NOAA Scientific Publications Report

April 25, 2016

Highlighted Articles

Quantifying atmospheric methane emissions from oil and natural gas production in the Bakken shale region of North Dakota
Journal of Geophysical Research (3.44)

Antibiotics as CECs: an overview of the hazards posed by antibiotics and antibiotic resistance
Frontiers in Marine Science

Effects of high temperatures on threatened estuarine fishes during periods of extreme drought
Journal of Experimental Biology (2.897)

The importance of benthic habitats for coastal fisheries
BioScience (4.739)

Additional Articles

NMFS Publications

Optimizing transmit interval and logging range while avoiding aliased seabed echoes
ICES Journal of Marine Science (2.525)

A systematic survey of the integration of animal behavior into conservation
Conservation Biology (4.32)

Morphological and ecological evidence for two sympatric forms of Type B killer whale around the Antarctic Peninsula
Polar Biology (1.586)

Systematics of stalked jellyfishes (Cnidaria: Staurozoa)
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Ecosystem effects of invertebrate fisheries
Fish and Fisheries (8.258)

Modeling spatially-varying ecological relationships using geographically weighted generalized linear model: A simulation study based on longline seabird bycatch
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The influence of the El Niño Southern Oscillation on paralarval market squid (*Doryteuthis opalescens*)
Fisheries Oceanography (2.542)

Seascapes are not landscapes: An analysis performed using Bernhard Riemann's rules
ICES Journal of Marine Science (2.377)

An ecosystem services perspective for the oceanic eastern tropical Pacific: commercial fisheries, carbon storage, recreational fishing, and biodiversity
Frontiers in Marine Science

OAR Publications

Empirical algorithms to estimate water column pH in the Southern Ocean
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Intercomparison of selected fixed-area areal reduction factor methods
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Sensitivity of global upper ocean heat content estimates to mapping methods, XBT bias corrections, and baseline climatologies
Journal of Climate (4.904)

Differential patterns of divergence in ocean drifters: Implications for larval flatfish advection and recruitment
Journal of Sea Research (1.990)

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NOS Publications

Great Lakes Mussel Watch Sites Land-use Characterization and Assessment
NCCOS Report

REServ: An Ecosystem Services Assessment using bioextraction technologies for removal of nitrogen and other substances in Long Island Sound and the Great Bay/Piscataqua Region
NOAA Coastal Ocean Program Decision Analysis Series No. 194.

Marine Biogeographic Assessment of the Main Hawaiian Islands
NOAA technical memorandum

HIGHLIGHTED ARTICLES

Quantifying atmospheric methane emissions from oil and natural gas production in the Bakken shale region of North Dakota
Journal of Geophysical Research (3.44)
J. Peischl, A. Karion**, C. Sweeney,** E. Kort, M. L. Smith, A. R. Brandt, T. Yeskoo**, K. Aikin,** S. Conley, A. Gvakharia**, M. Trainer, S. Wolter, T. Ryerson (OAR/ESRL)**

- This is the first scientific paper to quantify methane emissions from the Bakken shale region in the Williston Basin in North Dakota, a region of rapidly growing oil and natural gas production.

- The average methane emission rate derived in this study is significantly lower than a previous estimate in the region using satellite remote sensing data, but greater than the 2013 EPA GHG inventory emission rate.
- The authors attribute the majority of methane emissions to oil and gas operations in the Bakken.

Researchers from the Cooperative Institute for Research in Environmental Sciences (CIRES) and NOAA ESRL's Chemical Sciences Division and Global Monitoring Division, with other university partners, present in situ airborne measurements of methane (CH_4) and ethane (C_2H_6) over the Williston Basin in northwestern North Dakota, a region of rapidly growing oil and natural gas production. The Williston Basin is best known for the Bakken shale formation, which has seen a significant increase in oil and gas extraction since 2009.

The researchers derived a methane emission rate from this region from airborne data taken aboard a NOAA DHC-6 Twin Otter research aircraft and collected downwind of the Bakken shale region from three flights and five transects in May 2014. The average methane emission rate is significantly lower than a previous estimate of CH_4 emissions from northwestern North Dakota and southeastern Saskatchewan using satellite remote sensing data, but approximately a factor of 1.4–2.3 greater than the 2013 EPA GHG inventory emission rate.

Because the atmospheric enhancement ratios of ethane to methane are consistent with the composition of raw natural gas withdrawn from the region, the researchers attribute the majority of methane emissions to oil and gas operations in the Bakken. Stated in terms of the natural gas extracted from the ground, they estimate atmospheric loss rates from natural gas production of 4.2 – 8.4 percent, which is similar to the rate found for the Denver-Julesburg oil-producing region in Colorado.

Expected Publication Date: TBD

Antibiotics as CECs: an overview of the hazards posed by antibiotics and antibiotic resistance

Frontiers in Marine Science

G. I. Scott, D. E. Porter, G. T. Chandler, R. S. Norman, C. H. Scott, M. I. Uyaguari-Diaz, K. Maruya, S. B. Weisberg, **M. H. Fulton, E. F. Wirth, J. Moore, P. L. Pennington**, D. Schlenk, G. P. Cobb, N. D. Denslow **(NOS/NCCOS)**

- Four antibiotics were identified as higher risks for concern based upon the risk assessment approaches presented in the paper.

- Triclosan was the only compound to have a MEC/NOEC ratio [Measured Exposure Concentration / No Observable Effect Concentration] > 1 and was recommended for monitoring in future studies.

