Contents

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Population and Ecosystem Dynamics, 2015

Short-term pain and long-term gain: using phased-in minimum weights to rebuild the Pacific bluefin tuna stock.

Lisa E. Ailloud, Todd Gedamke, John M. Hoenig

The Pacific bluefin tuna stock is highly depleted. A long history of high exploitation rates on very young fish has driven the spawning stock biomass down to just 4% of virgin conditions. We explored the potential benefits of setting a minimum weight regulation as a possible mechanism for rebuilding the stock. Through simulations, we estimated the short- and long-term effects on yield and biomass of different minimum weight restrictions. Data from the 2014 assessment were used to populate the simulations. A variety of scenarios were considered for growth compensation, the stock-recruitment relationship and discard mortality rates; and the present value of the fishery over a 20-year period was calculated by discounting future earnings according to a range of interest rates. The long-term value of the fishery was maximized by setting a minimum weight of 18kg, which resulted in a 70% loss in yield in the first year. To reduce short-term pain to the fishery, we explored the benefits of a phased-in management strategy whereby the minimum size gradually increases as biomass rebuilds. By implementing the minimum weight in two phases (12 kg in year 1, 18 kg in subsequent years) the long-term value of the fishery was maintained and the short-term pain was reduced to a 63% loss in yield in any one year. By implementing the minimum weight in three phases (5 kg, 11kg, and 18 kg) the short-term pain was further reduced to a maximum loss of 45% in any one year. Long term benefits, both in terms of economics and conservation, were quickly diminished with increasing discard mortality. Lowering the minimum size limit to account for discard mortality helped lower short-term pain and recover some economic gains but did so at the cost of conservation.

Key Words: minimum size limit, phased-in management, stock rebuilding plans, spawning biomass, discard mortality, growth compensation.

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Population and Ecosystem Dynamics, 2013

Application of the extractable lipofuscin aging method to estimate mortality and population dynamics of the burrowing shrimp, Neotrypaea californiensis

Katelyn Bosley

Structured population models are among the most widely applied models in population ecology and typically assume that individuals can be divided into discrete classes based on stage, size or age. The lack of robust aging methods in crustaceans has caused researchers to classify individuals based on size but differences in growth among individuals can bias population parameter estimates. Recent advances in aging crustaceans with the biochemically-produced aging pigment, lipofuscin, has created the opportunity to apply age-structured models to understand the population ecology of marine crustaceans. This study sought to apply the lipofuscin aging method to estimate mortality rate in N. californiensis, a burrowing shrimp that inhabits estuaries along the US west coast. While the species is an important member of the estuarine community, N. californiensis also has a negative impact on oyster production in the region. As a result, managers are interested in understanding more about the population dynamics of the species and developing a theoretical cohort-based model to explore these dynamics. Randomized surveys were conducted over a four year period from 2011-2012 to estimate population abundance, average density and population age structure. Mortality rate was estimated to be 0.719 yr-1 (95% CI; 0.633-0.793 yr-1) and did not vary significantly across cohorts. The spatial extent of the survey revealed spatial patterns in shrimp density that could be explained by variation in mortality and recruitment rates. This is the first study to apply lipofuscin aging to estimate population parameters of a crustacean and the methods presented here can be used to inform managers seeking to incorporate population ecology into management plans for N. californiensis and could potentially apply to other crustacean species worldwide.

Key Words: cohort model, age determination, burrowing shrimp, aquaculture

Andrew Carr-Harris

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Marine Resource Economics, 2015

Evaluating the Behavioral Response to Harvest Restrictions and Preferences of Anglers in the Recreational Fishery for Atlantic Striped Bass

Andrew Carr-Harris

Collecting information from recreational anglers about fishing preferences and behavioral stimuli is necessary to infer economic and biological consequences of changes in fisheries management. I provide an overview of the procedures for an upcoming choice experiment survey to be conducted during the summer of 2016 to anglers in the recreational fishery for Atlantic striped bass (Morone saxatilis). The project aims to better understand how changes in harvest restrictions influence angler welfare and fishing effort, and the degree to which economic responses vary between the fishery's diverse user-groups (shore, private boat, and charter boat anglers). A description of the experimental design, survey implementation, and qualitative results from focus groups participants in Massachusetts, New York, and Maryland are presented. A framework is discussed for integrating angler behavior and preferences with stock assessment models and outputs.

