National Marine Fisheries Service
and
Sea Grant College Program

Graduate Fellowship Program
in
Population Dynamics
and
Marine Resource Economics

2012 Annual Meeting

NOAA Fisheries Service – National Sea Grant College Program

Fellowships in Population Dynamics and Marine Resource Economics

2012 Fellows Meeting

California Sea Grant
Southwest Fisheries Science Center
La Jolla, CA

April 24–25, 2012

Tuesday, April 24	**Scripps Forum Auditorium**, Scripps Institution of Oceanography
8:30—9:00	Continental breakfast and coffee (Fellows, NMFS and Sea Grant staff)
9:00—9:30	**Welcome and Introduction** James Eckman—Director, California Sea Grant Cisco Werner—Director, Southwest Fisheries Science Center Terry Smith—Fellowship Coordinator, NMFS and National Sea Grant Office
9:30 –12:00	**Fellows' seminars** (see seminar schedule)
12:00—1:00	**Lunch** (catered for Fellows, NMFS and Sea Grant staff)
1:00 –5:00	**Fellows' seminars** (see seminar schedule)
5:30—7:30	**Reception** Martin Johnson House (T-29), hosted by California Sea Grant
Wednesday, April 25	**Martin Johnson House**, University California San Diego
8:30—9:00	Continental breakfast and coffee (Fellows, NMFS and Sea Grant staff)
9:00 –12:00	**Meet the Scientists** The fellows will break into sections—population dynamics and marine resource economics—and meet with NMFS scientists in those focus areas in informal group discussions
12:00—1:00	**Lunch** Lunch will be provided to the fellows at Russell Johnson House. Other scientists are welcome to join the group for informal discussion.
1:00—2:00	**Fellowship Discussion** Discussion with fellows relative to program requirements, future schedules, completion timing issues and other issues of interest
2:00 pm	**Adjourn**

The Fellowships

In 1999, NOAA National Sea Grant Office and NOAA Fisheries established a Graduate Fellowship Program in two specialized areas: population dynamics and marine resource economics. Population dynamics is the study of fish populations as affected by fishing mortality, growth, recruitment and natural mortality. Ph.D. candidates interested in the population dynamics of living marine resources and the development and implementation of quantitative methods for assessing their status can receive up to three years of funding. Ph.D. students in marine resource economics, concentrating on the conservation and management of living marine resources, can receive two years of funding.

The four main goals of the NOAA Fisheries/Sea Grant Fellowship Program are:

- *To encourage qualified applicants to pursue careers in either population dynamics and stock assessment or in marine resource economics*
- *To increase available expertise related to these fields*
- *To foster closer relationships between academic scientists and NOAA Fisheries*
- *To provide real-world experience to graduate students and accelerate their career development.*

Fellowships in Population Dynamics and Marine Resource Economics

2012 Fellows Meeting

SEMINAR SCHEDULE
Tuesday, April 24
Scripps Forum Auditorium

Session I

9:30 – 9:50	**Jocelyn Lin**, University of Washington *jl3335@u.washington.edu* *Linking evolution to demography: modeling local adaptation and dispersal in wild salmon populations*
9:50 —10:10	**Patrick Lynch**, Virginia Institute of Marine Science *pdlynch@vims.edu* *Incorporating exploited habitats into estimates of relative abundance for highly migratory species in the Atlantic ocean*
10:10— 10:30	**Skyler Sagarese**, Stony Brook University *ssagares@ic.sunysb.edu* *Assessing spiny dogfish migration and population dynamics in the Northwest Atlantic: Progress on habitat modeling and factors influencing survey catchability*
Break	
10:40— 11:00	**Emil Aalto**, University of California Davis *aalto@ucdavis.edu* *Ecological obstacles: evolutionary trajectories and predator-prey interactions in a size-selective harvest model*
11:00—11:20	**Mark Henderson**, Virginia Institute of Marine Science *mhender@vims.edu* *Using growth models to discern recreational angler noncompliance with minimum length regulations*
11:20—11:40	**Mark Fitchett**, University of Miami Rosenstiel *mfitchett@rsmas.miami.edu* *Satellite logbook system to remotely capture real-time data to define billfish population densities and fishing effort distribution: the Guatemala billfish sport fishery as a case study*
11:40—12:00	**Dan Goethel**, University of Massachusetts Dartmouth *dgoethel@umassd.edu* *Incorporating spatial population structure in stock assessment models of marine species*

