

PACIFIC MARINE MONITORING PROGRAM

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Draft
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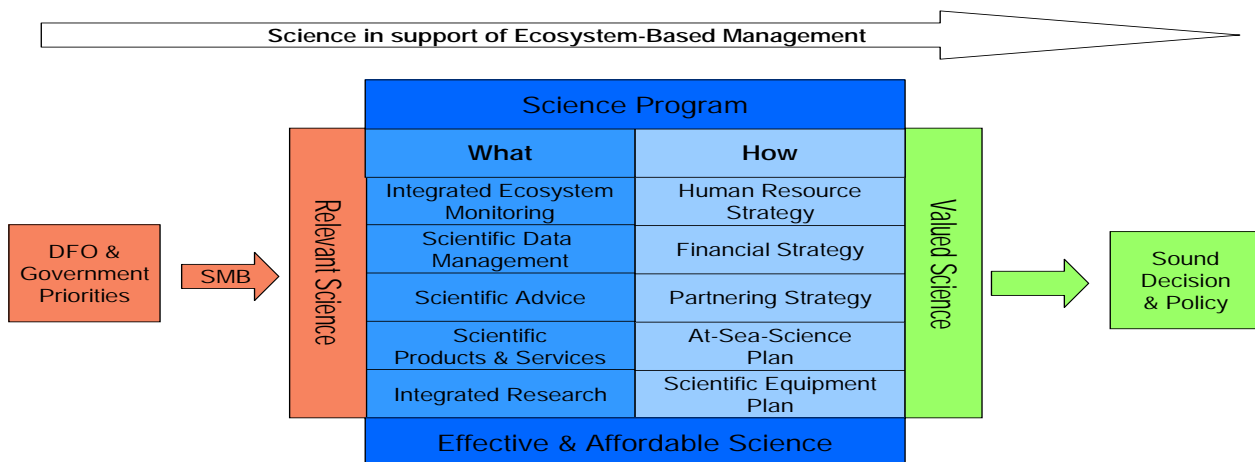
Pacific Marine Monitoring Program

1. Introduction

This document outlines the “at-sea” monitoring program for DFO Science in the Pacific Region. Completion of this document was identified as a deliverable under the Science Renewal Action Plan. Similar plans have been developed for the Atlantic “at-sea” program, the Arctic and the freshwater environment. One more plan for the Pacific salmon monitoring program is in preparation.

DFO has one of the most complex and comprehensive Science programs in the federal government, both in terms of function and geography. We expect the demand will continue to grow for scientific advice and information about complex issues of importance to Canadians. A key outcome of Science Renewal is to ensure a modern and effective delivery of science activities, which can be achieved through a balanced science program that is aligned with government and departmental priorities (Figure 1). Science Renewal initiatives are contributing to the scope and depth of scientific activities, ensuring transparency and credibility of scientific advice, as well as contributing to scientific innovation and commercialization of technology.

Figure 1: Science in support of Ecosystem-Based Management



To describe the science program more simply, the principal activities (“what” in Figure 1) were categorized as monitoring, data management, scientific advice, products & services and research. Separate plans and/or actions were undertaken to review each of these activities to ensure that they are aligned to contribute effectively and efficiently to sound decision making and policy. As part of this review process and in response to the high costs associated with the Monitoring function, a national review of the At –Sea Monitoring program was completed in 2006 (DFO, 2006). In parallel with this review of activities, DFO Science has developed a new focus on aquatic ecosystems (A New Ecosystem Science Framework in Support of Integrated Management - http://www.dfo-mpo.gc.ca/science/research/ecosystem_index_e.htm).

2. Monitoring programs in DFO - a brief historical perspective

Existing monitoring programs were developed against the context and priorities of the time they were created. In many cases, the context and priorities have remained fairly stable (e.g. monitoring the status

of fish and shellfish stocks to develop harvest recommendations). In other cases, changes in context and priorities resulted in the cancellation of some monitoring programs and revision to others to fit new objectives (e.g. monitoring of toxic chemicals in harvest areas closed due to contamination). Most programs were not designed to contribute to our new ecosystem focus in support of integrated management. While many existing monitoring programs are actually well-configured to contribute to this new ecosystem focus, some are not.