Key Words: Recreational fishing, stated preference methods, survey design

Allison Dedrick

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Population and Ecosystem Dynamics, 2014

Quantifying the effects of hatchery management on the portfolio effect in salmon

Allison Dedrick

Diversity within populations can help buffer against collapse in a changing environment. This phenomenon, called the portfolio effect, is particularly applicable to salmon stocks because varied conditions in streams can create runs with diverse traits, such as outmigration timing. In the California Central Valley fall-run Chinook system, which is heavily affected by humans through hatcheries, harvest, and habitat change, eroded diversity among runs could have contributed to the recent population collapse. In particular, hatchery release practices can change the amount of exchange among creeks: juvenile fish released farther from the hatchery and closer to the ocean are more likely to stray and return to a non-natal creek when they return to freshwater as adults to breed. Using a quantitative genetic model with two creeks, one with a hatchery and one without, we investigate the effect of hatchery management practices on the portfolio effect that arises from population dynamics and diversity across creeks. Specifically, we ask whether trucking hatchery fish downstream can drive the homogenization of outmigration timing across creeks and if so, what the consequences are for population dynamics. We find that releasing hatchery fish closer to the ocean results in both genetic and demographic effects across the whole population, not just in the creek with the hatchery. As hatchery fish are released farther downstream, the mean traits become more similar between the two creeks and both the mean and the variance of annual total population size increase, presenting a tradeoff between average total run size and stability through time. These results indicate that hatchery release practices can drive homogenization among streams and weaken the portfolio effect, making returns larger on average but also more variable. We also consider a version of the model without genetics where the hatchery release practices affect the survival and straying of hatchery fish but the genotype distributions of the creeks stay constant through time. In the demographic-only case, there is still a slight tradeoff between average population size and variability through time as hatchery fish are trucked farther downstream but the tradeoff becomes much stronger when genetic effects are considered as well.

Key Words: hatcheries, chinook salmon, environmental variability, selection

Mary Donovan

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Population and Ecosystem Dynamics, 2015

Ecological indicators of coral reefs across multiple spatial scales in Hawai‘i

Mary Donovan

Central to implementing ecosystem approaches to management is providing scientific support for the development of indicators for assessment and monitoring of ecosystem state. When developing indicators it is important to understand the spatial and temporal scaling of the underlying ecological processes, as the most useful indicators will be relevant at multiple scales. This study is investigating ecosystem indicators for Hawaii's near shore marine ecosystems with the goal of identifying the appropriate spatial scale to measure each indicator. The analysis utilizes a synthesis of biological monitoring datasets that is matched with data on environmental and human drivers, and tests for any non-linear relationships or thresholds for each indicator and stressor combination. These relationships are modeled with a Bayesian hierarchical model that accounts for variation due to data coming from multiple sources, and explicitly models relationships at multiple nested spatial scales. The results therefore include both information on indicators for assessing the status of the ecosystem, and the spatial scale at which the information is applicable. The results are important for multiple ongoing management planning processes in Hawaii that operate on fundamentally different spatial scales, and therefore may not be able to rely on the same suite of indicators.

Key Words: indicators, ecosystem, coral reef, bayesian, scale

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Population and Ecosystem Dynamics, 2015

Using VMS Data to Understand the Spatial and Temporal Dynamics of the Commercial Vertical Line Fishery for Reef Fish in the Gulf of Mexico

Nicholas Ducharme-Barth, Robert Ahrens, Sherry Larkin, Bill Lindberg, Kai Lorenzen, and Kyle Shertzer

Commercial fleets play a critical role in the population dynamics of exploited stocks. Understanding the spatial distribution of fleets allow managers to anticipate: issues with lower productivity stocks in multispecies fisheries, the effect of changes in regulations such as lower TACs or spatial/temporal closures for species, and the effect of large scale natural or anthropogenic perturbations. Understanding how effort distributes spatially and temporally allows managers to identify unforeseen consequences when targeted community compositions change and develop a more proactive response to these events. Modern fisheries monitoring techniques including vessel monitoring systems (VMS) have advanced this endeavor, however limitations still exist. The use of VMS data to identify the spatial and temporal distributions of fishing effort has yet to be done for vertical line fishing fleets, and has also yet to be applied to fisheries within the Gulf of Mexico. This project addresses the aforementioned issues in a four step process specifically focusing on the commercial vertical line fishery targeting reef fish in the Gulf of Mexico: 1) a framework for classifying VMS from vertical line fisheries in the Gulf of Mexico targeting reef fish to create spatial distributions of effort, catch, and catch-per-unit-of-effort (CPUE) by species is developed; 2) resultant spatial distributions of CPUE by species will be spatially interpolated to generate relative indices of abundance which will then be compared to existing abundance time series to assess the feasibility of this new data source for use in assessments; 3) multivariate and network analyses of the spatial distributions of CPUE by species will identify the different species complexes that are encountered in the different regions of the Gulf of Mexico and the sub-components of the vertical line fleet that target those species; 4) commercial fleet response to perturbing events (such as regulatory changes, oil spills, hurricanes, red tide, etc..) will be assessed for sub-components of the vertical line fleet targeting reef fish.

