BC Centre for Disease Control
An agency of the Provincial Health Services Authority

CANADIAN DIARRHETIC SHELLFISH POISONING SYMPOSIUM – PROCEEDINGS

HELD NOVEMBER 27, 2012
NORTH VANCOUVER BC

PARTICIPANT EVALUATIONS AND SUMMARY OF SPEAKER PRESENTATIONS

PREPARED JANUARY 2013
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OVERVIEW OF THE DSP SYMPOSIUM

The first Canadian Diarrhetic Shellfish Poisoning Symposium was held in North Vancouver on November 27, 2012. This free symposium was funded through multiple agencies: *BC Centre for Disease Control* (BCCDC), *BC Shellfish Growers Association* (BCSGA), *Canadian Food Inspection Agency* (CFIA), *Health Canada* (HC), and the *UBC-CDC Communal Funds*. The organizing committee was drawn from these same agencies. Funding and services were also provided by several other organizations. The *National Collaborating Centre for Environmental Health* assisted with costs associated with hosting the meeting by Web-ex and additionally provided a staff member to monitor the proceedings. Two shellfish industry members sponsored delicious shellfish at the symposium, *Mac's Oysters* provided clams and *Sawmill Bay Shellfish* provided oysters. Finally, we also gratefully acknowledge the support of three industry suppliers who paid for booths at the symposium: *3M Food Safety Canada*, *Biomérieux Industry* and *Agilent Technologies*.

The symposium was initially advertised on August 22nd, 2012 as a "Save the Date" e-mail to organizing committee members, presenters and e-mail lists encompassing staff from the Health Authorities, Ministry of Agriculture, Ministry of Health, and to individual contacts at CFIA laboratories, Ministry of Environment, Fisheries and Oceans, University of BC and Simon Fraser University. Organizing members were asked to forward the information to their networks. A detailed program and supporting information was made available on September 21st, 2012 on the BCCDC web site. Registrations were open at that time and updates made to the BCCDC site weekly. A wait list was established by mid-October and registration was capped to 110 delegates.

Participants of the symposium came from Canada and the United States, and included one international speaker via teleconference. There were 111 persons attending the symposium. Representatives from industry, public health, inspection, regulation, academia and laboratories were in attendance. A breakdown of the delegates who returned their evaluation form is shown in Figure 1 below.

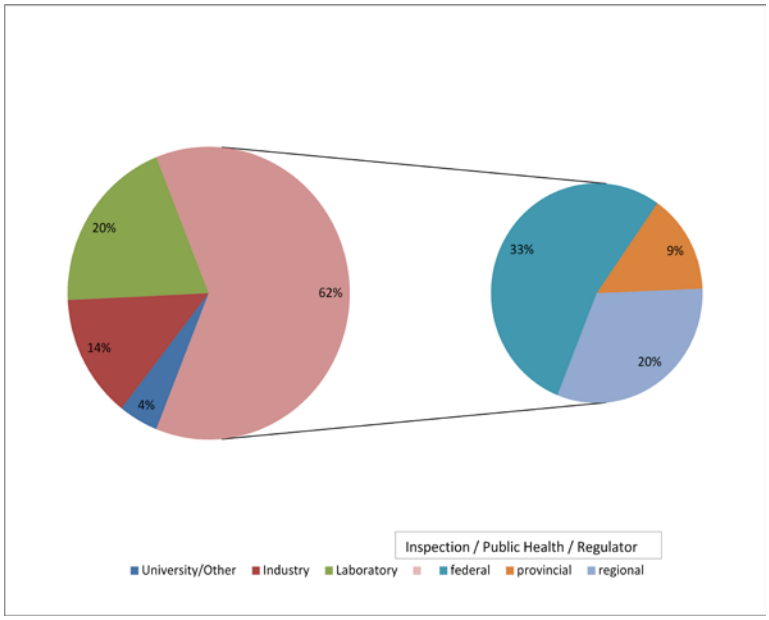

Figure 1 – Participants of the DSP Symposium

SYMPOSIUM PRODUCTS

Participant contact information was distributed during the symposium in the participant package, and this included the participant name, their organization and position in the organization, business address, telephone, and e-mail contact information. All information was shared with participant consent. This information was collected, in part, to assist in creating a network of individuals and organizations interested in Diarrhetic Shellfish Poisoning – one of the symposium objectives. This contact information, along with speaker presentations from the symposium who granted consent for their work to be posted publicly can be found on the BCCDC web-site at http://www.bccdc.ca/foodhealth/fish/DSP_Symposium.htm

Other objectives of the symposium were to identify research opportunities and communication strategies, and to improve outbreak management. These objectives were discussed during facilitated sessions after presentations and captured in the evaluation forms. The summary of this data follows.

EVALUATION OF DSP SYMPOSIUM SURVEY RESULTS

There were 70 feedback forms returned, providing a response rate of 63%. A plan to elicit feedback via an on-line survey was considered, however, based on the response rate success of the forms handed in on the day of the symposium, this activity was deemed unnecessary.

FEEDBACK FROM PARTICIPANTS

Participants were asked to evaluate the symposium objectives and the session learning objectives. The symposium objectives and session learning objectives were articulated in the program registration form, listed on the backs of the evaluation forms, and are summarized here in Tables 2 and 3.

Symposium objectives were formulated during the initial design phase, and then shared with the organizing committee who had the responsibility to find speakers and design the agenda. These same objectives were declared to supporting agencies and during funding submissions. The session learning objectives were developed by the organizing committee and vetted by the speakers before the symposium. These objectives formed the basis of this symposium.

