area that does not experience freezes, raising questions about processes controlling the Pacific mangroves range. We conducted lab experiments and distribution modeling to compare the fundamental and realized niches of mangroves along both coasts. Mangroves were collected from populations near both range limits, grown under controlled conditions, and submitted to two sets of experiments to

characterize their tolerance to cold air and water temperatures. Seedlings were put in coolers with water temperatures spanning from 30°C to 13°C. We also simulated overnight freezes in chambers ranging from -0.5°C to -15°C. Their survival was monitored for six months. We developed correlative distribution models using climate and mangrove presence/absence data to see if the experimental thresholds matched the realized mangrove niches. The Atlantic mangroves air temperature mortality thresholds matched thresholds identified from distribution models, validating that these populations are indeed controlled by the occurrence of freeze. For the Pacific coast, the current environmental conditions at the range in BC are not at the tolerance limits of mangroves, implying that mangroves could be controlled by other factors such as species interactions or dispersal limitation.

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IMPACTS OF OCEAN ACIDIFICATION AND WARMING ON THE SURVIVAL AND SETTLEMENT OF LARVAL PINTO ABALONE (*HALIOTIS KAMTSCHATKANA*)

1 - University Of Washington School Of Aquatic And Fishery Sciences, 2 - Puget Sound Restoration Fund

From 1992 to 2017 pinto abalone experienced a 97% decline in Washington waters. As the only abalone species native to the state, their decline is a loss for indigenous tribes, recreational divers, and the health of rocky reefs and kelp beds. Puget Sound Restoration Fund and Washington Department of Fish & Wildlife are working to restore populations in the San Juan Islands. As this restoration occurs, however, climate change is causing ocean acidification (OA) and warming in the northeast Pacific, further threatening pinto abalone recovery. The purpose of this research was to inform best hatchery practices for restoration and to better understand the tolerance and physiological flexibility of wild abalone larvae under future climate change scenarios. We exposed abalone post-fertilization to four treatments for ten days: 1) ambient pH + hatchery rearing temperature, 2) low pH + hatchery rearing temperature, 3) ambient pH + high temperature, and 4) low pH + high temperature. Abalone in the ambient pH + hatchery rearing temperature treatment had the best survival, those in the low pH + high temperature treatment had the worst survival, and those in the two single-stressor treatments had survival in between. This indicates an additive effect of the stressors. While temperature appeared to have a minor effect on settlement, pH was the dominant stressor determining settlement success, with higher settlement rates under ambient pH treatments (both temperatures). Our results demonstrate the interacting effects of warming and OA on the vulnerable early life stages of pinto abalone.

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ABALONE MARICULTURE IN BAJA CALIFORNIA: A CONSERVATION AQUACULTURE PROJECT

1 - Universidad Autónoma De Baja California, 2 - California Department Of Fish And Wildlife's, 3 - Hopkins Marine Station Of Stanford University, 4 - International Abalone Society

Landings of fished abalone have significantly decreased in the last decades and global production has drastically changed from fishing to farming. In particular, multiple stressors

related to climate change and overfishing are threatening these resources in California, USA, and Baja California, Mexico. Aquaculture and subsequent restocking efforts may support sustainable harvesting of abalone. To test, inform and promote innovative sustainable seafood production strategies in the Northeastern Pacific, we designed an experimental mariculture system at San Jeronimo Island, Baja California in collaboration with the local fishing cooperative. Specifically, this pilot experiment aimed to explore the feasibility of rearing red abalone *Haliotis rufescens* during its early stages to a larger size for a future local restocking program. We also tested the effects of two different depths, surface and bottom (6 m) and three different macroalgae diets on the survival and growth of juvenile red abalone (30 ± 8 mm), using a long line system. Our results show a 7.22 ± 0.27 mm mean increase in shell length after four months of experiment, which appears to be greater than for abalone raised in the lab. We did not find any effect of depth or macroalgae diet treatments. High growth rates suggest mariculture might allow abalone to attain size refuge and increase its survival when restocked in its natural habitat. If scaled successfully, these conservation aquaculture strategies could contribute to sustainable abalone populations and landings in North America.

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IS THIS THE PLACE? CHEMICAL AND PHYSICAL SETTLEMENT CUES UTILIZED BY BARNACLE AND MUSSEL LARVAE

No affiliation[s] given

Recruitment of larval organisms from the plankton to the substrate is the mechanism of population growth for most marine species and is one of the most important processes controlling intertidal ecosystems. Mussels and barnacles recruits are incredibly important to their ecosystem because they provide food and habitat to many other intertidal species. However, very little work has been done on the mechanisms that induce settlement from the plankton onto the rocky shore. It is known that both mussel and barnacle recruits prefer to settle on rough surfaces such as established adult barnacles. Recent studies have identified two chemical cues that also may play a key role in barnacle and mussel settlement: MULTIFUNCin in the barnacle Balanus glandula and KEYSTONEin in the mussel Mytilus californianus. However, the importance of the roughness of a surface versus the chemical cues are unknown. In this study, we made and deployed plastic molds of barnacle-covered (rugose) and smooth rock that had either no chemical cue, barnacle cue (MULTIFUNCin), or mussel cue (KEYSTONEin) in the intertidal for multiple days to determine if recruits or predators respond to surface rugosity and/or chemical cues. We found that barnacles generally preferred rugose over smooth surfaces. However, barnacle settlement was high regardless of rugosity in the presence of mussel chemical cues, and barnacle settlers did not respond to barnacle chemical cues. These results suggest that barnacle settlers may avoid competition with conspecifics, but may preferentially settle on or near mussels.

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EFFECTS OF LOCAL MANAGEMENT AND MACROALGAE ON ANTI-PATHOGEN DEFENSES OF CORALS

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Coral reefs are undergoing precipitous decline due to coral bleaching and disease following thermal stress. We tested three common corals (*Acropora millepora*, *Pocillopora damicornis*, and *Porites cylindrica*) for defenses against the thermally-regulated bleaching pathogen *Vibrio coralliilyticus* - comparing defenses of individuals from coral-dominated marine protected areas (MPAs) versus algae-dominated fished areas. All corals possessed defenses, but the magnitude of pathogen suppression varied across species, and for *A. millepora*, defenses were suppressed if individuals grew in algae-dominated versus coral-dominated areas. Reciprocal transplantation between MPAs and fished areas demonstrated that *Acropora* defense was variable; defense increased if moved to coral-dominated areas and decreased if moved to algae-dominated areas. Defenses were not altered for the ecologically hardy poritid coral or the weedy pocilloporid coral. We also tested whether specific species of macroalgae differentially impacted *Acropora* defense. We found that bloom forming *Sargassum* inhibited anti-pathogen defense of *Acropora*, while the red alga *Galaxuara* and an artificial, plastic seaweed did not. Experimental removal of *Sargassum* allowed coral defense to rebound. For some important reef building but bleaching susceptible species such as acroporids, algae-dominated reefs may suppress coral defense toward *Vibrio* bleaching pathogens, but the extent of suppression will depend upon the algal species present and their duration of interaction with the coral.

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A SEARCH FOR LOCAL ADAPTATION IN A MARINE SNAIL REVEALS HIGH PLASTICITY, MALADAPTATION, AND LOW SURVIVAL IN SOUTHERN REGIONS

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Climate change creates mosaics of stressor gradients that can produce divergent selection along a species' range, which in turn can drive local adaptation (LA). The role of LA in buffering populations from climate change is uncertain given the influence of other processes, such as plasticity. Here, we test the presence and extent of LA and plasticity in a marine snail, *Nucella lamellosa*, using reciprocal transplants and a common garden experiment. We transplanted four populations of snails from two regions in British Columbia that differ in oceanographic conditions, and measured growth and survival over six months. We also held all populations in mesocosms for 2.5 months under factorial temperature and pH levels that simulated current and future oceanic conditions in each region. Contrary to our expectations, we did not find evidence of LA in any population in either experiment: populations transplanted within their native region demonstrated lower growth rates relative to foreign transplants; and source population did not affect snail growth in the lab. However, we did observe plasticity in growth and feeding rates across thermal gradients. We also observed high mortality across all populations in southern transplant sites and treatments that simulated southern climate change scenarios, indicating that environments in these regions may be approaching lethal limits for certain species. This study reveals differential vulnerability to climate change across a species' range, and likely dominance of plasticity relative to local adaptation in shaping performance and survival.

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INVESTIGATING THE EFFECTS OF LAND-BASED POLLUTION ON CORAL THERMAL TOLERANCE IN A BRANCHING CORAL SPECIES

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Coral reefs, some of the most diverse ecosystems in the world, face increased pressures from global and local scale anthropogenic stressors. Therefore, a better understanding of the ecological ramifications of thermal anomalies and land-based pollution on coral reef ecosystems is necessary. In this study, we used thermal performance curves to quantify the shape of the relationship between metabolic rates (photosynthesis, respiration, and calcification) of *Pocillopora acuta* and temperature at high and low pollution sites in Mo'orea, French Polynesia. We also measured key physiological parameters including chlorophyll a content, endosymbiont densities, tissue biomass, and tissue nitrogen content. We found that corals at low pollution sites exhibited higher endosymbiont densities, and chlorophyll a content. Furthermore, we found that corals from low pollution sites exhibited higher maximum rates of performance (Pmax) and rates at a constant temperature (b(Tc)) for gross photosynthetic and respiration rates. Respiration rates exhibited higher thermal optimums than gross photosynthetic and calcification rates. Gross photosynthetic rates had higher activation energy (E), Pmax, and b(Tc) than respiration and calcification rates. These results indicate that higher levels of land-based pollution can negatively influence corals' metabolic response to thermal stress. Understanding how local anthropogenic stressors influence corals' response to temperature is integral information for coral reef management to help mediate the influx of pollution into coastal coral reef ecosystems.

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UNDERSTANDING THE MECHANISMS LEADING TO RECRUITMENT INHIBITION OF MACROCYSTIS PYRIFERA BY OPPORTUNISTIC UNDERSTORY ALGAE

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Foundational *Macrocystis pyrifera* and the communities it supports have been decreasing in places across its native range. The sudden removal of giant kelp fronds by disturbance events, like storms, enhance space and light for the colonization of opportunistic species, altering local community composition. Understanding the mechanisms by which macroalgal species compete can provide insight into recovery following canopy removal and predicting future community structure. This study experimentally tested independent and combined effects of how three different algal competitive mechanisms (shade, scour, unique organismal effects) affect recruitment of two early life stages of *M. pyrifera* in the Point Loma kelp forest in San Diego, CA. *M. pyrifera* macroscopic recruitment and growth were recorded under each treatment. Scour, regardless of shade, negatively affected *M. pyrifera* survival, recruitment and growth and had the greatest negative impact on macroscopic sporophyte recruitment, while shading negatively affected macroscopic sporophyte growth. Canopy-removing events, like storms, are increasing in frequency and intensity and this change could facilitate the rise of opportunistic species, like *Desmarestia herbacea*, to alter community succession and inhibit *M. pyrifera* recovery. Understanding the potential mechanisms by which opportunistic species suppress future canopy recovery will provide novel information about interspecific algal interactions in giant kelp forests that can be utilized to create effective plans to enhance *M. pyrifera* conservation efforts.

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SEA ANEMONE MUTUALISM LEADS TO FACILITATION: COMPLEX INTERACTIONS INCREASE BIODIVERSITY IN THE ROCKY INTERTIDAL ZONE

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Sea anemones in the genus *Anthopleura* create unique microhabitats in the California rocky intertidal zone. These sea anemones, which are hosts to symbiotic unicellular algae, must maintain relatively low body temperatures to maintain their endosymbionts. If temperatures are too high, the partnership between host and symbiont breaks down. It is therefore necessary for *Anthopleura* to maintain consistent, cool body temperatures even when low tides expose them to environmental fluctuations. Anemones slowly release water from their bodies at low tide to maintain cooler temperatures via evaporative cooling. Mobile invertebrates take advantage of this behavior and congregate under the edges of anemones during low tides. We hypothesize that anemones increase biodiversity in the upper intertidal zone by providing favorable microhabitat. We designed an experiment that manipulated anemone microhabitat at three sites along a gradient in temperature and desiccation conditions. Treatments included anemone removal, anemone addition, and adjacent bare-rock controls. We surveyed invertebrates and measured temperature and relative desiccation in these plots over several weeks before and following manipulations. Temperatures were up to 6° C lower and relative desiccation was lower next to anemones than on adjacent rock. Mobile invertebrate biodiversity was higher in anemone plots than in adjacent bare-rock and removal plots, but community changes were also site-specific. Our results highlight the importance of cnidarian endosymbiosis for temperate rocky-shore biodiversity.

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SPATIOTEMPORAL VARIABILITY OF ROCKFISH RECRUITMENT AND SURVIVAL ON CALIFORNIA'S NORTH COAST IN RELATION TO HABITAT AVAILABILITY

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Rockfish, of the genus *Sebastes*, are an ecologically important group of marine fishes common on rocky reefs and kelp forests and remain a major target of recreational and commercial fisheries on the California coast. Spatial and temporal variability in recruitment rates, influenced by factors including habitat availability and oceanographic conditions, are major determinants of rockfish population dynamics throughout the Eastern Pacific, but while many new recruits utilize kelp canopy as habitat during this critical life history stage, the degree to which this impacts their survival has not yet been investigated along California's north coast, where *Nereocystis* bull kelp beds are declining annually. Using standardized fish traps and monthly benthic SCUBA surveys targeting multiple life stages, we examined the effect of kelp abundance on the recruitment and survivorship of several rockfish species along the Mendocino coastline. Additional factors of rocky relief, understory algae abundance, predator presence and temperature were considered. Modeling results suggest that while rockfish recruits typically associate with *Nereocystis* canopy, individuals may be utilizing alternate habitats as kelp becomes less available. If kelp beds continue to decline, the influence of factors such as relief and understory algae abundance on rockfish recruitment success and survival may increase. The impacts of this study and

subsequent collaborations has management implications, improving the ability of researchers to understand how ecosystem phase shifts affect local population dynamics

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KELPWATCH: A PUBLICLY AVAILABLE TOOL FOR VISUALIZATION AND ANALYSIS

1 - Uc Santa Barbara, 2 - Uc Los Angeles, 3 - The Nature Conservancy

The past decade has seen numerous advances in measuring kelp canopy dynamics using remote sensing platforms, however accessing and using these data has, at times, been challenging. In collaboration with The Nature Conservancy, we present a publicly available visualization tool for giant kelp canopy biomass along the California and Baja California coast. Users are able to see how kelp canopy has changed at their sites from 1984 – present at a 30m pixel resolution and can easily select and download data for an area of interest. The processing of Landsat satellite imagery into estimates of canopy biomass has been fully automated and implemented in Google Earth Engine, allowing for frequent and regular data updates. By utilizing the cloud-based processing in Google Earth Engine, we plan to develop a kelp canopy time series for the entire NE Pacific, a true opportunity for transboundary science.

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UNDERSTANDING YELLOWTAIL (*SERIOLA DORSALIS*) MOVEMENT IN THE SOUTHERN CALIFORNIA BIGHT THROUGH ACOUSTIC AND CONVENTIONAL TAGGING

1 - NOAA - Southwest Fisheries Science Center, 2 - Scripps Institution Of Oceanography - Uc San Diego

Yellowtail (*Seriola dorsalis*), are iconic and valuable gamefish. Despite their importance, their Southern California Bight (SCB) movement patterns and population status remain poorly studied. Between September 2014 and January 2016, we tagged 184 yellowtail with conventional (Floy) tags in inshore and offshore areas throughout the SCB. 22 of the tagged fish were fitted with Vemco acoustic transmitters. To date, 22% of tagged fish have been reported recaptured. As further evidence of high fishing pressure, tag returns coincided with periods of maximum fishing effort. For electronically-tagged yellowtail, typical daily movements regularly extended outside the scope of the region’s two marine protected areas. Additionally, larger fish were more likely to be consistently detected throughout the year, suggesting that larger yellowtail may remain resident year-round. This finding lends credence to previously untested claims that some yellowtail are residents in certain SCB nearshore habitats. Results also indicate there is one contiguous population of yellowtail in the SCB. However, due to elevated fishing pressure, this population may rely on seasonal influxes of southern fish to sustain itself. This reliance on northward migration into the SCB could mean a climate-mediated northward range-shift would expose a greater percentage of the west-coast yellowtail population to elevated fishing pressure.

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CLIPPERTON ATOLL AS A MODEL TO STUDY SMALL MARINE POPULATIONS: ENDEMISM AND THE GENOMIC CONSEQUENCES OF SMALL POPULATION SIZE

1 - University Of California Santa Cruz, 2 - Cabrillo College, 3 - University Of California Santa Barbara, 4 - University Of Hawaii, 5 - Smithsonian Tropical Research Institute

Estimating population sizes and genetic diversity are key factors to understand and predict population dynamics. Marine species have been a difficult challenge in that respect, due to the difficulty in assessing population sizes and the open nature of such populations. Small, isolated islands with endemic species offer an opportunity to groundtruth population size estimates with empirical data and investigate the genetic consequences of such small popu- lations. Here we focus on two endemic species of reef fish, the Clipperton damselfish, *Stegastes baldwini*, and the Clipperton angelfish, *Holacanthus limbaughi*, on Clipperton Atoll, tropical eastern Pacific. Visual surveys, performed over almost two decades and four expe- ditions, and genetic surveys based on genomic RAD sequences, allowed us to estimate kin- ship and genetic diversity, as well as to compare population size estimates based on visual surveys with effective population sizes based on genetics. We found that genetic and visual estimates of population numbers were remarkably similar. *S. baldwini* and *H. limbaughi* had population sizes of approximately 800,000 and 60,000, respectively. Relatively small popu- lation sizes resulted in low genetic diversity and the presence of apparent kinship. This study emphasizes the importance of small isolated islands as models to study population dynamics of marine organisms

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KELP (*MACROCYSTIS PYRIFERA*) PRESERVATION TECHNIQUE IMPACTS THE GROWTH OF JUVENILE RED ABALONE (*HALIOTIS RUFESCENS*)

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Effective abalone aquaculture production requires consistent availability of macroalgae as a primary food source, but natural macroalgae availability can be highly variable and collection can require substantial resources. These problems present challenges for large and small aquaculture operations alike and are sometimes resolved by the collection, preservation, and storage of algae for later use. The impact of macroalgae preservation on abalone production is not well described, therefore the goal of this research was to determine if common preservation techniques affect the growth of juvenile abalone. Red abalone (*Haliotis rufescens*) juveniles were fed dried, frozen, and fresh giant kelp (*Macrocystis pyrifera*) while also being exposed to the scent of macroalgae prepared using each method. Change in length and wet mass was measured over the course of 22 weeks and short-term food consumption rates were determined to elucidate potential impacts on feeding behavior. Preliminary data analysis indicates that while abalone fed fresh and dried kelp had no significant difference in mass or length change, abalone fed frozen kelp gained significantly less mass than did abalone fed fresh kelp (2-way ANOVA, p=.006). Exposure to the scent of various kelp preparations had no effect on growth, and neither treatment appeared to impact consumption rate. We conclude that when natural, financial, or logistical circumstances require the preservation of kelp, it may be advisable to feed abalone dried kelp instead of frozen kelp.

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EFFECTS OF NUTRIENT ENRICHMENT ON SEAGRASS COMMUNITY STRUCTURE

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Across the northern hemisphere, the eelgrass Zostera marina is identified as a priority for coastal protection efforts due to its role as habitat and foraging ground for ecologically and commercially important species and ability to the mitigate of the effects of climate change (e.g. wave attenuation, coastline stabilization) on coastal communities. We assessed the eelgrass meadow community at two sites of high conservation interest in Boundary Bay, British Columbia over the spring and summer of 2018. One site, Mud Bay is impacted by effluent from the Serpentine and Nicomekl rivers and experiences high terrestrial nutrient input by runoff from the watershed. The second site, Crescent Beach, was close to the mouth of the bay and less influenced by discharge from the two rivers. The effect of elevated nitrate and phosphate on eelgrass and algal abundance and invertebrate community structure was considered by sampling ambient and experimentally enriched plots at both sites. All invertebrates >500 µm were identified to the lowest taxonomic level possible. Nutrient enrichment caused an increase in the abundance of detrital material and a decrease in eelgrass shoot density at both sites. Invertebrate communities were influenced by site and the month of sampling and also shifted in response to nutrient enriched conditions. The information collected from this study are being used to inform management-driven assessments of eutrophication in Boundary Bay to establish restoration targets to reduce nutrient stressors that indicate a negative impact to eelgrass meadow communities.

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ADDRESSING KNOWLEDGE GAPS IN THE ECOLOGY OF GIANT SEA BASS (STEREOLEPIS GIGAS) USING TAGGING AND STABLE ISOTOPE ANALYSES.

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Overfished for much of the first half of the 20th century, Giant Sea Bass (*Stereolepis gigas*) still face contemporary threats despite regulations limiting landings in California. These threats include incidental catch by commercial and recreational fishers in the United States and an open commercial fishery in Mexico. In this study we combine tagging and stable isotope analyses to learn more about the spatial and trophic ecology of this species to inform our knowledge of risks associated with these threats. We are tagging fish in the La Jolla kelp forest using internal acoustic tags to track movement across years and seasons. We are also performing bulk stable isotope analyses using samples from individuals throughout their range to look for regional and ontogenetic patterns in their trophic ecology. Initial tagging results show that fish are spending considerable time outside of marine protected areas where they are susceptible to incidental catch by recreational fishers. Initial stable isotope results indicate no relationship between d^15 N and fish size, location, or time of capture (year or season). For d^13 C, we found a significant relationship between and fish size, but no relationship with location or time of capture (year or season). These results could be indicative of spatial partitioning of foraging locations or

ontogenetic shifts in prey. Future compound specific stable isotope analyses will help elucidate the patterns seen in the bulk isotope analyses and further inform spatial implications of these environmental tracers in Giant Sea Bass.

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INTERACTIVE EFFECRS OF OCEAN ACIDIFICATION AND WARMING ON DEVELOPING RED ABALONE (*HALIOTIS RUFESCENS*)

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Absorption of carbon dioxide (CO_2) by the world's oceans is causing a decline in global pH, resulting in the phenomenon termed ocean acidification (OA). Complex negative effects of OA have been documented in several commercially produced species of shellfish. We are working to develop adaptive aquaculture techniques to mitigate and even improve molluscan aquaculture in the face of changing ocean chemistry. Red abalone (*Haliotis rufescens*) is a culturally, ecologically, and an economically important aquaculture species, ranging from Oregon, USA to Baja California, MEX. We investigated mitigation actions to reduce OA impacts on the culture of this species. Actions included seawater buffering during sensitive developmental stages, tailoring settlement and grow out temperatures, and querying natural genetic variation responsible for tolerance to OA. Abalone cultured and settled under OA during the larval phase had 30% greater survival to two months compared to abalone cultured and settled as larvae under control pH. Tailoring grow out and settlement temperatures significantly increased abalone growth such that abalone settled at 14°C and grown at 18°C were 27% larger than animals cultured settled at 11°C and grown out at 14°C; however, this positive temperature effect was only observed when these animals were raised under control pH. Our results suggest the combined effects of OA and temperature are complex; adaptive aquaculture techniques for abalone should consider these interactions to improve and maintain culture operations for this species.

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TROPHIC AND ENVIRONMENTAL FORCING IN ALASKAN ROCKY INTERTIDAL ZONES

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Zonation of rocky intertidal communities can be strongly influenced by top-down pressure from predation and grazing. In order to explore the relative importance of these trophic pressures in comparison to environmental drivers, we quantified intertidal zonation and size and density of mobile invertebrates at 25 semi-protected rocky beaches in Southeast Alaska. In our study region on the west coast of Prince of Wales Island, sea otters (*Enhydra lutris*) prey on intertidal invertebrates, including sea urchins (*Strongylocentrotus spp.*), sea stars (*Pisaster ochraceous*) and black katy chitons (*Katharina tunicata*). Our study sites vary in length of time since sea otter recolonization as well as in environmental factors, such as slope, aspect, fetch, and substrate. Through multivariate analysis we found that mobile invertebrate density is influenced by slope in the upper intertidal, by slope and aspect in the mid intertidal, and by aspect, fetch, rugosity and sea otter occupation time in the lower intertidal. In contrast, all tested environmental forces and sea otter occupation time are significantly influential on sessile invertebrate frequency within each zone. Future analyses will explore the relationship between mobile invertebrate abundances and frequency of occurrence of sessile organisms.

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SPATIAL VARIATION OF ALGINATE PROPERTIES AND A NUTRITIONAL QUALITY COMPARISON OF SIX KELP SPECIES FROM THE ALEUTIAN ARCHIPELAGO

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Understanding the nutritional quality of kelps can provide important insight into energy flow within coastal ecosystems, as numerous species rely on kelp as their primary source of food. In the Aleutian Archipelago, the dominant kelp forests have mostly disappeared from the ecosystem due to overgrazing reducing overall energy flow. What is unclear is how nutritional quality of the remaining kelps varies among species or geographically. Nutritional quality of the dominant kelp-forest forming species *Eularia fistulosa* was compared to five understory species (*D. viridis, A. clathrus, A. clathratum, L. longipes* and *S. latissimi*) and alginate properties of E. fistulosa were compared throughout the archipelago to measure geographic variability. As predicted, alginate yield, viscosity and strength all showed their maximum values in more exposed sites and increased with increasing distance from the continent, presumably because wave exposure affects their mechanical strength. In contrast, there was no major differences in nutritional quality between the species examined. The percent of the thallus made of the different molecules (proteins - 12.1%, Lipids - 0.35%, fiber - 5.5%, and energy content -2230 cal/g) were all similar among species. Only the total mineral (lower) and carbohydrate (higher) content composition in *A. clathratum*differed, compared to the other species. Together, these results suggest that the impacts of kelp loss on energy flow with the ecosystem varies geographically and may be contingent on which species remain under intense grazing pressure.

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BACK TO THE FUTURE: COASTAL PALAEOECOLOGY AND PALAEOCEANOGRAPHY OF THE ATACAMA DESERT (CHILE, 25°S) DURING THE HOLOCENE

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SST plays an important role modulating natural conditions of nearshore habitats. At the same time, subsistence strategies of fishing communities are strongly linked to the oceanographic patterns of these habitats. Using archaeological evidence from ancient shell middens, palaeotemperatures derived from shellfish carbonates and modern ecological and oceanographic information we reconstruct the coastal palaeocology of the desertic coast of northern Chile during the Holocene. The scenarios suggested through palaeotemperature patterns indicate that an early, cold, Holocene period gave way to a much warmer mid Holocene, with weaker coastal upwelling and a coastal front closer to shore. The scenario is supported by increased abundance of oceanic fish and a change in the composition of mollusks in the archaeological remains. On the other hand, palaeotemperatures patterns during the late Holocene together with modern oceanographic patterns indicate a strengthening of upwelling and a similar reorganization of human foraging patterns. Our results indicate that past oceanographic changes where a source of large variations in the ecological structure of nearshore and intertidal communities, together with the lifestyles of the ancient inhabitants of the desert coast.

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TIDE POOL CONNECTIVITY INFLUENCES THE EFFECTS OF TEMPERATURE ON ROCKY INTERTIDAL ZONE GASTROPODS

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Spatial variation in temperature is a fundamental driver of many patterns of diversity, across a variety of scales, in rocky intertidal ecosystems. The degree to which spatial thermal variation drives patterns in the distribution and abundance of species depends on both the strength of thermal effects and the degree to which local effects are swamped by movement among thermal microhabitats. Here, we take advantage of tide pools, which differ in temperature from emergent rock and from one another, as an ecologically important feature of the thermal landscape. This project examined the species-specific responses to tide pool temperatures in two herbivorous gastropods (*Littorina sitkana* and *L. scutulata*) in two habitats that differed in the likelihood of dispersal among pools: pools distributed across a flat rocky shoreline vs. pools situated on top of an array of tall (~1m) wood pilings. Through lab-based experiments, we found that *L. scutulata's* thermal tolerance and herbivory rates exceeded those of *L. sitkana*. Between the two field contexts, we found a relationship between tide pool temperature and abundances of *L. sitkana* relative to other littorinids in the more disconnected mud flat site but none in the more connected flat site, and that more individuals moved out of and between tide pools on the flat shoreline than in the vertical pilings. These results indicate the importance of connectivity and

movement in understanding the impacts of temperature on small scale abundance variation across a shoreline.

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CLARIFYING REGIONAL POPULATION STRUCTURE OF THE CALIFORNIA SPINY LOBSTER (PANULIRUS INTERRUPTUS)

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Many marine organisms are distributed across large geographic ranges that span international borders. When these organisms are exploited, effective conservation plans must account for variation in environmental and anthropogenic impact across their entire range. The United States and Mexico share several productive ecosystems (e.g. salt marshes, kelp forests) and fisheries in both countries target many of the same species. The spiny lobster, Paulirus interruptus, represents one of the most lucrative fisheries in both California and the Baja peninsula. Using a limited number of genetic markers, previous work has established that despite the year long pelagic larval duration of spiny lobster, some pairwise population differentiation exists within their range (Pt.Conception to Bahia Magdalena). We aimed to expand on these results by using next-generation sequencing (RADseq) to identify and analyze thousands of single nucleotide polymorphisms (SNPs) across the entire lobster genome. We found samples from Santa Barbara and San Diego to be genetically distinct from those in Bahia Tortugas, indicating regional differentiation. Clarifying population structure of transnational fisheries species elucidates how populations on either side of the border may impact each other and can provide the basis for collaborative management initiatives.

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MOBILE MARINE PREDATORS: AN UNDERSTUDIED SOURCE OF NUTRIENTS TO CORAL REEFS IN AN UNFISHED ATOLL

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Animal movements can facilitate important ecological processes, and wide-ranging marine predators, such as sharks, potentially contribute significantly towards nutrient transfer between habitats. We applied network theory to 4 years of acoustic telemetry data for grey reef sharks (*Carcharhinus amblyrhynchos*) at Palmyra, an unfished atoll, to assess their potential role in nutrient dynamics throughout this remote ecosystem. We evaluated the dynamics of habitat connectivity and used network metrics to quantify shark-mediated nutrient distribution. Predator movements were consistent within year, but differed between years and by sex. Females used higher numbers of routes throughout the system, distributing nutrients over a larger proportion of the atoll. Extrapolations of tagged sharks to the population level suggest that prey consumption and subsequent egestion leads to the heterogeneous deposition of 50.9 kg d-1 of nitrogen around the atoll, with approximately 86% of this probably derived from pelagic resources. These results suggest that sharks may contribute substantially to nutrient transfer from offshore waters to near-shore reefs, subsidies that are important for coral reef health.

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DISTURBANCE, RESOURCES, AND CLIMATE INTERACTIVELY SYNCHRONIZE KELP FORESTS ACROSS SCALES

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Spatial synchrony—correlated temporal fluctuations in abundance at different locations—is a ubiquitous feature of population dynamics, but many aspects of this phenomenon are not well understood. In particular, ecologists have had difficulty determining how the individual and combined effects of multiple environmental drivers interact to determine synchrony, and whether these effects vary across spatial and temporal scales. Using several new statistical techniques, we characterized spatial synchrony in populations of the giant kelp *Macrocystis pyrifera*, a widely-distributed marine foundation species, and related it to synchrony in oceanographic conditions across 35 years and >900 km of coastline in California, USA. We discovered that three ecological processes (wave disturbance, seawater nitrate, and oceanographic climate) combine and interact synergistically and antagonistically to produce population synchrony, but that these interactions differ between regions on short, medium, and long timescales. Therefore, accurately predicting spatial population synchrony relies crucially on knowing whether Moran effects magnify or counteract one another across both geography and timescales.

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QUANTIFYING THE STOCHASTIC NATURE OF LARVAL CONNECTIVITY AMONG NEARSHORE MARINE POPULATIONS

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Larval dispersal is the primary mechanism of connectivity in marine metapopulations, impacting ecological and evolutionary processes from population persistence to gene flow and community dynamics. Dispersing marine larvae are subject to substantial temporal heterogeneity in their fluid environment, but the magnitude of temporal variability in realized larval dispersal is largely unknown. Here we quantify the dispersal kernel across seven years for a common coral reef fish, *Amphiprion clarkii*, using genetic parentage assignments. Dispersal kernels varied substantially among years, with annual mean dispersal distances ranging from 6.8 to 46.3 km. Interannual variation in kernel scale and shape introduced substantial temporal correlations among dispersal routes with overall positive covariance across the metapopulation. Our results support the conclusion that the utility of dispersal estimates depend on the ecological or evolutionary question at hand, and the relative importance of average dynamics versus variability for the processes and patterns of interest.

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FISHES AS “MOBILE MONITORS” OF HYPOXIC CONDITIONS ACROSS OCEAN BASINS

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Over the past 50 years, the open ocean has lost 2% of its oxygen content and more than 500 coastal sites have reported exposure to hypoxia in a process known as deoxygenation. Specifically, open ocean deoxygenation occurs in regions called Oxygen Minimum Zones (OMZs). OMZs are midwater masses at depths of about 200 to 1500 meters and contain the world's largest reservoirs of hypoxic waters, comprising ~ 7% of total ocean volume. Climate change is expanding OMZs worldwide and is likely to have implications for marine organism populations and global cycles of major nutrients and carbon. For example, deoxygenation may alter the distribution and decrease the biodiversity of fishes, ultimately affecting fishing yields, and may also increase the production of N_2O, a potent greenhouse gas.

We hypothesize that the hypoxic conditions found in different OMZs (both the Southern California Bight and the Benguela current ecosystem) will lead to unique elemental signatures in fish otoliths, which are similar to earbones and grow to reflect the surrounding environmental conditions much like the rings of a tree. Through the analysis of different fish species, we were able to detect common elemental patterns in the otoliths of those species living inside OMZs, across different ocean basins. This unique elemental signature was significantly different from that of a shallow marine fish species living outside the OMZs. By using fish as "mobile monitors" of hypoxic conditions, we seek to elucidate how the past, current, and future deoxygenation processes are likely to affect fish growth.

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EVALUATING THE IMPORTANCE OF REEF-BASED RESOURCES FOR REPRODUCTION IN A TEMPERATE REEF FISH

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California sheephead are among the most ecologically important fish on temperate reefs in California and Mexico, yet little is known about their reproductive ecology. Environmental factors can affect reproductive success in fish populations in a variety of ways, including by affecting diet. The goal of this study was to determine if any differences in reproduction among populations of California sheephead (Semicossyphus pulcher) were related to differences in diets among them. We measured the prey availability, diet composition, and batch fecundity of California sheephead on three large reefs within the Southern California Bight. Reproductive output, diet, and prey availability all differed between years, implying that variation in prey availability affected diet, which affected reproductive output. Understanding how changes to kelp forest habitat impact reproductive output can aid in future management efforts of economically and ecologically important species of fish.

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SNAIL CORALLIVORY CAN DISRUPT CORAL MICROBIOMES BUT THE EFFECTS ARE SPATIALLY CONSTRAINED

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The impact of biotic stressors such as predation on coral-associated microbial communities has gained increasing attention as corals decline worldwide. Evidence suggests that corallivore feeding may alter coral microbiomes in ways that contribute to dysbiosis, but corallivore feeding strategies are diverse – complicating generalizations about the nature and extent of their impacts on coral microbiomes and the fitness of the holobiont in general. Using a combination of field-based approaches, we found that feeding by *Coralliophila violacea*, a parasitic snail that significantly suppresses coral growth, can alter *Porites cylindrica* microbiomes in ways that may be indicative of dysbiosis, but that impacts are localized. Changes in microbial community composition and variability were restricted to locations where snails were attached and feeding; microbiomes from nearby (=1.5 cm) and more distant (6-8 cm) locations on the coral did not differ from control corals without snails. The microbial impacts of *C. violacea* feeding are limited and may be under different evolutionary constraints than more mobile corallivores that forage across and among hosts. These insights may inform predictions regarding the effects of other corallivores, such as those with parasitic feeding strategies and intimate ties to their host. The spatial specificity of these microbial changes also suggest rethinking future assessments of corallivory on coral microbiomes in general.