Key Words: VMS, spatial analysis, reef fish, commercial fishery, vertical line fishing, Gulf of Mexico, fleet dynamics

Christopher Free

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Population and Ecosystem Dynamics, 2013

Evaluating and refining the ORCS Working Group approach for data-poor fisheries stock status and catch limit estimation

Christopher M. Free, Olaf P. Jensen, John Wiedenmann, Jonathan J. Deroba

The 'Only Reliable Catch Stocks' (ORCS) Working Group approach to data-poor catch limit estimation has been widely used by U.S. fisheries managers in the Southeast Atlantic and Caribbean but its performance has yet to be fully evaluated. The ORCS method involves estimating stock status using a fourteen question 'Table of Attributes' and estimating the overfishing limit by scaling a historic catch statistic based on stock status. We evaluated the performance of the current method by applying it to data-rich stocks with traditional stock assessments in the RAM Legacy Database and found that the method is a poor predictor of true stock status. We refined the current ORCS approach by using boosted regression trees to remove uninformative predictors, weight predictors by their relative importance, incorporate interactions between predictors, and generally build a more predictive model for estimating stock status. We also used catch time series in the RAM Legacy Database to empirically identify the best historic catch statistic and status-specific scalars for estimating overfishing limits. Overall, we show that the refined version of the ORCS approach to data-poor catch estimation is an improvement over the original approach and develop a web tool for managers to implement the new model.

Key Words: data-poor fisheries, data-limited fisheries, catch-only methods, stock assessment, RAM Legacy Database

William Goldsmith

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Marine Resource Economics, 2015

Modeling angler choices, preferences, and values in the U.S. east coast recreational Atlantic bluefin tuna fishery

William Goldsmith and Andrew Scheld

The Atlantic bluefin tuna (Thunnus thynnus) (ABT) is targeted by big-game recreational anglers along the U.S. east coast from Maine to North Carolina, and is thought to be of considerable economic value to anglers and to coastal communities. The National Marine Fisheries Service uses a combination of permitting, size and bag limits, and in-season monitoring in order to maintain landings within internationally and domestically prescribed limits. Despite these strategies, managing the recreational ABT fishery continues to be a challenge, with landings dramatically exceeding allowable catches in some years due to interannual variability in ABT availability, limited predictability of angler effort, and difficulties in accurate monitoring of recreational landings. Researchers continue to study ABT movements, and efforts to improve catch monitoring are ongoing; however, without understanding the drivers of ABT angler behavior, it is difficult to predict how angler effort and harvest may vary as a function of changing fish availability or changes in regulations. In addition, the lack of understanding of ABT angler preferences and values limits the ability of managers to achieve optimum yield for the fishery, as required by the first National Standard of the Magnuson-Stevens Act. To gain insight into the decision-making, preferences, and values of recreational ABT anglers, we surveyed private recreational ABT anglers from Maine to North Carolina. The survey employed discrete choice experiments, a type of stated choice approach, which will be used to determine the regulatory and non-regulatory trip-specific variables that influence the decision to target ABT. Preliminary data indicate a 35% response rate. We will model the decision-making of recreational ABT anglers using discrete choice random utility models in order to quantify, for example, angler willingness to pay for harvesting versus releasing fish, potential non-consumptive values of ABT fishing (e.g., from hooking and losing fish), and overall angler benefits derived from the fishery. We will also examine potential heterogeneity in angler preferences and values by geographic location, avidity, primary gear type used, ABT size classes targeted, and other relevant factors. Results will be communicated to fisheries managers, recreational anglers, and researchers, and will inform domestic management efforts that aim to maximize ABT angler benefits while maintaining catch within biologically acceptable limits.

Key Words: Choice experiment; non-market valuation; recreational fisheries; Atlantic bluefin tuna

Quang Huynh

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Population and Ecosystem Dynamics, 2015

Multispecies Extensions to a Non-equilibrium Length-based Mortality Estimator

Quang Huynh

Recent advances in methodology allow the history of total mortality rate experienced by a population to be estimated from periodic (e.g., annual) observations on mean length in the population. This approach is generalized to allow data on several species that are caught together to be analyzed simultaneously on the theory that changes in fishing effort are likely to affect several species; thus, the estimation of times when the mortality rate changed for one species borrows strength from data on other species that are caught together. Information theory can be used to select among models concerning the degree of synchrony (if any) of mortality changes in a suite of species. The approach is illustrated using data on handline catches in Puerto Rico of three species of snapper: Silk Snapper Lutjanus vivanus, Blackfin Snapper Lutjanus buccanella, and Vermilion Snapper Rhomboplites aurorubens. It is found that the best model is one that provides for simultaneous decreases in mortality rate around the year 1997 and separate magnitudes of changes in total mortality among the species. The simultaneous estimation of parameters can provide for more credibility in the inferred trends in mortality than independent estimation by species.