Table 2. Symposium Objectives

- To provide a forum to educate key stakeholders on this emerging issue
- To create a DSP network
- To identify research and surveillance priorities in BC
- To build capacity in BC to respond to DSP and other shellfish toxin outbreak investigations.
- To optimize risk communication messaging to stakeholders and the public during outbreaks and harmful algal bloom events

Table 3. Session Learning Objectives

Name of Session	Learning Objectives
An Overview of Harmful Algal Blooms and Human Health	• Identify harmful algal bloom (HAB) shellfish poisonings associated with natural aquatic toxins including paralytic shellfish poisoning (PSP), amnesiac shellfish poisoning (ASP), diarrheic shellfish poisoning (DSP), neurotoxic shellfish poisoning (NSP) and azaspiracid shellfish poisoning (AZP) as well as other HAB-associated illnesses; • Explore clinical symptom profiles caused by shellfish toxins during patient diagnoses; • Identify most commonly consumed shellfish associated with shellfish toxins poisonings; • Describe acute and chronic sequelae associated with shellfish toxin poisonings.
Monitoring Programs for Shellfish Safety, Risk Assessment, Regulation	• Describe shellfish monitoring and management programs; differentiate agency roles and responsibilities & recognize Canadian Shellfish Sanitation Program (CSSP) activities, • Relate marine biotoxin program to outcomes when toxin levels exceed standards, and recognize common shellfish species associated with marine biotoxins. • Identify the types of toxins associated with DSP (OAs & DTXs) and their mechanism of action, • Describe illness thresholds for toxins & relationship to risk assessments, • Review Canadian and international standards. • Describe existing and emerging methods for DSP toxin testing, • Describe sensitivity/specificity and TAT for tests.
Harmful Algal Blooms: Environmental Factors, Phytoplankton Monitoring and Research	• Enumerate environmental and human factors contributing to harmful algal blooms (red tides) leading to DSP, • Consider partnerships between industry, universities and governments focusing on algal identification and toxicity that provide a greater understanding of diarrhetic shellfish poisoning in the Pacific Northwest. • Interpret application of HAMP to fish and shellfish farming operations, • Assess value of phytoplankton monitoring for HAB and poisoning syndromes. • Consider value of volunteer based harmful algal bloom monitoring, • Appraise networking opportunities
BC and Washington DSP Outbreaks in 2011 / Risk Management and Risk Communication	• Describe the DSP outbreaks that occurred in Washington and BC • Differentiate modes of communications used by agencies, • Recommend risk communication best practices.

When delegates were asked if the symposium met their own learning goals and if the symposium met its goals, responses were favourable. Over 98% either strongly agreed or agreed this symposium met its goals and objectives, further over 95% either strongly agreed or agreed this symposium met their own personal goals.

However, when delegates were asked about two key symposium objectives, 1) to identify research and surveillance priorities in BC, and 2) to optimize risk communication messaging by identifying opportunities to improve communications between industry, government and researchers, the results were not as favourable. While most did strongly agree or agree these objectives were met, many felt these areas were not well-identified. Regarding identification of research and surveillance priorities, 17.5% of symposium participants either disagreed or were undecided on whether this objective was met. One third (33.6%) of the symposium participants were undecided or disagreed that opportunities to improve communications between the stakeholders were articulated. Clearly these are areas that require further effort, both to improve our understanding of the effects of

harmful algal blooms leading to shellfish toxicity and human illness, and to improve communications with all stakeholders.

A depiction of these results is shown in Figure 2.

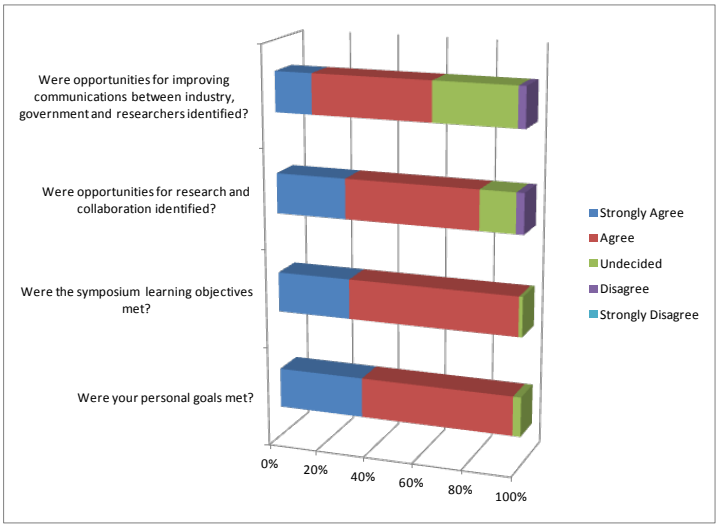

Figure 2 – Participant feedback on opportunities for communications, research and collaboration, and for personal and symposium learning objectives.

Symposium participants were also asked to record what steps could be taken to further symposium objectives and identify research and surveillance opportunities on their evaluation form. Key opportunities identified in the evaluation forms included sharing monitoring and research data among agencies, investigating and establishing an early warning system (based on phytoplankton monitoring), identifying environmental predictors, improving lab capacity and turn-around-time, finding useful indicators for industry, creation of on-line networking groups or a list serve group to share information and ideas, linking shellfish growers to HAMP, and many others. These comments are listed verbatim in Appendix 2 and Appendix 3.

Regarding the symposium topics and speaker presentations, between 94% and 98% of participants either agreed or strongly agreed that these sessions were useful. The highest rated session was from the opening speaker, Dr. Lora Fleming, who provided an overview of harmful algal blooms and human health. This was very useful feedback for two important reasons. Dr. Fleming was speaking from the UK, and there was concern that a remote presentation would be sub-optimal. Although Dr. Fleming was not present to interact with the delegates personally, she provided an excellent introduction to human health issues, and was able to spend over 20 minutes answering questions from the audience. The audio was very clear and she was able to remotely advance her presentation without issue[1]. The second reason of importance was that although this symposium was focused on Diarrhetic Shellfish Poisoning, the broad overview of health issues related to harmful algal blooms in general was well received by an audience who had not previously had an opportunity to hear from a medical practitioner and expert in this field. Issues specific to DSP are also common themes of many HAB and shellfish poisoning incidents, and this presentation set the stage for all later sessions. The next highest rated series of talks concerned the formation of harmful algal blooms and the research being done in BC and Washington on phytoplankton monitoring and this relationship to the DSP outbreak in 2011. Many research and surveillance opportunities were highlighted in this session.

[1] The organizers would like to extend special thanks to Ms. Tina Chen from NCC-EH and to Mr. Abdol Vahimi from PSAV for handling the logistics of this presentation, and to Ms. Petrina Bradbrook in the UK for her facilitation.

