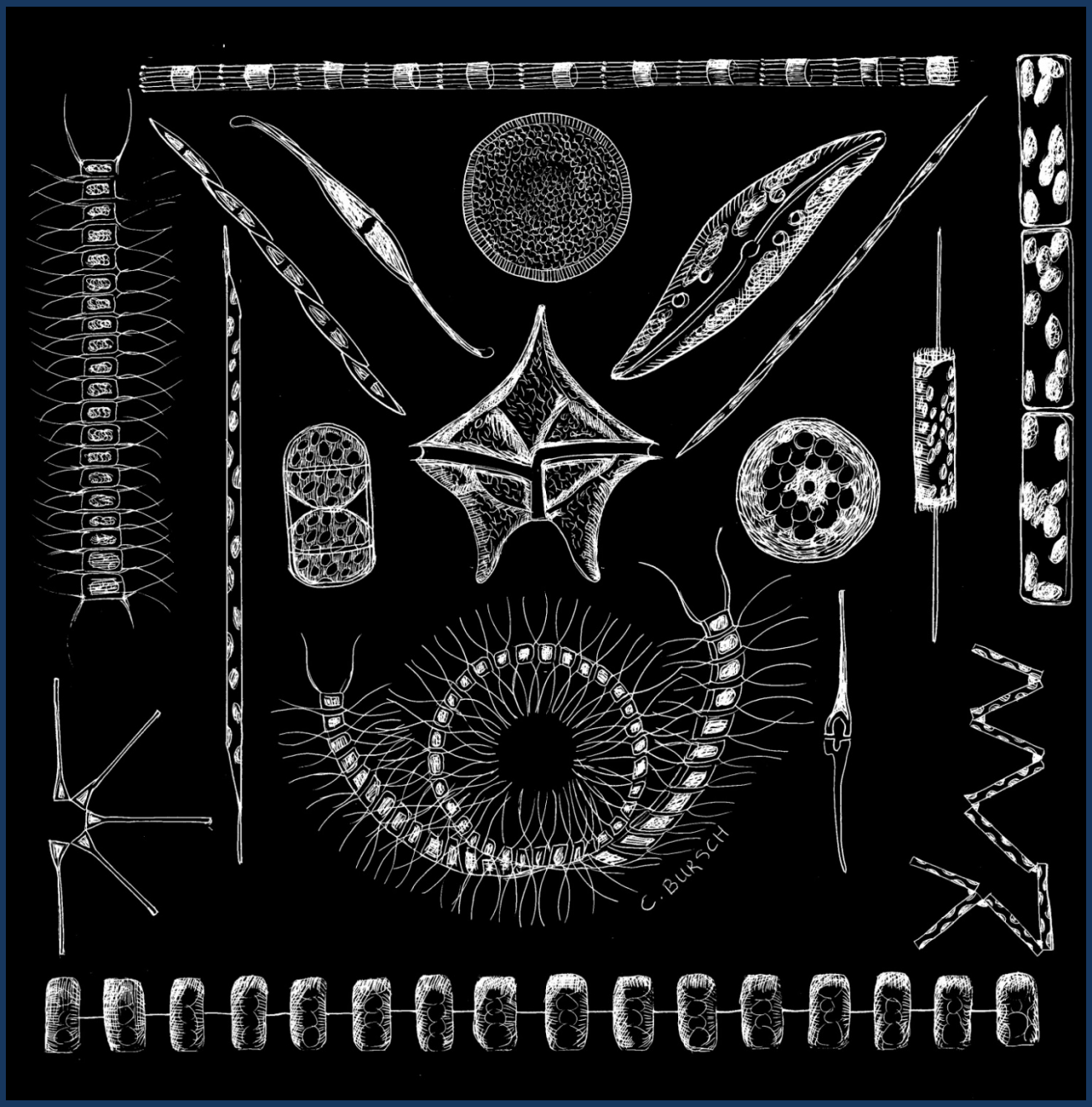
Kachemak Bay Phytoplankton and Harmful Algal Blooms

February 11-12, 2014

Islands & Ocean Visitor Center Homer, Alaska

PROGRAM & ABSTRACTS



Overview

Phytoplankton serve as the base of the marine food web, providing an essential ecological function for marine life and a key food item for aquaculture and mariculture alike. Phytoplankton may rapidly proliferate and "bloom" in the marine environment. While most algal blooms are beneficial, sometimes they can produce toxins and sicken humans and marine animals.