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POPULATION-SPECIFIC DIFFERENCES IN THE EFFECTS OF ACIDIFICATION ON PREDATOR FORAGING TRAITS

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Recent and ongoing evolution can cause predator populations to vary in traits and their effects on prey, but few studies have tested if divergent predator traits respond similarly to acute environmental stressors. We tested how predators from populations with varying natural exposures to low pH seawater altered their foraging traits when experimentally exposed to acidified seawater. We tested how *Nucella* dogwhelks from three populations with distinct pH regimes altered search, handling, and total consumption time (the sum of search and handling), and size selectivity of mussel prey (*Mytilus californianus*) in ambient (pH 8.0) and acidified (7.6) seawater. Under experimental acidification, predators from the population with the least natural exposure to low pH showed increased search time but decreased handling time, possibly caused by a behavioral response to leave the acidified water immediately after ingestion. Predators from the population with intermediate low pH exposure showed the opposite responses, and those from the population with greatest natural exposure to low pH showed almost no response to experimental acidification. Total consumption time varied by population only, where consumption time was longer in populations with less natural low pH exposure. These results indicate that *Nucella* predation responses to acute acidification are population-specific and highlight the importance of understanding population-specific responses to climate change because they can lead to differences in ecological processes that may restructure communities.

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WHAT GOES IN MUST COME OUT: INVASIVE PREDATORS CAN MAINTAIN REEF NUTRIENT DYNAMICS BY REPLACING NATIVE FISH EXCRETION

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Non-native species can alter biodiversity and ecosystem function in the regions they invade. The recent invasion of the Western Atlantic by Indo-Pacific lionfish (*Pterois* sp.) has reduced native fish biomass on some coral reefs but the effects of these predators on reef nutrient dynamics have not been assessed. We tested the extent to which lionfish change the function of native fish communities as nutrient sources on coral reefs using an 18-month-long large-scale experimental manipulation of lionfish densities on patch reefs in Eleuthera, The Bahamas. We also evaluated the relationship between native reef fish vulnerability to lionfish predation and their overall contribution to nutrient supply. High densities of invasive lionfish caused declines in small and medium-sized native prey fish over 1.5 years. Similar changes in biomass were not seen in large size classes of fish, which contributed the majority of reef-wide ammonium excretion. As a result, the limited reductions in native fish excretion caused by lionfish predation on small fish were roughly matched by inputs from lionfish excretion, resulting in overall maintenance of reef-wide ammonium budgets. Native fish with high vulnerability to lionfish predation contributed negligible amounts to overall reef-wide ammonium budgets due to their small size and low abundance. Thus, from a functional perspective, nutrient provisioning by reef fish appears to be robust to invasive lionfish and, in areas with high lionfish densities, reefs may actually experience enhanced nutrient supply, at least over short time scales.

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INTEGRATING PALEOECOLOGICAL, HISTORICAL, AND ECOLOGICAL DATA TO UNDERSTAND THE MECHANISMS OF CARIBBEAN ACROPORID CORAL LOSS

1 - Scripps Institution Of Oceanography, 2 - University Of California Santa Barbara, 3 - Roger Williams University, 4 - University Of Bremen, 5 - New England College, 6 - University Of Queensland

Acropora mass mortality has transformed Caribbean reefs from coral- to macroalgal-dominated habitats since systematic monitoring began in the 1970s. Declines have been attributed to overfishing, pollution, sea urchin and coral disease, and climate change, but the mechanisms are unresolved due to the dearth of pre-1970s data. We used paleoecological, historical, and survey data to track *Acropora* presence and dominance throughout the Caribbean from the pre-human period to present. Declines in dominance from pre-human values first occurred in the 1950s for *A. palmata* and the 1960s for *A. cervicornis*, decades before outbreaks of acroporid disease or bleaching. We compared trends in *Acropora* dominance since 1950 to regional and local potential drivers. Human population had a negative effect and fertilizer usage for agriculture had a positive effect on *A. palmata* dominance, likely due to lower human presence in agricultural areas. *Acropora* dominance was not affected by regional stressors including hurricanes and ocean warming. The earlier, local roots of acroporid coral declines highlight the urgency of mitigating local human impacts.

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THE MOLECULAR BIOGEOGRAPHY OF THE INDO-PACIFIC: TESTING HYPOTHESES WITH MULTISPECIES GENETIC PATTERNS

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Biogeographic regions defined by species assemblages and climatic/environmental factors provide the foundation to identify patterns of biodiversity and, more recently, to define conservation regions. To test eight hypothesized biogeographic partitions of the tropical Indo-Pacific Ocean, we used phylogeographic data from 56 taxa using a novel modification to analysis of molecular variance. We observed a diversity of outcomes, although the majority of species fit a few broad biogeographic regions. Repeated coalescent simulation of a simple vicariance model of the last glacial maximum yielded a wide distribution of pairwise F_{ST} that was very similar to empirical distributions observed across five putative barriers to gene flow. Three of these barriers had median F_{ST} that were significantly larger than random expectation. Only 21 of 52 species analyzed with distance-based redundancy analysis rejected the null model, with overwater distance being the dominant predictor of structure. Although there is support for three previously described barriers, phylogeographic discordance in the Indo-Pacific Ocean indicates incongruity between processes shaping the distributions of diversity at the species and population levels. Among the many possible causes of this incongruity, genetic drift provides the most compelling explanation: given massive effective population sizes of Indo-Pacific species, even hard vicariance for tens of thousands of years can yield F_{ST} values that range from 0 to nearly 0.5.

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THE EFFECTS OF TEMPERATURE ON THE PHYSIOLOGY AND FORAGING ECOLOGY OF THE CA SPINY LOBSTER (PANULIRUS INTERRUPTUS)

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Metabolic theory hypothesizes that the temperature-dependence of species interaction strengths is the result of increases in metabolism with temperature driving increased predator consumption rates to balance energy expenditure. However, few studies have simultaneously measured metabolic performance and predator-prey interaction strengths across temperatures, which may be important for predicting how the functional role of predators will shift across thermally heterogeneous environments. We explore the relationship between metabolism and interaction strengths across temperatures in the CA spiny lobster (Panulirus interruptus). We acclimated lobsters to 11, 16, 21, and 26°C, then used respirometry to measure standard and maximum metabolic rates (SMR, MMR), and aerobic scope (AS). We then quantified species interaction strengths by conducting feeding assays using the California mussel as prey and fit functional responses to individual- and treatment-level data. We found that AS and handling times were highly variable among individuals in all temperatures. Despite this variation, SMR and consumption increased with temperature. MMR did not differ across 16, 21, and 26°C, but was 1.5 times greater than MMR of lobsters acclimated to 11°C, leading to diminished AS at 11°C. Handling times were negatively correlated with temperature. Overall, our results suggest that the capacity for lobsters to forage is limited at cold temperatures by small aerobic scopes. Therefore, lobsters may not be fulfilling the functional role as kelp forest predator during months when temperatures are coldest.

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IMPACT OF TWO SEAGRASS SPECIES (ZOSTERA MARINA AND RUPPIA MARITIMA) ON ESTUARINE MACROINVERTEBRATE COMMUNITY COMPOSITION

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Seagrasses provide important ecosystem services, and informed management is required to ensure the persistence of these valuable habitats despite increasing anthropogenic pressure. In Southern California, the dominant seagrass is *Zostera marina*, which occasionally co-occurs with the ephemeral and regionally understudied *Ruppia maritima*. Clarifying differences in the habitat value provided by these two species is increasingly necessary as regional climate models predict *Ruppia* proliferation into areas traditionally occupied by *Zostera*. This two-year study examined *Zostera* and *Ruppia* beds growing within a 13-acre tidal lagoon in Long Beach, CA. Seagrass beds were sampled for vegetation characteristics, abiotic parameters, and benthic and epiphytic macroinvertebrates. Turion densities were positively correlated with macroinvertebrate abundances, and both turion density and invertebrate abundance values were greater in *Ruppia* beds than in *Zostera*. Furthermore, differences were observed in the temporal persistence of above-ground structure for each species. *Zostera marina* remained perennially present, while *Ruppia* cycled between winter senescence and spring recolonization. *Ruppia* and *Zostera* may therefore provide similar structural roles as macroinvertebrate habitat, but inconsistency in *Ruppia's* persistence over time may prevent the development of communities traditionally associated with seagrass presence. This study offers insight into the regional role of *Ruppia* and may be useful in management considerations for this increasingly relevant species.

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THE ECOLOGY OF EELGRASS IN JAMES BAY, QC

1 - University Of British Columbia, 2 - Mcgill University, 3 - University Of Quebec At Rimouski, 4 - Bamfield Marine Sciences Centre

Eelgrass is a foundation species that can dominate shallow coastal habitats throughout the northern hemisphere. In James Bay, it provides food for ducks and geese, which in turn provide invaluable cultural and provisioning services to coastal communities of the Cree first nation. Until the late 1990's James Bay was home to an extensive eelgrass meadow (*Zostera marina* L.) that was thought to be among the largest in North America. The extent of eelgrass habitat, as well as canopy density and height, have declined since 1998. Over this same period, Cree report severe declines in goose abundance during their spring and fall hunting seasons, and attribute these changes to declines in eelgrass. In partnership with Cree land users, we surveyed areas likely to host eelgrass along James Bay's eastern coastline to document its current abundance, distribution, and associated biota. This is the first publicly available survey on this scale of James Bay eelgrass assemblages. We documented shoot density, height, epibiota composition, and used eelgrass morphometrics to assess growth rates and reconstruct recent growth. We are testing hypotheses that salinity, ice-off timing, and nutrient availability affect eelgrass presence and growth. We also compare James Bay eelgrass and associated biota to eelgrass meadows on Canada's Pacific Coast and in the St. Lawrence River (QC). Understanding the status of eelgrass in James Bay will clarify connections between declines in eelgrass and declines in eelgrass-associated species of cultural, economic, and ecological importance.

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METAPOPULATION PERSISTENCE IN A MARINE SYSTEM: THE CLOWNFISH CASE

1 - Stanford University, Rutgers University, 2 - Rutgers University, 3 - Oregon State University, 4 - Visayas State University

Many marine populations are spatially structured and exist as metapopulations, with distinct patches connected through dispersal of individuals. Understanding marine metapopulation dynamics and persistence is particularly challenging because most of the connectivity takes place through dispersal of tiny larvae. Though the theoretical understanding of population persistence is well-developed, this theory has rarely been applied in the field. Here, we assess persistence for a metapopulation of yellowtail clownfish (*Amphiprion clarkii*) along the coast of Leyte, Philippines. Clownfish are particularly well-suited to metapopulation studies, with limited movement as adults and a relatively short pelagic larval duration. Using mark-recapture and genetic parentage methods, we estimated survival, reproduction, and dispersal to understand and characterize persistence mechanisms, taking into account uncertainty in demographic estimates. We found that the 19 subpopulations along our study region of coastline have persisted over seven sampling years with stable abundances. However, we did not find evidence that any patch could persist individually by retaining enough of its own offspring or that

the set of sites could persist in isolation. Our findings suggest that we have sampled a ‘sink’ portion of a larger metapopulation and that our sites rely on recruits from outside areas to persist. Our study region would require about 2.8 times the current production of recruits or about 2.5 times more habitat to persist as an isolated metapopulation.

†Deith, M.C.M. [1*], Brodie, J.F. [2]

SAVING SPACE FOR DINNER: CAN SPATIAL RESERVES PROMOTE SUSTAINABILITY EVEN WHEN DATA ARE SCARCE?

1 - University Of British Columbia, 2 - University Of Montana

Growing human populations demand more and more natural resources, particularly food. Especially in the tropics, subsistence harvesting of wild meats – fish and mammals – provide substantial protein to remote populations. Such small-scale harvest systems are prone to poor management, nonenforcement of harvest rules, and inadequate monitoring. In such data-deficient systems, quota-based management rarely ensures sustainability. Recently, spatial protections have been touted as an easier and more robust form of management, capable of balancing human demands for food with ecological sustainability. But protected areas are far from a panacea; many offer little-to-no benefit to those who rely on wild foods. Nevertheless, governments are increasingly interested in spatial protections for the sake of food security and sustainability. For example, state governments in Malaysian Borneo have discussed implementing *tagal hutan*, spatially- and temporally-dynamic reserves to regulate terrestrial bushmeat hunting. As a first assessment of this proposed management system, I simulated the outcomes of dynamic reserves in a multi-species harvest system over a 50-year time horizon. I then applied Bayesian decision analysis to highlight the susceptibility of spatially protected harvest systems to uncertainty in hunter behaviour, prey responses, and ecological conditions. While simulations highlighted the contingency of management outcomes, my simulations showed that spatially dynamic reserves can provide essential protein to rural peoples if designed with hunter and prey dynamics in mind.

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DECOUPLED PHYSIOLOGICAL RESPONSES TO INCREASED TEMPERATURE – IMPLICATIONS FOR ADAPTATION POTENTIAL TO OCEAN CHANGE

University Of Southern California

Understanding the mechanisms that set physiological limits to temperature change is critical for predicting adaptive potential to a warming ocean. We reared larvae of two species of sea urchin (*Lytechinus pictus*; *Strongylocentrotus purpuratus*) under different temperature regimes and measured the thermal sensitivity (Q-10-) of key physiological processes related to (1) cellular energy production (ATP from respiration) and (2) energy demand for growth (protein synthesis). We report that the Q-10- value for respiration is lower than that of protein synthesis. Under thermal stress, this differential sensitivity will result in greater allocation of the ATP pool to support the biosynthetic demand for growth, leaving less available energy to support other essential processes. Analysis of ATP allocation strategies is a valuable index for predicting the “tipping point” for sustaining physiological state in a changing ocean.

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LIFE ON THE EDGE: THE PHENOLOGICAL RESPONSE OF A CRITICALLY-ENDANGERED FISH TO A RAPIDLY CHANGING CLIMATE

Uc Davis

Climate change is causing ever greater variability in the frequency of floods, droughts, and heat waves, however less attention has been focused on estuaries and freshwaters which could be even more sensitive to climate change than other ecosystems. Delta Smelt (*Hypomesus transpacificus*) is a small endemic estuarine species nearing extinction in the wild due to a variety of factors such as loss of habitat, reduction in freshwater flows, changing food webs, and entrainment into water diversions. Climate change is likely to exacerbate these problems and lead to new challenges for the management of this imperiled species. In this study we documented changes to the estuarine thermal regime over the last 20-years, including a period of extreme heat wave in 2014 and 2015, causing Delta Smelt to reproduce earlier and contributing to a miss-match with prey and decreased recruitment. Furthermore, using a 20-year otolith dataset, we've documented an effect of early warming on the dispersal history causing fish to shift habitat use towards areas of the estuary with cooler temperatures but less food. Combined, these changes appear to be pushing the species ever closer to extinction, and emphasize the need to consider thermal management strategies in future conservation efforts

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NATIVE DIVERSITY AND BIOSECURITY: BLACK ABALONE DECLINES SHIFTED HERBIVORE COMMUNITIES TO THOSE THAT AVOID INVASIVE SARGASSUM

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Although native herbivores provide greater biotic resistance against invasive seaweeds than exotic herbivores, some native herbivores may better provide this ecosystem service. For example, because herbivores display species-specific feeding preferences for invasive seaweeds and harvesting of herbivore populations may affect target species differentially, shifts in grazer composition associated with grazer loss could change a community's susceptibility to invasion–even in the absence of herbivore invasions. In southern California, the loss of an abundant native herbivore, black abalone *Haliotis cracherodii*, may have resulted in a shift in the native herbivore community to one that does not include an herbivore that readily fed upon invasive the rockweed, *Sargassum horneri*. To test this hypothesis, we compared the feeding preferences of black abalone and three abundant herbivore species (black turban snails, blue-band hermit crabs, and striped shore crabs) when offered agar-based foods made from either *S.horneri* or kelp, *Macrocystis pyrifera*. Black abalone readily ate both choices and did not distinguish between the two. In contrast, the three other herbivore species that dominate these herbivore communities today, strongly preferred *M.pyrifera* and almost completely avoided grazing of *S.horneri*. Our results are consistent with previous reports that black abalone have a greater preference for rockweeds. Thus, protecting native herbivore diversity is an important part of biosecurity plans that aim to minimize invasive species and their impact on native communities.

†Dickens, J. D. [1*], Gravem, S. A. [1], Garza, C. [2], Morgan, S. G. [3]

BURN IN SHELL: USING 3-D MAPS TO PREDICT MUSSEL BED DYNAMICS WITH RISING TEMPERATURES

1 - Oregon State University, 2 - Csu Monterey Bay, 3 - Uc Davis Bodega Marine Lab

As Earth's climate changes, temperature is expected to generally increase. Because intertidal species spend their lives on the edge of their thermal tolerance limits, sessile species such as the mussel *Mytilus californianus* may also serve as early indicators of rising temperatures. Though body temperatures of intertidal organisms are strongly influenced by their vertical height on shore and their microhabitat, we can utilize these microclimates to evaluate the sensitivity of mussels to rising temperature. We utilized strong temperature gradients around 24 large intertidal boulders near Bodega Bay, CA to test the effect of small changes in temperature stress on the centimeter-scale vertical distribution of *M. californianus*. We sampled mussel cover in 575 quadrats and temperature of mussel biomimics during summer in 48 microhabitats. We modeled how cover and maximum body temperature covaried with shore level, compass heading, and incline. We then generated 3-D "flyover" maps of interpolated mussel coverage and predicted maximum mussel temperature throughout the boulder field. We found that on eastern faces receiving morning sun during summertime low tides, and on flatter surfaces, mussels were scarce. We will investigate how a predicted 2-degree increase in average mussel body temperature will alter emergent bed dynamics. By harnessing the information gleaned at the microhabitat scale, we gain insight into the expected effects of climate on entire populations.

†Dillon, E.M. [1*], Mccauley, D.J. [1], O'Dea, A. [2]

DERMAL DENTICLE ASSEMBLAGES REVEAL SHIFTS IN SHARK COMMUNITIES ON CORAL REEFS OVER THE LAST 7000 YEARS IN PANAMA

1 - University Of California, Santa Barbara, 2 - Smithsonian Tropical Research Institute

Many coastal shark populations have declined steeply over the last several decades, but longer records of change are unavailable. This hinders our ability to determine baseline shark abundance, understand natural variation in shark communities over time and space, and interpret sharks' functional roles on coral reefs in natural and human-impacted systems. Here, we explore the use of dermal denticles, the small tooth-like scales that cover the bodies of sharks and rays, as a new tool for reconstructing historical shark communities on coral reefs. We compared denticle assemblages extracted from low-energy mid-Holocene (~7ka) fossil reefs in Bocas del Toro, Caribbean Panama with modern reefs in the same area to investigate how shark communities have changed over time. Denticle accumulation rates (denticle count per amount sediment per unit time) were, on average, five-fold higher on the fossil reefs than on the modern reefs, implying that these reefs supported many more, or larger, sharks 7000 years ago. Furthermore, we observed a significant shift in the relative abundance of denticle morphotypes over time. *Abrasion strength* denticles belonging to demersal sharks (e.g. nurse sharks) increased in relative abundance on the modern reefs, whereas *drag reduction* denticles, which are associated with fast-swimming species (e.g. requiem and hammerhead sharks), decreased in relative abundance, suggesting an ecological shift in shark communities on these reefs.

These new data can provide insight into pre-human shark communities on coral reefs and can help guide management targets.

Dinsdale, E. [1]*, Doane, M. [2], Turlund, A. [1], Goodman, A. [1], Dillon, T. [1], Lima, L. [1], Rohner, C. [3], Christine Legaspi [4], Deni Ramirez [5], Mora, M. [1], Araujo, G. [4], De La Parra, R. [5], Pierce, S. [3], Pilians, R [6], Peterson, M. [1]

GLOBAL WHALE SHARK (*RHINCODON TYPUS*) MICROBIOME

1 - Sdsu, 2 - Sims, 3 - Marine Megafauna, 4 - Larmva, 5 - Whale Shark Mexico, 6 - Csiro

Whale sharks, the largest fish in the ocean, have a global distribution and are often targeted for shark tourism. The whale shark feeds low on the food chain, including phytoplankton, eggs, and larvae of vertebrates, such as fish and invertebrates, such as coral. The whale shark has a global distribution. We sampled the skin microbiomes of 120 whale sharks from 5 location around the world to explore microbial biogeography. Microbial samples were collected on snorkel using a supersucker device. The device was filled with sterile sea water and flushed the microbes off the skin of the shark from the flank region under the dorsal fin. Microbes were collected in a 0.22 um sterivex and DNA extracted and sequenced on the Illumina platform. Annotation was conducted using Focus and Superfocus, two kmer based programs. The microbial taxonomic diversity varied across geographic regions, whereas functional diversity showed no difference. The taxonomic make-up of the microbiome was highly distinct at each location. A bray-Curtis analysis showed 5 % similarity between the microbiomes from La Paz, Mexico and Ningaloo, Western Australia, 21 % between Ningaloo, and Oslob, Philippines, with Cancun, Mexico, and Tanzania showing 42 % similarity between microbial taxa. Whereas, the microbial functions showed > 83 % similarity between sharks from all regions, suggesting core functional attributes are required for life on the skin of whale sharks and the functions are found in different microbes depending on location.

†Dolinar, D.*, Dr. Matthew Edwards, Natalie Goetz

IMPACTS OF ANTHROPOGENIC DISTURBANCE ON RHODOLITH COMMUNITY PRIMARY PRODUCTION AND RESPIRATION

San Diego State University

Rhodoliths are red coralline algae that can be found throughout the world's oceans in places ranging from the Arctic to southern Australia. When aggregated, rhodoliths form beds that can serve a variety of important ecological roles such as providing habitat for a diverse range of organisms. On Santa Catalina Island, CA, these beds occur in protected coves where networks of vessel moorings have been built to support recreational boating activities. Unfortunately, the heavy chains and spanner lines associated with these moorings disturb the benthos, crushing the rhodoliths and altering their communities. We examined if the impacts alter primary production and respiration by the rhodoliths and their associated taxa. Specifically, we measured the amount of oxygen produced and consumed by intact and crushed rhodoliths, and the dominant invertebrate taxa in a closed bottle system. We observed a gradual decrease in oxygen in the system due to respiration taking place and we observed an increase in oxygen in the system due to photosynthesis. Our results suggest that crushing the rhodolith thalli does not

immediately impact mass-specific rates of photosynthesis or respiration, but over time both will increase but at different rates. In addition, the loss of invertebrate taxa due to this crushing resulted in decreased respiration in the ecosystem. This study has provided insight into better understanding how humans are disturbing community productivity and respiration of these ecologically important habitats.

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UNDERSTANDING THE INDIRECT EFFECTS OF SEA OTTER HABITAT FACILITATION ON JUVENILE SALMON ABUNDANCE IN SOUTHEAST ALASKA

1 - University Of Alaska Fairbanks, 2 - University Of Alaska Southeast

Sea otters (*Enhydra lutris*) serve as apex predators that through a trophic cascade result in increased seagrass. Therefore sea otters may create and maintain fish habitat. On the other hand, they are despised in southeast Alaska because they eat and deplete traditionally and economically valuable shellfish. As seagrass is an important nursery habitat for fish including juvenile salmon (*Oncorhynchus spp.*), we were interested in whether sea otters may have indirect effects on salmon species. Our objective was to determine changes in salmon abundance across an index of sea otter impact that incorporates various measures of sea otter occupation. We conducted beach seines in 2017 and 2019 to quantify abundance of the five species of salmon at 21 different sites. We hypothesized salmon abundance may be greater in high sea otter impact areas compared to low sea otter impact, may increase closer to anadromous streams, and decline throughout the summer as salmon out migrate from nearshore environments. Preliminary analysis suggests highly variable abundance of juvenile salmon species in eelgrass habitat. Understanding the direct and indirect effects of an apex predator as it expands throughout Southeast Alaska will be important for management of sea otters and other commercial and recreational fisheries, as these economies are vital to Southeast Alaska.

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MODELING OCEANIC CO~2 USING HYDROGRAPHIC VARIABLES. AN APPROACH TO FILL THE SAMPLING VOIDS IN THE GULF OF MEXICO AND CARIBBEAN SEA

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Ocean Dissolved Inorganic Carbon (DIC) has taken on relevance in recent years since it plays a key role in biogeochemical and environmental phenomena such as ocean acidification, however, there are not direct methods for DIC determination yet, instead, measurements involve analytical procedures on discrete samples. Sampling difficulties and geopolitical issues have led to large sampling gaps, particularly, in the Caribbean Sea (CS) and the Gulf of Mexico (GM). As an attempt to fill these gaps, we have developed a set of models to estimate DIC through dissolved oxygen, temperature and salinity, since these variables have larger temporal and spatial coverages. The dataset consisted of the available public data of oceanographic surveys

in the study region, merged with 6 oceanographic campaigns carried out between 2010 and 2017 in the GM. Model training and validation datasets of 4548 and 2583 samples respectively, were used to perform multiple regression analyzes. Results suggest the existence of different DIC regimes within each water mass, since individual water mass models showed considerable improvements over full-column models. Model applications showed qualitatively good approximations to vertical and horizontal DIC distributions. R^2 obtained ranged from 7.8 to 9.8, the 85% of the residuals were inside ±5 units threshold.

†Early-Capistrán, M.M. [1*], Solana-Arellano, E. [2], Abreu-Grobois, F.A. [1]

QUANTIFYING LOCAL ECOLOGICAL KNOWLEDGE TO RECONSTRUCT GREEN TURTLE ABUNDANCE IN THE GULF OF CALIFORNIA

1 - Universidad Nacional Autónoma De México, 2 - Centro De Investigación Científica y De Educación Superior De Ensenada

Deriving reliable historical population trends for long-lived species subject to human exploitation is challenging in scenarios where technical or quantitative data are scarce. To understand long-term trends and human impacts prior to scientific monitoring, we reconstructed abundance of the heavily-exploited East Pacific green turtle (*Chelonia mydas*) in the Gulf of California by integrating local ecological knowledge (LEK) and ecological modelling.

In Baja California, Mexico, *C. mydas* was driven to near extinction by a largely unregulated fishery from the early 1950s to the 1980s, with no validated abundance data available for this time frame. In collaboration with local fishers, we applied ethnographic methods (e.g., participant observation, semi-structured interviews), to document LEK and obtain corroborated, systematized qualitative data to understand the socio-environmental complexity of this green turtle fishery. We then synthesized and quantified LEK to generate a standardized and statistically reliable LEK-derived Catch-Per-Unit-Effort (CPUE) time-series back to the early 1950s. This approach allowed us to transform qualitative data into statistically reliable quantitative data, and generated a baseline abundance level which revealed that the most critical decline occurred between 1960 and 1980. Our data can be combined with ecological survey data for a holistic view of a species' historic and contemporary conservation status. This robust integration of LEK data with ecological science is of critical value for conservation and management.

Eckert, G.L. [1*], Raymond, W.W. [1], Hughes, B.B. [2], Mattson, C. [3], Shields, M. [3], Domke, L. [1], Cates, B. [1], Stephens, T.A [1]

APEX PREDATORS, SEAGRASS COMMUNITY STRUCTURE, AND BLUE CARBON: ARE SEA OTTERS KEYSTONE SPECIES IN ALASKAN SEAGRASS MEADOWS?

1 - University Of Alaska Fairbanks, 2 - Sonoma State University, 3 - University Of Alaska Southeast

In marine systems, recent evidence suggests that predators can play a critical role in protecting vegetated coastal habitats, including salt marshes, seagrass meadows, and kelp forests. These vegetated coastal habitats play a large role in the global capture and storage of carbon and have been characterized as "blue carbon ecosystems". Seagrasses, in particular, have been

classified as the most carbon-rich ecosystems in the world, with storage of up to 25 billion tonnes of C. Seagrass meadows are also one of the most widespread habitats in shallow coastal systems and are declining worldwide. The recolonization of sea otters (*Enhydra lutris*) in Southeast Alaska after a more than 150 year absence provides a rare opportunity to investigate the impact of apex predators on seagrass (*Zostera marina*) community structure and carbon sequestration across a large temporal and spatial scale. We identified a positive relationship between sea otters and seagrass; however, we also found significant disturbance of intertidal seagrass habitat by sea otters digging for clams. The upper tidal limit of seagrass varied as a function of sea otter activity, with lower seagrass areal cover with high sea otter disturbance. Preliminary analyses suggest sedimentary carbon content in seagrass meadows was higher when sea otters were present, suggesting that sea otters may facilitate carbon sequestration. The net effect of sea otters on seagrass appears to be positive, supporting their role as a keystone species in seagrass meadows and coastal ecosystems in general.

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ECOLOGY AND SUSTAINABILITY OF A CO-MANAGED COMMERCIAL GOOSENECK BARNACLE FISHERY

Simon Fraser University

Gooseneck barnacles are harvested commercially on the west coast of Vancouver Island and are a traditional food source for the Nuu-chah-nulth people. This fishery is exclusively First Nations and is co-managed with Department of Fisheries and Oceans Canada (DFO). We investigated sustainability of this fishery, to explore the possibility of expanding the harvest. Two key questions were: how quickly can gooseneck barnacles recover and what are the impacts of by-catch on the California mussel beds in which they grow. We cleared 42 plots of various sizes on six harvest rocks in Clayoquot Sound, British Columbia, Canada. We returned to these plots after one year to measure the regrowth of gooseneck barnacles and understand how California mussels help to facilitate this recovery. We found that smaller plots cleared in deeper mussel beds have faster recovery rates and reduced mussel by-catch. These results, along with the traditional knowledge of the harvesters, will help our project partners to expand this fishery and ensure the ability for all member Nations to participate in this economic opportunity.

Eernisse, D.J.*

ISLAND LIFE: WHAT TWO MOLLUSCAN ENDEMICS ON CALIFORNIA’S CHANNEL ISLANDS REVEAL ABOUT REPRODUCTIVE CONTRASTS IN MARINE ANIMALS

Cal State Fullerton

In his 1880 book, *Island Life*, Alfred Russell Wallace pioneered the study of insular faunas and floras on isolated oceanic islands, but even islands close to the mainland can have striking patterns of endemism. Ongoing studies of *Cyanoplax* cf. *caverna*, a small chiton that broods, and *Siphonaria brannani*, a siphon limpet that lays benthic jelly masses with embryos that likely crawl away, are each relatively common on multiple islands of California’s Channel Island Archipelago, but are unknown from the nearby mainland coast. Although much of the islands remain unexplored for these relatively high intertidal molluscan grazers, comparisons of

mitochondrial gene sequences (16S and COI), and a nuclear intron gene region for the chiton, have revealed that each species also has a striking pattern of phylogeographic structure. For populations on different islands, or in one case even on different sides of an island, substantial genetic divergence was observed, with little or no within population variation. The unusually restricted distributions of these populations, inferred to have limited dispersal, and the curious absence of either species from the mainland, could be attributed to similar ecological factors. They could be out-competed by more widely dispersing species of mostly larger-bodied grazers on the mainland, or they might have a refuge from predation pressure on islands. These competitors or predators could be less successful at recruiting to an island habitat if their planktonic larvae are swept away by currents, unlike the direct developing island endemics.

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TROPHIC REDUNDANCY AND PREDATOR SIZE CLASS STRUCTURE DRIVE DIFFERENCES IN KELP FOREST ECOSYSTEM DYNAMICS

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Ecosystems are changing due to climate change and a wide variety of other anthropogenic stressors. These stressors have the potential to cause phase shifts to less productive ecosystems. A major challenge for ecologists is to identify ecosystem attributes that enhance resilience and can buffer systems. In this study, we used the Northern Channel Islands, California, as a model kelp forest ecosystem that had been perturbed from the loss of a sea star predator due to a sea star wasting disease (SSWD). To determine the mechanisms that prevent phase shifts from productive kelp forests to less productive urchin barrens, we compared pre- and post-disease predator assemblages as predictors of purple urchin densities. We found that prior to SSWD, the sunflower sea star exerted strong predation pressures and was able to suppress purple urchin populations. After the disease outbreak, which functionally extirpated the sunflower star, we found that the ecosystem response depended on the abundance and size of other predators. Inside Marine Protected Areas (MPAs), the prevalence and size of other urchin predators suppressed purple urchin populations and prevented phase shifts. However, outside of the MPAs, where urchin predators are fished, less abundant, and smaller; urchin populations grew dramatically in the absence of sunflower stars. Our results demonstrate that protected trophic redundancy inside MPAs creates a net of stability that could limit kelp forest ecosystem phase shifts when perturbed. This highlights the importance of harboring diversity and managing predator guilds.

†Estrada, A.C. [1*], Rogers-Bennett, L. [2], Steele, M.A. [1]

QUANTIFYING POST-SETTLEMENT RECRUITMENT OF RECOVERING ABALONE (HALIOTIS SSP.) AT SANTA CATALINA ISLAND, CALIFORNIA

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California's abalone populations have been slow to recover, after 22 years of fishery closure, or are not recovering at all due to recruitment failure. Regular and substantial recruitment is required for recovery, but recruitment is poorly understood, especially for critical early life stages (< 3 mm). Recently, green abalone (*H. fulgens*) have shown signs of population recovery at sites at Santa Catalina Island, yet there is no information on newly settled abalone. We use novel techniques to quantify the presence and density of newly settled (< 3 mm) abalone (*Haliotis spp.*) at 2 sites from multiple depths (2-12m) at Santa Catalina Island, California, monthly from May-September 2017. We found 112 abalone recruits (0.22–2.12 mm) on 326 crustose coralline covered cobbles (8.45 m^2 total surface area), or 13.25 recruits per m^2. The presence and density of recruits differed between the two sites, the depths surveyed, and between months, with greatest recruitment occurring during June and September at Intake Pipes in 6-8 m. Abalone settlement at Catalina was lower than in Baja California, Mexico where there were 20-152 settlers per m^2 (Rossetto et al. 2013). This is the first work to quantify newly settled abalone in the recovery zone in southern California. It reveals that recruitment is occurring and documents the rate of recruitment, which will aid future efforts to monitor and quantify recovery of depleted and endangered abalone species.

†Felix A. C.[*], Lorda J., Beas R., Montaño G.

EFFECTS OF INVASIVE MACROALGAE ON RED SEA URCHINS MESOCENTROTUS FRANCISCANUS

Mexcal, Uabc

The red sea urchin Mesocentrotus franciscanus feeds mainly on the native giant kelp Macrocystis pyrifera, and other laminar brown algae. In recent years, the Asian invasive species akamoku, Sargassum horneri, and wakame, Undaria pinnatifida, have been found in Baja California but their potential effects on the red sea urchins are still unknown. This work aims to compare growth and gonad development (GSI) of red sea urchins fed with native and non-native macroalgae. We developed a laboratory experiment to: 1) estimate the difference in growth and gonadal development of juvenile red sea urchins after six months of exclusive feeding them with one of the three species of macroalgae and 2) test which algae is preferred by sea urchins. We found that urchins fed with S. horneri had lower growth and GSI compared to urchins fed with U. pinnatifida and M. pyrifera. We also found that urchins seem to preferred M. pyrifera and U. pinnatifida, however, they definitively did not choose S. horneri. Our findings suggest that the ecological effects of U. pinnatifida on red urchins growth and reproduction should be significantly lower compared to the effects of S. horneri. However, more field and laboratory studies are needed to fully assess the effects of these two invasive species on the red sea urchin.

