SYMPOSIUM

on Science in Support of Archipelagic Management

I pono ka 'ike i ke kumu

The value of the knowledge is found at the source.

November 19 - 20, 2018
Ala Moana Hotel

PROGRAM

Photo by Greg McFall/NOAA

Symposium on Science in Support of Archipelagic Management

November 19 - 20, 2018 • Ala Moana Hotel

November 19, 2018

8:30 am **Check In**

9:00 am **Opening Oli and Welcome**

9:15 am **Keynote - Documenting the Global Biodiversity Library: Exploration and Discovery on Deep Coral Reefs - Dr. Rich Pyle**

10:00 am Predators, Genetics, and Climate Change: Prioritizing Conservation Actions for Endangered Hawaiian Tree Snails - Melissa Price

10:15 am Spatially quantifying and attributing 17 years of vegetation and land cover transitions across Hawai`i - Matthew Lucas

10:30 am Weaving Together Cultural and Natural Resources - Joey Latsha

10:45 am **Break**

11:00 am Ensuring long-term survival of Papahānaumokuākea Marine National Monument's three endemic songbirds through monitoring, habitat management, and translocation - Sheldon Plentovich

11:15 am Assessing past, present, and future impacts of sea-level rise at Lalo, Papahānaumokuākea - Chip Fletcher

11:30 am Population Genetics of the Band-rumped Storm Petrel (*Oceanodroma castro*), an Endangered Hawaiian Seabird - Carmen Antaky

11:45 am Developing Ecosystem Metrics of Plastic Ingestion by Hawaiian Seabirds - David Hyrenbach

12:00 pm **Lunch**

1:00 pm Over 40 Years of Hawaiian Green Sea Turtle Research: Using Current Trends and New Research to Better Predict the Honu Population's Resiliency to Climate Change - Marylou Staman

1:15 pm A Historical Review of Commercial fishing Around French Frigate Shoals and its Possible Effect on the Hawaiian Monk Seal - Frank Parrish

1:30 pm A seal-eyed view of the underwater habitats of the Hawaiian Archipelago - Stacie Robinson

1:45 pm Long Term Acoustic Monitoring of Cetaceans in the Pacific Islands - Ann Allen

2:00 pm HICEAS 2017: A Six Month Ship-Survey of Cetaceans and Seabirds throughout the Hawaiian Archipelago - Kym Yano

2:15 pm An Acoustic Survey of Beaked Whale and Kogia in the Main Hawaiian Islands Using Drifting Recorders - Jennifer Keating

2:30 pm Discovery of a Western North Pacific Humpback Whale (*Megaptera novaeangliae*) Breeding Area in the Mariana Archipelago - Marie Hill

2:45 pm Three Frontiers in Conservation Genetics: Case Histories from Hawaiian waters - Brian Bowen

3:00 pm **Break**

3:15 pm Population Genomics at the Archipelago Scale: Applications, (Reduced) Costs, and Value to Conservation of Hawai'i's Biodiversity - Evan Barba

3:30 pm Assessing the vulnerability of marine life to climate change in the Pacific Region - Jonatha Giddens

3:45 pm New Marine Geological Maps Reveal the Complexity and Deep-sea Habitability of the Northwestern Hawaiian Ridge - John Smith

4:00 pm Identifying and Characterizing High-Density Coral and Sponge Communities on Deep Seamount Ridges Within Papahānaumokuākea Marine National Monument - Chris Kelley

4:15 pm A Characterization of Mesophotic Reef Fish Assemblages of the Papahānaumokuākea Marine National Monument - Randy Kosaki

4:30 pm American Samoa's Coral Diversity and Mesophotic Zone - Anthony Montgomery

4:45 pm Deep and Deeper: Invertebrate Composition from Meso- to Subphotic Depths - Elena Conser

5:00 pm **Reception & Poster Presentations**

7:00 pm **Closing**

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8:30 am **Check In**

9:00 am **Opening Oli**

9:15 am **Keynote - NOAA Science in the Northwestern Hawaiian Islands prior to Papahānaumokuākea Marine National Monument - Dr. Mike Seki**

10:00 am Maritime Cultural Seascape of the Pacific Remote Islands Marine National Monument - Jesi Bautista and Savannah Smith

10:15 am Probability-based Sampling Surveys of Stony Coral Populations in the Northwestern Hawaiian Islands - Dione Swanson

10:30 am Integration of Structure-from-Motion Photogrammetry into the Reef Assessment and Monitoring Program - Atsuko Fukunaga

10:45 am **Break**

11:00 am Unexpected genetic structure in corals; implications for conservation and management. - Zac Forsman

11:15 am Lab Rat or Shapeshifter? Genetic Identification Reveals Frequent Misidentification of Pocillopora Corals Throughout the Hawaiian Archipelago - Rob Toonen

11:30 am Mass coral bleaching due to unprecedented marine heatwave in Papahānaumokuākea Marine National Monument - Courtney Couch

11:45 am Exploring Coral Reef Disturbances with 3D Reconstruction Tools - John Burns

12:00 pm **Lunch**

1:00 pm Investigating natural and anthropogenic drivers of coral diseases in the Hawaiian archipelago - Jamie Caldwell

1:15 pm Partitioning of *Symbiodinium* Clades in the Coral *Montipora capitata* Across Shallow Reefs of the Remote Northwestern Hawaiian Islands - Christopher Wall

1:30 pm Comparing Watershed Health and Development with Adjacent Coral Reef Conditions to Prioritize Coastal Protection and Restoration in Hawai'i - Iain Caldwell

1:45 pm Cryptofauna Distribution and Detection along the Hawaiian Archipelago - Molly Timmers

2:00 pm Marine Alien Species Distribution and Management in the Papahānaumokuākea Marine National Monument - Brian Hauk

2:15 pm The Theory of Resistance to Marine Bioinvasions in Tropical Systems: Is Hawai'i an exception? - Scott Godwin

2:30 pm West Hawaii Ichthyoplankton Project: Exploring a Unique Ecosystem and Their Impact on Larval Fish Ecology - Jonathan Whitney

2:45 pm Lessons learned from data-limited stock assessments of coral reef fish in the central and western Pacific - Marc Nadon

3:00 pm **Break**

3:15 pm Metabarcoding as a Tool to Examine Herbivore Diets and Inform Management - Eileen Nalley

3:30 pm From spawning to settlement: describing dispersal and connectivity in the Convict Tang, *Acanthurus triostegus*, across archipelago and island scales - Richard Coleman

3:45 pm Effects of SCUBA Exhaust on Fish Surveys in a Large Remote Marine Protected Area - Keolohilani Lopes

4:00 pm Sub Regional Comparison of the Life History Parameters for a Deep-Water Snapper within the Hawaiian Archipelago - Ryan Nichols

4:15 pm Impact of Exploitation Evident in Age-based Demography of the Deepwater Snappers *Pristipomoides flavipinnis* in the Samoa Archipelago and *P. auricilla* in the Mariana Archipelago - Joseph O'Malley

4:30 pm Global Genetic Inventory of the Silky Shark: A Local Shark with a Fishing Problem - Derek Kraft

4:45 pm Challenges in Monitoring and Managing Large Marine Fishes: Lessons from the Galapagos Archipelago - Adam Smith

5:00 pm **Closing**

Long Term Acoustic Monitoring of Cetaceans in the Pacific Islands

*Ann N. Allen[1], Karlina P. Merkens[2], Simone Baumann-Pickering[3], Erin M. Oleson[1]

[1]NOAA NMFS Pacific Island
[2]Contractor for PIFSC, Lynker Technologies LLC
[3]Scripps Institution of Oceanography
*Presenter

The Pacific Islands Fisheries Science Center maintains the Pacific Islands Passive Acoustic Network (PIPAN) of ocean floor-mounted acoustic recorders in order to monitor the cetacean species of the Pacific Islands. Since recording began in 2007, PIPAN sensors have been placed at 13 different locations in the central and western Pacific, including sites in the Hawaiian Islands, Wake Atoll, Palmyra and Kingman Reef, and the Northern Mariana Islands. Sound is recorded up to either 100 kHz or 160 kHz. This broadband sampling encompasses both the low frequency vocalizations of baleen whales and the high frequency echolocation clicks of odontocetes. Six sites have been maintained for at least 5 years, with the Hawaii Island and Pearl and Hermes Reef dataset spanning 12 and 9 years, respectively. Although many analysis efforts have been specific to a species, location, or time period, over the past few years we have focused on understanding temporal and geographic patterns of occurrence throughout the network for species often difficult to monitor using other methods. These analyses include a mixture of manual and automated detection methods and have focused on deep-diving cetaceans such as beaked whales, sperm whales, and dwarf and pygmy sperm whales, as well as species of management concern, such as false killer whales, humpback whales, and others. The extended dataset from some sites now allows for examining trends in occurrence and their relation to changing anthropogenic activity. The PIPAN dataset is a valuable tool in evaluating and effectively managing the protected cetacean of Pacific Island waters.

Population Genetics of the Band-rumped Storm Petrel (*Oceanodroma castro*), an Endangered Hawaiian Seabird

*Carmen C. Antaky[1], Emily E. Conklin[2], Robert Toonen[2], Ingrid Knapp[2], & Melissa R. Price[1]

[1]Department of Natural Resources and Environmental Management, University of Hawai'i at Mānoa
[2]Hawai'i Institute of Marine Biology, University of Hawai'i at Mānoa
*Presenter

The Hawaiian Band-rumped Storm Petrel ('Akē'akē; *Oceanodroma castro*), listed in 2016 as federally Endangered, nests in remote locations that are difficult to access and spends most of its life at sea. As such, very little is known about movement among islands and the potential for establishing new breeding colonies in managed areas with predator controls. As a first step in assessing connectivity, in this study we evaluated patterns in genetic diversity between populations on two islands known to host breeding populations. Blood or feather samples were collected from breeding colonies on Kaua'i and Hawai'i Island. Kaua'i and Hawai'i Island represent the northern and southern extent of the main Hawaiian Islands, and are approximately 300 miles apart. We performed next-generation sequencing on pooled samples from each island. Results indicated moderate genetic differences between populations and higher genetic diversity than expected. Despite their Endangered status and indication of population loss, this study suggests genetics of *O. castro* in the Hawaiian Islands currently do not warrant management concern. Findings from this study can be used to inform seabird conservation efforts in Hawai'i.

Population Genomics at the Archipelago Scale: Applications, (Reduced) Costs, and Value to Conservation of Hawai'i's Biodiversity

*Evan W Barba[1], Emily E Conklin[1], Zac H Forsman1, and Rob J Toonen[1]

[1]Hawai'i Institute of Marine Biology, University of Hawai'i at Mānoa
*Presenter

Geographic remoteness and barriers to geneflow in the Hawaiian Archipelago introduces crucial challenges that must be considered for management at the population scale. Understanding how genetic exchange between populations varies across the entire archipelago is key to identifying hotspots of diversity, sinks and sources for the next generation, and regions potentially predisposed to resiliency. Single marker studies offer insights, but some also argue that these approaches may be missing subtle patterns or even misleading due to under sampling of the genome. Relying solely on single markers can also limit the ability to detect some important aspects of biology (such as male mediated dispersal). Next generation sequencing (NGS) tools allow us to examine a wider scan of the entire genome that can provide finer scale resolution and improve confidence in defining management boundaries. However, the cost of genome scans per individual is considerably higher in comparison to single marker studies, and we need to know if that additional investment is worthwhile. Pooled sequencing (pool-seq) approaches offer a compromise that may be particularly well suited for gathering population genetic information across many individuals and broad geographic areas. Pool-seq approaches start with small tissue samples from multiple individuals, from which DNA is extracted and then pooled by location, thereby drastically reducing sequencing costs. When site-level, rather than individual, patterns are of interest, this pool-seq approach provides very fine resolution information at a fraction of the cost to facilitate management decisions regarding the conservation of marine resources across the Hawaiian Archipelago.

A Maritime Cultural Seascape of the Pacific Remote Islands Marine National Monument

*Jesi Q. Bautista[1], *Savannah J. Smith[1]

[1]Kupu, Pacific Islands Regional Office, National Oceanic and Atmospheric Administration
*Presenter

The Pacific Remote Islands Marine National Monument (PRIMNM, Monument) is one of four Pacific Marine National Monuments co-managed by the National Oceanic and Atmospheric Administration. The PRIMNM, consisting of Howland, Baker and Jarvis Islands, Wake, Johnston and Palmyra Atolls, and Kingman Reef, is a unique marine protected area because of its remote and widespread distribution across the central Pacific Ocean. Compared to Papahānaumokuākea, Marianas Trench, and Rose Atoll Marine National Monuments, people's historical connections to the PRIMNM have been less documented. A deeper understanding of the Monument's maritime cultural heritage is vital for the protection and management of its natural and cultural resources. Through archival research, interpreting people's connections and interactions with this seascape is an instrumental step to support further research, inform management, and engage the public. Over a four month period, initial archival and literary research was conducted at the Hawai'i State Archives, Bernice P. Bishop Museum Archives, Hawaiian and Pacific Collections at University of Hawai'i at Mānoa, and online archival and newspaper databases. Resources gathered at these sites have been documented to develop an inventory of maritime cultural resources, historical events and personal accounts before the 1900s. Further analysis of these resources will lead to the production of detailed narratives and an extensive bibliography of sources for each PRIMNM location. By understanding people's connection to place, this research can be utilized as a powerful tool to better inform management of the Monument's resources.

