NOAA SCIENTIFIC PUBLICATIONS REPORT

MARCH 25, 2016

HIGHLIGHTED ARTICLES

Estimating sea turtle exposures to Deepwater Horizon oil
Endangered Species Research (2.259)

The Pacific decadal oscillation, revisited
Journal of Climate (4.904)

Ochre star mortality during the 2014 wasting disease epizootic: role of population size structure and temperature
Philosophical Transactions of The Royal Society B (7.055)

ADDITIONAL ARTICLES

NMFS Publications

Evaluating the effect of soak time on bottomfish abundance and length data from stereo-video surveys
Journal of Experimental Marine Biology and Ecology (1.87)

Demographics of a nearshore mating queen conch (*Lobatus gigas*) aggregation on the southeast Florida Reef Tract
Bulletin of Marine Science (1.457)

The influence of seasonal migrations on fishery selectivity
ICES Journal of Marine Science (2.525)

Hydrologic indicators of hot spots and hot moments of mercury methylation along river corridors
Science of the Total Environment (3.163)

Young of the year bluefish (*Pomatomus saltatrix*) as a bioindicator of estuarine health: establishing a new baseline for persistent organic pollutants after Hurricane Sandy for selected estuaries in New Jersey and New York
Marine Pollution Bulletin (2.793)

Phaeohyphomycosis resulting in obstructive tracheitis in three green sea turtles *Chelonia mydas* stranded along the Florida coast
Diseases of Aquatic Organisms (1.752)

Mycobacterium haemophilum infection in a juvenile leatherback sea turtle (*Dermochelys coriacea*)
Diseases of Aquatic Organisms (1.752)

Trends in biomass of coral reef fishes derived from shore-based creel surveys in Guam
Fishery Bulletin (1.135)

NMFS/OAR Publications

Seasonal phytoplankton blooms in the North Atlantic linked to the overwintering strategies of copepods
Elementa: Science of the Anthropocene (unavailable)

Improving marine disease surveillance through sea temperature monitoring, outlooks and projections
Philosophical Transactions of The Royal Society B (7.055)

HIGHLIGHTED ARTICLES

Estimating sea turtle exposures to Deepwater Horizon oil
Endangered Species Research (2.259)
B. P. Wallace, **B. A. Stacy (NMFS/OPR)**, M. Rissing, D. Cacela, **L. P. Garrison (NMFS/SEFSC)**, **G. D. Graettinger(NMFS/ORR)**, J. V. Holmes, T. McDonald, D. McLamb, and **B. Schroeder (NMFS/OPR)**

- Describes analyses used to quantify exposure of sea turtles to oil during the Deepwater Horizon spill.
- Provides a peer-reviewed method that can be used to comprehensively estimate harm to sea turtles and other marine resources resulting from future spills.

The Deepwater Horizon (DWH) oil spill was unprecedented in extent and duration, and affected marine natural resources, including sea turtles, throughout the northern Gulf of Mexico. Consequently, U.S. federal and state Trustees documented and quantified oil exposure and resulting injuries to sea turtles under the DWH Natural Resource Damage Assessment. At-sea rescue operations focused on surface-pelagic juvenile sea turtles, which were especially at risk to oil exposure within oceanic convergence zones, and provided direct observations of the degree that turtles in this young life stage were exposed to DWH oil. In contrast, locations of larger neritic juvenile and adult turtles were documented during aerial surveys, but because these turtles were not captured, their oiling status could not be directly evaluated. Both the rescue operations and aerial surveys were able to observe only a small fraction of sea turtles within the vast spill footprint. We developed a spatio-temporally explicit approach that used direct observations of oiled surface-pelagic juvenile sea turtles and satellite-derived surface oil distributions to statistically estimate the probabilities of oil exposure for all sea turtles that were present within the area of the DWH spill, but whose oiling status was unknown. Our results enabled an expansion of exposure and injury quantification across the entire DWH spill area and period. This approach was conceptually straightforward and used common geospatial and statistical techniques, making it applicable to other situations in which the full extent of oil exposure for marine natural resources must be estimated from an incomplete sample.
Accepted: 11 March 2016