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PREY TELL: QUILLBACK ROCKFISH EARLY LIFE HISTORY TRAITS AFFECT SURVIVAL IN PREDATION ENCOUNTERS WITH JUVENILE COHO SALMON

1 - Hatfield Marine Science Center, Oregon State University, 2 - Cooperative Institute For Marine Resources Studies, Oregon State University, 3 - Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, NOAA

Predation is a major source of mortality in the early life stages of fishes and a driving force in shaping fish populations. Theoretical, modeling, and laboratory studies have generated hypotheses that larval fish size, age, growth rate, and development rate affect their susceptibility to predation. Empirical data on predator selection in the wild are challenging to obtain, and most selective mortality studies must repeatedly sample populations of survivors to indirectly examine survivorship. While valuable on a population scale, these approaches can obscure selection by particular predators. In May 2018, along the coast of Washington, USA, we simultaneously collected juvenile quillback rockfish (*Sebastes maliger*) from both the environment and from the stomachs of juvenile coho salmon (*Oncorhynchus kisutch*). We used otolith microstructure analysis to examine whether juvenile coho salmon were age-, size-, and/or growth-selective predators of juvenile quillback rockfish. Our results indicate that juvenile rockfish consumed by salmon were significantly smaller, slower growing at time of capture, and younger than surviving (unconsumed) juvenile rockfish, providing direct evidence that juvenile coho salmon are selective predators on juvenile quillback rockfish. These differences in early life history traits between consumed and surviving rockfish are related to timing of parturition suggesting that maternal effects may substantially influence survival at this stage.

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DISTRIBUTION AND DELIVERY OF MEROPLANKTONIC LARVAE IN THE BAY OF TODOS SANTOS: THE ROLE OF INTERNAL TIDAL WAVES AND ONSHORE WINDS

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Marine invertebrate larvae accumulate at different distances from the coast due to their behavior, ontogenic stage, habitat and the variability of physical mechanisms on the shelf. To understand the role that internal tidal waves play during the last 2 km that larvae must travel before reaching the shore, we evaluated high-frequency changes (hourly) in the abundance and vertical distribution of target meroplankters (gastropods, oysters, barnacles, and bryozoans) using a cross-shore sampling array (2 km, 1.3 km and 10 m from shore) during a period of strong internal tidal forcing in summer. Concurrent measurements of temperature, currents, and winds helped to identify the mechanisms occurring while meroplankton abundance was measured. Semidiurnal internal waves dominated the temperature and current fields, especially from the midwater to the bottom, and were most likely responsible for aggregating organisms at different sites depending on their habitat preferences. Also, some taxa appeared to be delivered to the coast by the interaction between breaking internal tidal waves and onshore winds, showing for the first time an interaction between both forcing factors as a mechanism of delivery. These results further emphasize the complicated impact that internal waves might have on structuring intertidal communities.

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THE CARBON FOOTPRINTS OF MEXICAN SMALL-SCALE FISHERIES REVEAL NEW INSIGHTS INTO MARINE RESOURCE TRADE-OFFS ON A CHANGING PLANET

1 - Uc San Diego - Scripps Institution Of Oceanography, 2 - Uc Riverside - The University Of California Institute For Mexico And The United States, 3 - Centro Para La Biodiversidad Marina y Conservación Ac

Notable studies have explored the carbon footprint of global fisheries, often using data that is coarse relative to the heterogeneity observed across operations. We contend that previous studies which examine the carbon footprint of global fisheries in aggregate have, in the absence of detailed data, very likely underestimated the footprint of small-scale fisheries. We provide evidence of this using high-resolution fisheries data generated by voluntary monitoring efforts in Northwest Mexico, combined with landings data reported to the Mexican government. Additionally, we calculated the “emissions intensities” of various seafoods produced by small-scale fisheries throughout the region, comparing the footprint of these to other sources of animal protein such as industrial wild catch and terrestrial livestock. Some of these small-scale seafoods (like clam and crab) may offer low-carbon to moderate-carbon sources of animal protein, while others (like shrimp) do not. Connecting these results to prior knowledge of climate change and fishing impacts, and incorporating new ideas about socially-just policy and management in the Anthropocene, we discuss how to weigh the benefits of certain small-scale fisheries against the social-ecological costs of carbon pollution.

†Fields, J.B.*, Silbiger, N.J.

A TALE OF TWO TIDE POOLS: EFFECT OF *MYTILUS* AND *PHYLLOSPADIX* REMOVAL ON ECOSYSTEM FUNCTION WITHIN OREGON ROCKY INTERTIDAL

California State University, Northridge

Foundation species create shelter, enhance biodiversity, and maintain ecosystem functioning within their environment. Within the rocky intertidal ecosystem, a coastal ecosystem dominated by mussels and surfgrass, foundation species are expected to decrease in abundance with climate change, extreme climatic events, and increased human impact. However, there is a need to better understand how foundation species loss will affect ecosystem functioning through changes in biogeochemical cycling, thermal buffering, and ecosystem metabolism. Using tide pools in coastal Oregon as a study system, I tested how the loss of mussels (*Mytilus californianus*) and surfgrass (*Phyllospadix* spp.) affect biogeochemistry, thermal buffering, and ecosystem metabolism (net ecosystem calcification [NEC] and net ecosystem production [NEP]) using a Before-After-Control-Impact (BACI) experimental design. Our results show that foundation species loss altered ecosystem function and was dependent on short-term community composition shifts. This study will anticipate immediate cascading impacts of foundation species loss on ecosystem function to aid in conservation management policies of our intertidal ecosystems.

†Flood, A.S. [1*], Haggitt, T.R. [2], Shears, N.T. [2], Radford, C.A. [2]

GUT INSTINCTS: FEEDING BEHAVIOUR OF THE SOUTHERN ROCK LOBSTER, JASUS EDWARDSII

1 - University Of Auckland, 2 - Univeristy Of Auckland

Growing human pressure on marine systems has led to a push for more effective conservation efforts. No-take marine reserves are a widely recognised conservation tool in restoring and preserving biodiversity and provide a spatial refuge for intensely exploited species. However, highly mobile predators, especially those that make use of both reef and soft-sediment fauna are usually not fully protected by small marine reserves. Long term population monitoring of the southern rock lobster (Jasus edwardsii) within New Zealand's first established no-take marine reserve (Goat Island) has shown a decline to pre-reserve numbers. This could potentially be explained by individuals making offshore migrations across the reserve boundary, where fishing is permitted. These movements appear to follow after energetically demanding events, such as mating and moulting. Previous laboratory studies have also indicated that migrations occur at times when captive lobsters are consuming the most food. Therefore, it is hypothesised that lobsters could be making offshore movements in search of energy-rich offshore feeding grounds. To understand the reasoning behind these offshore movements a grid of sediment grabs were conducted to describe the distribution of potential lobster prey. Additionally, different reef and sand prey species were tested for possible feeding preferences and to describe lobster feeding patterns, handling times and energetics. It is hoped that the findings of this study will help policymakers better understand and accordingly protect these vulnerable and valuable species.

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KELP FOREST DEFORESTATION LEADS TO COMMUNITY-WIDE DIETARY NICHE CONTRACTION

Coastal And Marine Institute, San Diego State University

Foundation species provide primary habitat and energy to their ecosystems, and their losses often leads to decreases in species abundance and diversity. Less understood is how these losses lead to changes in species interactions, specifically the feeding networks that create food webs. The loss of sea otters across the Aleutian Islands has led to the ecological release of sea urchins, an increase in their grazing intensity, and ultimately to the formation of sea urchin barrens that are characterized by high urchin densities, low abundances of fleshy macroalgae, and high cover of crustose coralline algae. To estimate how this kelp loss impacted the ecosystem's food webs, we compared food web structure among nearshore kelp forests and urchin barrens, and offshore communities across 10 Aleutian Islands. We constructed food webs for each habitat using primary producer and consumer stable isotope values (carbon d13C, a proxy for food source, and nitrogen d15N, a proxy for trophic level). Our results indicate that the loss of kelp forests and their associated biodiversity leads to a loss of stable isotope variation for entire communities, suggesting community-wide dietary niche contractions and homogenization of energy flow pathways. These contractions were caused by reduced dietary niche breadth for primary and secondary consumers and decreased trophic levels for fishes and

secondary consumers. Surprisingly, fishes appear to increase their dietary niche breadth within urchin barrens and offshore habitats.

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FATTY ACIDS REVEAL LARGE-SCALE GEOGRAPHIC VARIATION IN THE TROPHIC NICHE OF LINGCOD

Oregon Institute Of Marine Biology

Predators with very large geographic distributions are often trophic generalists, because their diets vary according to available prey across biogeographical regions within their range. Lingcod are known to consume a diversity of pelagic and demersal fishes and mobile invertebrates and inhabit a cosmopolitan distribution throughout the northeastern Pacific Ocean, from the Gulf of Alaska to central Baja Mexico. The bright blue coloration in the flesh of some lingcod has also been hypothesized to be diet-related. We collected lingcod from 7 regions (Alaska, Puget Sound, Coastal Washington, Oregon, and Northern, Central, and Southern California) to study variation in the trophic ecology of lingcod across their full range. We analyzed the multivariate fatty acid composition of muscle tissue from 175 fish (n=25 from each region), as an indicator of their time-integrated assimilated diets and ‘trophic niche’ across space. The fatty acid composition of lingcod differed by region (p=0.003) and with color (p=0.002) but not by sex (p=0.24), with no interactions. The multivariate dispersion in fatty acids did not differ among regions. We found evidence for 4 distinct biogeographical groups, with lingcod from Coastal Washington, Oregon, and the Northern and Central California coasts being similar to each other, and lingcod from regions at the edge of the range (Alaska, Southern California) and in inland waters (Puget Sound) each being different from all other regions. These results show that this key predator may be playing different ecological roles in different parts of its range.

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ECOLOGY AND FISHING INTERACTIONS OF JUVENILE WHITE SHARKS IN A NURSERY AREA FROM THE MEXICAN PACIFIC COAST

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In the northeastern Pacific, Vizcaíno Bay (VB), Mexico, has been confirmed as a nursery area for juvenile white sharks (JWS). Based on high local productivity and suitable habitat year round, this area meets the qualifications for nursery habitat, like providing high food abundance and potential protection from predators; however, VB also hosts several artisanal fishery communities, that interact with JWS during their fishing operations. To understand the ecological role of JWS and the degree of interaction with artisanal fisheries and develop strategies to minimize these interactions, we are using several approaches. Semi-structured interviews applied to 77 fishers along the coast of VB helped to describe artisanal fishing activities, showing that target species are potential prey of JWS and indicating that the higher interaction

areas are in nearshore habitats close to the mouth of the Ojo de Liebre lagoon (OLL). Passive acoustic monitoring of 17 JWS (tagged at VB and California, US) inside and outside OLL indicate that there is a higher number of JWS detected in months with lower incidental catches. Carbon and nitrogen bulk stable isotope analyses revealed a higher contribution of demersal prey heavily targeted by local fisheries to JWS isotopic values, as well as a partial overlap in the isotopic niche with hammerhead sharks of similar sizes. Our findings may help to improve current management strategies to minimize the landings of local artisanal fisheries on JWS bycatch.

†Garcia, Eric [1*], Bernardi, Giacomo [2], Brian Simison [3]

GENOMIC ANALYSIS REVEALS DRIFT AND CONVERGENT SELECTION IN DISJUNCT MARINE FISH POPULATIONS OF THE PACIFIC AND SEA OF CORTEZ

1 - Old Dominion University, 2 - Uc Santa Cruz, 3 - California Academy Of Sciences

Disjunct populations provide an excellent opportunity to study the early stages of speciation as these are separated by a physical barrier and have potential to remain the same species or diverge depending on how effectively the barrier impedes gene flow. The sargo, *Anisotremus davidsonii* (Haemulidae); the zebraperch, *Kyphosus azureus* (Kyphosidae); the California sheephead, *Semicossyphus pulcher* (Labridae); and the longjaw mudsucker, *Gillichthys mirabilis* (Gobiidae), have disjunct distributions with populations in the Pacific being separated from those in the Sea of Cortez by the Baja California Peninsula. Here, restriction site-associated DNA (RADseq) is utilized to analyze genomic structure in putative neutral and outlier loci, and to search for genomic regions diverging convergently in disjunct populations of multiple species. Significant genomic differentiation (Fst= 0.03-0.31) and structure, as well as evidence of drift, were found between populations of every species, except for S. pulcher. Results also exposed 35 loci with different alleles fixed in disjunct populatios and high levels of divergence in the other putative loci under selection (Fst= 0.15-0.99). Forty of the outlier loci were further found to be diverging at the same time in multiple species and were matched to coding genes involved in at least 15 similar cellular functions. This study sheds light into the initial processes in the speciation continuum in these species and provides a deeper understanding of how populations are structured and how biodiversity might be shaped in these regions.

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VARIATION IN SPECIES ABUNDANCE FOLLOWING SEA STAR WASTING DISEASE OUTBREAK IN CENTRAL BRITISH COLUMBIA, CANADA.

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Disease can cause dramatic declines in animal populations. Sea star wasting disease (SSWD) infects up to 20 species of sea star, although the etiology of the disease is still under debate. There is variability in susceptibility and mortality among the sea star species, which could lead to species specific response to disease outbreak. We document the effect of sea star wasting disease on population size and sea star size structure in response to SSWD around Calvert

Island, British Columbia. Sea star wasting disease was first documented at Calvert Island in the winter of 2015. We conducted expert intertidal and subtidal diver surveys; in the rocky intertidal (2014-2019), seagrass beds pre- and post-wasting (2014-2018), and in kelp beds monthly during initial disease spread (2015). We found species specific responses to wasting across habitats. In the seagrass beds, mean *P. helianthoides* size decreased in 2015, increased incrementally through 2017, and decreased in 2018, a potential indicator of juvenile recruitment. *Dermasterias imbricata* mean star size increased from 2015-18. In kelp beds we saw a loss of large bodied *P. helianthoides* from May to October, 2015. We saw declines in abundance for *Solaster*, *Evasterias troscheli* and *Orthasterias koehleri*. At the same sites, there was no change in mean abundance of *D. imbricata*, *Mediaster aequalis*, or *Henricia* sp. Resilient populations could be an indication of reduced susceptibility to infection, or release from competitors hit harder by SSWD.

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ANIMAL AND ALGAL FORESTS AND THEIR INFLUENCE ON COMMUNITY COMPOSITION AND CORAL PHOTOPHYSIOLOGY IN UNDERSTORY COMMUNITIES

California State University Northridge

On shallow coral reefs, arborescent taxa are increasing in number and produce forests with dense canopies. This study tested for the effect of such forests on understory invertebrates through analyses of macroalgae in Moorea, French Polynesia, and octocorals in St. John, US Virgin Islands. Each forest type was quantified by height and density of component organisms and their ability to occlude down-welling photon flux density. Communities within canopies were quantified from the number of scleractinians in Moorea, and all macroscopic invertebrates in St. John. Algal forests were formed from moderately tall and dense patches of *Turbinara ornata* that occluded 0–40% of down-welling light. Octocoral forests formed tall and sparse patches that occluded 0–67% of down-welling light. 18 scleractinians were found in algal forests, and that community was unaffected by variations in canopy characteristics; invertebrate communities within octocoral forests included 26 scleractinians and members of six other phyla. These communities were also unaffected by variations in canopy characteristics. Both types of forests created transient heterogeneous light regimes, however, only algal forests effected the photosynthetic induction time of Porites spp. Overall, the results suggest that natural variations in these forests do not affect the community structure of understory invertebrates, yet, corals in dense macroalgal forests were better able to utilize temporally variable light regimes than those in sparse forests.

†Glanz, J.S.*, Carpenter, R.C.

CRUSTOSE CORALLINE ALGAL MORTALITY AND MORPHOLOGY INFLUENCE ASSOCIATED EPIFAUNAL DIVERSITY IN MOOREA, FRENCH POLYNESIA

California State University, Northridge

Foundation species are important to structuring reefs and supporting high biodiversity. However, increasing anthropogenic disturbance may cause their mortality and impair their role as habitat. Crustose coralline algae (CCA) serve as foundation species on reefs globally. Yet our

understanding of the factors driving epifaunal assemblages associated with CCA remains limited. This study examined the importance of flow environment, thallus partial mortality, and morphology (e.g., interstitial volume, branch density, and thallus rugosity) in structuring epifaunal assemblages within the branch-forming CCA species, *Lithophyllum kotschyanum*, on a back reef in Mo'orea, French Polynesia. A total of 1,879 invertebrates were removed from 52 *L. kotschyanum* thalli, the majority of which were crustaceans (accounting for 78.4% of the total). Regardless of the flow environment, thalli with high levels of partial mortality supported assemblages with similar abundances and significantly higher taxa richness than entirely live thalli. Assemblage abundance and richness increased with interstitial volume (available living space) and lower branch density, which were morphological traits associated with higher partial mortality of algal thalli. These results suggest that the physical structure provided by a branch-forming algal foundation species has the potential to sustain reef biodiversity following host mortality, but its persistence will likely depend on erosion and disturbance rates over time.

†Gold, Z. [1*], Sprague,J. [2], Kushner, D.J. [2], Barber, P.H. [1]

COMPARISON OF ENVIRONMENTAL DNA TO UNDER WATER VISUAL CENSUS METHODS ACROSS THE SOUTHERN CALIFORNIA MARINE PROTECTED AREA NETWORK

1 - Department Of Ecology And Evolutionary Biology, Ucla, 2 - Channel Islands National Park, National Park Service

Accurate monitoring and assessment of ecosystem function and biodiversity is critical for determining marine ecosystem health and the efficacy of marine protected area (MPA) management. However, current methods for evaluating marine biodiversity are costly, time and labor intensive and require substantial taxonomic expertise. New environmental DNA (eDNA) techniques offer an alternative approach for monitoring marine biodiversity that is rapid and affordable. Recent studies demonstrate eDNA is an accurate and highly sensitive species detection tool, out performing traditional fish biodiversity surveys. However, to be maximally useful for the monitoring of MPAs, eDNA must also be able to detect both species diversity and estimate relative abundance. To determine the efficacy of eDNA for MPA monitoring, we collected eDNA samples inside and outside of 25 reserves in the Southern California MPA network. At each site, 3 replicate eDNA samples were taken at 50m intervals along a 150m transects and compared to visual census surveys by the Kelp Forest Monitoring Program and Reef Check California. 12S rRNA metabarcoding sequence data from eDNA revealed a far broader diversity of marine vertebrates than underwater visual census surveys, demonstrating a significant advantage of eDNA. Results of relative abundance estimates were promising, but require further refinement of lab techniques to reduce amplification bias. Overall, results indicate that eDNA is an effective method to rigorously compare kelp forest communities both inside and outside of marine protected areas across the Southe

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OCEANOGRAPHIC CONDITIONS EFFECTS ON THE FISH COMMUNITY IN LOS PEÑASQUITOS LAGOON IN THE LAST 30 YEARS

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Estuaries are complex coastal environments at the land-ocean-atmosphere interface affected by environmental variability, oceanographic processes, and constant anthropogenic stress. Consequently, fish communities in these ecosystems are subject to changes in their assemblages and abundances. In this study, we analyzed changes in the fish community at Los Peñasquitos Lagoon as a response to the effects of oceanographic processes variability over the last 30 years. Our results showed that the different species of fish have different responses to oceanographic processes variations, and anomalies in the physical-chemical water parameters. Multivariate statistical analyses suggest that the principal causes of community changes have been strong coastal upwelling conditions, warm water temperature anomalies, strong ENSO events, and the lagoon's inlet closures. ENSO conditions and warm water temperature anomalies are favorable for the invasive species like mosquitofish, *Gambusia affinis*, but negative for the lagoon's dominant species, topsmelt, *Atherinops affinis*. Furthermore, time-series statistical trend analysis results suggest a downward trend in fish densities for the longjaw mudsucker, *Gillicthys mirabilis*, and staghorn sculpin, *Leptocottus armatus*. Long-term studies like this are important to understand oceanographic drivers that shape the fish community in an estuary over different time scales, therefore provide valuable information for future possible scenarios in estuaries and management plans addressing climate change challenges.

†Goodman, A.Z.[*]

UNTARGETED METABOLOMIC SERUM PROFILES OF THREE CAPTIVE SHARK SPECIES FOR THE GENERATION OF A SEMI- INVASIVE CHONDRICHTHYES HEALTH

San Diego State University

As near-shore shark species experience abrupt die-off events and habitat loss directly resulting from anthropogenic forces, the need for more specialized conservation efforts for coastal dwellers grows critical. Our research project aims to develop a health metric and subsequent preventative health care strategy for Chondrichthyes. The growing field of metabolomics provides a qualitative approach by identifying potential biomarkers in sharks, particularly those in the circulatory system. Sharks in captivity provide an ideal opportunity to study healthy individuals: aquariums maintain long-term shark inhabitants with individual veterinarian records encompassing blood chemistry and pathology reports that span several years. One such organization is the San Diego Birch Aquarium which houses several species of Elasmobranches, including leopard (Triakis semifasciata), horn (Heterodontus francisci), and swell (Cephaloscyllium ventriosum) sharks. Untargeted metabolic data sampled from these resident sharks has provided over 9,906 significant ($p = 0.05$), tentatively identified molecules of interest. Furthermore, blood metabolic profiles belonging to swell and leopard sharks exhibit similarity while horn shark samples are collectively distinct, signifying species-specific metabolites. The field of Chondrichthyes blood metabolite composition and possible dysregulation between shark species is an emerging area of research. These molecules will

serve as a foundation for potential indicators of shark health and will be implemented in the future sampling of wild sharks.

†Gossard, D.J. *

EPIPHYTE-HOST DYNAMICS BETWEEN *PYROPIA NEREOCYSTIS* AND *NEREOCYSTIS LUETKEANA* SOUTH OF MONTEREY BAY

Moss Landing Marine Laboratories

Seaweed populations are influenced by many abiotic and biotic factors and thus have evolved nuanced lifecycles to fill a variety of niches. For example, along the northwestern American coast, the canopy forming annual kelp *Nereocystis luetkeana* (Order Laminariales) is commonly epiphytized by the macroscopic stage of the annual rhodophyte *Pyropia nereocystis* (Order Bangiales). I studied the dynamics of this interspecific interaction at the southern limit of the *Nereocystis*'s range. Using a mixture of field sampling and *Nereocystis* collections over multiple years, I investigated morphometric characteristics of the host and spatiotemporal variability in the host and epiphyte populations. I hypothesized that morphometric characteristics of the host would positively correlate with the biomass of the epiphyte, and that temporal maxima of host densities would correspond with epiphyte frequency of occurrence (% epiphytism) maxima. *Nereocystis*'s total length positively correlated with *Pyropia* total dry weight, but did not correlate with *Pyropia*'s distance along the stipe. Furthermore, using two mixed-factor ANOVAs, neither *Nereocystis* density nor *Pyropia* frequency of occurrence varied spatially, although both varied temporally and interacted spatiotemporally. Additionally, a lag period existed between establishment of host canopies and epiphytism, which is interesting given that both species are annuals. These findings suggest high interannual epiphyte resiliency and persistence in the presence of high spatiotemporal variability in host populations.

†Grathwohl, R.G. [1]* **, Davis, K.** [2]**, Caselle, J.** [2]

DO PURPLE SEA URCHINS ALTER THEIR MORPHOLOGY IN RESPONSE TO VARIATION IN PREDATOR ABUNDANCE AND RESOURCE AVAILABILITY?

1 - Colorado College, 2 - University Of California, Santa Barbara

Predators can trigger defensive traits in their prey through a variety of mechanisms. In this study, we studied whether predators stimulate inducible defenses of sea urchins, in temperate kelp forests in Southern California. We hypothesized that inside of Marine Protected Areas (MPAs), where fishing is completely restricted or limited, urchins would be better defended than in fished areas due to the recovery of predators in the MPAs. We collected urchins from four management zones that varied in predator and resource abundance and measured variation in two defensive traits: crush resistance and spine length. While we did not find strong differences in crush resistance between management zones, we did document significant variation in spine length. However, this variation was related to resource abundance but not predator abundance. This suggests that resource availability may interact with urchin behavior to influence this trait; urchins need to develop longer spines because they are exposed while searching for food when it is scarce, placing them in higher risk of predation even when predator abundance is low. Interestingly, we found small-scale difference in habitat resulted in strong variation in

gonadosomatic index and spine lengths between sampling zones directly adjacent to one another. Understanding the morphological differences of purple urchins inside and outside of these MPAs is pertinent in comprehending how different management actions impact predator-prey dynamics in California kelp forests.

Gravem, S.A.*, Poirson, B.N., Robinson, J.W., Menge, B.A.

BACK TO THE FUTURE: USING A LONG-TERM DATASET TO EXPLORE WHETHER ROCKY INTERTIDAL COMMUNITY STRUCTURE IS SENSITIVE TO CLIMATIC VAR

Oregon State University

Natural climate patterns like the Pacific Decadal Oscillation (PDO), North Pacific Gyre Oscillation, and El Niño Southern Oscillation (ENSO) and seasonal upwelling provide a suite of existing climactic variability that we can utilize to determine marine community sensitivity to global climate change. Prior research showed that growth rates, recruitment rates, and physiology of rocky intertidal species were sensitive to one or more of these climatic patterns. Whether sensitivity in these processes translates into emergent community-level sensitivity to climate variation is unclear. We used an 11-year dataset (2006-2017) from 10 sites in Oregon and northern California. We asked whether the community structure, the direction or rate of community change, the abundance of focal functional groups, or biodiversity correlated with yearly fluctuations in PDO, NPGO, ENSO and upwelling. Contrary to expectations, community structure responded weakly to yearly variation in the 4 climate modes (each contributing 2.7% or less). Similarly, we found no effects on the direction or rate or community change, abundance of functional groups, or biodiversity. We conclude that previously established sensitivity of ecological processes to climate mode does not translate into sensitivity in community structure. Possible reasons include that many taxa are long-lived, can regenerate after disturbance, can plastically respond to stress, and are controlled by top-down forces. Overall, at the decadal scale of our study, this system appears resilient to climate-related environmental change.

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TRANSGENERATIONAL PLASTICITY AND PARENTAL GENOTYPE ALTERS THE CAPACITY TO ADAPT TO LOW SALINITY IN THE EASTERN OYSTER

Louisiana State University

The eastern oyster, *Crassostrea virginica*, is known for its tolerance to a wide range of salinities. Despite its high plasticity, salinity conditions are expected to decline below the range of conditions typically experienced by this species due to increased precipitation from climate change and Mississippi River diversions. To predict the future of the species, we used a breeding experiment to determine the capacity of *C. virginica* to adapt to future declines in salinity. Parental oysters from a single population in Louisiana were raised and acclimated in either a high or low salinity environment and were then subsequently crossed using a North Carolina II breeding design. We measured body size and survival of the larvae raised under low or high salinity. We found that offspring had a larger body size when raised under high salinity, but were also larger under high salinity if one of their parents came from the low salinity environment. We hypothesize that epigenetic mechanisms may explain the high plasticity of this

species under stressful low salinity conditions, which is inherited by their offspring and increases fitness when exposed to optimal salinity conditions. Estimates of heritability for body size was also high for this population (~0.5), suggesting that this trait can evolve, but it is also heavily influenced by parental acclimation. The results of this experiment provides valuable insights into successfully breeding this economically important species to be resistant to low salinity.

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MODELING EFFECTS OF OCEAN ACIDIFICATION ON PREDATOR-PREY DYNAMICS IN THE ROCKY INTERTIDAL ZONE

1 - California State University, Long Beach, 2 - Humboldt State University

Increasing concentrations of atmospheric CO_2 are resulting in a decrease in the pH of seawater, so-called ocean acidification (OA). Previous experiments have shown that mussels raised in low pH seawater are typically smaller, have thinner and weaker shells, and exhibit poor physiological condition compared to those living under ambient conditions. In contrast, calcifying predatory crabs have exhibited mixed responses – negative, neutral, or positive – depending upon the species and life stage considered. If crabs get larger and stronger as mussels become smaller and weaker, the predator-prey relationship between the two taxa could be dramatically altered against mussels. We have developed a mechanistic model parameterized with data from the field and lab to predict effects of OA and crab predation on mussel population growth and persistence. Mussel population fitness, as a function of projected reproductive output, can then be compared among models representing different combinations of OA and predation risk. We evaluated the effects of changes in mussel shell thickness and growth rate, and changes in crab carapace size, claw strength, and feeding and foraging behavior on mussel population performance. Scenarios with the greatest negative impact involved limitations on the ability of mussels to reach a predation-resistant size – specifically, decreases in mussel growth rate and/or increases in crab size. We are currently testing our predictions with manipulative experiments done under controlled conditions in the laboratory.

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NOVEL USE OF SATELLITE IMAGERY REVEALS SURPRISING POPULATION TRENDS AND ENVIRONMENTAL DRIVERS IN NEREOCYSTIS LUETKEANA (BULL KELP)

1 - Oregon State University - Department Of Integrative Biology, 2 - Uc Santa Barbara - Earth Research Institute, 3 - Oregon State University - Department Of Geography

The generation of long-term datasets for marine ecosystems has lagged behind that of terrestrial ecosystems due to the added technical skill, time, and expense required. Consequently, our understanding of marine ecosystems is often based on shorter, less-complete datasets. In this study, we leverage 35 years of Landsat satellite imagery to track the population size of *Nereocystis luetkeana*, a dominant canopy-forming kelp along the North American Pacific coast, in Oregon and thus create a long-term dataset for an understudied ecosystem engineer in a region where kelp forests have not historically been monitored. We found high levels of interannual variability in *Nereocystis* canopy area and that current canopy area generally remains within a wide range of canopy sizes seen over the last 35 years.

Surprisingly, Oregon *Nereocystis* population sizes have not dramatically declined since 2014, when a historic marine heatwave and concurrent increases in urchin densities decimated Northern California *Nereocystis* populations, and some reefs have actually increased in area since 2014. Analysis of environmental drivers found that *Nereocystis* population size is often negatively correlated with nutrient level and positively with winter wave height, opposite of the relationships predicted based on extensive previous work on *Macrocystis*. This work demonstrates the value of novel remote sensing tools to create long-term datasets that can challenge our current understanding of nearshore marine species and ecosystems.

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MARINE RESERVE EFFECTIVENESS AND THE NEW ZEALAND ROCK LOBSTER JASUS EDWARDSII

University Of Auckland

How effectively a marine reserve protects a mobile species is dependent on that species movements relative to the reserve's size. For coastal reserves, effectiveness is determined by the extent the reserves offshore limits encompass the offshore movements of the protected species. Within an effective reserve's boundaries, abundance and mean sizes of the protected species will increase towards the reserve's centre as probability of fishing mortality decreases. Monitoring of rock lobster (Jasus edwardsii) in two small north-eastern New Zealand marine reserves has identified substantial declines over the last 10 years. These declines are believed to be driven by the capture of lobster moving across offshore reserve boundaries. To understand the extent these declines are related to reserve size, lobster populations were surveyed across both reserves and in adjacent non-protected areas using commercial lobster-pots. Spatial analysis revealed little difference in CPUE and mean size between reserve centres and potting stations close to longshore boundaries. Overall, CPUE was 3.5 (±0.3) and 3.4 (±0.4) kg within the reserves, and only 0.1 (±0.03) kg in non-protected areas. These results show both reserves provide resistance to the extractive effects of fishing, but suggest the level of resistance is compromised by loss across offshore boundaries. It is suggested that the effectiveness of these small reserves can be improved by extending the reserve boundaries further offshore to encompass the offshore movements of lobster.

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THE EFFECT OF MICROPLASTIC ON MUSSEL BIODEPOSIT SINKING AND RESUSPENSION

University Of Washington

Intertidal habitats are routinely exposed to varying levels of biotic and abiotic particles. As microplastics (MP, plastic < 5mm) become more prevalent in our waters, it is important examine how MP affects key ecosystem processes, such as benthic-pelagic coupling by suspension-feeders. We focused on mussels (Mytilus spp.), well-known suspension-feeder and bioindicator species, and how the sinking and resuspension rates of their biodeposits are affected by a diet that includes MP. Mussels are known to ingest MP both in natural and laboratory settings around the world but it remains unclear whether MP affects the biophysical

characteristics of biodeposits. Due to the size and buoyancy of MP in seawater, we hypothesized mussel biodeposits containing MP sink at a slower rate and are more easily resuspended into the water column than biodeposits without MP. Preliminary results demonstrate biodeposits containing MP are larger and sink at a slower rate than biodeposits that do not contain MP. Further, mussels fed high quantities of MP produce larger and slower sinking biodeposits than those fed low quantities of MP. These findings suggest that mussels can effectively clear MP from the water column, but the biodeposits they produce can concentrate MP and re-introduce the pollutant into the water-column in the form of a more bio-available package.

Heineke,M.R. [1*], **Grosholz, E.D.** [2]

DRAMATIC REPRODUCTION DEFEATS EFFORTS TO ERADICATE AN INVASIVE MARINE PREDATOR

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As biological invasions increase planet wide, so do costly invasive species eradication programs. Eradication programs can fall victim to overcompensation, which is the paradoxical model result that under certain conditions, harvest can result in greater equilibrium population size relative to unharvested levels. While overcompensation has been well studied in most systems, no have involved invasive species or marine systems. Following five years of intensive eradication efforts, we documented a dramatic population explosion of the invasive European green crab (*Carcinus maenas*) in an isolated California estuary. After a >90% removal of the adult population from 2009-2013, we recorded a 30-fold increase in population size in 2014 relative to 2013. Populations in four surrounding bays monitored over the same five-year period did not experience the same increase in 2014. This indicates this was not caused by regional oceanography but was due to overcompensation. Substantial isolation of this population, demonstrated by molecular data, also suggests that the increase was due to internal population dynamics and not to outside recruitment. In mesocosm experiments, we demonstrated adult control of recruitment, via size dependent cannibalism; this control was subsequently lost during the eradication, creating the dramatic recruitment. This study demonstrates a novel example of overcompensation in a coastal marine system, and also sends a cautionary message to resource managers considering costly eradication programs.

Hennessey, S.M. [*], **Novak, M.**

EFFECTS OF PREY PREDICTABILITY ON THE FORAGING EFFICIENCY OF PREDATORY WHELKS

Oregon State University

Individual diet variation in predator populations is increasingly recognized to alter population- and community-level processes, yet the processes generating and maintaining variation at ecological scales remain poorly understood. Individual specialization is expected to increase in predictable environments as greater individual-level foraging efficiency can increase fitness and decrease intraspecific competition. In contrast, unpredictability should promote generalist diets

as these can confer fitness advantages in times of resource scarcity. These predictions remain largely untested, but are subject to assumptions regarding a generalist's diet plasticity via learning and heritability. Here, we use manipulative laboratory experiments to quantify the relative contributions of learning and heritable diet plasticity in shaping individual specialization in the hatchlings of six populations of *Nucella ostrina* across a gradient of environmental predictability. Preliminary analyses suggest that, regardless of the predictability of an individual's source location, prior foraging on mussels decreases subsequent foraging time on mussels compared to naïve individuals. However, whelks from sites with more predictable prey showed a ~10% decrease in handling times, suggesting increased efficiency in handling mussels regardless of prior experience. These combined influences of learning and heritable diet efficiency indicate that feedbacks exist between resource predictability, an individual's degree of diet variation, and subsequent effects of that variation on community composition.

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CREME: CORAL RESILIENCE MODULE EXPERIMENT

University Of Hawaii

Adding baby corals to degraded coral reefs alone typically does not enhance ecosystem restoration because overfishing of herbivores allows benthic algae to overgrow those corals. We are testing the hypothesis that artificial coral heads with many shelter holes will enhance the local abundance of herbivorous fishes and urchins, eventually resulting in lower cover of benthic algae, and thereby enhancing the recruitment, survival, and growth of corals. We are monitoring 12 cubic-meter concrete modules (half with many holes, half with no holes) off the south coast of the island of Oʻahu, Hawaiʻi, half located near a severely degraded reef, and half located in the oldest fully protected marine reserve in the state. Results during the first two years of this 10-year experiment indicate that the relative health of the local reefscape is more important than shelter availability per se in determining benthic succession on these modules. Coral recruitment was initially greater were herbivores were less abundant, perhaps because where urchins were common they dislodged newly settled coral larvae as they overgrazed benthic algae. However, subsequent coral growth was correlated with higher abundances of herbivores as algal overgrowth inhibited surviving coral colonies where herbivores were rare. These initial results are consistent with the idea that coral restoration must occur hand-in-hand with herbivore enhancement for effective conservation of coral reefs.