Fellowships in Population Dynamics and Marine Resource Economics

2012 Fellows Meeting

SEMINAR SCHEDULE
Tuesday, April 24
Scripps Forum Auditorium

Session II

1:00—1:20 **Geret DePiper**, University of Maryland *gdepiper@arec.umd.edu*
To bid or not to bid: an investigation into economic incentives underlying auction participation

1:20—1:40 **Peter Hayes**, University of Maine *pshayes@maine.rr.com*
An adaptive agent-based model of Maine fisheries

1:40—2:00 **David Kling**, University of California Davis *dmkling@ucdavis.edu*
Taming the lionfish

2:00—2:20 **Andrew Ropicki**, University of Florida *aropicki@ufl.edu*
An analysis of harvest efficiency gains from IFQ implementation in the Gulf of Mexico red snapper fishery

2:20—2:40 **Elizabeth Councill**, University of Miami *emartin@rsmas.miami.edu*
A comparative theoretical study of age-structured fish subpopulations

2:40—3:00 **Ben Galuardi**, University of Massachusetts Dartmouth *galuardi@eco.umass.edu*
Incorporating electronic tag information in stock assessments

Break

3:10—3:30 **Dovi Kacev**, San Diego State University *dkacev@sunstroke.sdsu.edu*
Incorporating genetic data into a population assessment for pelagic sharks

3:30—3:50 **Charles Perretti**, Scripps Institution of Oceanography *cperrett@ucsd.edu*
A comparison of model-free versus mechanistic forecasting for nonlinear ecological systems

3:50—4:10 **Holly Ann Perryman**, University of Miami Rosenstiel *hperryman@rsmas.miami.edu*
An Atlantis model to inform ecosystem-based management for the Gulf of Mexico

4:10—4:30 **Sam Truesdell**, University of Maine *samuel.truesdell@maine.edu*
Recruitment spatial dynamics of Atlantic sea scallops

4:30—4:50 **Matthew Smith**, Virginia Institute of Marine Science *mws212@vims.edu*
Impact of epizootic shell disease on the American lobster in southern New England

4:50—5:00 **Melissa Hedges Monk**, Louisiana State University *mhedge1@lsu.edu*
The impact of fishing on food web dynamics and single-species stock assessment decisions through the use of a Lotka-Volterra food web model

5:00 **James Thorson**, University of Washington *JimThor@uw.edu*
Multi-state robust-design tag-resighting models for skip-nesting species such as sea turtles and birds

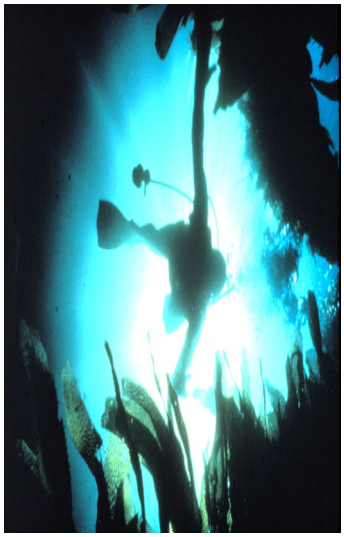
Sea Grant

Population Dynamics Fellows–Abstracts

Linking Evolution to Demography: Modeling Local Adaptation and Dispersal in Wild Salmon Populations

Jocelyn Lin[1]
Jeffrey J. Hard[2]
Lorenz Hauser[1]
[1]*School of Aquatic and Fishery Sciences, University of Washington,* [2] *Northwest Fisheries Science Center*

Microevolutionary processes determine levels of local adaptation within populations and presumably affect population productivity, although evolutionary change has rarely been linked explicitly to population dynamics. Here, we developed a stochastic, individual-based model that simulates evolutionary and demographic effects of gene flow and selection in interconnected sockeye salmon (*Oncorhynchus nerka*) populations. Two populations were simulated, representing beach and stream spawning ecotypes. Individuals undergo a full salmonid life cycle, experiencing sexual selection, size-selective harvest, predation, and natural stabilizing selection based on body length at maturity. Body length, body depth and age at maturity are tracked for each fish, and these three traits evolve in a genetically correlated manner. Simulation results showed that stabilizing selection on fish phenotypes was always critical for maintaining local adaptation, especially when dispersal rates were high, but loss of local adaptation did not result in substantial loss of productivity. Rather, productivity was more strongly affected by the opposing effects of stabilizing and harvest selection, as strong stabilizing selection caused the salmon to evolved larger body sizes that made them more vulnerable to the fishery. These results suggest that the selection pressures affecting wild populations merit further study.



