Abstracts

2024 NMFS-Sea Grant Fellowship Research Symposium

Honolulu, Hawai‘i

Sea Grant

Marine Resource Economics

NMFS-Sea Grant Fellow: Karl Aspelund
PI/NMFS-Sea Grant Mentor: Dr. Benjamin Olken and Dr. Min-Yang Lee

Title: Who Gets the Fish? The Distributional Impact of Transferable Quotas
Abstract: Individual transferable quotas are meant to harvest a limited aggregate quantity at lower cost to maximize the value from a fishery. In practice, however, governments design markets to steer that value to particular types of firms or workers, through trade restrictions, exemptions, or even separate markets. To what extent are gains from trade realized with these permit market designs? Who gains from these design choices? Are there designs that improve surplus with the same distributional consequences? I analyze Iceland's permit market in its fisheries, which combines detailed production data and linkages to worker information with many design choices common to permit market design around the world: more lenient regulation for small firms and limiting the share of allocation that can be traded. I show the impacts of the expansion of the permit market to small boats, as well as the consequence of the designs on firms and workers. I then estimate a dynamic model of fisheries harvests and permit market behavior to estimate aggregate surplus and understand how profits were divided across different types of boats. After showing how aggregate surplus evolved as more boats were allowed to trade, I consider under four counterfactuals: no-trading and first-best benchmarks, removing the trading limit, and removing the dual market. I can then consider whether alternative allocations could have generated a Pareto improvement, even to the labor groups that lose out.

NMFS-Sea Grant Fellow: Kaitlyn Malakoff
PI/NMFS-Sea Grant Mentor: Dr. Kailin Droetz and Dr. Ben Fissel

Title: Price impacts of supply chain traceability programs: evidence from the United States' Seafood Import Monitoring Program
Abstract: Unilateral traceability programs are one pathway to improving socio-environmental conditions associated with the harvest of seafood products. One prominent program is the 2017 United States' Seafood Import Monitoring Program (SIMP), which requires improved chain of custody documentation for imports of 13 priority species groups deemed susceptible to seafood fraud and/or Illegal, Unreported, and Unregulated (IUU) fishing practices. We expand on recent advancements in time series econometrics to estimate the initial impacts of SIMP on import prices by comparing observed import prices to forecasts of counterfactual prices. We find an average increase in import price of 10.15%, or 725.16 USD/ton, in the first year of the program. Aggregated across import volume and assuming no quantity change, this represents a $305 million increase in import value. Our analysis provides the first causal evidence that SIMP induced changes along supply chains, motivates future work directly estimating program benefits, and advances methods that can be used in many fisheries economics contexts where policies can have far-ranging impacts and where suitable controls cannot be identified.

Population and Ecosystem Dynamics

NMFS-Sea Grant Fellow: Matthew Marrero
PI/NMFS-Sea Grant Mentor: Dr. Alastair Harborne and Dr. Matthew McPherson

Title: Mapping Recreational Fishing Effort along the Florida Keys Reef Tract
Abstract: Recreational angling accounts for over 75% of marine fish landings in the Southeast United States and is a driver of the tourism industry in the Florida Keys. While recreational fishing is very popular and impactful, there is a lack of data regarding how anglers utilize space. This project aims to sample vessel use in the Florida Keys using satellite imagery over a two-year period. Underlying patterns and drivers are space use are then assessed using generalized linear mixed models (GLMM). Additionally, these data will be used to help parameterize and validate simulation models of recreational vessel space use.

NMFS-Sea Grant Fellow: Katrina Munsterman
PI/NMFS-Sea Grant Mentor: Dr. Jake Allgeier and Dr. Matthew Campbell