Hohman, Rietta M.*

COLLABORATIVE STRATEGIES FOR BULL KELP RESTORATION IN NORTHERN CALIFORNIA

Greater Farallones Association

Over the last few years, the northern California coastline has suffered an extensive loss of bull kelp forests. Convened in 2018, the Kelp Recovery Working Group established a strong, interdisciplinary partnership which assessed the resilience of bull kelp forests under changing conditions and developed the science-based Bull Kelp Recovery Plan. The Recovery Plan outlines strategies for active kelp recovery, restoration site selection, monitoring and research,

and community engagement. These strategies provide pathways to immediately begin recovery efforts in bull kelp forests, establish long-term monitoring efforts and increase resiliency of bull kelp forests to changing ocean conditions through adaptive management. These strategies support the ongoing work of collaborations facilitated by the Kelp Ecosystem and Landscape Partnership for Research on Resilience (KELPRR).

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RESOURCE MANAGEMENT IN A MULTI-STRESSOR WORLD: WHY, HOW, AND KELP!

1 - Simon Fraser University, 2 - Fisheries And Oceans Canada

As stressors on a given ecosystem or species increase, so too does the need for management strategies that account for cumulative and non-linear effects of stressors. We review and compare the processes used by federal governments for making place-based management decisions in Canada, the United States, and Mexico, and assess if and how these processes account for multiple-stressors. We find that, despite a wide range in terminology used, the decision-making processes in each country are very similar, especially between Canada and the U.S., and are based loosely around an Open Standards framework. The key stages identified in which managers can account for multiple stressors lie in (1) defining the system, including inviting diverse stakeholder and agency involvement, and (2) quantifying linkages among stressors and targets in the system. To illustrate the importance of the latter, we construct Bayesian Belief Networks of a hypothetical kelp forest to assess the consequences of management decisions when cumulative and non-linear effects are overlooked or incorporated. By highlighting these specific phases of the decision-making process, we aim to aid academic researchers in better understanding how to contribute science for management, and to create a roadmap for modifying decision-making frameworks to incorporate cumulative effects and non-linear interactions.

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EFFECT OF TIDAL POSITION ON METABOLIC PHENOTYPE IN COMMON ACORN BARNACLE, BALANUS GLANDULA

1 - California Polytechnic State University, 2 - Cornell University, 3 - Sonoma State University

The rocky intertidal is characterized by tidally-driven fluctuations in abiotic and biotic stressors that vary in magnitude and severity from the low to high tidal heights. Since many of these stressors (temperature, O_2) are strong drivers of metabolic rate, we hypothesized that sessile conspecifics residing in different tidal zones would exhibit distinct ‘metabolic phenotypes,’ a term we use to describe an organisms’ baseline metabolic characteristics and capacity. To investigate this, we collected acorn barnacles (*Balanus glandula*) from low, mid and high intertidal positions and measured biochemical ([lactate], lactate dehydrogenase (LDH) and citrate synthase (CS) activity), physiological (MO_2, body size), and behavioral (cirri beat frequency, time active) indices of metabolism. We found that low intertidal barnacles had a greater capacity for anaerobic metabolism (increased LDH activity), fed less when submerged, and consequently, were smaller in size compared to those in the high intertidal. We observed no lactate accumulation in

barnacles from any tidal height following 24h air exposure, which suggests that the enhanced anaerobic capacity of low intertidal barnacles is not a response to acute emersion. Finally, there was no effect of tidal position on CS activity or MO_2 (in air or seawater), implying that aerobic capacity may not be as sensitive to tidal position as anaerobic processes. How individuals differ in metabolic capacity is interesting in the context of climate change, as the intertidal is predicted to experience greater extremes in abiotic stressors.

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CORALLINA OFFICINALIS VAR. CHILENSIS* (CORALLINALES RHODOPHYTA) NOT A "VARIETY" AND DISCOVERED IN BOTH HEMISPHERES

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Geniculate coralline algae are notoriously challenging to identify in the field due to cryptic speciation and few distinguishing characteristics. Historical species delimitations based on morphology are often unsupported by sequence-based phylogenies. In 1902, Yendo reported *Corallina officinalis var. chilensis* (Decaisne) Kuetzing in British Columbia, Canada. Unfortunately, Yendo's collections of articulated corallines have not been found, making it impossible to verify Yendo's report. In attempt to determine if the name was applied correctly, we sequenced Darwin's type specimen, the Chilean basonym *C. chilensis* (Decaisne), using rbcL (263 bp). Darwin's type sequence corresponded with a British Columbian species congeneric to, but not synonymous with, *Corallina officinalis*. We propose reversing Kuetzing's synonymization that designated *C. chilensis* as merely a variety of *C. officinalis*, retiring the name *C. officinalis var. chilensis* and restoring the name *C. chilensis* in its place.

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INVESTIGATING THE EFFECTS OF OCEAN ACIDIFICATION ON PHOTOSYNTHETIC PROCESSES ON A CRUSTOSE CORALLINE ALGA AT DIFFERENT DEPTHS

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Ocean acidification (OA) negatively affects marine calcifying organisms, and can alter many chemical and physiological processes. Crustose coralline algae (CCA), such as *Porolithon onkodes*, are important structural calcifying components on coral reefs and they grow across a range of depths. The current study aimed to quantify the impacts of OA on this foundational reef-building species through measuring photosynthesis. This was done by investigating the interactive effects of light quantity, spectral quality and pCO_2 on *P. onkodes* to determine if CCA are impacted differentially by OA at depth. CCA samples were placed in mesocosms fitted with distinct and previously measured light filters, using both a PAR sensor and spectrometer, which were utilized to simulate the light characteristics that occur at shallow (2 m) and deeper (17 m) reefs in Moorea, French Polynesia in both ambient (400 uatm) and elevated (1000 uatm) pCO_2 treatments. Photosynthetic performance was determined by the relative rate of electron transport, measured weekly using Pulse Amplitude Fluorometry (PAM), and compared to the rates of oxygen evolution in incubation chambers from a previous 32 day experiment. Results

suggest that the rate of photosynthesis in OA conditions in high light environments is relatively unchanged and the difference in photosynthesis is significantly less in lower light environments at elevated pCO_2 levels when compared to ambient. Overall, this study demonstrates that light quantity may partially mitigate the effects of OA in higher light environments.

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EXTINCTION OF CALIFORNIA'S FLIGHTLESS DUCK IMPACTS OTTERS & ABALONE; COLORADO DELTA DESICCATION RISKS INTROGRESSIVE SPECIES LOSS.

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Human exploitation extinguished *Chendytes lawi* an abundant large flightless duck of the California coast @ 3000 years ago. Ancient DNA reveals that *C. lawi* diverged from dabbling ducks in the Miocene indicating the substantial lineage histories lost as human populations expanded. Despite *C. lawi*'s ancient connection to dabbling ducks, nitrogen isotopes indicate that it was an invertivore with a diet more extreme than modern king-eider and that overlaps with sea otters. Otters became more abundant in the archaeological record once the competing duck was gone, and abalone become substantially smaller suggesting reorganization in the trophic ecology involving direct effects of anthropogenic predation on abalone and *C. lawi*, but also indirect effects associated with increased otter populations through the loss of this competing large invertivore and an enhanced impact on abalone via otter.

20th century export of water for agricultural and urban use eliminated the freshwater flow of a large North America river to the Colorado Delta. We document that the silverside *Colpichthys hubbsi* an endemic exclusive to the channels of the Delta is now experiencing introgression from its congener *C. regis* a widespread more marine species of the Gulf of California. Thus, one apparent consequence of freshwater loss is the potential elimination of species, not through the loss of habitat specifically, but through loss of ecological separation of related species that permits hybridization and reversal of ecologic species - extinction through genetic swamping.

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GUTS OR GONADS? MESO-PREDATOR CHOICE BETWEEN STARVED AND GRAVID SEA URCHINS IN BARREN AND KELP FOREST HABITATS

University Of California, Santa Cruz

Prey condition (e.g., young, old, sick, starved) and quality (e.g., caloric content) are important drivers of predator-prey interactions. While prey preferences have been widely documented in top predators, less is known about how prey quality influences selection by mid-trophic level predators. Along the central coast of California, active sea urchin grazing has shifted extensive kelp forests to patchy "barren" areas. In patches of forest, sea urchins are healthy (i.e., gravid) and invest energy into gonad production, while those in patches of barrens are starved and lack fully developed gonads. In this study, we examined if two meso-predators commonly found in kelp forests (red rock crab, leather sea star) preferentially target gravid sea urchins over those that are starved. Predators were given a choice between a gravid urchin and a non-gravid

urchin in a controlled laboratory seawater system and monitored via video surveillance. Videos were analyzed for three different interactions from the predator: touch, pass, and attack. Analysis on first attacks revealed leather stars have a preference for gravid urchins (p=0.0, AIC=98.4, DF=1), while red rock crab exhibited no preference. These results suggest that red rock crab may help reduce barren urchin population leading to the recovery of barren areas, while leather star will help strengthen the resiliency of kelp forest patches.

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25 YEARS OF TAG AND RECAPTURE DATA: INSIGHTS INTO THE POPULATION STATUS AND RECOVERY OF AN ICONIC, CENTURY-OLD SPORT FISHERY

1 - Scripps Institution Of Oceanography, Uc San Diego, 2 - The Nature Conservancy

The marine recreational fishery for Barred Sand Bass (*Paralabrax nebulifer*) in southern California was once an economic engine for the state. Overfishing of spawning aggregations combined with poor population recruitment are hypothesized to have contributed to dramatic catch declines. Catches remain at all-time lows, and there is uncertainty in whether the level of current allowable take is adequate for rebuilding the population. Mortality estimates are lacking for this species, yet they are a key aspect of fish population assessment. We used a uniquely long-term mark-recapture data set spanning several decades in a Barker mark-recapture model to estimate survival and derive fishery exploitation during each period. After accounting for tag loss (mean = 15.8%, 95%CI = 10.2 - 21.3%), annual survival in the 1990s (mean = 16.0%, 95%CI = 7.9 - 25.9%) was lower and more variable than in the 1960s (mean = 36.6%, 95%CI = 31.2 - 41.9%) and more recently, in 2013 (mean = 27.7, 95%CI = 22.4 – 33.1%). Exploitation rates were approximately 25% higher in the 1990s than in the 1960s and in 2013. Cursory estimates of BSB population size based on these data suggest the Barred Sand Bass population in southern California increased nearly 2-fold between historic levels and levels at the height of the fishery (although fishing fleets were also increasing catch efficiency during this time), before returning to low levels again. This study provides the first estimates of historical BSB exploitation and provides insight into the longer-term population trends of this iconic sport fishery.

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EUTROPHICATION DECREASES SALT MARSH RESILIENCE THROUGH PROLIFERATION OF ALGAL MATS

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Globally, many estuaries are affected by nutrient loading from human land uses in watersheds. One consequence of increased nutrient levels is proliferation of macroalgae. We investigated spatial and temporal dynamics of ephemeral macroalgal mats and their effects on salt marsh in a eutrophic estuary in central California. An 80-year time series analysis revealed that algal

wrack on salt marsh increased exponentially in frequency, and was highly correlated with nutrient concentrations in the estuary, which have increased along with fertilizer use. Analysis of sediment $d^{15}N$ showed a dramatic increase in nutrient loads attributable to agricultural fertilizer over the past 50 years. We monitored 15 salt marsh plots along the bank edge and detected a negative relationship between algal wrack cover and salt marsh cover, flowering, and canopy height. Algal wrack also led to retreat of vegetation from the bank edge, and increased bank erosion. We experimentally added algal wrack to salt marsh edge plots. Algal addition decreased salt marsh cover, flowering, and canopy height, and increased retreat rate. By integrating time series analyses, isotope data, algal and marsh monitoring and manipulative experiments, we identified robust linkages between increased anthropogenic nutrient loading, increased algal wrack cover, reduction in marsh resilience and conversion of marsh habitat to mudflat through bank erosion. Decreasing nutrient inputs to eutrophic estuaries is thus essential for conservation and restoration of salt marshes and enhancing resilience in the face of sea level rise.

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SYNERGISTIC EFFECTS OF TEMPERATURE AND SALINITY ON THE GENE EXPRESSION AND PHYSIOLOGY OF CRASSOSTREA VIRGINICA

No affiliation[s] given

The eastern oyster, *Crassostrea virginica*, forms reefs that are at risk from climate change in part because of altered local salinity fluctuations that are impacting oyster populations. In this study, we used comparative transcriptomics, measurements of physiology, and a field assessment to investigate what phenotypic changes *C. virginica* uses to cope with combined temperature and salinity stress in the Gulf of Mexico. Oysters were exposed to fully crossed temperature (20°C and 30°C) and salinity (25, 15, and 7 PSU) treatments. Using comparative transcriptomics, we identified a greater number of genes that were differentially expressed (DE) in response to low salinity at warmer temperatures. Functional enrichment analysis showed low overlap between genes DE in response to thermal stress compared with hypoosmotic stress. Experiments also showed that at low salinity, oysters had significantly increased respiration rates at 30°C. However, despite the higher energetic demands, oysters did not increase their feeding rate. To investigate transcriptional differences between populations *in situ*, we sampled oysters from three locations and two time points across the Louisiana coast and used quantitative PCR to measure the expression levels of seven target genes. We found an upregulation of genes that function in osmolyte transport and stress mediation at our low salinity site and sampling time point. These synergistic effects of combined temperature and salinity stress suggest that climate change will exacerbate the negative effects of low salinity exposure on eastern oysters.

José G. Kuk-Dzul*

BENTHIC COLONIZATION OF AN ARTIFICIAL REEF LOCATED IN THE WEST COAST OF BAJA CALIFORNIA: A PLATE EXPERIMENTAL APPROACH.

Universidad Autónoma De Guerrero

Victoria Díaz-Castañeda & José Kuk-Dzul

An artificial reef has been defined as a submerged structure placed on the seabed to mimic some characteristics of a natural reef (UNEP-MAP, 2005). They are usually sunk to promote marine life and increase diversity. Community structure is controlled by the successful settlement of species which may then become dominant. The goal was to study benthic recruitment on two types of substrates: steel and PVC plates located in the artificial reef Uribe 121, placed in Rosarito, Baja California over a period of one year. A total of 90 plates (15 x 15cm) were placed at two depths: 19 and 27m on March 2016. Experimental plates were suspended vertically and periodically recovered using scuba diving. Two replicates from each depth were randomly recovered monthly. Salinity ranged between 33.4 to 34 PSU, temperature varied between 11.3° and 16.5°C. A total of 29,109 organisms were collected: 18,023 on metal plates and 11,086 on PVC plates, they correspond to 82 and 46 taxa respectively. Before the arrival of invertebrate colonizers we observed diatoms and filamentous green and red algae on metal plates, PVC plates were colonized mainly by green algae. First zoobenthic colonizers in metal and PVC plates were crustaceans “Ischyrocerus sp”, “Perotripus sp”, Jassa sp”, “Metopa cf. dawsoni”, “Erichtonius sp”, followed by molluscs “Crepidula” sp, “Hermissenda sp”; later polychaetes Serpulidae, Syllidae, Nereididae and Chrysopetalidae. Abundance and diversity was higher in metal plates.

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BRIDGING MANGROVE RESEARCH AND GOVERNMENT ACTION TO SUPPORT CARBON ABATEMENT

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There is a scale mismatch between mangrove conservation and carbon emissions mitigation policies, despite mangroves contributing disproportionally to global carbon sequestration. Using Mexico as a case study in the integration of these scales, we calculate mangrove carbon value and deforestation rates at the municipio (local government) scale and develop a prioritization model that indicates where to focus conservation efforts. We estimated municipio-specific mangrove carbon stocks averaging 519.3 Mg C ha-1 and an average annual gross deforestation rate of 1.15%. The current rate of deforestation will result in a social cost of 3 thousand million US$ over the next 25 years. The prioritization model identified 19 municipios where, if all mangroves are conserved, 80% of this cost could be avoided. Bridging the gap between research and governmental action using local initiatives will be paramount for the effective management of mangrove carbon.

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ESTIMATION OF FISH AND INVERTEBRATE BIODIVERSITY USING VIDEO AND ACOUSTICS

1 - University Of Victoria, 2 - Ocean Networks Canada

The increase in climate and anthropogenic stressors in the marine environment can lead to important losses in habitat for fishes and invertebrates. Consequently, monitoring marine

biodiversity has become a critical task for ecologists. Traditional biodiversity measurements are costly and logistically challenging and there is an increasing need to develop new techniques that are more suitable for long-term and large-scale monitoring. The objective of this work is to assess the efficiency of underwater video, and active and passive acoustics to monitor the presence and diversity of fish and invertebrates. This work uses a multi-instrument platform, deployed on Ocean Networks Canada's VENUS cabled observatory in the Strait of Georgia (British Columbia, Canada), comprised of a high-definition video camera with a pair of LED lights, a dual-frequency imaging sonar and a hydrophone. Fish and invertebrates are automatically counted and identified using the data from the video camera and sonar. Several acoustic indices such as acoustic complexity indices and similarity sound clusters are computed from the hydrophone data. The time series of these indices estimated from the passive acoustic data are then compared to the camera and sonar recordings to assess the ability of passive acoustics alone to determine the presence and diversity of fish and invertebrates.

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ORGANOCHLORINE CONTAMINANTS AS AN ECOLOGICAL TOOL TO EXPLORE NICHE PARTITIONING IN THREE SPECIES OF PELAGIC SHARK

1 - Scripps Institution Of Oceanography - Ucsd, 2 - The Georgia Aquarium, 3 - The Southwest Fisheries Science Center

The niche overlap hypothesis states that for competing species to occur in sympatry, there must be a partitioning of ecological resources. Evaluating niche partitioning in wild systems is difficult due to the complex nature of ecological niches. Ecotoxicological contaminant profiles accumulate across the life of individuals, providing a potential tool by which to assess niche partitioning in situ. Shortfin Mako, Blue, and Common Thresher Sharks comprise a predatory guild within the Southern California Bight, and thus likely partition spatial and dietary resources to limit competitive exclusion. Given that organic contaminants are acquired mainly through prey, a resource under potential competition, and vary geographically, they represent a potential useful ecological marker. We analyzed legacy organic contaminant profiles for 47 Mako, 22 Blue, and 51 Thresher Sharks to determine the degree of niche partitioning among these three species. Species could be distinguished based on total contaminant loads, as there was a 10-fold stepwise difference in total concentrations among them, and by their contaminant fingerprint, as random forest analysis found that species could be correctly classified with a 4% error rate. DDTs comprised the greatest proportion of organic contaminants for all three species, suggesting that prey contaminants are heavily influenced by the coast, highlighting the pervasiveness of historic DDT dumping in the SCB. Our results demonstrate the utility of toxicological analyses for ecological studies, and support previous research using traditional methods.

Karen Crow*

HOW THE DEVIL RAY GOT ITS HORNS: THE GENETIC BASIS OF BODY PLAN REMODELING IN MANTA RAYS AND THEIR RELATIVES

San Francisco State University

Compared to sharks, the skates and rays exhibit highly modified body plans that are adapted to life on the benthos, including dorso-ventral compression and pectoral fins that extend anteriorly and fuse to the head. Patterns of morphological evolution in pectoral fins of most batoids are constrained due to their dual use in feeding and swimming. Skates use their pectoral fins to capture prey by “tenting”, and employ undulatory swimming for locomotion. However, the manta rays and their relatives (Myliobatidae) have evolved distinct pectoral fin domains that are functionally dedicated to feeding (cephalic lobes) or swimming (modified pectoral fins). Due to the presence of cephalic lobes, the mobulids have been referred to as the only vertebrate with three paired appendages. However, we found no evidence that cephalic lobes develop independently from pectoral fins nor of independent posterior patterning by HoxD, and conclude that cephalic lobes are neither independent nor novel appendages. Myliobatid cephalic lobes and pectoral fins exhibit adaptations associated with specialized feeding or oscillatory swimming, including a redistribution of pectoral fin rays in the Myliobatidae and Gymnura that arose multiple times independently in association with pelagic flight and oscillatory swimming. In an analysis of differential gene expression from comparative RNASeq data and in situ hybridization, we identified candidate genes that are likely associated with subtle changes in paired fin development that may be responsible for morphological disparity among batoids.

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LONG-TERM STABILITY OF PALMYRA’S CORAL REEFS OVER 10 YEARS DESPITE TWO BLEACHING EVENTS

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The prevalence of coral bleaching due to heat stress has been increasing on reefs worldwide with the progression of climate change. As part of the Northern Line Islands in the Central Pacific, Palmyra Atoll is an ideal location to study global change in the absence of confounding local impacts (e.g., fishing and pollution) since it is remote, uninhabited, and federally-protected. Permanent photoquadrats were taken approximately annually at 8 sites around Palmyra from 2009-2018 on the fore reef (10m depth) and reef terrace (5m depth). Using image analysis, we quantify spatial and temporal changes in benthic community composition, focusing on coral and algal functional groups/genera/species as well as any other benthic taxa. Throughout this period, thermal stress-induced coral bleaching events occurred in 2009 and 2015. However, over the past decade this reef system has remained stable overall in terms of benthic cover, other than a slight deviation from stability shortly following the respective bleaching events. While the disturbances seemed to initially favor dominance by turf and other fleshy algae, within 1-2 years following the bleaching events, the percent cover of each benthic group– including corals and crustose coralline algae, was generally similar to pre-bleaching levels. These data suggest that Palmyra’s reefs may have a remarkable ability to recover from bleaching events in relatively short periods of time. Understanding the mechanisms involved in these rapid recovery trajectories will be important for managing reefs under current and future warming scenarios.

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MAINTENANCE OF GENETIC DIVERSITY DESPITE LARGE-SCALE DISTURBANCE SUPPORTS RESILIENCE OF GIANT KELP IN SOUTHERN CALIFORNIA

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Population genetic diversity and connectivity may assist in resilience of a species to stressful environmental conditions. The marine keystone species Giant Kelp (*Macrocystis pyrifera*) is experiencing a multitude of pressures from climate change and associated El Niño events that threaten its future distribution and persistence. This study analyzed the temporal change in genetic structure of 4 kelp populations in southern California that were subjected to a series of large-scale disturbance events, including the 2015-16 El Niño Southern Oscillation event. We tested the hypothesis that disturbance and resulting population size fluctuations decrease intra-population allelic richness and increase inter-population genetic differentiation. Utilizing previously collected data, we quantified the magnitude of disturbance using Landsat imagery for canopy biomass coverage and completed a temporal microsatellite-based analysis. Despite significant decreases in surface canopy coverage, sites showed no change in allelic richness or genetic structure, suggesting high population level resilience. Future work should look to model the demographic threshold at which a population can decline without a change in genetic diversity. Our results might be due to genetic diversity maintained in juvenile sporophyte (e.g. non-canopy forming) or microscopic gametophyte stages during stressful environmental periods that negatively impact canopy-forming adults.

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CONSPECIFIC CUES, NOT STARVATION, MEDIATE HABITAT-SPECIFIC RESPONSES OF URCHINS TO PREDATION RISK

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Predators can induce behavioral responses in prey that lead to trophic cascades. Although prey state and density may mediate such interactions, few studies examine these contexts simultaneously. This omission is surprising given that prey state and density often co-vary across habitats (e.g. urchin barrens are dominated by high densities of starving urchins). Also, most studies manipulate prey state rather than comparing anti-predator responses of prey collected from habitats that vary naturally in prey state. We used mesocosms to compare the responses of purple sea urchins (*Strongylocentrotus purpuratus*) from either kelp forests or barrens to waterborne cues from lobster predators (*Panulirus interruptus*). When tested at ecologically relevant densities (low or high density, for kelp forests and barrens, respectively), urchins from forests, but not barrens, reduced kelp grazing by 72.7% when exposed to lobster cues. Interestingly, barren urchins failed to respond to lobster cues only in the presence of waterborne cues from high densities of conspecifics (i.e. when a quorum was detected). Isolated barren urchins starved for up to 64 days strongly reduced grazing in the presence of predation risk. Similar to microbes that dramatically change gene expression with density, we propose that urchins use quorum sensing to mediate responses to predators. Such behaviors should reduce the non-consumptive effects of lobsters on urchins in barrens, which could impair kelp recovery in deforested habitats, and may generally contribute to the persistence of alternative stable states.

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TO FRY OR TO SAUTÉ: INNOVATIONS IN THERMAL MANIPULATIONS TO UNDERSTAND DIRECT AND INDIRECT EFFECTS OF WARMING ON TIDE POOL COMMUNITIES

The University Of British Columbia

With extreme temperature events becoming more frequent and more intense, microhabitats, such as tide pools, could act as thermal refuges. It is therefore important to understand how tide pools may be altered by extreme temperature events. We used a low-cost, thermal manipulation system to effectively alter tide pool temperatures in the field. Through two field manipulations in Burrard Inlet, BC we explored: 1) how multi-day periods of extreme temperatures throughout the summer and herbivore (*L. pelta*) density might impact tidepool community structure and 2) how a late summer heatwave might impact tide pool community structure and whether impacts depend on the dominant foundation species present (*B. glandula, M. trossulus,* Diatoms). In our first experiment, we saw that high grazer density decreased microalgal cover and increased the abundance of barnacles and species richness. There was no effect of heating on the tide pools *per se*, but we saw high mortality in experimentally added limpets. In our second experiment, we found that a simulated heatwave altered community structure through a decrease in isopod abundance and species richness. When examining the response of foundation species to heating, we found a decrease in the abundance of barnacles, but mussel abundance and diatom cover were unaffected. We also saw differences in community structure between habitat treatments with the greatest species richness in barnacle dominated pools. While the direct short-term effects of heating on tide pool communities were few, the indirect long-term effects due to decreased herbivore density and barnacle abundance could be plenty.

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CONTRASTING EFFECTS OF DEPTH AND PREDATION ON THE DISTRIBUTION, SIZE, AND GROWTH OF ACROPORA RETUSA AND ACROPORA HYACINTHUS

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Coral cover on the fore reef of Moorea has rapidly recovered following a set of large disturbances, particularly on the north shore where cover was reduced from ~40% to <3% by 2010. However, recovery has been markedly stratified by depth, with coral cover inversely related to depth, despite similar levels of coral recruitment at 10m and 17m. Here, we tested the independent and interactive effects of depth and coral predation as mechanisms contributing to patterns in coral abundance and distribution across depths. To do so, we coupled MCR LTER time series data, observational surveys, and reciprocal transplant experiments using *Acropora retusa* and *A. hyacinthus*, the two most common Acroporid coral species on the fore reef of Moorea. We found contrasting, taxa-specific patterns in abundance, growth rates, and predation that varied with depth. By 2018, *A. retusa* was most abundant at 10m and 17m, while *A. hyancinthus* colonies were most abundant at 5m and decreased in density and size with depth. Experimental colonies of *A. retusa* were not influenced by corallivory at any depth but grew slower when artificially wounded, suggesting limited ability to cope with predation. In contrast, corallivory reduced growth rates of exposed *A. hyacinthus* colonies at 5m and 10m depth but had no effect on growth rates at 17m. These findings suggest that corallivory is likely an

important biological force driving the distribution and growth of these important corals on Pacific reefs, but that the impact of coral predation varies by coral species and is mediated by depth.

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CHANGES IN FISH ASSEMBLAGES IN BOTTOMFISH SURVEYS IN THE STRAIT OF JUAN DE FUCA AND PUGET SOUND 2005-2019

No affiliation[s] given

Since the early 1980s, biologists from the Seattle Aquarium have been informally monitoring bottom fish on rocky reefs throughout the Salish Sea in Washington State. Based on increasing concern over the long term stability of bottom fish populations in the region by both state and federal agencies, the aquarium formalized monitoring in 2005 with diver based video surveys to monitor bottom fish diversity and abundance over time. Divers performed 100 m video transects devised to be non-invasive and repeatable for assessing diurnally active bottom fishes over time. Transects were conducted in August from 2005-2019 in The Strait of Juan de Fuca with Puget Sound sites surveyed seasonally since 2009. Species were qualified and quantified by biologists counting fish off of the archived video. Over fifteen years there was an increase in diversity of sessile adult rockfish and a decrease in density of adult schooling rockfish such as blacks and blues at sites in the Strait of Juan de Fuca, while since 2009, the opposite was true in many sites in Puget Sound. There were several significant young of the year (YOY) rockfish recruitment “jackpot recruitment” events documented in 2006, 2008, 2011, 2012, 2014 and 2016. Numbers of adult and YOY rockfish densities were not significantly correlated with environmental variables measures such as sea surface temperature (SST) and chlorophyll. This study elucidates long term trends in rockfish diversity and abundance and may be used to advise management plans for rockfish conservation.

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COLLABORATIVE COASTAL MARINE HABITAT RESTORATION WITHIN AN INDIGENOUS CO-MANAGEMENT CONTEXT IN GWAII HAANAS, HAIDA GWAII, CANADA

1 - Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, And Haida Heritage Site, 2 - Haida Fisheries Program, Council Of The Haida Nation, 3 - Florida State University

Relationships between indigenous Haida, sea otters, and ecosystems of Haida Gwaii, British Columbia, Canada, adapted and persisted for millennia until the maritime fur trade disrupted Haida culture and extirpated sea otters. For nearly 200 years, ocean ecosystems in Gwaii Haanas have been out of balance. With loss of sea otters that are voracious shellfish predators, macroinvertebrates became larger and much more abundant. Kelp forests today are greatly diminished in abundance, depth and area due to intense grazing by hyperabundant urchins freed from top-down control. Degraded kelp forests negatively impact marine ecosystems, species at risk, and culturally important species by reducing habitat, primary productivity and coastal protection. The Haida Nation and Canada are collaborating to restore kelp forests over a 3-km long restoration site. Working with fishing industry partners, we mimicked sea otter

predation by removing and cracking >75% of the urchins at the site, providing traditional foods, guuding.ngaay (red urchin) and styuu (green urchin), to Haida communities. With researchers, we are leveraging restoration efforts to better understand how urchin removals cause dynamic change in rocky reef ecosystem components and population dynamics, using a before-after control-impact design. Remarkable change in kelp depth and density has already occurred 6-9 months post-restoration. Through the Chiixuu Tll iinasdll project, Gwaii Haanas' cooperative management partners are showcasing how co-management and collaboration can advance shared conservation goals and objectives.

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ISOTOPIC EXAMINATION OF LIFE HISTORY DIVERSITY IN ENDANGERED ESTUARINE FISHES

Uc Davis

Delta Smelt and Longfin Smelt are two imperiled and sociopolitically important migratory forage fish in the San Francisco Estuary (SFE), California. While Delta Smelt have received national attention and both state and federal protection, Longfin Smelt have received less attention despite experiencing equal or even greater declines within the estuary. Both species live and reproduce directly downstream of the Sacramento-San Joaquin River Delta, where demands by California's agriculture industry and 39 million residents place these fishes in the crossfire between the "coequal" goals of species-habitat conservation and water supply-delivery. Here, we describe similarities and differences between these two osmerids in their status, biology, and threats; as well as recent discoveries, using otolith geochemistry, regarding the diversity of life-history strategies each species uses as it struggles to persist in a naturally-dynamic, highly-modified, and ever-changing estuarine environment.

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MATHEMATICAL MODELING OF THE CORAL MICROBIOME: THE INFLUENCE OF TEMPERATURE AND MICROBIAL NETWORK

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The coral microbiome is essential to the health of coral reefs and sensitive to environmental changes. Environmental factors and microbial interactions act simultaneously on the microbial community structure, making the microbiome dynamics challenging to predict. We developed a dynamic model to determine the coral microbiome using temperature and microbial network. The metagenomes associated with the mucus of the coral *Pseudodiploria strigosa* from inner and outer reefs in Bermuda showed a reef zone-specific microbiome. The main classes contributing to the dissimilarity between reef zones were Chlamydiia, Deinococci and Flavobacteriia. The microbial network in the outer coral microbiome was more tightly connected compared with the inner coral microbiome. The metagenomes of the coral mucus microbiome provided data for the model development and validation, by comparing the predicted relative abundances to the observed relative abundances. The model accurately predicted the

microbiome of *P. strigosa*. To investigate the drivers of the coral-microbial community dynamics from each reef zone, the model was applied to six scenarios that combined different profiles of temperature and microbial network. The microbiome was best predicted by model scenarios with the temperature profile that was closest to the local thermal environment, regardless of microbial network profile. Our model shows that seasonal temperature variation is the primary driver of microbiome composition, while the microbial network is a secondary driver.

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SEABIRD SUBSIDIES TO A “LARGE” ISLAND SHIFT THE ISOTOPIC SIGNATURE OF PLANTS, ARTHROPODS, AND RATTLESNAKES IN BAJA CALIFORNIA

1 - San Diego State University, 2 - Florida State University, 3 - Southern California Research Learning Center, Nps, 4 - Universidad Autónoma De Aguascalientes

Although ecologists have long recognized the links between marine and coastal ecosystems, these connections are best studied for islands <0.5 km^2. Such small islands typically receive more subsidies because of a higher shoreline:area ratio and because they harbor greater densities of nesting seabirds. Also, humans or human-introduced vertebrates have often reduced seabird populations below historic levels on large islands (>1.0 km^2). However, subsidies could be increasingly important on large islands where restoration efforts have increased nesting seabird densities by removing non-native predators and preventing egg poaching. We compared the stable isotope signatures from the same seven plant species and three animal taxa from South Coronado Island (SCI, a relatively large island with abundant seabirds) and Cabrillo National Monument (CNM, a low seabird site). Tissues from SCI were isotopically heavier than tissues from CNM for 6 plant species reliant on soil nitrogen, but not the legume. Beetle and rattlesnake tissues from SCI were also isotopically heavier. Further, the isotope signatures from SCI tissues matched those from much smaller islands in the Gulf of California. Thus, marine subsidies influence this large island. We hypothesize that restoration efforts and nearby human activities may be fueling such interactions.

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USING HISTORICAL DATA TO TEST WHETHER SPECIES DIVERSITY HAS DECLINED IN MUSSEL BED COMMUNITIES IN NORTHERN CALIFORNIA

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Published analyses of historical data indicate striking declines in the diversity of taxa inhabiting intertidal mussel beds in southern California over the past ~50 years. However, whether similar declines have occurred in northern California is largely unknown. Using an unpublished student project conducted with Dr. S.F. Light in 1941, we tested whether species diversity in mussel beds at Dillon Beach has declined over the past 78 years. We located and re-surveyed the same large plot from the original 1941 report, as well as 3 replicate plots, to tease apart temporal versus spatial variation in community richness and diversity. We found a diverse assemblage of mussel bed fauna including >90 invertebrate species. In contrast to prior studies from southern California, there was no evidence of a decline in species richness and diversity. A few of the observed changes in abundance and composition might reflect shifts in geographic

ranges. Only one species found in the 1941 study was entirely absent from our 2019 survey. However, the sea cucumber (*Cucumaria pseudocurata*) disappeared from the region recently, during a harmful algal bloom in 2011. Spatial variation in abundance among the replicate plots was relatively high, particularly for highly mobile or brooding species. The stability of species diversity over time is a positive sign for the health of these mussel bed communities. As of now, it appears that extreme climatic events and mass mortality events, rather than long-term warming trends, may have greater effects on mussel bed communities in northern California.

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MARINE HEATWAVES IN CENTRAL AND SOUTHERN CALIFORNIA FROM 2013 TO 2018

1 - NOAA Mbnms, 2 - Esnerr, 3 - Uabc, 4 - Trnerr

Ongoing global ocean warming and a recent increase in the frequency, intensity and duration of marine heatwaves (MHWs) have demonstrably impacted marine ecosystems. Growing evidence points to both short- and long-term biological changes along the eastern Pacific. Six publications since 2016 documented various responses by 166 species that co-occurred with multiple MHWs along the west coast of the US. We present data collected by in situ temperature loggers and direct measurements from one coastal bay and two National Estuarine Research Reserve (NERR) sites in California (Monterey Bay and both Elkhorn Slough and Tijuana River NERRs) from 2013 to 2018. Monthly temperature anomalies at the NERRs were continuously above the long-term mean from 2014 through 2016, representing the longest and most dramatic increase in temperature at these sites since monitoring began. Both NERR sites had more MHWs than the open coast site and the individual duration of MHWs varied from 5 days (the defined minimum) to 109 days. The longest individual MHW occurred in 2015 at each of the three sites, as did the highest °C days, a cumulative measure of heat intensity. In 2015 TRNERR experienced 463.8 °C days, double that of ESNERR (219.8) and triple HMS (143.2). The 2015 MHWs were most frequent January-March and again July-October. After a relatively cool 2017, the number of MHWs increased at the NERR sites in 2018, particularly for TRNERR, which had 12 MHWs lasting a total of 177 days and a cumulative intensity 250 °C days, its 3rd highest intensity behind 2014 and 2015.