The Pacific decadal oscillation, revisited
Journal of Climate (4.904)
M. Newman (OAR/ESRL), M. A. Alexander (OAR/ESRL), T. R. Ault, K. M. Cobb, C. Deser, E. Di Lorenzo, **N. J. Mantua (NMFS/SWFSC)**, A. J. Miller, S. Minobe, H. Nakamura, N. Schneider, D. J. Vimont, A. S. Phillips, J. D. Scott, and **C. A. Smith (OAR/ESRL).**

- Research over the last fifteen years has led to an emerging consensus: the PDO (Pacific decadal oscillation) is not a single phenomenon, but is instead the result of a combination of different physical processes, including both remote tropical forcing and local North Pacific atmosphere/ocean interactions.

- We suggest that assessment of PDO-related regional climate impacts, reconstruction of PDO-related variability into the past with proxy records, and diagnosis of Pacific variability within coupled GCMs (general circulation models) should all account for the effects of these different processes, which only partly represent direct forcing of the atmosphere by North Pacific Ocean SSTs (sea surface temperatures).

The Pacific decadal oscillation (PDO), the dominant year-round pattern of monthly North Pacific sea surface temperature (SST) variability, is an important target of ongoing research within the meteorological and climate dynamics communities, and is central to the work of many geologists, ecologists, natural resource managers, and social scientists. Research over the last fifteen years has led to an emerging consensus: the PDO is not a single phenomenon, but is instead the result of a combination of different physical processes, including both remote tropical forcing and local North Pacific atmosphere/ocean interactions, which operate on different timescales to drive similar PDO-like SST anomaly patterns. How these processes combine to generate observed PDO evolution, including apparent regime shifts, is shown using simple autoregressive models of increasing spatial complexity. Simulations of recent climate in coupled GCMs are able to capture many aspects of the PDO, but do so based on a balance of processes often more independent of the Tropics than is observed. Finally, it is suggested that assessment of PDO-related regional climate impacts, reconstruction of PDO-related variability into the past with proxy records, and diagnosis of Pacific variability within coupled GCMs should all account for the effects of these different processes, which only partly represent direct forcing of the atmosphere by North Pacific Ocean SSTs.
Accepted: 1 March 2016

Ochre star mortality during the 2014 wasting disease epizootic: role of population size structure and temperature
Philosophical Transactions of The Royal Society B (7.055)
M. E. Eisenlord, M. L. Groner, R. M. Yoshioka, J. Elliott, J. Maynard, S. Fradkin, M. Turner, K. Pyne, N. Rivlin, **R. van Hooidonk (OAR/AOML)**, and C. D. Harvell

- In 2013 to 2014, over 20 species of asteroids from Mexico to Alaska were devastated by a sea star wasting disease (SSWD).
- Time-series monitoring of *Pisaster ochraceus* in Puget Sound and the Washington outer coast showed rapid disease spread and high mortality rates in 2014.
- Laboratory experiments on *P. ochraceus* found that time between development of disease signs and death was influenced by temperature.
- Unusual 2-3°C warm temperature anomalies in Washington State were coincident with the summer 2014 mortalities; the authors suggest that warm waters could have increased the disease progression and mortality rates of SSWD in Washington State.

Over 20 species of asteroids were devastated by a sea star wasting disease (SSWD) epizootic, linked to a densovirus, from Mexico to Alaska in 2013 and 2014. For *Pisaster ochraceus* from the San Juan Islands, South Puget Sound and Washington outer coast, time-series monitoring showed rapid disease spread, high mortality rates in 2014, and continuing levels of wasting in the survivors in 2015. Peak prevalence of disease at 16 sites ranged to 100%, with an overall mean of 61%. Analysis of longitudinal data showed disease risk was correlated with both size and temperature and resulted in shifts in population size structure; adult populations fell to one quarter of pre-outbreak abundances. In laboratory experiments, time between development of disease signs and death was influenced by temperature in adults but not juveniles and adult mortality was 18% higher in the 19°C treatment compared to the lower temperature treatments. While larger ochre stars developed disease signs sooner than juveniles, diseased juveniles died more quickly than diseased adults. Unusual 2–3°C warm temperature anomalies were coincident with the summer 2014 mortalities. We suggest these warm waters could have increased the disease progression and mortality rates of SSWD in Washington State.
Publication date: 15 February 2016
Available online:
http://rstb.royalsocietypublishing.org/content/371/1689/20150212