Monitoring programs have traditionally monitored legacy contaminants but are shifting focus to Contaminants of Emerging Concern (CECs). CECs present many challenges for monitoring and assessment, because measurement methods don't always exist nor have toxicological studies been fully conducted to place results in proper context. Also some CECs affect metabolic pathways to produce adverse outcomes that are not assessed through traditional toxicological evaluations. Antibiotics are CECs that pose significant environmental risks including development of both toxic effects at high doses and antibiotic resistance at doses well below the Minimum Inhibitory Concentration (MIC) which kill bacteria and have been found in nearly half of all sites monitored in the US. Antimicrobial resistance has generally been attributed to the use of antibiotics in medicine for humans and livestock as well as aquaculture operations. The objective of this study was to assess the extent and magnitude of antibiotics in the environment and estimate their potential hazards in the environment. Antibiotics concentrations were measured in a number of monitoring studies which included Waste Water Treatment Plants (WWTP) effluent, surface waters, sediments and biota. A number of studies reported levels of Antibiotic Resistant Microbes (ARM) in surface waters and some studies found specific ARM genes (e.g. the *blaM-1* gene) in E. coli which may pose additional environmental risk. High levels of this gene were found to survive WWTP disinfection and accumulated in sediment at levels 100-1000 times higher than in the sewerage effluent, posing potential risks for gene transfer to other bacteria.in aquatic and marine ecosystems. Antibiotic risk assessment approaches were developed based on the use of MICs and MIC Ratios [High (Antibiotic Resistant)/Low (Antibiotic Sensitive) MIC] for each antibiotic indicating the range of bacterial adaptability to each antibiotic to help define the No Observable Effect Concentration (NOEC) for each antibiotic which were compared to maximum Measured Exposure Concentrations (MEC) in the environment to predict individual environmental risks. Four antibiotics had high MEC/NOEC and high MIC ratios and were identified as higher risks for concern based upon this approach, but only Triclosan had MEC/NOEC ratios >1 and was recommended for monitoring in future studies.

Publication date: 20 April, 2016
Available online:
http://journal.frontiersin.org/article/10.3389/fmars.2016.00024/full

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

Effects of high temperatures on threatened estuarine fishes during periods of extreme drought

Journal of Experimental Biology (2.897)

K. M. Jeffries, R. E. Connon, B. E. Davis, **L. M. Komoroske (NMFS/SWFSC),** M. T. Britton, T. Sommer, A. E. Todgham, N. A. Fangue

- This study investigated the effects of elevated water temperatures associated with climate change and the california drought on two ESA listed fishes, the longfin smelt and the delta smelt.
- Physiological responses in these fish related to the experimental temperature manipulation indicate that longfin smelt may be more susceptible than delta smelt to increases in temperatures.
- Because longfin smelt have little room to tolerate future warming indicates that effective conservation efforts need to incorporate suitable thermal habitat in management and restorations plans.

Climate change and associated increases in water temperatures may impact physiological performance in ectotherms and exacerbate endangered species declines. We used an integrative approach to assess the impact of elevated water temperature on two fishes of immediate conservation concern in a large estuary system, the threatened longfin smelt (*Spirinchus thaleichthys*) and endangered delta smelt (*Hypomesus transpacificus*). Abundances have reached record lows in California, USA, and these populations are at imminent risk of extirpation. California is currently impacted by a severe drought resulting in high water temperatures, conditions that will become more common due to climate change. We exposed fish to environmentally-relevant temperatures (14°C, 20°C) and used RNA-sequencing to examine the transcriptome-wide responses to elevated water temperature in both species. Consistent with having a lower temperature tolerance, longfin smelt exhibited a pronounced cellular stress response, with an upregulation of heat shock proteins, after exposure to 20°C that was not observed in delta smelt. We detected an increase in metabolic rate in delta smelt at 20°C and increased expression of genes involved in metabolic processes and protein synthesis, patterns not observed in longfin smelt. Through examination of responses across multiple levels of biological organization, and linking these responses to habitat distributions in the wild, we demonstrate that longfin smelt may be more susceptible than delta smelt to increases in temperatures and they have little room to tolerate future warming in California. Understanding the species-specific

physiological responses of sensitive species to environmental stressors is critical for conservation efforts and managing aquatic systems globally.
Acceptance date: 31 March 2016

The importance of benthic habitats for coastal fisheries
BioScience (4.739)
J. P. Kritzer, M. DeLucia, E. Greene, C. Shumway, M. F. Topolski, J. Thomas-Blate, **L. A. Chiarella (NMFS/GARFO), K. B. Davy (NMFS/SERO),** K. Smith

- Importance of different fish habitats changes with latitude
- The importance of soft sediments is notable because environmental assessments often assume their ecological value is lower
- Submerged aquatic vegetation was a key nursery habitat coast-wide

Ecosystem-based management requires greater attention to habitat conservation. We evaluate the importance of benthic habitats as space for shelter, feeding, and breeding by coastal fishes and motile invertebrates in four biogeographic regions of the eastern United States. The importance of different habitats changed with latitude. Soft sediments and riverine systems scored higher in northern regions, and marshes and coral reefs scored higher in the south. The importance of soft sediments is notable because environmental assessments often assume their ecological value is lower. Submerged aquatic vegetation was a key nursery habitat coast-wide. An important consideration is that anthropogenic impacts have altered habitat availability and use, and climate change is causing ongoing disturbance. Furthermore, distinct habitats should not be managed in isolation but rather as interconnected mosaics. Our approach, combined with information on status, vulnerability, and other ecological functions, can be used to evaluate trade-offs and develop habitat-management strategies.
Published: 1 April, 2016
Available Online:
http://bioscience.oxfordjournals.org/content/early/2016/03/04/biosci.biw014.abstract