Incorporating Exploited Habitats Into Estimates of Relative Abundance for Highly Migratory Species in the Atlantic Ocean

Patrick D. Lynch
Kyle W. Shertzer
Robert J. Latour
Virginia Institute of Marine Science

Comprehensive monitoring programs do not exist for highly migratory species due to the high cost of implementation. Therefore, fishery-dependent data are used for making inferences about population dynamics. Relative trends in abundance are typically estimated by standardizing fishery catch rates to account for factors (in addition to changes in abundance) that may influence catch rates. Exploited habitat has been demonstrated to be an important factor to consider when estimating abundance indices from pelagic longline fishery data. However, due to uncertainty surrounding habitats fished, this factor is not typically incorporated, but rather proxies are used, such as gear configurations or target species. Using fisher logbook data from the United States pelagic longline fishery, we estimated indices of abundance for a suite of highly migratory species in the Atlantic Ocean following an approach that has been shown to be insensitive to errors in estimates of habitats exploited. We defined habitat variables as temperature regimes, and incorporated these variables into the contemporary approach to data truncation, variable estimation, and model selection typically used when analyzing these data. A habitat variable was selected for inclusion in the statistical models for all species analyzed except yellowfin tuna, and for several species, this variable explained a substantial amount of the variability in catch rates. Indices of abundance were then estimated for all species analyzed using the selected models.

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Sea Grant

Population Dynamics Fellows-Abstracts

Assessing Spiny Dogfish Migration and Population Dynamics in the Northwest Atlantic: Progress on Habitat Modeling and Factors Influencing Survey Catchability

Skyler Sagarese
School of Marine and Atmospheric Sciences, Stony Brook University

Recent declines of principal groundfish stocks in the northwest Atlantic have promoted harvest of previously undesirable and undervalued spiny dogfish (*Squalus acanthias*). The sustainability of this resource has been questioned by management after years of unrestricted harvest of fecund females, highly skewed sex ratios and reduced recruitment in fishery-independent surveys, and declining size in both fishery-dependent and -independent surveys. Complex migratory behavior, high variability in distributional trends and ubiquitous abundance introduce uncertainty into the assessment of this elasmobranch. For neonate, juvenile, and adult spiny dogfish, I am investigating: (1) habitat preference and the influence of density-dependent and -independent factors on seasonal and decadal distribution and abundance (2) potential driver(s) of these distributions by relating environmental, spatial, temporal, and biological variables to the occurrence and abundance of each life-stage using generalized additive models (GAM) and boosted regression trees (BRT), (3) diurnal variation of catch rates in fishery-independent bottom-trawl surveys and the resulting influence on relative indices of abundances, and (4) the dynamics of spatial and temporal interactions among spiny dogfish and commercial fishers in the northwest Atlantic. Fishery-dependent and -independent data were provided by the Northeast Fisheries Science Center (NEFSC) observer program (1989-2010) and annual bottom trawl surveys (1963-2009) for both spring and autumn. Highly variable distributional trends and significant habitat associations were documented both within and between stages. Spring occurrence of most stages was predominantly controlled by environmental properties whereas temporal variables were also important during autumn. Spring trends in abundance identified bottom temperature as highly influential for most stages whereas during autumn biological factors predominantly controlled abundance. Generally, all stages revealed higher CPUE during the day compared to night during both seasons. Upon completion of this ongoing project, our results will enhance assessment of this species by contributing stage-specific information on habitat selection, population ecology, and catchability and reducing inconsistencies in trend monitoring.

Ecological Obstacles: Evolutionary Trajectories and Predator-prey Interactions in a Size-selective Harvest Model

Emil Aalto
University of California Davis

Fishery harvest affects target species through mechanisms besides simple population loss. Heavy mortality can exert strong evolutionary pressure as well through its effect on species demographics. Size-specific harvest has been shown to produce rapid changes in growth rate and size at maturity in both models and observations. The effect of species interactions on this evolutionary response is less well understood. The presence of other species may constrain the evolutionary trajectory through predation or competition while, reciprocally, the strength of those interactions may be altered by the ongoing trait change in the target species. Marine predators are often gape-limited, and a smaller prey adult size would be expected to increase the effects of predation by increasing the proportion of the population vulnerable to attack. I use a two-species quantitative genetics model to examine how optimal size under harvest changes with the addition of a gape-limited predator. I compare results for a generalist predator with those for an obligate Nicholson-Bailey predator to determine which forms of predation exert the greatest selective pressure. In general, the model suggests that the evolutionary effects of fishing can intensify the negative effects of gape-limited predation and lead to extinction under lighter harvest levels than single-species models would indicate. Although the target species may be capable of evolving in response to strong directional selection from harvest, the niche space it is evolving toward must be able to support it. If increased predation or competition make coexistence impossible, then it will be forced into extinction.