ADDITIONAL ARTICLES

NMFS Publications

Evaluating the effect of soak time on bottomfish abundance and length data from stereo-video surveys

Journal of Experimental Marine Biology and Ecology (1.87)

W. Misa (OAR/JIMAR), **B. Richards (NMFS/PIFSC), G. T. DiNardo (NMFS/PIFSC),** C. Kelley, V. Moriwake, J. Drazen

- The authors examined methods for increasing the efficiency of fishery-independent stereo-video sampling of bottomfish and similar fish species
- The authors found that a reduction in camera soak time does not sacrifice fish abundance and length data quality
- Abundance trends were found to be highly influenced by fish behavior and length trends were dependent on species' frequency of occurrence suggesting the need for species-level considerations when conducting video surveys

Baited stereo-camera surveys of fish assemblages provide conservative estimates of abundance and length-frequency distributions. While underwater camera systems have numerous advantages over traditional fishing and diver surveys, limitations in sampling capacity, data processing time, and resultant data still exist. Previous studies have shown that shorter camera soak times can increase sampling efficiency and reduce per-sample data processing time without affecting overall data quality. Using data from stereo-video surveys of bottomfish in the main Hawaiian Islands, this study evaluates the effect of camera soak time on relative abundance metrics, fish length data, sampling efficiency, and power to detect differences in relative abundance and fish lengths. A soak time of 15 min was found to be the shortest duration able to capture bottomfish abundance and length metrics while 30 min generated data that did not significantly differ from the standard 40-min soak time. These shorter soak times allow for better survey efficiency and improved cost-benefit through increased levels of field sampling and reductions in video-processing time, while maintaining the power to detect differences in bottomfish relative abundance and lengths. The main drawback to shortening soak time was the concurrent reduction in the number of length measurements collected per species. An increased sample yield can alleviate this effect but only for bottomfish with a higher frequency of occurrence. Species-specific patterns in abundance were apparent in this study suggesting a strong influence of fish behaviour on stereo-video abundance metrics. While a soak time of 15 to 30 min was found to be sufficient for effectively sampling bottomfish, the cost-benefit of employing a given soak time in future stereo-video surveys should be assessed based on the target species and survey goals.

Acceptance date: 2 March 2016

Expected publication date: April 2016

NOAA SCIENTIFIC PUBLICATIONS REPORT

MARCH 25, 2016

*Demographics of a nearshore mating queen conch (*Lobatus gigas*) aggregation on the southeast Florida Reef Tract*

Bulletin of Marine Science (1.457)

C. Berry, **R. L. Hill (NMFS/SEFSC)**, B. K. Walker

- This paper explains that queen conch are present in greater numbers than expected near the Port Everglades inlet, in the northern part of the Florida reef tract, and argues that expanded surveys are needed in order to explore
- Queen conch are successfully reproducing the full extent of conch habitats.in nearshore waters, implying better habitat quality than in the nearshore waters of the middle Florida Keys, where reproductive disruptions have been reported.
- For successful egg-laying and hatching, queen conch require relatively coarse, clean sand, although not all of the requirements have been well defined. Beach renourishment or channel dredging projects could affect the habitat characteristics important to queen conch for successful reproduction.

The queen conch, *Lobatus gigas* (Linnaeus, 1758), is a large gastropod found throughout the Caribbean region, including off Florida. The extent, habitat association, and population demographics of an aggregation were investigated off southeast Florida near a major shipping port. Population surveys were conducted over 4 km^2 of hard-bottom habitats to document benthic cover, conch distribution, and size data within 2 km north and south of the shipping inlet. In total, 122 conch were recorded for the entire surveyed area, equating to 70.6 conch ha−1. Mean density was highest south of the inlet. Juvenile and subadult conch were found throughout the study area, but mostly in the westernmost, shallowest hard-bottom habitats. The highest density of adult conch was found in the CPW south of the inlet. Analyses showed that CPW south has a unique community composition dominated by macroalgae and sand. This area was surveyed further using cross-shelf transects measuring conch extent and demographics. Five-hundred-and-twenty-five conch were found, resulting in a density of 495 ha−1. Confirmed mating sightings, females with eggs, and solitary egg masses were found indicating reproduction in this nearshore habitat is successful. The ratio of females with eggs to those without indicated that, although 21.2% of the females with eggs had a thinner lip, the majority had a lip thickness >12 mm. Nearshore mating conch should be a consideration in beach construction projects. Future research should include reconnaissance for other aggregations, monitoring, and comparisons among other nearshore populations.