Key Words: Mean length, Silk Snapper, Blackfin Snapper, Vermilion Snapper, Total instantaneous mortality rate, Fisheries Management, Population Dynamics

Kelli Johnson

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Population and Ecosystem Dynamics, 2015

Same data different story: guidelines for data weighting in a multi-species statistical catch-at-age stock assessment framework

Kelli F. Johnson and André E. Punt

Abstract: Multi-species stock assessment frameworks that use standard statistical tools and are fit to the same data as their single-species counterparts are rapidly developing and may signify the path of least resistance towards an ecosystem-based approach to fisheries management. Nevertheless, the transition from single-species stock assessments to multi-species stock assessments faces many obstacles including but not limited to: (a) increased data requirements, (b) increased uncertainty, (c) decreased transparency, and (d) the inability to generate traditional management reference points. Monte Carlo simulations were used to quantify the effect of changing pre-specified weightings of compositional data on parameter estimates within a multi-species statistical catch-at-age stock assessment framework. Models were fit to diet-composition data, which are often numerous and highly variable, as well as traditional length- and age-composition data and fishery-independent estimates of relative abundance. Three weighting algorithms were applied to each model run that differ in how they treat assumptions regarding correlation in the residuals. Adjusting weights assigned to diet-composition data had the largest impact on estimates of recruitment. Results should be of interest to both stock assessment scientists and fisheries managers because biased estimates of recruitment can lead to ill-informed management reference points.

Key Words: atka mackerel; data weighting; ecosystem-based fisheries management; multi-species stock assessment; Pacific cod; walleye pollock

Katherine Kaplan

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Population and Ecosystem Dynamics, 2014

Marine protected areas limit the spread of the invasive tunicate Didemnum vexillum on Atlantic sea scallop Placopecten magellanicus habitat on Georges Bank

Katherine Kaplan

While the success of marine protected areas (MPAs) in promoting high fish biomass in some fisheries has been well-documented, less well known is how MPAs might serve to protect against impacts from invasive species. In 2002, an invasive colonial tunicate (Didemnum vexillum) was discovered on Georges Bank, and it has since spread both inside and outside of the MPAs located there. It can form dense mats on gravel substrates that are also a preferred habitat for the Atlantic sea scallop (Placopecten magellanicus), which supports a highly valuable commercial fishery. We used Habcam, a vessel-towed underwater imaging system, to investigate the spatial distributions of P. magellanicus and D. vexillum both inside and outside of an MPA. Our results indicate that D. vexillum is more common in areas open to fishing than in the MPA, even taking bottom substrate effects into account. Additionally, we found a negative correlation between P. magellanicus and D. vexillum,suggesting that D. vexillum competes with the scallops for substrate. Our results support the hypothesis that D. vexillum is more prevalent in the areas open to bottom-fishing and the spread of this species may be linked to fishing. This research highlights the potential for MPAs to protect essential fish and invertebrate habitat from degradation due to invasive species.

Key Words: biological invasions, fisheries, essential fish habitat, vessel-towed underwater camera system, sea squirt, non-indigenous species, ascidians

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Population and Ecosystem Dynamics, 2013

Carry-over effects from nursery habitats influence reproductive life history of a coastal marine fish

Ian R. Kroll, F. Joel Fodrie, J. Kevin Craig

Carry-over effects (COEs) are hypothesized to be important drivers of fitness variation within species, however, difficulty in measuring COEs has made specific examples rare. Here, we examined whether use of alternative, putative nursery habitats influences later life-history dynamics (i.e., growth and sexual transition) of the black sea bass (Centropristis striata). First, geochemical signatures from adult otoliths were used to quantify the function of natal habitats as a source contributing to the spawning, adult population. Second, we measured the following potential carry-over effects resulting from the use of estuarine versus offshore nurseries: (1) juvenile-through-sub adult growth rates and (2) timing of female-to-male sexual transition. Overall, 10.6% of 277 adults were linked to offshore nursery habitats. Although we did not find any clear size or growth advantages resulting from the use of either nursery habitat, we did find that sex-at-age varied significantly: fish utilizing inshore nurseries appear to transition earlier than those associated with offshore nurseries. Additional demographic models are being used to examine how changes in nursery habitat contribution could further impact sex-at-age and stock abundance. Though applied to a coastal fish here, these results would be applicable for a wide range of taxa with ontogenetic habitat migrations across life histories.