Three Frontiers in Conservation Genetics: Case Histories from Hawaiian waters

*Brian W Bowen[1]

[1]Hawai'i Institute of Marine Biology, University of Hawai'i at Mānoa
*Presenter

The scientific field of conservation biology is dominated by three specialties: phylogenetics, ecology, and evolution. Under this triad, phylogenetics is oriented towards the past history of biodiversity, conserving the divergent branches in the tree of life. The ecological component is rooted in the present, maintaining the contemporary life support systems for biodiversity. Evolutionary conservation is concerned with preserving the raw materials for generating future biodiversity. Advances in all three domains can be documented with genetic case histories in the waters of the Hawai'i. This review includes cases that demonstrates 1) phylogenetic studies have identified previously unknown species that are endemic to Hawaiian waters; 2) population genetic surveys reveal management units as isolated marine ecosystems and islands, and 3) phylogeographic analyses illustrate the pathways of colonization into Hawai'i. Over the last three decades, genetic studies in Hawai'i have advanced all three domains in conservation biology, and recent genomic technologies are especially valuable for monitoring and managing the marine biodiversity of Hawai'i.

Exploring Coral Reef Disturbances with 3D Reconstruction Tools

* John H. R. Burns[1], Courtney Couch[2,3], Atsuko Fukunaga [2,4], Randall K. Kosaki[4]

[1]Marine Science Department, University of Hawai'i at Hilo
[2]Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa
[3]NOAA/Pacific Islands Fisheries Science Center, Ecosystem Sciences Division
[4]NOAA Papahānaumokuākea Marine National Monument
*Presenter

The structural complexity of reefs plays a major role in the biodiversity, productivity, and functionality of coral reef ecosystems. A three-dimensional (3D) approach can better quantify topography, rugosity and other intricate structural characteristics that play an important role in the ecology of coral reef communities. Structure-from-Motion (SfM) provides an effective photogrammetric method for high-resolution 3D topographic reconstruction. We have been applying SfM photogrammetry techniques to create 3D reconstructions of coral reefs throughout the the Papahānaumokuākea Marine National Monument, which encompasses the Northwestern Hawaiian Islands and is one of the largest marine conservation areas in the world. Creating 3D maps of long-term monitoring sites has enabled us to conduct temporal analyses to explore the impacts of natural disturbances on the volume and 3D architectural complexity of coral communities. This work captured the impacts of severe coral bleaching at Lisianski, where mean coral cover at monitoring sites decreased by 68% due to severe losses of *Montipora dilatata* complex. Structural and volumetric analyses of 3D reconstructions from these sites found significant and rapid reductions in 3D habitat complexity that was directly correlated with loss of live coral. Continued analyses since the mortality event have shown reef habitat volume to be diminishing as the dead coral substrate erodes, and several phases of macroalgal cover have been documented. Applying SfM technology to reef monitoring has improved our ability to quantify how these disturbance events affect coral reef communities in the Northwestern Hawaiian Islands.

Comparing Watershed Health and Development with Adjacent Coral Reef Conditions to Prioritize Coastal Protection and Restoration in Hawai'i

*Iain R. Caldwell[1], Ku'ulei S. Rodgers[1], Paul L. Jokiel[1], Erik C. Franklin[1]

[1]Hawai'i Institute of Marine Biology, School of Ocean and Earth Science and Technology, University of Hawai'i at Mānoa
*Presenter

Land use change can indirectly impact other nearby ecosystems, affecting areas far beyond their relatively localized, direct impacts. In Hawai'i, the idea that watershed activities can affect adjacent coral reefs has long been recognized, with land once managed in ahupua'a land divisions extending from the mountains to the sea. Scientific studies have quantitatively demonstrated such links between landscapes and seascapes in Hawai'i and elsewhere. In this study, we expanded upon and refined past efforts to identify landscape-seascape connections. We used satellite-derived land cover/land use data to calculate terrestrial indices of health (Watershed Health Index) and development (Landscape Development Intensity), and created predictive models of coral reef health components (fish abundance, fish diversity, fish biomass, coral diversity, and coral cover) to extend marine health estimates (Reef Health Indices) to all watersheds in the Main Hawaiian Islands. We also explored factors that could account for differences in the strength of watershed-reef connections among watersheds (e.g. island, amount of effluent, wave energy). When we compared the two terrestrial indices with the marine health index, most watersheds fell within the pattern expected: healthier coral reefs tend to be adjacent to healthier and less developed watersheds and vice versa. Such watersheds should be prioritized for protection (if healthy and/or less developed) or restoration (if unhealthy or highly developed), since land activity is reflected in adjacent reefs. Watersheds that did not fall within the expected pattern also yield potentially useful management information (e.g. prioritizing marine over terrestrial conservation where watersheds are healthy but reefs are unhealthy).

Investigating natural and anthropogenic drivers of coral diseases in the Hawaiian archipelago

*Jamie M. Caldwell[1,2], Greta S. Aeby[3], Scott F. Heron[3,4,5], C. Mark Eakin[3], Bernardo Vargas-Angel[6], Megan J. Donahue[1]

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[2]Department of Biology, Stanford University, USA
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[4]NOAA Coral Reef Watch, 5830 University Research Court, College Park, MD, USA
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[7]NOAA Ecosystem Science Division, USA
*Presenter

A variety of coral diseases have been reported across the Indo-Pacific in both highly-disturbed and near-pristine areas, indicating that a combination of natural and anthropogenic conditions likely contributes to disease onset. In this study, we estimated the effect of hypothesized climate, physical, environmental, and anthropogenic drivers on disease risk using coral health observations from 18 islands and atolls in the Hawaiian archipelago between 2004 and 2015. We found that the conditions associated with disease risk differ between two common disease types: growth anomalies and tissue loss diseases, and, relative disease risk can also differ for the same disease type affecting different coral species. These results indicate that similar disease lesions on different coral species could be caused and transmitted by different pathogens and/or processes. By assessing broad spatial and temporal trends in background levels of coral disease, we are beginning to understand natural and anthropogenic drivers specific to different coral species and diseases. We are now building on this research by developing dynamic, forecasting tools for coral disease risk in Hawai'i, the Pacific Remote Islands, American Samoa, and the Great Barrier Reef. Given recent mass bleaching events in Hawai'i and globally, predictive models of disease risk specific to different diseases, host species, and locations could be particularly useful for monitoring and managing coral health in the near future.

From spawning to settlement: describing dispersal and connectivity in the Convict Tang, *Acanthurus triostegus*, across archipelago and island scales

*Richard R. Coleman[1,2], Derek W. Kraft[1], Robert J. Toonen[1], Brian W. Bowen[1]

[1]Hawai'i Institute of Marine Biology, University of Hawai'i, Mānoa
[2]Department of Biology, University of Hawai'i, Mānoa
*Presenter

Accurately estimating patterns of population connectivity in marine systems remains an elusive goal despite being necessary to properly inform strategies for managing coastal resources. Here, we describe dispersal and connectivity patterns of a species heavily targeted by recreational fisheries and identified as a species of interest by Native Hawaiian community leaders, the Convict Tang, *Acanthurus triostegus*. Connectivity was assessed across different spatial scales: archipelago-wide and within an island. At the archipelago scale, samples were collected from 12 islands and atolls across the entire 2600 km of the Hawaiian Archipelago and Johnston Atoll. Population genetic analyses indicate a main Hawaiian island (including Johnson Atoll) population and a Northwestern Hawaiian island population. At the island scale, a total of 1063 samples of adults and juveniles were collected from 24 locations around O'ahu, including 20 patch reefs within Kāne'ohe Bay. A parentage analysis, a direct measurement of dispersal, recovered 80 parent-offspring pairs (~8% recover), with the majority of pairs recovered showing spawning and settlement along the eastern and south-eastern side of O'ahu. The high parent-offspring recover in conjunction with self-recruitment back to the natal reefs observed at three locations indicate limited dispersal despite the potential for wide-range dispersal based on their pelagic larval phase. Our results will directly benefit fishery managers by describing connectivity across different spatial scales and identifying critical areas for fish production and recruitment to ensure sustainable harvest of the reefs of O'ahu. Native Hawaiian community leaders and local fishermen will gain information about areas vulnerable to high fishing pressure, informing community-based management efforts. Finally, this research will demonstrate patterns of fish larval dispersal and recruitment providing a baseline to evaluate future changes in coastal circulation and reef connectivity.

Deep and Deeper: Invertebrate Composition from Meso- to Subphotic Depths

*Elena Conser[1,2], Mariska Weijerman[2]

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*Presenter

Interest in deep coral reefs has been burgeoned by the threats facing shallow water reefs. However, the deeper we go, the more we are in the dark about community composition, especially with regard to invertebrates. Below the photic zone, numerous species of structural corals and sponges foster rich and diverse ecosystems. Most studies of these deep reefs have focused on precious corals or bottomfish assemblages; few, however, have investigated benthic macroinvertebrates. Invertebrates are important members of the ecosystem, serving as links from detritus to higher trophic levels, such as commercially important fishes. We investigated community composition, abundance, and productivity of benthic macroinvertebrate communities along a depth gradient. Invertebrate data from 532 Hawaiian Undersea Research Laboratory submarine dives in depths of 30-400 meters were analyzed using community ecology statistical methods. Results show four significantly distinct depth clusters (permutational multivariate analysis of variance, $p<0.001$), each with an associated assemblage of macroinvertebrates. In these depth ranges, filter feeding invertebrates dominated, whereas abundance of mobile invertebrates was relatively low. The mesophotic zone was dominated by hard corals, whereas the subphotic was defined by soft corals. We calculated abundance and biomass and inferred dynamic parameters from literature data for each taxon. Below the photic zone unique ecosystems exist, and our results shed some light on the abundance, dynamics and contribution of these remarkable communities. These data can directly feed into ecosystem models to assess community dynamics and evaluate how disturbances influence the trophic connections between the subphotic zone, mesophotic zone and shallow coral reefs.

Mass coral bleaching due to unprecedented marine heatwave in Papahānaumokuākea Marine National Monument

*Courtney S. Couch[1,2], John Burns[1,3], Gang Liu[4], Kanoelani Steward[2], Tiffany Nicole Gutlay[1], Jean Kenyon[5], C. Mark Eakin[6], Randall Kosaki[7]

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[5]U.S. Fish and Wildlife Service, Honolulu, HI
[6]Coral Reef Watch, NOAA/NESDIS/STAR, College Park, MD
[7]NOAA Papahānaumokuākea Marine National Monument, Honolulu, HI
*Presenter

2014 marked the sixth and most widespread mass bleaching event reported in the Papahānaumokuākea Marine National Monument (PMNM), the world's second largest marine reserve. This event was associated with an unusual basin-scale warming in the North Pacific Ocean, with an unprecedented peak intensity of around 20°C-weeks of cumulative heat stress at Lisianksi Island. In situ bleaching surveys and satellite data were used to evaluate the relative importance of potential drivers of bleaching patterns in 2014, assess the subsequent morality and its effects on coral communities and 3D complexity, test for signs of regional acclimation, and investigate long-term change in heat stress in PMNM. Surveys conducted at 4 islands/atolls showed that in 2014, percent bleaching varied considerably between islands/atolls and habitats, and was up to 91% in shallow habitats at Lisianski. The percent bleaching during the 2014 event was best explained by a combination of duration of heat stress, relative community susceptibility, depth and region. Mean coral cover at permanent Lisianski sites decreased by 68% due to severe losses of Montipora dilatata complex, resulting in rapid reductions in habitat complexity. Spatial distribution of the 2014 bleaching was significantly different from the 2002 and 2004 bleaching events likely due to a combination of differences in heat stress and local acclimatization. Historical satellite data demonstrated heat stress in 2014 was unlike any previous event and that the exposure of corals to the bleaching-level heat stress has increased significantly in the northern PMNM since 1982, highlighting the increasing threat of climate change to reefs.

Assessing past, present, and future impacts of sea-level rise at Lalo, Papahānaumokuākea

*Charles Fletcher[1], Haunani Kane, Kristian McDonald, Kammie Tavares, Tiffany Anderson

[1]Department of Geology and Geophysics, School of Ocean and Earth Sciences and Technology (SOEST), University of Hawai'i at Mānoa
*Presenter

Global sea-level rise is predicted to exceed 1-2 m by the end of the century, potentially threatening the very existence of low-lying islands and the critical habitats they provide for priority species. Reef islands are composed of carbonate sand and gravel derived from the adjacent reef, partially stabilized by limited plant cover, and constantly reshaped by marine and atmospheric forces, including sea level rise. Within Papahānaumokuākea island loss has already been documented at Lalo (French Frigate Shoals) and seasonal changes in island shape and location are common. As global mean sea-level rise continues along an accelerating path, reef islands are very likely to experience significant change that threatens critical habitats. In July, 2018 we visited Gin and East islands at Lalo Atoll to collect data related to (1) reconstructing island origin and evolution, and (2) establishing the foundation for an island monitoring time series. A seawater drill was used to collect short cores of the fossil reef platform underlying each island, and of two lines of stranded beach rock offshore of East Is. Pits, 1.5 to 1.9 m deep, were excavated in representative locations on each island to collect vertical sequences of sands and gravels constituting the island stratigraphy. Bathymetric soundings and offshore sand fields were sampled as well. Survey-grade GPS and Total Station point collection were used to map the shoreline, and overlapping drone imagery used to build a digital elevation model of the island. Analysis of the age and composition of island sediments and fossil reef cores will improve understanding of reef island origin, relationship to sand and gravel sources, and evolution in response to past changes in sea-level. High resolution digital mapping depicts the current state of each island (size, shape, shoreline position, etc) and calls upon the need for additional surveys to understand the interannual and seasonal variability, as well as longer-term trends. Coupling historical and modern datasets will improve understanding of how to best manage essential habitat within Papahānaumokuākea within in the context of accelerating sea level rise.