Acceptance date: 2 December 2015

Published: 15 January 2016

The influence of seasonal migrations on fishery selectivity
ICES Journal of Marine Science (2.525)
R. O'Boyle, M. Dean, **C. M. Legault (NMFS/NEFSC)**

- Demonstrates that domed selectivity patterns are not necessarily expected when seasonal migration modeled. This contrasts with earlier work by others that showed one way migration almost always led to domed selectivity.
- We recommend the use of simulation modeling to examine the potential for domed selectivity.

Based on previous work, dome-shaped fishery selectivity patterns are expected in place of asymptotic patterns when one-way fish movements amongst areas are considered. It is less clear if this occurs when the "round-trip" seasonal movements observed in many fish stocks are considered. A simulation of a long-distance migrating fish stock (Atlantic menhaden) was used to study the influence of life history and fishery processes on selectivity, under an 'areas as fleet' (AAF) stock assessment context. When age-constant two-way migration was assumed to occur at a low rate, a domed selectivity pattern in the area experiencing the highest fishing mortality was produced, consistent with previous work. However, as the two-way migration rate increased, the domed selectivity pattern diminished and eventually disappeared. When age-varying migration was introduced, with a higher movement probability for older fish, domed selectivity prevailed in the source (i.e., spawning) area. If movement away from the spawning area occurs at younger ages than are selected by the fishing gear, the extent of the dome in this area is reduced. When movement away from the spawning area occurs at ages that are already available to the fishing gear, the dome in the spawning area is exaggerated. The area in which domed selectivity occurred was primarily determined by whether the probability of movement increased or decreased with age. In contrast to previous work that considered one-way or diffusive movement, the temporal or spatial distribution of recruitment and overall fishing mortality did not have a significant influence on selectivity. Building simulations that reflect the life history of the stock can guide assessment efforts by placing priors and constraints on model fits to selectivity patterns and be used to explore trade-offs between model complexity and the ability to produce reasonable management advice. Their development is encouraged as a standard feature in the assessment of migratory fish stocks.

Acceptance date: 7 March 2016

Hydrologic indicators of hot spots and hot moments of mercury methylation along river corridors

Science of the Total Environment (3.163)

M. B. Singer, **L. R. Harrison (NMFS/SWFSC)**, P. M. Donovan, J. D. Blum, M. Marvin-DiPasquale

- This research addresses a gap in the understanding of how flood inundation along river corridors can initiate the production of bioavailable mercury, which may contaminate food webs in rivers impacted by 19th century gold mining across the western Sierra Nevada.

The biogeochemical cycling of metals and other contaminants is in part controlled by the activity of bacteria that can convert them to and from bioavailable forms. Since microbial activity is often affected by redox conditions, river-floodplain corridors may be particularly dynamic in this regard, as they experience low to depleted oxygen conditions during flood inundation. Riverine flooding thus has the potential to initiate biogeochemical processes in sediment and thereby affect speciation of redox-sensitive metals such as mercury (Hg). Therefore, flow history over a period of decades potentially holds information on past production of bioavailable Hg. We investigate this process within a Northern California river system that has a legacy of industrial-scale 19th century hydraulic gold mining. In the first known application of this methodology, we combine hydraulic modeling, measurements of Hg species in sediment and biota, and first-order calculations to assess the role of river floodplains in producing monomethylmercury (MMHg), which accumulates in local and migratory biota. We identify areas that represent 'hot spots' (frequently inundated areas of floodplains) and 'hot moments' (floodplain areas inundated for consecutive long periods). We show that the probability of MMHg production in each sector of the river system is dependent on the spatial patterns of overbank flow and drainage that affects its long-term redox history. We also show that tin-reducible 'reactive Hg' (methodologically defined) is uniformly high in well drained floodplain sediment along the western slope of the Sierra Nevada, representing a consistent source of potentially bioavailable Hg(II) under temporarily favorable redox conditions. Furthermore, local (non-migrating) aquatic biota are contaminated with MMHg compared to biota in non-mining Coast Ranges streams subjected only to atmospheric Hg deposition, a strong indicator of the protracted biogeochemical legacy of 19th century gold mining. MMHg bioaccumulation within the aquatic food web may pose a major risk to humans and waterfowl that eat migratory salmonids, which are being encouraged to come up these rivers to spawn, and there appears to be no end to MMHg production under a regime of increasingly common large floods with