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

ADDITIONAL ARTICLES

NMFS Publications

Optimizing transmit interval and logging range while avoiding aliased seabed echoes
ICES Journal of Marine Science (2.525)
J. S. Renfree, D. A. Demer (NMFS/SWFSC)

- Echosounder surveys of fish and zooplankton are typically conducted using fixed values of the echosounder transmit-pulse ("ping") interval and data-logging range.
- We present algorithms that improve these measurements, including the elimination of false bottoms, increasing sample resolution and signal-to-noise ratio of the data which can improve the detection of the deepest dwelling target species and improving temporal and spatial resolution of shallower target species. The algorithms may also reduce the total data volume and storage-space requirement. The algorithms have been collectively implemented in the EAL program (available at https://swfsc.noaa.gov/EAL/)
- These improvements enable NOAA Fisheries to better survey and assess single and multi-species aggregations of fishes.

Echosounder surveys of fish and zooplankton are typically conducted using fixed values of the echosounder transmit-pulse ("ping") interval and data-logging range. The transmit-pulse interval must be long enough to sample to the range of the farthest (deepest) species under study, potentially causing under-sampling of closer (shallower) species. We present an algorithm to dynamically minimize both the logging range and transmit-pulse interval while ensuring that the logging range equals or exceeds the range to the seabed up to a chosen maximum data-logging range. The algorithm also allows avoidance of aliased seabed echoes ("false bottoms") by adjusting the minimized transmit interval such that seabed reverberation from a previous transmission is not present in the data logged for an ensuing transmission. Additionally, periodic measures of ambient noise allow evaluations of signal quality and useful range. This optimisation scheme ("adaptive logging") effectively increases the horizontal resolution and signal-to-noise ratio of the data, and may reduce the total data volume and storage-space requirement. The efficacy of the adaptive logging algorithm is quantified using simulations.

Furthermore, an example implementation of the algorithm is demonstrated for a commonly used scientific echosounder (Simrad EK60).
Acceptance date: 14 March, 2016
Expected publication date: May, 2016

A systematic survey of the integration of animal behavior into conservation
Conservation Biology (4.32)
O. Berger-Tal, D. T. Blumstein, S. Carroll, R. N. Fisher, **S. L. Mesnick (NMFS/SWFSC)**, M. A. Owen, D. Saltz, C. C. St. Claire, R.R. Swaisgood

- Using a systematic 'heat map', to visualize the results, we found substantial but variable use of behavioral ecology in the conservation and management literature.
- We discuss opportunities to better integrate knowledge of animal behavior into conservation through directed research, translating behavioral theory and taking a conservation evidence approach.

The role of behavioral ecology in improving wildlife conservation and management has been the subject of much recent debate. We aim to answer two foundational questions about the current use of behavioral knowledge in conservation: 1. To what extent is behavioral knowledge used in wildlife conservation and management? 2. How does the use of behavior differ among conservation fields in both frequency and types of use? To answer these questions, we searched the literature for intersections between key fields of animal behavior and conservation biology and created a systematic 'heat' map to visualize relative efforts. Our analysis challenges previous suggestions that there is little association between the fields and reveals tremendous variation in the use of different behaviors in conservation. For instance, some behaviors, such as foraging and dispersal, are commonly considered, but other behaviors such as learning, social or anti-predatory behaviors are hardly considered. Our analysis suggests that in many cases awareness of the importance of behavior does not translate into applicable management tools. We suggest that behavioral ecologists should focus on developing research in underutilized intersections of behavior and conservation themes for which preliminary work show a potential for improving conservation and management, on translating behavioral theory into applicable and testable predictions, and on creating systematic reviews to summarize the behavioral evidence within the behavior-conservation intersections for which many studies exist.
Acceptance date: March, 2016

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

Expected publication date: Spring, 2016

Morphological and ecological evidence for two sympatric forms of Type B killer whale around the Antarctic Peninsula
Polar Biology (1.586)
J. W. Durban, **H. Fearnbach**, D. G. Burrows, G. M. Ylitalo, **R. L. Pitman (NMFS/SWFSC)**

- First description of two sympatric forms for Type B killer whales in Antarctica.
- Use of quantitative morphometrics to describe killer whale types.
- Ecosystem assessments of trophic interactions can now be stratified by type.

Killer whales (*Orcinus orca*) are apex marine predators in Antarctica, but uncertainty over their taxonomic and ecological diversity constrains evaluations of their trophic interactions. We describe two distinct, sympatric forms sharing the characteristic pigmentation of Type B, the most common around the Antarctic Peninsula. Laser photogrammetry revealed non-overlapping size differences among adults: based on a body length index (BLI: blowhole to dorsal fin) adult females of the larger form ("B1") were 20% longer than the smaller form ("B2"), and adult males were 24% longer on average. Dorsal fins of B1 adult females were 19% taller than B2 females, and adult males 32% taller. Both types were strongly sexually dimorphic, but B1 more so, including for BLI (B1 males =1.07x females; B2 = 1.05x) and especially for dorsal fin height (B1 male fins =2.33 x female; B2 =2.10x). The characteristically large Type B eye patch was more extensive for B1 than B2, comprising 41% and 37 % of BLI, respectively. Average group size was also significantly different, with B1s in smaller groups (mean = 7, range = 1-14) and B2s more gregarious (mean = 36, range = 8-75). Stable isotope analysis of skin biopsies indicated dietary differences: a significantly lower nitrogen 15N/14N ratio in B2s supported observations of feeding primarily on krill consumers (e.g., pygoscelid penguins), while B1s prey mainly on predators of krill consumers (e.g. Weddell seals *Leptonychotes weddellii*). These differences likely represent adaptations to distinct foraging niches, which has led to genetic divergence; their ecology now needs further study.
Available online: http://link.springer.com/article/10.1007%2Fs00300-016-1942-x