Unexpected genetic structure in corals; implications for conservation and management

*Z.H. Forsman[1], I.S.S. Knapp[1], E. Johnston[1], R. Ritson-williams[1], K. Tishammer[2], R.J. Toonen[1]

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[2]Kewalo Marine Laboratory
*Presenter

Genetic tools are needed to answer fundamental management and conservation questions for reef building coral such as; What is the capacity for adaptation to changing conditions? Why do some corals bleach and others do not? Which corals are at risk of extinction? Which coral species are endemic to Hawai'i? How do we identify new species of coral? These questions have been extremely challenging to ask for corals, due largely to two factors: 1) a lack of understanding of morphological and genetic variation within and between coral 'species', 2) a lack of genetic markers that provide information on corals and their endosymbiotic algae. With the advent of new tools and technology these limitations are being overcome and these questions are beginning to be answered. Here we provide an overview of recent progress towards answering these questions with new data from a variety of Hawaiian coral genera, including *Porites*, *Montipora*, *Pocillopora*, and others.

Integration of Structure-from-Motion Photogrammetry into the Reef Assessment and Monitoring Program

*Atsuko Fukunaga[1,2], John H. R. Burns[3], Randall K. Kosaki[2]

[1]Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa
[2]NOAA Papahānaumokuākea Marine National Monument
[3]Marine Science Department, University of Hawai'i at Hilo
*Presenter

The Northwestern Hawaiian Islands (NWHI) are part of the Papahānaumokuākea Marine National Monument, one of the largest marine conservation areas in the world. Fish assemblages on the shallow reefs of the NWHI have been surveyed annually during the Reef Assessment and Monitoring Program (RAMP) expeditions. The large size of the Monument and its remoteness, as well as the wide range of reef habitats it encompasses, present some challenges for scientists and managers to survey the reefs efficiently and to evaluate whether the protected area is achieving its objectives. We describe our efforts to incorporate Structure-from-Motion (SfM) photogrammetry into RAMP's in situ fish surveys, allowing for collection of high-resolution habitat data from each of the fish survey sites with relatively small amounts of additional bottom time to divers. Overlapping benthic imagery collected by divers produces 3-dimentional models of reef habitats, digital elevation models and orthomosaics. These files are, in turn, processed using various programs (e.g. R, Python, ArcGIS, CoralNet) to quantify the structural complexity of coral reefs, including rugosity, surface complexity, slope and curvature, and the distribution of macrobenthic organisms. We discuss how various habitat metrics obtained using different methods correlate with one another or with benthic cover and how they can be used to investigate associations between fish assemblages and habitat. As fish assemblages are directly and indirectly affected by habitat, habitat variables extracted using SfM photogrammetry provide us with cost-effective means for detailed investigations into possible causes if any changes in fish assemblages are detected in the monitoring data.

Assessing the vulnerability of marine life to climate change in the Pacific Region

*Jonatha L. Giddens[1], Donald Kobayashi[1], Mark Nelson[2]

[1]NOAA Pacific Islands Fisheries Science Center
[2]NOAA Office of Science and Technology
*Presenter

Our changing climate poses growing challenges for the effective management of marine life, ocean ecosystems, and the human communities that depend upon them. Which species are most vulnerable to climate change and where should science and management focus efforts to reduce these risks? For the first time in the Pacific region, the Pacific Islands Vulnerability Assessment (PIVA) project is implementing a practical and efficient tool for assessing the vulnerability of 83 marine taxa to the impacts of climate change. This collaborative project utilizes expert knowledge, literature review, and climate projection models to assess the relative vulnerability of marine species. This research: 1) provides a relative climate vulnerability ranking across species; 2) identifies key attributes/ factors that drive this vulnerability, and 3) identifies key data gaps in understanding and mitigating climate change impacts to living marine resources. Ultimately, this project aims to advance our understanding of the research needs and the management options to both sustain marine life and seafood security in the Pacific Ocean and beyond.

The Theory of Resistance to Marine Bioinvasions in Tropical Systems: Is Hawai'i an exception?

*Scott Godwin

*Presenter

There are latitudinal patterns of alien species establishment that suggest fewer successful marine invasions in the tropics, relative to temperate regions. It has been hypothesized that biotic resistance to bioinvasion is greater in high diversity tropical marine habitats; such as coral atolls; due to stronger and more specialized interactions between species. These interactions are predicted to decrease success in the establishment of alien species. The coral reef habitats of the Hawaiian Archipelago; compared to other areas of the tropical Pacific; are characterized by lower diversity and high endemism. This lower diversity is exhibited in the paucity of native epifaunal growth on natural and man-made substrates. This creates a situation in which any predicted biotic resistance would be minimized in these epifaunal communities, especially for novel species. Preliminary species inventories for epifaunal marine alien invertebrates in the Northwestern Hawaiian Islands (NWHI) at Midway Atoll recorded over 40 established species. The majority of these marine aliens at Midway Atoll are solitary tunicates, which are a poorly represented group in the native fauna of coral reefs in Hawai'i. In the Papahānaumokuākea Marine National Monument (PMNM), which encompasses the NWHI, the coral atoll environments are more susceptible to invasion for this reason and a marine biosecurity plan is in place to limit alien species exposure. A review of the biosecurity plan for PMNM and hypothesized importance of predation influences, niche habitats, and propagule pressure in relation to the establishment of novel species in a low diversity coral atoll will be presented.

Marine Alien Species Distribution and Management in the Papahānaumokuākea Marine National Monument

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The Papahānaumokuākea Marine National Monument (PMNM) is a marine protected area encompassing over 1.5 million square kilometers of areas surrounding the Northwestern Hawaiian Islands (NWHI). As of 2008, out of the more than 400 species of marine alien species recorded in the main Hawaiian Islands, only 13 species were considered established in the PMNM: one macro-algae, nine marine invertebrates and three fishes. The nine established alien marine invertebrates were mostly recorded from Midway Atoll and French Frigate Shoals. Despite the higher number of established alien invertebrates, less information concerning their abundance and distribution existed in the Monument than alien algae or fishes. In order to fill this information gap and update the current status of marine alien species in the Monument, the authors have focused on marine invertebrate surveys during the annual Reef Assessment and Monitoring Programs (RAMP) expeditions and other dedicated ship-based and land-based missions since 2010. RAMP surveys collected quantitative data on primarily fish and corals, but also algae and invertebrates, and they covered all islands and atolls in the Monument. Our study found that there are currently 41 established alien species, 10 cryptogenic species and two aliens that are found but not established. PMNM will continue opportunistically monitoring alien species during future RAMP expeditions. PMNM also has a permitting and inspection program to help prevent further introductions of alien species into or among different islands/atolls of the NWHI and hopes to eliminate new anthropogenic rooted introductions in the future.

Discovery of a Western North Pacific Humpback Whale (*Megaptera novaeangliae*) Breeding Area in the Mariana Archipelago

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Most humpback whale populations were delisted under the U.S. Endangered Species Act in 2016, but the western North Pacific (WNP) distinct population segment remains endangered. Studies within WNP humpback whale breeding areas off Japan and the Philippines and feeding areas off Russia and Alaska suggest that the extent of this population's breeding range is unknown. Full knowledge of the breeding habitat is critical to the population's recovery. The occurrence of humpback whales in the Mariana Archipelago (MA) was known from whaling logbooks, incidental sightings, acoustic detections, and a sighting during a 2007 shipboard survey. To learn more about humpback whales in the MA, photo-identification and biopsy sampling were conducted during small-boat surveys off Saipan in February-March 2015-2018. Fourteen mother-calf pairs and 31 additional non-calf whales were encountered providing 33 fluke photo-identification images and 27 biopsy samples. Seven individuals were re-sighted between years including two females that had calves in both years they were observed. Comparisons with photos and genetic samples collected during the program SPLASH (Structure of Populations Level of Abundance and Status of Humpbacks) revealed two matches to the Ogasawara Islands, Japan. Additional genetic analyses and comparisons to SPLASH and other WNP photo-identification catalogs are in progress. The re-sightings of whales between years demonstrate site fidelity to the MA for some individuals. The presence of competitive groups and small calves, including a neonate, indicates that the MA is a breeding area. Continued research in the MA is needed to support recovery planning for endangered WNP humpback whales.

Developing Ecosystem Metrics of Plastic Ingestion by Hawaiian Seabirds

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Since 2008, we have studied plastic ingestion incidence and loads in seabirds from the Main and the Northwestern Hawaiian Islands following three complementary approaches: (1) assessing community-wide patterns in locally-breeding species; (2) developing local pollution metrics using species with restricted foraging distributions; and (3) comparing regional plastic distributions using far-ranging species. We opportunistically necropsied 350 specimens of 16 species from French Frigate Shoals and documented ingestion in 11 species (68.7%), belonging to 7 families and representing 5 distinct feeding guilds: albatrosses, tuna birds, nocturnal petrels, plunge divers, and frigatebirds. Plastic ingestion rates varied within species, with chicks having significantly higher incidence and loads than conspecific adults. Overall, we documented high incidence rates (>50% in adults, >90% in chicks) in several surface-foraging tubenoses: Tristram storm-petrels (*Oceanodroma tristrami*), Bonin Petrels (*Pterodroma hypoleuca*), Laysan (*Phoebastria immutabilis*) and Black-footed (*Phoebastria nigripes*) Albatrosses. Studies of local bio-indicators revealed high incidence rates (>50%) in Wedge-tailed Shearwater (*Ardenna pacifica*) chicks and adults from O'ahu, with significant differences in incidence / mass by stomach organ (proventriculus versus gizzard). Regional comparisons of Laysan / Black-footed Albatrosses highlighted the large plastic loads in boluses cast by chicks from Kure Atoll, with plastic accounting for 62.8% of the bolus mass. Together, these results underscore the value of seabirds as bio-indicators of pelagic plastic at local and regional scales. Coupling plastic ingestion studies with tracking, dietary and chemical analyses provides a wider context for investigating seabird foraging behavior during changing ocean conditions and the flow of pollutants in North Pacific marine ecosystems.

An Acoustic Survey of Beaked Whale and Kogia in the Main Hawaiian Islands Using Drifting Recorders

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During the 2017 Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS) a network of 13 drifting hydrophone recorders was deployed around the main Hawaiian Islands with the goal of improving detection of beaked whales and *Kogia*. These Drifting Acoustic Spar Buoy Recorders (DASBRs) contained a two-element vertical hydrophone array at 150 m depth, sampling at 288kHz for 2 min of every 10 min. Deployment locations were planned to cover a 50 nmi minimum convex polygon around the main Hawaiian Islands (MHI Stratum). In actuality, DASBRs drifted significantly within the MHI Stratum and up to 200 nmi beyond. Overall the DASBRs collected data on 251 days and over 6,354 km of drifting track. Using the Click Detector Module within PAMGuard (version 2.00.11), 2-min periods of clicking were classified based on peak frequency. We found frequency modulated (FM) pulses characteristic of Longman's, Cuvier's, Blainville's, and Cross Seamount beaked whales (BWC) in over 900 2-min files, spread along the drift track of each DASBR. Additionally, two types of *Kogia* echolocation clicks were detected with peak frequencies of 116 kHz and 123 kHz. To further improve detections of *Kogia* echolocation clicks, custom MATLAB subroutines were used to re-analyze the recordings in greater detail resulting in 60 2-min detections. Acoustic detections of beaked whales and *Kogia* were much more numerous than those from the towed array efforts during HICEAS and will enhance understanding of the distribution of these species in the main Hawaiian Islands.

Identifying and Characterizing High-Density Coral and Sponge Communities on Deep Seamount Ridges Within Papahānaumokuākea Marine National Monument

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The National Oceanic and Atmospheric Administration (NOAA) recently conducted the Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE): a 3-year effort designed to provide critical new information on the deep-water resources within the US national marine monuments and sanctuaries throughout the Pacific. The CAPSTONE project was executed by NOAA's office of Ocean Exploration and Research (OER) with the mission to generate baseline characterizations of the poorly known deep-water biology and geology within these marine protected areas. The CAPSTONE "Hohonu Moana" expeditions in 2015 and 2016 were focused on documenting the coral, sponge and fish communities on previously unexplored seafloor features in the Papahānaumokuākea Marine National Monument (PMNM). Prior to this campaign, only three large-scale high-density communities had been documented at depths below 1,000 meters within PMNM, all three of which were located on steep ridge features. High densities of corals and sponges were found on eleven of the twenty-six Hohonu Moana sites selected for exploratory Remotely Operated Vehicle (ROV) surveys. Three of these sites were located on features only recently incorporated into PMNM after the 2016 monument boundary expansion. These communities were found on some, but not all ridges surveyed, suggesting that other factors such as substrate composition and depth are also important. The lower depth limit for these communities is not well understood, but high densities of corals and sponges were not observed at depths below 2,700 meters in PMNM nor anywhere else during the three-year CAPSTONE project.