Key Words: Habitat, estuaries, carry-over effects, black sea bass, geochemical tagging, reproductive ecology

Peter Kuriyama

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Population and Ecosystem Dynamics, 2014

Developing indices of abundance from hook-and-line survey methods in the Southern California Bight

Peter Kuriyama

The Southern California hook-and-line survey has been conducted by the Northwest Fisheries Science Center since 2004 to monitor the untrawlable habitat of the Southern California Bight. Data from the survey have been used in stock assessments and supporting research for a number of shelf rockfish species, such as bocaccio (Sebastes pauicispinis) and vermilion rockfish (S. miniatus). However, an index of abundance estimated from hook-and-line data may be biased due to the fixed-site design of the survey and issues with hook saturation and hook competition. Here, I will present empirical results from the hook-and-line data and results of a simulation study exploring the biases associated with aspects of the survey. Bocaccio are the most sampled species in the survey, and sites with low catch rates of bocaccio have high catch rates of vermilion rockfish. Preliminary results from the simulations indicate that hook saturation causes estimates of abundance to be negatively biased at large population sizes. Additionally, hook competition leads to positively biased indices of abundance, and weighting catch rates by site leads to the least biased index of abundance. These results identify methods of incorporating hook-and-line data from untrawlable habitat into stock assessments and identify biases that are applicable to general hook-and-line survey methods.

Key Words: stock assessment, CPUE standardization, rockfish

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Population and Ecosystem Dynamics, 2014

Effects of Temperature on the Metabolism and Hypoxia Tolerance of Two Demersal Fishes

Benjamin J. Marcek, Richard W. Brill, and Mary C. Fabrizio

Environmental conditions in Chesapeake Bay have been changing for decades. During the last 70 years, the average temperature and the magnitude, duration, and spatial extent of hypoxia (<2 mg O2 l-1) have increased. The former has undoubtedly induced increases in metabolic rates of fishes, as measured by oxygen consumption, and the latter reduced the amount of energy available for processes beyond maintenance of homeostasis (e.g., movement, growth, reproduction). Using intermittent-flow respirometry, we measured the standard metabolic rates (SMR) and maximum metabolic rates (MMR) at 10, 15, 20, 25, and 30oC of two species (Atlantic croaker and spot) common in Chesapeake Bay. The SMR, the metabolic rate of an individual at zero overt activity, for both species and the MMR for spot increased with increasing temperature. The MMR of Atlantic croaker increased with temperature to 25oC, where it plateaued. SMR of spot was greater than that of Atlantic croaker at all temperatures except 10oC and MMR of spot was greater than that of Atlantic croaker at all temperatures. The hypoxia tolerance of both species also increased with increasing temperature, but tolerances were similar at all temperatures tested. Our results suggest that increasing temperatures will result in higher metabolic rates and reduced tolerance of hypoxic conditions for both species; indicating that as temperatures continue to rise and hypoxic areas expand, suitable habitat in Chesapeake Bay for these fishes will decrease. This will result in reduced productivity of the portion of these stocks that rely on Chesapeake Bay for foraging and nursery areas.

Key Words: Hypoxia, Atlantic croaker, spot, metabolic rate, critical oxygen saturation

Lisa McManus

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Population and Ecosystem Dynamics, 2014

Larval dispersal as a mechanism for coral persistence on reef communities

Lisa McManus

Connectivity through larval dispersal is thought to be a major determinant of coral persistence, especially in terms of the recovery potential for populations that suffer catastrophic mass bleaching events. However, our understanding of the interactions between coral recruitment and mortality on reefs is limited, particularly when reproduction occurs in a discrete, seasonal manner as in most stony coral species in the Indo-Pacific. Here, we model coral-algal competition on a reef patch, accounting for larval input from within the patch and an external source. We incorporate coral recruitment in two ways, with larvae arriving either seasonally or continuously through time. Our goals were to (1) determine the conditions under which connectivity can offset the effects of higher mortality due to bleaching and (2) evaluate the impact of recruitment and mortality on the stability of coral- vs. algal-dominated regimes. In general, incorporating coral recruitment, even seasonally, erodes the basin of attraction associated with algal-dominated states. This allows coral to persist in a parameter space that, without larval input, would lead to algal dominance. When coral cover is low, there exists a threshold number of arriving larvae to a patch that will stimulate coral recovery; this threshold depends on the initial algal cover. If algal cover is beyond a critical level, however, no amount of larval input can induce a shift to coral dominance. In this case, there is an increase in the importance of within-patch processes in setting the trajectory towards a particular reef state.