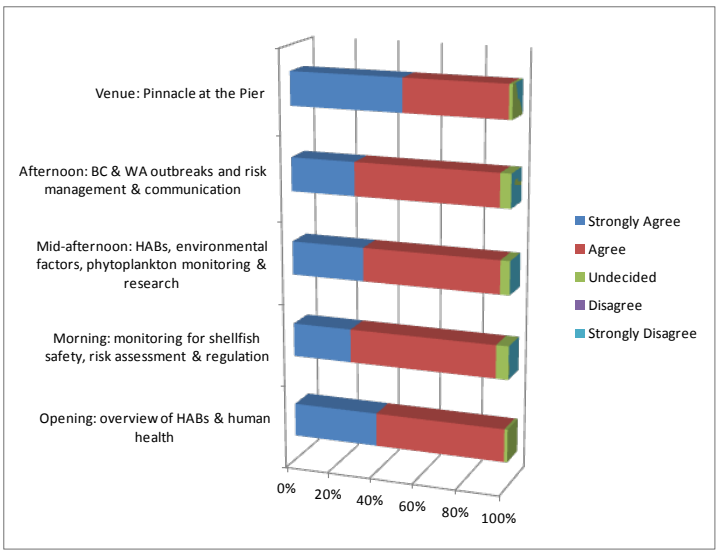

Figure 3 – Participant feedback for symposium speaker presentations and venue.

The venue itself was rated very high, over 98% either strongly agreed or agreed that they supported the choice of location, food and services at the Pinnacle at the Pier. Perhaps one common comment was that the room was on the cold side. All comments about the venue and all other comments about the symposium are listed verbatim in Appendix 4.

SUMMARY OF SYMPOSIUM PRESENTATIONS

The symposium was a single day event with presentations divided into four sessions. The list of speakers and presentations for each session are shown in Table 4. Following the table, for each of the sessions, the program abstract and notes taken during the presentation are provided below. Additionally, postings of speaker presentations can be found on the symposium web-site.

Table 4. List of session topics for DSP Symposium

Session	Presenter	Title of Presentation
Opening	Dr. Lora Fleming	An Overview of Harmful Algal Blooms and Human Health
Morning	Deirdre Kelly	Monitoring Programs for Shellfish in BC
	Dr. Nathalie Arnich	Health Risk Assessment & Regulatory Standards for DSP
	Wade Rourke	Testing for Marine Toxins and DSP
Mid-afternoon	Dr. Vera Trainer	Marine ecology of harmful algal blooms
	Nicky Haigh	The benefits of phytoplankton monitoring for aquaculture operations: lessons learnt from HAMP and 2011 DSP outbreak
	Dr. David Cassis	Phytoplankton diversity and screening for small shellfish growers
Afternoon	Jenny Lloyd	Washington DSP Outbreak in 2011
	Marsha Taylor	BC DSP Outbreak in 2011
	Elysha Gordon, Roberta Stevenson, Deirdre Kelly, Lorraine McIntyre	Risk Communications and Risk Management

OPENING SPEAKER: DR. LORA FLEMING *"AN OVERVIEW OF HARMFUL ALGAL BLOOMS AND HUMAN HEALTH"*

Program abstract: Dr. Fleming will provide a general overview of the most common types of non-infectious shellfish poisoning (Diarrhetic, Paralytic, Neurotoxic and Amnesiac shellfish poisoning syndromes—DSP, PSP, NSP, ASP). These syndromes are caused by specific marine toxins (okadaic acid, saxitoxin, brevetoxins, domoic acid); other toxins, such as azaspiracids and emerging marine threats such as blue-green algae (cyanobacteria) and ciguatera (from fish) will also be introduced. A differentiation of clinical symptom profiles arising in acute and chronic sequelae and exposure sources for these toxins will be highlighted.

Notes from session[2]*:* Harmful algal blooms (HABs) come in a variety of colours and can grow on the surface or through the water column. Causes of HABs are organism specific and include environmental, human, and global impacts. HABs are increasing recently, possibly due to pollution and increasing organic contaminants, possibly due to climate change. More is known about HABs at the cellular level, and less at the epidemiological level. Toxins cannot be eliminated by heat or acid. Transmission of HAB illness is via three routes of exposure: food, air and water. Food vectors, such as shellfish transmit PSP, ASP, DSP; fish transmit ciguatera, fugo; and water/air vectors transmit blue-green algae diseases. A general review of symptoms and onset times for toxin illnesses was given. Of interest for DSP, onsets are short, from 30 min to 3 hours, mainly gastrointestinal symptoms, generally of short duration. One paper looked at linkages between DSP illness and risk of colon cancer. Emerging issues include transmission of harmful algae via ballast water of boats to new locations; complications in defining vectors – transvector – when fish eat toxic algae or shellfish; new toxins and multitoxins. Co-toxins and symptom multiplier effects may also be possible. Other serious emerging issues, in drinking water blue-green algae, microcystins and cyanobacteria can be detected. In one case, patients became ill from intravenous exposure when receiving dialysis (o to 20% fatality). Generally prevention of shellfish poisoning is through an effective monitoring program. The organism (algae) or toxin is monitored in the shellfish bed and then warnings are posted to close sites. In Florida, messaging includes warnings to asthmatics to avoid beaches during red tides – note: no reports of aerosolized toxins have ever caused illness for shellfish workers. There are many factors needed to predict HAB's and these include wind, current, salinity, and freshwater stratification among others. Very poor epidemiology is available for long-term chronic conditions. There is a lack of biomarkers for human diagnoses, lack of surveillance in humans, more is needed to define susceptible populations, chronic conditions and burden of illness associated with climate change.

MORNING SESSIONS: MONITORING PROGRAMS FOR SHELLFISH SAFETY, RISK ASSESSMENT, AND REGULATION

DEIRDRE KELLY "MONITORING PROGRAMS FOR SHELLFISH IN BC"

Program abstract: Shellfish monitoring and management is well regulated in BC. Do you know what is being done, and who is responsible? Deirdre will provide an overview of the Canadian Shellfish Sanitation Program (CSSP) and describe the roles and responsibilities of the federal government agencies involved. How CFIA monitors and manages marine biotoxins will be explored, and what occurs when levels exceed standards will be reviewed. Details on common toxins in BC, areas and types of shellfish where they're found will be highlighted.

