Ecological Forecasting Webinar

Hosted by AOOS in collaboration with NOAA
Sept 16, 2014 Anchorage

In attendance: Allison Allen, NOAA; Doug Limpensel, NOAA habitat; Kris Holderied, NOAA Kasitsna Bay Lab; Nick Bond, NOA PMEL/UW; Louise Fode, NOAA NWS; Julie Matweyou, Alaska Sea Grant Kodiak; Terri Lomax, AK DEC; Angie Doroff, KBRR; Katie Bursch, KBRR; Molly McCammon, AOOS; Ellen Tyler, AOOS; Darcy Dugan, AOOS. *(Around 20 additional people by phone/webinar)*

Meeting Objective

The National Oceanic and Atmospheric Administration (NOAA) is developing an Ecological Forecasting Roadmap and is interested in hearing from key researchers and stakeholders about existing efforts and needs across Alaska. NOAA asked the Alaska Ocean Observing System (AOOS) to assist in developing the agenda for the webinar, identifying speakers and co-hosting it. The webinar provided the latest state of the science on harmful algal blooms, pathogens and other environmental change. Discussion included developing operational tools in Alaska, scenario modeling, early warning systems and forecasts of marine events. Since the meeting, a strategic vision for NOAA's Ecological Forecasting Roadmap has been published and is posted at: aoos.org/workshops-and-reports.

Intro - Allison Allen, NOAA program officer

NOAA is interested in predicting future changes in the ecosystem to better provide early warning for ecological events. Their goal is to deliver more reliable and consistent forecasts- not just for episodic events but for the long-term outlook as well. To reach this goal, they are producing an "Ecological Forecasting Roadmap" with focus areas on harmful algal blooms (HABS), hypoxia, pathogens and species distributions. Five technical teams have been set up across NOAA to address these issues. The first year was spent organizing these teams, and now they are trying to learn what eco-forecasting activities are taking place in each region around the country. Allison showed the projects NOAA is aware of; there are currently no Alaska projects and they would like to include some in their plan.

HABS Team Report - Rick Stump and Alan Lewitus, NOAA program office

The goal is to create a national system for forecasting HABS, recognizing there are many similarities in types of data and models around the country, although the species involved may differ. NOAA would like to effectively create forecasts for different types of HABS, and validate, maintain, and transition existing forecast from research into operations. Rick and Alan listed a number of projects going back to 2004, none of which were in Alaska.

Requirements for a HABS forecast include:

- A critical need for a forecast. For Alaska, paralytic shellfish poisoning (PSP) is probably the prime issue.
- Mature Science. There is evidence for temperature/salinity dependencies in Alaska so a habitat or probability model may be possible but not certain.
- Known appropriate models and data that can be implemented in the overall strategy.

In Alaska, a habitat probability model would help in planning and testing for PSP. However, several inputs are needed to develop something like this; for example, a hydrodynamic model and regular sampling of temperature, salinity and nutrients at fixed locations are needed to form the basis of predictions. The next step would be to observe presence/absence of toxins, which would identify thresholds and validate model results.

The vision for the national strategy is to have a national operational forecast network. They hope to have 6 regions active within the first 5 years, and then progress towards establishing operational systems in NY, AK, the Caribbean and others after that.

HABS in Alaska - Kris Holderied, NOAA Kasitsna Bay Lab

HAB forecasts in Alaska have focused on localized monitoring and there is good background information available. A workshop conducted by the Kachemak Bay Research Reserve (KBRR) in February 2014 helped pull together the work Alaskans are doing collectively. The big question now is how do we develop better decision support tools and make the knowledge available.

PSP is a huge issue in Alaska, caused by Alexandrium species (dinoflagelates). These species accumulate in shellfish, clams, mussels and crabs and maybe others and do not go away with freezing or cooking. Kris showed a map with 30 years of PSP events in the state. The problem is particularly big in Kodiak and southeast Alaska. Geographically, all these places are within the Alaska coastal current, which has variable conditions with lots of freshwater influence. An animation of 2003 drifting buoys over five days from the NOAA FOCI program shows insight into PSP. Kris and others are trying to learn more about variability in conditions through Cook Inlet oceanography and plankton surveys. There are three years of sampling data so far, and they are starting to build up a database to understand connectivity. Intensive plankton monitoring is being conducted in Kachemak Bay and they are looking for Alexandrium species to understand the relationship between temperature and salinity. KBRR has shore stations at the Homer and Seldovia harbors, and a seasonal station at Bear Cove at the head of Kachemak Bay. There is also community based monitoring occurring in the area.