Within Kachemak Bay there are several organizations involved in the study and monitoring of phytoplankton for potential harmful algal blooms (HAB). While these studies are largely conducted independently, discussion about the current state of phytoplankton monitoring in Kachemak Bay, the unique challenges researchers face, and opportunities for increased coordination have given rise to the first-ever Kachemak Bay Phytoplankton and Harmful Algal Blooms Workshop. This Workshop, organized by the Kachemak Bay Research Reserve, brings together regional experts and the local community to share their results with key subject experts to guide the future direction of local phytoplankton research and monitoring.

The objectives of this workshop are to:

- Facilitate information exchange about phytoplankton and harmful algal blooms in Kachemak Bay
- Encourage improved cooperation and communication among researchers, agencies, and shellfish growers
- Identify major impediments to research and monitoring, and the integration of this information into a coordinated network to address them;
- Determine next steps towards future coordinated interaction.

Plenary Speaker

Dr. Tester earned her B.A. with honors in Life Sciences and Chemistry at California State University in Sonoma, her M.S. in Oceanography from Oregon State University and her Ph.D. in Oceanography also at Oregon State University.

Pat has worked for the National Oceanic and Atmospheric Administrative, (NOAA) with the National Ocean Service, and National Marine Fisheries Service since 1981.

All this means that Pat Tester is a biological oceanographer with interests in phytoplankton-zooplankton interactions and the effects of toxic or harmful phytoplankton on marine food webs. Her early work includes remote sensing in the detection and tracking of algal blooms which led to real time satellite imagery. Pat's congressional testimony in 1987 led to the Small Business Administration amending the definition of "disaster" to include "red tides, brown tides and other natural events" so low cost loans could be made to communities affected by HABs.

Midcareer, Pat's interest in using molecular techniques to resolve HAB problems ranging from species identification to toxin detection culminated in multiple awards for developing a domoic acid test kit. Having served on a number of international steering committees (2006-2008, 2010-2014), Pat is a founding member and past president of the International Society for the Study of Harmful Algae. The North Pacific Research Board appointed Pat to its Science Panel in 2002 and she continues to serve in that capacity. Her current interests in Alaska support shellfish safety and focus on detection technologies for paralytic shellfish toxins and the organism responsible for those toxins

Patricia A. Tester, Ph.D.
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NOAA Supervisory Oceanographer (Retired)
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Agenda

Tuesday, February 11

8:15- 8:30 Registration and check-in

8:30 -8:45	Welcome & workshop goals	**Catie Bursch** Kachemak Bay Research Reserve
8:45-9:30	Plenary A Comparative Ecosystem Approach to Understanding Phytoplankton and Harmful Algal Blooms in Kachemak Bay Alaska	**Pat Tester** Center for Coastal Fisheries and Habitat, National Centers for Coastal Ocean Science, NOAA
9:30-9:45	Introductions	
9:45-10:05	Kachemak Bay Research Reserve's research and monitoring program: updating the circulation model for Kachemak Bay	**Angela Doroff** Kachemak Bay Research Reserve
10:05-10:25	A Hydrographic Model for Cook Inlet	**Georgina Gibson** University of Alaska Fairbanks
10:25-10:45	Oceanographic Drivers for Phytoplankton Blooms in Kachemak Bay, Alaska	**Kris Holdereid** NOAA Kasitsna Bay Laboratory
10:45-11:00	Networking break	Coffee/tea- auditorium
11:00-11:20	A Community's First Effort to Understanding Primary Production in Kachemak Bay: the Good and the Bad	**Catie Bursch** Kachemak Bay Research Reserve
11:20-11:40	Bloom and Bust: Monitoring Phytoplankton populations in Kachemak Bay	**Domonic Hondolero** NOAA Kasitsna Bay Laboratory
11:40-12:00	Abiotic Conditions and Bloom Timing in Kachemak Bay (possibly poster instead of presentation)	**Steve Baird** Kachemak Bay Research Reserve
12:00-13:00	Lunch	Provided for registered participants