Notes from session: Canadian Shellfish Sanitation Program (CSSP) is comprised of 3 federal agencies: Environment Canada, Fisheries and Oceans (DFO) and the Canadian Food Inspection Agency (CFIA). Each agency has specific roles. The CFIA has a biotoxin monitoring program, recommends harvest area openings and closures based on the biotoxin results, registers and audits federal processing establishments, certifies product for export and is the liaison for international issues such as audits. Environment Canada monitors water quality (fecal coliforms), classifies shellfish growing areas, also recommends harvest area openings and closures based on water quality, and also advises on emergency closures resulting from waste-water plant issues and extreme rainfall events etc. DFO issues licenses to harvest, enforce and post closures, and issue harvest closures. Three areas in Canada report to the National shellfish committee, these are known as Regional Interdepartmental Shellfish Committees, and meet 2X per year (Pacific area – PRISC). Provincial members are associate members and provide local advice, and industry partners are invited to observe.

[2] Notes gleaned courtesy of participants E. Galanis, M. Taylor and L. McIntyre

Harmful algal blooms appear to be increasing, but this may also be increased awareness. In BC, shellfish monitoring for PSP has been in place since the 1940's. Species monitored are oysters, clams and mussels – mussels are the sentinel species for HAB. There are 70 stations monitored weekly in summer for PSP along the south coast, and 50 stations in northern BC monitored less often. If toxin testing exceeds the limit, DFO posts web notification of closure, and CFIA distributes e-mail information. Closures remain until 14 days after the last acceptable sample. PSP saxitoxin is the most frequent toxin detected. ASP domoic acid is less frequent, there was one bloom in Haida Gwaii this year, the 1st time since 2000, and prior to that, 1988 (large outbreak in Atlantic Canada). There is only limited data for DSP, between 2004 and 2012 the EU required monitoring, 2 BC areas were sampled, 60 samples per year. The DSP monitoring was expanded to 6 sites in 2010/11. This year (2012) 1100 samples were taken from 64 sites. There was one closure in 2012, Effingham Inlet, and higher levels in Barkley Sound. Yessotoxins are over EU standard as well. Questions: DSP monitoring is weekly in the summer and biweekly in the winter. Frequency of sampling would typically increase when levels rise. Industry helps by collecting about half of the samples for testing.

DR. NATHALIE ARNICH "HEALTH RISK ASSESSMENT AND REGULATORY STANDARDS FOR DSP"

Program abstract: The types of toxins associated with DSP (OAs, DTXs, PTXs), their mechanisms of action, risk assessment and illness thresholds will be explored. Canadian and international standards will be discussed.

Notes from session: DSP toxins are made up of Okadaic Acids (OA) and Dinophysis toxins (DTXs 1, 2, 3). DTX-3 is a group of ester derivatives of the OA and DTX-1, and DTX-2 toxins, 35+ DTX-3 derivatives are described in the literature so far. Pectenotoxin (PTX) and yesstoxins (YTX) can co-occur, but do not show any toxicity in animal studies. Symptoms are headache, diarrhea, nausea and vomiting; there is no known fatality from exposure to OA group toxins. Outbreaks have occurred in Japan, UK, Ireland, France, Chile, the US and Canada. There were some suspected cases in Quebec in October of this year (2012). DSP toxins can be found in clams, crabs and mussels. Symptom severity is correlated to dosage of toxin, and the toxin affects the small intestine. Acute toxicity, or the LOAEL – lowest observed adverse effect level is 50 µg OA eq/person. Long term toxicity is not known, and a tolerable daily intake has not been calculated as there is insufficient data. Regarding consumption, look at the Canadian Community Health Survey data. High consumers of shellfish eat 208 grams/day, the mean is 93 g/day. In digestive tissue, 1mg/kg of OA toxins; in shellfish edible tissue, 0.2 mg/kg are the standards. Prior to 2011, the OA toxin standard didn't include DTX-2 or DTX-3. Standards in other countries include all OA-group toxins (and EU includes PTX toxins), they range from 0.16 mg OA eq/kg (US, EU) to 0.2 mg OA eq/kg (Aus/NZ/Japan). The Codex Alimentarius standard is 0.16 mg OA eq/kg. To calculate NOAEL need to collect exposure data on non-ill people and evaluate toxin levels in leftover meals. Questions: Mussels seem to pick up DSP toxin fastest, but if they are "canary in coal mine" what other species can be tested? And if no mussels at that site? In Washington, large savory clams picked up DSP at 10X the closure level.

WADE ROURKE "TESTING FOR MARINE TOXINS AND DSP"

Program abstract: The methodology used to detect DSP and related toxins will be described, highlighting changes that have been implemented based on technological improvements. There will be some discussion of different forms of the toxins, the methods which can be used to detect these different forms, and practical laboratory considerations (including turn-around-time and sensitivity).

Notes from session: A test for DSP includes tests for OA and analogues, pectenotoxins, azaspiracids, yessotoxins and cyclic imines. They are all co-extracted, all lipophilic, but have difference structures, and different modes of actions on our bodies. Toxins are looked at twice for hydrolyzed and unhydrolyzed, to look at parent compounds.

There are several methods for detection, mouse bioassay (MBA) which is not sensitive but can detect unknown toxins; immunoassays, functional assays, chemical methods – these are expensive and require standards, but give toxin profile data. Their lab uses LC-MS/MS, also expensive but is specific and sensitive, and multiple toxins can be detected. In 2008 the EFSA recommended to move away from the MBA to LC-MS/MS. In 1987, only PSP was detected in Atlantic area, by 2005 many toxins were tested for and found. This is due to changing lab methods, increased sensitivity led to more monitoring. In 2001, for DSP, their lab looked for 2 toxins – OA and DTX-1. In 2012 they look for 29 toxins! The turn-around-time for a test is 3.4 days (normal is 5 days), and STAT sample analysis (same day results) is possible. They have a big issue with finding standards, NRC is the only agency providing them. There is now more testing in western vs. eastern Canada. Yessotoxins have not been associated with illness, but 12 µg/g found in BC (EU limit is 1 µg/g) and this is a trade issue. Issues identified included monitoring around salmon DFO areas, but not shellfish areas, that DSP depuration needs long periods, and overall desire for more testing. Questions: How much would it cost to get testing moved to the west coast? $0.5 million and 3 additional people. Limiting factor is people, and also finding reference standards for the test.