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Population Dynamics Fellows–Abstracts

Using Growth Models to Discern Recreational Angler Noncompliance with Minimum Length Regulations

Mark Henderson
Virginia Institute of Marine Science

Angler noncompliance with management regulations can severely degrade the ability of fishery managers to prevent overexploitation of a fish species. To discern recreational angler noncompliance with minimum size limits for Chesapeake Bay summer flounder we fit a series of growth models to mark-recapture data collected by a volunteer angler-tagging program conducted in Virginia from 2000-2011. Based on data from 3474 recaptures, the most appropriate growth model included a parameter that accounted for individual variability in growth, parameters for two different growth phases, separate measurement error terms for fish recaptured by trained taggers and untrained anglers, and a process error term linearly related to the fish's time at liberty. Summer flounder growth patterns change when fish reach 34.7 cm, which may represent the length when the majority of fish reach maturity. Length measurement errors reported by anglers trained to tag fish for the game fish tagging program were about 1.5 cm less than measurement errors reported by untrained anglers. The analysis of residuals indicated that the reported length measurements for harvested fish that were predicted to be sublegal had a positive bias of 2.2 ± 0.5 cm. Through time, the model predicted mean size of harvested fish increased in response to increases in minimum size regulations, though sublegal fish continued to be harvested. Of the fish that were reported as harvested, 39-79% were predicted to be sublegal based on the growth model. The percentage of sublegal fish that were harvested increased dramatically when there were large (5 cm) increases in the minimum size limits. We conclude that Virginia recreational anglers respond to management regulations by adjusting the minimum size of harvested fish in compliance with regulations, but also continue to harvest sublegal fish.

Satellite Logbook System to Remotely Capture Real-time Data to Define Billfish Population Densities and Fishing Effort Distribution: the Guatemala Billfish Sport Fishery as a Case Study

Mark Fitchett
Rosenstiel School of Marine and Atmospheric Science
University of Miami

Billfishes, particularly the Indo-Pacific sailfish (*Istiophorus platypterus*), remain in high densities off the Pacific coast of Central America due to environmental and ecosystem dynamic characteristics in the region. These conditions have a dual beneficial effect on billfish by inhibiting suitable volumetric habitat and increasing forage species densities that lead to high billfish catch rates. A state-of-the-art satellite logbook system has been utilized in the region to monitor the behavior of sport fishing vessels and densities of billfish species with respect to ecosystem dynamics in the region on a real-time and spatially explicit basis. This system allows the ability to hindcast and extrapolate billfish densities on a high precision spatial-temporal scale to better estimate local densities that may be susceptible to exploitation by both catch-and-release sport fisheries and commercial fisheries. Preliminary analyses show that billfish density "hot spots" correspond with strong convergence zones that fall within vessel fishing ranges. Additionally, satellite logbook data shows a significant effect of water color and primary productivity on billfish aggregations. In addition to ecosystem dynamics, satellite logbook data yields important information on the proximity of fishing vessels to one another and allows the ability to elucidate effects of crowding, density, and patchiness of fishing vessels relative to their catch rates. The long-term research on the billfish ecosystem off Guatemala offers the opportunity to define an effective habitat range and develops the unique ability to precisely assess billfishes with respect to environmental variables and fishery dynamics.

Population Dynamics Fellows-Abstracts

Incorporating Spatial Population Structure in Stock Assessment Models of Marine Species

Dan Goethel
School for Marine Science and Technology
University of Massachusetts Dartmouth

Centuries of fisheries research demonstrate that marine species exhibit complex spatial structure. Yet, spatially-explicit population dynamics models have only begun to gain popularity in the last two decades. Ignoring the spatial complexities of sub-population structure can be detrimental to sustainable fisheries management and lead to loss of biocomplexity. Recently, spatially-explicit assessment models have been developed in an attempt to match the spatial scales of natural populations. These models can incorporate a variety of spatial population structures, but are limited by data constraints. We describe a generic spatially-explicit tag-integrated stock assessment framework and the advanced data requirements for successful implementation of these types of models. Application of tag-integrated assessments requires knowledge of the population structure, fine-scale data, and information on connectivity between population components often in the form of tagging data. Spatially-explicit, tag-integrated models also use more conventional assessment information, such as catch-at-age and indices of abundance. The increase in resolution and realistic biological characteristics of spatially-explicit models comes at the cost of data sample size and associated increases in uncertainty. However, the development of fine-scale population models is imperative to effectively assess and manage spatially structured marine populations.

