NOAA FISHERIES | National Sea Grant College Program

Fellowships in Marine Resource Economics and Population and Ecosystem Dynamics

2014 Fellows Meeting | Alaska Fisheries Science Center | Seattle, WA | June 16 – 18, 2014

SCHEDULE OF EVENTS — DAY 1 | MONDAY, JUNE 16

	Presentation	Speaker
8:00	Tour of Fishermen's Terminal	Pete Granger, *WA Sea Grant, Marine Advisory Services*
11:00	Lunch	
12:20	Opening Remarks	Laura Oremland, *Fellowship Prog. Manager*
12:30	AFSC Welcome	Steve Ignell, *AFSC Deputy Director*
12:50	The Easy Job of Staying Busy as a NOAA Fisheries Economist	Alan Haynie, *AFSC*
1:20	Linking habitat to stock assessment: rigorously modeling the role of estuarine juvenille habitats in sustaining off-shore fishery production	Ian Kroll, *Univ. of NC–Chapel Hill*
1:40	ss3sim: An R package for Fisheries Stock Assessment Simulation with Stock Synthesis	Cole Monnahan, *Univ. of WA*
2:00	Break	
2:15	Implementing OFLs and ABCs for data-poor stocks managed by the Pacific Fishery Management Council	Martin Dorn, *AFSC*
2:45	Does substock structure matter when fishing pressure is spatially heterogeneous within a managed fishery?	Elizabeth Councill, *Univ. of Miami*
3:05	Quantifying the potential for marine reserves to enhance ecological resilience	Lewis Barnett, *Univ. of CA–Davis*
3:25	Evaluating the ORCS Working Group Approach for data-poor catch estimation using the RAM Legacy Stock Assessment Database	Chris Free, *Rutgers Univ.*
3:45	Break	
4:00	An Atlantis model to inform ecosystem-based management for the Gulf of Mexico	Holly Perryman, *Univ. of Miami*
4:20	Dynamic Efficiency costs of Non-efficiency Objectives in Tradable Permit Programs	Kailin Kroetz, *Univ. of CA–Davis*
4:40	Live Fast, Die Young: The boom and bust dynamics of California market squid	Charles Perretti, *Univ. of CA–San Diego, Scripps Inst. of Oceanogr.*
5:00	Integrating electronic tag information into stock assessment of large pelagic animals	Benjamin Galuardi, *Univ. of MA–Dartmouth*
5:30	Adjourn	
5:45	Social with NMFS scientists	

SCHEDULE OF EVENTS — DAY 2 | TUESDAY, JUNE 17

	Presentation	Speaker
8:30	Development of a novel nested-patch occupancy model applied to river network data	Lynn Waterhouse, *Univ. of CA–San Diego, Scripps Inst. of Oceanogr.*
8:50	Costly avoidance in a multispecies catch share fishery	Andrew Scheld, *Univ. of WA*
9:10	Exploring mechansims of mortality in the first ocean year of Chinook salmon	Jeff Rutter, *Univ. of WA*
9:30	Trends and variability of vital rates in a recovering population of green sea turtles (Chelonia mydas): Potential Tools to Evaluate Population Recovery and Density-Dependence	Susan Piacenza, *OR State Univ.*
9:50	Break	
10:05	Age-structured matrix modeling of burrowing shrimp population dynamics with application of biochemically-based lipofuscin aging method	Katelyn Bosley, *OR State Univ.*
10:25	Modeling the impacts of gear regulations in the northern Gulf of Mexico recreational reef fishery	Steve Garner, *Univ. of South AL*
10:45	Assessing the benefits and costs of modifications to rights-based management programs	Marysia Szymkowiak, *Univ. of DE*
11:05	Lunch and tour of AFSC — *Please join us for lunch in the AFSC Cafeteria at 11:15*	
12:45	Depart for Northwest Fisheries Science Center	
2:00	Panel Discussions	**WA Sea Grant Director:** Penny Dalton **NOAA Fisheries:** Ron Felthoven, Sandra Lowe, Carey McGilliard **Univ. of WA:** Chris Anderson, Trevor Branch, Lorenz Hauser
3:30	Break	
4:00	Discussion with NMFS Science Board on NMFS/Sea Grant Fellowship Program	
5:00	Break	
5:30	Social with NMFS Science Board at the *Ram Restaurant and Brewery*	