MID-AFTERNOON SESSIONS: HARMFUL ALGAL BLOOMS: ENVIRONMENTAL FACTORS, PHYTOPLANKTON MONITORING AND RESEARCH

DR. VERA TRAINER "MARINE ECOLOGY OF HARMFUL ALGAL BLOOMS"

Program abstract: Dr. Trainer will discuss what is known about the conditions leading to some harmful algal blooms, and review whether increases may be occurring due to global warming and human activities. She will also discuss how partnerships between industry, universities and governments focusing on algal identification and toxicity have provided a greater understanding of the first cases of diarrhetic shellfish poisoning in the Pacific Northwest.

Notes from session: Many species of *Dinophysis* exist, easy to identify under the microscope, finding toxins in more places and dinoflagellates are producing more toxins. Warming oceans are allowing dinoflagellates to move farther north (ref Hallegraef 2010), and to bloom more often, becoming dominant in our oceans. For PSP, *Alexandria catenella*, bloom window increases as sea surface temperatures increase – historically 68 day window, a +6°C rise increases this to a 191 day window. *Dinophysis* eats other organisms, called mixotrophy. Does what it eats affects its toxicity? Practices cellular vampirism and sucks out plastids from other algae, myzocytosis (ref Park et al, 2006). Six of 11 more common species of *Dinophysis* are toxigenic: *D. acuminata, D. acuta, D. caudata, D. fortii, D. norvegica, D. sacculus.* Can use cell based monitoring to show when shellfish may be toxic. In Washington, sea water samples are filtered to provide total number of *Dinophysis* cells. 100% of the cells filtered were *D. acuminate* and known to produce toxin. In some cases toxin is seen but no *Dinophysis* is present. This might be from where the sample is taken in the water column, these organisms occur at the density gradient when fresh and salt water is mixing – the pycnocline (~1.2 m depth). They also migrate up during the day (for photosynthesis) and down at night (for nutrients). In Washington they have 18 phytoplankton monitoring sites, and use an early warning system for shellfish – *Dinophysis* is either "absent", "present", "common" or in "bloom". In 2011, high snowpack and late melt caused the Fraser River to have increased flow levels increased in 2011 and this coincided with higher *Dinophysis* cell counts in Sequim Bay and human illnesses. High fresh water inputs appear to favour DSP toxicity and *Dinophysis* growth. They are using the PP2A Okatest as a screening test – they can get test results in <2hr, and it has high throughput*. We are in a dinoflagellate dominated regime*. Questions: what environmental factors are important? Each species of phytoplankton is different – generally light (low or high levels), temperature, salinity, dissolved oxygen. Under phosphate nutrient stress cells become more toxic, also increased CO_2 may increase toxic spp. Long term monitoring is important, either look at a specific area or at flow during season.

NICKY HAIGH "THE BENEFITS OF PHYTOPLANKTON MONITORING FOR AQUACULTURE OPERATIONS: LESSONS LEARNT FROM HAMP AND 2011 DSP OUTBREAK"

Program abstract: Phytoplankton monitoring is a relatively low-cost and simple way to detect harmful algae bloom (HAB) species before they affect other marine organisms. HAMP has helped BC salmon farmers with monitoring and management of HABs for 14 years. Samples are collected and sent to HAMP for analysis weekly; providing real-time warning of harmful species, and allowing the construction of a long-term database to predict future HABs. HAMP also has an educational component - fish farmers who routinely analyse samples on site are trained in microscopic phytoplankton identification and supplied with the HAMP Plankton Identification Manual. Routine monitoring can also be of benefit to shellfish growers. Among other things, phytoplankton sample analysis may give advance warning of poisoning syndromes, e.g. paralytic shellfish poisoning (PSP), affecting shellfish stocks. In 2011 regular HAMP samples from salmon farm sites near Quadra Island had notably high concentrations of Dinophysis species, known to cause diarrhetic shellfish poisoning (DSP) elsewhere; shortly afterward the first reported cases of DSP in BC were traced to a nearby shellfish aquaculture site. In addition, HAMP sample analysis often shows PSP-causing *Alexandrium* species to be present prior to the closure of the areas for shellfish harvesting by DFO.

Notes from session: HAMP has been working with the salmon farmers since 1999. HABs cause losses of $1-4 million /year to salmon farmers. The HAMP program also teaches basic phytoplankton identification to salmon farmers so they can monitor on-site. They monitor 12 to 28 sites. Farmers take samples at 1, 5 and 10 metres, and send samples to Nanaimo weekly from March to October. The samples are analysed for total biomass (on scale of 1 to 5), harmful and dominant phytoplankton species and note other unusual species. Temperature and salinity data is also collected. *Dinophysis* was seen in HAMP samples in early July 2011, before the outbreak at Conville Bay (25 miles from Gorges). They saw four species of *Dinophysis*, 83% were identified as *D. acuminanta.* There is some intersection between phytoplankton species of harm to fish and shellfish. Phytoplankton monitoring could provide an early warning of toxic species and provide other information to farmers. Questions: Can we see increased blooms early enough to take meaningful action? We have seen the 2011 scenario, however, we have seen increases in *Dinophysis* before but with no increased report of illnesses. The ACRDP funded a program to look at HAB species for 2 years on the west coast, and there will be net tow data to compare this to. Currently, Okoever is monitoring phytoplankton as a volunteer at their shellfish farm.

DR. DAVID CASSIS "PHYTOPLANKTON DIVERSITY AND SCREENING FOR SMALL SHELLFISH GROWERS"

Program abstract: The 2011 DSP outbreak highlighted the need for a monitoring system that can serve as an early warning to flag potential problems in BC. Unlike other areas of the west coast of North America (e.g. Alaska, Oregon), BC does not currently count with a volunteer-based harmful algae monitoring program. Such a program could focus on training shellfish growers, as well as interested members of local communities and universities, in seawater sampling techniques and harmful algae identification. The objective is to use volunteers, low cost materials, and freely available information and resources for maximum community engagement, geographical coverage, high temporal resolution, and low cost.