extended duration. These findings identify river floodplains as periodic, temporary, yet important, loci of biogeochemical transformation in which contaminants may undergo change during limited periods of the historical hydrologic record. We suggest that inundation is the primary driver of MMHg production in river corridors and that the entire flow history must be analyzed in terms of magnitude and frequency of inundation in order to accurately assess biogeochemical risks, rather than merely highlighting the largest floods.
Acceptance date: 2 March 2016
Expected publication date: Spring 2016

*Young of the year bluefish (*Pomatomus saltatrix*) as a bioindicator of estuarine health: Establishing a new baseline for persistent organic pollutants after Hurricane Sandy for selected estuaries in New Jersey and New York*
Marine Pollution Bulletin (2.793)
K. L. Smalling, **A. D. Deshpande (NMFS/NEFSC)**, V. S. Blazer, **B. Dockum (NMFS/NEFSC)**, **D. Timmons (NMFS/NEFSC)**, **B. L. Sharack (NMFS/NEFSC)**, R. J. Baker, **J. Samson (NMFS/NEFSC)**, T. J. Reilly

- Young-of-the-year bluefish served as unique biomarkers of organic contaminants in different NY/NJ estuaries.
- Pesticide concentrations following Hurricane Sandy were similar compared to pre-Sandy levels, while changes in PCB and PBDE concentrations varied by the estuary.
- We reported, probably for the first time to our knowledge, contaminants in the bluefish parasitic isopods.

New Jersey and New York coastal bays are essential habitat for young of the year bluefish (*Pomatomus saltatrix*). Their residence in these estuaries during critical life stages, high lipid content, and piscivory make bluefish an ideal bioindicator species for evaluating estuarine health. Individual fish from four estuaries impacted by Hurricane Sandy were collected, analyzed for a suite of persistent organic pollutants (POPs) including polychlorinated biphenyls, polybrominated diphenyl ethers and organochlorine pesticides and evaluated using health metrics. Concentrations in bluefish differed by estuary; however, concentrations for many POPs decreased or were similar to those observed prior to the hurricane. Prevalence of the ectoparasitic gill isopod (*Lironeca ovalis*) varied by estuary and no relationships between contaminants and lesions were observed. As bluefish integrates contaminants throughout an estuary, it should be considered for routine monitoring programs and, if sampled frequently, could be an effective bioindicator of incremental and episodic changes in contaminants within aquatic food webs.
Acceptance date: 10 March 2016

Phaeohyphomycosis resulting in obstructive tracheitis in three green sea turtles Chelonia mydas *stranded along the Florida coas*t
Diseases of Aquatic Organisms (1.752)
K. Donnelly, T. B. Waltzek, J. F. Wellehan Jr, D. A. Sutton, N. P. Wiederhold, **B. A. Stacy (NMFS/OPR).**

- This is the first report of infection by the fungus *Veronaea botryosa* in free-ranging marine animals
- This infection appears to have contributed to the stranding and death of three green sea turtles, which are all listed under the US Endangered Species Act as endangered (Florida and the Pacific coast of Mexico) or threatened (all other populations)