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

Systematics of stalked jellyfishes (Cnidaria: Staurozoa)
PeerJ (2.112)
L. S. Miranda, Y. M. Hirano, C. E. Mills , A. Falconer, D. Fenwick , A. C. Marques, **A. G. Collins (NMFS/NEFSC)**

- Elucidating biodiversity through sound systematics is of foundational importance to ecosystem management.
- This paper advances systematics of staurozoans, common but poorly known animals that mostly live upon macroalgae in colder seas, making them susceptible to human-mediated climate change.

Staurozoan classification is highly subjective, based on phylogeny-free inferences, and suborders, families, and genera are commonly defined by homoplasies. Additionally, many characters used in the taxonomy of the group have ontogenetic and intraspecific variation, and demand new and consistent assessments to establish their correct homologies. Consequently, Staurozoa is in need of a thorough systematic revision. The aim of this study is to propose a comprehensive phylogenetic hypothesis for Staurozoa, providing the first phylogenetic classification for the group. According to our working hypothesis based on a combined set of molecular data (mitochondrial markers COI and 16S, and nuclear markers ITS, 18S, and 28S), the traditional suborders Cleistocarpida (animals with claustrum) and Eleutherocarpida (animals without claustrum) are not monophyletic. Instead, our results show that staurozoans are divided into two groups, herein named Amyostaurida and Myostaurida, which can be distinguished by the absence/presence of interradial longitudinal muscles in the peduncle, respectively. We propose a taxonomic revision at the family and genus levels that preserves the monophyly of taxa. We provide a key for staurozoan genera and discuss the evolution of the main characters used in staurozoan taxonomy.
Accepted: March 30, 2016

Ecosystem effects of invertebrate fisheries
Fish and Fisheries (8.258)
T. Eddy, H. K. Lotze, E. Fulton, M. Coll, C. Ainsworth, J. de Araújo, C. Bulman, A. Bundy, V. Christensen, C. Bulman, **J. C. Field (NMFS/SWFSC)**, N. A.Gribble, M. Hasan, S. Mackinson, **H. Townsend (NMFS/Chesapeake Bay Office)**

- Uses a set of ecosystem models (primarily ecopath with ecosim) to explore the potential consequences of exploitation on marine invertebrates to other components of the food web.

- Follows on similar analysis of the role of forage species in the ecosystem and consequences to management (Smith et al. 2011, Science *333:*1147-1150).
- Highlights the importance of managing such fisheries sustainably to minimize impacts to dependent species in the food web.

Since the 1950s, invertebrate fisheries catches have rapidly expanded globally to more than 10 million tonnes annually, with twice as many target species, and are now significant contributors to global seafood provision, export, trade, and local livelihoods. Invertebrates play important and diverse functional roles in marine ecosystems, yet the ecosystem effects of their exploitation are poorly understood. Using 12 ecosystem models distributed worldwide, we analyzed the ecosystem effects and tradeoffs of invertebrate fisheries. Although not always recognized for their contributions to marine food webs, the magnitude of trophic impacts of invertebrates on other species of commercial and conservation interest is comparable with those of forage fish. Invertebrates also strongly contribute to benthic-pelagic coupling. Finally, on average, invertebrates produce maximum sustainable yield at lower levels of depletion (~45%) than forage fish (~65%), highlighting the need for management targets that avoid negative consequences for target species and marine ecosystems as a whole.
Acceptance date: April 4, 2016
Expected publication date: Fall, 2016

Modeling spatially-varying ecological relationships using geographically weighted generalized linear model: A simulation study based on longline seabird bycatch
Fisheries Research (1.843)
Y. Li, Y. Jiao, **J. A. Browder (NMFS/SEFSC)**

- Relationships between probability of catching a seabird on pelagic longline and environmental variables vary spatially.
- Spatially varying relationships between seabird bycatch and influencing factors need to be taken into account when developing bycatch management plans.

A geographically weighted generalized linear model (GW-GLM) that allowed relationships of seabird bycatch to environmental variables to vary spatially performed better than non-spatial GLMs in describing seabird bycatch by the U.S. Atlantic pelagic longline fleet. Relationships between seabird bycatch probability and water depth and temperature varied significantly across the study region and from one statistical area to another within the region, which was made up of three

contiguous statistical areas: Northeast Coastal, Middle Atlantic Bight, and South Atlantic Bight. GW-GLM performed best regardless of the percentage of zeros in the dataset.
Acceptance date: 3/29/2016
Expected publication date: Unknown

Photogrammetry of blue whales with an unmanned hexacopter
Marine Mammal Science (1.820)
J. W. Durban (NMFS/SWFSC), M. Moore, G. Chiang, L. S. Hickmott, A. Bocconcelli, G. Howes, P. A. Bahamonde, **W. L. Perryman (NMFS/SWFSC)**, D. J. LeRoi

- First use of UAS for photogrammetry of large whales
- Length data support link between blue whales feeding in Southern Chile and those measured in the ETP
- Data on length and condition of southern hemisphere blue whales to assess whale health compared to other populations