Researchers have been heartened to see patterns arise from monthly temperature anomalies from the Seldovia station. Continuous temperature time series provide the information to answer questions about variability over time and space. Vertical profiles also show temperature and salinity, and the temperature decreasing at depth as salinity increases with depth. These create major stratifications, which are very different between inner sub bays and mid bay, and change with seasonality. It is possible to graph temperature and Alexandrium concentration, and higher temperatures show higher concentrations of Alexandrium in Kachemak Bay. There appears to be a threshold at 9 degrees C, which is consistent with results from the Gulf of Maine where similar experiments have been conducted.

Wayne Kitaker has had an NPRB funded project to determine which species of Alexandrium exist and if they're toxic. His research has shown that A. fundysense and A ostenfieldii are present and toxic. This is new information that could go on a map.

New and more expedient saxitoxin testing has been developed, and the new field test kits take about 5 minutes. This provides a cost effective ability to test toxins during response events. However, there are multiple forms of the toxin so you have to know which kit to use.

We know that Alexandrium prefer a stable water column with low turbulence, salinity 24-32, 9-18 degree T, nutrients, and sufficient life for growth. We can compare average monthly sea surface temperatures from buoys.

An effective monitoring system would:

- Model environmental conditions, predict risk and identify when best to sample
- Monitor for early warning
- Test shellfish in field or lab
- Target sampling
- Communicate results

<u>Future steps for ecological forecasting:</u>

1. Use our understanding of environmental triggers to put together an assessment tool.
2. Host the tool on the AOOS website and link to other sources of PSP and HABS.
3. Address concerns about non-toxic bloom response – situations where people become alarmed when the water is brown or oysters turn pink but there is no harm to human health.
4. Incorporate zooplankton and ecology into a more robust model.
5. Apply ocean circulation models like the one from NOAA in Cook Inlet.
6. Identify the increased risks in a changing climate - model now to help with scenario planning.

HABS Discussion

<u>It's important to work with the National Weather Service (NWS) on outreach/alert statements about HABS</u>. This has been done before in Southeast Alaska and was

effective at reaching a big audience. There was discussion about working through NWS communication avenues on a routine basis instead of just during events, but others expressed concern that PSP levels must warrant a health risk to justify an alert. NOAA has an existing MOU with CDC that includes communications and messaging protocols. Participants suggested trying a new pilot project in Alaska and institutionalize it.

PSP problems are really bay specific – in one location it's a major problem, the next bay over no problem. How do we not cry wolf? We may not have enough specific science for specific forecasts. Right now the forecast is a blanket warning for Alaska – if you eat shellfish you may die. However, we can't replace one model with another until you know the new one is better than the one that exists.

Developing a response plan. Beach kits are one answer. It is helpful to be able to test the shellfish you're going to collect. A good ecological forecast could target when you might use the test kit. We have the observing capacity to let people know when water temperatures are high, alert harvesters of a potential problem and recommend that they test. However, it should be noted that an advisory will not cause all harvesters to test or use caution harvesting, and an example from Kodiak was described.

Note: Vera Trainor put together idealized shellfish safety coordination plan.

Pathogen Team - John Jacobs, Silver Spring, MD

Vibrio is a naturally occurring bacteria responsible for 95% of all seafood related deaths nationwide. In addition to the dangers vibrio deliver via consumption of raw seafood, the bacteria can cause wound infections, the rates of which have increased 41% across the US over the past decade. The US has spent $300 million in health care to treat patients infected with vibrios.

In Alaska in 2004, there was a vibrio outbreak on a cruise ship in Prince William Sound. A reanalysis of satellite data showed sea surface temperatures of 15 degree Celsius (threshold) coming into the Gulf during that time. Right now NOAA is using a fully operational validated model (ROMS or other) that can predict sea surface temperature, currents, and tidal heights. The model is supported by a marine buoy network. There is no routine monitoring for vibrio in Alaska, although oyster farmers have to do some water sampling for vibrio on site through ADEC.

Process:

In locations where data for 16 different parameters (including vibrio) are available, models exist which can predict an outbreak of vibrio 48 hours into the future; since most places don't have real-time data for all 16 parameters, the focus for this team has been on guidance models instead of forecast models.

John discussed activities in each region, which included stakeholder engagement, gap analysis, empirical model development, quality control/feedback, and finally a NOAA product. They are still working on what the products will look like. Right now there are 6 models in 4 regions for vibrio. They are joined with US Food & Drug Administration models and served through National Ocean Prediction Center. Right now they are password protected since they are being further developed. John showed one assessing the 5 previous days and 48 hour forecast.