ELWHA FIELD TOUR | SCHEDULE OF EVENTS — DAY 3 | WEDNESDAY, JUNE 18

Location: Port Angeles, WA

Meet at the West end of the Safeway Parking lot, ***110 East 3rd Street, Port Angeles, WA 98362***

	Location	Speaker
7:55	**Ferry:** Edmonds to Kingston	
9:45	Arrive Port Angeles, meet at Safeway Parking lot	
10:30	Lower Dam site	Mike McHenry, *Habitat Biologist, Lower Elwha Klallam Tribe*
11:30	Travel to West Beach	
11:45	West Beach: Short discussion, lunch and explore	Ian Miller, *Coastal Hazards Specialist, Washington Sea Grant (HOST)*
12:45	Travel to upper part of lower reservoir	
1:00	Lower Reservoir Hike	Josh Chenoweth, *Restoration Botanist, Olympic National Park*
2:00	Drive into Middle Valley	
2:30	Either middle river stretch or upper dam site	Andy Ritchie, *Elwha Project Hydrologist/ Geomorphologist, Olympic National Park*
3:30	Head Back towards ferry	
5:30	**Ferry:** Kingston to Edmonds	

Additional Speaker: Barb Maynes, *Public Information Officer, Olympic National Park*

Be prepared to...

Bring your own lunch | Spend the day outside | Get muddy!

ABSTRACTS

Age-structured matrix modeling of burrowing shrimp population dynamics with application of the biochemically-based lipofuscin aging method

Katelyn Bosley[1]

Fellow: Katelyn Bosley | **University:** OR State Univ. | **Advisor:** Brett Dumbauld | **NMFS Mentor:** Thomas Wainwright

Abstract: Surveys for the burrowing shrimps, *Neotrypaea californiensis* and *Upogebia pugettensis* demonstrated significant declines in populations of both species over the last decade. Consistently low recruitment has impacted shrimp density and population size, raising concern over the long-term sustainability of shrimp populations in PNW estuaries. Efforts are currently underway to develop a cohort-based population dynamics model for both U. pugettensis and N. californiensis. This Leslie-matrix style population model includes estimates for rates of growth, recruitment and mortality obtained through annual population monitoring surveys conducted in Yaquina Bay, Oregon from 2011 through 2014. Because previous work has shown body size to be weakly correlated with actual age in burrowing shrimp, age structure within these populations will be obtained using analysis of the aging pigment, lipofuscin, as an alternative to size-based aging methods. Age structure information determined though analysis of lipofuscin will then be used to derive growth and mortality parameters for the cohort models. Additional field and controlled mesocosm growth experiments are being conducted to test the lipofuscin aging method and confirm its applicability for estimating shrimp age. Once verified these models can be used to predict changes in Yaquina Bay shrimp populations and potentially be applied to burrowing shrimp populations in other PNW estuaries including Willapa Bay where they cause oyster mortality. The novel methods developed in this study may also assist in building successful harvest plans for other crustacean fisheries.

[1]Dept. of Fisheries and Wildlife, Oregon State University

An Atlantis model to inform ecosystem-based management for the Gulf of Mexico

Holly Perryman[1]

Fellow: Holly Perryman | **University:** University of Miami | **Advisor:** Elizabeth Babcock | **NMFS Mentor:** Michael Schirripa

Abstract: Integrated ecosystem assessments are incremental frameworks that support the implementation of ecosystem-based management. Ecosystem modeling plays a critical role in an integrated ecosystem assessment by providing a means to monitor and assess various management policies (management strategy evaluation), and assist in the analysis of ecological indicators (measurable quantities that track an operational objective). Atlantis is a biogeochemical, "end-to-end" ecosystem modeling framework that provides a detailed coupling of ecology, biology, physical oceanography, and fisheries. Over the last three years, an extensive group of researchers collaborated on the construction of an Atlantis model for the Gulf of Mexico, with the aim at supporting the Southeast Fisheries Science Center's Gulf of Mexico integrated ecosystem assessment. This collaboration has produce various individual studies: i) laboratory dissections to complete a food web model, ii) a general additive models to estimate biomass distributions, and iii) historical landings time series for model fitting. With the Gulf of Mexico Atlantis model soon being applicable for qualitative analysis, my studies will focus on utilizing the Atlantis model to investigate i) the development of ecosystem indicators and targets, with a focus on the fisheries indicators mean trophic level, total landings, and pelagic-demersal ratio, and ii) a management strategy evaluation of the potential impacts of pelagic MPA's on key fisheries stocks, like bluefin tuna. Results from these studies will provide information to the Gulf of Mexico integrated ecosystem assessment, with the aim of promoting sustainability of the Gulf of Mexico ecosystem.