Title: Beyond attraction: Building evidence for enhanced fish production on artificial reefs
Abstract: Artificial reefs (ARs) create new habitat with the intention of augmenting fish recruitment and survival; however, their efficacy depends on whether they simply attract fish (potentially promoting overfishing) or if they enhance fish production at ecosystem scale – known as the 'attraction-production debate'. We have shown support for enhanced production on ARs in tropical seagrass ecosystems through an individual based model, whereby consumed-derived nutrients fertilize local seagrass and increase ecosystem-scale seagrass production. But understanding how this increase in primary production translates to secondary production on ARs is still unknown and testing this empirically has proven to be challenging if not impossible. Here, we identified mechanisms by which creating new habitat can enhance new fish production. We collected mark-recapture, acoustic telemetry, and growth data from AR fish populations to parameterize a fish production model and used nearly a decade of time series data from underwater visual surveys to determine the processes that promote fish production on ARs in tropical seagrass ecosystems. Beyond improving production models, our study helps to develop sampling methodologies for assessing the efficacy of ARs for fisheries rehabilitation and management.

NMFS-Sea Grant Fellow: Zoe Rand
PI/NMFS-Sea Grant Mentor: Dr. Trevor Branch and Dr. Paul Wade

Title: Longer mothers tend to have more female calves: evidence for adaptive sex ratio behavior in rorqual whales
Abstract: Various hypotheses address how individuals may adjust fetal sex ratios to enhance their lifetime reproductive success. One hypothesis suggests that, in polygynous mammals, mothers in good condition will produce more males due to the success of larger males in male-male competition. Historical whaling data provide a uniquely large dataset to test this idea. Because the potential sex misidentification of small fetuses complicates analysis, we first estimate the extent of fetal sex misidentification in whaling data by fitting Bayesian models to estimate the lengths at which fetuses are correctly sexed for eight great whale species, finding evidence for frequent sex misidentification at lengths shorter than 30–120 cm. Small females were recorded as males in Antarctic blue (Balaenoptera musculus intermedia), fin (B. physalus), sperm (Physeter macrocephalus), humpback (Megaptera novaeangliae), and sei whales (B. borealis), and small males were recorded as females in Antarctic minke whales (B. bonaerensis). After correcting for sex misidentification, we tested whether longer female rorqual whales have more offspring of one sex using

Bayesian generalized linear mixed models. Across all species, we found a 90% probability that longer mothers produce fewer male offspring with some inter-species variation: greater probabilities in sei whales (99%) and fin whales (94%) and the lowest probability in humpback whales (77%). This evidence implies that in rorquals, longer mothers, with more available energy reserves, invest in female offspring to maximize lifetime reproductive success. These results counter the early hypothesis that larger females invest more in male offspring in polygynous species. In aquatic environments, it may be more difficult to completely exclude small males from competition. Coupled with the relatively high gestation and lactation costs for baleen whales, this implies that females are the "riskier" offspring, as larger females have a significantly higher chance of successful reproduction compared to smaller females.

NMFS-Sea Grant Fellow: Johnna Brooks
PI/NMFS-Sea Grant Mentor: Dr. Jeffrey Buckel, Dr. Jie Cao and Dr. Kyle Shertzer

Title: Development of a seasonal size-structured tag-integrated stock assessment model for spotted seatrout in North Carolina and Virginia
Abstract: Size-structured stock assessment models possess the advantage that knowledge of fish length at time of tagging and recapture are far easier to obtain while having less measurement error compared to age of tagged fish. This is an important benefit when integrating a tagging sub-model into the stock assessment because it allows for the estimation of size-structured parameters such as fishing mortality and natural mortality. Natural mortality often fluctuates with environmental factors such as temperature, as evident from the mass mortality events of spotted seatrout from noted cold stun events. Therefore, I am building a seasonal size-structured stock assessment model for spotted seatrout in North Carolina and Virginia with an integrated tagging sub-model to better inform estimates of natural mortality and growth. This model is currently being developed in Template Model Builder (TMB) and estimates parameters based on likelihood components for removals and abundance indices with plans to include likelihood components for tag-returns, growth, and random effects in the future.