A Comparative Theoretical Study of Age-structured Fish Subpopulations

Elizabeth Councill
Marine Biology and Fisheries and Department of Mathematics
University of Miami

Many species of harvested fish undergo changes in reproductive strategies and behaviors as a consequence of fishing pressure or changes in habitat. Many of these changes occur in subpopulations where management efforts are disproportional across large spatial scales or where the habitat of the population in a particular area is altered. This project provides a new way of modeling such populations where subpopulations are reproductively isolated and shows how using a comparative modeling approach, we can understand the processes that dictate the age structure of these populations. The model derived in this study is a discrete-time Leslie process, the components of which are functional response curves derived from modeled behaviors. Here, I present a brief overview of the derivation of the model with underlying assumptions, solvability, and a brief analysis of the solution. I also present a simplified two-stage model of a fish population in which both mature and immature individuals are present with a comparison between individuals who are reproducing in multiple spawning seasons and those who spawn in a single large burst. Finally, I present an outline of the ongoing research being done on this project as it applies to harvested marine fishes, particularly Atlantic tarpon, bluefin tuna, swordfish, and skipjack tuna.

Population Dynamics Fellows-Abstracts

Incorporating Electronic Tag Information in Stock Assessments

Benjamin Galuardi
Steven X. Cadrin
Timothy J. Miller
Molly Lutcavage
School for Marine Science and Technology
University of Massachusetts Dartmouth

The goal of my dissertation project is to improve stock assessments of large pelagic fishes. Currently, there are several efforts either underway or completed to study the movement and spatial structure of highly migratory species using electronic tags. Unlike observations from conventional tags, movement information from electronic tags does not always fit cleanly into current assessment frameworks, which has prohibited extensive use.

We plan to explore multiple modeling approaches for inclusion of electronic tag data using Atlantic bluefin tuna as a study fishery. The fishery is relatively well studied and data rich, and is assessed using virtual population analyses for Eastern and Western Atlantic stocks. Data from bluefin tuna tagged with pop-up satellite tags in the northwest Atlantic from 2002-present will be used to: 1) simulate an advection-diffusion reaction (ADR) framework to tune Western Atlantic catch rate indices 2) Expand previous applications of finite-state continuous time model (FSCT) to multiple areas in the Western Atlantic and possibly Eastern Atlantic. These efforts will be complemented by work underway to construct an operational model of Atlantic bluefin tuna dynamics for examining alternate management strategies. Further research may include the application of ADR and FSCT methods to a relatively data poor species and biophysical modeling of Atlantic bluefin tuna to assess sensitivity to alternate spawning regimes.

Incorporating Genetic Data into a Population Assessment for Pelagic Sharks

Dovi Kacev
San Diego State University

Accurate estimation of the size of wild populations is critical for effective management, but incredibly difficult in pelagic ecosystems. Traditional population assessments have relied upon fisheries catch records to generate CPUE trends, however this is difficult for non-target species where data can be very sparse. In this study, we developed a model using population genetic data in a mark-recapture framework to generate a rough estimate of population size. We simulated data for 16 microsatellite loci using average allelic richness and allele distributions drawn from a wild population of short fin mako sharks. We then "bred" these individuals by choosing two at random and randomly selecting one allele per locus from each to create an offspring genotype. From each paring we generated one to four offspring based on litter sizes found in the literature. We thus created an f1 generation based on 10 years of the model run. We sampled the genotypes of the f1 generation and used these data to reconstruct the putative parental genotypes, which could then be compared to known adults, and assigned each to its putative parents. The first time an offspring was assigned to a putative parent, it was considered a mark on that parent, and each subsequent assignment of an offspring to that parent was considered a recapture. These mark-recapture data were used in a Jolly-Seber model to generate an estimate of the putative adult population, which could then be compared to the actual adult population size to assess the utility of this method for population size estimation.