[1]Rosenstiel School of Marine and Atmospheric Science, University of Miami

Assessing the benefits and costs of modifications to rights-based management programs

Marysia Szymkowiak[1]

Fellow: Marysia Szymkowiak | **University:** Univ. of DE | **Advisor:** Lee Anderson | **NMFS Mentor:** Ron Felthoven

Abstract: Rights-based fisheries management programs allocate to fishermen a specified portion of the annual TAC. Fishermen then have the incentive to optimize the value of this share, which has been shown to lead to more economically efficient behavior. Less efficient operators will tend to leave the fishery, decreasing overcapacity, but this exodus can have negative socioeconomic impacts, especially on isolated coastal communities. Managers often seek to minimize these

adverse impacts by implementing community protection measures, which, in turn, restrict the ability of shareholders to optimize the value of their shares, thus reducing the economic efficiency gains possible with unrestricted privileges. Although such measures are common throughout rights-based management programs, the literature on their costs and benefits is sparse. This research addresses this gap by assessing several community protection measures in the Alaskan halibut individual fishing quota (IFQ) program. In the first part of this research, I assess the costs of categorizing quota shares by vessel class and area and prohibiting inter-class and inter-area trading. Using linear programming, a mathematical modeling tool, I estimate the costs of these QS trading restrictions by estimating the potential increases in rent when these restrictions are loosened iteratively. This research demonstrates a different application of linear programming to fisheries management, and the models developed for this research can be adapted to estimate the costs of QS trading restrictions in other rights-based management programs.

[1]University of Delaware, College of Earth, Ocean, and Environment, Newark DE

Costly avoidance in a multispecies catch share fishery

Andrew Scheld[1]

Fellow: Andrew Scheld | **University:** Univ. of WA | **Advisor:** Chris Anderson | **NMFS Mentor:** Andrew Kitts

Abstract: Joint harvest technologies in multispecies fisheries are often characterized by imperfect selectivity, allowing only limited control of catch composition. This type of technology can be modeled by considering outputs weakly disposable, suggesting targeting and avoidance of individual stocks may be costly. In this paper, a simple individual optimization model is considered with a joint production transformation function which relaxes the assumption of free output disposal to analyze decisions under imperfect output selectivity. Costly avoidance, where production of joint outputs is given up to reduce that of the avoided species, is found to result when the marginal reward for landing an avoided stock is negative, a possible consequence of intense regulatory constraint. This model is then applied to New England groundfish, a multispecies fishery recently transitioned to catch share management, to test for costly avoidance. A hierarchical Bayesian estimation procedure is used to uncover marginal rates of product transformation between a constraining stock and the aggregate mix, finding generally positive values heterogeneously distributed throughout the fleet. We reject the null of costless avoidance, indicating constraining output controls for certain stocks decreased joint output of quota-abundant species. Furthermore, a unique management setting in which a constraining species quota increased 600% mid season allows us to identify ex-post costs of quota constraint. We estimate that had the low allocation remained, its cost to harvesters would have been in excess of US $4 million.

[1]School of Aquatic and Fishery Sciences, University of Washington

Does substock structure matter when fishing pressure is spatially heterogeneous within a managed fishery?

Elizabeth Councill[1]

Fellow: Elizabeth Councill | **University:** Univ. of Miami | **Advisor:** David Die | **NMFS Mentor:** Clay Porch

Abstract: This research examines the effects of failures in some of the common assumptions about the distribution of natural and fishing mortality rates both spatially and by age made by many stock assessment models. Specifically it investigates the effects on calculation of the proportion and abundance of mature fish in a two subpopulation connected exploited system using a new hybrid dynamical systems model. Different assumptions about the distribution of mortality rates by age lead to changes in the estimates of the proportion of mature fish and spawning stock abundance within each subpopulation. Long lived and fast maturing fish are most susceptible to changes in calculations of spawning stock abundance and the proportion of mature fish within the population when natural mortality rates are considered constant across age classes, but this pattern of changes in abundance and maturity composition do not hold for short lived or long lived and slow maturing species. Additionally, when connectivity between subpopulations operates in a source-sink fashion, when the higher exploitation rate occurs on the source population, the largest population of mature fish and the highest proportion of mature fish within the stock is achieved. Lastly, when a fishery is assumed to be targeting larger older fish but is actually targeting young adults, mature population structure and abundance calculations are very different than expected, even when the total fishing effort is equal. Information on the age distribution of fishing effort is necessary to determine mature stock composition and abundance.