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VARIABLE EXPOSURE TO COASTAL HYPOXIA ACROSS THE SOUTHERN CALIFORNIA CURRENT SYSTEM

1 - Hopkins Marine Station, Stanford University, 2 - Monterey Bay Aquarium Research Institute, 3 - Comunidad y Biodiversidad A.C, 4 - Bodega Marine Laboratory, University Of California, Davis, 5 - Cobia Lab, University Of Georgia

Exposure to hypoxia is increasing in coastal ecosystems, and this trend is expected to worsen with climate change. Spatial and temporal variability in dissolved oxygen dynamics and hypoxia exposure can mediate differences in vulnerability in coastal ecosystems, but such variability has only been documented at small spatial scales. Using a network of dissolved oxygen and temperature sensors across the southern California Current system, we characterize spatial and

temporal variability in dissolved oxygen dynamics and exposures to hypoxia in coastal kelp forest and rocky reef ecosystems across 13 degrees of latitude from northern California to Baja California. We find broad-scale regional trends alongside small-scale spatial variation in patterns of hypoxia exposure, with different drivers of hypoxia likely occurring at different times. We highlight the importance of understanding spatiotemporal variability in hypoxia exposure for designing realistic eco-physiological experiments and in climate change adaptation and management.

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THE IMPORTANCE OF TRANSBOUNDARY COLLABORATIVE RESEARCH ON HIGHLY MIGRATORY WHITE SHARKS

1 - Csu Long Beach, 2 - Monterey Bay Aquarium, 3 - Southern California Marine Institute, 4 - Cicese

White Sharks (*Carcharodon carcharias*) of the northeast Pacific use coastal and offshore island habitats along both California and Mexico during certain life stages or times of the year, making collaborative research that extends beyond political boundaries essential. Although adult White Sharks that have been tagged in both locations appear make extensive use of offshore, pelagic environments, the most vulnerable age classes of this population (young-of-the-year [YOY] and young juveniles) primarily use coastal habitats, increasing their susceptibility to fishery and human interactions in both locations. Although there has been fisheries protections for this species in MX since 2007 and the establishment of fishing bans in 2012 (MX), 1994 (California), and 2005 (US waters), there are different levels of fishing-related mortality of juvenile White Sharks between the US and Mexico. Despite these levels of fishing mortality, there is evidence of White Shark population increase, which is likely promoted by recovery of adult prey (e.g., seals, sea lions, whales) and points toward the success of environmental protection measures. As neonatal and YOY White Sharks share their time between California nursery habitats during the summer months and Mexican nursery habitats during the winter months, establishing transboundary research collaborations can help to effectively monitor the status of vulnerable populations while also addressing changing conservation and management needs.

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PACIFIC HARBOR SEAL (PHOCA VITULINA RICHARDII) MOVEMENTS IN WATERS AROUND TODOS SANTOS ISLAND, ENSENADA, BAJA CALIFORNIA

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The harbor seal,*Phoca vitulina richardii*, is distributed from Japan to the Baja California Peninsula, Mexico. It has been widely studied in the Northeastern Pacific Ocean. Even though efforts have been made recently to learn about basic aspects of its ecology, there was no information on its movements in the waters adjacent to the colonies. The aim of this study was to describe the movements of animals in the waters off northern Baja California. To meet this

objective SPOT tags were placed on six males and females from the Todos Santos Island colony and satellite telemetry was used. Based on the movements of the marked individuals, the waters adjacent to Southern Todos Santos Island, Descanso Bay and Soledad Bay were identified as possible foraging sites and it was possible to describe that individuals made average movements between 5 and 30 km from the tagging site.

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VERTICAL DISTRIBUTION AND ABUNDANCE OF MEROPLANKTON INSIDE AND OUTSIDE OF A KELP FOREST DURING THE INTERNAL TIDE

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We compared high-frequency changes in the distribution and abundance of meroplankton (>150 µM) at small spatial (< 500 m) and temporal (< 30 min) scales during a strong semidiurnal internal tide event at two sites, one inside of a giant kelp forest of Macrocystis pyrifera at San Miguel Point, in the northern part of Todos Santos Bay, Baja California, Mexico, and the other 200 m offshore. The total abundance of meroplankton inside the kelp forest was more than one order of magnitude higher than outside. Taxonomic richness inside the kelp forest was also greater, with 54 taxa found inside compared to 28 taxa outside. Copepods and cyphonaute Membranipora spp. larvae were the main groups found at both sites, although their abundance and vertical distribution patterns during the development of the internal tide were opposite at the two sites. Both of these groups showed significantly greater abundance in the bottom strata during the cold phase of the internal tide outside of the kelp forest, however, within the kelp forest, the abundance of Membranipora spp. significantly increased in the surface strata. We propose that this might be due to the behavior of these bryozoan larvae in order to reach their near surface settlement habitat in the canopy, potentially combined with the effect of the physical structure of the kelp fronds causing shoaling, resulting in organisms found in the bottom strata offshore to be advected into the shallows inside the kelp forest.

Malpica-Cruz, L. [1*], Stuart Fulton [2], Quintana, A. [3], Zepeda-Domínguez, J.A. [4], Côté, I.M. [5]

CAN FISHING BE A TOOL TO CONTROL MARINE INVASIVE SPECIES?

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Indo-Pacific lionfish (Pterois sp.) has been one of the most publicized marine species invasions globally, and is considered a major biodiversity threat whose longer-term impacts are still uncertain. To fight back managers have explored several control strategies such as fishing tournaments (derbies) and establishing commercial fisheries. Concerns exist that the goal of a lionfish fishery might morph from conservation to purely economic benefits. We analyzed the characteristics and impacts of an incipient fishery aimed to control invasive lionfish in the

Mexican Caribbean. We analyzed official lionfish landings, lionfish derbies data, and lionfish densities from locations at the state of Quintana Roo, Mexico. We found that lionfish is captured across the coast but landings in Cozumel alone are comparable to or higher than numbers of lionfish captured in derbies across the wider Caribbean region. Survey data suggests a reduction (~ 60%) in lionfish density on Cozumel reefs from 2013 onward. Exploiting a new species with little regulation and comparable landed value to other harvested fish species (e.g., grouper) is a welcome opportunity to local communities. However, there is a challenge to maintaining market interest and keeping the fishery's momentum going to make it financially sustainable. Results suggest that this incipient fishery was only viable and yielded the observed benefits by being developed within an established fishery. If fisheries are to be established and used as management strategies to control future invasions, clear conservation goals must come first.

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A REPORT ON THE CALIFORNIA SPINY LOBSTER FISHERY OF EL ROSARIO, BAJA CALIFORNIA: SUBLEGAL BYCATCH RATE, EFFORT, AND CATCH VARIANCE

1 - Stanford University, 2 - Cooperativa Pesquera Ensenada Scpp

The spiny lobster, *Panilirus interruptus*, is the target of economically important fisheries in California and in Baja California. Current management practices in the Baja fisheries include seasonal closure, effort control and the return of captured lobsters under a minimum legal size. These management practices have lead to relative success in the fishery, however, there is a high rate of sublegal bycatch, and a large amount of variance in catch success rate between fishing sites, and fishing teams. In this study we aimed to understand the composition of the lobster population effected by the fishery, looking at size and sex breakdown of the individuals caught through on board observations of catch of 16 different fishing teams. In addition, we hoped to understand the variance of this catch from both the perspective of the lobster caught by location, and the success and effort by fishing teams. We found that there is a consistent rate of bycatch of sublegal individuals throughout the season, in addition to a high rate of female catch. These observations have helped to informed additional studies on the effect of sublegal bycatch and can provide information local scale distribution, and thus variable catch success within a single fishing cooperative.

Mark H. Carr[*], Daniel P. Malone, Shannon Myers

GOT CRABS? RED ROCK CRABS MIGHT JUST CONTRIBUTE TO THE RECOVERY OF CALIFORNIA KELP FORESTS

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A sequence of events led to persistent outbreaks of purple sea urchins (PSU; Strongylocentrotus purpuratus), deforestation of kelp forests, and establishment of "urchin barrens" along the coast of California and Mexico. Recovery of kelp forests appears contingent on widespread reductions of PSU numbers or shift in their foraging behavior. The Pacific red rock crab (RRC; Cancer productus) is among a paucity of urchin mesopredators in throughout California. We conducted field experiments to test four hypotheses relevant to the potential for

RRC to facilitate the reforestation of urchin barrens: (1) mortality of PSUs from barrens increases in the presence of RCC, (2) increased PSU mortality increases survivorship of small kelps, (3) RCC predation causes PSUs to restrict their foraging distribution, and (4) this behavioral response is induced by conspecific death, rather that the mere presence of RCC. We found that RCC causes both direct mortality and shifts in foraging distribution of PSUs from barrens, which leads to increased survival of young kelps, and that the behavioral response of PSUs is in response to conspecific deaths, not the mere presence of RCC.

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DISTRIBUTION, ABUNDANCE, AND HABITAT ASSOCIATIONS OF PISMO CLAMS, *TIVELA STULTORUM*, IN CALFORNIA

California Polytechnic State University

Pismo clams (*Tivela stultorum*), an iconic fishery species in California, once supported a thriving commercial and recreational fishery. Overharvest led to the closure of the commercial fishery in 1947, while recreational harvest is still permitted today. However, Pismo clam populations have continued to decline throughout the state of California despite numerous management actions. We designed a study to examine the relationship between Pismo clam abundance and a variety of abiotic and biotic factors. This study will improve our understanding of this socioeconomically important species and inform Pismo clam management within California.

We quantified Pismo clam presence and abundance at 38 sites across their range in California from Monterey Bay, CA to the US-Mexico border during 2018 and 2019. Additionally, we evaluated the relationship of biotic and abiotic factors, such as predator presence, human population density and sediment characteristics, on clam presence and abundance using a mixed model framework. Our results suggest that local sediment characteristics are an important predictor of Pismo clam presence. However, it is likely that several factors interact to influence clam abundance. Additional analyses will further examine the interactions among biotic, anthropogenic, and habitat parameters to help us better understand the ecology and potential recovery of Pismo clam populations in California.

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MULTIVARIATE HABITAT-BASED PREDICTIVE MODELING OF THREE DEMERSAL ROCKFISH SPECIES ALONG THE CENTRAL CALIFORNIA COAST

1 - Humboldt State Univerisity, 2 - Humboldt State University

Refining our understanding of the associations between benthic habitat characteristics and fish distributions is essential for developing stock assessments and measuring the success of marine protected areas. Current research employs methods to estimate either occupancy (presence-absence) or abundance (density or biomass) of a species within an area. This study shows how these two approaches can be combined to simultaneously estimate occurrence and abundance by specifying an incomplete-detection zero-inflated distribution. This modeling approach is particularly useful when the patterns of occurrence and abundance stem from different processes. In most instances, species' detection data are pooled, and any ontogenetic

patterns of distribution are lost. By modeling distinct age classes separately, we see there are significant differences in habitat associations between young-of-the-year, sexually immature adolescents, and reproductive adult members of three commonly-occurring rockfish species along California's central coast. Additionally, there is evidence of adaptive habitat usage between locations that differ in physical composition, suggesting it may be incorrect to assume there is a "one-size-fits-all" model when predicting rockfish distributions across a large geographic range.

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IDENTIFYING THE DRIVERS OF STRUCTURAL COMPLEXITY ON HAWAIIAN CORAL REEFS USING STRUCTURE FROM MOTION

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Structural complexity on coral reefs is commonly associated with high abundance of reef fish and Scleractinian corals. Thus, methods to efficiently and accurately assess structural complexity are relevant for coral reef monitoring and conservation. Using Structure from Motion (SfM), it is now possible to quantify the structural complexity of coral reefs using interactive 3D models. This study uses SfM to quantify linear rugosity, the ratio of contour distance to horizontal distance across the reef surface, across spatial scales at reefs in the Main and Northwestern Hawaiian Islands (MHI and NWHI). Cross-scale patterns of rugosity differed among reef types: coral-dominated reefs exhibited the highest structural complexity at small scales (mm to cm), while reefs with large variations in substrate topography (due to ridges, canyons, boulders, or other geologic features) exhibited more structural complexity at large scales (cm to m). Degraded reefs were characterized by low rugosity across all spatial scales. Using these methods, cross-scale differences in rugosity between the MHI and NWHI were attributed to higher coral cover at sites surveyed in the MHI rather than differences in underlying reef topography between regions. This study demonstrates how traditional methods of assessing reef condition can be scaled up to yield new insights using SfM. The ability to rapidly measure rugosity across scales using SfM can improve our ability to identify aspects of the reef (biotic vs. geologic) that drive structural complexity and contextualize change in complexity over time.

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REEF MICROBIOME VARIABILITY IN THE MO'OREA ISLAND SOCIO-ECOLOGICAL SYSTEM

1 - Oregon State University, Dept. Of Microbiology, 2 - Oregon State University, Dept. Of Geography, 3 - Oregon State University, Dept. Of Statistics, 4 - Oregon State University, Dept. Of Anthropology, 5 - Oregon State University, Dept. Of Environmental Sciences, 6 - Rice University, 7 - Oregon State University, Ceoas, 8 - Oregon State University, Dept. Of Microbiology/Ceoas

The coral microbiome has been an integral component of holobiont persistence throughout the evolution of Scleractinian corals, but the speed of global change during the Anthropocene currently challenges the limits of holobiont resilience. Understanding inherent spatio-temporal variability within corals, and their associated symbionts, is fundamental to our ability to quantify resilience and observe potential tipping points within coral reef socio-ecological systems. We tracked microbiome variability across nested spatial scales of island side, reef habitat, sites, and within 3 host species during two seasons around the island of Mo'orea, French Polynesia. Water, sediment and three coral species' microbiomes were distinct from each other although all shared taxa. There were also spatial and temporal patterns within each of the different microbiome types, although factors, especially season, did not always result in a different microbial community associated within each group. The bacterial family *Endozoicamonaceae*, associated with carbon cycling, represented 75% of coral microbiomes and was the most deterministic in distinguishing groups. The remaining 25% of coral microbiome sequence abundance represented the vast majority (99%) of richness. Resampled coral colonies showed within-site variance, and clear spatial heterogeneity supported that sites are deterministic of microbiomes. These fine-scale spatial differences allow us to interrogate factors driving microbiome shifts (including nutrient enrichment and sedimentation), offering enhanced understanding of system health

Mcdonald, M.K. *

YOUTH ENGAGEMENT - PARTICIPATORY BASED EDUCATION AS A TOOL FOR COMMUNITY BASED CONSERVATION IN BAHÍA DE LOS ÁNGELES

Vermilion Sea Institute

The Vermilion Sea Field Station, located on the Sea of Cortez in Bahía de los Ángeles, has been a hub for scientific research and education in the area since 1960. We are fortunate to be situated in one of the most biologically diverse places in the Sea of Cortez, considered a priority area for natural resource management, a popular ecotourism destination, and a nationally recognized biosphere reserve . However, in this unique, vital, and close-knit community, children in the area do not have the same opportunities to experience native wildlife as visiting ecotourists do. Over the last several years, we have formalized our efforts to involve local youth in our activities in a project we call Estrellas al Mar. Its goal is to educate and empower Bahía's next generation of conservation leaders. Estrellas al Mar is designed to help local youth and teens to discover Bahía's marine and terrestrial ecosystems, how humans impact these ecosystems, and the importance of balancing human needs while working toward solutions to conservation problems. We invite young people living in Bahía to participate in programs concurrently with visiting citizen scientist volunteers, participate in data collection, and help design educational activities. Local students are introduced to another side of ecotourism while having the chance to improve their English language skills. Simultaneously, visitors are able to develop deeper connections to the community and learn how to apply conservation leadership action in their own communities.

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BLACK HARE MAGIC: FEEDING RATES OF A LARGE SEA HARE, APLYSIA VACCARIA, ON BROWN ALGAE AND EXPLORATION OF POTENTIAL DRIVERS

1 - Scripps Institution Of Oceanography, Ucsd, 2 - California State Polytechnic University, Pomona

Found in southern California intertidal and subtidal habitats, the Black Sea Hare, *Aplysia vaccaria* has been described as a voracious grazer on brown seaweeds in order to meet the energetic demands of growing ~14 kg within its 1-year life span. Despite the expected high consumption rates and possible large impact in driving seaweed community composition in local waters, little work has been conducted to measure their feeding rates. Therefore, the first goal of my study was to measure and compare the feeding rates of *A. vaccaria* when offered eight brown seaweeds common in the herbivore's habit. As documented in studies with other, often smaller, herbivores, consumption rates and seaweed diet selectivity may be driven by characteristics that vary among algal species, such as chemical defenses (phlorotannins) and nutritional content (C:N). The second goal of this study was to elucidate the potential role of seaweed chemical composition in driving the relative feeding rates of *A. vaccaria*, focusing on phlorotannin concentrations and C:N. Consumption rates by A. vaccaria on eight common brown seaweeds were relatively similar among taxa, suggesting that the herbivore is an indiscriminate, generalist consumer. Feeding rates did not appear to be extensively driven by either seaweed traits. Although total consumption by *A. vaccaria* was markedly higher than that of other common herbivores in the region, the feeding rate standardized by biomass of herbivores was relatively similar among herbivore taxa, suggesting that *A. vaccaria* is not as voracious as originally believed.

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INDIRECT INTERACTIONS IN NORTHERN CALIFORNIA REEFS EXPERIENCING PHASE SHIFT FROM KELP FOREST TO URCHIN BARREN

Reef Check Foundation

The loss of an apex predator in a system can have cascading top-down impacts on the linkages between lower trophic level species. In kelp forest ecosystems, the direct interactions between an apex predator, herbivore, and algae can lead to indirect effects on inshore fish populations due to the loss of viable habitat, food, and protection previously provided by algae, and the temperate rocky reef itself. In 2013, Northern California experienced significant loss of an apex predator, the sunflower star. Simultaneously, we observed an increase in purple urchin densities, which caused a decline in bull kelp, understory algae and red abalone densities. According to data collected by Reef Check community scientists, fish populations in this region have declined by roughly 70% since 2016. Undergoing this decline are ecologically and economically important species such as lingcod (74% decrease), cabezon (80% decrease), and kelp greenling (75% decrease). Prior to the decline, an increase in fish populations was observed from 2014-2016. It is possible that observed fish populations had returned to 2014 levels after an unexplained increase; however, it is also possible that the 2014-2016 trend did not represent an actual increase, but was an artifact of the sampling technique and/or changes to animal behavior following the phase shift. This is similar to an observation in 2014 with red abalone density and behavioral changes. Nonetheless, the decrease since 2016 is feared to

represent an actual decline in fish populations due to the phase shift from kelp forest to urchin barren states.

†Mcintire, L.M. [1*], Bourdeau, P.E. [2]

CAN'T STAND THE HEAT? GET OUT OF THE TIDEPOOLS: EVALUATING TEMPERATURE REGULATION IN GUMBOOT CHITONS

1 - Humboldt State University, 2 - Humboldt State Univserity

Warming from climate change is predicted to reduce thermally-favorable habitat for species globally. This may be exacerbated in the intertidal zone, one of the most thermally dynamic places on earth, where tides expose organisms to extreme temperatures. Not all intertidal organisms will experience the same risk: in northern regions of the US, summertime low tides occur during warm middays, in contrast to cooler pre-dawn tides in southern regions. Some organisms may be able to behaviorally thermoregulate to avoid exposure to thermal extremes. We compared thermoregulation efficiency of gumboot chitons (*Cryptochiton stelleri*), a thermally-sensitive species, from thermally-stressful sites on San Juan Island, WA (SJI) and in more thermally-benign sites in northern California (CA) with three components: 1) biomimetic models (roboboots) deployed in the intertidal zone at four sites in CA and four sites on SJI; 2) chiton thermal preference in a laboratory-based thermal gradient; and 3) chiton body temperatures at field sites where roboboots were deployed. We found that CA chitons encountered extreme temperatures less frequently but expressed some thermoregulative activity compared to SJI chitons, which experienced thermal extremes more often but avoided thermally favorable habitat, possibly to increase access food or to reduce the probability of exposure to thermal extremes. These results suggest that chitons in northern regions of the US may be particularly susceptible to warming and extreme temperatures brought about by climate change compared to those in more southern regions.

Mcmillan, S.M.[*], Mchugh, T.A., Abbott, D., Friewald, J.

ADAPTING LONG-TERM ECOLOGICAL AND ENVIRONMENTAL STUDIES AND MONITORING PROTOCOLS TO A CHANGING CLIMATE

Reef Check Foundation

Long-term ecological and environmental studies (LTEES) of marine ecosystems are becoming ever more important in the wake of a changing global climate. LTEES provide data needed to investigate changes to ecosystems over time. However, protocols developed initially may need to be altered or updated as ocean conditions change, stressors shift, or management strategies are adapted. For example, new species may appear due to range expansions or invasions, specific areas may become important to be monitored (i.e. newly established Marine Protected Areas (MPAs)), or a more realistic representation of a changing ecosystem might be needed. The Reef Check California (RCCA) citizen science program has been collecting ecological data on the rocky reefs of California since 2006. Initially, RCCA developed a monitoring protocol to address existing management questions. In recent years, however, many of California's reefs have experienced dramatic changes, including phase shifts from kelp forests to urchin barrens, transitions from endemic to invasive algae, and appearances (and in some cases

establishments) of more tropical invertebrate and fish species. Over time, RCCA has adjusted their monitoring protocols to capture these developments, without compromising the existing data set. Recent data (especially from Southern California) have demonstrated the importance of adapting LTEES monitoring protocols to ensure that ongoing changes to ecosystems are identified and recorded. Without adapting to new realities, LTEES will lose their relevance for research and resource management.

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ISOTOPIC SEGREGATION IN THE TROPHIC HABITAT FROM SHARKS SPECIES IN THE WESTERN COAST OF BAJA CALIFORNIA SUR, MEXICO

Instituto Politécnico Nacional. Centro Interdisciplinario De Ciencias Marinas

On the southwest coast of Baja California Sur, Mexico, we record four shark species: *Carcharhinus falciformis*, *Prionace glauca*, *Isurus oxyrinchus* and *Sphyrna zygaena*, which are sharks of economic and ecologic importance and coexist in the same ecosystem. However the trophic role of each species is poorly known. Stable isotopes of nitrogen and carbon (d15N, d13C) are used as indicators of feeding habits on different time scales, allowing to know their foraging areas and trophic position. Also the stable isotope analysis in blood and muscle, will allow to infer trophic levels and breadth, and the intraspecific and interspecific interactions in different time life scales. The stable isotope results showed values in blood for *C. falciformis*: d15N = 16.65 ± 0.68 ‰, d13C = -17.03 ± 0.25 ‰; *I. oxyrinchus*: d15N = 18.34 ± 0.61 ‰, d13C = -17.47 ± 0.53 ‰;*P. glauca*: d15N = 18.17 ± 0.78 ‰, d13C = -17.22 ± 0.83 ‰; *S. zygaena*: d15N = 19.28 ± 1.14 ‰, d13C = -16.94 ± 0.63 ‰. Whereas in muscle were: *C. falciformis*: d15N = 16.66 ± 0.69 ‰, d13C = -17.03 ± 0.25 ‰; *I. oxyrinchus*: d15N = 19.41 ± 1.16 ‰, d13C = -17.18 ± 0.52 ‰; *P. glauca*: d15N = 17.83 ± 0.66 ‰, d13C = -17.76 ± 0.59 ‰ and *S. zygaena*: d15N = 19.66 ± 1.10 ‰, d13C = -16.68 ± 0.37 ‰. Significant isotopic differences were found between, tissues, sexes and maturity stages within species, which would indicate interspecific trophic segregation at different time scales.

Key words: Stable isotopes, feeding interactions, elasmobranchs.

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SOCIAL-ECOLOGICAL VULNERABILITY AND ADAPTATION TO A CHANGING OCEAN

1 - Hopkins Marine Station And Stanford Center For Ocean Solutions, 2 - Hopkins Marine Station, Stanford University, 3 - Universidad Autonoma De Baja California, 4 - Monterey Bay Aquarium Research Institute, 5 - Stanford University, 6 - Comunidad y Biodiversidad, A.C.

Coastal ecosystems and human communities are affected by shocks from climate, market, political and social change. Small-scale fisheries (SSFs) produce half of seafood consumed annually and are critical to the subsistence of hundreds of millions of people but are particularly vulnerable. Adaptation strategies include establishing protected areas, allocating exclusive access rights, improving fisheries management, and developing aquaculture to compensate for

declining fisheries. Each pathway is associated with benefits and risks but SSFs often have limited access to the knowledge and resources needed for effective decision-making. Field research on the coupled social-ecological SSF systems of Baja California, Mexico, is addressing the overarching question of what processes and conditions promote resilience and adaptive capacity of coastal social-ecological systems. Results indicate a complex landscape of winners and losers among species and fisheries exposed to environmental variability, including heat waves, harmful algal blooms and extreme hypoxia, and that a suite of adaptive actions by the local fishing cooperative have helped confront these rapid and drastic changes. This log-term research shows that communities empowered to take local actions can be resilient to environmental change, providing a framework for an expanded network of social-ecological participatory research spanning the whole California Current region and highlighting the need to consider ecological, economic and social outcomes of local to global actions.

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REPEATABLE PATTERNS OF SMALL-SCALE SPATIAL VARIATION IN INTERTIDAL MUSSEL BEDS AND IMPLICATIONS FOR RESPONSES TO CLIMATE CHANGE

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The interaction of ocean conditions and weather with small-scale features of a habitat can have profound effects on the experiences of individual organisms. Within aggregations such as mussel beds, a mosaic of environmental conditions can develop, and the resulting variation could drastically alter the performance of neighboring individuals. Using sensors mounted to *Mytilus californianus* mussels over two summers, we characterized temperature and valve gaping variation found at two spatial scales: within a group separated by centimeters, and between groups located at the upper and lower extents of the mussel zone. While temperature conditions near the lower edge of the mussel bed were generally more benign, temperature extremes were similar at both heights in the bed, and variation in body temperature among neighbors increased as the daily mean temperature rose. Gaping behavior was highly variable among individuals, though variability diminished at the high end of the mussel bed where submergence time was constrained. These data indicate that an individual's physiological status and past history can be drastically different than those of nearby neighbors, complicating our ability to characterize representative conditions within a habitat. This also provides for the possibility that the impacts of future climate change will be highly specific to certain individuals based on their relative exposure within the mosaic. Future work must examine correlations between genotypic and physiological traits that determine individuals' unique experiences in their micro-environments.

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METAGENOMIC ANALYSIS OF MYXOZOAN PARASITES FROM AMAZONIAN FISHES

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Myxozoans are diverse, global, microscopic, obligate parasites that cause infections that can yield detrimental symptoms in many economically important fish species. Analysis of the

frequency and diversity of myxozoan species present in samples from a particular location can provide information about the water quality and ecological state of the locality. To determine if myxozoan DNA can be amplified and sequenced directly from fish tissue, we isolated DNA from over 500 gill samples without knowledge of their infection status. The fishes were found near the confluence of the Rios Amazona, Tapajós, and Arapiuns, all of which have distinct water types. Myxozoan and ciliate SSU rDNA was amplified in pooled groups of the isolates. Ciliate sequences present were predominantly of the genus Trichodina. 22 of 44 pools revealed gill infections by 12 total species of myxozoans (esp. species of Ellipsomyxa, Henneguya, and Myxobolus) across all of the samples from all 3 rivers. There were 35 occurrences of myxozoan infections in samples from the Rio Tapajós, 12 in samples from the Rio Arapiuns, and 7 in the Rio Amazona samples. Some species of infected fish from the Rio Tapajós were uninfected in the less acidic Rios Arapiuns and Amazona, while some species only amplified for myxozoans if from the Rio Amazona. 10/19 fish species sampled from the Rio Tapajós, 3/8 from the Rio Arapiuns, and 4/13 from the Rio Amazonas had myxozoan infections. Because the 3 rivers have different environments, the rates of myxozoan infections in fishes can be used as an indicator of environmental status.

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INTRA-ANNUAL VARIATION OF THE ATLANTIDAE COMMUNITY IN THE SOUTHERN CALIFORNIA CURRENT (WINTER-SPRING, 2016)

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Holoplanktonic mollusks of the family Atlantidae have a relatively short life cycle, and even though they respond rapidly to environmental changes, it is currently unknown how their distribution and abundance varies with the intra-annual environmental changes. On the California Current System (CCS), the most rapid and intense changes in the environmental conditions and in the composition of planktonic species in this area occurs between winter and spring, linked to upwelling enhancement. This study aims to determine the variation of the distribution and abundance of the Atlantidae family occurred between winter and spring of 2016 off the West Coast of Baja California, Mexico. A total of 15 species were found, where *Atlanta brunnea* and *A. helicinoidea* represent distribution range extensions and we recorded for the first time *A. fragilis* and *A. rosea* in the American Pacific. *Atlanta californiensis* was the most abundant and widely distributed species. Although in both seasons the greatest abundance, richness (S), diversity (H') and evenness (J) were observed towards the oceanic region and near Bahía Vizcaíno, the taxocene characteristics are different between seasons, as the values of the ecological indices (S, H' and J) were greater in winter. The canonical correspondence analysis and the cluster analysis showed four groups in winter and none in spring. The difference in the community structure in both seasons show that the atlantids are good indicators of the intra-annual change in the southern CCS.

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SOMETHING ABOUT PARASITES IN KELP FOREST FOOD WEBS

1 - Uc Santa Barbara, 2 - Usgs

Parasites often track food web linkages through their complex life cycles, with distinct effects on food web structure. Kelp forests are famous for strong trophic interactions, and are physically and biologically distinct from ecosystems where parasites have been thoroughly studied. Our objective was to build a high-resolution topological kelp forest food web that includes parasites. We defined the study system as rocky reef that supports giant kelp in the Santa Barbara Channel, CA. Three trophic sub webs (predator-prey, parasite-host, and predator-parasite) were constructed using information from primary and grey literature, direct sampling (dissections), expert opinion, and logical inference. Resolving free-living species and their parasites increased the number of nodes in the web by nearly 5 fold relative to previously published webs. Inclusion of parasites affected food web metrics, with strong effects of concomitant predation. Maximum trophic level and food chain lengths increased via both improved resolution of mid-trophic levels and the addition of parasites feeding on top predators. Larval stages of shark and bird parasites were prevalent and abundant in fishes, highlighting the importance of transient predators. The open and dynamic nature of kelp forest ecosystems is highlighted by the presence of many free-living and parasitic species with life cycle stages occurring outside the ecosystem, while also serving as source of parasitic larval stages infecting transient predatory hosts.

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THE COUPLED EFFECTS OF UPWELLING AND PREDATION ON BENTHIC COMMUNITY STRUCTURE IN THE GALAPAGOS SUBTIDAL

Brown University

The Galapagos Islands are a natural laboratory to study the effects of biological and physical environmental factors on community composition and functioning. We experimentally investigated the relative importance of upwelling (influx of cold, nutrient-rich water to the surface) and consumer effects on benthic communities in the Galapagos subtidal. We measured macroalgal and sessile invertebrate abundance, diversity, biomass, and multivariate community structure in response to variation in upwelling strength and exposure to consumers through the deployment of 6-month recruitment plates. We found a negative relationship between species richness and upwelling strength in the form of an average reduction of 5 species per 2 degrees C decrease in temperature. Stronger upwelling also reduced multivariate dispersion, indicating a reduction in community variation. These two results suggest dominance by few benthic species when nutrients are plentiful and temperature is low. In a second set of experiments, consumption reduced invertebrate diversity and reduced multivariate community dispersion, but only in zones of low upwelling, suggesting that nutrient addition by upwelling may result in a bottom up effect that overrides consumption in structuring communities. As ocean temperature regimes are expected to change drastically over the next century, using the wide natural range of physical variables available in the Galapagos subtidal may help predict the response of benthic communities to climate change.

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KELP HELP: FRAGMENTED NEREOCYSTIS LUETKEANA FORESTS ALTER SEAWATER CHEMISTRY, MITIGATING OCEAN ACIDIFICATION

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Our world's oceans are absorbing excess anthropogenic carbon dioxide (CO_2), causing ocean acidification (OA), which has been shown to have negative impacts on calcifying invertebrates. However, marine macrophytes like kelp can uptake CO_2 via photosynthesis, reducing nearby ocean acidity, and thus have the potential to buffer calcifying organisms from OA stress. Recently, it has been shown that persistent, large kelp forests have large impacts on the local carbon cycle. On the California coast, historically large kelp forests have been reduced to smaller fragments, raising the question of whether these small fragments are able to mitigate OA to the same degree as large forests. To address this question, we captured spatial and temporal variability in seawater chemistry in multiple habitats within, in close proximity to, and outside recently fragmented bull kelp (*Nereocystis luetkeana*) forests on the north coast of California. Within fragmented *Nereocystis* forests, canopies increased pH, dissolved oxygen, and aragonite/calcite saturation levels relative to forest bottoms and nearby urchin barrens, and to a similar degree as large kelp forests. Our results therefore indicate that even small, fragmented kelp forests can provide potential refuge from OA stress for calcifying invertebrates and that kelp density, rather than area, may play a larger role in a forest's ability to buffer OA than previously noted.

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COLLABORATIVE FISHERIES MONITORING IN THE YAP OUTER ISLANDS

1 - University Of California Santa Cruz, 2 - Cabrillo College, 3 - NOAA Fisheries, 4 - One People One Reef

Subsistence fisheries in the outer islands of Yap (Federated States of Micronesia) are largely regulated by local community leaders and chiefs with little guidance from governmental sources. Despite expansive reefs that are generally in good health and small human populations, many of these communities are catching fewer, smaller fishes and report increasing threats to food security. We worked with fishermen and community leaders on nine remote atolls to establish fishery monitoring programs, recording the species, numbers, sex/maturity, and sizes landed, with the goal of providing basic analyses of these data to the communities where the results could be applied to management efforts. Here, we provide a description of these fisheries, an outline of the programs established, and preliminary results applied to landings data from 2017 and 2018. We also describe the management actions implemented by these communities.

†Nicolás-Chávez, A. [1*], Ayala-Bocos, A. [2], Reyes-Bonilla, H. [1]

EFFECT OF ENVIRONMENTAL CONDITIONS ON THE RELATIVE ABUNDANCE OF MANTAS (*MOBULA BIROSTRIS*) IN REVILLAGIGEDO NATIONAL PARK.

1 - Universidad Autónoma De Baja California Sur, 2 - Ecosistemas y Conservación, Proazul Terrestre A.C.

The Revillagigedo National Park is one of the most complex groups of oceanic islands in the Tropical Eastern Pacific that present a great species richness. *Mobula birostris* is a pelagic filter-feeding species that is found in tropical and subtropical waters around the world. The objective of this study is to evaluate the relationship between relative abundance of *M. birostris* with sea surface temperature (sst) and chlorophyll-a concentration (chl-a) in three islands of the park. Visual censuses were carry out during the cruise season from 2015 to 2018. The relative abundance of mantas was determined by the total number of organisms observed among the total number of dives conducted each month. The oceanographic parameters were downloaded from NASA's MODIS-AQUA sensor. According to the data obtained, there are significant differences between the abundance of mantas per island. San Benedicto was the island with the highest average value of relative abundance (2.1 mantas/diving), followed by Roca Partida (1.4 mantas/diving) and Isla Socorro (1.2 mantas/diving). In the case of environmental variables, the sst fluctuated between 23.5 and 27.6 °C and the chl-a concentration between 0.078 and 0.28 mg/m^3. Unlike other studies, none of the two variables had a significant effect on the relative abundance of mantas in the park. This is because being an oceanic archipelago these variables have more stable values than coastal areas, favoring the availability of food throughout the season, as well as the presence of *M. birostris* in the Revillagigedo National Park.