NMFS-Sea Grant Fellow: Max Grezlik
PI/NMFS-Sea Grant Mentor: Dr. Sarah Gaichas and Dr. Sean M. Lucey

Title: Management Strategy Evaluation to Support Portfolio Theory Management of Georges Bank Fisheries
Abstract: When portfolio approaches to fisheries management have been compared to single species approaches in simulation, they have produced favorable outcomes in the form of increased value of the resource, reducing risk, and improving buy-in from stakeholders. Here we conduct a Management Strategy Evaluation (MSE) to test the relative performance of single species and portfolio management of Georges Bank fisheries. Operating models for the MSE were conditioned using an Rpath model for Georges Bank. This analysis found that EBFM of Georges Bank fisheries outperformed single species management both in revenue of the fisheries and minimizing financial risk to achieve the realized revenue. The findings from this work align with and expand upon findings of previous research for this region and advanced the science of EBFM by demonstrating the capability of an emerging tool to aid multispecies decision making in the presence of uncertainty.

NMFS-Sea Grant Fellow: Sophia Rahnke
PI/NMFS-Sea Grant Mentor: Dr. Lisa McManus Dr. Donald Kobayashi

Title: Exploring size-structure, seasonality, and predator-prey interactions in Hawai'i's reef fisheries
Abstract: In Hawai'i, historical reconstructions have revealed that Indigenous fisheries management practices supported high fisheries harvest from reef resources for centuries, without evidence of over

harvesting. Here, we aimed to quantify some of the underlying mechanisms that likely contributed significantly to these historical abundances and the sustainability of fisheries practices. We developed an age-structured predator-prey model that allowed for fisheries harvest across trophic levels and age classes. Within this framework, we examined historical management strategies that focus fishing effort on smaller age classes, implement seasonal fishing restrictions during spawning, and consider trophic interactions between predators and prey. We then paired these historical simulations with scenarios of current-day fisheries management strategies. Through these examples, we investigated management approaches that emphasized fishing effort on larger age classes, implemented year-long rotational closures, and focused on protecting specific functional groups.

NMFS-Sea Grant Fellow: Annie Innes-Gold
PI/NMFS-Sea Grant Mentor: Dr. Lisa McManus and Dr. Tye Kindinger

Title: Restoration of an Indigenous aquaculture system can increase reef fish density and fisheries harvest in Hawai‘i
Abstract: While aquaculture is increasingly considered a globally important source of protein, growing fish for human consumption is not new. Indigenous aquaculture systems, such as loko i‘a (fishponds), were successfully implemented in ancient Hawai‘i and represent a technological advancement designed to sustain a growing human population while maintaining – instead of supplanting – natural ecosystem function in the process of increasing food availability. Biocultural restoration efforts in Hawai‘i, aimed at revitalizing Indigenous stewardship, have included restoration of loko i‘a to sustainably increase the availability of local seafood. While it is clear from historical accounts that loko i‘a can augment fish within estuaries, their role as a nursery ground that supplements surrounding fish populations and fisheries harvest (i.e., providing spillover) remains unstudied in current literature. This study aimed to test the extent to which loko i‘a restoration can supplement fish populations and fisheries harvest both inside the loko i‘a and in the surrounding waters. A food web model was constructed representing nutrients, phytoplankton, fish, and fisheries in three distinct habitats. The model, set in Kāne‘ohe Bay, O‘ahu, Hawai‘i, revealed that there were interactive effects of the area under loko i‘a management, bay fishing effort, and fish dispersal rates on fish density and fisheries harvest. We found that increasing the area under loko i‘a management not only increased loko i‘a fish density and fisheries harvest but also created the potential to supplement bay fish populations and fisheries harvest under certain scenarios. We also identified a tradeoff whereby at high fish dispersal rates, a larger area under loko i‘a management provided maximal benefits to the bay fish population and fisheries harvest, while at low fish dispersal rates, a smaller area under loko i‘a management was more beneficial to bay fish populations and harvest. As expected, loko i‘a also created a surplus of fish within the pond. Our results support the idea that restoration of Indigenous aquaculture systems can positively impact conservation efforts and food security by increasing local fish availability, both through direct production and supplementation of surrounding fish stocks.