Key Words: Coral larvae, dispersal, competition, alternative stable states

Cole Monnahan

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Population and Ecosystem Dynamics, 2013

Faster estimation of Bayesian modesl in ecology using Hamiltonian Monte Carlo

Cole Monnahan, James T Thorson, Trevor A Branch

1. Bayesian inference is a powerful tool to better understand ecological processes across varied subfields in ecology, and is often implemented in generic and flexible software packages, with the widely-used BUGS family (BUGS, WinBUGS, OpenBUGS and JAGS) being the most common. However, some models have prohibitively long run times when implemented in BUGS. A relatively new software platform called 'Stan' uses Hamiltonian Monte Carlo (HMC), a family of MCMC algorithms which promise improved efficiency and faster inference relative to the MCMC algorithms used by BUGS. Stan is gaining traction in many fields as an alternative to BUGS, but adoption has been slow in ecology.
2. HMC sampling is complex, so we first provide an intuitive illustration of how it works on a set of simple ecological models. We then compare the efficiency between BUGS and Stan using population ecology models that vary in their size, complexity, and hierarchical structure.
3. For fixed effects models, we found little difference between the platforms for relative small and simple models, but Stan consistently outperformed BUGS as model size and complexity grew. Stan also performed well for hierarchical models, but was more sensitive to the parameterization than BUGS. Stan is also more robust to pathologies that lead to biased inference, naturally producing diagnostic warnings where BUGS provides none. Some of the drawbacks of Stan are the inability to use discrete parameters, more complex diagnostics, and a greater requirement for hands-on tuning.
4. Although the BUGS family of software is more widely used, we expect Stan will be a more useful tool for many ecologists utilizing Bayesian inference, and that it will likely extend the boundaries of feasible models for applied problems, leading to better understanding of ecological processes. Fields that would benefit likely include estimation of individual and population growth rates, meta-analyses and cross-system comparisons, and spatio-temporal models.

Key Words: Bayesian inference; No-U-Turn sampler; Markov chain Monte Carlo; Stan; hierarchical modeling

Matthew Nuttall

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Population and Ecosystem Dynamics, 2014

Exploratory Analysis of Factors that Explain Observations of Predator Diet

Matthew Nuttall

Predator-prey relationships are typically quantified from diet studies that are limited in spatial and temporal scope and concentrate on only a few species, necessitating the use of multiple studies. However, the use of multiple studies typically results in considering ecosystems, habitats, time periods, and/or life stages that are beyond the scope of research objectives. For example, the objective of my second chapter is to obtain predictions of the dietary habits of predators observed to prey upon Brevoortia spp (i.e. menhaden) in the current northern Gulf of Mexico (GOM) ecosystem. To obtain such predictions requires a method to control for the effects of area, time, and any other study-specific factors that have influence on predator diet. These effects may also differ between prey species, requiring testing of a number of prey-specific effect parameters. To inform decisions as to which factors need to be controlled and for which prey groups, I conducted a canonical correspondence analysis to assess the relative influence of study area, time, sampling gear, and predator species on prey-specific observations of predator diet. This analysis is conducted on data collected from a variety of active, opportunistic, pelagic predators (e.g., tunas, mackerels, jacks, billfish).

Key Words: Predator Diet; Predictors; Meta-Analysis; Canonical Correspondence Analysis; Gulf of Mexico

Cecilia O'Leary

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Population and Ecosystem Dynamics, 2015

Demonstrating the influence of temperature dependent vital rates on fish abundances through hierarchical Bayesian models

Cecilia O'Leary and Janet Nye

Climate can impact fish population dynamics directly through changes in vital rates or indirectly through changes in connectivity or ecosystem productivity. This project aims to determine how variation in fish population vital rates between subpopulations across time can account for observed shifts in productivity, how this variation can be incorporated into a stock assessment framework, and how this impacts management. Using summer flounder (Paralichthys dentatus) as the model species, the effect of climate on fish demographic rates was considered as a potential driver of abundance patterns. The influence of temperature was explored through various functional forms of natural mortality and stock-recruitment relationships. Simulations for Paralichthys dentatus included temperature as a nonlinear covariate predictor of natural mortality and stock-recruitment, vital rates critical to population persistence. The effects of climate and spatial dynamics can be integrated into a spatially implicit stock assessment model. The results describe patterns in productivity over time as influenced by temperature-dependent natural mortality and stock recruitment to be used when considering various scenarios of climate change in future management.

Key Words: modelling, Bayesian, temperature, hierarchical, summer flounder

Jeffrey Shrader

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Marine Resource Economics, 2014

Expectations and adaptation to environmental risks

Jeffrey Shrader

Responses by economic agents to environmental risks--also called environmental adaptation--informs optimal policy, determines costs, and influences the interpretation of empirical analyses. These issues are well known, but to date, estimating environmental adaptation has been challenging. This paper introduces a method for identifying adaptation based on changes in expectations about a stochastic environmental process, provides conditions under which public forecasts of the environmental process are good proxies for these expectations, and applies the method. Using a novel dataset of El Nino/Southern Oscillation (ENSO) forecasts, I estimate total adaptation by North Pacific albacore harvesters to ENSO-driven climate variation. The results show that in this setting, at least three quarters of the damage from ENSO can be eliminated through adaptation.

Key Words: Expectations, climate, fisheries, adaptation

Christine Stawitz

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Population and Ecosystem Dynamics, 2014

The importance of somatic growth variability in population production.