[1]University of Miami, Rosenstiel School for Marine and Atmospheric Science

Dynamic efficiency costs of non-efficiency objectives in tradable permit programs

Kailin Kroetz[1], James N. Sanchirico[2], Daniel K. Lew[3]

Fellow: Kailin Kroetz | **University:** Univ. of CA-Davis | **Advisor:** James Sanchirico | **NMFS Mentor:** Daniel Lew

Abstract: Economic efficiency is not the sole objective in many Individual transferable quotas (ITQs) programs. Other objectives may include community, cultural, and other non-economic goals. In response to the presence of these non-economic goals, restrictions on trade are often implemented. However, if these restrictions on trade are binding, they likely decrease economic efficiency. We develop a dynamic discrete choice model to investigate the impacts of restrictions on the evolution of a fishery managed with an ITQ program. Using data from the Alaskan halibut and sablefish ITQ program, we model the transition dynamics from the initial allocation of permits and identify the key mechanisms that impact the transition period. Furthermore, by using the model to develop counterfactual scenarios we quantify the magnitude of the economic efficiency loss. We also explore the relative impacts of different types of restrictions and identify interactions between restrictions.

[1]Dept. of Agricultural and Resource Economics, University of California, Davis; [2]Dept. of Environmental Science and Policy, University of California, Davis; [3]Alaska Fisheries Science Center, NMFS, NOAA and Dept. of Environmental Science and Policy University of California, Davis

Evaluating the ORCS working group approach for data-poor catch estimation using the RAM legacy stock assessment database

Christopher M. Free[1], Olaf P. Jensen[1], John Wiedenmann[1], Jonathan J. Deroba[2]

Fellow: Christopher Free | **University:** Rutgers Univ. | **Advisor:** Olaf Jensen | **NMFS Mentor:** Jonathan Deroba

Abstract: In response to the 2006 reauthorization of the Magnuson-Stevens Act, the National Marine Fisheries Service established a requirement to set acceptable biological catch limits for all stocks, including those for which reliable catch data are the only information available. The "Only Reliable Catch Stocks" (ORCS) Working Group approach for the data-poor estimation of acceptable biological catch is being increasingly used but has yet to be evaluated. We will evaluate the ORCS method using data-rich stocks from the RAM Legacy Stock Assessment Database. First, we will identify stock assessments considered reliable by knowledgeable experts and score a subset of these assessments according to the "Table of Attributes" (TOA) criterion defined in the ORCS method. We will use this training dataset to assess the ability of each TOA criterion to predict stock status using boosted regression trees, which will also serve to identify the threshold values that most accurately classify stocks into vulnerability categories. We will apply this refined approach to a subset of data-rich stocks reserved for testing classification accuracy and compare the estimated status to the known status for each stock. Finally, we will evaluate the consistency of TOA scores from different stakeholders to identify criteria that are widely viewed as objective. Because this project is in its infancy, I will also present on my work studying the motivations for increased fishing in Mongolia and the potential impact of illegal fishing on the endemic Hovsgol grayling (*Thymallus nigrescens*) and endangered taimen (*Hucho taimen*), the largest trout species in the world.

[1]Institute of Marine and Coastal Sciences, Rutgers University; [2]Northeast Fisheries Science Center, National Oceanic and Atmospheric Administration

Evaluation of a nested patch occupancy model applied to PIT tagged salmon in a branching river network

Lynn Waterhouse[1]

Fellow: Lynn Waterhouse | **University:** Univ. of CA-San Diego | **Advisor:** Brice Semmens | **NMFS Mentor:** Tomo Eguchi

Abstract: River systems are highly impacted by anthropogenic influences, such as, river channelization, agricultural runoff, urbanization, and dam construction. These impacts have, in part, led to management concerns regarding the diversity of species that use these systems for rearing, migration, and reproduction (e.g., salmon, sturgeon, lamprey, and eels). In an effort to assess the efficacy of restoration actions, and in order to improve monitoring for species of concern, managers have turned to PIT (passive integrated transponder) tag studies with in-stream detectors to monitor movements of tagged individuals throughout river networks. We propose a flexible Bayesian analytic framework that models the movement of tagged individuals in a nested PIT tag detector river network. This model structure allows for imperfect observations by modeling the location of each tagged individual with an underlying state variable. This model framework is applied to data from steelhead (*Oncorhynchus mykiss*) in the Upper Columbia River basin in 2012. The model precision/variance is evaluated as a function of population tagging rates and detection array densities within the river system.