Sea Grant

Population Dynamics Fellows–Abstracts

A Comparison of Model-free Versus Mechanistic Forecasting for Nonlinear Ecological Systems

Charles Perretti
Scripps Institution of Oceanography

Resource managers must accurately forecast resource abundance in order to effectively implement sustainable management plans. Therefore, it is important to determine how various forecasting methods perform under ecologically realistic levels of noise. We compared the forecast accuracy of a model-free forecasting approach based on nonlinear state-space reconstruction (SSR) against a suite of mechanistic models fit to their own noisy time series. The mechanistic models were fit using a Bayesian adaptive MCMC algorithm initiated on the correct parameter values. Surprisingly, we found that for all four ecological models, the SSR forecasts were at least as accurate as the correct mechanistic model despite being fit to only one time series of a multivariate system. Using time series from experimental populations of flour beetles, the model-free (SSR) forecasts were at least as accurate as a previously validated mechanistic model. Our results suggest that for forecasting real ecosystems, where the correct model is never known, a robust model-free approach such as SSR may be a more practical alternative to complex fitted models with many free parameters.

An Atlantis Model to Inform Ecosystem-based Management for the Gulf of Mexico

Holly Ann Perryman
Rosenstiel School of Marine and Atmospheric Science
University of Miami

The Gulf of Mexico provides a wide range of economically and ecologically important goods and services to the U.S., Mexico and Cuba. Long-term impacts on the Gulf from problems like habitat modification, pollution, and fishery overexploitation remain uncertain. Studies concerning ecosystem impacts typically focus on coastal waters which are assumed to suffer the most from anthropogenic impacts, but since the *Deepwater Horizon* oil spill released oil and methane directly into offshore waters, there are growing concerns for the Gulf ecosystem as a whole. Ecosystem-based fishery management (EBFM) is a strategy of managing fisheries with the overall goal of sustaining healthy ecosystems, and ecosystem models such as ATLANTIS are becoming widely accepted tools to implement EBFM. ATLANTIS is a deterministic, biogeochemical model that tracks nitrogen and silica flows through the biological groups, which are modeled in a 3 -D spatial domain. The main objective of this project is to develop an ATLANTIS model for the entire Gulf of Mexico ecosystem. We intend to use this model to investigate a range of research questions, specifically to i) explore connections between inshore and offshore environments, ii) evaluate fishery management plans of important fisheries stocks, and iii) propose and test ecological indicators to evaluate thresholds and tipping points.

NOAA

Population Dynamics Fellows-Abstracts

Recruitment Spatial Dynamics of Atlantic Sea Scallops

Sam Truesdell
University of Maine

A standard assumption throughout the history of fisheries assessment has been the "dynamic pool," meaning a population of fish is thoroughly mixed and (in terms of modeling) lacks any spatial structure. While fisheries scientists have always known this to be a vast over-simplification, limitations in model development and computing power precluded spatially explicit models. The dynamic pool assumption is particularly inapt for sedentary species, such as scallops, because at harvestable size their movement is negligible relative to the scale of the fishery so the population is not mixed. For this reason, when describing sedentary populations it is especially important to consider spatial structure. As part of a larger analysis of the consequences of ignoring spatial structure, a simulation of the US Atlantic Sea Scallop population and fishery was developed, and recruitment, fishing, natural mortality and growth are all described. The recruitment submodel, the focus of this work, was derived from empirical survey data and is both spatially explicit and stochastic. The techniques used to describe recruitment account not only for year-to-year variability in the magnitude of recruitment but also variability in its spatial composition. The recruitment submodel methodology is described here and some example results are presented.

Population Dynamics Fellows-Abstracts

Impact of Epizootic Shell Disease on the American Lobster in Southern New England

Matthew W. Smith
Donald F. Landers Jr.
Jeffrey D. Shields
John M. Hoenig
Virginia Institute of Marine Science

Epizootic shell disease was first identified in 1997 in American lobsters caught in Block Island Sound and Narragansett Bay, Rhode Island. Since then the disease has spread throughout most of the southern New England lobster stock where it is now found at prevalence levels as high as 20-30%. During the same time period the lobster population in southern New England experienced a dramatic decline in abundance. Stock assessments of the American lobster have suggested low recruitment and increased natural mortality rate as the likely causes of the stock decline. However, the extent to which shell disease contributes to the presumed increase in natural mortality and the overall population decline remains unknown. Epizootic shell disease is characterized by an extensive erosion and melanization of the cuticle and is readily identified through gross inspection in the field. The external signs of the disease provide an indicator of infection and a measure of disease severity. These data were recorded as part of a long- term tagging study conducted in eastern Long Island Sound. We used logistic regression to estimate disease-associated mortality by disease severity state, sex, and reproductive status (ovigerous or non-ovigerous). Our analysis shows significant mortality associated with epizootic shell disease and suggests that natural mortality rate for the southern New England lobster stock has more than doubled from the previously assumed rate. This study also shows that ovigerous females are most affected by the disease. Female lobsters rarely molt when ovigerous and this likely contributes to mortality in affected ovigerous females. Our data identifies shell disease in lobsters as small as 35mm carapace length suggesting significant disease associated mortality is likely taking place prior to these animals recruiting to the fishery. Shell disease is likely reducing reproductive output through lost clutches as well as reducing spawning stock biomass through disproportionately elevated female mortality. These findings corroborate the stock assessments suggestion that natural mortality rate has risen in the southern New England stock and identifies a path by which disease may be affecting the stock-recruitment relationship in the region.