A Characterization of Mesophotic Reef Fish Assemblages of the Papahānaumokuākea Marine National Monument

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Mesophotic coral ecosystems (MCEs) extend from 30 to 150 m in depth and support diverse, poorly explored communities of coral reef-associated organisms. Since 2010, we have been using technical diving (open-circuit trimix, and closed-circuit rebreathers) to quantitatively characterize fish assemblages at 161 sites across the Papahānaumokuākea Marine National Monument (PMNM) and 28 sites in the main Hawaiian Islands (MHI). The structure of these reef fish assemblages exhibited distinct gradients from shallow to mesophotic depths, and also along the latitudinal gradient from the MHI to the northern end of PMNM. Fish assemblages at mesophotic depths had higher total densities than those on shallow reefs. Assemblage structure changed along both depth and geographical gradients. Increasing depth was associated with lower abundances of herbivores and invertivores, and higher abundances of planktivores. Endemism increased dramatically with both latitude and depth, ranging from approximately 20% in the main Hawaiian Islands to over 90% on deep reefs at Kure Atoll. The introduced bluestripe snapper, *Lutjanus kasmira*, was common on shallow and deep reefs as far north as French Frigate Shoals. Deep reefs in the northern half of PMNM were found to be completely devoid of this widespread introduced species, creating a large refuge for native fish species. For purposes of management and monitoring, MCEs in PMNM can be grouped into three distinct groupings (Nihoa to French Frigate Shoals, Gardner Pinnacles through Lisianski, and the three northern atolls), distinguished by high abundances of *L. kasmira*, absence of *L. kasmira*, and high abundances of endemic species respectively

Global Genetic Inventory of the Silky Shark: A Local Shark with a Fishing Problem

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Silky sharks (*Carcharhinus falciformis*) occur in all oceans and are the second most harvested shark on earth. Their habitat overlaps with commercial tuna across the globe including the long line industry around the Hawaiian archipelagoes. Globally they account for >90% of the shark bycatch in tropical purse seines. Silky sharks are also one of the most exploited species in the shark fin trade. As a result, this formerly abundant species has declined by >85% in the last 20 years and is now listed as vulnerable and Declining by International Union for Conservation of Nature (IUCN). Despite this dramatic population crash, there is little information on genetic stock structure to identify the basic units of wildlife management. This project provides a global genetic inventory with 657 specimens from 12 globally distributed locations. Using restriction site-associated DNA polymorphisms (ezRAD) in whole genome scans, 16,000 single nucleotide polymorphisms (SNPs) were identified to calculate population structure. We show distinct genetic differences between and within major ocean regions, suggesting this species is not as cosmopolitan as previously thought. Finally, we are using this global genetic inventory as a baseline to identify the origins of Silky sharks in the fin markets. Over 1000 specimens from the fin market in Hong Kong, China will be compared to our global baseline. This will allow the identification of sharks in the fin trade to both the species-level and oceanic region of origin, identifying if any Silky sharks from the Hawaiian archipelago are falling victim to the shark fin trade.

Weaving Together Cultural and Natural Resources

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The introduction of Makaloa, a native Hawaiian plant, to aid in the recovery of the critically endangered Laysan duck, has led to an unexpected resurgence of a cultural resource. Makaloa was a dominant plant on the main Hawaiian Islands, but due to habitat fragmentation and degradation has become rare in both nature and culture. Mats woven entirely from Makaloa have been absent in the Hawaiian culture since the 1800's. Makaloa was brought to Midway to provide nesting habitat to 42 Laysan ducks during the translocation efforts in 2004-2005. Since its translocation, Makaloa has thrived and flourished at Midway Atoll, becoming one of the healthiest populations in the Hawaiian archipelago.
Fish and Wildlife Service and Kupu members partnered with the Office of Hawaiian Affairs and Bishop Museum to bring cultural practitioners to Midway Atoll for the first time to develop a makaloa weaving project, where a moena makaloa would be woven for ceremony and other special events. The moena Makaloa will be a cultural resource specific to Midway, and provide the synergy to weave together habitat restoration, and the conservation of natural and cultural resources.

Effects of SCUBA Exhaust on Fish Surveys in a Large Remote Marine Protected Area

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This study examined the effects of SCUBA exhaust on fish counts in underwater visual surveys conducted in the Papahānaumokuākea Marine National Monument (PMNM). Specifically, paired surveys were conducted at each site, utilizing two different gear types: open-circuit SCUBA (OC) and closed-circuit Rebreather (CCR). The exhaust from the OC equipment is an intrusive source of bias for in-situ fish observations, as the audio and visual disturbances caused by these bubbles could either attract or repel fishes depending on whether their behavior is more driven by caution or curiosity. As the PMNM is a remote and extremely large (~1.5 million km2) MPA in which coral reef fishes are fully protected, fish responses to divers represent natural responses of fishes that are largely unaccustomed to divers. Overall, we found no significant difference in total fish biomass (BR=CCR:OC biomass ratio: -0.29, 95%CI: -0.60, 0.16) or abundance (AR: 0.08, 95%CI: -0.05, 0.28) between CCR and OC surveys, and those patterns were true for most taxa we examined. However, there were some differences for roving piscivores, including that significantly more Jacks were recorded on OC than on CCR (*Caranx ignobilis* ~ 33% more, and *Caranx melampygus* ~ 50% more). The instance of first encounter of some species varied between OC and CCR: with higher numbers of. *Aprion virescens* ($p = 0.04$), and *C. melampygus* ($p = <0.001$) being observed early in the surveys on OC, and, conversely, higher counts for *Triaenodon obesus* ($p = .0214$) in the early portion of the CCR surveys.

Spatially quantifying and attributing 17 years of vegetation and land cover transitions across Hawai'i

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The past several decades in Hawaii have seen widespread shifts in land use and vegetation, yet little information exists on the rate or extent of land cover change across Hawaii. This research developed annual, high resolution, percent cover maps of forest, grassland and bare earth from 1999 to 2016, identified trends in land cover dynamics, and attributed changes to known land management history. Sub-pixel land cover was quantified for the state of Hawaii using archived LANDSAT imagery and a custom remote-sensing algorithm developed in Google Earth Engine. Annual maps were then used to fit linear models to identify per-pixel land cover transitions across the 18-million-pixel landscape, allowing for quantifying total area of change, rates of change, and final cover outcomes statewide. Areas of change were then attributed to past and current land management using a statewide spatial dataset of development, agriculture, intensive conservation action and burned areas assembled from multiple sources. Results indicated that 7.63% of the state's land surface is changing. Land cover changes were seen resulting in losses and gains all three cover types and while large swaths of bare area and grass cover expansion were observed, overall, a net gain in woody cover was observed. In general, these findings suggest that Hawaii is going through a forest transition, primarily driven by agricultural abandonment and possibly woody invasive species expansion. This work provides a statewide assessment of fine-scale land cover transitions in Hawaii and a powerful new tool to improve the attribute transitions to land use and policy.

American Samoa's Coral Diversity and Mesophotic Zone

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The coral diversity of American Samoa has been extensively studied, while the mesophotic zone (30–150 meters) has been poorly studied. The mesophotic zone is 357.5 square kilometers (km2) out of 451.5 km2 of all coral reef depths (0–150 meters) which represents 79% of coral reef depths. Despite the significant portion of coral reef area, the mesophotic zone has had little attention. In 2016, a series of dives were completed in the upper mesophotic zone (30–70 meters) to document the stony coral species richness. These surveys resulted in documenting 110 coral species with six new records. A species accumulation curve based on this study and three additional studies indicates a total coral diversity of 316–359 coral species. An analysis of 36 papers shows there have been approximately 374 coral species documented from American Samoa. Based on an agglomerative hierarchical clustering analysis of 162 sites across American Samoa, upper mesophotic communities are distinctive from shallow water coral communities. The management implications for distinctive mesophotic coral communities raises the uncertainty of the mesophotic zone providing a deeper refuge for coral communities. However, species of concern such as the threatened corals *Acropora speciosa* and *Euphyllia paradivisa* were discovered at mesophotic depths. Mesophotic depths may provide a depth refuge for individual species and a better understanding of the species connectivity across depths is needed.

Lessons learned from data-limited stock assessments of coral reef fish in the central and western Pacific

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In recent years, the Pacific Islands Fisheries Science Center has been involved in generating stock assessment analyses for coral reef-associated fish populations around the Hawaiian Archipelago and Guam Island in the Mariana Archipelago. This effort has proven challenging given the high number of exploited coral reef species, limited resources, and the unavailability or poor quality of critical data needed to support these analyses. To address some of these challenges, fishery scientists have focused on length-based mortality assessment models coupled with an innovative tool to generate missing life history parameters related to growth, longevity, and maturity, with the ultimate goal of determining the status of these stocks and generating management information required by law. This general approach was applied to 27 reef fish species in Hawaii and 12 others around Guam Island, with results showing that 11 out of 27 (41%) species were likely experiencing overfishing in Hawaii. Overfishing risk tables for different size and catch limits were generated to inform managers. We present here an overview of this stock assessment approach, including solutions found to address some of the data challenges. We also present the results of applying this approach to Hawaii and Guam reef fish and discuss ideas to improve data-limited stock assessment in archipelagoes worldwide.

Metabarcoding as a Tool to Examine Herbivore Diets and Inform Management

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The process of herbivory on coral reefs is well studied, but the partitioning of resources within functional groups of herbivores is less understood. In particular, many studies that examine fishes' diets do not differentiate between species of turf algae, which is a major food source for grazing herbivores. This study addresses that need by employing metabarcoding, a genetic tool, to identify algae in the gut contents of herbivorous reef fishes. This approach can allow for the identification of species of algae that may be otherwise indistinguishable and can assist in the exploration of diet breadth and niche overlap. In addition, a metabarcoding approach can illuminate herbivores that are consuming invasive algae, as well as species that may be more specialized and vulnerable to habitat disturbance. This study focuses on grazing surgeonfishes that are commonly targeted by recreational and subsistence fishermen, such as manini (*Acanthurus triostegus*), and species that are abundant on degraded reefs, such as the brown surgeonfish (*A. nigrofuscus*). Preliminary results from six species of common surgeonfishes indicate differences in diet breadth and composition, and *A. nigrofuscus*, a generalist, even appears to exhibit variation among individuals. Applying molecular methods to explore diet breadth in herbivores can assist in the development of management strategies that more accurately reflect the response of reef communities to human impacts and also provides information about the ecology of species that are important to fishermen, resource managers, and ecosystems in Hawai'i.

Sub Regional Comparison of the Life History Parameters for a Deep-Water Snapper within the Hawaiian Archipelago

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Life history parameters (age, growth and maturity) are rarely documented for fish across archipelagoes and this documentation is often confounded by the insufficient biological and fisheries data. Regional or sex-specific variations (spatial or temporal) in life-history parameters of a fish or other resource are important inputs for management and contemporary stock assessments. Estimates of size-at-age relationships, mean body length at sexual maturity (L50) and longevity for ehu (*Etelis carbunculus*) are presented for the two sub-regions of the Hawaiian Archipelago, the main Hawaiian Islands (MHI) and the north-western Hawaiian Islands (NWHI). *E. carbunculus* show highly asymptotic size-at-age relationships, with most growth achieved within the first 8 years, yet results indicate that differential growth characteristics are evident between sub-regions and sexes. The growth coefficient (k) for females and males were estimated to be 0.15 and 0.19 v. 0.13 and 0.15 in the MHI v. NWHI respectively. The maximum ages between sexes were similar in the MHI at 22 years; however, they varied between sexes in the NWHI, 28 years and 35 years for males and females, respectively. The mean L50 were found to be smaller in the MHI compared to NWHI for females, and evidence for sexual dimorphism were present in fish within the Hawaiian Archipelago. This case study bolsters the general importance of identifying regional or sub-regional variations in vital rates, the value of incorporate sex-specific life history data into assessments and management strategies, and drawbacks to relying solely on traditional length-based assessment methods.

Impact of Exploitation Evident in Age-based Demography of the Deepwater Snappers *Pristipomoides flavipinnis* in the Samoa Archipelago and *P. auricilla* in the Mariana Archipelago

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Remote areas (i.e., unfished due to distance/economic constraints) within archipelagos provide unique opportunities to examine the influence of fishing on age-based demographics of commercial and subsistence valued species. They also allow the determination of the notoriously difficult to estimate natural mortality, a population dynamics parameter that is essential to quantitative stock assessments. The Samoa and Mariana Archipelagos contain such areas and were sampled to compare the life history information from 2 deepwater snappers, the goldeneye jobfish (*Pristipomoides flavipinnis*) and the yellowtail snapper (*P. auricilla*) between fished and unfished areas. The maximum ages (28 and 32 years for *P. flavipinnis* and *P. auricilla*, respectively) and the von Bertalanffy growth model parameter estimates were similar between the sexes but were significantly different between the fished and unfished areas. The size compositions from the fished and unfished areas were also similar, but the age compositions in the fished areas were severely truncated relative to the unfished areas, implying an age-based signature of fishing pressure not reflected in the size distributions. This highlights an area of concern with size-based analyses compared to age-based analyses in long-lived species because size and age can become decoupled. Further, each species maximum age from the unfished area, relative to the fished area, resulted in different natural mortality estimates which, in turn, influenced fishery exploitation rate calculations. This combination of more reflective age compositions and natural mortality estimates from the unfished areas provides accurate reference point advice to better inform fisheries managers across these archipelagos.

A Historical Review of Commercial fishing Around French Frigate Shoals and its Possible Effect on the Hawaiian Monk Seal

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A decade after the Papahānaumokuākea Marine National Monument was established the question persists about how survivorship of monk seals was influenced by the ecosystem effects of commercial fishing on the abundance of prey, competitors or predators. The sixty years (1949-2010) of documented fishing on the northern Hawaiian ridge shows continuous hook and line fishing, trawling of northern seamount ground fish (since 1968), and trapping of crustaceans from 1977-1999. Analyses of patterns looked for both direct effects, removal of potential prey (bottomfish, lobster, octopus) and/or reduction of competitors (jacks and reef sharks), and indirect effects including limiting the recruitment of prey (armorhead) or increasing the abundance of competitors by augmenting their forage base with fishery vessel discards of bait and bycatch. The resolution of monk seal data deteriorates as you go back in time. It is best after the mid 80's when demographic data was collected and poorer for the years prior when there are only intermittent beach counts that extend back to 1969. Correlation analyses of fishery data with the best seal data showed survivorship of 1-2 year old seals negatively associated with prey landings and lagged positive significance with landings of competitors. Looking at the full 60 years the landings and CPUE data were integrated to estimate a biomass trends to look for patterns that would explain the observed increase of monk seals during the 1970's and their subsequent decline after its peak in the mid 1980's.