Photogrammetric measures of growth and condition of whales are important for understanding population dynamics and monitoring responses to environmental change. We describe the first use an unmanned aircraft to obtain quantitative photogrammetric measurements of large whales. In February and March 2015, we collected photogrammetry images from 22 blue whales (*Balaenoptera musculus*) off southern Chile, during 59 flights with a small hexacopter launched from an 18.6 m boat. Flights averaged 12.1 minutes (max =17.3 minutes) with a photographing altitude of 50-60 m. Onboard pressure readings of altitude allowed scaling from image pixels to real measurements with a bias averaging <0.002% (range <5%) of the boat length. Whales ranged in length between 14.4 m and 23.6 m, including two dependent calves (14.4 m and 15.5 m) and the two presumed adult mothers (22.7 m and 22.2 m); consistent with measurements of blue whales in the eastern Tropical Pacific that have been genetically linked to those off Southern Chile. Body widths measured at 40% of body length were variable in whales of adult size, demonstrating the potential for using repeated estimates of length and width to monitor changes in growth and body condition of blue whales over time. We suggest this utility will also extend to other whale species.
Acceptance date: April 5, 2016
Expected publication date: Mid-2016

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

The influence of the El Niño Southern Oscillation on paralarval market squid (*Doryteuthis opalescens*)
Fisheries Oceanography (2.542)
C. T. Perretti (NMFS/NEFSC) and **M. Sedarat (NMFS/SWFSC)**

- Provides insight into how the environment drives fluctuations in market squid abundance and landings.

California market squid (Doryteuthis opalescens) support one of the largest and most valuable fisheries in California. However, market squid abundance varies greatly from year to year, ostensibly due to the El Niño Southern Oscillation (ENSO) phenomenon, although the underlying mechanism is not known. Classic hypotheses suggest that the early larval stage may be the key to uncovering this mechanism. Here, we perform a time series analysis, length-distribution analysis, and growth analysis to investigate the effects of ENSO on paralarval D. opalescens. In contrast to classic hypotheses, we find that ENSO does not drive early paralarval survival or growth. Instead, we find that the ENSO operates primarily on the late paralarval stage, with El Niño conditions associated with lower survival of late-stage paralarvae. We also find that time series models which use ENSO conditions during the previous juvenile and adult stage outperform models that use ENSO conditions during the paralarval stage. Our results suggest that the population bottleneck for D. opalescens does not occur in the early paralarval stage, but instead lies later in the squid's life.
Acceptance date: April 7, 2016
Expected publication date: August 2016

Seascapes are not landscapes: An analysis performed using Bernhard Riemann's rules
ICES Journal of Marine Science (2.377)
J. P. Manderson (NMFS/NEFSC)

- This study provides a theoretical rationale for implementing Dynamic Ocean Management, particularly in the face of climate change.
- Applied seascape ecology currently rests on the landscape paradigm, but ecological dynamics in seascapes is driven primarily by hydrography and hydrodynamics and secondarily by seabed processes.
- Developing a seascape ecology on the foundation of hydrodynamics is now possible and essential for natural resource management in the sea.

Applied seascape ecology currently rests on the landscape paradigm. Persistent seabed features are usually the fundamental units of analysis. Persistent

oceanographic features provide context while dynamic features are often ignored. Should seascape ecology rest on terrestrial paradigms? I applied Reimann's rules in an analysis of the differences between seascapes and landscapes. Reimann's method uses hypotheses about system function to guide the development of models of components based on fundamental laws. The method prohibited me from developing an understanding of habitat ecology in the sea using terrestrial analogies. Seascapes and landscapes emerge from organism-environment interactions and function to support at least one viable population. The laws applying to organisms are the conservative requirements of metabolism underlying individual performance and population growth. The laws applying to the external environment are physical properties that dictate the strategies organisms use to meet metabolic requirements. Marine organisms meet requirements using weak physiological regulation and strong habitat selection for volumes of liquid with specific temperatures, and essential gas and solute concentrations. Drag controls movement because seawater is dense and viscous. Many organisms have access to the water column where food webs are regulated by mixing that is driven by fast atmospheric and tidal forces. Dynamic hydrography and hydrodynamics are the foundation of seascape ecology. In contrast, landscape ecology rests on slower biogeochemical processes including soil development occurring along the land-atmosphere interface. Terrestrial organisms are decoupled by gravity and internal regulation from the dynamics of a thermally variable atmosphere largely devoid of water and solutes, but abundant with essential gasses. Gravity controls movement. The atmosphere is inaccessible to most organisms that show strong habitat selection for metabolically important materials concentrated on the land surface. Living in a liquid is different from living in a gas and natural resource use management in the sea needs to be tuned to ecological dynamics on seascapes driven primarily by hydrography and hydrodynamics and secondarily by seabed processes. Developing a seascape ecology on the foundation of hydrodynamics is possible and essential now that the "hydrosphere" regulating marine ecosystems is changing rapidly due to climate change.

Acceptance date: 3 April, 2016

An ecosystem services perspective for the oceanic eastern tropical Pacific: commercial fisheries, carbon storage, recreational fishing, and biodiversity

Frontiers in Marine Science

S. L. Martin (NMFS/PIFSC), L. T. Ballance (NMFS/SWFSC), T. Grooves

- Marine resources are typically viewed in terms of value of commercially-fished species but the ocean provides a variety of additional services that benefit humans that are often ignored. We use the eastern tropical Pacific as a test ecosystem to explore these other ecosystem services.
- Average catch value for the 10 top commercially fished species was US $2.7 billion yr-1 but the value of carbon export to the deep ocean dwarfed this (over US $12.9 billion yr-1). Sport fishing expenditures at just three locations totaled $1.2 billion yr-1. And a significant proportion of the world's cetacean, seabird, and marine turtle species are found in this ecosystem.
- Quantifying ecosystem services provides a mechanism for making informed decisions regarding use, management, and conservation of marine ecosystems.