13:00- 13:20	Quantitative assessment of *Chaetoceros Spp.* Concentrations and Adaptive Salmon Smolt Stocking Procedures in the Nick Dudiak Fishing Lagoon on the Homer Spit, Alaska	**Mike Booz** Alaska Department of Fish and Game
13:20-13:40	Guide to Phytoplankton of Kachemak Bay	**Jane Middleton** Community HAB Monitor
13:40-4:00	Breakout session overview	**Stacey Buckelew** Kachemak Bay Research Reserve
14:00-16:00	Breakout sessions Session 1: Can long-term trends be determined for Kachemak Bay: Can bloom triggers be found? Session 2: Best methods for tracking/identifying phytoplankton in Kachemak Bay. Session 3: Coordinated network for regional monitoring and research.	Session moderators: **Stacey Buckelew** **Jess Ryan** **Marianne Aplin**
16:00-16:30	Groups reconvene & summarize sessions	**Marianne Aplin**

Wednesday, February 12

8:30- 8:40	Summary from previous day	**Pat Tester**
8:40- 9:00	Harmful Algae Blooms in Alaska: An Historical Perspective, Current State of Knowledge, and Prospects for Research and Monitoring	**Raymond RaLonde** Alaska Sea Grant Marine Advisory Program
9:00-9:20	Developing an Integrated Monitoring System for Detecting Toxic *Alexandrium* Species and Saxitoxins in Kachemak Bay Alaska	**Wayne Litaker** Center for Coastal Fisheries and Habitat, National Centers for Coastal Ocean Science, NOAA
9:20-9:40	Detection of Human Exposure to Saxitoxin and Neosaxitoxin in Urine by Online-SPE-LC MS/MS	**William Bragg** Centers for Disease Control and Prevention
9:40-10:00	Testing for Toxins in Alaskan for Commercial Shellfish & Recreational Shellfish Monitoring	**George Scanlan** Dept of Environmental Conservation
10:00-10:20	A Tale of Two Species: An Exploration into the Effects of Increased *Alexandrium* populations on Shellfish Harvesting in Kachemak Bay	**Persnickety Protoperidinium** National Ocean Science Bowl Homer High School Team
10:20-10:40	Networking break	
10:40-11:40	Concurrent breakout sessions Session 4: Bloom event response Session 5: Mechanisms to bridge research and monitoring to decision makers.	Session moderators: **Stacey Buckelew** **Jess Ryan** **Marianne Aplin**
11:40-12:00	Groups reconvene & summarize sessions	**Marianne Aplin** – facilitator
12:00-13:00	Lunch	Provided for registered participants
13:00-15:00	Planning the next steps with concrete action items What are the outcomes/research needs identified in breakout sessions the group wishes to accomplish? What are the next steps that can be taken to maintain interaction and data sharing?	**Marianne Aplin**- facilitator

Abstracts

A Comparative Ecosystem Approach to Understanding Phytoplankton and Harmful Algal Blooms in Kachemak Bay Alaska

Tester Patricia, Litaker Wayne

Center for Coastal Fisheries and Habitat Research, National Centers for Coastal Ocean Science, National Ocean Science, NOAA

The advantage of applying a comparative ecosystem approach to the study of phytoplankton in Kachemak Bay is that it strengthens the scientific understanding of complex dynamics controlling ecosystem structure, productivity, resilience and population connectivity, as well as effects of climate variability and anthropogenic pressures on living marine resources and critical habitats. Retrospective studies that analyze, re-analyze or synthesize existing information (historic, time-series, ongoing program) are especially valuable to the comparative approach. One goal of the Conference will be to identify Kachemak Bay-specific data sets to information monitoring efforts and ecosystem management activities. Specific comparisons between Kachemak Bay and similar ecosystems will define key environmental variables or processes that can serve as important monitoring metrics. For example, a recent study in the Baltic found that diatoms and dinoflagellates had comparable nutrient requirements (excluding Si), appeared to provide similar ecosystem services with respect to new production but a decadal shift toward dinoflagellate dominance was credited to climate variability. The amount and timing of freshwater input are critical to both nutrient delivery and stratification in the Baltic as well as Kachemak Bay. In the Baltic, dinoflagellates were favored by enhanced water column stratification. What does this portend for Kachemak Bay and the potential for harmful (dinoflagellate) blooms?

Kachemak Bay Research Reserve's Research and Monitoring Program: Updating the Circulation Model for Kachemak Bay

Doroff, Angela M.