The Impact of Fishing on Food Web Dynamics and Single-species Stock Assessment Decisions Through the Use of a Lotka-Volterra Food Web Model

Melissa Hedges Monk
Louisiana State University

Single-species management actions can potentially affect production of other species in the same ecosystem and alter food web dynamics. In this study we examine the effects of ignoring ecosystem considerations when fitting single-species stock production models and estimating management benchmarks. We constructed a multispecies Lotka-Volterra model to simulate a suite of ecosystems with differing characteristics, including variations in the species parameters, e.g. intrinsic rate of increase and initial biomass, and species interaction strengths. The connectance of the ecosystem, or the proportion of realized links in the species interaction matrix, also affects the magnitude of fishing effects on food web dynamics. Ecosystems were created with varying levels of connectance ranging from 25-45%, while maintaining a system of 100 species. Fishing scenarios were applied to each simulated ecosystem and included varying levels of fishing pressure, fishing pressure applied only to specific species, and scenarios in which fishing pressure was changed over time. These simulations allow us to explore the effects of fishing on all species in the ecosystem and quantify the magnitude of disruption to the food web. We can also explore the possibility of food web reorganization as a result of fishing pressure. Time series of catch and an index of abundance from the Lotka-Volterra simulations were used as input to fit stock-production models, while ignoring any species interactions observed in the simulated ecosystem. We estimated single species management benchmarks from the surplus production model and then implemented these benchmarks in the Lotka-Volterra model. The effects of estimating and implementing a single-species fishing mortality rate's associated maximum sustainable yield with and without accounting for non-target species interactions will be discussed.

Multi-state Robust-design Tag-resighting Models for Skip-nesting Species Such as Sea Turtles and Birds

James T. Thorson[1]
André E. Punt[1]
Ronel Nel[2]
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[2] *Department of Zoology, Nelson Mandela Metropolitan University*

Sea turtles and sea birds generally have high conservation importance worldwide, and are often difficult to survey except when present on nesting grounds. Consequently, many surveys for sea turtles and birds tag nesting individuals and use tag-resighting models to estimate population size and assess anthropogenic impacts. However, the conventional Cormac-Jolly-Seber (CJS) tag-resighting model is problematic for these data for two reasons: individuals may return to nesting areas only in alternating years due to high energetic costs for nesting, and estimated detectability confounds sampling design and temporary emigration effects.

In this study, we develop a multi-state, robust design model that uses higher-order Markovian transitions to approximate skip-nesting behaviors and incorporates multiple observations for each nesting individual to estimate changes in temporary emigration, i.e., the probability of returning to the surveyed area rather than alternative nesting areas. We also approximate time-varying effects using a flexible spline method, and demonstrate the model using data for leatherback and loggerhead sea turtles in South Africa. We show that apparent lack of recovery for leatherback sea turtles after implementing beach protection, as observed in nest count data, is likely due to declining detectability caused by habitat expansion during population recovery. By contrast, loggerhead turtles have approximately constant detectability and stable abundance since the 1970s.
Based on study results, we recommend that future tag-resighting programs for sea turtles and sea birds are periodically conducted beyond the regularly monitored nesting areas to provide confirmation for any evidence of range expansion. However, the identification of range expansion in historical data is only possible using model-based inference and multi-state robust design methods such as presented in this study.

Sea Grant

Resource Economics Fellows–Abstracts

To bid or not to bid: An Investigation into Economic Incentives Underlying Auction Participation

Geret DePiper
Department of Agricultural and Resource Economics
University of Maryland

This research investigates the individual characteristics correlated with auction participation decisions using data from two commercial fishing license buybacks. I use the joint empirical analysis of stated and revealed preferences, with two major findings emerging. First, the results of my analysis suggest that individuals with relatively low willingness to accept values and low engagement in the fishery faced problems with the participation decision which prevented them from tendering bids in the auction. This has serious policy implications given that the efficiency of reverse auctions relies on buying goods back from individuals who value them the least. The low participation rate suggests that the licenses bought back represent between 47 – 64 percent of the maximum achievable with the same funds under a first best outcome.