Three wild immature green sea turtles Chelonia mydas were found alive but lethargic on the shores of the Indian River Lagoon and Gulf of Mexico in Florida, USA, and subsequently died. Necropsy findings in all 3 turtles included partial occlusion of the trachea by a mass comprised of granulomatous inflammation. Pigmented fungal hyphae were observed within the lesion by histology and were characterized by culture and sequencing of the internal transcribed spacer 2 domain of the rRNA gene and D1/D2 region of the fungal 28s gene. The dematiaceous fungus species *Veronaea botryosa* was isolated from the tracheal mass in 2 cases, and genetic sequence of V. botryosa was detected by polymerase chain reaction in all 3 cases. Genetic sequencing and fungal cultures also detected other dematiaceous fungi, including a Cladosporium sp., an Ochroconis sp., and a Cochliobolus sp. These cases are the first report of phaeohyphomycosis caused by V. botryosa in wild marine animals.
Expected publication date: 8 April 2015
Available online: http://www.int-res.com/abstracts/dao/v113/n3/p257-262/

Mycobacterium haemophilum infection in a juvenile leatherback sea turtle (Dermochelys coriacea)
Journal of Veterinary Diagnostic Investigation (1.353)
K. Donnelly, T. B. Waltzek, J. F. X. Wellehan Jr., N. I. Stacy, M. Chadam, **B. A. Stacy (NMFS/OPR)**

- Mycobacteriosis (disease caused by the bacteria group known as mycobacteria), was reported in many stranded juvenile sea turtles from 2004 - 2015.
- This report of *Mycobacterium haemophilum* infection of a juvenile leatherback turtle *(Dermochelys coriacea)* is the reported case of this mycobacteria species in any sea turtle
- Leatherback turtles are listed throughout their range as endangered under the US Endangered Species Act.

Title of paper: Mycobacteriosis is infrequently reported in free-ranging sea turtles. The nontuberculous *Mycobacterium haemophilum* was identified as the causative agent of disseminated mycobacteriosis in a juvenile leatherback turtle (*Dermochelys coriacea*) that was found stranded on the Atlantic coast of Florida, USA. Disseminated granulomatous inflammation was identified histologically, most notably affecting the nervous system. Identification of mycobacterial infection was based on cytologic, molecular, histopathologic, and microbiologic methods. Among stranded sea turtles received for diagnostic evaluation from the Atlantic and Gulf of Mexico coasts of the USA between 2004 and 2015, the diagnosis of mycobacteriosis was over-represented in stranded oceanic-phase juveniles compared to larger size classes, which suggests potential differences in susceptibility or exposure among different life phases in this region. This report is the first description of *M. haemophilum* in a sea turtle and contributes to the knowledge of diseases of small juvenile sea turtles, an especially cryptic life phase of the leatherback turtle.
Expected publication date: 2016

Trends in biomass of coral reef fishes derived from shore-based creel surveys in Guam
Fishery Bulletin (1.135)
M. Weijerman, **I. Williams (NMFS/PIFSC),** J. Gutierrez, S. Grafeld, B. Tibbatts, **G. Davis (NMFS/PIRO)**

- Reconstruction of historical targeted fish biomass based on catch-per-unit-effort time series showed a general decrease in biomass.
- Current (2012) biomass levels are less than half of values from 1985.

- Given their ecological and societal importance these low biomass levels are a reason for concern to managers.

Coral reef fisheries have a cultural, economic, and ecological importance and sustain the societal well-being of many coastal communities. However, the complexities of these multispecies, multigear fisheries pose challenges for fisheries management. In this paper, we focus on the Guam shore-based coral reef fishery 1) to evaluate the characteristics of the past and recent fishery in terms of catch composition and effort per gear type and 2) to reconstruct the reef-fish population in shallow (depths ≤30 m) water during 1985–2012. To accomplish this work, we used the results from a detailed creel survey program conducted by the Guam Division of Aquatic and Wildlife Resources. The total estimated effort has stayed more or less stable; however, the estimated total catch has dropped from an annual mean of 100 metric tons (t) in the period 1985–1990 to 37 t in the period 2007–2012. Catch per unit effort (CPUE) declined for most gear types between the 2 time periods. Reconstruction of historical targeted fish biomass, based on the CPUE, showed a general decrease in biomass from 1985 to 2012. Biomass quickly dropped to about half the 1985 values, then leveled off for a decade before declining again beginning in 2003 and continuing through 2012.
Accepted: 2 March 2016