[1]Scripps Institution of Oceanography, University of California, San Diego

Exploring mechanisms of growth and mortality in the first ocean year of Columbia River Basin Chinook salmon

Jeff Rutter[1]

Fellow: Jeff Rutter | **University:** Univ. of WA | **Advisor:** James Anderson | **NMFS Mentor:** Richard Zabel

Abstract: Columbia River Chinook salmon rear in freshwater, migrate to the ocean where they grow until they die or return to spawn. Very little is known about the marine life-history of these salmon—they migrate northward and only a small fraction return. I am developing a model to explore the mechanisms behind the patterns of return we have observed—in particular the number of returns of precocious 1-ocean fish ("jacks") which appear largely decoupled from their out-migration counts. The model is based on a modified McKendrick-VonFoerster partial differential equation—a framework for modeling a cohort's growth and mortality simultaneously. Both growth and mortality are strongly size-differential, and are modeled as such. I model three distinct time periods after ocean entry: northward migration, feeding, and winter. At the end of the first year, the population splits into those that will remain in the ocean and those that will return to spawn as "jacks" using a size-at-age model. I've developed the model to be flexible and incorporate a number of effects, including density dependence and environmental covariates. I have fitted the model to a small amount of data and am working to assemble a broader and deeper dataset in order to better inform the model and examine the larger pattern of jack returns.

[1]School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington

Integrating electronic tag information into stock assessment of large pelagic animals

Benjamin Galuardi[1]

Fellow: Benjamin Galuardi | **University:** Univ. of MA-Dartmouth | **Advisor:** Steve Cadrin | **NMFS Mentor:** Tim Miller

Abstract: Accounting for movement and mixing of fish stocks has the potential to improve stock assessments. However movement rates are difficult to estimate, because they are often confounded with estimates of recruitment, mortality and selectivity. Conventional tagging studies typically rely on fishery recaptures, so tag recovery observations are most appropriately modeled within a tag-integrated stock assessment model, because they are influenced by patterns of fishing mortality and selectivity. As an alternative, electronic tagging provides fishery-independent observations that can support inferences of movement that are external to stock assessment models. Advection-diffusion parameters derived from estimated tracks of tagged fish can be used in simulations to determine seasonal residency in differing geographic regions and movement among regions. The resulting age specific seasonal transfer rates can then be used as input information for spatially-explicit stock assessment models. This framework is applied to Atlantic bluefin tuna using age and time based subsets of a large pop-up satellite tag database. Incorporating complex movement patterns into stock assessment models represents a possible mechanism for consideration of electronic tag data in stock assessments and a basis for evaluation of potential changes in distribution using fishery independent information.

[1]Dept. of Fisheries Oceanography, School of Marine Science and Technology (SMAST), University of Massachusetts, Dartmouth

Linking habitat to stock assessment: Rigorously modeling the role of estuarine juvenile habitats in adult stock dynamics of black sea bass (*Centropristis striata*)

Ian Kroll[1], F. Joel Fodrie[1], C. Kevin Craig[2]

Fellow: Ian Kroll | **University:** Univ. of NC-Chapel Hill | **Advisor:** Joel Fodrie | **NMFS Mentor:** Kevin Craig

Abstract: Degradation of estuarine and coastal systems has threatened valuable ecosystem services, such as juvenile habitat availability, and, as a result, may impact the stability of fish populations. However, it is unknown how specific nursery habitats influence development, or sexual succession, and how that may affect the resulting population structure. Furthermore, models used in stock assessment often ignore the relationship between habitat availability and fishery production by not incorporating a habitat-specific variable in their simulations. My research, which utilizes elemental analysis of otoliths, attempts to quantify the productivity of estuarine and offshore juvenile habitats as a source for the spawning, adult population as well as introduce a demographic modeling approach to the management of black sea bass (*Centropristis striata*). Preliminary analysis of juvenile otoliths from both inshore (estuarine) and offshore (open-coast) habitats from the years 2008-2014 indicates significant differences in signatures amongst sites. These signatures will be compared to those of adult fishes

in order to determine the proportional contributions of estuarine versus offshore habitats in maintaining the black sea bass stock. Growth rate analysis and sex identification of these adults will also help to identify the presence of any carry-over effects resulting from juvenile habitat. Finally, this data will be used to explore the applicability of stage-based population matrices for the assessment of black sea bass.