The monitoring activities described here have a variety of ‘means of support’, including:

- Programs that DFO conducts directly and supports with staff, ship time and O&M. These are programs that we consider sustainable in a “business as usual” funding environment.
- Programs that DFO contributes to, but are substantially supported by partners. If there is a partnership breakdown, we would be unable to sustain these programs in a “business as usual” funding environment.
- Programs where DFO contributes little or nothing, but benefits from the data. An example here would be the seabird monitoring program conducted by the Canadian Wildlife Service. Results from this program are reported in the annual State of the Ocean Reports for the region as an indicator of ecosystem status, but we do not bear the costs of managing, executing or funding the observational program or analysis.

3. Linkage to the other Science Functions

While the portrayal of Science activities as a group of five functions can be a useful description, it also has some limitations. These activities cannot operate independently. A robust monitoring function needs to be tightly bound to the other functions to be successful and effective. For example:

- **Data Management.** Monitoring data demands high quality data management. Monitoring implies long time series (longer than the time that an individual would typically hold a specific position) and careful attention to metadata so that potential changes in the quality of the monitoring (accuracy, precision) can be determined (or at least, flagged). There is more flexibility in this area for some aspects of Research data, but very limited flexibility for Monitoring data
- **Research.** Monitoring programs rely on Research programs for development of methodologies, sampling strategies, data analysis, scrutiny and challenge and for integration with other ecosystem data. In many cases, the actual activities (e.g. go to sea and collect the data/samples) are supported by staff and funding that are associated with both the research function and the monitoring function, and research initiatives are often highly dependent on monitoring data. This must be kept in mind when changes to either component are contemplated.
- **Advice.** In many cases, the advice function is supported by both Monitoring and Research. As we observe or anticipate changes to requests for Advice, these changes must feed back into the design of Research and Monitoring components. This is a challenge for clients, as they are often only interested in the “end product” (Advice) and have limited interest in some of the costly and long lead-time components that go into Advice (like Research and Monitoring).
- **Products and Services.** While the “Products and Services” function is mainly associated with the Canadian Hydrographic Service, specific data or data products (e.g. BC Lighthouse temperature and salinity data - http://www-sci.pac.dfo-mpo.gc.ca/osap/data/SearchTools/Searchlighthouse_e.htm) can be provided to many clients for a variety of applications. With some careful planning and attention, data products derived from monitoring that are of broad use can be generated and distributed at relatively low cost.

4. Pacific Monitoring Program - Structure

The goal of this report is to identify activities by marine ecoregions and ecosystem component. The report should identify gaps and propose approaches to fill these gaps and/or optimize the existing monitoring program.

4.1 Marine Ecoregions – what are they?

We have identified four marine ecoregions for this analysis.

Table 1: Ecozones for the Pacific Coast of Canada

Ecozone Name	Ecozone Boundaries
Strait of Georgia (SoG).	From Discovery Passage to the mouth of Juan de Fuca Strait. Bounded on the west by the east coast of Vancouver Island and on the east by the mainland.
West Coast of Vancouver Island (WCVI).	From the mouth of Juan de Fuca Strait to Brooks Peninsula. Bounded on the east by the west coast of Vancouver Island and on the west by the foot of the continental slope.
The Pacific North Coast Integrated Management Area (PNCIMA)	The continental shelf area north of Brooks Peninsula and north of Cape Mudge to the border with Alaska, including Queen Charlotte Sound, Johnstone Strait, Queen Charlotte Strait, Hecate Strait, Dixon Entrance and the very narrow strip of continental shelf along the west coast of the Queen Charlotte Islands. Bounded on the east by the mainland and on the west by the foot of the continental slope.
Open Ocean	All areas seaward of the foot of the continental slope. This includes areas within and outside of Canada's Exclusive Economic Zone.

This classification is not without its challenges and limitations. Some deficiencies include:

- Fiords and narrow (but very deep) inlets are not well represented. They might better considered as a separate “ecozone” that share more features with each other than they do with the geographic area in which they are “lumped” for this review.
- Juan de Fuca Strait. There are arguments that Juan de Fuca Strait “belongs” with WCVI rather than the Strait of Georgia.
- Inshore/nearshore regions (including the subtidal zone and estuaries) are poorly represented. There are arguments that these areas are a particularly important ecosystem component that does not receive sufficient attention from DFO.