Research Coordinator, Kachemak Bay Research Reserve ADF&G,

Knowledge of circulation patterns is essential for determining the transport of pollutants, harmful algal blooms, and invasive species. Similarly, understanding circulation patterns also informs us of the physical processes that shape our coastline and determine productivity. The mission of the

Kachemak Bay National Estuarine Research Reserve (KBNERR) is to enhance understanding and appreciation of the Kachemak Bay estuary and adjacent waters to ensure that these ecosystems remain healthy and productive. As a sentinel site for the region, the KBNERR serves the coastal communities by providing baseline and long-term datasets that range from the headwaters to open ocean. Baseline work region has been accomplished through efforts of KBNERR and through key collaborations with local, regional, and national partners. The data collected in our monitoring programs provides the basic "ingredients" to examine long-term environmental trends in weather, water chemistry, and biology. An example of long-term monitoring and base-line data for Kachemak Bay include our ongoing System-Wide Monitoring Program featuring water quality, meteorological, and emergent salt marsh vegetation mapping. Currently, the KBNERR is involved with three major projects that will help update and refine ocean circulation patterns in Kachemak Bay; 1) we are collaborating with University of Alaska, Fairbanks to collect data on tidal and sub-tidal circulation patterns from drifting buoys; 2) we are collaborating with UAF to validate a NOAA regional circulation model based on KBNERR long-term oceanographic data collected since 2001; and 3) we are collaborating with the NOAA Kasitsna Bay Lab to monitor oceanography and plankton trends in lower Cook Inlet and Kachemak Bay. Collectively, these studies at the KBNERR contribute to our understanding of regional circulation patterns.

A Hydrographic Model for Cook Inlet

Gibson, Georgina[1]; Johnson, Mark[1]; Coyle, Kenneth[1]; Lyon Lanerolle[2]

1. University of Alaska Fairbanks, 2. National Ocean and Atmospheric Administration

A high resolution hydrographic model has been developed for Cook Inlet by NOAAs National Ocean Service. The model was initially developed to be an operational forecast system. The model is three-dimensional, high resolution with the capacity to resolve the strong tides and the wetting/drying of the coastline observed in the Inlet. In this presentation we will provide an introduction to the hydrographic model, and to the validation efforts that we are undertaking to assess the model skill in reproducing observed conditions within the inlet. We will demonstrate the utility of hydrographic models in addressing questions of ecosystem relevance through research examples that have used coupled hydrographic-biological models in Alaskan waters. Our aim is to provide grounding in the utility of models as research tools, and to generate discussion about how model products can support harmful algal bloom research and monitoring programs in Kachemak Bay.

Oceanographic Drivers for Phytoplankton Blooms in Kachemak Bay, Alaska

Holderied, Kristine; Brainard, Starr; and Ko, Stanley

NOAA Kasitsna Bay Laboratory, kris.holderied@noaa.gov, 907-235-4004

Subarctic estuaries are affected by several environmental conditions that can cause phytoplankton blooms, including the blooms of toxic species which are known as harmful algal blooms or HABs. Kachemak Bay Alaska, a subarctic fjord, experiences occasional HAB events, including paralytic shellfish poisoning events associated with blooms of the dinoflagellate *Alexandrium* species. Kachemak Bay waters are affected by seasonal and inter-annual changes in temperature and the bay receives freshwater input from precipitation, snow pack melt and glacier melt. The bay also exchanges water with Cook Inlet and experiences periodic upwelling of ocean water from the adjacent Gulf of Alaska shelf. Temperature, salinity, water column stratification and circulation are all factors which may influence plankton growth and these conditions can vary significantly with freshwater input and ocean water upwelling. Our ongoing oceanographic monitoring program measures these conditions and their spatial and temporal variability, in order to assess future HAB risks under changing climate conditions. Oceanographic conditions are measured using vertical oceanographic profile station data collected in repeated small boat surveys with a conductivity-temperature-depth (CTD) profiler and water quality monitoring station data from the Kachemak Bay National Estuarine Research Reserve water quality monitoring stations at the Homer and Seldovia harbors. Kachemak Bay oceanography is strongly influenced by freshwater input, resulting in a persistently high stratification and vertical stability that can maintain phytoplankton cells near the surface. Significant inter-annual variability includes differences in mean monthly water temperatures of up to 6 degrees C in winter and 5 degrees C in summer, as well as in the timing of spring snow melt and enhanced water stratification in the summer. A future goal is to combine water temperature and stratification data with other factors such as nutrient concentrations and phytoplankton ecology, to create an index for periods of increased HAB threats.