[1]Institute of Marine Sciences, University of North Carolina-Chapel Hill; [2]NOAA, National Marine Fisheries Service, Beaufort Laboratory

Live fast, die young: the boom and bust dynamics of California market squid

Charles Perretti[1]

Fellow: Charles Perretti | **University:** Univ. of CA-San Diego | **Advisor:** George Sugihara | **NMFS Mentor:** Stephan Munch

Abstract: Market squid (*Doryteuthis opalescens*) currently support the largest and most valuable fishery in California. However, their abundance varies widely from year to year– booming in La Niña, and busting in El Niño. Classic fishery hypotheses suggest that the larval stage may be the key to understanding these swings in abundance (e.g., the Critical Period hypothesis). Here, we combine a time series analysis, a size-distribution analysis, and a growth analysis to uncover the effects of ENSO on larval market squid. Surprisingly, and in exact contrast to population abundance, we find that larval squid actually survive better during El Niño, with a lower mortality rate and a larger size-at-age. In addition, we find that ENSO conditions with a six-month lag provide better predictions of larvae abundance than ENSO conditions during the actual larval stage. In contrast to the classic fishery hypotheses, this suggests that the population bottleneck does not occur during the larval stage, but instead lies later in the squid's life.

[1]Scripps Institution of Oceanography, University of California San Diego

Modeling the impacts of gear regulations in the northern Gulf of Mexico recreational reef fish fishery

Steven B. Garner[1], William F. Patterson[1], Clay E. Porch[2]

Fellow: Steve Garner | **University:** Univ. of South AL | **Advisor:** Olaf Jensen | **NMFS Mentor:** Jonathan Deroba

Abstract: Fishery selectivity at both local and population scales can influence stock assessment model outputs critical to accurate status evaluation and effective management. In the northern Gulf of Mexico, the recreational sector of the reef fish fishery has been modeled historically using an asymptotic form despite catches dominated by relatively young fish. In 2008, circle hooks were mandated when fishing for reef fishes to reduce release mortality, but the impact of circle hooks on catch rates and selectivity had not been tested previously. We conducted multiple fishing experiments to assess the effect of hook size and type on catch metrics for Red Snapper and Gray Triggerfish in the nGOM. We estimated hook (contact) selectivity directly by conditioning catch length distributions on the in situ length distributions observed at artificial reef sites with remotely operated micro ROVs. Selectivity curves were estimated using both fixed (asymptotic) and flexible models capable of either asymptotic or dome-shaped forms, with model fitness based on AICc values. Catch rates and species composition significantly decreased with increasing hook size, but increases in fish length were minimal between large and small hooks. Hook type had no effect on catch metrics. The exponential-logistic function consistently out-performed both the logistic and double-logistic functions and resulted in dome-shaped selectivity for all hook size and type combinations tested for both species. Results from selectivity exercises will be used to inform stock assessment models for Red Snapper and Gray Triggerfish to test the effect of alternative selectivity patterns on stock biomass estimates and projections.

[1]Dept. of Marine Sciences, University of South Alabama, Dauphin Island Sea Lab; [2]National Marine Fisheries Service, Southeast Fisheries Science Center

Quantifying the potential for marine reserves to enhance ecological resilience

Lewis A.K. Barnett[1], Marissa L. Baskett[1]

Fellow: Lewis Barnett | **University:** Univ. of CA-Davis | **Advisors:** Lou Botsford, Marissa Baskett | **NMFS Mentor:** John Field