FY 15 Activities for the NOAA pathogen team:

- Stakeholder engagement – refine and prioritize needs and work plans regionally. Transition to new regions.
- Transition to operations – skill assessment, user defines products. Chesapeake bay pilot is an example.
- FDA/NOAA collaborative activities - implementation of risk assessment models (harvest and time-temp components as part of modeling system). Validation and improvement where needed (using observations).

Pathogen Discussion
What about other kinds of pathogens? NOAA decided to narrowly focus and do one at a time, starting with vibrio. FDA is interested in noraviruses and would like to have them included in this system. Vibrio is first and foremost for Alaska.

Communicating information: The Google Earth format with various layers of information products in one spot is helpful. There is still discussion about where things should be hosted and how they should be archived. There will be a focus on web development this year. Suggestion to get intended audiences to pilot web interfaces. This is a possible role for AOOS.

Leveraging model development between regions: Models are specific to geography. The models for the Chesapeake don't work very well for Puget Sound, although temperature is almost always the number one determinate (and usually 15 degrees C or higher increases risk).

This could be a good resource: ADEC 2010 Vibrio Parahaemolyticus Control Plan Update. George.scanlan@alaska.gov presented at AK Shellfish growers Association in 2010. Link: https://seagrant.uaf.edu/map/aquaculture/shellfish/techtraining/2010/adec2010vibriopara.pdf

Habitat and species distribution - Howard Townsend, NOAA Chesapeake Bay Office
This group's task is to address the growing challenge of coastal and marine habitat loss and degradation. The NOAA habitat conservation team (NHCT) helps coordinate NOAA across offices and discusses how to fill science needs. Science needs include foundational information, habitat usage, ecosystem services valuation, and climate change effects and how those might affect connections to different species and conservation. [more details in PPT]. Unlike other forecasts, these may or may not be event driven.

Why produce ecoforecasts for habitat and species distribution?

- Identify priority habitat restoration areas based on higher probability of success
- Forecast and understand species responses to climate change
- Forecast gains/losses in ecosystem services provided by habitat and animals
- Forecast ecological hotspots for protected species
- Define and evaluate survey design (use ocean models to estimate bottom temperatures linked to catchability of bottom fish. Adjust catchability equations that go into stock assessments and reduce uncertainty of biomass)

NOAA is interested in using spatial structures to predict temporal changes. Examples of variables include habitat, bathymetry and physiographic variance. Together, these spatial datasets can be used to t estimate biological diversity. These spatial analyses provide a possible role for AOOS since visualizing data will be key.

Invasive Species, Gary Freitag – Alaska Sea Grant
Species of concern for Alaska include European green crab, two kind of tunicates, Atlantic salmon, and an algae called "undaria". Alaska has an Invasive Species Working Group made up of Alaska Sea Grant, Alaska Department of Fish and Game, Smithsonian, Alaska SeaLife Center, and others. All groups are trying to sample for tunicates.

- Tunicates: The tunicate problem is currently in Sitka. Arrival and takeover by the tunicate shut down an oyster farm by the airport, and the species is very capable of spreading by fracturing.
- European Green Crab: Can be transported by ocean current or ballast water from ships (can withstand 40 days in bilge water). Sampling techniques include sampling ships in dry dock as well as remote sampling from airplanes. You can see European green crab moving up the coast along the Alaska Current – map with dates. Hasn't hit Alaska yet, but was found in Gale Passage north of Vancouver in 2011.

Citizen Science Approach – very little money is available for invasive species work, so most is done through citizen science. Researchers are using Allan Marine passengers (tourists) in Southeast Alaska to help monitor for invasive species. They put traps in the water and give presentations about invasives on the tour boats; the tourists then deploy and retrieve crab pots, looking for invasive species. Visitors love it and go home with a photo of what they capture. Allen Marine recorded 80 sampling events/year.

Japanese Tsunami Debris – there are concerns about invasive species attached to tsunami debris arriving along Alaska's remote coastline. The Washington coastline has already seen Japanese barges wash up carrying invasive species in the height of their reproductive cycle. The Western regional panel on aquatic nuisance species has produced a report with priorities on how to set management goals and research needs to prevent further spread from tsunami debris.

Downscaling Climate Model Projections for Marine Ecosystems Applications - Nick Bond, NOAA PMEL/UW

Nick gave an overview of several climate model projects underway.

The UAF group called SNAP (Scenarios Network for Alaska Planning) has been working on modeling climate parameters for Alaska out to 2100. Their team took 20+ models and compared them with data (1958-2000) for surface air temperature, sea level pressure and precipitation, as well as episodic events (# days with average temp >x, incidence of storms). Results of this project are available through SNAP and AOOS websites.

Nick has also been involved with the modeling component of the North Pacific Research Board's Bering Sea Integrated Ecosystem Research Program, looking at all trophic levels including humans.