NMFS/OAR Publications

Seasonal phytoplankton blooms in the North Atlantic linked to the overwintering strategies of copepods
Elementa: Science of the Anthropocene (unavailable)
K. D. Friedland (NMFS/NEFSC), N. R. Record, R. G. Asch, T. Kristiansen, **V. S. Saba (NMFS/NEFSC)**, K. Drinkwater, S. Henson, R. T. Leaf, **R. E. Morse (NMFS/NEFSC)**, D. G. Johns, S. I. Large, S. S. Hjøllo, J. A. Nye, **M. A. Alexander (OAR/ESRL)**, R. Ji

- Provides an understanding of the seasonal phytoplankton blooms in the North Atlantic and demonstrates the importance of bloom timing in the size and duration of blooms.
- Poses a hypothesis related to the effect of zooplankton grazing in shaping the dynamics of blooms on a basin scale.

The North Atlantic Ocean contains diverse patterns of seasonal phytoplankton blooms with distinct internal dynamics. We analyzed blooms using remotely-

sensed chlorophyll a concentration data and change point statistics. The first bloom of the year began during spring at low latitudes and later in summer at higher latitudes. In regions where spring blooms occurred at high frequency (i.e., proportion of years that a bloom was detected), there was a negative correlation between bloom timing and duration, indicating that early blooms last longer. In much of the Northeast Atlantic, bloom development extended over multiple seasons resulting in peak chlorophyll concentrations in summer. Spring bloom start day was found to be positively correlated with a spring phenology index and showed both positive and negative correlations to sea surface temperature and the North Atlantic Oscillation in different regions. Based on the characteristics of spring and summer blooms, the North Atlantic can be classified into two regions: a seasonal bloom region, with a well-defined bloom limited to a single season; and a multi-seasonal bloom region, with blooms extending over multiple seasons. These regions differed in the correlation between bloom start and duration with only the seasonal bloom region showing a significant, negative correlation. We tested the hypothesis that the near-surface springtime distribution of copepods that undergo diapause (*Calanus finmarchicus, C. helgolandicus, C. glacialis*, and *C. hyperboreus*) may contribute to the contrast in bloom development between the two regions. Peak near-surface spring abundance of the late stages of these Calanoid copepods was generally associated with areas having a well-defined seasonal bloom, implying a link between bloom shape and their abundance. We suggest that either grazing is a factor in shaping the seasonal bloom or bloom shape determines whether a habitat is conducive to diapause, while recognizing that both factors can re-enforce each other.
Acceptance date: 8 March 2016

<u>NESDIS</u>
Improving marine disease surveillance through sea temperature monitoring, outlooks and projections
Philosophical Transactions of The Royal Society B (7.055)

J. Maynard, **R. van Hooidonk (OAR/AOML)**, C. D. Harvell, **C. M. Eakin (NESDIS)**, **G. Liu (NESDIS)**, B. L. Willis, G. J. Williams, M. L. Groner, A. Dobson, **S. F. Heron (NESDIS)**, R. Glenn, K. Reardon, J. D. Shields

- This paper describes an iterative process for developing new environmental surveillance tools. A case study of epizootic shell disease in the American lobster is presented. Long-term projections indicate that bottom temperatures suitable for ESD may occur in the coastal bays of Maine.

To forecast marine disease outbreaks as oceans warm requires new environmental surveillance tools. We describe an iterative process for developing these tools that combines research, development and deployment for suitable systems. The first step is to identify candidate host–pathogen systems. The 24 candidate systems we identified include sponges, corals, oysters, crustaceans, sea stars, fishes and sea grasses (among others). To illustrate the other steps, we present a case study of epizootic shell disease (ESD) in the American lobster. Increasing prevalence of ESD is a contributing factor to lobster fishery collapse in southern New England (SNE), raising concerns that disease prevalence will increase in the northern Gulf of Maine under climate change. The lowest maximum bottom temperature associated with ESD prevalence in SNE is 12 degrees C. Our seasonal outlook for 2015 and long-term projections show bottom temperatures greater than or equal to 12 degrees C may occur in this and coming years in the coastal bays of Maine. The tools presented will allow managers to target efforts to monitor the effects of ESD on fishery sustainability and will be iteratively refined. The approach and case example highlight that temperature-based surveillance tools can inform research, monitoring and management of emerging and continuing marine disease threats.
Acceptance date: 16 December 2015