Christine C. Stawitz, Timothy E. Essington

Fisheries researchers have long documented variability in recruitment as the most significant driver of production variability in marine stocks. Recently, there is an increasing awareness that somatic growth variation also can drive changes in productivity, yet few studies have compared the relative and combined effects of variability in these demographic processes on production across stocks. In this study, we use a simulation analysis to contrast these relative effects across several life history types. Realistic growth and recruitment variability time series are generated across a number of scenarios (i.e. low and high coefficient of variation [CV] for each process) and input into a standard age-structured fisheries population model parameterized using fisheries stock assessment estimates for eight life history types. We quantify and compare variability in the output surplus production and spawning stock biomass across scenarios with growth variation only, recruitment variation only, and both types of variation, and across three fishing rates. We find that somatic growth variability induces biomass fluctuations that are almost as large as or larger than recruitment variation for three species (petrale sole [growth variation scenario biomass is 1.99x magnitude biomass CV under Fmsy], canary rockfish [1.33x], Pacific cod [.90x]). Somatic growth variability was found to induce production fluctuations more than recruitment variation in four species (Pacific cod [3.46x magnitude surplus production CV under Fmsy], petrale sole [5.49x], canary rockfish [4.57x], widow rockfish [1.42x]). The relative effect of each type of variability did not correspond with life history traits. Rather, species with higher empirical estimates of recruitment variability were more strongly driven by recruitment, and higher output variability in growth variation scenarios corresponded with a larger magnitude autocorrelation in somatic growth time series. This study suggests estimates of somatic growth variability may be important to include in population dynamics and fishery management models. Additionally, we highlight the importance of collecting empirical time series data on life history variation in marine fish, as time series characteristics of this variation might play an important role in mediating how exogenous variability affects populations.

Key Words: population dynamics, life history, somatic growth, early life history, simulation analysis

Mark Stratton

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Population and Ecosystem Dynamics, 2014

Climate and fishing predictors of abundance for U.S. South Atlantic coastal fishes and invertebrates

Mark Stratton

Abundance of marine stocks fluctuate in response to external drivers, including the physical environment, fishing, and trophodynamic interactions. In combination with internal population processes (e.g., density-dependence), these factors interact and integrate to determine abundance by exerting influence on vital rates such as growth, survival, recruitment, and demographics such as age composition and spatial range. Research investigating ecosystem drivers has been limited to data-rich systems, primarily in the North Atlantic and Pacific. Towards a more holistic understanding of important ecosystem drivers in the Southeast U.S. Continental Shelf Large Marine Ecosystem (U.S. Southeast LME), we modeled the effects of climate and fishing covariates on 71 fish and invertebrate (crustaceans and squids) species sampled by a coastal trawl survey. Fourteen species exhibited strong, persistent associations with one or more fishing and climate factors. We detected direct and indirect fishing effects, namely for elasmobranchs and crustaceans, driven by changes in bycatch mortality within a penaeid shrimp fishery. Among cold-season climate indices, the Pacific Decadal Oscillation was most prevalent in well-supported dynamic linear models. The Western Bermuda High Index and Pacific North American Pattern, which were most prevalent among warm-season indices, warrant further analysis at temporal and spatial scales matching species-specific spawning and recruitment periods. Observed annual abundance trends were synchronous among some taxonomically-related species, highlighting similar responses to external influences based on life history strategy. This study, the first multispecies investigation of ecosystem drivers in the Southeast U.S. LME, strengthens the foundation for advancing ecosystem-based fisheries research within the region.

Key Words: ecosystem approach to fisheries; climate teleconnections; bycatch

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Developing an alternative approach to managing fisheries using food web dynamics

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In 2002, Nature featured an article with the attention-grabbing title ``Commercial fisheries worldwide are being driven to collapse''. It voiced a growing concern that conventional single-species fisheries management has failed and that fisheries scientists must abandon their focus on individual stocks and adopt an ecosystem perspective. Most managed stocks rely on single-species stock assessments to provide the necessary information to support sustainable harvest. In many cases these approaches have worked, especially when fisheries data and enforcement are adequate and the environmental regime is highly productive. However, fisheries failures have occurred in cases where single-species models have not accounted for changes in ecosystem dynamics. Within the past twenty years, there has been a push to use and create ecosystem-based models; despite this, there is a relative paucity of information on their shortcomings. Ecosystem-based models have significantly more parameters than single-species models due to the additional ecological processes that need to be modeled such as trophic interactions, energy transfer efficiency rates, and predator-prey feeding habits. Given the complex nature of ecosystems, data limitations will always exist for ecosystem-based models. As such, ecosystem-based models generally have a plethora of unknown parameters that need to be estimated from the data and are therefore often criticized due to their potential for higher uncertainty and lower precision when compared to single-species models. Given the natural complexity in ecosystems, there is a possibility that there will never be enough data to include all the relevant interactions and to make strong enough assumptions to reduce the amount of uncertainty. Instead of attempting to explain all the ecological processes in one model, a possible approach is to take a step back and look at the ecosystem in a broader context. By applying ecological theory, such as food web dynamics and energy transfer efficiency rates, we can come up with a more feasible model to examine a fish's population dynamics. This talk will focus on how we can use this approach to provide a more robust approach of quantifying the carrying capacity of an ecosystem.