Once a potential harmful algal event has been observed, a "yellow alert" could be declared. The response to such an alert could include increased monitoring and a self-imposed moratorium on shellfish extraction until further toxin testing can be effected. A quick preliminary risk assessment could be obtained by means of qualitative toxin testing with Jellett Rapid tests.

To be effective and actionable, the information gathered by this network needs to be analysed, modulated, and channelled in real time to CFIA and other government environmental agencies. These channels need to be defined and regulated, and could be created by liaising and training existing experts, industry associations, government agencies and educational institutions.

Notes from session: Dinoflagellates, diatoms – some cause mortalities for fish and shellfish farms, especially problems for small seed oysters. *Alexandrium* occurs late spring to fall; *Dinophysis* usually June/July to October; and *Heterosigma* in the spring. Algal negative effects are toxicity (PSP, ASP, DSP) and mortalities/reduced growth. Both of these lead to increased costs. Plan to include eyes on the ground in the form of volunteer industry phytoplankton monitoring network. Support using an internet based tool. If HAB detected declare a "yellow flag" with this actionable information and link to government organizations. Decide on a proportional response plan – suggest a voluntary preventative closure. A rapid test could be used to raise or lower the flag until testing could be confirmed by CFIA. If positive this would result in DFO closure. Increasing collaboration with networks internationally would help form new local experts. Questions: (VT) In the US, baby steps were taken to develop a program that involved public health, industry, tribal associations and NOAA.

AFTERNOON SESSIONS: BC AND WASHINGTON DSP OUTBREAKS IN 2011, RISK MANAGEMENT AND RISK COMMUNICATION

JENNY LLOYD *"WASHINGTON DSP OUTBREAK IN 2011"*

Program abstract: DSP has been documented in Europe and Asia, but never before reported in the United States. Though the dinoflagellate associated with DSP has been observed in Puget Sound and Washington coastal waters in previous years, DSP toxins have been detected at levels too low to cause human illness. In July, 2011, Seattle & King County Public Health received a report of possible DSP in a family who had harvested and consumed mussels from the underside of a public dock at Sequim Bay State Park in Clallam County, WA on June 24, 2011. This is the first time toxin levels have knowingly increased to pathogenic levels in Washington state waters. Ongoing sampling should be conducted to detect the presence of DSP toxins in Washington State waters. Because the symptoms are nonspecific, illness from DSP is likely to be under-reported. Health care providers should consider DSP in the differential diagnosis of patients presenting with gastrointestinal symptoms and recent shellfish consumption, and report illnesses to Public Health.

Notes from session: The first finding of OA in the US was in Texas in gulf coast oysters, but no illnesses were detected. PSP reportable in 1985, ASP (domoic acid) in 2010; DSP not reportable, but captured under foodborne outbreaks. Most cases of shellfish poisoning involve self-harvesting. In 2010 pilot study, started weekly monitoring of 18 growing areas – 15 had DSP above 300,000 cells per litre. In Europe illness typically occurs at levels above 3-5,000 cells per litre, but no illnesses were reported. Sampling was cut-back in 2011 to 6 sites. In 2011 at a WA state park, one family of self-harvesters, 3 of 4 ill. Ten samples exceeded threshold, 2 of them collected prior to illnesses. Range was 37.5 – 160.3 µg OA + DTXs / 100g. In 2012, 13 different sites showed elevated levels of DSP, resulting in 8 recreational and 3 commercial closures, although no illnesses reported.

MARSHA TAYLOR *"BC DSP OUTBREAK IN 2011"*

Program abstract: In 2011, BC experienced an outbreak of DSP for the first time. Over 60 cases were reported associated with cooked mussels from a single harvest area. Collaboration and investigation by industry, public health and food safety colleagues lead to rapid mitigation and control measures. The trigger for toxin production that led to this outbreak is unknown but improved understanding could improve monitoring and approaches to

surveillance for clinical illness. This outbreak provided colleagues in BC and the Pacific Coastal waters an opportunity to expand knowledge in this area and make changes to regulatory action levels and monitoring programs in BC. Ongoing work to improve our understanding of marine biotoxins and appropriate public health response will help investigate and control any potential future events.

Notes from session: Previous outbreaks in Canada have occurred in 1990 in Nova Scotia from mussels, OA was detected in 1989 in Atlantic Canada areas. In 2011, multiple cases of gastroenteritis were identified in 2 restaurants in 2 areas of the province. Restaurant complaints went directly to the harvester, and public health investigations included case and restaurant follow-up and collection of tags to assist traceback. In total, 62 cases from 15 retail locations found, mussels consumed between July 29 – Aug 6, 2011. No self-harvesting cases. Traceback was to a single harvest area. Symptoms of DSP are similar to norovirus, but 6 stool specimens tested negative for norovirus and other stool culture. 7 mussel samples were collected between Jul 31 – Aug 17, 2 of these were above 20 µg/100 g for DTX-1. DTX-3 was also found in all samples. Harvest area was closed Aug 5, and health hazard alert issued on Aug 6th. Future considerations include improving communications with the public, clinicians and public health.

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Notes from session: DFO (Gordon) Web-site information includes the sanitary contamination closures, biotoxin contamination updates. These are given in maps. Also on the web-site, info about recreational fishing requirements, and sign-ups to receive automatic fishery notices. BCSGA (Stevenson) BCSGA represents 65% of growers (150 members). Most farmers have cell phones and internet, but on site may not have coverage or do not check e-mail daily. BCSGA uses e-mail, web-site and fax to reach their growers. Growers monitor their water quality and no-one wants product recalls. Farmers spend more time out on their farms than in an office. Large Vietnamese populations work in the shellfish industry, more translations of materials would be helpful, but it's costly at $0.22 per word. CFIA (Kelly) Have many fact sheets on their web-site, CSSP manual, send out data on shellfish as its received by e-mail (have discontinued fax), food recall report site where all recalls are posted, good communication process between CFIA and public health agencies (HA/BCCDC). BCCDC (McIntyre) Use the web-site to post information for industry, inspectors and consumers (food and your health pages), respond to requests for risk assessment (e.g. Cadmium in shellfish, botulism in canned products) although sometimes controversial depending on stakeholders. What risk messaging do public health practitioners want with respect to shellfish monitoring data? This data won't describe if there will be an increase in shellfish illnesses.