NMFS-Sea Grant Fellow: Kristin Privitera-Johnson
PI/NMFS-Sea Grant Mentor: Dr. André Punt and Dr. Richard Methot

Title: Testing Strategies for Incorporating New Information in Fisheries Management
Abstract: Estimates of fish abundance, and hence catch limit recommendations, can change drastically when new data are included in ecological models, adjustments are made to pre-specified parameters, model assumptions are changed, or an entirely new modeling framework is adopted. Such changes can be due to modifications to the fisheries management process, including changes to modeling teams, scientific reviewers, or management terms-of-reference. Sudden large changes in catch limits are undesirable from a socioeconomic viewpoint and should ideally be minimized to the maximum extent possible. This study uses management strategy evaluation (MSE) to evaluate the effectiveness of management strategies

designed to minimize variation in catch, while mitigating potential ecological risks when new assessments lead to changes in fish abundance and catch limit recommendations. Specifically, the study investigates the performance of harvest control rules for long- and short-lived fish that a) gradually introduce new catch limits over time, and b) incorporate constraints on catch limits or fishing mortality rate. Scenarios related to large changes in catch limits are caused by the estimation method being initially misspecified with respect to natural mortality, stock-recruit steepness, catch history, and selectivity form and later implemented with no misspecification. Through modeling the effects of changes in management processes and assessing the implications of fluctuations in fish abundance, we aim to contribute to the broader discussion on identifying effective decision points, tools, and information.

NMFS-Sea Grant Fellow: Samara Nehemiah
PI/NMFS-Sea Grant Mentor: Dr. Michael Wilberg and Dr. Amy Schueller

Title: Evaluating the performance of spatially explicit population models for Striped Bass Morone saxatilis
Abstract: The use of spatially explicit stock assessment models for fisheries management depends on the ability of these models to reliably estimate biological parameters. Simulation studies are useful for determining the implications of available data and mis-specified model structure on accuracy of spatial model estimates of abundance and fishing mortality. A multi-stock, spatially explicit population model was developed to estimate abundance of Striped Bass Morone saxatilis in the Chesapeake Bay and along the Atlantic coast. However, the model has not been evaluated to understand how the accuracy of model estimates changed under different assumptions of stock structure, age composition, and movement, compared to current methods used to inform management decisions. The goals of our study were to assess the performance of spatially-explicit models compared to spatially-implicit models (i.e., fleets-as-areas) to estimate abundance of Striped Bass in the Chesapeake Bay, determine how improved data quality (e.g. stock composition) affects spatially-explicit model performance, and determine the effect of aging error on model accuracy

NMFS-Sea Grant Fellow: Katrina Zarrella Smith
PI/NMFS-Sea Grant Mentor: Dr. Tim Miller and Dr. Adrian Jordaan

Title: Integrating data across spatiotemporal scales using species distribution models
Abstract: Long-term standardized surveys are encountering more frequent disruptions while data of varying resolution and time series length is becoming more accessible, prompting the need for data integration methods that can accommodate gaps and mismatches in data. Alongside this push to integrate and characterize system-wide trends, fine-scale analyses are yielding results that could impact fundamental stock assumptions of shared population attributes. The choice of spatiotemporal scale can therefore be a complicating factor in data decisions for a stock assessment model, especially when varying data sources and associated covariates lead to differences in estimates. Using a case study stock where biomass trends are uncertain, spatiotemporal species distribution models with sdmTMB were generated to enable focus on both regional and stock-level processes. Various model outcomes were explored as data across spatial and temporal scales were gradually aggregated to the stock-level. Ultimately, we demonstrate the sensitivity of the abundance index and perceptions of productivity to various data decisions, providing the foundation for building analytical assessments using newer frameworks.

NMFS-Sea Grant Fellow: Janelle Morano
PI/NMFS-Sea Grant Mentor: Dr**.** Patrick Sullivan and Dr. Kevin Friedland

Title: Heterogeneous spatial distribution of coastwide biomass growth in Atlantic menhaden

Abstract: As a forage species, Atlantic menhaden (Brevoortia tyrannus) support a variety of marine and estuarine fishes (e.g., striped bass, bluefin tuna) and marine protected species (e.g., humpback whales), and their commercial and recreational harvest constitutes the largest fishery, by biomass, in the US. Yet rapidly changing ocean conditions under a warming climate may affect the overall abundance and distribution of this stock, presenting challenges for management of this wide-ranging forage base. We assembled fishery independent survey data across agencies throughout the menhaden coastwide range to describe range-wide spatiotemporal distribution dynamics of this forage base from 1972-2023 and assessed the strength of association of menhaden with key environmental variables. Overall, menhaden indices have increased over the past 10 years and menhaden abundance is increasing in the northern region of its range. While menhaden are potentially expanding its northward range, the distribution of this species is dominated by patterns of local variability and patchiness. Our results indicate that further changes in distribution within its existing range requires continued coordination across state boundaries for managing both fishery resources, protected species interactions, and food web resilience.