General thoughts

- Models are different and none are perfect. Don't put too much emphasis on any one model.
- Modelers must leave time and money for data visualization, otherwise people can't use model output. The AOOS system is a good example of providing data visualization in a user friendly way.

J-SCOPE project

J-SCOPE is a seasonal prediction system developed for the coastal waters of the Pacific Northwest (a similar effort is beginning on the Bering Sea). Elements of the forecast system include large-scale atmospheric and oceanic conditions provided by the National Centers for Environmental Prediction's (NCEP) coupled forecast system model and a seasonal forecast. They embed a Regional Ocean Modeling System (ROMS) model with a Nutrient, Phytoplankton, Zooplankton and Detritus (NPZD) model (lower tropic level) and now the Northwest Fisheries Science Center is using this in its integrated ecosystem forecast center. The emphasis is more on chemistry than biology.

The Northwest NANOOS (the Pacific Northwest sister organization of AOOS) has played a big role in J-SCOPE by getting the information info a format that is useful. The forecast system is experimental and has promise, but isn't perfect. Interpretive help to analyze J-SCOPE outputs are available on the Northwest Affiliated Network of Ocean observing Systems (NANOOS) website.

Modeling Discussion

Data is sparse in the Bering Sea. Where does it come from? These are projections rather than predictions. Projections are made with less concern about initial conditions. Predictions come from a reasonably well-known initial state, and predict how things will change from those conditions. There was a benthic component in the Bering Sea model but no baseline initial conditions. There is also demand for subsurface and bottom temperatures- a need that gliders may be able to fill. With limited data on initial conditions, bathymetry helps scientists to make guesses about benthic communities since the flow of water is such an important determinant of the composition of benthic communities.

Ecological Forecasting Roadmap Infrastructure & Process - Nicole Kurkowski, National Weather Service headquarters

Goals: Look across teams, develop a common national ecological forecasting infrastructure. Enhance the processes to facilitate transition of ecological forecasts to operations. Develop white papers to move from research to operations. Working with technical teams on pilot projects.

Examples of major tasks and accomplishments:

- Generated EF infrastructure and process for Research to Applications
- Defined a "one NOAA" product in a white paper
- Evaluating environmental process system for forecast system. NCO group at NCEP is partner. Running HABS forecast temporarily.
- CO-OPS looking at other avenues for ecological forecast
- Compiling best practices and skill assessment tools

Infrastructure Discussion

Ecological forecasting pilot projects are 1-2 years in length and none are in Alaska right now. Is assistance needed in connecting AK's existing activities with NOAA data or modeling capacities? Cook Inlet HABS forecasting looks close to reality. Vibrio forecasts are less mature. If we want to do ecological forecasting well, we need to identify where we need more observations. Alaska has more trouble meeting requirements because of its size, remoteness, etc. If we could refine some of the models to not have so many needs, we could implement more here.

Take-home messages:

- There are significant strides being made in ecoforecasting in Alaska that were previously not on NOAA's radar. Some of these have received little direct funding, but have succeeded and grown due to strategic leveraging of other projects and available money.
- To increase forecasting capability in Alaska, we need to work together to identify and prioritize needs; then work around expensive solutions. Sometimes projects in Alaska need to use different methods than the rest of the country because of our big geography, remoteness, and tough conditions.

- Right now there is a big need for more data and model output. There is also a corresponding need to expand capacity to get model output in the right hands in a timely matter. This requires not only computing capacity, but also personnel time.
- Cook Inlet HABS forecasting looks like it could be the most mature and ready for an operational forecast. Scientists in Alaska have already determined the necessary next steps. Alaska is not on the NOAA's list of 6 regions to support HABS forecasting but there are still many ways to work together.
- AOOS can be helpful in aggregating and visualizing useful data. The NWS could be helpful in circulating important forecast alerts.

<u>Some of the participants by phone: KRIS or ALLISON – do you know these? It would still be helpful to know who else is interested in this.</u>

- Kris Brown with NSDS
- Greg Stump with NOAA Maryland
- Wayne Lydiker – NOAA beaufort lab
- ? NCOS Silver Spring
- Julie Turton? climate and health effects of ecological
- Gabe Turner – NOAA Chesapeake
- Nicole Kerkowski NWS
- ?? NOAA fisheries Chesapeake bay
- Yi Chao – ROMS
- Julie Martigue – cooperative program on Gulf Coast
- ?K
- Domonic Hondolerero – Kbay
- Tammy Neher - Kbay
- Ryan Himmel-Bloom – Kodiak science center
- Durrelle Smith USGS
- ? AKSLC
- Marine mammal center