APPENDIX 1. Summary of Comments Received for the Question "*Identify 2 New Things You Learned.*"

- ✓ Prescreening of organisms to help predict blooms – excellent idea
- ✓ Dinophysis monitoring in Washington State (cell based early warning)
- ✓ What DSP is; mussels bioaccumulate DSP toxin faster than other species
- ✓ Large # of closures in WA state due to DSP; Science and causes of DSP
- ✓ The different species of algae & toxins; importance of having a monitoring or some screening of algae/sentinel species
- ✓ Limitations/difficulties of toxin monitoring (esp DTX-3), lack of BC baseline data
- ✓ Quantity of shellfish consumed/yr/person; There is more than red for algal blooms
- ✓ Turn-around for DSP analysis through Dartmouth lab; Phytoplankton monitoring studies
- ✓ The different toxins that make up DSP; Rapid test kits that have been developed
- ✓ Don't eat shellfish, especially raw; Monitoring algae blooms could be helpful
- ✓ DSP aeration/respiration concerns; HAMP & phytoplankton as early warning mechanism
- ✓ Learned about Dinophysis & HAB
- ✓ The diversity of the toxins / advanced technology required to shorten TAT
- ✓ Awareness of phytoplankton monitoring. On-going work of colleagues in Washington State.
- ✓ Need more HAB research especially DSP. Need better coordination between government agencies.
- ✓ Dartmouth lab method efficiencies introduced this year; global warming = "dinoflagellate regime".
- ✓ Possible nitrate/phosphate limitation --> more toxin production; the work details of the Halifax lab
- ✓ No plankton monitoring (is occurring) at shellfish sites
- ✓ Potential links to chronic disease & marine biotoxins; details on harmful algal bloom monitoring programs in BC
- ✓ The Washington experience; the role of different departments
- ✓ DSP toxin not inactivated by heat/acid; attack rates for HAB toxins not known
- ✓ DSP + LC-MS technique for identification
- ✓ That Dinophysis has a 2-stage feeding; much from the US monitoring efforts
- ✓ DSP, PSP risk factors; monitoring approach to DSP toxins
- ✓ Ideas for phytoplankton monitoring, info about phytoplankton monitoring instead of rapid kits
- ✓ Existing & emerging methods for DSP testing; Agency roles & responsibilities & CSSP activities
- ✓ The potential of phytoplankton monitoring, the vast chemical family known as DSP
- ✓ DSP specifics; DSP is not one toxin
- ✓ Health risks & long-term effects; Toxins associated with DSP & causes of uptakes
- ✓ Different monitoring programs; DSP & PSP & other shellfish toxin poisonings in general
- ✓ DSP is most prevalent in mussels; research is being done in BC
- ✓ Effectiveness of a volunteer-based monitoring program; Relationship to warming oceans and HABs
- ✓ Organization of CSSP (multi-agency-federal); surveillance cross historically related to fisheries, not shellfish.
- ✓ Toxin categories; correlation between toxin levels & cell numbers
- ✓ The different levels of monitoring (industry, government etc.); in different areas different signs and symptoms appear for DSP
- ✓ DSP can have aerosol exposure; no real testing for confirmation of illness

- ✓ The various HAB shellfish poisonings associated with natural aquatic toxins; types of toxins associated with DSP
- ✓ Mussels are used as sentinel species because they accumulate toxins; Digestive glands of shellfish have most toxin.
- ✓ Phytoplankton monitoring; HAMP
- ✓ Phytoplankton monitoring; Washington updates
- ✓ Cell based monitoring and additional detection tool. Density gradient and influx of freshwater / increase flow can cause increase in organisms
- ✓ Phytoplankton monitoring; Complex process to analyze DSP toxins.
- ✓ Use of cell count monitoring as a possible early warning for development of shellfish toxins
- ✓ Phytoplankton monitoring may provide value; high river flow can increase risk.
- ✓ Variety of potential for new monitoring; factors that may lead to DSP
- ✓ HAB diseases differences; How biotoxin monitoring works
- ✓ Monitoring efforts in Canadian public health agencies
- ✓ Challenges in monitoring & accurately identifying risk; great info from Washington monitoring & experience; complexity in testing & players involved
- ✓ Unaware of water/aerosol transmission of HABs; Biomarker non-existent in clinical specimens
- ✓ DSP being effected by both environment, in addition to genetics; work of various government agencies
- ✓ Details on outbreak; monitoring & regulation
- ✓ Shellfish are able to select their phytoplankton consumed; dinoflagellates like stratified water column
- ✓ Better understanding of roles of diff. Canadian public health/regulatory agencies; better understanding of monitoring in Canada
- ✓ We still have lots of improvements to do in our monitoring programs; Climate change is leading to an increase in the occurrence of toxic algae
- ✓ Mussels are the main indicator for DSP. BC DSP sampling will surpass the rest of Canada this year in terms of numbers.
- ✓ Available test kits & brevetoxins emergence

APPENDIX 2. Summary of Comments Received for the Question, "*What Steps Would You Recommend to the Organizers to Further Symposium Objectives, such as Improving Knowledge About Marine Toxins in BC, Improving Communications and Furthering Research and Collaborations?*"