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VARIABILITY IN HOW HETEROTROPHIC ECOSYSTEM ENGINEERS MODIFY SEAWATER CHEMISTRY

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A variety of ecosystem engineers modify their physical environment through the dense association of many individuals, which has implications for the chemical environment of the created habitat. The reduced water exchange with the seawater surrounding these aggregations can limit the transfer of metabolic substrates or waste products involved with the dominant biological processes of the habitat. In autotrophic habitats, photosynthesis may increase both oxygen and pH. In heterotrophic habitats lacking appreciable photosynthesis, however, modifications resulting from respiration and calcification can dominate, which generally lower oxygen and pH, elevating stresses on both the habitat former and its residents. Here, we compare the chemistry modification capability of several ecosystem engineers including the California mussel, Pacific oyster, and the purple sea urchin. In a laboratory flow tunnel, we measured vertical gradients of pH and oxygen above and within aggregations of each of these habitat-formers under a variety of seawater velocities. We observed decreases up to 0.1 pH and 25 µmol kg^-1 oxygen in the mussel bed and 0.04 pH and 10 µmol kg^-1in the oyster reef. Gradients were much less pronounced within urchin aggregations with decreases of only 0.01 pH and 3 µmol kg^-1 oxygen observed. The strength of these gradients strongly depends on biological and physical factors like respiration and calcification rates and seawater velocity. We

additionally explore whether these gradients might impose feedbacks that alter the performance of the habitat former.

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MUSSELS, MODELS, AND MICROCHEMISTRY - LARVAL SUBSIDIES FROM AQUACULTURE MAY ASSIST WITH RESTORATION

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Shellfish beds perform a number of ecosystem functions disproportionate to their size. Anthropogenic activities have degraded these populations and sparked interest in their restoration. Population connectivity determines if restored populations are sustainable through self-recruitment or larval supply from alternate source populations. This study investigated larval dispersal of green lipped mussels, *Perna canaliculus*, from aquaculture sites in the Firth of Thames (FoT), a coastal embayment in Northern New Zealand. This species was once abundant in the area, however currently the largest known populations of *P. canaliculus* in the area are in aquaculture operations. There is also an active restoration effort for this species in the area. A biophysical particle tracking model was used to determine potential larval dispersal pathways from aquaculture sites. Results were then compared to a shell microchemistry study which empirically estimated the natal origin of recent settlers at sites throughout the area. The model showed that larvae can settle throughout the FoT. Larvae originating from only a few sites are likely to dominate settlement in the area due to high larval production at these sites. Shell microchemistry suggested recent settlers originated throughout the study area supporting the results of modelling. These results suggest that larvae produced at aquaculture may contribute to a well-mixed larval pool which may settle throughout the FoT and potentially contribute to population recovery and assist with the selection of restoration locations.

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EXTREME MARINE HEATWAVES ALTER KELP FOREST COMMUNITY NEAR ITS EQUATORWARD DISTRIBUTION LIMIT

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Climate change is increasing the frequency and severity of marine heatwaves. A recent extreme warming event (2014-2016) of unprecedented magnitude and duration in the California Current System allowed us to evaluate the response of the kelp forest community near its southern distribution limit. We obtained sea surface temperatures for the northern Pacific of Baja California, Mexico, and collected kelp forest community data at three islands, before and after the warming event. The warming was the most intense and persistent event observed to date, with anomalies 1°C warmer than the previous extremes during the 1982-1984 and 1997-1998 El

Niños. The period between 2014-2017 accounted for ~50% of marine heatwaves days in the past 37 years, with the highest maximum temperature intensities peaking at 5.9°C above-average temperatures for the period. We found significant declines in the number of “Macrocystis pyrifera” individuals, except at the northernmost island, and corresponding declines in the number of fronds per individual. We also found significant changes in the community structure associated with the kelp beds: half of the fish and invertebrate species disappeared after the marine heatwaves, species with warmer affinities appeared or increased their abundance, and introduced algae, previously absent, appeared at all islands. These results suggest that the effect of global warming can be more apparent in sensitive species, such as sessile invertebrates, and that warming-related impacts have the potential to facilitate the establishment of tropical and invasive species.

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MARINE SUBSIDIES DRIVE PATTERNS IN AVIAN ISLAND BIOGEOGRAPHY

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The classical theory of island biogeography (TIB) predicts that the number of species on an island depends on both an immigration rate determined by island isolation, and extinction rate, which depends on island size. TIB has expanded to consider additional factors, including the influence of marine subsidies, although this has rarely been tested. The input of marine subsidies to nutrient-limited islands could cause shifts in population densities, which may result in altered extinction rates and could lead to changes in species richness. In this study, we integrate TIB with the role of ecosystem subsidies in order to understand how nutrients from the ocean can affect terrestrial species diversity and population density of terrestrial breeding birds.

We studied 91 small islands along the Central Coast of British Columbia, Canada. We found that avian species richness was affected by both island area and marine subsidies, which are vectored by wind, water, and animals. Avian species richness increased with island area, as expected, but it decreased with marine subsidy. Population density decreased with island area but increased with marine subsidy. The effect of marine subsidy on density strengthened disproportionately on smaller islands. These patterns suggest that some terrestrial bird species may benefit from marine subsidies at the expense of others. Our results suggest that nutrients from the sea have the potential to alter population densities of higher trophic level terrestrial species, leading to deviations from classical TIB predictions about species diversity.

Okamoto, D.K.*

REDEFINING FISHERIES SUSTAINABILITY: ACCOUNTING FOR COMPLEX FEEDBACKS AMONG ECOLOGICAL, GOVERNANCE, AND SOCIOECONOMIC DYNAMICS

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Natural resource management has historically been driven by a one-dimensional notion of sustainability that is rooted in the ecological concept that the ability of a population to withstand harvest is equal to its growth rate. Yet this perspective of sustainability neglects diverse

objectives and feedbacks. Specifically, complex social, cultural, ecological and governance dynamics are frequently ignored and often have spatial structure. Using Pacific herring (*Clupea pallasii*) as a case-study, I summarize several recent studies that chart a path toward integrating these dynamics into management strategy evaluation (MSE) with the aim of revealing trade-offs and improving sustainability.

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SYNOPSIS: A PNW MICROPLASTICS MONITORING WORKSHOP HELD AT THE SEATTLE AQUARIUM

Seattle Aquarium

Microplastic particles, here defined as 330 micrometers (µm) to 5 millimeters (mm) in size, are ubiquitous throughout the marine environment. However, the contamination level within the Puget Sound and the Salish Sea are largely unknown. The Seattle Aquarium, centrally located on Elliott Bay, uses incoming saltwater pumped directly from Puget Sound for use in animal exhibits. The Aquarium laboratory began filtering seawater through sieves as small as 63 µm to determine if microplastic pollution was coming into the Aquarium and exposing animals in exhibits. After literature searches on methodology and communication with other pollution laboratories in the region, it was determined that there was high variability in protocols and no standard in which to collect, measure, and analyze these particles. Methodology varies greatly due to geographic location, accessibility and cost of equipment, current equipment technology and ultimately researcher preference. A Microplastics Monitoring Workshop was held at the Seattle Aquarium on October 1-2, 2019 and hosted 12 laboratories from British Columbia to Oregon including universities, federal and non-profit organizations. Goals of the workshop included building a microplastic research community in the Pacific Northwest, facilitating a large-scale understanding of microplastic research in the region, and establishing some standardization of methods and QA/QC protocol. Here, I will present a synopsis of the workshop and key points from discussions. Ideally, the combined effort of these researchers will provide the context for large-scale

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SPONGE FORAGING PREFERENCE BY THE HAWAIIAN TIGER COWRIE AND IMPLICATIONS FOR MANAGEMENT OF INVASIVE SPONGES IN KĀNEʻOHE BAY, OʻAHU

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Sponge predation is an important ecological factor that can shape the community composition of sponges in coral reefs. Identifying spongivorous predators along with consumption quantification of their prey is fundamental for identifying strategies of survivorship from top-down pressures among sponges. In this study we identify the Hawaiian tiger cowrie *Cypraea tigris schilderiana* as an important sponge predator. We examined the feeding preferences of cowries in flow-through aquaria by quantifying the consumption rate of 18 sponge species along with 3 native coral species in Kane'ohe Bay. Deterrence of crude extracts from prey species against cowries and the whitespotted toby *Canthigaster jactator* were also tested. Overall, cowries

avoided corals and completely consumed sponges *Dysidea cf. arenaria*, *Dysidea* sp. 3, and *Dysidea* sp. 7 within 72 h; *Mycale parishi*, *Haliclona caerulea*, *Halichondria coerulea*, and *Cladocroce burapha* within 96 h; *Mycale grandis*, and *Gelliodes wilsoni* within 144 h. Consumption by cowries resulted in a removal of 567.96 ± 65.47 g of wet sponge tissue per week. Other prey species were either minimally consumed (<50%) or completely avoided. Among avoided sponges, only *Monanchora clathrata* and *Lissodendoryx schmidti* produced cowrie and toby deterrent extracts. Our study highlights that feeding deterrence by cowries is not always influenced by sponge chemical defenses. We propose that cowries be considered as a biocontrol of non-native sponge species and encourage conservation efforts of this overharvested spongivore in Hawai'i.

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COMMUNITY CONTRIBUTIONS TO BENTHIC BIOGEOCHEMISTRY IN TEMPERATE ROCKY REEFS

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Kelp forest benthic zones have reduced water motion from kelps' structural biomass and friction with the seafloor, potentially enabling organisms to contribute to local water chemistry. Understory community composition is variable and shifts to alternative states such as urchin barrens may have biogeochemical consequences with producer loss. Here we assess community contributions to biogeochemistry in the benthic zone of temperate reefs. Dissolved oxygen (DO), temperature and relative water motion were continuously measured along with discrete pH measurements directly in and 1 meter above bottom (MAB) in 3 benthic community types within Monterey Bay: a dense understory algal community in a kelp forest, a patchy understory algal community in a kelp forest, and an urchin barren lacking algae. Universal point contacts and understory height were used to assess community composition and structure, which differed significantly between community types. Differences in DO between communities were strongest at the bottom with temporal variation likely driven by physical processes as offshore water masses changed depending on upwelling strength and the presence of internal bores. Patchy understory showed similar DO across depths but differences in relative water movement between bottom and 1 MAB with bottom having the lowest flow. In the dense understory and urchin barren, water movement was similar across depths and DO was higher 1 MAB compared to bottom. This demonstrates that communities contribute to *in situ* biogeochemistry, shaping distinct microhabitats of benthic organisms.

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ASSESSING LIFE HISTORY PARAMETERS OF THE PISMO CLAM *TIVELA STULTORUM* ON PISMO BEACH, CALIFORNIA

No affiliation[s] given

Pismo clams (*Tivela stultorum*), a historically important bivalve species in California, once supported a productive commercial and recreational fishery. Overharvest prompted a commercial harvest ban in 1947 and a minimum recreational harvest size of 4.5/5 inches in 1986. Despite these management efforts, Pismo clam populations have continued to decline in

California. Bivalves exhibit body-size scaling, where larger individuals produce more gametes and therefore contribute disproportionately to future recruitment. Recent surveys indicate few legal sized adults and a shifted size structure to smaller individuals, potentially influencing the slow recovery of this species. Our study investigates the reproductive status and body condition of Pismo clams on Pismo Beach, CA. 70 clams were collected monthly between January 2018 and August 2019 and length and height were measured for each clam. 30 clams were weighed (whole mass and desiccated tissue mass) to determine body condition and the remaining 40 clams were analyzed histologically to determine reproductive stage. Preliminary results show that peak reproductive condition occurs in mid to late summer, indicating preparation for spawning in late summer and early fall. Our data suggest that reproductive cycles deviate slightly from historical records, with clams spawning later in the year than they were decades ago. Updated life history parameters could be used to progress our understanding of the processes affecting this iconic species and improve fisheries management.

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HISTORICAL DYNAMICS OF KELP FOREST BLUE CABRON CAPTURE IN ENSENADA, MEXICO

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Kelp forests are one of the most productive coastal ecosystems in the world. They provide a great diversity of ecosystem services. Here we focus on the capture of atmospheric CO2, a service known as “Blue Carbon”. Ensenada´s kelp forests in Baja California, Mexico, are comprised of a variety of kelp patches with multiple anthropogenic pressures. Therefore, we considered this area as a prime example to study how the historical dynamics of these kelp patches have changed over the years along with their capacity to capture carbon. In this study, we used multispectral satellite imagery to monitor changes in giant kelp biomass in Ensenada, from 1989-2017, centering on 5 areas with different anthropogenic pressures. We found a seasonal trend over the years, but a general reduction in total biomass related to heating events. Moreover, we evaluated the general persistence with a total average of 23.3% and found that highly persistent areas, like Punta Banda Sur and Punta San Miguel, are highly related (correlation coefficient= 0.86) to high carbon capture. Our data suggest kelp forests in this area are comparable with tropical rainforests in the amount of C they can capture per unit area (annual average 8.54 gr C m^-2). Besides, we found an interesting spatial variability with persistent patches of kelp sequestering as much as 900 gr C m^-2 annually. In this first approximation, we highlight the role of coastal marine ecosystems at Ensenada as important players in mitigating the effects of climate change through the capture of atmospheric CO2.

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COMMUNITY STRUCTURE AND DYNAMICS OF FORAGE FISHES IN THE EASTERN GULF OF MEXICO (1998-2017)

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Forage fish are an important component of the marine ecosystem. They serve as the primary prey source for many predators, including economically important species, and they have a direct economic importance as part of a global fishery for bait, fish feeds, and fish oil. Despite their importance, forage fishes are relatively under-represented in marine ecological studies and fisheries management plans, and community-level studies of forage fishes are even more uncommon. The goal of this study was to characterize forage fish communities, analyze patterns of spatiotemporal variations in community composition among four spatially separated (>500km) estuaries in the eastern Gulf of Mexico, and identify potential drivers of the patterns. Fifty forage fish taxa were identified from a 20-year fishery-independent dataset collected by Florida's Fish and Wildlife Research Institute. The four estuaries separated into two distinct groups by latitude based on forage fish community composition: Apalachicola Bay and Cedar Key in the north, and Tampa Bay and Charlotte Harbor in the south. Further separation occurred between the two northern estuaries, while community composition was similar between the two southern estuaries. Communities differed by season, and temporal analyses revealed a distinct seasonal cycle in forage fish community composition consistent across all estuaries, related to variation in both biotic and abiotic factors. This study illustrates important considerations for management of forage fish species and can guide future research on their community dynamics.

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THE LOS ANGELES URBAN OCEAN EXPEDITION 2019

1 - Natural History Museum Of Los Angeles County (Lacm), 2 - Lacm

In August and September of 2019, the Natural History Museum of Los Angeles County (LACM) hosted a two-week-long intensive investigation into the marine invertebrate diversity of coastal waters in the Los Angeles area. This event attracted the attention of numerous taxonomists (27 attended from across the U.S. and Canada), as well as support from a number of agencies and non-governmental organizations. With a combination of diver collections, benthic grabs, and trawls, the expedition yielded thousands of specimens across a broad range of taxonomic groups. Each specimen was identified by an attending taxonomist, photographed live, tissue-sampled for genetic analysis, and curated for permanent storage in the LACM collection. The goal is to use the specimens to generate genetic barcode reference sequences.

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IDENTIFYING PROCESSES AND SCALES IN NEARSHORE LARVAL TRANSPORT FROM SETTLEMENT AND HIGH RESOLUTION PHYSICAL MEASUREMENTS

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Population dynamics and dispersal of benthic marine animals is dependent on settlement and larval transport. Resolving larval transport, however, is challenging, because larval distributions

are patchy, abundance vary at multiple scales, larval transport is episodic, and multiple physical processes are involved. We measured barnacle settlement daily in a Southern California rocky shore in spring and fall 2014 and 2015, and in spring 2016. Nearshore water temperature, circulation, and sea level were also measured. Larval settlement, and the potential physical transport processes associated with settlement, varied at multiple temporal scales. For example, settlement increased sharply coinciding with a change in the structure of the water column, and in another event, settlement increased strikingly a few weeks after the end of the 2015-2016 El Niño. The first event may be related to alongshore current reversal, downwelling, and the internal tide, and the second event to the return to El Niño-neutral stratification conditions. Observations in another location ~7 km distant, with different nearshore and coastal physiography, indicate consistent biological and physical patterns at some temporal scales, but not at others. Resolving larval transport in the nearshore requires multiple approaches, including settlement and physical time series, as well as observations of larval distribution.

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ACCOUNTING FOR POPULATION DYNAMICS IMPROVES THE USE OF NO-TAKE MARINE RESERVES FOR FISHERY MANAGEMENT

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Today, fisheries are managed using information obtained through periodic stock assessments. These provide reference points, such as how depleted the fishery is compared to its unfished state, to inform catches and prevent over-fishing. However, these stock assessments typically need long time series of historical or catch and abundance data, to accurately assess depletion. These data may be difficult to obtain for smaller, or mainly recreational, fisheries. Populations in no-take marine reserves, that are unfished, may therefore help serve as a reference point to determine depletion. One method developed in the past decade uses the ratio of fish density outside to inside the reserve to serve as a proxy reference point for depletion. From this, we can determine catch based on control rules. The density ratio is especially useful because it does not require a long time series of data, and can be applied at a local spatial scale with observable fluctuations in annual recruitment. Two limitations to the original method include failing to account for both strong, periodic recruitment pulses and short-term population dynamics – separate from the long-term, unfished dynamics. Using age-structured spatial population modeling of Black Rockfish (*Sebastes melanops*) populations, I show how these factors can be accounted for to help determine consistent, sustainable catches. Furthermore, this use of information from no-take marine reserves illustrates their ability to aid in management as well as conservation.

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THE INFLUENCE OF CRUSTOSE CORALLINE ALGAE BIOFILMS AND EXOMETABOLITES ON CORAL LARVAL SETTLEMENT

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The chemical mechanisms that drive coral larval settlement and the survival of new recruits are poorly understood, yet some research suggests that the microbial biofilms associated with benthic surfaces and their associated metabolites serve as chemical cues that the larvae can sense. Coral larvae often settle preferentially on or near crustose coralline algae (CCA), but experimental studies show that certain CCA species actually inhibit coral larval settlement. To investigate the differences between species of CCA shown to facilitate or inhibit coral larval settlement, we characterized the microbiomes and the fluorescent portion of the dissolved organic matter (fDOM) released by two Pacifc species of CCA, *Hydrolithon reinboldii* (facilitator) and *Porolithon onkodes* (inhibitor). *P. onkodes* exuded significant concentrations of humic-like fDOM that potentially enriched for higher prevalence of two distinct OTUs in the clades Alteromonadales and Oceanospirillales. To further describe the roles of chemical cues in coral larval settlement, we extracted both exuded and tissue-bound metabolites from two Carrbibean species of CCA, *Hydrolithon boergesenii* (facilitator) and *Paragoniolithon solubile* (inhibitor). Metabolite extracts were used to perform settlement assays with larvae of three coral species (*Acropora palmata*, *Diploria labyrinthiformis*, and *Orbicella faveolata*). We found that *A. palmata* settlement was significantly higher in response to tissue metabolites from *P. solubile*, whereas exometabolites from both CCA species facilitated coral settlement.

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ARE THE MARINE PROTECTED AREAS OF THE GULF OF CALIFORNIA RESILIENT?

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Reef ecosystems inside Marine Protected Areas (MPAs) should have higher species diversity than fishing areas, due reduced fishing pressure. In theory, higher diversity increases the probability of functional compensation by redundancy, which increases the resilience of an ecosystem to disturbances. We aimed to evaluate if fish species diversity, functional redundancy and level of resilience were different between MPAs with distinct levels of enforcement and a fishing zone in the Gulf of California. From 2004 to 2017, we conducted visual censuses to register species richness of fish at four sites: a marine reserve (Cabo Pulmo, 23°N), multi-use MPAs (Espíritu Santo, 24°N; Loreto, 26°N), and a fishing zone (San José, 24°N). With information on six functional traits (size, mobility, activity, gregariousness, position, and diet) we calculated functional redundancy. We compared species richness and functional redundancy considering as factor the site; also we evaluated if temporal tendencies in these indices presented correlation with temperature anomalies and hurricanes. Functional redundancy was low in the region (<2 spp/functional group), which make the idea of functional compensation unlikely. However, the marine reserve presented stability in the indices through time, despite the impact of hurricanes and increase of temperature, while the other sites presented significant declines. These results indicate that in spite of the low redundancy, fish assemblages in the marine reserve could be more resilient compared with those present in multi-use MPAs and the fishing zone.

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MARINE CONSERVATION ACROSS POLITICAL BORDERS

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Political borders in marine ecosystems are not delimited by physical barriers, however, the lack of collaborative research and management of marine resources can generate equivalent results to those caused for fences or walls. In the marine environment, political borders are essentially imaginary lines that often divide well-connected populations, communities and habitats. Scientific evidence shows that collaboration among nations can improve the effectiveness of program management, conservation, and cost-efficiency. Despite the evidence that the marine region between California (US) and Baja California (Mexico) constitutes a single ecoregion, our research revealed a lack of binational collaboration and differences in knowledge, conservation, and management of trans-boundary marine species. Kelp forest are the most species-rich and productive communities in this marine ecoregion. We found 40 times more scientific articles regarding kelp-forest ecosystems north of the US-Mexico border than those south of it. The case of the critically endangered Giant Sea Bass shows how asymmetries in species protection and differential fishing pressure across political borders may threaten populations through disruption of connectivity and undervalue conservation efforts. A network of 124 marine protected areas has been established north of the border, whereas south of the border there is a lack of similar conservation initiatives. Our results highlight the need for greater cross-border cooperation in conservation and marine resources management and generate research political-borderless.

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AN ASSESSMENT OF ECOSYSTEM HEALTH AND BIODIVERSITY IN LOS ANGELES COUNTY

Ucla Sustainable La Grand Challenge

Set to be released in January 2020, the Ecosystem Health Report Card will provide the first comprehensive analyses of ecosystem health in the L.A. region. Indicators for this report card have been selected to measure land-use, habitat connectivity, habitat quality, biodiversity, threats to ecosystem health and community environmental health. This report card will establish a critical baseline for many ecosystem indicators that can be utilized to create a regional ecosystem management strategy. The Ecosystem Health Report Card will assist regional managers with policy decisions and resource allocation that aligns with the Sustainable LA Grand Challenge's goals of 100% renewable energy, 100% local water and enhanced ecosystem health by 2050. Specifically, this report card will help with the implementation of the City of L.A's Green New Deal and the County's Sustainability Plan's Ecosystem Health Targets. This will ensure that effective, data-driven decisions are made at the ecotope scale rather than

through individual departments and government entities. Finally, as it will be publicly available, it will also act as an educational resource for local stakeholders and the general public to learn more about the natural resources in our region and what issues are currently threatening them as well as the solutions needed to preserve them. In addition to the data on LA County that this report card will provide, it will also act as a template for other regions to begin to monitor, record and protect their natural resources to ensure biodiversity is preserved for future generations.

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ECOLOGICAL DRIVERS AND LONG-TERM IMPACTS OF PARROTFISH PREDATION ON ENDANGERED ORBICELLA ANNULARIS CORALS

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Parrotfishes (*Scarinae*) are a major Caribbean herbivore that reduce coral-algae competition. While parrotfishes are mainly herbivores, some species occasionally feed on live corals. They prey upon multiple coral species, but preferentially target *Orbicella annularis*– a endangered species and major reef-building coral. Researchers are concerned that parrotfish predation may contribute to substantial long-term declines in *O. annularis*, particularly if parrotfishes do not scale back predation as its cover decreases. We compared the intensity of predation on *O. annularis* across a gradient of parrotfish biomass, relative *O. annularis* cover, total coral cover and algae cover between St. Croix (where parrotfish are heavily fished) and Bonaire (where their harvest is banned). We also used photo monitoring and ImageJ analysis to quantify healing of *O. annularis* with fresh parrotfish bite scars for up to three months. Preliminary results show that scar healing rate decreased significantly in response to increased initial scar area, decreased significantly over time and decreased as relative coral tissue loss increased. Initial results support that relative area of bite scars to total *O. annularis* cover increases in response to increased parrotfish biomass. These data allow us to model long-term rates of tissue loss in *O. annularis* in response to scar size and density, as well as determine how community composition influences the intensity of predation on this endangered coral species across areas with drastically different fishing pressure.

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LARVAL ACCUMULATION AND TRANSPORT IN THE NEARSHORE

1 - University Of San Diego, 2 - Woods Hole Oceanographic Institution

Larval transport in the nearshore plays a central role in larval dispersal and connectivity of shallow water species; however, few studies have resolved the relevant scales of larval transport and patterns of larval distribution in this region. To better understand the physical-biological mechanisms that determine larval transport, we combined high-resolution physical measurements (temperature, currents and pressure) with vertically-stratified sampling of barnacle larval distributions in a nearshore region within 1km from adult, rocky intertidal habitat, in depths from 4 to 12m. We sampled larvae from 2014-2016, using a semi-vortex pump to determine how larval vertical distributions varied spatially and temporally with changing hydrodynamic conditions. Barnacle nauplii and cyphonautes larvae were vertically distributed above the thermocline, while brachyuran zoeae and barnacle cyprids were slightly deeper and

more associated with the depth of the thermocline. Additionally, barnacle cyprids were distributed closer to shore when thermal stratification was greatest. Our data suggests that cyprids are transported by the internal tide and accumulate at a well-mixed nearshore station, where stratification breaks down.

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MULTISCALE SPATIO-TEMPORAL VARIABILITY IN PREDATION AND HERBIVORY: A FISHY TALE

1 - Institute Of Water And Environment, Florida International University, 2 - Department Of Biological Sciences, Florida International University, 3 - Department Of Environmental Engineering Sciences, University Of Florida, Gainesville, 4 - University Of Florida/ Institute Of Food And Agricultural Sciences Nature Coast Biological Station, 5 - Smithsonian National Museum Of Natural History, Smithsonian Marine Station At Fort Pierce, 6 - Centre For Ocean Research And Education, 7 - Department Of Life Sciences, Texas A&M At Corpus Christi, 8 - Smithsonian Marine Station At Fort Pierce, Smithsonian National Museum Of Natural History, 9 - Soil And Water Sciences Department, University Of Florida, Gainesville, 10 - Institute Of Ocean Sciences And Limnology, Universidad Nacional Autónoma De México

Predation and herbivory are critical processes that influence ecosystem functioning and resilience. Yet few studies have directly measured in the field how these processes vary across spatial and temporal scales. In conjunction with the *Thalassia* Experimental Network, we deployed standardized replicate consumer assays of raw squid, dried squid, and seagrass across seven sites in seagrass beds encompassing 20 degrees of latitude (from Crystal River, Florida, USA to Bocas del Toro, Panama) and across three seasons (summer, winter, and spring). We video-recorded and visually observed assays to quantify relative rates of predation, mesopredation, and herbivory over 24 hours. Assays were primarily consumed by marine fishes, and highlight predictable differences in relative consumption rates across scales – region versus reef, and season versus day/night. Relative consumption rates on all prey types were higher at mid-latitudes, with proximity to reef, and in late summer, and declined sharply in the winter and spring. Within reef, relative predation rates were greater at night relative to day, while relative herbivory rates were greater at crepuscular periods. Our findings build upon recent studies of temperature-driven gradients in predation across latitude, and risk-driven gradients in herbivory within reef, relating relative consumption rates to metabolic theory, biodiversity-function, and optimal foraging theory. Further, our findings uniquely and explicitly quantify the relative and combined impacts of multiscale environmental changes on ecosystem processes and function.

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A TRANSDISCIPLINARY STRATEGY FOR THE SUSTAINABLE DEVELOPMENT OF FISHING COMMUNITIES OF THE UPPER GULF OF CALIFORNIA

1 - Intercultural Center For The Study Of Deserts And Oceans/Autonomous University Of Baja California, 2 - Autonomous University Of Baja California, 3 - Intercultural Center For The Study Of Deserts And Oceans

A socio-environmental conflict is having place at the coastal communities of the Upper Gulf of California because of: 1) the incursion of transnational criminal organizations in poaching, especially of totoaba (Totoaba mcdonaldi) for the illegal traffic of its swim bladder and its commercialization in the black market; 2) the need to innovate in the design of fishing gear and alternative equipment that avoid incidental capture of vaquita (Phocoena sinus), which can be accepted by most of the traditional fishing sector; and 3) the most restrictive, repressive and surveillance forms and politics implemented by the Mexican government since 2015. These reasons may not attempt to disappear the traditional livelihoods of fishing communities, but precipitate the extinction of the Vaquita and threat to pauperize, and violent more and more, the society-nature relationship.

In this context, since 2017 CEDO coordinates a transdisciplinary strategy, whose preliminary results aim to consolidate a multi-sectoral and inter-community forum, capable to support cultural and environmental education activities and lead collective actions for the governance of the commons and promote rural development for the well-being, whose results measurable in the long-term will also be reflected in the protection of endemic species and the rehabilitation of the socio-ecosystem.

Robinson, J.W. [1]*, Gravem, S.A. [1], Raimondi, P.T. [2], Menge, B.A. [1]

ARE WE THERE YET? A COAST WIDE LOOK AT THE RECOVERY OF KEYSTONE FUNCTION TO SSWD, FIVE YEARS IN.

1 - Oregon State University, 2 - University Of California Santa Cruz

Sea star wasting syndrome (SSWS) caused mass mortality of sea stars along the U.S. West Coast in 2013 and 2014. Paine's (1966) classic keystone predation hypothesis predicts that decimation of *Pisaster ochraceus* should initiate coast-wide changes in community structure in the rocky intertidal low zone, with increases in mussels and reductions in low zone diversity. Five years later, sea star abundance has recovered at some sites along the coast. Has this recovery resulted in a rebound of its function as a keystone predator? In spring 2018, we initiated predator exclusion experiments at thirteen sites from southern California to central Oregon. At the termination of the experiment in fall 2019, results showed that rather than a uniform effect of strong keystone predation on communities along the coast, keystone effects varied among sites. We simultaneously quantified predation rate by *Pisaster* on mussels and found that sea star feeding rate also varied among sites. However, high predation rates did not uniformly correlate with strong keystone effects on communities. This lack of correspondence between the two experiments suggests that other factors such as the supply of mussel and barnacle recruits alters the keystone effects of *Pisaster* on intertidal communities.

Rogers-Bennett, L.*

MAKING HOLISTIC KELP FOREST ECOSYSTEM AND ABALONE RESTORATION PLANS CLIMATE SMART

Bodega Marine Lab, Uc Davis

Climate change will not only threaten marine ecosystems, the fisheries they support and other ecosystem services but will also pose significant challenges for ecosystem restoration plans. Ecosystems restoration will be more difficult if there have been abrupt (non-linear) changes to an alternative “stable state”. In northern California, sea star disease and a persistent marine heat wave combined to tip the robust kelp forests to purple sea urchin barrens. In Baja California Mexico, spatially patchy hypoxic events have killed nearshore kelp and invertebrate communities including abalone. Given these climate stressors, fishing pressures will need to be modified and restoration measures enhanced due to reduced productivity. Restoration site selection should be informed by temperature and oxygen data to ensure sites are suitable year-round or periodically have cool water and oxygen rich periods. The establishment of Marine Protected Areas can help to mitigate some stressors but not others. Sea urchin removal and ranching may need to be conducted to aid kelp ecosystem recovery. Starving abalone will need to be supported in captive rearing programs or mariculture to avoid mass mortality. Abalone reproduction and recruitment will need to be quantified and supported with stocking to support population persistence. The challenges presented by climate change to kelp forest and abalone restoration will require aggressive restoration actions that anticipate a warmer, more hypoxic, sea urchin dominated ecosystem to enact holistic, climate smart, ecosystem based restoration plans.

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ENVIRONMENTAL DRIVERS OF TOP-DOWN AND BOTTOM-UP INTERACTIONS

1 - NOAA Southwest Fisheries Science Center, 2 - University Of California, Irvine

The strength of top-down (TD) and bottom-up (BU) interactions are traditionally evaluated through manipulative experiments, but how trophic control varies through time in response to natural environmental fluctuations and across larger spatio-temporal scales is an open question. In this study, we used monthly time series data from 12 lakes (ranging from oligotrophic to eutrophic) to quantify how interactions between phytoplankton (chl-a) and zooplankton functional groups vary across lakes and through time within lakes. We analyzed the data using empirical dynamic modeling (EDM) to infer how chl-a and zooplankton growth rates vary in response to past chl-a and zooplankton abundances. This methodology produces estimates of TD and BU interaction strengths at each timepoint. We explored how these interaction strengths varied with nutrient enrichment, temperature, and other variables. We found that TD interactions were strongest at intermediate nutrient levels and that interaction strengths exhibited strong seasonality. Results indicate that the relative importance of TD and BU effects is not static, but varies with abiotic conditions.

Ruttenberg, B.I [1*], Stanchev, L. [1], Egbert, H. [1], Wolman, A. [1], Cline, D. [2]

USING MACHINE LEARNING TO IDENTIFY DEEP WATER BENTHIC ORGANISMS: A WEB-BASED TOOL TO FACILITATE ENVIRONMENTAL ANALYSIS

1 - Cal Poly State University, 2 - Mbari

Machine learning and artificial intelligence are rapidly changing how we deal with image-based datasets, allowing us to quickly extract ecological information that had been time-consuming for humans to process. California is exploring opportunities to develop offshore renewable energy capacity, but there are few data on the benthic communities such projects might impac, but permitting decisions will require surveys pre- and post-construction in challenging deepwater environments. Underwater video is a powerful tool to facilitate such surveys, but the interpretation of the imagery is costly and time-consuming. Emerging technologies have improved automated analysis, but the technologies are not yet accurate or accessible enough for widespread adoption. We develop a single web-based platform to facilitate all phases of analyses of video datasets. The tool allows users to 1) quickly and efficiently annotate video imagery using customizable lists to develop effective training datasets, 2) efficiently conduct quality control work on those annotations, 3) train, run, and evaluate specific artificial intelligence models that extract quantitative ecological data from video. Critically, the entire platform is web-based, allowing collaborators and users to work from anywhere, and the system is self-contained, requiring no additional software. Together, these advances will make the deployment of this tool more approachable for a wide-range of applications and end-users, especially those with little to no technical training in computer science.

†Ryder, A. [1*], Ward, M. [2], Oechel, W. [1], Edwards, M. [1]

EELGRASS BEDS OF SAN DIEGO BAY: CARBON SINK OR SOURCE?

1 - Sdsu, 2 - Uc-Davis/Sdsu

Urban areas are responsible for up to 70% of current greenhouse gas emissions and therefore there is a need to seek local solutions to combat this global challenge. Because coastal margins play a disproportionate role in oceanic carbon absorption, port cities like San Diego have a unique opportunity for climate mitigation by conserving these habitats. This study aims to quantify carbon fluxes in the San Diego Bay by measuring gross community production and respiration, and the resulting net community production (NCP) in eelgrass beds and unvegetated sediments. Here we present data from August 2018-August 2019 deployments at a site in the southern San Diego Bay, where eelgrass habitats are abundant. Benthic incubation chambers equipped with dissolved oxygen sensors were deployed for 24 hours in both eelgrass beds and unvegetated sediments. Water samples were collected at dawn, dusk, and prior to chamber removal the following day for carbon chemistry analysis. Our data indicate that these beds act as carbon sources, with negative NCP and increases in inorganic carbon during all months, though eelgrass beds were less of a carbon source than unvegetated sediments. These habitats were less of a carbon source in early spring than in late summer and winter, likely because of anomalously warm temperatures and bed senescence during the summer. Further research should be undertaken to determine the influence of site, water temperature, hydrodynamics, and anthropogenic impact, among other variables, on seagrass carbon metabolism.