Ensuring long-term survival of Papahānaumokuākea Marine National Monument's three endemic songbirds through monitoring, habitat management, and translocation

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The Papahānaumokuākea Marine National Monument is home to three species of federally Endangered songbirds found nowhere else in the world. The Nihoa Millerbird, Nihoa Finch, and Laysan Finch are each endemic to their namesake island. Successful translocations of Nihoa Millerbird and Laysan Finch have reduced their extinction risk. Millerbirds translocated to Laysan continue to flourish with increasing numbers and expanding range, while the source population on Nihoa undergoes substantial population fluctuations. Translocated Laysan Finches at Pearl and Hermes Atoll persist on two islets, Southeast and North, but the islets are starting to experience wash-over events related to sea level rise, precluding long-term persistence. The Laysan Finch source population on Laysan remains stable at ~10,000 birds, but annual monitoring has not occurred since 2011. Extensive long-term habitat restoration has enabled both Laysan Finch and translocated Nihoa Millerbirds to flourish. Translocation of Nihoa Finches is a conservation priority supported by USFWS and the Monument. Kure Atoll and Lisianski were identified as the best options for a translocated population in a 2006-2007 structured decision making exercise. However, Nihoa Finches are highly susceptible to avian malaria, and mosquitoes that vector this disease were detected on Kure and persist on relatively nearby Midway, making Kure an unviable option. Lisianski has suitable habitat and food resources and current sea-level models indicate that songbirds could persist on Lisianski for at least 150 years. Consistent annual monitoring combined with habitat restoration efforts and translocations to high islands are necessary for the long-term survival of these species.

Predators, Genetics, and Climate Change: Prioritizing Conservation Actions for Endangered Hawaiian Tree Snails

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*Presenter

Endemic Hawaiian tree snails (*Achatinellinae*) have been rapidly disappearing due to introduced predators and habitat disturbance, and only remain in fragmented refugia. All populations are at the highest elevations available, over steep precipitation gradients, and will likely be impacted by climate change as native habitats become warmer and drier. Using restriction-site associated DNA sequencing (RADseq) we generated millions of DNA sequences from across the genomes of 67 populations representing 28 species, 6 genera, and 3 subfamilies. We constructed whole and partial mitochondrial genomes, and evaluated nuclear and mitochondrial single nucleotide polymorphisms (SNPs). Alarmingly, we see evidence of limited connectivity among populations for species where multiple populations remain, with a large number of fixed differences among geographic sites. Together with low heterozygosity, this suggests a decreased capacity for adaptation to environmental change. These results may inform decisions to combine populations in predator-free enclosures in ways that will maximize adaptive ability in the face of global climate change.

A seal-eyed view of the underwater habitats of the Hawaiian Archipelago

*Stacie Robinson[1], Charles Littnan[1]

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*Presenter

Understanding how animals interact with their environment can reveal ecological needs and provide insights for managing healthy populations. In the effort to recover endangered Hawaiian monk seals, it is important to understand how seals use their under-water habitat and what factors influence foraging effort and ultimately survival. Emerging technology has produced instruments that streamline the process of collecting data from seals in the marine environment, making it possible to record video footage along with data on depth, location, speed, and other movement parameters for a foraging seal. We deployed multi-sensor cameras to record metrics related to foraging habitats, such as depth and bottom type, as well as metrics related to individual foraging behavior, such as foraging trip distance and dive depths. We selected research subjects representing a range of ages in varied locations. The seals studied ranged in age from yearling to adult, and they occupied divergent habitats including French Frigate Shoals in the Papahānaumokuākea Marine National Monument and Molokai in the main Hawaiian Islands. In this presentation, we will share foraging videos from these areas across the archipelago and describe differences in the foraging conditions encountered by monk seals in the monument versus the main islands. We will further describe variation in foraging tactics in younger versus more experienced seals.

Challenges in Monitoring and Managing Large Marine Fishes: Lessons from the Galapagos Archipelago

*Adam N H Smith[1], David Acuña-Marrero[1], Matthew D M Pawley[1], Marti J Anderson[1]

[1]Massey University, Auckland, New Zealand
*Presenter

With the recent rise of very large Marine Protected Areas, there is a growing need for effective, non-destructive methods to monitor the status of marine ecosystems. Large fishes, such as sharks, are usually of high priority in monitoring programmes, largely due to their vulnerability to fishing and other human impacts. Recent technological developments have improved our ability to collect useful data on these taxa. Yet, many challenges remain with respect to how to design and analyse the data from broad-scale monitoring programmes of sharks, due to a range of factors such as their cryptic nature, tendency to undertake long migrations, and complex relationships with humans. I will discuss some of these challenges and some potential solutions, drawing on examples from our recent work at the Galapagos Islands and other locations in the Pacific.

New Marine Geological Maps Reveal the Complexity and Deep-sea Habitability of the Northwestern Hawaiian Ridge

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[1]Oceanography Dept., School of Ocean & Earth Science & Technology, University of Hawai'i at Mānoa
*Presenter

Recently collected and archival multibeam bathymetry and backscatter data, along with gravity modelling, have been synthesized and used to update 25-year-old interpretations of the deep-sea marine geology of that portion of the Northwestern Hawaiian Ridge (NWHR) within the Papahānaumokuākea Marine National Monument (PMNM). Our comprehensive mapping effort has allowed us to divide the NWHR into four provinces, or zones, based on the carbonate caps, underlying volcanic edifices, and subsurface characteristics. Beginning from the northwestern end, the first zone is composed of isolated and composite seamounts, guyots, and atolls of mixed Hawaiian and Cretaceous age, from Turniff Seamount to the bank just west of Lisianski Island. The second zone is distinguished by medium-sized features, some with long narrow rift zone ridges, and a noticeable shift to multiple volcanic centers as defined by gravity anomalies. The third zone is dominated by much larger edifices with increasing numbers of volcanic centers, broad rift zones, and extensive carbonate caps. This zone includes the massive structures of Gardner Pinnacles and French Frigate Shoals. Small volcanic islands and shallow banks comprise the final and fourth zone, adjacent to the main Hawaiian Islands and ending with Middle Bank. These interpretative geological and structural maps can also be used to "bio-prospect" for deep-sea biological communities consisting of deep-sea corals, sponges, and associated organisms. Over the years, and on many deep-diving expeditions, we have repeatedly discovered such communities on high relief, high slope, and hard substrate areas that allow filter feeding organisms to orient into the maximum current flow.

Over 40 Years of Hawaiian Green Sea Turtle Research: Using Current Trends and New Research to Better Predict the Honu Population's Resiliency to Climate Change

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*Presenter

Residing in the most geographically isolated island group on the planet, the Hawaiian Archipelago green (*Chelonia mydas*) sea turtle population, or Honu, was recently designated as a Distinct Population Segment (DPS) under the Endangered Species Act. One of 11 global segments, this Central North Pacific DPS offers unique research opportunities as it can be considered a "closed" population, with almost no movement of individuals into or out of the region. For 45 years, the population's primary nesting habitat at French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands has been monitored and studied by what is now the NOAA Marine Turtle Biology and Assessment Program (MTBAP). This long-term tagging study produced a wealth of information about the status and trends of Hawai'i's nesting females and revealed a promising 5.7% annual increase in nester abundance. Despite previous research, large data gaps remain to be filled, especially relating to this population's susceptibility and resilience to the potential effects of climate change. Through advancements in field techniques and technology, research at FFS now includes the collection of nest success and nest incubation temperature data, as well as increased genetic sampling and satellite telemetry data. The next phase of research will cover two lesser-known aspects of Honu biology: 1) the effects of climate change on nesting biology, which will include ground-truthing previously modeled pivotal nesting temperatures to better predict population feminization; and 2) male migratory ecology (foraging and energetics), paternity, and the resulting operational sex ratios at Honu's principal rookery.

Probability-based Sampling Surveys of Stony Coral Populations in the Northwestern Hawaiian Islands

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Spatially explicit estimates of size-structured abundance can provide the ability to track temporal population changes and improve understanding of environmental and anthropogenic factors contributing to coral declines. Principles of probability-based sampling were used to guide large-scale surveys of stony coral populations in the Northwestern Hawaiian Islands coral reef ecosystem (Papahānaumokuākea Marine National Monument) from 2007 to 2014. Three consecutive surveys conducted from 2007 to 2014 employed a two-stage stratified random sampling design that partitioned the 1556 km2 survey domain into strata defined by island, reef zone and depth. Estimates of coefficient of variation (CV, ratio of standard error to the mean) for stony coral population density consistently ranged from 10% to 23% for four of the top six principal species for each survey. These density estimates were similar to those reported from coral surveys in other U.S. Pacific regions and the Florida Keys. Design performance evaluation indicated that survey efficiency and precision could be improved through Neyman allocation of total domain-wide sampling effort and a reduction of replicate sampling effort at primary sampling units.

Cryptofauna Distribution and Detection along the Hawaiian Archipelago

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Here we investigate the cryptofauna community across the Hawaiian Archipelago using standardized 3-dimensional collection devices known as Autonomous Reef Monitoring Structures (ARMS). Recovered units were quantitatively processed producing 3 bulk samples fractionated by size and mobility. Using metabarcoding techniques, the cytochrome oxidase 1 (COI) gene was targeted and amplified for each bulk sample from 84 units (29 sites). Organisms greater than 2 mm were sorted, photographed, and identified to the lowest taxon. Multivariate generalized additive mixed models were built to examine biotic and abiotic drivers on diversity across the archipelago, and annotated sequences were examined for invasive species detection.

Lab Rat or Shapeshifter? Genetic Identification Reveals Frequent Misidentification of Pocillopora Corals Throughout the Hawaiian Archipelago

Erika Johnston[1], *Zac Forsman*[1], **Robert J. Toonen*[1]

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*Presenter

Species within the scleractinian genus *Pocillopora* Lamarck 1816 exhibit extreme phenotypic plasticity, making identification in the field exceedingly difficult. However, the mitochondrial open reading frame DNA marker provides a useful genetic tool for identification of most species in this genus, with a notable exception of *P. eydouxi* and *P. meandrina*. Based on recent genomic work, we have determined clear genetic boundaries between all the species, and developed a quick and simple gel-based DNA amplification method for the positive identification of all six *Pocillopora* species occurring in Hawai'i. Using this approach targeting diagnostic sequence differences among species, we document frequent misidentification of *Pocillopora* species based on colony morphology. For example, we found that *P. damicornis* appears to be rare in Kāne'ohe Bay, with most sampled colonies instead being the congener *P. acuta*, which was not previously reported from Hawai'i. Likewise, we found that not a single one of the presumed *P. meandrina* sampled at the three most northerly islands (Pearl and Hermes, Midway, and Kure) were correctly identified. Instead, it appears *P. meandrina* is restricted to more southerly locations, and *P. ligulata*, which appears to be a Hawaiian endemic, becomes common and is regularly mistaken for *P. meandrina* in these more northerly locations. This genetic identification technique offers the first unambiguous method for providing a reliable species name for *Pocillopora* corals in Hawai'i.

Partitioning of *Symbiodinium* Clades in the Coral *Montipora capitata* Across Shallow Reefs of the Remote Northwestern Hawaiian Islands

**Christopher B. Wall*[1], *Ruth D. Gates*[1]

[1]Hawai'i Institute of Marine Biology
*Presenter

Reef corals form symbiotic relationships with dinoflagellates in the genus *Symbiodinium*. However, symbiont communities differ according to coral species, geography, and environmental conditions. The coral *Montipora capitata* is found across the Hawaiian archipelago and associates with clade C (namely, C31) and clade D (*S. glynnii*, D1-4-6) *Symbiodinium*, with the presence of the latter often correlating with abiotic stress. However, an understanding of the distribution of coral-host assemblages in NWHI is incomplete. We genetically screened *Symbiodinium* communities of NWHI *M. capitata* (N= 348) from 40 sites across 7 islands/atolls and found Clade C to be the sole symbiont in >80% of corals. Clade D was observed in corals from French Frigate Shoals and Laysan Island (4% and 11% of corals) and was in mixed communities with clade C, although D was numerically dominant (89–98%) when detected. Fourteen and 20% of corals hosting clade C at Lisianski and Laysan Island also harbored clade A symbionts – a symbiont previously found in diseased corals in NWHI. Clade A was also found in 2–3% of corals from Kure Atoll and Maro Reef. Our findings support the conclusion that *M. capitata* host-symbiont assemblages show stability at geographic scales, suggesting local adaptation of either the host or symbiont. While, alternative host-symbiont assemblages exist in low numbers, recent environmental challenges (regional coral bleaching) at some sites may have allowed more opportunistic clades (clades A, D) to infect corals. The stability or long term implications of these associations for the health of the coral host is unknown.

West Hawaii Ichthyoplankton Project: Exploring a Unique Ecosystem and Their Impact on Larval Fish Ecology

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*Presenter

A major goal in marine ecology is to improve our understanding of how larvae interact with oceanographic features and how those biophysical interactions impact dispersal, survival and recruitment. This study is investigating the ecological and physical oceanographic properties of surface slicks, their importance for larval fish and overall relevance for local ecosystem dynamics in the West Hawaii region. The areas within and around slicks aggregate floating material and attract organisms in areas where food resources are otherwise sparse and dispersed, functioning as biological oases and contributing to the recruitment and retention of early life history stages of fishes. Despite this potential ecological importance, very little is known with respect to the underlying physical mechanisms, the ecological relevance, the ephemerality and motility of surface slicks in the region. Research conducted by our collaborative team is revealing how nearshore surface slicks serve as nursery habitat for ecologically and commercially important fishes. From a broader perspective, we will also report on our progress in assembling a 20-year (1997 - 2018) time series of neustonic ichthyoplankton collections from West Hawaii in order to assess inter-annual variation in larval abundance and distribution of multiple commercially and ecologically important taxa as well the spatial extent and physical drivers of key oceanographic features. Finally, we will discuss how our work aims to inform management by identifying the environmental conditions that drive that variability and ultimately use this knowledge to develop indicators to improve stock and ecosystem assessments.