Second, fishermen are frequently modeled as strict profit maximizers and harvest histories are often assumed to serve as a good proxy for expected future profits in many circumstances. I find evidence against both of these assumptions. Indicators for bequest and enjoyment values are associated with an increased bid equivalent to that of a $6,500 - $20,000 increase in annual profits. Indicators of bequest and enjoyment values are also significantly correlated with the decision of whether to tender a bid at all. Expected future usage patterns are an important consideration in the participation decisions, and the expected usage can differ significantly from past usage patterns. These results suggest that market experience plays an important role in auction participation decisions, and the problems which develop from inexperience should be addressed explicitly through the auction design.

An Adaptive Agent-based Model of Maine Fisheries

Peter Hayes
University of Maine

As part of a larger, interdisciplinary, NSF effort in coupled human-natural systems, I have been investigating adaptive multi-agent models of Gulf of Maine fisheries. Fisherman agent adaptation is provided by machine learning techniques, potentially giving agents the ability to adapt to evolving social, economic, and ecological factors in the model. These programming techniques can also provide benefits to the models and modelers such as heterogeneity, eased model design, and reduced modeler bias. Our applied work has both found promise and raised questions regarding the use of these decision mechanisms in simulations of human behavior. Questions largely relate to the definition and requirements of learning, and conditions under which learning can occur. We are using our fisheries models to explore issues of learning, both machine and human, while creating tools that might provide better insight into the complex responses of humans engaged in resource exploitation.

NOAA

Resource Economics Fellows-Abstracts

Taming the Lionfish

David Kling
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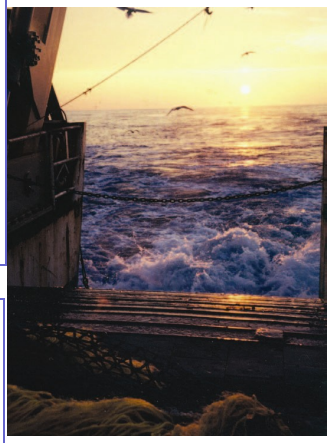
The high costs of biological invasions in terms of reduced ecosystem services, biodiversity, and management effort are now well known, and economists have produced a large volume of research characterizing how to efficiently combat established invaders and prevent new introductions. Much of this work has focused on terrestrial species while key questions relating to the control of established invasive species in marine and coastal environments have been neglected. The case of the invasive Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) suggests that controlling marine invaders may be a necessary component of resource management in invaded systems. Lionfish have spread rapidly along the southeast coast of the United States and into parts of the Caribbean and South America, where they prey intensively on native marine life and pose a significant threat to already stressed coral reef communities. This aim of this project is to develop a bioeconomic model of lionfish control at a local scale, for example in and around a marine reserve. Local control of a marine invader introduces difficulties that are absent from many terrestrial invasion control problems, including only partial observability of invader density and long distance dispersal. The model will be calibrated using data on lionfish spread dynamics in the southeast Atlantic and recent small-scale control efforts in order to suggest when and where to concentrate management effort to reduce the impact of the invasion on sensitive habitat. The model will also help inform management of other invasive species – including terrestrial species – that share characteristics with the lionfish.



An Analysis of Harvest Efficiency Gains from IFQ Implementation in the Gulf of Mexico Red Snapper Fishery

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The use of catch shares in fisheries management has been hailed as a means to decrease overcapitalization in a fishery and increase the technical efficiency of the remaining harvesters. The generally held belief is that more efficient harvesters will place a higher value on harvest privileges than their less efficient counterparts and will buy out the less efficient fishers, leading to decreased capacity and increased harvest efficiency. Past research has focused on possible efficiency gains and cost reductions by switching to a catch shares management structure assuming that share trading is efficient. In essence, past research assumed a centralized exchange with low transaction costs and uniform knowledge of pricing information. Oftentimes, the fisheries being examined include numerous fishers spread out over great distances that only interact with fishers in close proximity to themselves (i.e., same port or town) or from similar social circles. Given the structure of these fisheries, is it reasonable to assume share trading markets are efficient? This research analyzes IFQ trading in the Gulf of Mexico red snapper fishery and measures possible technical efficiency gains under two distinct scenarios: 1) quota trading markets are efficient and exchange is possible between all IFQ market participants, and 2) quota trading is limited to a participant's social network (who they know). Both scenarios will then be compared to the observed change in fleet technical efficiency to determine which better describes actual quota trading. This presentation will outline preliminary findings related to the IFQ trading markets and discuss subsequent research steps.