The ocean provides ecosystem services (ES) that support humanity. Traditional single-issue management largely failed to protect the full suite of ES. Ecosystem-based management (EBM) promotes resilient social-ecological systems that provide ES. To implement EBM, an ES approach is useful: 1) characterize major ES provided (magnitude, geographic extent, monetary value, trends, and stakeholders), 2) identify trade-offs, 3) determine desired outcomes, and 4) manage anthropogenic activities accordingly. Here we apply the ES approach (steps 1-2) to an open ocean ecosystem, the eastern tropical Pacific (ETP), an area of 21 million km^2 that includes waters of 12 nations and the oceanic commons, using 35 years (1975-2010) of fisheries and economic data, and 20 years (1986-2006) of ship-based survey data. We examined commercial fisheries, carbon storage, biodiversity, and recreational fishing as the major provisioning, regulating, supporting, and cultural ES, respectively. Average catch value (using U.S. import prices for fish) for the 10 most commercially fished species was $2.7 billion yr-1. The value of carbon export to the deep ocean was $12.9 billion yr-1 (using average European carbon market prices). For two fisheries-depleted dolphin populations, the potential value of rebuilding carbon stores was $1.6 million (cumulative); for exploited fish stocks it was also $1.6 million (an estimated reduction of 544,000 mt). Sport fishing expenditures totaled $1.2 billion yr-1, from studies of three popular destinations. These initial, conservative estimates do not represent a complete summary of ETP ES values. We produced species richness maps for cetaceans, seabirds, and ichthyoplankton, and a sightings density map for marine turtles. Over 1/3 of cetacean, seabird, and marine turtle species occur in the ETP, and diversity (or density) hotspots are widespread. This study fills several gaps in

the assessment of marine and coastal ES by focusing on an oceanic habitat, utilizing long-term datasets, mapping the spatial distribution of ecological components, and concentrating on an area beyond Europe and the USA. Our results improve our understanding of ETP ES, highlight their variety, and offer a new perspective for a fisheries-dominated system. This study sets the stage for further analyses of trade-offs, which can inform decisions about resource management and biodiversity conservation.
Publication Date: April, 2016
Available Online:
http://journal.frontiersin.org/article/10.3389/fmars.2016.00050/abstract

OAR Publications

Empirical algorithms to estimate water column pH in the Southern Ocean
Geophysical Research Letters (4.456)
N. L. Williams, L. W. Juranek, K. S. Johnson, **R. A. Feely (OAR/PMEL),** S. C. Riser, L. D. Talley, J. L. Russell, J. L. Sarmiento, and **R. Wanninkhof (OAR/AOML)**

- Algorithms are developed for estimation of pH from biogeochemical floats in the Southern Ocean
- The pH algorithms can also be used to adjust pH sensor data on biogeochemical floats
- The seasonal cycle in surface pH ranges from 0.05 to 0.08 for the study region

Empirical algorithms are developed using high-quality GO-SHIP hydrographic measurements of commonly measured parameters (temperature, salinity, pressure, nitrate, and oxygen) that estimate pH in the Pacific sector of the Southern Ocean. The coefficients of determination, R2 are 0.98 for pH from nitrate (pHN) and 0.97 for pH from oxygen (pHOx) with RMS errors of 0.010 and 0.008, respectively. These algorithms are applied to Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) biogeochemical profiling floats, which include novel sensors (pH, nitrate, oxygen, fluorescence, and backscatter). These algorithms are used to estimate pH on floats with no pH sensors, and to validate and adjust pH sensor data from floats with pH sensors. The adjusted float data provide, for the first time, seasonal cycles in surface pH on weekly resolution that range from 0.05 to 0.08 on weekly resolution for the Pacific sector of the Southern Ocean.
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Available Online: http://onlinelibrary.wiley.com/doi/10.1002/2016GL068539/full

NOAA SCIENTIFIC PUBLICATIONS REPORT
APRIL 25, 2016

NWS Publications

Intercomparison of selected fixed-area areal reduction factor methods
Journal of Hydrology (2.693)
S. Pavlovic, **S. Perica**, **M. St. Laurent**, A. Mejía **(NWS/NWC)**

- The authors analyze different methods of calculating areal reduction factors (ARF), which are used to convert point precipitation frequency estimates (e.g., from NOAA Atlas 14) to areal precipitation frequency estimates.
- They find significant uncertainties in ARF estimates calculated with all methods and discrepancies in ARF estimates between different methods.

The areal reduction factor (ARF) is a concept used in many hydrologic designs to transform a point precipitation frequency estimate of a given duration and frequency to a corresponding areal estimate. Various methods have been proposed in the literature to calculate ARFs. Proposed ARFs could vary significantly, and it is unclear if discrepancies are primarily due to differences in methodologies, the dissimilar datasets used to calculate ARFs, or if they originate from regional uniqueness.

Our goal in this study is to analyze differences among ARFs derived from different types of fixed-area ARF methods, which are suitable for use with precipitation frequency estimates. For this intercomparison, all the ARFs were computed using the same, high-quality rainfall-radar merged dataset for a common geographic region. The selected ARFs methods represent four commonly used approaches: empirical methods, methods that are based on the spatial correlation structure of rainfall, methods that rely on the scaling properties of rainfall in space and time, and methods that utilize extreme value theory. The state of Oklahoma was selected as the study area, as it has a good quality radar data and a dense network of rain gauges. Results indicate significant uncertainties in the ARF estimates, regardless of the method used. Even when calculated from the same dataset and for the same geographic area, the ARF estimates from the selected methods differ. The differences are more pronounced for the shorter durations and larger areas. Results also indicate some ARF dependence on the average recurrence intervals.

