Interstate Shellfish Sanitation Conference
Priorities to Improve Shellfish Monitoring for Harmful Algal Bloom Toxins

Introduction

The priorities to improve shellfish monitoring for harmful algal bloom (HAB) toxins (i.e., biotoxins) below were obtained from a variety of sources: responses to a survey of the Interstate Shellfish Sanitation Conference (ISSC) members by the Engagement Workgroup of the Laboratory Methods Review Committee (LMRC), as well as input from the Engagement Workgroup, the LMRC, and the Biotoxins Committee. The priorities were presented to the membership of the ISSC at the 2015 Biennial Meeting.

General Needs

Specific and new resources to develop, validate, and implement new methods by state regulatory agencies.

- Without additional resources, it will be difficult to address needs identified in this document and/or their incorporation into routine state monitoring.
- Infrastructure is needed to contend with novel toxins and advanced technologies.
- Capacity needs to be built on a regional basis.

More efficient and transparent processes for ISSC review and approval of new methods, extension of existing validated methods to additional shellfish species (matrix extension), and laboratory certification/verification processes.

Increased commercial availability of toxins and their relevant metabolites for use as standards and for other testing purposes.

NSSP certified laboratories that can analyze existing and/or emerging toxins on a per sample basis using appropriately approved methods when the need arises due to resource limitations.

Education and Outreach Needs

Training courses for managers and industry in HAB cell identification/quantification and specific methods for toxin analysis.

Training and outreach programs for subsistence and recreational shellfish harvesters[1].

Training and low-cost equipment to for networks of volunteers/managers to conduct real-time phytoplankton observations.

[1] Non-commercial harvest is outside the purview of the ISSC, but many of the same state agencies monitor to protect public health

Research Needs

Methods for HAB toxins in bivalve[2] molluscs. There is a need for qualitative (screening) and quantitative/confirmatory methods of analysis for all toxins and for each commercially-harvested bivalve species (see Table 1). All methods must be validated according to NSSP guidelines and demonstrated as fit for intended purpose[3].

- Screening methods for qualitative or semi-quantitative detection of toxins.
  - Field deployable by managers and industry.
  - Reliable with respect to guidance levels (no false negatives and minimal false positives).
  - Inexpensive, rapid, and facile.
- Quantitative and confirmatory methods, such as liquid chromatography (LC) and liquid chromatography with mass spectroscopy (LC-MS/MS) methods are available for some toxins and species, but they require costly instrumentation and considerable technical expertise. Multiple additional methods are needed with the following characteristics:
  - High throughput.
  - Minimal cost and technical expertise.
  - Do not require costly instrumentation.

HAB cell and toxin monitoring and prediction for early warning

- Identification of toxin-producing algal species and toxin profiles, as well as the factors influencing toxin production/profiles. For example, what species are producing okadaic acid, dinophysis toxins, and related toxins in each region where DSP toxins have been measured in shellfish?
- Quantification of the relationship between HAB species abundance and shellfish toxicity in order to set species (shellfish and HAB)-specific and region-specific thresholds for cell counts to trigger shellfish monitoring or shellfish closure.
- Development and validation of molecular methods to rapidly identify toxin-producing HAB species and, where possible, specific toxins in water samples or net tows. For example, identify which species of *Pseudo-nitzschia* are toxic in each region and develop probes to rapidly identify those species and the toxin.
- Inexpensive field microscopes for use by managers and volunteer monitoring networks with
  - Cameras to capture and send images to experts.
  - Applications (Apps) for quick identification of HABs.
- Development of new or improvement of existing methods of automated, *in situ* continuous monitoring of HAB cells and toxins (e.g., imaging flow cytobot, environmental sample processor, optical phytoplankton detector, Flow Cam, satellite imagery). Expand species/toxins/regions for which they can be used.
  - Reduce cost, improve ease of deployment, minimize maintenance.
  - Improve versatility in terms of *in situ*, field, and lab applications.
  - Provide training in use of early warning systems.