HICEAS 2017: A Six Month Ship-Survey of Cetaceans and Seabirds throughout the Hawaiian Archipelago

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From July to December 2017, the Pacific Islands and Southwest Fisheries Science Centers conducted the Hawaiian Islands Cetacean and Ecosystem Assessment Survey (HICEAS, pronounced "high-seas"), a large-scale ship survey for cetaceans and seabirds throughout the full extent of the Hawaiian archipelago from shore to 200 nmi offshore. HICEAS 2017 was the third survey of its kind in Hawaiian waters, with prior efforts in 2002 and 2010. HICEAS included visual observation for cetaceans and seabirds, passive acoustic monitoring for cetaceans, and a variety of environmental sampling and ancillary projects conducted with collaborators and partners. Data from these surveys provide updated information for several management and conservation priorities, including updated population estimates and distribution maps for cetacean and seabird species that are found around the Hawaiian archipelago. After 179 days, we had 326 visual cetacean sightings of at least 21 species of cetaceans, over 50 species of seabirds, and 726 daytime passive acoustic detections in Hawaiian waters. This project marked the start of a new multi-agency plan called Pacific Marine Assessment Program for Protected Species (PacMAPPS), a partnership among the National Oceanic and Atmospheric Administration (NOAA) Fisheries, Bureau of Ocean Energy Management, U.S. Navy, and U.S. Fish and Wildlife Service. The PacMAPPS schedule includes two additional surveys in the Pacific Islands Region: Winter-HICEAS to begin in January 2019 and the Marianas Archipelago Cetacean Survey (MACS) of waters around Guam and the Commonwealth of the Northern Mariana Islands in Summer 2020.

Poster Presentations

November 19, 2018 • Ala Moana Hotel

Pupping Site Trends of Endangered Hawaiian Monk Seals (*Neomonachus schauinslandi*) at Lalo (French Frigate Shoals) - Brenda Becker

Behavioral Ecology of Hawaiian Stilt (*Himantopus mexicanus knudeseni*) Chicks - Dain Christensen

Fine-scale connectivity to inform management around Moloka'i, Hawai'i - Emily Conklin

Variation in Coral-Associated Cryptofaunal Communities across the Hawaiian Archipelago - Chelsie Counsell

The Little Shrimp That Could: Phylogeography of the Circumtropical *Stenopus hispidus* (*Crustacea: Decapoda*), Reveals Divergent Atlantic and Pacific lineages - 'Ale'alani Dudoit

The Invasive Green Alga *Avrainvillea* sp. Transforms Native Epifauna and Algal Communities on a Hard Substrate Reef - Alexa Foster

The Impacts of Light Pollution on Wedge-tailed Shearwaters Along Southeastern O'ahu - Brooke Friswold

Reproductive ecology and population genetics of Hawaiian wiliwili, *Erythrina sandwicensis* (Fabaceae) - Emily Grave

Impacts of Surface Water Levels and Predation on Hawaiian Stilt Nesting Success - Kristen Harmon

Using citizen science to understand and prepare for sea-level rise in Papahānaumokuākea Marine National Monument - Katy Hintzen

Crabbing and Connectivity: Science for Sustainability - Kaleonani Hurley

The Effect of Human Presence and Burrow-site Characteristics on the Nesting Success of Wedge-tailed Shearwaters - Jessica Idle

The Reef Runway Coral Nursery: Ecological Impacts - Samantha Iliff

Adaptation Drives Coral Resilience under Ocean Acidification and Climate Change - Christopher Jury

The Gap: Institution Understanding vs. Citizenry Needs vs. Political Will - Katie Kamelamela

The Genetic Ramifications of Limited Gene Flow Between Fragmented Populations of *Achatinella sowerbyana* - Philip Kitamura

Nothing ventured nothing gained: improving the efficacy of coral reef restoration in Hawai'i - Ingrid Knapp

Ridge to Reef Connections: Effects of Invasive Mangrove Removal on Nearshore Coral Reef Environment - Ashley McGowan

Micromollusks – Another Useful Group for Mesophotic Faunal Assessment? - Dan Polhemus

Distinct and Abundant Mesophotic Macroalgal Assemblages in the Hawaiian Archipelago - Heather Spalding

Quantifying the Embodied Environmental Impact of Doubling Hawai'i's Local Food Supply - Tanya Torres

Salinity, Dissolved Oxygen, Temperature, and pH Predict Use of Freshwater Ponds by Hawaiian Waterbirds in Kawainui Marsh - Kimber Troumbley

Application of Adaptive Management for Monitoring in Two Archipelagos - Robert Uyeyama

Effects of ocean acidification and warming on coral reef cryptofauna in Kaneohe Bay, Hawaii using Autonomous Reef Monitoring Structures (ARMS) - Kathryn Van Artsdalen

How Many Species of Sponges Occur in Kāne'ohe Bay, Where Did They Come From & Where Are They Hiding? - Jan Vicente

Soil Bacterial Community Response to Removal of Nonnative Feral Pigs from Tropical Montane Wet Forests - Nathaniel Wehr

Habitat Use and Nesting Biology of Hawaiian Short-eared Owls (*Asio flammeus sandwichensis*) on O'ahu - Chad Wilhite

Pupping Site Trends of Endangered Hawaiian Monk Seals (*Neomonachus schauinslandi*) at Lalo (French Frigate Shoals)

*Brenda Becker[1], Shawn Farry[2], and Charles Littnan[1]

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*Presenter

Lalo, or French Frigate Shoals (FFS), located in the Northwestern Hawaiian Islands, has the highest annual number (ca. 20%) of Hawaiian monk seal births range-wide. Data from 1984 to 2016 were reviewed to evaluate pupping site use and trends at this atoll. Pupping peaked in 1988 (127 pups) and is currently one-fourth of this total. Births occur on 10 low-lying sandy islets, which differ in physical attributes (permanence, size, elevation, and protective reef) and potential threats to pup survival. The primary pupping islets were East, Whaleskate, and Trig Islands. Births among the islets have shifted over the last 33 years, along with a decline in pup survival to weaning. East Island was the primary pupping site (ca. 40% births annually) until 1992, when births declined with a simultaneous resurgence of threatened green turtle (*Chelonia mydas*) nesting. Pupping shifted to Whaleskate Island until it completely eroded away in 1998. Since 1998, Trig has been the primary pupping islet, accounting for ca. 40% of annual births. Unfortunately, concurrent with this pupping site shift, pup survival dramatically declined, primarily due to Galapagos shark (*Carcharhinus galapagensis*) predation, which is unique to FFS. Overall, Hawaiian monk seals demonstrated plasticity in pup site use. The ability to use alternate pupping sites has enabled this endangered species to persist at FFS despite exposure to increased threats to pup survival (e.g., shark predation, islands going awash). With rising sea levels, we expect a continued loss of quality pupping habitat at FFS and likely lower pup survival rates.

Note: This study demonstrates value of long-term data sets

Behavioral Ecology of Hawaiian Stilt (*Himantopus mexicanus knudeseni*) Chicks

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*Presenter

The Hawaiian Stilt (*Himantopus mexicanus knudeseni*) is an endangered subspecies with ecological and cultural value. This study aimed to: (1) determine temporal characteristics of hatching and fledging the nest; (2) compare the relative impact of invasive and native predators on chick survival between hatching and fledging the nest, approximately days 0-4 following hatching. Nests were selected in wetlands on O'ahu with large populations of nesting stilts. Camera traps were placed 10 feet from nests prior to expected hatch date. We monitored a total of 37 chicks from 12 nests, with 226 ± 178 hours (range of 18-576) of camera-based observations per individual nest. Eight of the twelve cameras were placed on nests after hatching and were not incorporated in estimating the mean time spent at the nest. Chicks spent 51.1 ± 20.1 hours (range of 18 to 79; n = 4) in the nest area after hatching. After leaving the nest area, chicks reappeared into the frame at three of the 12 nests. Predators spent less than 12 minutes in the frame among all nests. Of known predators, only Cattle Egrets (*Bubulcus ibis*) triggered the cameras. No predation events were observed during the study period. Too few chicks were detected after leaving the nest to justify using camera traps to monitor hatchlings. Other methods such as mark and resight or radio transmitters may be necessary. Based on these results, removal of Cattle Egrets from waterbird nesting habitat may improve nesting success in endangered Hawaiian Stilts, by decreasing mortality during the vulnerable period between hatching and fledging from the nest area.

Fine-scale connectivity to inform management around Moloka'i, Hawai'i

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*Presenter

We use a novel individual-based model to simulate larval dispersal around the island of Moloka'i. Using the MIT general circulation model together with biological data on four invertebrate and seven fish species of interest to the local community, we produce connectivity maps among sites around the island. These 11 species span the range of life history characteristics of Hawaiian coral reef species and show different spatial and temporal patterns of connectivity as a result. As expected, the longer the pelagic larval duration (PLD), the greater the proportion of larvae that disperse longer distances, but regardless of PLD (3 – 270d) most successful dispersal occurs either over short distances within the island (<30 km) or to adjacent islands (50-125km). Again, regardless of PLD, around the island of Moloka'i, connectivity tends to be greatest among sites along the same coastline. Using a graph-theoretic approach to visualize the data, we show that the eastern side of the island is highlighted as one of the most important larval sources and connectivity pathways for the rest of the island. Further, the marine protected area surrounding Kalaupapa National Historical Park (KNHP) emerges as a likely source for rare between-island larval connections, and the west coast of KNHP is one of the few regions on Moloka'i that is a net larval source across all species. Using this new approach, we reveal patterns of exchange between regions within an island and map critical larval sources and dispersal chokepoints that highlight priority areas for marine resource managers.

Variation in Coral-Associated Cryptofaunal Communities across the Hawaiian Archipelago

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*Presenter

Most of the diversity on coral reefs is in the cryptofauna, hidden organisms that inhabit the interstitial spaces of corals and other habitat-forming benthos. However, little is known about the patterns and drivers of diversity in cryptofauna. We investigated how the cryptofaunal community associated with the branching coral *Pocillopora meandrina* varies across spatial scales and environmental gradients. We performed non-destructive visual surveys of the cryptofaunal community on 1935 *P. meandrina* colonies across the Hawaiian archipelago (55 sites across 3 islands and 3 atolls). We identified 110 species of fishes and invertebrates associated with *P. meandrina*. Most of these species were observed rarely, with only 30 species occurring on greater than 1% of surveyed colonies. Variation in species richness was greatest at the scale of the coral colony, then at the site scale and the island scale. Colony-scale factors, including colony size, depth, and percent live coral tissue, were important drivers of community composition. Across the archipelago, we found higher community diversity in *P. meandrina* colonies in the main Hawaiian Islands than in the Papahānaumokuākea Marine National Monument. These regional differences in community composition are likely driven by variation in wave energy, habitat complexity, and the abundance of predators. Overall, these patterns emphasize the importance of host coral characteristics (i.e. colony size and percent live tissue) and physical characteristics of the surrounding habitat (i.e. wave energy, habitat complexity) in structuring cryptofaunal communities.

The Little Shrimp That Could: Phylogeography of the Circumtropical *Stenopus hispidus* (*Crustacea: Decapoda*), Reveals Divergent Atlantic and Pacific lineages

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*Presenter

The banded coral shrimp, *Stenopus hispidus* (*Crustacea: Decapoda: Stenopodidea*) is a popular marine ornamental species with a circumtropical distribution. The planktonic larval stage lasts ~120 – 253 days, indicating considerable dispersal potential, but few studies have investigated genetic connectivity on a global scale in marine invertebrates. To resolve patterns of divergence and phylogeography of *S. hispidus*, we surveyed 525 bp of mitochondrial cytochrome c oxidase subunit I (COI) from 198 individuals sampled at 10 locations across ~27,000 km of the species range. Phylogenetic analyses reveal that *S. hispidus* has a Western Atlantic lineage and a widely distributed Indo-Pacific lineage, separated by sequence divergence of 2.1%. Genetic diversity was much higher in the Western Atlantic ($h = 0.929$; $\pi = 0.004$) relative to the Indo-Pacific ($h = 0.105$; $\pi < 0.001$), and coalescent analyses indicate that the Indo-Pacific population expanded more recently (95% HPD (highest posterior density) = 60,000 – 400,000 yr) than the Western Atlantic population (95% HPD = 300,000 – 760,000 yr). Divergence of the Western Atlantic and Pacific lineages was estimated at 710,000 – 1.8 million years ago, which does not readily align with commonly implicated barriers between the ocean basins. The estimated age of populations contradicts the prevailing dispersal route for tropical marine biodiversity (Indo-Pacific to Atlantic) with the oldest and most diverse population in the Atlantic, and a recent population expansion with a single common haplotype shared throughout the vast Indian and Pacific oceans. In contrast to the circumtropical fishes, this diminutive reef shrimp challenges our understanding of conventional dispersal capabilities of marine species.