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http://www.sciencedirect.com/science/article/pii/S0022169416301329

NOAA SCIENTIFIC PUBLICATIONS REPORT
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CROSS LINE OFFICE ARTICLES

Sensitivity of global upper ocean heat content estimates to mapping methods, XBT bias corrections, and baseline climatologies
Journal of Climate (4.904)
T. Boyer (NESDIS/NCEI), C. M. Domingues, S. A. Good, **G. C. Johnson (OAR/PMEL)**, **J. M. Lyman (OAR/PMEL)**, M. Ishii, V. Gouretski, J. K. Willis, J. Antonov, S. Wijffels, J. A. Church, R. Cowley, N. Bindoff

- The authors investigate the sensitivity of global ocean heat content anomaly (OHCA) estimates to different calculation methods by comparing results from seven independent groups.
- Despite significant discrepancies between global OHCA estimates for the upper 700m produced by different methods, there is a statistically robust warming trend from 1970-2008 in all cases.

Ocean warming accounts for the majority of Earth's recent energy imbalance. Historic Ocean Heat Content (OHC) changes are important for understanding changing climate. Calculations of OHC anomalies (OHCA) from in situ measurements provide estimates of these changes. Uncertainties in OHCA estimates arise from calculating global fields from temporally and spatially irregular data (mapping method), instrument bias corrections, and the definitions of a baseline climatology from which anomalies are calculated. To investigate sensitivity of OHCA estimates for the upper 700 m to these different factors, the same quality controlled data set is used by seven groups and comparisons made. Two time periods: 1970–2008 and 1993–2008, are examined. Uncertainty due to the mapping method is 16.5 ZJ for 1970–2008 and 17.1 ZJ for 1993–2008. Uncertainty due to instrument bias correction varied from 8.0 to 17.9 ZJ for 1970–2008 and 10.9 to 22.4 ZJ for 1993–2008, depending on mapping method. Uncertainty due to baseline mean varied from 3.5 to 14.5 ZJ for 1970–2008 and 2.7 to 9.8 ZJ for 1993–2008, depending on mapping method and offsets. On average mapping method is the largest source of uncertainty. The linear trend varied from 1.3 to 5.0 ZJ yr^{-1} (0.08 to 0.31 W m^{-2}) for 1970–2008 and 1.5 to 9.4 ZJ yr^{-1} (0.09 to 0.58 W m^{-2}) for 1993–2008, depending on method, instrument bias correction, and baseline mean. Despite these complications, a statistically robust upper ocean warming was found in all cases for the full time period.
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Differential patterns of divergence in ocean drifters: Implications for larval flatfish advection and recruitment

Journal of Sea Research (1.990)

T. Wilderbuer (NMFS/AFSC), J. T. Duffy-Anderson (NMFS/AFSC), P. Stabeno (OAR/PMEL), A. Hermann (OAR/PMEL)

- Tides play a major role in dispersing oceanic drifters in the eastern Bering Sea.
- Including tides in a ROMS (Regional Ocean Model System) hydrodynamic model improves fit to drifter dispersal data.
- Synchronization of tides and larval vertical migrations aids transport to nurseries.

In an effort to better understand the physics of the eastern Bering Sea shelf current as it relates to flatfish advection to favorable near-shore areas, sets of multiple, satellite-tracked, oceanic drifters were released in 2010, 2012 and 2013. The release sites and dates were chosen to coincide with known spawning locations for northern rock sole (*Lepidopsetta polyxystra*) and known time of larval emergence. The drifters were drogued 5-each at 20 and 40 m in 2010 and 2012, and 4 at 40 m and 2 at 20 m in 2013. The locations of drifters were used to calculate divergence over a 90-day period that corresponds to the larval pelagic duration of Bering Sea shelf northern rock sole. Results indicate that there are alternating periods of positive and negative divergence with an overall trend toward drifter separation after 90 days, roughly the end of the rock sole planktonic larval period. Examination of the drifter behavior at the hourly scale indicates that semi-daily tidal forcing is the primary mechanism of drifter divergence and convergence. Field observations of early-stage northern rock sole larval distributions over the same period indicate that predominant oceanographic advection is northerly over the continental shelf among preflexion stages, though juveniles are predominantly found in nursery areas located ~ 400 km eastward and inshore. Evidence from drifter deployments suggests that behavioral movements during the postflexion and early juvenile larval phases that optimize eastward periodicity of tidal cycles is a viable mechanism to enhance eastward movement of northern rock sole larvae to favorable nursery grounds. A regional ocean modeling system (ROMS) was implemented to track the different rates of dispersion in simulations both with and without tidal forcing, and was used to estimate effective horizontal eddy diffusion in the case of both isobaric (fixed-depth) and Lagrangian (neutrally buoyant) particles. The addition of tidal forcing had a pronounced effect on horizontal eddy diffusion, increasing its value by a factor of

five in the case of fixed-depth floats, as compared with a factor of two in the case of neutrally buoyant floats. Further, the incorporation of diurnal vertical behavior in phase with favorable (on shelf) tides transported the "larvae" ~ 400 km within 40 days of their release date. Empirical drifter data coupled with model evidence suggest that semi-diurnal tidal forcing is the primary mechanism of eastward advection over the Bering Sea shelf, and larval observational data suggest that northern rock sole larvae can maximize their eastward transport to nursery grounds by synchronizing their vertical movements to tidal periodicity during the postflexion stage.
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http://www.sciencedirect.com/science/article/pii/S1385110116300211?np=y

OTHER REPORTS, BOOK CHAPTERS, AND INTERNAL PUBLICATIONS

NOS Publications

Great Lakes Mussel Watch Sites Land-Use Characterization and Assessment
NCCOS Report
M. A. Edwards, A. Jacob, K. Kimbrough, W. E. Johnson, E. D. Davenport (NOS/NCCOS)

- The information provided in this report can serve as a resource for local as well as regional assessment of land-use within MWP sites.
- The information provided can also be useful to stakeholders and resource managers in making informed decision in protecting the Great Lakes nearshore resources.