A Community's First Effort to Understanding Primary Production in Kachemak Bay: the Good and the Bad

Bursch, Catie

Kachemak Bay Research Reserve, ADF&G

Kachemak Bay Research Reserve has been monitoring the phytoplankton of Kachemak Bay since 2009 with the support of the NOAA Phytoplankton Monitoring Network. The main goal of

the program is to look for groups of phytoplankton that are known to carry toxins that can result in shellfish poisoning in humans. Not being satisfied to learn only about the harmful algae in Kachemak Bay, this group has pushed to learn about the other important primary producers because of lack of information on this topic. Over the past five years, roughly forty different volunteers have contributed over four hundred plankton samples for the program. As each volunteer made a tow, labeled a bottle, or filled in a data sheet, the expertise and information of the program grew. This is a perfect time to reflect on how much more we know now than we did five years ago. It's also a good time to examine the frustrating and ineffective areas of the program that have kept us from a deeper understanding of primary production in our Bay.

Bloom and bust: Monitoring Phytoplankton Populations in Kachemak Bay

Hondolero, Dominic; Holderied, Kristine; Pickens, Chris

Kasitsna Bay Laboratory, NOAA

Establishing baseline monitoring information on ecological systems is essential for determining current health of the ecosystems as well as providing the ability to detect changes to ecosystems. NOAA's Kasitsna Bay Laboratory, in partnership with the NOAA Phytoplankton Monitoring Network and the Kachemak Bay National Estuarine Research Reserve, has been monitoring phytoplankton populations in Kachemak Bay for 2 years. In Kachemak Bay it appears that spring phytoplankton blooms begin when PAR reaches a threshold of approximately 380 millimoles/m^2 in early April. This bloom continues until nutrient levels begin to drop in late July and a second bloom generally occurs in August and September. The spring bloom is dominated by diatoms of the genus *Chaetoceros.* The 2012 late summer bloom was dominated by *Pseudo-nitzschia* species. Spring and summer were dominated by *Chaetoceros* spp., which declined in late summer and fall, disappearing in winter when dinoflagellate species became dominant. Near-synoptic sampling of several sites in Kachemak Bay on the same day does indicate spatial differences in productivity, with highest cell counts (>1,000,000 cells/liter) at Jakolof Bay near the middle of Kachemak Bay and Bear Cove located at the head of Kachemak Bay. However, additional sampling would be needed to assess the spatial variations in productivity. In 2013 there were two bloom events that discolored water over large areas, a red water event in June which was caused by the ciliate *Mesodinium rubrum* and a brown water event in late September, early October which was caused by micro algae *Karenia mikimotoi*. Our Kasitsna Bay Laboratory monitoring program is providing information on seasonal plankton patterns and bloom events to resource managers and the public, and future work will incorporate this baseline information into ecological models of the productive Kachemak Bay estuarine ecosystem.

Community Monitoring for Phytoplankton: Comparison with Long-term Weather and Water Data

Baird, Steve; Bursch, Catie; Doroff, Angela

Kachemak Bay Research Reserve, ADF&G

This poster will present the results of KBRR's phytoplankton community monitoring. We will relate the timing and magnitude of plankton blooms with various physical factors as measured by our long-term water-quality and weather monitoring data. We will specifically examine the relationship between plankton and such factors as PAR (photosynthetically active radiation, or available sunlight), turbidity, and temperature.

Quantitative assessment of *Chaetoceros Spp.* Concentrations and Adaptive Salmon Smolt Stocking Procedures in the Nick Dudiak Fishing Lagoon on the Homer Spit, Alaska.

Booz, Mike; Kee, Jon; and Kerkvliet, Carol.

State of Alaska Department of Fish and Game, Division of Sport Fish.