- ✓ Convergence of information from all parties including CSSP, WDOH, HAMP, industry groups, etc.
- ✓ Please include actual data for both HABs and toxins in BC
- ✓ Economic value of industry and impact of recall to industry
- ✓ Provide slide presentations to participants/attendees after this symposium
- ✓ On-line collaboration/info-sharing site
- ✓ Set-up HAMP with shellfish growers & communicate results with BCSGA. Determine if there are local radio stations, programs which can target small islands & First Nations communities
- ✓ Consider research into elimination of marine toxins in shellfish meat as a CCP in HACCP system rather than rely on sampling
- ✓ Get DFO science back into HAB research! Collaboration between DFO-CFIA?
- ✓ Informal research email group or web page (facebook?)
- ✓ Building capacity in BC by providing training for monitoring programs
- ✓ More collaboration between agencies
- ✓ Present to public health students!
- ✓ Would be great if this symposium could be repeated every year. Could be useful to advertise it more in academia so more participants could come from universities and research centers
- ✓ Provide a forum to educate key stakeholders on these emerging issues.
- ✓ Make updated web-site easily accessible
- ✓ Introduce more scientific-based methods for DSP & PSP toxins, identification prior to toxic event
- ✓ Recommend strategies for identifying early signs/symptoms of outbreak
- ✓ Overview of industry - "Day in life of shellfish grower" - process of getting to market.
- ✓ Introduce all speakers at start of event, so people can identify them & speak to them during breaks/lunch.
- ✓ Include any grower information / practices currently implemented that may influence shellfish safety (industry practices other than monitoring)
- ✓ How would this incorporate to HACCP? CCP? (phytoplankton)
- ✓ Harmful algal blooms & human health contained a lot of info on ciguatera toxins - would have been better to stick with shellfish toxins
- ✓ Institute cell count monitoring to assist/direct toxin testing: start small.
- ✓ Identify collaborative projects - small follow-up meeting
- ✓ Ensure continued collaboration with Washington State Officials. Differences between US & Canada, dealing with same issues, also how different gov dept roles in issues are
- ✓ Set up list serve to include interested partners
- ✓ Greater/increased collaboration with Washington State research.
- ✓ Don't lose momentum! DSP working group with regulators & stakeholders should be formed.
- ✓ It would be nice to communicate movement forward on any or all of the good ideas that came out today
- ✓ Possibly break-out session for structured networking/planning
- ✓ The need to pursue phytoplankton monitoring for the shellfish industry as an aid in preventing shellfish poisoning outbreaks
- ✓ Make presentations available on line for future reference
- ✓ To establish a streamlining method of having DSP test results quicker to industry

APPENDIX 3. Summary of Comments Received for the Question, "*Describe Opportunities for Research and Collaboration that Were Well-Identified.*"

- ✓ How to share research & monitoring information between governments and industry
- ✓ Expanding lab capacity, HAB vs. toxin modelling, environmental predictors for HAB
- ✓ Not really sure how well opportunities for research * collaboration were provided for. This is difficult however, as applies more on networking basis.
- ✓ If toxicity dinophysis increases when stressed - this may be a defence mechanism - are there options to add nutrients to reduce toxicity? But if so what are the resultant implications (ie. environmental chain reactions).
- ✓ Kits for screening/ faster TAT. Better monitoring program (more partners / web)
- ✓ Industry needs to take more responsibility with respect to the product quality coming off their farm.
- ✓ Volunteer monitoring ideas; the networking & contact along the coast & elsewhere
- ✓ More collaboration between different agencies both states & BC; HAMP - DFO need to collaborate share data and training
- ✓ Opportunities and areas that need attention were easily identified and the contacts to solve these issues were readily made.
- ✓ Merits of phytoplankton monitoring need to be explored, not enough data.
- ✓ Plankton monitoring. Improving testing result turn around times.
- ✓ Monitoring programs in BC & general Canada, sampling locations
- ✓ Opportunities for experts & physicians to clarify diagnoses. Opportunities for experts & regulatory agencies on both sides of border. Opportunities for experts & volunteers to broaden monitoring network.
- ✓ Washington State vs. BC/Canada - idea of industry/volunteer monitoring & field test kits
- ✓ Cell based monitoring - through volunteering / growers & regulatory agencies. Triggers for increase in toxin production in Dinophysis.
- ✓ Symposium brought together regulators, researchers & stakeholders. Form working group!
- ✓ Would have liked more time to discuss.
- ✓ Is there any collaboration/share of information with Vancouver Island University - Nanaimo (Nicky Haigh). Re: benefits of phytoplankton monitoring - seems like a good idea.
- ✓ HAMP should be expanded to shellfish growers. Funded by BCSGA and in clear communication with health jurisdictions.

APPENDIX 4. Summary of Comments Received for the Question "*Please Describe Any Other Comments You Have About This Symposium.*"

- ✓ Diversity of the topics covered by the speakers was good
- ✓ Lunch was excellent
- ✓ Fair amount of duplication in presentations with respect to algal bloom species. Probably need to let presenters know ahead of time if an earlier presenter is going to cover general aspects
- ✓ Recommend microphone to be available for persons that ask questions as it was a little hard to hear
- ✓ Topics were repeated too many times
- ✓ More real life shellfish algal bloom management cases to learn from
- ✓ Great format; great opportunity to meet people you know, but have not met in person
- ✓ Was very interesting to get a world wide perspective on the issue
- ✓ All guest speakers were excellent, job well done, really pleased I attended
- ✓ Ensure speakers can be heard, not helpful to have Q&As on the front which group cannot hear: waste of time. Get speakers to speak into microphone & adjust for each speaker as necessary.
- ✓ If handouts could be provided would be of great help
- ✓ This was a terrific gathering of expert knowledge & industry representatives along with the gov. participants.
- ✓ Amazing!
- ✓ Enjoyed having shellfish for lunch!
- ✓ Would have been better if 1st speaker had been present; too much repetition between speakers.
- ✓ Excellent, thank-you!
- ✓ It was really educational. I enjoyed it! Excellent talk by Dr. Trainer!
- ✓ Good speedy presenters, adequate visuals & question times.
- ✓ Maybe having roving mike, hard to hear at times.
- ✓ Great, knowledgeable (expert) speakers, well organized & objectives for symposium met.
- ✓ Thanks for the shellfish lunch
- ✓ Further extend invite to federal processors; Topics often strayed to other biotoxins, away from DSP discussion
- ✓ The venue food was excellent.
- ✓ Topics sometimes strayed form DSP/shellfish toxins. Would be nice if topic of symposium remained the focus.
- ✓ Thanks to BCCDC especially Lorraine for organizing!
- ✓ Excellent session!
- ✓ Very well organized – lots of learning including identification of gaps in knowledge
- ✓ Thank you Lorraine. Great networking & content.
- ✓ Excellent 1st step for collaboration opportunities between US & Canada
- ✓ Great lunch. Well organized and stayed within time schedule
- ✓ Good networking opportunity.
- ✓ Excellent organization, content & speakers!
- ✓ Work is still needed to bring the 3 industry/govt/academia into a more active communication network
- ✓ RE: outbreaks, both presentations were very interesting
- ✓ Thank-you!
- ✓ Very well presented & a good start on understanding DSP.