Abstract: Ecological resilience, the magnitude of perturbation a community can withstand and remain in a given state, is a critical component of ecosystem-based fishery management. No-take marine reserves may enhance resilience by preserving a fraction of the community that can provide larvae to repopulate depleted areas in the event of an environmental or anthropogenic catastrophe. However, intensification of mortality in unprotected areas caused by displaced fishing effort may decrease resilience relative to spreading the total fishing effort across an entire region. We test whether reserves can increase resilience compared to conventional fishery management using a dynamic model of a groundfish community with

structured predation and competition that cause a cultivation effect, generating alternative stable states. Relative to conventional fishery management, reserves increase the range of initial predator densities that result in reaching the desired (predator-dominated) state, thus enhancing resilience. This result holds even when fishing effort is displaced from reserve to unprotected areas in proportion to the areal coverage of reserves. Furthermore, our results indicate that for degraded systems (those in the undesirable, competitor-dominated state), some combination of reserves and culling of competitors or stock enhancement of adult predators may be the most effective approach for restoration of the preferred state.

[1]Dept. of Environmental Science and Policy, University of California, Davis

ss3sim: An R package for fisheries stock assessment simulation with stock synthesis

Cole Monnahan[1], Sean C. Anderson[2], Kelli F. Johnson[1], Kotaro Ono[1], Juan L. Valero[3]

Fellow: Cole Monnahan | **University:** Univ. of WA | **Advisor:** Trevor Branch | **NMFS Mentor:** Jim Thorson

Abstract: Simulation testing is an important approach to evaluating fishery stock assessment methods. In the last decade, the fisheries stock assessment modeling framework Stock Synthesis (SS3) has become widely used around the world. However, there lacks a generalized and scriptable framework for SS3 simulation testing. Here, we introduce ss3sim, an R package that facilitates reproducible, flexible, and rapid end-to-end simulation testing with SS3. ss3sim requires an existing SS3 model configuration along with plain-text control files describing alternative population dynamics, fishery properties, sampling scenarios, and assessment approaches. ss3sim then generates an underlying 'truth' from a specified operating model, samples from that truth, modifies and runs an estimation model, and synthesizes the results. The simulations can be run in parallel, reducing runtime, and the source code is free to be modified under an open-source MIT license. ss3sim is designed to explore structural differences between the underlying truth and assumptions of an estimation model, or between multiple estimation model configurations. For example, ss3sim can be used to answer questions about model misspecification, retrospective patterns, and the relative importance of different types of fisheries data. We demonstrate the software with an example, discuss how ss3sim complements other simulation software, and outline specific research questions that ss3sim could address.

[1]School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington; [2]Earth to Ocean Research Group, Dept of Biological Sciences, Simon Fraser University, Burnaby, British Columbia, Canada; [3]Center for the Advancement of Population Assessment Methodology, La Jolla, California

Trends and variability of vital rates in a recovering population of green sea turtles (*Chelonia mydas*): Potential tools to evaluate population recovery and density-dependence

Susan E Piacenza[1], George Balazs[2], Stacy Hargrove[3], Paul Richards[3], and Selina Heppell[1]

Fellow: Susan Piacenza | **University:** OR State Univ. | **Advisor:** Selina Heppell | **NMFS Mentor**: George Balazs, Paul Richards

Abstract: In Hawaii, green sea turtles, Chelonia mydas, have shown a 5.7% per year population growth since 1973, but with wide annual fluctuations in the abundance of nesting sea turtles, making recovery diagnosis difficult. Currently, the population is under review for down-listing from the US Endangered Species List. The National Research Council has recommended additional demographic research to understand how vital rates vary over time and with population density. In response to this challenge, we evaluated annual changes in vital rates of nesting green turtles from a long-term tagging program at French Frigate Shoals, Northwestern Hawaiian Islands. We used generalized linear mixed models and multistate open robust design models (MSORD) to estimate vital rates and generalized linear models to correlate vital rates with abundance of nesting females. Mean straight carapace length (SCL) showed short term and longer term changes, suggesting shifts in age structure. MSORD models also predicted a year effect on breeding probability, but not adult female survival estimates. A positive relationship between the nesting population and breeding probability was evident, and breeding probability is showing promise as an indicator of population size. Nester SCL did not show a strong relationship with nester abundance. These vital rate estimates differ from published point estimates, and have important implications for population models used to estimate current and future trends in population size. Ours is the first investigation of temporal variability in these vital rates for the Hawaiian population.

[1]Dept. of Fisheries and Wildlife, Oregon State University, Corvallis, OR; [2]NOAA Pacific Islands Fisheries Science Center, Honolulu, HI; [3]NOAA Southeast Fisheries Science Center, Miami, FL