NMFS-Sea Grant Fellow: Sarah Weisberg
PI/NMFS-Sea Grant Mentor: Dr. Janet Nye and Dr. Sarah Gaichas

Title: Resilience and efficiency properties differentiate three neighboring food webs of the Northeast US Continental Shelf

Abstract: One major advantage of food web models is that they allow for the quantification of holistic system properties. Integrating system-wide metrics into management, however, is an ongoing challenge. Metrics like relative ascendency provide insight into system resilience, which managers could use to understand potential drivers of change in resilience and use as an indicator to detect ecosystem regime shift. My research focuses on advancing the utility of the relative ascendency metric via an uncertainty-based approach. I have constructed models of multiple ecological production units (EPUs) within the Northeast US Continental Shelf and applied uncertainty-based network analyses to identify the trophic flow pathways most important for food web persistence and resilience. Although the EPUs are adjacent and interconnected and the models are parameterized similarly, I have found fundamental differences in the important flow pathways that affect resilience in each ecosystem.

NMFS-Sea Grant Fellow: Genoa Sullaway
PI/NMFS-Sea Grant Mentor: Dr. Curry Cunningham and Dr. Lauren Rogers

Title: Applying an integrated population model to understand marine processes affecting Yukon River chum salmon productivity

Abstract: Towards the northern end of the chum salmon range, Yukon River chum salmon runs (Oncorhynchus keta, uqurliit means fall chum in Yupik and uqurliruat means summer chum in Yupik, one of the native languages in the region) recently collapsed to below 90% of their long-term average. This collapse resulted in closure of subsistence fisheries, and a significant and detrimental impact on food security and cultural tradition for Alaska Native peoples who are facing a multi-species salmon collapse. Historically, chum salmon have been able to supplement for other salmon species, such as Chinook salmon, during past periods of decline but this is no longer the case. Changes in marine prey availability and environmental conditions have been hypothesized as factors contributing to decline in Yukon River chum salmon abundance, however relative contributions of these factors have not been assessed in an integrated modeling framework. This study uses an integrated population model to identify the relative importance of biological and physical bottom-up processes in influencing Yukon River chum salmon survival. We hypothesize that early marine processes and prey availability will have the largest influence on relative abundance across summer and fall Yukon River chum salmon runs. A better understanding of what

is leading to chum salmon declines in this region will inform fishery management and planning for the benefit of the ecosystems and native peoples of Western Alaska.

NMFS-Sea Grant Fellow: Andrea Odell
PI/NMFS-Sea Grant Mentor: Dr. Marissa L. Baskett and Dr. Kristin Marshall

Title: Harvested Groundfish Species Exhibit Spatial and Temporal Patterns in Somatic Growth
Abstract: Elucidating variability in somatic growth of marine fish can improve estimates of productivity and expected responses following environmental change, supporting more robust and climate-ready fisheries. Oceanographic, ecological, and fishery factors drive variability, which can interact and result in a complex mosaic of somatic growth spanning multiple spatial and temporal scales. We used geostatistical models to characterize spatiotemporal variability in two interrelated traits associated with somatic growth – growth rate and body condition – of nine commercially-important U.S. West Coast groundfish species with contrasting life histories. Our models reveal fine-scale spatial patterning in growth rate and body condition for all nine species. For species with data available in recent years, nearly all show declining growth rates at the regional scale since 2015, potentially in response to the 2014–2016 marine heatwave. Despite downward trends observed in growth rate, body condition remained stable or trended upward through time potentially indicating a weak or negative relationship between growth rate and body condition for some species.