Key Words: transfer efficiency rates, trophic levels, net primary production, Eastern North Pacific Ocean

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Summary of the Stock Assessment for White Seabass for the State of California

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An integrated sex-specific statistical age-structured model with sex-specific growth estimated within the model was implemented using the stock assessment platform Stock Synthesis 3 to assess white seabass (Atractoscion nobilis) from California, USA. White seabass have been exploited for more than 125 years. The first quantitative records date back to 1889. Alternative model runs were conducted covering white seabass dynamics between 1889-2014 and 1969-2014. The model is fit to several relative indices of abundance: Commercial Passenger Fishing Vessel (CPFV) historic (pre-1980), CPFV modern (post-1980), drift gillnet logbook catch-per-unit-effort (CPUE), set gillnet logbook CPUE, Hubbs SeaWorld Research Institute (HSWRI) gillnet CPUE and Power Plants Heat Treatment CPUE. The relative indices of abundance were calculated using the delta-glmm method with a gamma function for positive values. Length data was available for a portion of the recreational and commercial fisheries. Under Pacific Fishery Management Council (PFMC) Groundfish management policy, if the current spawning biomass of a stock falls at or below 25% of the unexploited biomass, the stock is considered overfished. The base case model estimates white seabass female spawning biomass in 2015 at 569 mt (~95% asymptotic interval: 241- 896 mt). Virgin unfished female spawning biomass (B0) is estimated at B0: 2092 mt (~95% asymptotic interval: 1600 - 2584 mt). The base case model estimates 2015 depletion at 0.27 (~95% asymptotic interval: 0.16- 0.39). This level is below what would be a PFMC biomass target of 40% depletion, but above what would be a PFMC minimum stock size threshold of 25% biomass depletion. The assessment also results in a list of research needs for the species as well as areas of concern with the data used in the assessment.

Key Words: white seabass, stock assessment, delta glmm, ss3

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Effects of hatchery supplementation on variability in Chinook salmon populations

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Disentangling the causes and consequences of variability in fish populations has long been a focus for ecologists, motivated both by scientific curiosity and the need to sustainably manage harvested stocks. Analyses of stochastic population models with density dependence during recruitment have indicated that age-structured populations should be more sensitive to low frequencies and generational frequencies in their environment, a phenomenon termed cohort resonance. These sensitivities, and the overall variability in abundance increase with decreasing survival, such as through fishing. Testing whether these important effects appear in nature requires examination of actual population time series. For salmon, such testing may be hampered by the fact that many populations are supplemented by hatchery fish, and the effect of supplementation on variability is unknown. Here, we describe how annual additions of hatchery fish to a salmon population would change expected responses. We also explore how the distribution of environmental variability, experienced during freshwater residence or ocean entry, along with the management decision to truck hatchery smolts, influences the results. Our model was parameterized for Chinook salmon, a species often heavily supplemented by hatcheries, and includes management considerations applicable to the Sacramento River Fall-run, but could be easily adjusted for other populations and species. We used analysis of the equilibrium condition and wavelet analysis of stochastic simulations to determine both the overall sensitivity, and the time scales of variability to which populations with hatchery supplementation are sensitive. We found that when environmental variability was limited only to ocean entry, adding hatchery juveniles raised the equilibrium recruitment values as expected but only slightly diminished the coefficients of variation (CV) of spawner abundances. By comparison, greater population stability (i.e., a reduced CV) resulted when environmental noise was reallocated, such that recruits experienced variability during both freshwater residence and upon ocean entry. A notable exception was that a large fraction of hatchery smolts (90%) increased population stability when noise was limited to freshwater, and those juveniles were able to bypass downstream migration through trucking. Compared to its effects on total population variability, hatchery releases more substantially altered the time scales of population variability. Adding hatchery fish decreased sensitivity to generational frequencies and increased sensitivity to low frequency environmental variability, towards the frequency response (time scales of population variability) of the unexploited and unsupplemented population. However, the latter change in sensitivity was lessened

when freshwater noise was increased and juveniles were not trucked. While this study provides an initial assessment of the interaction among age-structured dynamics and hatchery management decisions (adding hatchery fish and trucking the smolts), additional modeling is needed to assess the comprehensive effects of other factors on salmon population variability.

Key Words: hatchery, cohort resonance, fishing, salmon