The Invasive Green Alga *Avrainvillea* sp. Transforms Native Epifauna and Algal Communities on a Hard Substrate Reef

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*Presenter

Invasive macroalgae, such as *Avrainvillea* sp., can compete directly with coral and native algae for resources and their spread can alter communities. This study investigates community structure and diversity between adjacent areas dominated by either *Avrainvillea* sp. or native algal species on a hard substrate reef. The biomass and species composition of fifteen paired plots (30 in total, plot type based on dominance of *Avrainvillea* sp. or native species) were quantified. *Avrainvillea* sp. plots had a significantly different assemblage of species characterized by lower algal diversity, mostly *Dictyota* spp. and *Laurencia* sp., and a higher abundance and diversity of invertebrates, such as small arthropods, polychaetes, and brittlestars. These results suggest that as *Avrainvillea* sp. becomes more abundant on hard substrate reefs it will engineer a different community composed of algal epiphytes and an invertebrate assemblage more typically associated with algae in soft sediment.

The Impacts of Light Pollution on Wedge-tailed Shearwaters Along Southeastern O'ahu

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*Presenter

The attraction to light was a previously beneficial behavior for seabirds. The invention of artificial light is now negatively impacting their survival due to distraction and disorientation, leading to fallout and often death. The Wedge-tailed Shearwater (*Ardenna pacifica*; WTSH) experiences fallout of hundreds of individuals each fledging season possibly due to artificial light pollution. We hypothesized the presence of artificial light was a significant factor contributing to fallout, and that fallout increased over time. From 2002 to 2010 standardized surveys were conducted on the Southeastern shore of O'ahu during the WTSH fledging season (November-December). The location of downed birds as well as the presence or absence of an artificial light source or fallout factors within 25 feet was noted along transects. We employed spatial and temporal analyses to determine if a correlation existed between likelihood of fallout with presence of artificial light and other fallout factors. The effects of wind and power lines were also analyzed. We found that artificial light was present in 94% of recovered WTSH, power lines in 83% and that fallout has been steadily increasing over time despite some years of decline. This research suggests artificial lights are negatively impacting fledging seabirds; the most endangered taxonomic group. The results may be used to improve management of seabird colonies near urban areas and to alleviate or influence human-induced effects. The information will assist with proactively resolving human-wildlife management across the state of Hawai'i concerning federally protected species.

Reproductive ecology and population genetics of Hawaiian wiliwili, *Erythrina sandwicensis* (Fabaceae)

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*Presenter

Hawaiian dry forests are severely endangered with little habitat remaining and many threatened or endangered species. Wiliwili, or *Erythrina sandwicensis* (Fabaceae), is among the most iconic and culturally significant dry forest trees. This research focused on the reproductive ecology, population genetics, and regeneration of wiliwili to provide useful, informative results for conservation management by addressing: 1) Who are the current flower visitors? 2) What is the effect of different pollination treatments on the number, size, and viability of wiliwili seeds and seedlings? 3) What is the genetic relationship among wiliwili populations? and 4) What is the regeneration status of populations on O'ahu and Hawai'i islands? I found that all floral visitors were non-native species. Outcrossed pollination treatments produced significantly more fruit and seeds than any other treatment. Few seedlings and saplings were found in any population, and populations were genetically distinct across islands. Outplanting efforts can increase recruitment by enhancing the potential for outcrossing and increasing the number of seedlings and saplings. However, genetic material (seeds or cuttings) collected from individual island populations should remain on their respective islands if resource managers wish to preserve the genetic identity of these populations. Conservation efforts should be put into effect now to assure the remaining fragments do not become more and more isolated, eliminating any chance to recover. With drier years approaching, future research could look at seed germination and survival in wetter climatic conditions, possibly at higher elevations.

Impacts of Surface Water Levels and Predation on Hawaiian Stilt Nesting Success

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The Hawaiian Stilt (*Himantopus mexicanus knudseni*) is an endangered, native Hawaiian waterbird that inhabits wetlands across the Hawaiian Islands. Nest predation is a major threat to Hawaiian Stilt nesting success; but the impact of egg predation and the relative impact of native and nonnative predators has not been evaluated. Predation risk may be reduced for nests surrounded by higher surface water levels, as water may act as a barrier to mammalian predators. In the Hawaiian Islands wetland hydrology varies both spatially and temporally, which may result in differences in predation across sites. In this study we used observational surveys and nest cameras to examine the impacts of surface water levels and predation on nesting success in wetlands on the Windward, Leeward, and North Shore regions of O'ahu. Confirmed egg predators included invasive cats, rats, and mongoose. No egg predation events by native predators were detected. The proportions of predated nests were not significantly different among regions ($p=0.57$). Predation was significantly dependent on surface water level in Leeward wetlands ($p=0.003$), where predation was greatest in surface water levels between one and two feet, and Windward wetlands ($p=0.01$), where predation was greatest in surface water levels less than one foot, but was not significantly dependent on surface water level in North Shore wetlands ($p=0.60$). The results of this study may be used to inform decisions for managing hydrological conditions of Hawaiian waterbird habitat, as well as trapping and removal of nonnative mammals.

Using citizen science to understand and prepare for sea-level rise in Papahānaumokuākea Marine National Monument

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*Presenter

First-person, placed-based experiences reinforce that climate impacts are local in nature and not a distant phenomenon. However, it can be challenging to connect large scale coastal hazards such as sea-level rise to local place-based impacts. The Hawai'i and Pacific Islands King Tides Project seeks to address this challenge by engaging citizen scientists in documenting the highest astronomical tides of the year, known colloquially as King Tides. Observing and documenting the local impacts of King Tide events helps us gain insight into what our coastlines may look like in the future with rising sea-levels. Citizen scientists across the Pacific region have already submitted over 2,400 photo records to this project including locations in the Papahānaumokuākea Marine National Monument. These publicly available photographic data provide a critical resource to scientists, policy makers, resource managers, and communities in better understanding and preparing for the impacts of coastal hazards and sea-level rise.

Crabbing and Connectivity: Science for Sustainability

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Hawaiian fishponds, or loko i'a, are ancient aquaculture systems that are models of sustainable aquatic resource management based on long-term experience from traditional Native Hawaiian havest practices. An estimated 350+ fishponds provided food security for ancient Hawai'i, but by 1901 only 99 remained in production, and most of those were abandoned by mid century. Reclamation efforts, beginning in the 1970s, have resulted in the rejuvination of 38 actively managed fishponds across the State. Fishponds are being adapted to modern human population needs, because functional fishponds contribute to improved food security. In this study, we seek to examine culturally and economically important crab fishery species to ask two primary questions: 1) Are fishponds self-seeding or well-connected to the surrounding coastal waters, and 2) What are the traditional management practices for our species, and can those still work today? To find whether fishponds are self-seeding, we will use genetic sequence data to estimate fine-scale patterns of dispersal and exchange between fishponds, adjacent coastal waters, and nearby islands for each of these species. In order to address merging traditional and modern management practices, we investigate traditional fishing and combine it with modern collection data to propose a sustainable crab fishery model.

The Effect of Human Presence and Burrow-site Characteristics on the Nesting Success of Wedge-tailed Shearwaters

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*Presenter

Due to previous management actions such as predator control and outplanting of native plants on Oahu's offshore islets, Wedge-tailed Shearwater (*Ardenna pacifica*, WTSH) populations have increased to the point that new WTSH colonies are forming on Oahu coastal areas. While there is limited human access to most of the offshore islets of Oahu, a beach such as Kailua Beach Park with unrestricted access and where new WTSH colonies are forming, was hypothesized to have a significantly lower nesting success compared to beaches that have little to no human activity. It was also hypothesized that nesting success would be higher for WTSH burrows with greater than 50 percent ground cover within five meters of the burrow. Nesting success, nest-site characteristics, and human presence data was collected from occupied WTSH nests on Kailua Beach between Kailua Beach Park and the Kāne'ohe Marine Corps Base Hawai'i (KMCBH). The Mayfield Method was utilized to calculate nesting success. Human activity was recorded as the amount of human presence within five meters of the burrow over a period of time. WTSH nesting success was negatively correlated with human presence and positively correlated with percent ground cover. Wildlife managers can utilize these results to make decisions regarding protection of nesting seabirds on public beaches, and to implement outplanting efforts to create more successful nesting habitat.

The Reef Runway Coral Nursery: Ecological Impacts

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*Presenter

Historically, the transplantation of coral from surrounding reefs has been thought to degrade source areas and jeopardize donor colonies. In rubble reef areas around Oahu Hawaii, coral colonies that settle and grow on unconsolidated substrate can become naturally overturned during surge events, causing tissue loss, bleaching, and eventually mortality. However, if these corals are transferred to a stable coral nursery platform and allowed to recover, the colonies could be used as donor material to restore damaged reefs with minimal impacts to donor areas. The Reef Runway Coral Nursery, deployed in May 2018, is a novel coral nursery concept designed to provide a net-positive benefit to coral restoration efforts in response to reef injuries. The purpose of this study was to evaluate the survivorship and physiological responses of dislodged corals placed on the platform and to identify any ecological impacts of collecting corals from donor sites or impacts from the nursery itself. This presentation will focus on the evaluation of the ecological aspects of the nursery through the monitoring of fish assemblages within the source area, as well as around the nursery structure. Preliminary results indicate that the collection of dislodged corals has an insignificant ecological impact on the source rubble areas. Moreover, the corals moved onto the nursery provide ample habitat for fish. The Reef Runway Coral Nursery could prove to be a multi-functional restoration tool that serves primarily to harbor recovering corals for future out-planting, and secondarily as an artificial reef habitat, providing an overall positive restorative impact.

Adaptation Drives Coral Resilience under Ocean Acidification and Climate Change

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*Presenter

Mass coral bleaching events are becoming more common as the climate warms, but the long-term trajectories of bleached and non-bleached corals may be impacted by ocean acidification. In response to a mass bleaching event during September 2014 in Hawai'i, bleached and non-bleached colonies of the corals *Montipora capitata* and *Porites compressa* were sampled from a low-pH, high-temperature environment in Kāne'ohe Bay, and from a nearby, high-pH, low-temperature environment in Waimānalo Bay. To examine the effects of ocean acidification on bleaching recovery, corals were exposed to two levels of pH in an aquarium experiment for 1 year using flow-through, Kāne'ohe Bay seawater, and the parent colonies sampled in Kane'ohe Bay were tagged and monitored for recovery under natural, field conditions. A second mass bleaching event occurred in September 2015, allowing us to investigate fixed vs. plastic effects as drivers of coral responses to repeated temperature stress. Corals from the low-pH, high-temperature site, Kāne'ohe Bay, showed higher tolerances to low pH and elevated temperature as compared to those from Waimānalo Bay, and bleaching responses were highly consistent across years. Following this 1 year study, we conducted a 2 year mesocosm experiment with corals collected from six locations around O'ahu and find that for all eight species tested, pH and temperature tolerances remain consistent over time for individuals, but vary among genotypes. Together these results show that coral pH and temperature tolerances depend strongly on fixed, heritable effects, and suggest that reef-scale resilience under global change could be driven by coral adaptation.

The Gap: Institution Understanding vs. Citizenry Needs vs. Political Will

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*Presenter

Community-Based Resource Management is a (k)new idea within Hawaii. From a historic decentralized place based specific knowledge to contemporary centralized generalized place absent decision-making capacity, it is no wonder that declining states of our ecosystems, mauka to makai, are being documented. Over ten years of learning about what people in Hawaii gather from the forest to the ocean I have worked closely with communities that have been intergenerational advocates of their place and knowledge-based lifestyles, governing agencies who are invested in respecting Hawaii values, as well as private firms who ensure policy efforts to safeguard cultural and natural resources are upheld. Through facilitating, organizing, and lynch pinning gatherings of practitioners, policymakers, lawyers, researchers, agencies, and the curious this presentation will review major takeaways to support two-way communication through analysis of historical and contemporary forest gathering practices conducted in a mix-methodology approach. Official State plant permit records were utilized to scaffold this conversation where we identify almost 200 plant species still being gathered. In short, the intent of an agency or community is only as outstanding as its ethics, its awareness of its own bias', and its ability to adapt. With our high islands, Hawaii is known for short noticed flashflood situations. Similarly, if co-management partnerships do not regularly "clean the stream" there will be backups, flooding, and general disasters that may be avoided with minimal effort upfront. We are a reflection of our landscapes, it's time we recognize and apply this concept throughout Hawaii.

The Genetic Ramifications of Limited Gene Flow Between Fragmented Populations of *Achatinella sowerbyana*

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*Presenter

Recent, drastic population declines caused by introduced predators suggest that Hawaiian tree snails in the subfamily Achatinellinae are unlikely to exist outside of predator-proof enclosures or captive rearing facilities by 2030. Today, a few wild populations of *Achatinella sowerbyana* remain in heavily fragmented refugia, scattered across the Northern Ko'olau mountain range. One population is protected in a predator-proof enclosure, and others are represented in a captive rearing facility. Remaining populations, whether in situ or ex situ, are likely to have limited gene flow without human intervention, potentially resulting in inbreeding depression and demographic declines. In this study we evaluated genetic diversity, connectivity, and relatedness among six populations of *A. sowerbyana* using three data types: seven microsatellite loci; whole and partial mitochondrial genomes; and thousands of single nucleotide polymorphisms (SNPs) that were generated using restriction-site associated DNA sequencing (RADseq). Phylogenetic trees generated using SNPs or mitochondrial genomes, a Structure analysis, as well as Fst values point to genetically distinct groups of *A. sowerbyana* populations that are within close proximity of each other (less than 1 km). Lower than expected values for heterozygosity, and significant Fis (inbreeding coefficient) values, suggest populations may benefit from increased gene flow between closely related populations.