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[2] Although the purview of the ISSC is molluscan shellfish, the survey indicated that there is concern about many non-molluscan species that are also eaten. See Table 1 for examples.
[3] see p. 36-40 in http://www.issc.org/about/constitutionandbylaws.aspx?section=Conference%20Administration

    - Enhance equipment availability by developing partnerships and funding opportunities.
- Identification of sentinel sites (near shore or offshore) where monitoring HAB cells, toxins in HAB cells, or HAB toxins in animals will provide early warning with respect to shellfish growing waters.
- Data bases/web portals for use for managers to input/access data and provide decision support tools.
- Development and/or improvement of models of HAB cells and toxins and the accumulation of toxins in shellfish.
    - Short-term forecasts of geographic extent, intensity, toxicity and transport.
    - Longer-term seasonal predictions to aid planning.
- Development of monitoring protocols for shellfish/fish grown/harvested in offshore (Federal) waters.

Toxin dynamics in molluscan[2] shellfish. Refer to Table 1 for species of interest.

- Determination of which molluscan shellfish species accumulate specific HAB toxins.
- Determination of which molluscs are appropriate to serve as sentinel species for HAB exposures.
- Determination of the distribution of toxins in shellfish tissues, especially between those typically consumed by humans and those not generally considered edible.
- Determination of what additional risks are posed by differences in shellfish preparation and consumption patterns.
- Establishment of trophic transfer patterns of HAB toxins, including biotransformation and bioaccumulation, from algal species to molluscan shellfish and higher levels in the food chain as relating to human health risk.
- For specific HAB toxins, determination of species-specific differences in metabolism and elimination, as well as chemical biomarkers for assessing exposure and toxicity, where applicable.
- Generation and review of toxicological information on HAB toxins and their metabolites in molluscs in order to set appropriate guidance levels reflective of composite toxicity.

Human health impacts of HAB toxins
- Identification of emerging and novel HABs and/or HAB-related toxins that require the attention of the ISSC and state shellfish managers.
- Assessment of the acute or chronic risk to human health posed by HABs that are responsible for aquatic animal mortalities.
- Determination of the chronic human health impacts from low-level exposures to HAB toxins.
- Determination of whether there are synergistic effects on human health from exposure to multiple HAB toxins.

Table 1. List of molluscan shellfish and other animal species[2] that are often consumed by humans and may accumulate HAB toxins.

	Common Name	Scientific Name
Molluscan shellfish	Sea Scallop	*Placopecten magellanicus*
	Rock Scallop	*Crassodoma gigantea*
	Atlantic Surfclam	*Spisula solidissima*
	Ocean Quahog	*Arctica islandica*
	Northern Razor	*Siliqua patula*
	Pacific Littleneck Clam	*Protothaca staminea*
	Butter Clam	*Saxidomus gigantea*
	Northern Quahog	*Mercinaria mercinaria,*
	Southern Quahog	*Mercinaria campechiensis*
	Sunray Venus	*Macrocallista nimbosa*
	Blue Mussel	*Mytilus edulis*
	Mediterranean Mussel	*M. galloprovincialis*
	California Mussel	*M. californianus*
	Eastern Oyster	*Crassostrea virginica*
	Oyster	*Crassostrea* spp.,
	Edible Oyster	*Ostrea edulis*
	Olympia Oyster	*Ostrea lurida*
	Geoduck Clam	*Panopea generosa, P. truncata*
	Moon Snail	*Euspira lewisii*
	Whelk	*Nucella lamellosa*
Other shellfish & fish[1]	Dungeness Crab	*Metacarcinus magister* (formerly *Cancer magister*)
	Rock Crab	*Cancer* spp.
	Blue Crab	*Callinectes sapidus*
	California Spiny Lobster	*Panulirus interruptus*
	American Lobster	*Homarus americanus*
	Northern Anchovy	*Engraulis mordax*
	Pacific Sardine	*Sardinops sagax*