The "Great Lakes Mussel Watch Sites Land-use Characterization and Assessment" report characterizes land-use and land uses around the Mussel Watch Program (MWP) monitoring sites in the Great Lakes. Mussel Watch sites are categorized based on the most predominant land-use and classified as Agriculture, Undeveloped, Urban and Low-developed. Additional information on the land-use change from 1992-2006, the presence of major outfalls and the population trend since 1970 for each site is presented through reader friendly maps and graphics. This report was prepared as a companion document to NOAA Tech Memo NOS NCCOS 180 "Mussel Watch Great Lakes Contaminant Monitoring and Assessment: Phase 1" and more information on Mussel Watch Program and its

recent focus on Areas of Concern under the Great Lakes Restoration Initiative is available online and can be found at https://coastalscience.noaa.gov/projects/detail?key=179.
Acceptance date: March, 2016

REServ: An Ecosystem Services Assessment using bioextraction technologies for removal of nitrogen and other substances in Long Island Sound and the Great Bay/Piscataqua Region
NOAA Coastal Ocean Program Decision Analysis Series No. 194.
S. Bricker, J. Ferreira, C. Zhu, **J. Rose**, **E. Galimany, G. Wikfors**, C. Saurel, R. Landeck Miller, J. Wands, P. Trowbridge, R. Grizzle, K. Wellman, R. Rheault **(NOS/NCCOS)**

- This study estimates the value of one of the ecosystem services provided by oyster and clam aquaculture - nutrient removal from the water through bioextraction via water filtration
- In New Hampshire's Great Bay Piscataqua Estuaries the value of bioextraction estimated through the cost avoided method for GBP is $1.1 and $1.3 million under the current scenario of 25 acres of shellfish lease area. If production acres were to expand to the potential 97 acres the range of values is estimated at $4.3 - $5.0 million.
- Regardless of whether shellfish farmers become eligible for nutrient credit trading, the valuation of the ecosystem services associated with shellfish culture will enhance public awareness of water quality issues, and could help shift attitudes to allow increased use of these programs.

Nutrient related water quality degradation, called eutrophication, is an issue of concern in Long Island Sound (LIS) and Great Bay Piscataqua Estuaries (GBP). The REServ project evaluated the feasibility and potential of nutrient removal directly from the water through bioextraction through the filtration of shellfish, oysters and clams as a complement to traditional land-based management measures.
Publication date: 13 April, 2016
Available online:
http://www2.coastalscience.noaa.gov/publications/detail.aspx?resource=O0hdKo2k2hSWOxLGFRcu/feoeR4U4RM469gysLLrINQ=

NOAA SCIENTIFIC PUBLICATIONS REPORT
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Marine Biogeographic Assessment of the Main Hawaiian Islands
NOAA technical memorandum

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- The state of Hawai‘i is planning development of its offshore renewable energy sources, notably wind. NOAA’s NCCOS partnered with BOEM and other agencies to characterize the marine biogeography around the main Hawaiian Islands and predict the distribution of environmental variables, fishes, bottom types, coral reefs, marine mammals, and seabirds.
- The assessment provides biogeographic data within BOEM's lease-sale framework where offshore wind-turbines may be placed and the nearshore right-of-way corridors needed to bring power onshore.
- For some taxa, this marine biogeographic assessment marks the first time that their space-use patterns were mapped or modeled in the MH
- Establishes a baseline for assessing potential impacts, a guide for monitoring change, a roadmap for prioritizing how to fill data gaps, and a framework for integrating ocean research and management efforts moving forward.

The biogeography of the Main Hawaiian Islands (MHI) is shaped by atmospheric and oceanographic conditions that operate at different temporal and spatial scales around the islands. Marine animals respond to these changing conditions in different ways. Some taxonomic groups and species use the same locations year round (e.g., on Penguin Bank or offshore of the Kona Coast, Hawai’i), while most taxa utilize different geographic areas at different times of the year. Understanding these spatial and temporal patterns is critical for marine spatial planning efforts. For some taxa, this marine biogeographic assessment marks the first time that their space-use patterns were mapped or modeled in the MHI, and the associated data compilation made available online. It establishes a baseline for assessing potential impacts, a guide for monitoring change, a roadmap for prioritizing how to fill data

gaps, and a framework for integrating ocean research and management efforts moving forward. The state of Hawai‘i would like to develop local renewable energy sources (notably, wind). Much of the State’s potential wind energy is located in federal waters. BOEM regulates renewable energy projects in federal waters, and is required to assess the potential environmental impacts of these projects during the leasing process. To help inform this process, NOAA’s NCCOS characterized the marine biogeography and identified key data gaps around the MHI. This project is a small piece of a much larger BOEM leasing process.
Expected Publication Date: 31 July, 2016