Nothing ventured nothing gained: improving the efficacy of coral reef restoration in Hawai'i

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*Presenter

Coral reefs provide a number of ecosystem services in Hawai'i including food, coastal protection, and opportunities for recreation and tourism, but their decline over the years means these services are at risk. This decline has resulted in increased interest in attempting active reef restoration, which offers a proactive way to help preserve reefs for future generations. The majority of active reef restoration to date have taken place in the Caribbean, but the habitat and coral species in the Caribbean are starkly different than Hawai'i. Although lessons learned in the Caribbean can inform efforts here, restoration methods also need to be tailored to suit the nuances of each location. At the Hawai'i Institute of Marine Biology (HIMB) coral nursery we have begun to explore methods of improving the time and cost efficiency of growing corals that could be used to help restore reef structure, fisheries and coastal protection in Hawai'i. We are currently researching a variety of factors potentially affecting coral growth including substrate color, texture, materials, fragment size, corallivore predation, residence time, flow and genotypic differences. Here we present some of our findings and our plans for the future.

Ridge to Reef Connections: Effects of Invasive Mangrove Removal on Nearshore Coral Reef Environment

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The He'eia watershed has been severely impacted by invasive species, including red mangroves (*Rhizophora mangle*). Mass removal of invasive species and replanting of native riparian plants and lo'i taro is underway since the recent incorporation of He'eia into the National Estuarine Research Reserve System (NERRS). Mangroves are native to most tropical ecosystems, but have become invasive in Hawai'i since introduction in 1902, and may not serve the same critical ecosystem functions as in their native range. The removal of mangroves in the He'eia watershed and opportunity for long-term monitoring presents a unique chance to study how mangrove removal affects nearshore coral reefs outside of the native range. We established 24 permanent monitoring sites on the He'eia reef flat where we assess marine fish populations, sedimentation levels, water quality, and coral reef condition before, during, and after restoration to identify watershed or reef management actions that can improve the health of the nearshore coral reef. Preliminary results provide baseline data for potential changes to the coral reef as restoration progresses with an increase in sediment depth at the stream mouth already observed. The marine ecosystem data we collect complements research in the freshwater, fishpond, and terrestrial environments to allow for an ecosystem approach in understanding and managing the entire ahupua'a while maximizing benefits to both natural and human communities. This collaborative effort between community members, researchers, and resource managers allows for a ridge to reef approach and data that can inform the application of traditional land use practices.

Micromollusks – Another Useful Group for Mesophotic Faunal Assessment?

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*Presenter

Micromollusks less than 1 cm in length represent a significant but understudied component of marine biodiversity in mesophotic zones. Many of these species are trophic specialists feeding on sponges (*Triphoridae, Cerithiopsidae*) and anemones (*Epitoniidae*), or as parasites of echinoderms (*Eulimidae*), and are potentially host-specific. Recent sampling of micromollusks by sediment samples taken in the mesophotic zone throughout the Hawaiian Islands has allowed initial comparison between species assemblages in shallow and deep waters, and indicates the presence of a potentially endemic and depth-mediated assemblage of mesophotic species. Although this work is still in its initial phases, the ease with which samples can be taken by divers and the straightforward sample sorting protocols make micromollusks a potentially useful taxonomic group for mesophotic biodiversity assessment and monitoring.

Distinct and Abundant Mesophotic Macroalgal Assemblages in the Hawaiian Archipelago

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*Presenter

Mesophotic coral ecosystems (MCEs) occur from 40 m to beyond 150 m depths in tropical locations around the globe. In these low-light environments, macroalgae may dominate over corals given algal lower depth limits (> 200 m), greater diversity, faster growth, and ability to grow over both soft and hard-bottom habitats. The Hawaiian Archipelago extends over 2,500 km across the north-central tropical Pacific Ocean, and consists of the inhabited Main Hawaiian Islands (MHI) and uninhabited Northwestern Hawaiian Islands (NWHI). Submersibles, remotely operated vehicles, and technical diving were used to survey benthic communities at 68 sites in the NWHI and MHI at depths from 40 - 212 m. Across this range, we found 14 dominant macroalgal assemblages with distinct floras, of ~ 100% cover over large areas. Some assemblages were distinct to specific regions, such as large beds of *Microdictyon setchellianum* in the NWHI, expansive sand-dwelling meadows of *Halimeda kanaloana* in the MHI, and stands of an undescribed species of *Udotea* around west and south O'ahu. Beds of rhodoliths, *Halimeda distorta*, and *Distromium* spp. were common throughout the archipelago. The recent characterization of a shallow water invasive *Avrainvillea* sp. to 80 m depths off O'ahu highlights the need to investigate dynamics of mesophotic communities to better understand the potential threat of this invasive on native shallow and deep communities. Mesophotic macroalgal assemblages in Hawai'i are abundant, diverse, and spatially heterogeneous with some assemblages unique to MCEs, thus highlighting the importance of surveying these deeper depths to fully characterize biodiversity of MCE.

Quantifying the Embodied Environmental Impact of Doubling Hawai'i's Local Food Supply

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*Presenter

Hawai'i imports about 90% of its food, resulting in an extremely low degree of food self-sufficiency. Thus, if food imports to the islands are disrupted, Hawai'i will be subject to major food stress and shortages. To address this vulnerability, Hawai'i's governor recently proposed to double local food production by the year 2030. While an increase in local food production may address Hawai'i's food self-sufficiency issues, expanding or intensifying local agriculture while reducing imports is also likely to affect local and global environmental services.

Here, we present a methodological framework for quantifying the embodied environmental qualities of Hawai'i's current food system to understand differential impacts of locally produced versus imported foods. Through a life cycle analysis (LCA), we will assess the environmental burdens and resource use at every stage of a product's 'life' from farm to plate. Five foods (banana, lettuce, taro, beef, and milk) have been identified to be used as parallels with the rest of the food supply. The LCA will be applied to the current food system as well as scenarios of doubled local food production, to explore the effects of increased agricultural production in Hawai'i. This assessment will provide novel data on the global warming potential and resource use of Hawai'i's food supply chain, as well as the eutrophication and acidification potential from nutrient runoff to the islands' nearshore ecosystems. Understanding the relative impacts of using Hawai'i's lands for agriculture versus relying on imports will aid the State of Hawai'i in identifying and adopting policies likely to encourage more sustainable agriculture.

Salinity, Dissolved Oxygen, Temperature, and pH Predict Use of Freshwater Ponds by Hawaiian Waterbirds in Kawainui Marsh

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In Kawainui Marsh, located on O'ahu, man-made ponds were developed by the U.S. Army Corps of Engineers and the Hawai'i Department of Forestry and Wildlife (DOFAW) to supplement nesting and foraging habitat for endangered, native Hawaiian waterbirds (ae'o - Hawaiian stilt (*Himantopus mexicanus knudseni*), 'alae kea Hawaiian coot (*Fulica alai*), and 'alae 'ula - Hawaiian gallinule (*Gallinula galeata sandvicensis*). Management of hydrological conditions is a priority for DOFAW, as robust water circulation is critical to provide optimal wetland habitat for native waterbirds, as well as to prevent outbreaks of avian botulism. A better understanding of Hawaiian waterbird use of managed wetland habitat in relation to water quality is needed to implement effective management strategies. Weekly surveys were conducted in the wetland pond system to measure water quality parameters (temperature, dissolved oxygen (DO), pH, salinity, turbidity, and oxidation-reduction potential). A census of the number of Hawaiian waterbirds and their behaviors was recorded in the pond system concurrently during these surveys. Generalized Linear Models were used to evaluate relationships between the number of Hawaiian waterbirds and water quality parameters. The number of foraging coots increased with increasing salinity and decreasing temperature ($p<0.001$ and $p<0.001$, respectively). The number of nesting coots increased with increasing pH and decreasing DO ($p<0.001$ and $p=0.04$ respectively), and the number of nesting stilts increased with increasing salinity ($p<0.001$). No significant relationships were identified between water quality parameters and the number of Hawaiian gallinules. Our results will be useful to inform decisions regarding management of Hawaiian waterbird habitat.

Application of Adaptive Management for Monitoring in Two Archipelagos

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Since 2006, United States Pacific Fleet (U.S. Navy) has invested approximately $26M in marine mammal and sea turtle monitoring in the Mariana and Hawaiian Islands in support of environmental compliance for Navy training and testing activities authorized under the U.S. Marine Mammal Protection Act and Endangered Species Act. The decision-making to support a particular portfolio of research projects is guided by a strategic planning process which is informed by programmatic goals and a dialogue with the regulator (National Marine Fisheries Service) via annual adaptive management review. Therefore investments and medium term goals have shifted as the marine species monitoring program has progressed, and is expected to continue to change as shorter term goals are accomplished and new methods, scientific knowledge, and technology become available for achieving the longer term goals of directly assessing the exposure and response of animals to stressors such as sonar. The Mariana and Hawaiian Islands provide a contrast in monitoring needs and illustrates how adaptive management is continually shaping decision-making for making monitoring investments.

Effects of ocean acidification and warming on coral reef cryptofauna in Kaneohe Bay, Hawaii using Autonomous Reef Monitoring Structures (ARMS)

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Ocean acidification and warming can reduce the biodiversity, structural complexity, and resilience of coral reef communities. The goal of this project is to better understand how these climate-induced stressors affect coral reef cryptofauna biodiversity, as well as growth rates and abundances of cryptic sponges. The project focuses on examining responses of entire suites of reef organisms recruiting to Autonomous Reef Monitoring Structures (ARMS) in benthic mesocosms. Twenty-four ARMS units were soaked for two years within a fully factorial mesocosm experiment consisting of four treatments of low and high temperature and pCO2 levels at the Hawaii Institute of Marine Biology (HIMB) in Kaneohe Bay. ARMS plates were removed every other month, weighed, and photographed to examine sessile community composition. At the experiment's conclusion in June 2018, sessile organisms (including sponges, tunicates, crustose coralline algae, tube worms, and bryozoans) were subsampled from all the ARMS plates and DNA barcoded. The plates were then scraped clean, sessile material was homogenized in a blender, and DNA was extracted for metabarcoding to examine biodiversity across treatments. Additionally, images were analyzed in Photoshop to observe sponge species abundance, growth, and turnover rates over time and treatments. This project is the first to investigate the effects of elevated temperature and pCO2 on reef biodiversity across a multiannual scale. Results from this research will help increase our understanding of long-term impacts of climate change on coral reef cryptofauna and advance our conceptual and empirical understanding of how marine ecosystems respond to rapid environmental change.

How Many Species of Sponges Occur in Kāne'ohe Bay, Where Did They Come From & Where Are They Hiding?

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Sponge biodiversity in Kāne'ohe Bay is much higher than previously realized. A detailed survey of sponges over the past year discovered more than 100 new species records not reported in previous studies. Most of these species grow deep in the reef matrix so that they are difficult to detect in visual surveys. We discuss this unknown biodiversity and ask where all these species came from – were they always here and just previously undiscovered, or are some of these cryptogenic sponges actually undetected invasive species? We conducted experiments to ask why some species grow on the reef surface whereas others are restricted to deep in the reef matrix. Using the spotted puffer *Canthigaster jactator*, and tiger cowrie *Cyprea tigris* as model predators, we determine which sponges are chemically defended such that they are avoided, and which appear tasty and likely cannot survive on the surface of the reef. Looking at 18 sponges thus far, we find three species (*Monanchora clathrata*, *Lissodendoryx hawaiiaensis*, and *Spongia* sp. 1) commonly found growing in the open that are avoided by both fish and cowries alike, whereas the others seem to have no defense from predation. These results show that defensive anti-feeding chemicals produced by sponges of Kāne'ohe Bay likely play an important role in determining which sponges can grow in the open and which are confined to protected interstices where predators are unable to reach them. These experiments may lead to biocontrol solutions using native predators for invasive sponges like *Mycale grandis*.

Soil Bacterial Community Response to Removal of Nonnative Feral Pigs from Tropical Montane Wet Forests

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Nonnative feral pigs (*Sus scrofa*) are ecosystem engineers that modify habitats and alter biogeochemical processes. In turn, the value of soil microbial communities for overall ecosystem structure and function is well understood, but the response of soil microbes to large scale management strategies, such as nonnative ungulate removal remains understudied. In this study, we examined changes in the soil microbial community following the removal of feral pigs from native tropical montane wet forests in Hawai'i. The study design utilized five paired study sites consisting of plots inside (feral pigs removed) and outside (feral pigs present) ungulate management units spanning a ~25 year chronosequence of removal in Hawai'i Volcanoes National Park and Pu'u Maka'ala Natural Area Reserve on the Island of Hawai'i. Microbial eDNA was extracted from soil samples and sequenced using the Illumina platform. The resultant data was clustered into >8,500 operational taxonomic units. The results indicate an overall increase in the biodiversity of soil bacterial communities following feral pig removal, with biodiversity positively correlating to time since removal. Additionally, we found that temperature and rainfall correlate to community dissimilarities among individual study sites. These results suggest that feral pigs likely limit the overall resilience of soil microbial communities by reducing biodiversity within the ecosystems they inhabit. Further, the recovery of native ecosystems following the removal of feral pigs can likely be attributed, in part, to increased biodiversity of soil microbial communities.

Habitat Use and Nesting Biology of Hawaiian Short-eared Owls (*Asio flammeus sandwichensis*) on O'ahu

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Pueo, or Hawaiian Short-eared Owls (*Asio flammeus sandwichensis*), play an important role in the cultural and ecological landscape of Hawai'i. Short-eared Owl populations are currently experiencing global declines, likely due to a combination of factors including predation, food availability, disease, and anthropogenic mortality. Despite significant population declines and high relative importance, very little is known about the basic biology of Pueo in the Hawaiian Islands. In this study we will utilize VHF transmitters to track Pueo on the island of O'ahu with the goal of identifying habitat use patterns and describing basic aspects of Pueo breeding biology. Developing an understanding of Pueo biology will help inform land managers how to limit anthropogenic activities in high quality habitat and during peak breeding seasons, potentially resulting in substantial reductions of human-caused mortality.

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