Starting in the mid 1980's, the Nick Dudiak Fishing Lagoon located on the Homer Spit has been stocked annually with Chinook and coho salmon by the State of Alaska Department of Fish & Game (ADF&G), Division of Sport Fish to create a terminal sport fishery in an easily accessible area. From the late 1980's through 2009, annual effort averaged 21,000 angler days with an average annual harvest of 1,900 Chinook salmon and over 7,000 coho salmon. Salmon smolt were reared in hatcheries located in Anchorage and trucked to Homer when ready for stocking. Smolt were held in floating net pens for five days prior to release in an attempt to help facilitate homing to the release location. In 2009, a large number of coho salmon smolt died during the holding period. Pathology results found *Chaetoceros Spp.* as the source of mortality through suffocation and laceration of the gills. Every year since this event, the levels of *Chaetoceros* have impacted ADF&G's ability to hold salmon smolt in net pens prior to release. Stocking methods have adapted through trial and error to find alternative methods that reduce mortality while still trying to facilitate homing to the release site. Initial sampling to assess the levels of *Chaetoceros* was qualitative and did not provide adequate information to decide how to stock salmon smolt. In 2012, ADF&G attempted to quantitatively assess the concentration of *Chaetoceros* daily in the Nick Dudiak Fishing lagoon from mid-April through July. Results suggested that the concentration of *Chaetoceros* were well above safe levels to hold salmon smolt in net pens throughout the stocking period. In 2013, *Chaetoceros* assessment was reduced to days around each stocking and helped guide how salmon smolt were stocked.

Guide to Phytoplankton of Kachemak Bay

Middleton, Jane; Bursch, Catie

Middleton, Jane: KBRR HAB volunteer; Bursch, Catie, Kachemak Bay Research Reserve, ADF&G

The Guide to Phytoplankton of Kachemak Bay is a pictorial guide to diatoms, dinoflagellates and ciliates found in Kachemak Bay, Alaska. Its purpose is to provide HAB monitors a reference when they analyze their samples and help them recognize harmful algae present in the waters of the bay. Educators will also find the guide useful when teaching about the ocean, marine ecosystems and identification of microscopic life.
This presentation will include a brief discussion about how to take good photographs from a microscope using a hand-held digital camera or built-in microscope camera.
The guide will be amended from time to time, as we obtain better photographs or find previously unidentified organisms. Users of this guide are encouraged to report new sightings to Catie Bursch at 226-4661. Include in your report a preserved sample, photo if possible, and complete description of the organism.

The guide may be downloaded as a PDF from the Kachemak Bay Research Reserve website: www.kbrr.adfg.alaska.gov.

Harmful Algae Blooms in Alaska: An Historical Perspective, Current State of Knowledge, and Prospects for Research and Monitoring.

RaLonde, Raymond

Alaska Sea Grant Marine Advisory Program

Alaska has significant and apparently growing problems with harmful algae blooms (HAB) causing ecological and human health impacts. Most prevalent is regular occurrences of paralytic shellfish poisoning (PSP) causing illness and fatalities among shellfish harvesters. Marine mammals and birds are also showing evidence of risk. *Alexandrium* dinoflagellate blooms that cause PSP are unpredictable, and appear to be locally generated. HAB and toxin monitoring has been inadequate and public warnings to prevent human illnesses have limited effect. Monitoring of PSP in shellfish has revealed much about the Alaska problem and collaborative research is underway to explore inexpensive laboratory and field methods that can enable expansion of monitoring. Domoic acid, another marine toxin produced by several species of *Pseudo-nitzschia*

diatoms, has been isolated in Alaskan shellfish testing, a two-year monitoring program found low concentrations in shellfish, but little is known about the potential human health and ecological impacts. Harmful algae blooms of other species throughout Alaska cause significant damage to Alaska's salmon enhancement program and raise concern about their ecosystem impacts in a number of locations, including Kachemak Bay.

This presentation will summarize monitoring and research results, describe the current state of knowledge about HAB occurrences in Alaska, the status of current monitoring programs and research efforts, and suggest projects for additional research and monitoring initiatives.

Detection of Human Exposure to Saxitoxin and Neosaxitoxin in Urine by Online-SPE-LC-MS/MS

Bragg, William[1]; Lemire, Sharon[1]; Coleman, Rebecca[2]; Hamelin, Elizabeth[1]; Johnson, Rudolph[1]

[1] Centers for Disease Control and Prevention, 4770 Buford Highway, MS F44, Atlanta, GA 30341

[2] ORISE Fellow, Centers for Disease Control and Prevention, National Center for Environmental Health, Division of Laboratory Sciences, Atlanta, GA 30341