†Ryznar, E.R.[*], Smith, L.L., Fong, P.

EVALUATING MECHANISMS FACILITATING THE INVASION SUCCESS OF SARGASSUM HORNERI AND THE RESILIENCE OF MACROCYSTIS PYRIFERA

Uc Los Angeles

Sargassum horneri, a brown alga, recently invaded the California coast. Despite its rapid spread, little is known about mechanisms facilitating success nor its impact on native species. We evaluated if herbivory and species interactions (*S. horneri* vs. *Macrocystis pyrifera*, a native foundation species) influence growth and survivorship of both species on subtidal reefs of Catalina Island. To assess herbivory, small (<10cm) stages of both species were caged or open to herbivory in the field. While both species were consumed, less of the invasive was eaten. Further, *S. horneri* grew faster than *M. pyrifera* when caged. To evaluate if species interactions enhance invasion success or recolonization by the native, we transplanted 3 sizes of *S. horneri* and 1 size (<10cm) of *M. pyrifera* into 3 sites: 1) *S. horneri* dominated, 2) *M. pyrifera* dominated, and 3) sparse algae. We monitored light and growth. All *S. horneri* sizes grew fastest in the bare site and slower in algal-dominated sites; overall, small *S. horneri* grew slowest. In contrast, all *M. pyrifera* lost biomass, regardless of site. Light levels were low in algal-dominated sites and high in the bare site. Taken together, our results suggest colonization into established beds of *S. horneri* or *M. pyrifera* by the opposite species is unlikely due to competition for light. Further, they imply that declines in *M. pyrifera* can facilitate the spread of *S. horneri* and herbivore preference for the native can further enhance *S. horneri* success. Thus, *S. horneri* may inhibit recovery of *M. pyrifera*.

†Salinas, H [*], Solana-Arellano, E

DYNAMIC SIMULATION OF A ZOSTERA MARINA MEADOW

Cicese

Seagrass meadows are economically and ecologically important areas, whose development is tightly regulated by the ambient conditions. For the number of factors that affect the development of seagrasses and their development, seagrass meadows are complex systems. A model that can account for the complexity of seagrass meadow dynamics could be of use in their study and conservation. Agent-based models (ABM) are a kind of computational model that has been used to simulate complex systems in ecology. Agent-Based models represent each component of a system and their actions, in this case, each individual of a population. The main goal of this study is to build, program and validate an ABM that describes the development of the Eelgrass (“Zostera marina”) meadow in the Punta Banda Estuary, Baja California. The propsed model was implemente in the programing language Python. The individuals simulated in the model as a hierarchical arrange of subunits: phytomers that form branches, which form individuals. The individuals of the model are programed to simulate horizontal growth, branching, asexual reproducción, ageing, and age-related mortality. The simulated processes correspond to a submodel, whose parameters were adjusted using Gibbs sampling. According to a Bayesian test analogous to ANOVA, there is no difference between simulated and observed terminal branch length. The model has an unexplored potential to study spatial or demographic growth patterns.

Samhouri, J.F. [1] [*], Feist, B.F. [2], Fisher, M. [2], Abraham, Briana [3], Forney, K [4], Woodman, Sam [4], Hazen, Elliott [1] [*]

THE ONLY CONSTANT IS CHANGE: HABS, CRABS, WHALES, AND FISHERIES IN THE CALIFORNIA CURRENT ECOSYSTEM

1 - NOAA Northwest Fisheries Science Center, 2 - University Of Washington, 3 - NOAA Southwest Fisheries Science Center

In some ways marine conservation has never been more successful. Threatened species of mammals in particular have benefited enormously from strong legislation mandating their recoveries. While this increase in population size is desirable from a conservation perspective, it can have unintended consequences for human activities such as shipping and fishing that operate in the same ocean waters. This presentation will provide an overview of the dramatic increase in whale entanglements in fishing gear in the California Current ecosystem over the last 5 years, and the unprecedented, ecosystem-based science and management efforts marshalled in response. We explore the potential for stakeholder-generated, spatial management measures to reduce both the ecological vulnerability of whales to entanglement and the social vulnerability of fisheries to forced, coastwide closures. These trade-off and scenario analyses are laying the foundation for forecasts of whale and fishing activity, and oceanographic conditions, that will enable managers to anticipate conflicts rather react to them after it is too late.

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EXTREME LIGHT REDUCTION IN THE UNDERSTORY OF GIANT KELP FORESTS CAN ACT AS A BARRIER FOR THE INVASIVE SEAWEED UNDARIA PINNATIFID

University Of Baja California

The Asiatic kelp *Undaria pinnatifida* is considered as highly invasive and a threat to native macroalgal assemblages worldwide. Nevertheless, the physiological plasticity behind its invasiveness capacity is largely unknown. Kelp monitoring programs in Baja California, Mexico, indicate that light availability within the native iconic Giant Kelp forests (*Macrocystis pyrifera*) determines the presence and growth of *Undaria* in their understory. To test this hypothesis and to obtain critical knowledge about the potential interaction between species, we performed a manipulative in situ experiment based on the transplantation of juvenile sporophytes of *Undaria* to the understory of a thriving forest, in order to assess their photo-acclimation capacities. After 7 days growing under very low light conditions (8% of the surface irradiance) we measured a wide range of photobiological descriptors and other biological traits such as nitrate uptake, oxidative stress, and growth. Our results demonstrated that *Undaria* was unable to adjust its photosynthetic efficiency, pigments content or its blade bio-optical properties. This low photoacclimative plasticity lead to severe plant carbon unbalance, a reduction in nitrate uptake capacity, and a general decrease in algae fitness. Our results highlight that the extreme light reduction caused by the canopy structure of dense/healthy Giant Kelp forests can constrain the development of *Undaria* in the understory, and hence its invasiveness capacity over these communities with key ecological and socio-economical values.

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FACTORS AFFECTING ENDANGERED SUAEDA CALIFORNICA ESTABLISHMENT AND USE AS HIGH TIDE REFUGE IN SAN FRANCISCO BAY

1 - Estuary & Ocean Science Center, San Francisco State University, 2 - Annapolis Field Station, Annapolis, Ca

Suaeda californica is a federally endangered coastal wetland shrub that occurs in a narrow high tide zone along salt marsh edges or estuarine beaches. The original native San Francisco Bay (SF Bay) population became extirpated around 1960. Plant material from Morro Bay was used to propagate and reintroduce *S. californica* to SF Bay in 1999, and roughly 30 total plants have survived until now. As these low numbers hardly represent a restored population of *S. californica*, and the plants have not successfully self-recruited from seed, research is needed to understand the best methods to restore *S. californica* populations. The objectives of this project are to 1) determine the effects of abiotic conditions, including freshwater availability and organic matter, on the germination of *S. californica*; and 2) evaluate the efficacy of “arbors” (various configurations of wooden branches as support) to enhance height growth of *S. californica*, which might enhance high tide refuge for endangered animals such as the Ridgway’s rail and the salt marsh harvest mouse. Results show that *S. californica* seeds have a higher germination rate when exposed to fresher water conditions and that experimental arbors do increase the height and size of plants in an SF Bay salt marsh. Understanding factors that promote *S. californica* reproduction, germination, and growth will aid future larger scale reintroduction efforts for this endangered plant while capitalizing on its potential to provide high tide cover for endangered and other wildlife in the face of sea level rise.

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NETWORK ANALYSIS OF LONG-DISTANCE MOVEMENTS IN THE GIANT MANTA RAY, MOBULA BIROSTRIS

1 - Pacific Manta Research Group, 2 - Pelagios Kakunjá, 3 - Manta Trust

The giant manta ray, *Mobula birostris*, is an economically important species supporting fisheries and tourism, particularly scuba diving, with a global distribution in tropical and subtropical waters. We studied the large-scale movement patterns of mantas at the Archipelago Revillagigedo (Socorro, San Benedicto, Clarion and Roca Partida), a cluster of volcanic islands located 390 km southwest of the tip of Baja California. The archipelago and its surrounding waters are protected under Mexican law as a National Park and as a UNESCO World Heritage Site. Due to their remote location and highly protected status, there is relatively little human activity at the islands, providing an opportunity to study low disturbance habitats and behaviors. We placed external acoustic tags on the dorsal surface of manta rays to track their movements at the Revillagigedos and Bahía de Banderas in the Mexican Eastern Pacific. Rays exhibited striking individual differences in propensity to travel. All individuals tracked showed a strong pattern of seasonal attendance at the islands with a lower detection rate during the summer. The network analysis shows differential movement frequency with the highest number of trips between sites occurring at San Benedicto. Multiple transits between the archipelago and the mainland were recorded, a distance of approximately 600 km.

†Scafidi, K.S.[*], Steele, M.A.

THE EFFECTS OF AN INVASIVE ALGA ON THE TROPHIC DYNAMICS OF TEMPERATE ROCKY REEFS

California State University, Northridge

Invasive species can alter habitats dramatically when they thrive in foreign conditions. *Sargassum horneri* is an invasive alga from the northwestern Pacific that is flourishing in the waters off Santa Catalina Island, California. The effects of this alga's presence on higher trophic levels, such as fish, is unknown. This study quantified the foraging rates of three common reef fishes (*Halichoeres semicinctus*, *Hypsypops rubicundus*, and *Semicossyphus pulcher*) and the abundance of small invertebrate epifauna the fish prey upon associated with understory algae, including *S. horneri*. Foraging observations were made via SCUBA at six sites along the leeward side of Catalina Island. Three of the most abundant native algae and *S. horneri* were collected at all six sites. Fishes foraged at higher rates among the native *Sargassum palmeri*, than the invasive *S. horneri*, even at sites with low algal diversity, and epifaunal abundance was greater on the native algae. Our results indicate that the invasive *S. horneri* negatively impacts the foraging of fishes, perhaps due to the low abundance of epifauna inhabiting this alga. These results suggest that the increasing prevalence of *S. horneri* on rocky reefs in southern California and Baja California may impact higher trophic levels in invaded ecosystems.

Schiel, D.R [1*], Alestra, T. [1], Gerrity, S. [1], Tait, L.W. [2]

LOSS OF ECOLOGICAL INFRASTRUCTURE AND RESILIENCE OF ALGAL COMMUNITIES FOLLOWING THE MW7.8 KAIKOURA EARTHQUAKE OF 2016

1 - Canterbury University, New Zealand, 2 - National Institute Of Water And Atmospheric Research, New Zealand

All communities rely on infrastructure for effective functioning. Since the 2016 Kaikoura earthquake, the ecological infrastructure of the nearshore zone has been severely compromised through the loss of biogenic habitat, poor recovery of key algal species from loss of population connectivity, and the interaction of altered physical properties of reef topography, temperature, sedimentation and light. Resilience of many species has been poor and recovery slow. Here we discuss these requisites of ecosystems and the prognosis of recovery of communities and functions along the 140 km of earthquake-affected coastline of the northeastern South Island.

Scott, A.R. [1*], Battista, T.A. [2], Blum, J.E. [3], Noren, L.N. [3], Pawlik, J.R. [3]

DEEP THOUGHTS: DOES SPONGE COVER INCREASE WITH DEPTH ON CARIBBEAN MESOPHOTIC REEFS?

1 - University Of California Davis, 2 - National Oceanic And Atmospheric Administration, 3 - University Of North Carolina Wilmington

Tropical mesophotic reefs (30–150 m) are an understudied ecosystem. It has been proposed that sponge abundance increases with depth through 150 m on reefs throughout the Caribbean (the ‘‘sponge increase hypothesis’’). A recent review concluded that there was not sufficient

evidence in the literature to support this hypothesis and that more quantitative studies are needed. In this study, percentage cover of sponges, macroalgae, and hard corals was estimated using images taken by remotely operated vehicles on mesophotic reefs off the coasts of Puerto Rico (to 180 m) and St. Thomas, and on the Flower Garden Banks (both to 100 m). Off Puerto Rico, sponge cover decreased with increasing depth below ~ 100 m, driven primarily by a decline in emergent (non-encrusting) sponge cover. Sponge cover did not change with depth off St. Thomas or on the Flower Garden Banks and was an order of magnitude lower on the Flower Garden Banks. The data from these three locations did not support the sponge increase hypothesis. Off Puerto Rico, cover of macroalgae decreased with depth in a manner similar to sponge cover, which may reflect a positive relationship between sponges and macroalgae in the lower mesophotic zone (> 100 m). Off St. Thomas and on the Flower Garden Banks, which were both shallower sites with more abundant macroalgae, sponge abundance was likely limited due to competition for space. Generalizations about patterns of sponge abundance across mesophotic depths await further studies, but our data suggest a depth-dependent relationship with macroalgal abundance.

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SHIFTS IN DOMINANT KELP FOREST SPECIES, MONTEREY BAY, CALIFORNIA

1 - Stanford University, 2 - Williams College, 3 - U.C. Santa Cruz, 4 - J.B. Phillips Historical Fisheries Project

A clear understanding of how marine biodiversity has changed over time is critical in the face of both local and global pressures from human activities. However, observations and scientific studies of marine life are often episodic and limited to a few years at the time. As a result, records of basic changes that have occurred to biodiversity and the environment are often missing. When baseline data are absent, the long-term local ecological knowledge of scientists, naturalists, and others can provide a powerful opportunity to understand the past. In an on-going project to reconstruct ecosystem changes in Monterey Bay, CA, we interviewed approximately 50 people who were students or researchers in Monterey Bay from 1938 to 2019. We document a marked change in the abundance of several species, including a shift in dominance from bull kelp (*Nereocystis luetkeana*) to giant kelp (*Macrocystis pyrifera*). This shift in the dominant kelp species occurred in the 1960s, following the return of sea otters to Monterey Bay. We will discuss these changes in terms of other historical records and in light of recent shifts in kelp species.

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SEASONAL UPWELLING INCREASES ALGAL COVER AND WEAKENS HERBIVORY ON PANAMANIAN ROCKY SHORES

1 - Smithsonian Tropical Research Insitute And Mcgill University, 2 - University Of Florida, 3 - Mcgill University, 4 - Smithsonian Tropical Research Institute

Seminal research on tropical rocky shores described a bare landscape dominated by encrusting algae and low fleshy macroalgal cover. The scarcity of fleshy algae was attributed to strong

top-down control by a diverse suite of consumers. That research, however, did not consider the influence of upwelling events which deliver deep, cold, nutrient-rich water to shallow coastlines, and can alter top-down control by marine grazers. The Pacific coast of Panama is exposed to seasonal upwelling events that generate seasonal and regional contrasts in near-shore hydrologic conditions, making it an ideal location to study the influence of oceanographic processes on tropical coastal ecosystems. We established herbivore exclusion experiments in six rocky intertidal sites nested within three regions exposed to different upwelling regimes. The experiments were repeated during two upwelling and two non-upwelling seasons, allowing us to explore temporal and regional variability in oceanographic conditions and herbivory. Our results indicate that upwelling activity has an important regulatory effect on herbivory and algal abundance on rocky shores along the Pacific coast of Panama. Herbivore effects declined during upwelling season within upwelling regions, while the strength of herbivory remained strong throughout the year in regions without upwelling activity. The temporal and spatial components of our research allowed us to show that temperature and nutrient availability can vary strongly in select tropical sites, leading to seasonality in top-down control by herbivores.

Shears, N.T. [1]*, Peleg, O. [1], Blain, C.O. [1], Allard, H. [1], Hanns, B. [1], Haggitt, T.R. [1], Babcock, R.C. [2]

LONG-TERM MARINE RESERVE PROTECTION UNEQUIVOCALLY DEMONSTRATES THE ECOSYSTEM-LEVEL CONSEQUENCES OF FISHING ON KELP FORESTS

1 - University Of Auckland, 2 - Csiro

It is 20 years since the long-term recovery of kelp forests was first documented in New Zealand’s oldest marine reserve (Babcock et al. 1999). Since this time, kelp forest ecosystems have been under increased pressure from a growing number of anthropogenic stressors including climate change. This raises questions as to the long-term value of marine protected areas (MPAs). We present twenty years of monitoring data across three long-established no-take MPAs in northern New Zealand to examine the role MPAs play in protecting kelp forest ecosystems. Biomass of predatory fish and lobster remain considerably higher in MPAs than in adjacent fished areas despite widespread collapse of adjacent fisheries. Within all three marine reserves kelp forests have now recovered on reefs previously dominated by urchin barrens, whereas on shallow fished reefs in all three locations urchin barrens and turfing algae remain dominant. Following recovery, kelp forests have remained stable in marine reserves, whereas fished reefs exhibited greater variability, fluctuating between urchin barrens, turfing algae and kelp forest at some sites. These long-term and contrasting patterns between fished and protected reefs unequivocally demonstrate the ecosystem-level consequences of fishing on kelp forests and how marine protection can promote recovery and increased resilience of kelp forests.

†Smith, J.G.*

A NEW HOPE? RECOVERY OF CENTRAL CALIFORNIA KELP FORESTS FOLLOWING DESTRUCTIVE SEA URCHIN GRAZING

University Of California Santa Cruz

Along California's Central Coast, active sea urchin grazing recently transformed expansive kelp forests to areas either entirely sea urchin "barrens", or to patchy mosaics of forest and barrens. In this study, I investigated two fundamental mechanisms for the recovery of kelp forests: (1) functional changes in urchin grazing behavior as a result of a shift in foraging modality (i.e., passive grazing on drift vs active grazing on live kelp) or movement, and (2) direct reduction of sea urchin density in barrens through mortality (as a result of predation, disease, or wave disturbance). Data on sea urchin density, size-frequency, and kelp density were collected through *in situ* field observations paired with 1m^2 photo quadrats. Photo quadrats were analyzed for the presence of exposed sea urchins and a universal-point-contact method was used to estimate cover of foliose algae. Results from three years (2016-2019) of extensive surveys indicate kelp forests recovered in barren patches following sea urchin movement to shallow water. *Nereocystis luetkeana* was the first habitat-forming kelp to colonize the deep water (15-20 meter) reef, followed by an understory stipitate (*Pterygophora californica*) and then *Macrocystis pyrifera*. The reduction of sea urchins in barren patches and the subsequent recovery of kelp forests appeared to be directly related to sea urchin movement and not mortality. These results suggest that movement of voracious grazers is an important factor for ecological resilience.

†Smith, N.S.[*], Côté, I.M.

BIOTIC RESISTANCE THROUGH FEAR OF PREDATORS ON CARIBBEAN CORAL REEFS

Simon Fraser University

Biotic resistance is the ability of a community to prevent or limit the success of non-indigenous species in novel environments. Typically, native species confer resistance by outcompeting or preying on non-native invaders. Here we ask whether fear of native predators can also provide biotic resistance. We use fishery-dependent diet studies and a field experiment on coral reef patches in The Bahamas to examine the consumptive and non-consumptive effects of native grouper predators on invasive, Indo-Pacific lionfish. Stomach content analysis of 200+ groupers revealed that direct predation is rare. We released tagged juvenile lionfish onto 11 reefs that varied naturally in grouper densities, and monitored lionfish behaviour over five weeks. At dawn, during peak grouper hunting times, small lionfish spent more time hiding, and thus less time feeding, on reefs with more groupers. There was no evidence of a trophic cascade: reduced lionfish predation on reefs with more groupers did not result in more lionfish prey. The seasonal peak in prey fish recruitment, which occurred during our study, might have masked the effects of lionfish predation. Fear of native predators by lionfish may reduce invader foraging success, but might not fully mitigate the effects of these invaders on native prey communities.

†Snyder, J.S.[1*], Bell, T.W.[1], Siegel, D.[1], Nidziedo, N.[2], Cavanaugh, K.[3]

SEA SURFACE TEMPERATURE IMAGERY ELUCIDATES SPATIAL NUTRIENT PATTERNS AND SERVES AS A TOOL FOR KELP AQUACULTURE SITING

1 - Earth Research Institute, University Of California, Santa Barbara, 2 - Department Of Geography, University Of California, Santa Barbara, 3 - Department Of Geography, University Of California, Los Angeles

Concentrations of nitrate, phosphate, and other nutrients can be limiting for kelp forest growth over seasonal to interannual time scales and can vary greatly across space, and this variability needs to be well understood if offshore kelp aquaculture is to be successful. It is also necessary to understand the appropriate spatial and temporal scale to observe these nutrient dynamics, as local circulation processes may play a critical role in nutrient delivery to aquaculture farms. Here, we use a combination of satellite imagery, *in situ* measurements, modeling, and known relationships between nutrient concentrations and kelp growth to estimate nutrient fields across multiple spatial scales (100 m to 25 km) and produce an optimal siting map for large, offshore aquaculture operations that could grow giant kelp for biofuel and other valuable products. Surface nutrient concentrations were modeled using daily sea surface temperature imagery at three spatial resolutions (25 km, 1 km, 100 m) using several satellite sensors including MODIS Aqua/Terra, AVHRR, VIIRS, and Landsat 8, and reveal zones with relatively high nutrient concentrations. Temperature to nutrient relationships were estimated from the empirical relationships between temperature and nitrate/phosphate measurements using generalized additive models, and cross validated with both offshore and nearshore *in situ* nutrient measurements. Finally, to determine the correct spatial scale of observation we performed a scaling analysis of the satellite-derived products in the Santa Barbara Channel.

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PLANNING FOR THE CONSERVATION OF THE WHITE SHARK (CHARCHARODON CARCHARIAS) IN MEXICAN WATERS: HOW ARE WE DOING?

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The white shark (WS, Carcharodon carcharias) is considered as threatened species in Mexico, and since 2014 a permanent fishing closure was established. Additionally, a seasonal moratorium on all shark landings was established, providing some additional protection for WS neonates. However, juveniles WS are incidentally caught by coastal artisanal fisheries along the western coast of the Baja California Peninsula and inside the Gulf of California, which could be affecting the part of the population that will be recruited to the adult population. Adults support a lucrative tourist diving industry in the Guadalupe Island Biological Reserve, in which the Mexican federal government has implemented several regulations to control this activity. In 2013, the National Commission for Natural Protected Areas (CONANP) promoted the development of an action plan for the conservation of this species. The plan contains six specific programs, including research, management, habitat protection, education, social interactions, and legal actions, including short, medium, and long-term goals. All authors have been involved

in achieving some aspects of one or more of these programs. We provide an update of our results, addressing the essential activities for the action plan, and efforts to continue minimizing the juveniles WS bycatch. Moreover, the challenges that we are confronting for conservation actions of this species in Mexican waters are discussed.

†Speare, K.E.*, Adam, T.C., Winslow, E.M., Lenihan, H.S., Burkepile, D.E.

CORAL BLEACHING DISPROPORTIONATELY AFFECTS THE SMALLEST AND LARGEST INDIVIDUALS

Uc Santa Barbara

Coral bleaching events are increasing in frequency and intensity worldwide, causing widespread coral mortality. We know that corals of different taxa differ in their susceptibility to bleaching, but bleaching may also disproportionately affect different sized corals within a genus or species. We investigated the relationship between colony size and bleaching-induced mortality following a severe, landscape-scale coral bleaching event in Moorea, French Polynesia in 2019. We assessed mortality across all size classes, from single-polyp recruits to the largest adult individuals for corals in the two dominant genera, Acropora and Pocillopora. We found that coral recruit morality was extremely high, with 98% mortality during this bleaching event, as compared to 67% mortality in a previous year. To assess mortality of juveniles (<5cm) and adult corals we quantified colony size, bleaching, and mortality for >2,700 individuals across 10, 15×1m belt transects. We found a strong, positive relationship between colony size and the percent of colonies with significant mortality (>50% colony mortality) for both Acropora and Pocillopora. For Pocillopora, mortality corals <10cm was low, with <2% of individuals with significant mortality. In contrast, >80% of individuals >35cm diameter had significant mortality. We show that bleaching may disproportionally affect the smallest and largest individuals in a coral assemblage, a grim prognosis for future coral reefs. As bleaching events increase in frequency, large, ecologically-important individuals will likely become less abundant.

†Spiecker, B.J.*, Menge, B.A.

EXPLORING SPATIOTEMPORAL VARIATION IN THE STRENGTH OF EL NIÑO ON OREGON INTERTIDAL KELPS

Oregon State University

Although the links between climate change and climatic patterns such as El Niño remain unclear, the impacts of El Niño events on coastal environments in the short-term likely mimic those of climate change in the long-term. Thus, El Niño can serve as a proxy for possible long-term ecological responses to an increasingly variable climate. Investigating how local processes modify the strength of El Niño on intertidal kelp communities across spatiotemporal scales is crucial to understanding our changing climate. After the 2015-16 Niño event, we monitored abundance, size and physiological performance of three common intertidal kelps (*Saccharina sessilis*, *Egregia menziesii*, *Postelsia palmaeformis*) across 300 km of the Oregon coast for three years. We found coastal upwelling, and by extension nutrient availability, plays a crucial role in modifying the strength of El Niño on the intertidal kelps. In the persistent upwelling region of southern Oregon, *S. sessilis* generally recovered faster with higher abundance, growth

and photosynthesis rate than in the intermittent upwelling regions of central and northern Oregon. However, the other intertidal kelps (*E. menziesii* and *P. palmaeformis*) experienced low abundance and high breakage in 2018, possibly from warming of the Oregon coast. Given the greater uncertainty associated with upwelling intensification in the California current and its biological implications, the findings could provide insights into how climate change influences the role of nutrient availability and temperature on the California Current Marine Ecosystem.

†Stark, K.A. [1*], Thompson, P.L. [1], Yakimishyn, J. [2], Lee, L. [3], O'Connor, M.I. [1]

BEYOND A SINGLE PATCH: LOCAL AND REGIONAL PROCESSES EXPLAIN DIVERSITY PATTERNS IN AN EPIFAUNAL SEAGRASS METACOMMUNITY

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Ecological communities are jointly structured by dispersal, environmental niche filtering, and biotic interactions. Metacommunity ecology provides a framework for understanding how these processes combine to determine community composition in sites that are connected through dispersal. We assessed the contributions of metacommunity processes to community structure in an important coastal habitat, seagrass meadows, across approximately 1000 km along the coast of British Columbia. We parametrized a hierarchical joint species distribution model describing the relationship between environmental conditions, spatial distance between sites, and random effects on epifaunal invertebrate species distributions across thirteen eelgrass (*Zostera marina* (L.)) meadows. Compositional similarity did not decrease at large spatial distances suggesting sites are well-connected by dispersal, but observed species distribution patterns suggested dispersal rates are not so high that they homogenize regional diversity. We found evidence of niche filtering in several species along an abiotic gradient; however, environmental conditions only explained a small fraction of the overall variation in species distributions, suggesting variable niche width among species and the contribution of processes other than niche filtering. This work has yielded refined hypotheses about the specific local and regional dynamics influencing seagrass epifaunal community structure, which in turn can inform targeted experiments, monitoring, and management decisions for preserving diversity in this important ecosystem.

Steller, D.L. [1*], Gabara, S.S. [2], Beckley, B.A. [3], Edwards, M.S. [3]

ECOSYSTEM UNDER DISTURBANCE: DIVERSITY OF SANTA CATALINA ISLAND RHODOLITH BEDS AND THE ROLE OF DEGRADED NURSERY HABITAT

1 - Moss Landing Marine Laboratories, 2 - San Diego State University, Uc Davis, 3 - San Diego State University

North Eastern Pacific (NEP) temperate rhodolith beds are diverse, complex benthic ecosystems ranging from Alaska to Bahía Magdalena, B.C.S., México. Globally, these beds of unattached, branching coralline algal nodules create a fragile ecosystem, often acting as nursery habitat. Santa Catalina Island supports numerous beds, all of which are threatened by intensive boat

mooring systems. Despite beds being within marine protected areas, the ecological role of Catalina Island rhodoliths is poorly understood. To characterize this ecosystem we 1) established metrics to describe spatial and temporal patterns of community variability among six Pacific rhodolith habitats at Catalina Island and 2) quantified population characteristics to identify species using beds as nursery habitat, 3) compared data to Méxican and other Pacific beds. Surveys of rhodolith characteristics, macroalgae, invertebrates and fishes were conducted in six rhodolith beds over three sampling periods. Rhodolith cover, heterogeneity and species abundances within beds were positively correlated suggesting that invertebrates and fish may associate with rhodoliths for habitat and food provision. Size frequency data suggests Catalina Island rhodolith bed habitats act as a persistent nursery grounds for the gastropod *Megastrea undosum* and the urchin *Lytechinus pictus*. While high in biodiversity, Catalina Island rhodolith beds are also the most disturbed along the Pacific coast. These results contribute to a growing body of work recognizing the diversity and fragility of this common Pacific marine ecosystem.

Stier, A.C. [1*], Osenberg, C.W. [2]

EXPANDING THE CORAL METAORGANISM TO INCLUDE CORAL ASSOCIATED FISHES AND INVERTEBRATES

1 - University Of California Santa Barbara, 2 - University Of Georgia

Historically our focus on symbiosis in corals has emphasized the linkages between the coral and the microorganisms that live inside or on the surface of coral (Symbiodinaceae, bacteria, and viruses): however less understood is how fishes and invertebrates living closely associated with corals affect coral growth, survival and condition. Here we present a comprehensive analysis linking the community structure of coral associated fishes and invertebrates to the tissue characteristics of the coral. Specifically, we link diversity, biomass, and composition of coral associated fishes and invertebrates to coral tissue biomass, lipid content, and microbial communities. We explore this link in Pocillopora corals in Moorea, French Polynesia, with particular emphasis on how coral size, amount, and, morphology, and configuration drive variation in coral associated fishes and invertebrates and consequently alter the coral tissue and Symbiodinaceae. These findings offer critical insight into how the loss and fragmentation of habitat may indirectly alter the resilience of corals by modifying the communities oof fishes and invertebrates living on the reef.

†Stockton, L.N.[*], Edmunds, P.J.

SPATIALLY AGGRESSIVE PEYSSONNELID ALGAL CRUSTS (PAC) CONSTRAIN CORALS TO DIADEMA GRAZING HALOS ON CARIBBEAN REEFS

California State University, Northridge

In recent years, peyssonnelid algal crusts (PAC) have expanded over hard surfaces on shallow reefs throughout the Caribbean. By depleting the settlement options for other benthic taxa, PAC accentuates the risks of declining population size for scleractinian corals. Although remaining low in density, current populations of *Diadema antillarum* may adopt important roles in promoting coral recruitment where the cover of PAC is reduced by grazing. On the shallow reefs of St. John, US Virgin Islands, aggregates of *D. antillarum* create grazing halos of bare space

and reduced PAC cover. Adjacent to these halos, PAC-dominated areas are associated with reduced densities of coral recruits. To test the hypothesis that the grazing halos provide ecologically important refuges for coral recruits, this study evaluated the distribution of corals in *D. antillarum* halos and on adjacent substrata as a function of PAC density (high vs low). Quadrats were placed within halos to quantify the density of scleractinians and were repeated on adjacent substrata outside halos; PAC cover was assessed in both locations. Within halos, mean densities of corals ranged from 10 colonies/0.25m^2 in PAC-free areas to 22 colonies/0.25m^2 in PAC-dominated areas. This pattern of distribution was reflected in a significant statistical interaction between *D. antillarum* clusters and PAC abundance for density of corals. If PAC continues to expand in coverage on Caribbean reefs, it will be important to observe mechanisms by which corals can recruit and survive on substrata depleted of suitable settlement areas.

Sullaway, G.H. [1*], Francis, T.B. [2], Samhouri, J.S. [1]

LANDSCAPE CONTEXT AND FISH LIFE HISTORY MEDIATE SHORELINE RESTORATION BENEFITS

1 - NOAA Nwfsc, 2 - University Of Washington, Tacoma

Valuable ecosystem processes provided by coastal ecosystems are often degraded by urbanization and human development. Specifically, seawalls, riprap and other hard structures, often referred to as shoreline armoring, decrease biodiversity and abundance along the associated intertidal. In an effort to mitigate negative impacts of shoreline armoring, resources have been increasingly dedicated to restoration projects. While the benefits of restoration have been well documented for beach and intertidal zones, less is known about impacts on subtidal habitat function and use by nearshore species. Our study aims to address these knowledge gaps by evaluating the effectiveness of shoreline restoration projects, specifically in the context of nearshore salmon and forage fish. We conducted nearshore surveys in Puget Sound, WA for two years along restored, armored and natural shorelines to estimate presence of seven forage and salmonid species. We found that forage fish were 5-11 times more likely, and salmon species twice as likely, to be found along natural or restored shorelines than developed shorelines. Spatial patterns in species presence leads us to hypothesize that these patterns may arise from variation in fish life history and the larger landscape context of the study site. We qualitatively evaluate how these mechanisms may drive observed patterns of habitat use. Overall, out study indicates that restored shorelines are preferentially used by forage fish and salmon and may be critical for the continued recovery of these species.

†Sura, S.A.[*], Fong, P., Lloyd-Smith, J.O.

A FUNCTIONAL GROUP MODEL DEMONSTRATES KEY HERBIVORE GUILDS SHAPE THE RESILIENCE OF CORAL REEF ECOSYSTEMS

Ucla

Coral reefs are shifting from healthy to degraded states due to natural and anthropogenic disturbances. For effective management, it is critical to know whether these shifts are smooth, threshold responses or bifurcations indicating alternative stable states (ASS). Herbivorous

fishes promote healthy reefs by consuming algae, and empirical evidence demonstrates functionally diverse fish communities are important. However, herbivore functional diversity is often missing in models testing for ASS. We incorporated herbivore functional groups (grazers, browsers, generalists) into a coral reef model to determine how this affects model predictions of the impact of fishing pressure on coral reef health and resilience. Our model predicts that herbivore community composition and fishing pressure interact to determine conditions that support a healthy coral reef state. A healthy reef is promoted by herbivore functional complementarity. However, as fishing pressure increases, functional redundancy becomes important for supporting a healthy reef. Herbivore community composition can interact with types of algal cover to affect conditions supporting healthy reef states. Also, depending on which herbivore group is dominant, reefs will exhibit bistability and hysteresis for varying ranges of fishing pressure. Overall, incorporating functional groups into coral reef resilience models provides novel insights about which functional groups are more important for healthy reefs and what conditions will cause bistability and hysteresis.

Swezey, D.S. [1*], Boles, S.E. [2], Aquilino, K.A. [3], Bush, D. [4], Rogers-Bennett, L. [5], Whitehead, A. [2], Sanford, E. [3]

LOCAL ADAPTATION? OCEAN ACIDIFICATION DIFFERENTIALLY AFFECTS SURVIVAL OF TWO POPULATIONS OF RED ABALONE

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Absorption of anthropogenic CO_2 by oceans is reducing the average pH of the marine environment, i.e. ocean acidification (OA). This process is dynamic, with coastal upwelling processes creating a mosaic of pH conditions along the west coast of North America. In regions of low pH, marine populations may be locally adapted to such conditions and potentially pre-adapted to future OA. We compared responses to OA among two different populations of the red abalone (*Haliotis rufescens*); one that experiences high levels of upwelling and low associated pH (Mendocino Coast) and one that experiences less intense upwelling and higher pH (Santa Barbara Channel). Animals were cultured from embryos to post settlement juveniles under both contemporary pH values (8.0 pH, 400 µatm CO_2) and more acidic conditions (7.6 pH, 1200 µatm CO_2). Mendocino abalone exhibited elevated maternally provisioned lipid concentrations during larval and post-settlement phases and grew more slowly than the Santa Barbara (SB) population. High CO_2 did not reduce survival in the Mendocino population, whereas the faster growing SB population experienced a 40% reduction in survival. Experiments on SB F2 generation animals generated similar results. Notably, a minority of family lineages from SB were resilient to OA, with no significant increase in mortality under low pH exposure. Our results suggest that OA-resistant growth strategies and genotype combinations exist within the red abalone metapopulation, which may be adaptive in future environments.