Saxitoxin (STX) and neosaxitoxin (NEO) are potent neurotoxins chiefly responsible for paralytic shellfish poisoning (PSP) in humans and marine mammals. PSP occurs through the ingestion of bivalve shellfish that have consumed toxin producing dinoflagellates associated with red tide. Depending on the levels of STX and NEO exposure the symptoms of PSP can range from mild to life-threatening, including paralysis, nausea, muscle weakness and tingling of the mouth and limbs. Worldwide cases of PSP have been reported from as far south as Chile and as far north as Alaska, where these exposures can be major concerns for the public health because of commercial, subsistence and recreational shellfish harvesting. Due to the fact that the initial presentation of symptoms for PSP is nonspecific, a clinical measurement is needed to confirm exposure to the toxins. Our group has developed an online solid phase extraction liquid chromatography method for the analysis of STX and NEO in human urine with tandem mass spectrometry, reducing analysis time and increasing sensitivity while maintaining precision and accuracy at or below 15%. This method rapidly identifies PSP toxin exposure, which can facilitate the work of public health authorities to track and contain the outbreak of PSP, complementing the many shellfish monitoring programs worldwide.

Testing for Toxins in Alaskan for Commercial Shellfish & Recreational Shellfish Monitoring

Scanlan, George

State of Alaska, Dept of Environmental Conservation, Shellfish Permit Coordinator

Molluscan shellfish are interesting animals that have been an important part of peoples' diets worldwide, particularly in Alaska, for hundreds of years. As delicious as these animals taste, they have unique characteristics that can make them very dangerous under certain conditions. Shellfish are filter feeders and therefore have the ability to concentrate microorganisms, including human pathogens (example: norovirus), and toxigenic micro-algae, from the water column if these organisms are present. Bivalve shellfish are quite often consumed raw or partially cooled and if pathogens or toxins at high concentrations are present, human illnesses can result. Pacific oysters, mussels and clams other than geoducks monitored through the state's Uniform Sampling Plan have been largely free of paralytic shellfish toxins (PST).

While levels of PST in shellfish varies greatly from species to species and within different areas of the state, the ability to predict PST levels is extremely difficult. Our efforts to implement and maintain a conservative approach to PST monitoring has resulted in no reported illnesses associated with commercially harvested shellfish. All paralytic shellfish poisoning illnesses so far reported in the state have been from recreational or personal use harvest. There is no state program in Alaska to certify beaches as "safe" for recreational or subsistence harvest. A limited four year pilot PST monitoring program for recreational shellfish harvest began in 2012 and it's ongoing. Alaska has more coastline than the East and West Coasts of the lower 48 combined and many areas where shellfish are harvested are not easily accessible. The cost and logistics in collecting and shipping samples can be very challenging. Only the state's Environmental Health Laboratory (EHL) in anchorage is certified by the National Shellfish Sanitation Program to conduct official regulatory testing for shellfish. In addition the EHL is responsible for analyzing animals, food, water, and environmental samples for regulatory purposes that require all of their current resources. DEC must use all of its resources to administer the commercial shellfish program.

A Tale of Two Species: An Exploration into the Effects of Increased Alexandrium Populations on Shellfish Harvesting in Kachemak Bay.

Reveil, Logan; Mitchell, Molly; Bunting, Nolan; Gillam, Axel; and, Moskios, Sierra

Persnickety Protoperidinium; Homer National Ocean Science Bowl Team

Kachemak Bay has the optimum conditions for shellfish of all types. A wide tidal variation and nutrients from glacial runoff, provide a highly favorable environment for the growing of oysters, mussels, and clams. In addition, the region's temperate summers discourage the development of Alexandrium, the dinoflagellate most commonly known to cause Paralytic Shellfish Poisoning (PSP). And as such, commercial and recreational harvesting has become one of the most productive in all of Alaska. However, this may not always be the case. The higher water temperatures and lower salinity levels caused by climate change are favored by Alexandrium. Furthermore, increased boat traffic and changing currents may lead to more frequent blooms of Alexandrium. This paper explores what an increase in Alexandrium would mean for Kachemak Bay's burgeoning shellfish industry and investigates what can be done to solve the problem of PSP.

THANK YOU!!

A special thanks to the following people for their assistance developing and coordinating key aspects of this workshop.

Planning, great ideas, plenary research	**Pat Tester**
Registration and fee administration	**Kachemak Bay Shellfish Growers**
Group facilitation	**Mairanne Aplin**
Registration logistics	**Center for Alaskan Coastal Studies – Loretta Brown**
Catering	**Fritz Creek**
Meeting notes / proceedings	**Carmen Field, KBRR**
	Kim Cooney, KBRR