Szuta, D. [1]*, Miller, S. [2], Martinez-Flores, L. [3], Zilliacus, K. [3], Croll, D. [3], Steller, D. [1]

LOGS FROM THE SEA OF CORTEZ: ESTIMATING DIET PREFERENCE OF HAWKSBILL SEA TURTLES FROM FORTUITOUS FECAL FINDS

1 - Moss Landing Marine Laboratories, 2 - Florida State University, 3 - University Of California Santa Cruz

Determining prey selection of threatened marine reptiles is key to understanding habitat protection that may enhance population recovery. The Hawksbill sea turtle (*Eretmochelys imbricata*) is a critically endangered species, with the eastern Pacific population as the most threatened one. Although many studies have shown that hawksbills forage on sponges in reef systems, the eastern Pacific population is known to spend extensive periods in mangrove estuaries. Among other potential uses, it is likely that hawksbills use mangrove estuaries as foraging habitat, but globally mangroves are experiencing unprecedented losses. The objective of this study was to use fecal samples to identify the diet of hawksbills utilizing mangrove habitat. Here, we analyze the composition of 13 fecal samples of Hawksbill turtles found fortuitously by divers on the benthos (2-6 m depth) of a mangrove estuary on Isla San Jose, Sea of Cortez, Mexico between 2016 and 2018. The primary components of the fecal samples were sponges (44.2%), followed by colonial tunicates (21.7%), mangrove roots (15.3%), algae (12.0%), sediment (4.2%), and other invertebrates (0.7%). Our data suggest that mangrove estuaries are key foraging areas for Hawksbill turtles in the Sea of Cortez, with species of sponge and tunicate as primary dietary components. We will combine these data with turtle tracking data to identify other key foraging areas within the Sea of Cortez to help inform spatial management strategies in the region.

Teague, C.H.*, Tissot, B.N., Craig, S.F.

ABALONE AND URCHIN POPULATION CHANGES ON SHALLOW ROCKY REEFS ALONG CALIFORNIA’S NORTH COAST

Humboldt State University

Northern California rocky reefs have been undergoing rapid changes in recent years following the marine heatwave of 2014 to 2016 and the prevalence of seastar wasting syndrome beginning in 2013. Red abalone (*Haliotis rufescens*), purple urchin (*Strongylocentrotus purpuratus*), and brown macroalgae populations have been under particularly close scrutiny following the closure of the recreational red abalone fishery beginning in 2018. Here we report results from the first six years of a marine protected area monitoring program that spans from the California-Oregon border to Mendocino County. Mean densities of red abalone have declined sharply over the study period while purple urchin abundance has increased rapidly. These changes seem to be strongest at the southernmost survey sites and in relatively shallow depth zones. Additionally, we examine the potential effects of a commercial urchin removal project at one Mendocino County site that began in 2018. While we observed an overall decline in purple urchin densities at this site, the effects seem to be highly localized. The results from these monitoring efforts will help to better understand the spatial and temporal complexity of these population changes across the North Coast.

†Tedford, K.N.[*], Castorani, M.C.N.

RESTORING VIRGINIA'S OYSTER REEFS: ENVIRONMENTAL CONTROLS ON OYSTER RECRUITMENT, GROWTH, AND SURVIVAL ACROSS SPATIAL SCALES

Department Of Environmental Sciences, University Of Virginia

Oyster reef restoration has the potential to improve the conservation status of depleted oyster populations while enhancing water quality, shoreline protection, biodiversity, and fisheries production. However, oyster restoration has experienced mixed success and lacked clear conclusions on the importance of oyster recruitment, growth, and survival. We carried a series of large-scale field experiments examining the relative importance of abiotic and biotic factors in determining the success of Eastern oysters (*Crassostrea virginica*) on restored reefs. We tested how tidal height, reef substrate, and broad-scale environmental variables interact to structure oyster recruitment, growth, and survival within coastal lagoons of the Eastern Shore of Virginia, site of the Virginia Coast Reserve Long-Term Ecological Research project. We measured the density and size of oysters recruiting to ceramic tiles across two years at 14 reefs spanning 22 km. In the first year, recruitment density was higher at sites with stronger flows and lower water-residence times. At most sites, recruitment peaked in June to July. We also carried out predation trials to assess how juvenile and adult oyster survival varied by tidal height and reef location. Survival was higher in adults compared to juveniles and on reefs in the inner bay for juveniles and outer bay for adults. Results from this study reinforce the importance of habitat connectivity and arrangement within a reef system and help to better understand how abiotic and biotic factors structure oyster populations and mediate restoration success.

†Torres, V.A. [1*], Wood, C.L. [2], Guerra, A.S. [1]

IS SOCIALITY CORRELATED WITH PARASITE BURDEN IN ACANTHURUS TRIOSTEGUS?

1 - University Of California, Santa Barbara, 2 - University Of Washington

Although social behavior has the potential to both increase and decrease the parasite burden of individual hosts, the links between sociality and parasitism remain little explored. I sought to understand how group size is related to parasite species richness and burden in convict tang (*Acanthurus triostegus*). I found that increasing group size was associated with diminishing parasite burden for two trematode taxa and one cestode taxon, but increasing parasite burden for one monogene and one nematode taxon. Two other nematode taxa were not affected by group size. Group size was unrelated to raw parasite taxon richness and the jackknife estimate of parasite taxon richness. The encounter-dilution effect could explain why increasing group size decreases the burden of larval trematodes. Dietary differences between solitary and social fish could explain why the burden of cestodes decreases with increasing group size while the burden of one nematode taxon increases with increasing group size. This dietary difference is probably a difference in the rate of consumption of certain prey rather than a wholesale difference in prey types because, while parasite abundances were significantly altered by group size, parasite taxon richness was not.

Traiger, S.B. [1*], Hirsh, H.K. [2], Cohn, B.C. [1], Panos, D. [1], Takeshita, Y. [3], Mucciarone, D.A. [2], Dunbar, R.B. [2], Nickols, K.J. [1]

BIOLOGICAL CONTRIBUTIONS TO BIOGEOCHEMICAL VARIABILITY OF KELP FOREST HABITATS

1 - California State University Northridge, 2 - Stanford University, 3 - Monterey Bay Aquarium Research Institute

Biogeochemical conditions are shifting with climate change, with expected decreases in pH and dissolved oxygen (DO) concentrations. Giant kelp may locally increase DO and pH due to their large, productive canopy, which also alters hydrodynamic conditions. Work by our group suggests that biogeochemical differences in the upper water column inside and outside of kelp forests are more pronounced in surface waters. Here, we investigated the contributions of the kelp canopy and phytoplankton to biogeochemical variability in surface waters. We deployed pH, DO, and temperature sensors inside and outside of two kelp forest sites during the summers of 2018 and 2019. We also collected twice-weekly discrete samples of dissolved inorganic carbon, particulate organic carbon (POC), and chlorophyll. Inside the kelp forest surface DO rose above subsurface levels from mid-day to early evening. Outside, DO rose above subsurface levels on an event-scale, corresponding with phytoplankton blooms. POC was generally lower inside the kelp forest, indicating that kelp rather than phytoplankton drives diel patterns in surface DO in the kelp forest. The upper few meters of the water column were usually more thermally stratified within the kelp forest than outside. This is likely due to the presence of the canopy increasing water residence time and reducing turbulent mixing, allowing more time for warming as well as for kelp to modify surface biogeochemistry. The combination of the kelp canopy productivity and its physical structure may play an important role in surface biogeochemical variability.

†Turba, R. [1*], Milne, H. [2], Onate, M. [3], Shapiro, B. [4], Jacobs, D. [1]

USE OF MUSEUM MATERIAL TO RECONSTRUCT THE EXTIRPATED FAUNA OF THE LOS ANGELES RIVER

1 - University Of California, Los Angeles, 2 - University Of Washington, 3 - Fulgent Genetics, 4 - University Of California, Santa Cruz

After regional extirpation, museum samples usually provide the only source of data, including genetic data, with direct implications for conservation and restoration planning. For those to be successful, we need a clear understanding of what has been lost. Museum material stored at the Natural History Museum of Los Angeles County was used to investigate extirpated populations of unarmored threespine stickleback, a species of freshwater unionid mussel, and an extinct and endemic species of shrimp that were all previously found in major drainages of the Los Angeles Basin. This work explores available protocols that were successful in the extraction of nuclear and mitochondrial genomes from museum tissue, including shells. Both fish and shrimp were preserved in 10% buffered formalin for an unknown period followed by storage in ethanol, and mussels were stored dry. The amount of endogenous DNA recovered varied between specimens and species suggesting quality of preservation and genomic resources are more relevant than specimen age or even fixation method. I was able to recover

23% of the stickleback nuclear genome, and the mussel's mitochondrial genome with 0.2X coverage. The shrimp was the least successful, but it is also the one with a distantly related reference genome. Further extractions and sequencing will allow the historical genetic information of the stickleback and unionid mussel to be incorporated in population genetics analysis to uncover their relationship to current populations and allow for appropriate "re-wilding" of the Los Angeles impacted systems.

Uyeda, K.A.*, Mccullough, J., Almeida, M., Thygersen, A., Ahmad, M., Warner-Lara, L., Crooks, J.A.

MONITORING LONG-TERM CHANGES IN LOW MARSH VEGETATION ASSOCIATED WITH SEDIMENT ACCRETION AT THE TIJUANA ESTUARY

Tijuana River National Estuarine Research Reserve

The lowest elevations of California and Baja California salt marshes are often colonized by monospecific stands of cordgrass, *Spartina foliosa*. This species provides important nesting habitat for the federally endangered light-footed Ridgway's Rail (*Rallus obsoletus levipes*). At the Tijuana Estuary, the low marsh has been subject to persistent sediment input from the Tijuana River and its sub-watersheds, as well as episodic sedimentation events that can dramatically increase marsh elevations in a single water year. We observed consistent indicators of increased elevations in what had historically been S. foliosa-dominated salt marsh in vegetation mapping records from 1986, long-term vegetation monitoring transects visited annually since 1989, and sediment accretion records beginning in 1992. Specifically, we found evidence of narrowing of channels, replacement of *S. foliosa* with species typically found higher in the salt marsh (e.g., *Salicornia pacifica*), and steady continuation of accretion rates. While sea level rise associated with global climate change is expected to shift distributions of salt marsh plants upwards, at the Tijuana Estuary the effects of sea level rise are being counteracted by sedimentation. Beyond causing shifts in habitats, this sedimentation is also compromising estuarine functioning by decreasing tidal exchange with nearshore waters. This highlights the need for restoration work that simultaneously recovers lost habitats and enhances ecosystem resilience by increasing tidal prism.

†Uyeoka, A.K.*, May, M.A., Brewster, R., Tomanek, L.

THE EFFECT OF UPWELLING STRESSORS ON OXIDATIVE STRESS PROTEIN ABUNDANCE IN *MYTILUS CALIFORNIANUS*

California Polytechnic State University

Though several studies focus on the benefits of upwelling, there is evidence suggesting that strong upwelling has detrimental effects on animal fitness. This study investigates the protein response of an important ecosystem engineer, *Mytilus californianus*, to upwelling-related hypoxia and cold temperatures. Oxidative stress pathways are known to be upregulated in organisms experiencing changes in both temperature and oxygen. Low oxygen and cold temperatures, typical of an upwelling event, were administered to 600 California mussels for 48 hours in tidal simulators. Two hours after lowering temperature from 16C to 10C and oxygen from 6mg/L to 2.5 mg/L, mussels were dissected at 3-h increments over 48 h and the gill tissue

was flash frozen for subsequent protein analysis. We used western blots to determine the relative abundance of two proteins that play important roles in regulating the oxidative stress response, the mitochondrial sirtuin 5 (SIRT5) and Cu/Zn superoxide dismutase (SOD1) at 6 h and 30 h into stress. In cold stressed mussels, SIRT5 abundance decreased when compared to the controls. However, the opposite was the case for SOD1 abundance, which was higher in control mussels. These data show that the SIRT5 and SOD1 pathways display opposite responses to upwelling conditions, suggesting that the pathways may not be directly linked.

†Velasco, M.F. [1]*, Ramírez, G. [2], Hollarsmith, J.A. [3], Reyes, H. [1]

FISH ASSEMBLAGES IN SUBTROPICAL MESOPHOTIC ECOSYSTEMS ACROSS TWO DIFFERENT ECOREGIONS

1 - Universidad Autónoma De Baja California Sur, 2 - Ciencias Biológicas Del Noroeste, 3 - Simon Fraser University

Knowledge of biodiversity at mesophotic depths including endemism, status of targeted species, and resilience, is limited throughout Mexican Pacific, and it is thus not incorporated into conservation management. Hence, our study aims to describe and compare the community structure and functional diversity of fishes at depths ranging from 12 to 94 m in continental islands (Espíritu Santo and Cerralvo) and oceanic islands (San Benedicto, Socorro, and Clarión) in the Mexican Pacific during Fall 2018. We used a ROV to record 81 video-transects of five minutes each. In each of them, we determined the fish species, species richness, taxonomic diversity, trophic level, and functional richness using presence data. We found that continental islands have higher species richness and a more uneven taxonomic tree, although oceanic islands are more taxonomically diverse, with a higher trophic level and functional richness. San Benedicto and Socorro showed a higher number of species, greater functional richness, and greater taxonomic diversity, in contrast to Clarión, Espíritu Santo, and Cerralvo. Nonetheless, we observed more functional entities on Espíritu Santo, which allowed a greater volume, meaning that less niches are unused. Although trophic level didn't vary statistically, oceanic islands showed higher values, which implies less fishing pressure on high trophic levels. We conclude that, based on taxonomic diversity and trophic level, oceanic islands are healthier and more pristine than their counterpart. However, Espíritu Santo offers more ecological services and resilience.

†Venkataraman, Y.R.*, Roberts, S.B.

INFLUENCE OF OCEAN ACIDIFICATION ON PACIFIC OYSTER DNA METHYLATION

University Of Washington

As negative effects of ocean acidification are experienced by coastal ecosystems, there is a growing trend to investigate the effect of ocean acidification has on multiple generations. For example, temporarily exposing adult Pacific oysters (*Crassostrea gigas*) to low pH prior to gametogenesis affects larval abundance. The documented effect on Pacific oyster larval abundance indicates a potential role for epigenetic modifications, specifically DNA methylation, in response to ocean acidification. To assess how ocean acidification affects the oyster epigenome, DNA was extracted from adult oysters exposed to either low pH (7.31 ± 0.02) or

ambient pH (7.82 ± 0.02) conditions for seven weeks. Whole genome bisulfite sequencing was used to identify methylated regions. The predicted function of genes containing differentially methylated loci location suggests a role for DNA methylation in acclimating to adverse conditions. Understanding a possible mechanism for phenotypic plasticity and acclimation across generations is valuable when considering organismal ability to persist in the face of environmental change.

†Vilalta, A. [1*], Beas, R. [1], Calderon, L.E. [2], Ladah, L.B. [2], Lorda, J. [3], Malpica, L. [1], Micheli, F. [4], Torre, J. [5], Zepeda, J.A [3]

A MASS-BALANCED FOOD WEB MODEL FOR A KELP FOREST ECOSYSTEM NEAR ITS SOUTHERN DISTRIBUTIONAL LIMIT IN THE NORTHERN HEMISPHERE

1 - Uabc-Iio, 2 - Cicese, 3 - Uabc, 4 - Standford University, 5 - Cobi

Coastal ecosystems are influenced by a suite of drivers and interactions, resulting in complex dynamics not captured by single species. Kelp forest ecosystems of the California Current region are subject to extreme environmental variability as well as a suite of fishing pressures, which remove organisms throughout the food web. We built a mass-balanced model of a kelp forest ecosystem near the southern limit of distribution in the northern hemisphere (Isla Natividad, Mexico). The model is informed by extensive ecological monitoring of fish, benthic invertebrates, and macroalgae obtained through 10-year, allowing the results of the model to be more precise and realistic. We unified two different techniques of ecological monitoring and models that are often used to improve the knowledge of the structure of ecosystems. In this study we estimated energy flow within functional groups, as well as the direct and indirect interactions between them and between the fishing fleets. This has led to a greater understanding of a complex coastal ecosystem with great potential to inform conservation measurements and better management practices. Based on this model, a dynamic phase is being generated that allows seeing space-time changes of the species. We are also developing a historical study of the biomass flows of the kelp forests around the island as background and for a better understanding of the functioning of that ecosystem. The objective is to better inform the cooperatives of the state of the ecosystem and provide feedback on the model with their responses.

Vilas, C. [1*], Bergeijk, S. [1], Gonzalez-Ortegon, E. [2], Baldo, F. [3], Llope, M. [3], Ramos, F. [3], Simon, F. [4], Vasseur, D. [4], Cañavate, J.P. [1]

ECOSYSTEM FUNCTIONING OF A TEMPERATE ESTUARY AND IMPLICATIONS ON PELAGIC FISHERIES MANAGEMENT: GUADALQUIVIR LTER 1997-2019

1 - Ifapa-Andalusian Institute Of Agrarian And Fishing Research-Spain, 2 - Marine Science Institute Of Andalucia-Icman-Csic, Spain, 3 - Spanish Institute Of Oceanography Ieo-Cadiz, Spain, 4 - Department Of Ecology & Evolutionary Biology - Yale University

Estuaries play an important role as nursery grounds for many marine species. The Guadalquivir estuary (sw Spain) is an Essential Fish Habitat for many commercial species in the Gulf of Cadiz. We show ecosystem functioning after been studied through a Long Term Ecological Research program by monthly samplings since 1997, recording oceanographic and climatic

variables, trophic web links, community structure and population dynamics. It shows high biodiversity (>350 species) and productivity, where mysids are key species in the estuarine food web as main prey for early life stages of marine crustaceans and fishes, especially for European anchovy *Engraulis encrasicolus* and Iberian sardine *Sardina pilchardus*. Both are abundant forage fishes of great ecological and economic importance for the Gulf of Cadiz marine ecosystem. Long time series analysis and GAM modelling of both estuary and fisheries datasets show how damming of the Guadalquivir river (since 1930) results in reductions in freshwater discharge and changes from the historical seasonality, which have led to decreases in anchovy and sardine juveniles in the estuary through cascading up by reduction of mysids, hence influencing recruitment and evolution of fisheries biomass stocks in the Gulf of Cádiz. By considering, the socio-economic-ecological impacts of different management strategies, we show that terrestrial and marine resources cannot be continued to be managed independently without negative consequences, for either industry, and propose an Integrated Ecosystem Management for the region

†Wang, J.[*], Manahan, D.T.

PHYSIOLOGICAL PROCESSES UNDERLYING FOOD CONVERSION EFFICIENCY DURING GROWTH OF SEA URCHIN LARVAE

University Of Southern California, Department Of Biological Sciences

The rate and efficiency with which larval forms of marine invertebrates process food has important implications for their ecology and recruitment. While it is well established that protein is a major biomass component of early stages of development, our understanding remains scant regarding the endogenous processes that regulate whole-body protein content – namely, protein synthesis and degradation. We examined the protein metabolic dynamics in larvae of the sea urchin (*Strongylocentrotus purpuratus*) reared under constant food environments. A series of integrated measurements of feeding, protein accretion, synthesis, and turnover were undertaken during larval growth. Notably, the rate of protein synthesis exceeded that of protein accretion and protein ingestion, highlighting the importance of protein turnover as a key endogenous regulator of growth. Defining the physiological mechanisms that result in stage-specific differences in food conversion efficiency will increase understanding of larval biology in a changing ocean.

†Weigel, B.L. [1*], Pfister, C.A. [2], Mark Welch, J.L. [3], Ramirez-Puebla, S.T. [4], Altabet, M.A. [5]

FROM MICRO TO MACRO: BACTERIAL COMMUNITIES AND NUTRIENT CYCLING ASSOCIATED WITH BULL KELP BLADES

1 - Committee On Evolutionary Biology, University Of Chicago, Chicago, Illinois, Usa, 2 - Department Of Ecology And Evolution, University Of Chicago, Chicago, Illinois, Usa, 3 - Marine Biological Laboratory, Woods Hole, Ma, Usa, 4 - Marine Biological Laboratory, Woods Hole, Ma And The Forsyth Institute, Cambridge, Ma, Usa, 5 - School For Marine Sciences And Technology, University Of Massachusetts, Dartmouth, Bedford, Ma, Usa

Canopy-forming kelp are the largest and most productive macroalgae in coastal ecosystems, yet little is known about their associated bacterial communities. We characterized microbial

communities living on blades of the bull kelp *Nereocystis luetkeana* with next-generation Illumina sequencing of 16S rRNA genes and CLASI-FISH imaging. Kelp blades host a dense microbial biofilm, which is shaped by both geographic location and blade tissue age. At the micron-scale, the kelp biofilm displays repeatable spatial structure, with tightly clustered cells of the dominant symbiont *Granulosicoccus sp.* and filamentous *Bacteroidetes* cells protruding out of the biofilm. Microbial cell density and diversity increased from young to old blade tissues throughout the summer growing season. Microbial communities were also characterized from healthy vs. stressed kelp populations on the outer coast of Washington and in southern Puget Sound, revealing significant differences in the abundance and composition of microbial communities between sites. To begin to understand nutrient cycling functions associated with kelp and their microbial symbionts, we used a dual stable isotope tracer experiment (^{13}C-bicarbonate and $^{15}NO_3$) to examine carbon fixation and dissolved organic carbon production by *N. luetkeana*, as well as microbial nitrogen cycling on kelp blade surfaces. Given the immense surface area of kelp forests, metabolic exchanges between kelp and their associated microbes may have far-reaching impacts on kelp forest productivity and coastal nutrient cycling.

Wells, C.D. [1*], Leray, M. [2]

DNA METABARCODING PROVIDES INSIGHTS INTO THE DIVERSE DIET OF THE GIANT PLUMOSE ANEMONE *METRIDIUM FARCIMEN*

1 - University At Buffalo, 2 - Smithsonian Tropical Research Institute

Benthic suspension feeders can have significant impacts on plankton communities by depleting plankton or by modifying composition of the plankton through prey selectivity. Quantifying diets of planktivorous animals can be difficult as plankton can lack diagnostic characters as larvae and are digested at variable rates. With the use of DNA metabarcoding, the identification of taxa within gut contents has become faster and more accurate, and allows for higher taxonomic resolution while also identifying rare and highly degraded items. We used DNA metabarcoding to examine the diet of the giant plumose anemone *Metridium farcimen*, a large, abundant, competitively-dominant anemone in the northeast Pacific Ocean. Gut contents were compared to concurrent, nearby plankton samples. The objectives of this study were both to determine if *M. farcimen* has a selective diet and to compare our findings with published, traditional gut content analyses. *M. farcimen* captures a wider range of prey than previously suspected and metabarcoding can find many more taxa than traditional sampling techniques. There were no overrepresented taxa in the gut contents compared to the plankton but there were many underrepresented taxa indicating that many species can escape predation or are too small to be detected. This study highlights the need for consideration of space and time in a sampling regime and the usefulness of the metabarcoding method in identifying prey within the gut of planktivorous animals.

†Wetmore, L.S. [1*], Anderson, T.W. [1], Hastings, A. [2]

A BEHAVIORALLY MEDIATED TROPHIC CASCADE PREDICTED BY SEA STAR WASTING DISEASE IN CALIFORNIA KELP FORESTS

1 - Department Of Biology And Coastal And Marine Institute, San Diego State University, 2 - Department Of Environmental Science And Policy, University Of California, Davis

Non-consumptive predator-grazer interactions have been suggested as critical regulatory mechanisms maintaining algal production within kelp forest food webs. However, ecosystem-level impacts of prey behavior in subtidal systems have proved difficult to quantify at large spatiotemporal scales. In 2015, the widespread outbreak of sea star wasting disease along the California coast presented a unique model system to evaluate the impacts of reef-scale predatory *Pisaster* removal on the grazing behavior and life history characteristics of resident subtidal turban snail populations (*Tegula spp.*) in the field. Based on the behavioral and physiological responses of *Tegula* to localized sea star extinctions observed during our empirical study, we developed a set of novel dynamic population models assessing the potential for predator removal events in this system to drive cascading grazing impacts on lower trophic levels. In all models, snail mortality rates were held constant so that only non-consumptive predator effects were considered. Results indicate that even historically low densities of sea stars can potentially maintain strong behaviorally mediated regulation of snail grazing activity, resulting in local stabilization of primary producers (i.e. giant kelp, benthic understory algae). However, when resident sea star populations were entirely extirpated, food web dynamics became unstable, and overutilization of slow-growing benthic algae resulted in population crashes and kelp forest loss in nearly all model scenarios, particularly under suboptimal environmental conditions.

Wetzer, R. *

WHY STOP AT THE BORDER: SPHAEROMATID ISOPODS, A CASE STUDY

Natural History Museum Of Los Angeles County

In 2018 the Western Association of Marine Laboratories (WAML) launched an initiative to increase participation and interaction among it members. WAML includes non-profit marine laboratories operated by federal, state, university and other non-profit organizations in the Western United States and Pacific Islands. The goal of this initiative is to improve the invertebrate library for the West Coast. This library would consist of high quality specimens with comprehensive locality data that would be available for both morphological and genetic study. To launch and initially focus the effort only a few taxa were targeted. Sphaeromatid isopods was one of the taxonomic groups targeted. Specimen contributions from British Columbia, Canada, and U.S.A. to the Mexican border revealed the expanding range of some non-native species, genetic diversity not previously recognized for other clades, and provided insights into the latitudinal diversity of others. Colleagues from south of the U.S.A.-Mexican border are encouraged to participate in and benefit from this collaborative effort.

Whalen, M.A. [1*]**, Starko, S.** [2]**, Lindstrom, S.C.** [3]**, Martone, P.T.** [3]

COMMUNITY-LEVEL RESPONSES OF INTERTIDAL SEAWEEDS TO A MARINE HEATWAVE IN CENTRAL BRITISH COLUMBIA

1 - Hakai Institute, 2 - University Of Victoria, 3 - University Of British Columbia

Among the most concerning recent news in marine science concerns population and ecosystem responses to acute increases in temperature, or marine heatwaves. Known impacts of marine heatwaves include changes in population size and structure, range shifts, and species replacements for one or a few species within an ecosystem, but we have yet to adequately explore how marine heatwaves affect entire assemblages. We utilize a nine-year time series of intertidal seaweed cover across three sites at high taxonomic resolution from Calvert Island, British Columbia, Canada, to explore the impacts of a recent wide-ranging heatwave – the 'blob' of 2014-2016. We find that while local species richness remained relatively stable throughout the time series, total algal cover fluctuated greatly, decreasing during the heatwave at all sites and rebounding afterwards at most. Assemblages changed in a variety of ways, from largely oscillatory dynamics in low intertidal and wave-exposed areas to more directional trajectories in high intertidal wave-protected areas. Across >100 species of seaweed and invertebrates, we found several taxon-specific responses during the heatwave, with sessile invertebrates being more sensitive to winter temperature anomalies and seaweeds to summer anomalies. Our results support growing evidence that ecological impacts of climate disruptions are dependent on existing spatial heterogeneity in the environment, and the varied responses we document across species suggest that predictions around ecological responses to abiotic stress may require updating.

White, C.[*], Walter, R., Ruttenberg, B., Wang, Y-H., Han, D., Kehrli, M., Hamilton, S.

TRADEOFF ANALYSIS INFORMS SPATIAL PLANNING OF OFFSHORE WIND ENERGY FARMS IN RELATION TO FISHERIES AND SEABIRDS

Cal Poly

California has an ambitious plan to develop renewable energy, and the Central Coast is being pursued by industry for developing offshore wind farms. This region also hosts a vibrant fishery and biodiverse marine ecosystem that could be impacted by wind farms. We analyzed spatially-explicit empirical atmospheric, economic, and biological data to estimate tradeoffs between electrical power gains possible from developing wind farms along the Central Coast and impacts the farms could have on fisheries revenue and seabird populations. We compared potential development locations, including the Morro Bay and Diablo Canyon Call Areas designed by BOEM, and identified those that best mediate tradeoffs among energy, fisheries, and seabird conservation objectives. We found large variation in potential gains and impacts across the domain, indicating ample opportunity to mediate tradeoffs with strategic spatial planning. Locations farther from shore mediate the tradeoffs best by allowing for both higher power production and lower fisheries and seabird impacts. Compared with areas we identify, neither Call Area is optimally located or configured for mediating the tradeoffs; however, both are better than more nearshore areas. Morro Bay mediates the power-fisheries tradeoff better than Diablo Canyon; it remains uncertain if one better mediates the power-bird tradeoff. More complete seabird data and more recent fisheries data would increase the precision and utility of our results for informing the evaluation and potential implementation of optimal offshore wind farms in Central California.

White, J.W. [1*], Yamane, M. [1], Caselle, J.E. [2]

ESTIMATING FISHERY HARVEST RATES TO ASSESS THE EFFICACY OF MARINE PROTECTED AREAS IN THE SANTA BARBARA CHANNEL ISLANDS

1 - Oregon State University, 2 - University Of California Santa Barbara

No-take marine protected areas (MPAs) are expected to increase the abundance of resident populations of previously-harvested species. Whether an MPA achieves this expectation is typically evaluated by assessing trends in abundance after implementation. However, the underlying assumption that harvest has actually ceased is rarely tested directly. Determining whether harvest has continued in an MPA is important to planning enforcement actions and to interpreting trends in abundance and biomass in an adaptive management context. Here, we estimated harvest rate for four kelp forest fish species inside MPAs and at non-MPA reference sites in the California Channel Islands. We were able to estimate harvest rates by fitting a size-structured population model to time series of subtidal diver surveys of fish size and abundance collected by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) at each site. Data spanned 2003 (when MPAs began) to 2017. Overall, we found that harvest rate (measured as the instantaneous rate *F*) was effectively zero in reserves and varied from near zero to greater than one (in units of year^{-1}) in reference sites. This indicates successful adherence to MPA regulations, and possible displacement of fishing effort to reference sites. However, a greater-than-zero harvest rate was found in one MPA site, highlighting the importance of assessing this quantity in an adaptive management context. Ongoing implementation of this modeling approach could provide a tool to complement the long-term management of MPA networks.

White, W. [1]*, Desantiago, R. [2], Long, J.D. [1]

SARGASSUM HORNERI INVASIONS SHIFT GRAZING ONTO NATIVE BENTHIC SEAWEEDS IN INTERTIDAL COMMUNITIES RECEIVING KELP SUBSIDIES

1 - San Diego State University, 2 - San Diego State University, Uc Davis

Species' ranges are shifting as climate change and humans introduce species into previously unoccupied regions. These range shifts could create opportunities for new interactions between species. Although important ecological theories (e.g. Enemy Release Hypothesis, Evolution of Increased Competitive Ability) benefited by studying such novel interactions in a pairwise fashion, less is known about how range shifts could impact the broader native plant community. For example, invasions may replace high preference natives with low preference invasives, thereby shifting herbivory onto other intermediate-to-high preference natives. We tested this hypothesis by asking how the current invasion of *Sargassum horneri* in Southern California could impact grazing on three other intertidal seaweeds via replacing kelp wrack– a high preference food source. Recent reports suggest that such impacts are possible given the negative impacts of *Sargassum* on kelp. We compared grazing by a realistic herbivore assemblage on agar-based foods made from two seaweed assemblages – one containing palatable native kelp and one replacing kelp with unpalatable invasive *Sargassum*. As predicted, this replacement shifted consumption onto the other natives, particularly the high preference seaweed, *Silvetia compressa*. This shift could fuel invasional meltdowns by reducing the abundance of native species, thereby increasing a community's susceptibility to future invasions.

†Williams, M.K.[*], Edmunds, P.J.

EFFECTS OF INTERSPECIFIC COMPETITION BETWEEN INCREASINGLY DOMINANT PEYSSONNELID ALGAL CRUST (PAC) AND SCLERACTINIANS

California State University, Northridge

In light of the increasing effects of climate change on coral reefs, understanding the roles of competitive interactions between corals and other taxa has become a priority as these communities shift from spatial dominance by scleractinians to other taxa. Recently, encrusting macroalgae described as “peyssonnelid algal crust” (PAC) have increased in abundance on shallow reefs throughout the Caribbean, due in part to their strong capacity for rapid growth and spatial competition. The objective of this study was to evaluate the role of PAC in driving changes in coral community structure on Caribbean reefs. On the shallow reefs of St. John, US Virgin Islands, the cover of PAC was affected by wave exposure and depth, with PAC covering 64% of reef surfaces at 3 m depth in exposed sites, but 48% at 3 m depth in sheltered sites, and within the exposed site, 64% at 3 m depth and 35% at 9 m depth. Independent of depth or wave exposure, PAC was growing on top of coral in 78% of PAC-coral interactions. To investigate the consequences of these interactions, we tested the effects of PAC on the growth of juvenile massive *Porites* spp. placed in contact with PAC. The experiment was conducted in the back reef of Moorea, French Polynesia, using PAC-coral interactions staged on tiles grown on a common garden. The growth of massive *Porites* was unaffected by contact with PAC over 3 weeks. These results suggest that the current success of PAC on Caribbean reefs may be more strongly mediated by rapid overgrowth and smothering of corals than their indirect effects in depressing coral growth.

†Wright, D.[1*], Professor Giacomo Bernardi[1], Professor Sophie Von Der Heyden[2]

CORRECTING THE COUNT: SPECIES RICHNESS REVISITED IN SOUTH AFRICA’S ROCKY INTERTIDAL

1 - University Of California, Santa Cruz, 2 - University Of Stellenbosch

Genetic cryptic species show no apparent morphological distinctions but are genetically as differentiated as other recognized species. The presence of cryptic species necessarily reduces species richness measures which, in South Africa, are the primary metric for prioritizing protection. Here, I present a combination of mitochondrial markers and genome-wide nuclear SNPs that separate 2 species of South African intertidal fishes (Muraenoclinus dorsalis, Clinus superciliosus) into 3 and 2 clades (genetic cryptic spp.) respectively. Samples were collected from the coasts of South Africa and Namibia (M. dorsalis N=48, 5 locations: C. superciliosus N=56, 9 locations). DNA for mitochondrial and SNP analyses were extracted from the same individuals. Mitochondrial markers were targeted using universal primers and amplified with PCR. A panel of 10k SNPs was produced using RADseq protocol. Admixture was analyzed and phylogenetic trees were generated and compared. The resulting trees were in complete concordance between the mitochondrial markers and SNPs placing all individuals into matching clades. The results from the admixture analysis further support this finding delineating individuals into 5 genetic groups. Two sample locations near the Cape Peninsula were sympatric, with individuals from multiple clades, but this finding will need to be validated with

additional samples and the cause of reproductive isolation explored. These findings promote further genetic investigation of species to understand how genetic cryptic speciation has arisen in this sympatric system.

†Yeager, M.E.*, Gouhier, T.C., Hughes, A.R.

EFFECTS OF SPATIOTEMPORAL CHANGES IN CONSUMER FUNCTIONAL DIVERSITY ON ECOSYSTEM STABILITY AND FUNCTIONING

Northeastern University

One of the reasons for preserving biodiversity is that increasing species richness will result in more functional roles within a community, potentially creating more productive and stable ecosystems. However, when examining functional roles, species may overlap in their functional traits (FTs), resulting in more functionally redundant communities. This may dictate the relationship between ecosystem functioning and stability, as more redundant communities may provide lower ecosystem functioning but be more stable to disturbances. Here we examined 13 FTs of fish consumer communities in Rhode Island coastal ponds, based on three functional roles: energy acquisition, locomotion, and nutrient recycling, to test the effects of functional diversity and redundancy on ecosystem functioning and stability. We fit GAMs to our 13 FTs and used these models to predict FTs based on species identity and length in a six-year fish survey. We calculated two multivariate functional diversity metrics: richness and redundancy, as well as ecosystem functioning and temporal stability of fish biomass to examine spatiotemporal changes in functional diversity and whether a stability-functioning tradeoff exists due to functional redundancy. Functional richness differed across time and space while redundancy was high for all communities. Both functional richness and redundancy were positively correlated with ecosystem function and stability resulting in no trade-off. These results suggest that highly redundant communities may be more resilient to disturbance while maintaining high ecosystem production.