4.2 Monitoring Program Components – What are they?

For the purpose of this analysis, the components of the ecosystem that are monitored are divided into:

Table 2: Monitoring Program Components

Monitoring program component name	Description
Physical and Chemical Environment	This includes measurements of waves, winds, currents, sea level, ice, temperature, salinity, oxygen and macronutrients.
Greenhouse Gases	This includes components of the carbon cycle (CO ₂ , Dissolved Organic Carbon, Particulate Organic Carbon, Alkalinity, pH, C ¹³ , CO, CH ₄) as well as other related “climate-related” measurements (Dimethylsulphide, Iron, CFCs, SF ₆)
Lower Trophic Levels – water column.	This includes measures of abundance, distribution and composition of phytoplankton and zooplankton
Lower Trophic Levels – benthos.	This includes measures of abundance, distribution and composition of benthos (plants and animals). This includes both infauna and epifauna
Higher Trophic Levels – fish and shellfish.	This includes measures of abundance, distribution, age structure and biological condition factors
Higher Trophic Levels – marine mammals.	This includes measures of abundance, distribution, age structure, biological condition factors and prey consumption
Aquatic Invasive Species.	This includes measures of the detection, distribution and abundance of invasive species
Aquatic Animal Health.	This includes measures on the distribution and abundance of diseases and parasites. This category is meant to be more inclusive than the specific listed diseases under the National Aquatic Animal Health Program (NAAHP)
Marine Environmental Quality (MEQ)	This includes measurements of contaminants in sediments, biota and the water column. This also includes toxic algal blooms
Marine Protected Areas.	This includes any ongoing measurements made specifically to track the status and efficacy of Marine Protected Areas

This classification approach is not precise. There are potential overlaps between certain MEQ measurements and Physical/ Chemical or Greenhouse Gas measurements (for example, when do measurements of macronutrients move from being an indicator of lower trophic level ecosystem status and become a eutrophication problem considered under MEQ?). This classification approach is not a traditional view of DFO Science activities, but it is a better match to our current Program Activity Architecture

4.3 How does this relate to the Atlantic Zonal Monitoring Program?

The Atlantic Zonal Monitoring Program (AZMP) is DFO's premiere monitoring program. The program design is described in Therriault et al (1998). In terms of areal coverage, AZMP is oriented to the continental shelf region (a much larger percentage of the EEZ on the Atlantic Coast) but omits (with the exception of the Continuous Plankton Recorder Data) the open ocean sampling, most notably the Labrador Sea line, which is more or less equivalent to the Line P/Station P program in Pacific Region. In terms of the ecosystem components samples, the AZMP program focus is on the Physical/Chemical Environment and Lower Trophic Level- water column component (plankton). The design document refers to tight integration with fisheries trawl surveys (Higher Trophic Levels – Fish and Shellfish), but these data are not reported on the AZMP website or in the AZMP Bulletins (http://www.meds-sdmm.dfo-mpo.gc.ca/zmp/main_zmp_e.html)

5. Pacific Monitoring Program - results

The results are summarized in Table 3. In each cell, the activities are briefly noted. Using the cell number and activity letter codes, users can review the details of the monitoring activities in Appendix A.

Some features of the Pacific monitoring program that clearly emerge from this table include:

1. The bulk of the monitoring activities are directed at Lower Trophic Level – benthos and Higher Trophic Levels – fish in the three continental shelf ecozones. This should come as no surprise. Most of this work is focussed on monitoring stocks to provide advice on the management of fisheries. In the Pacific Region, there are large contributions from industry to support this activity, although industry contributions have fallen as a result of court decisions related to “use-of-fish” in 2006.
2. There are no substantive monitoring activities aimed at the benthic ecosystem (excluding commercial species).
3. There are no substantive monitoring activities aimed at the nearshore and intertidal ecosystems. There are some volunteer activities carried out under a former DFO Shorekeepers program, but these are not reported here.
4. The Aquatic Invasive Species monitoring effort is modest. This is a new program with new (but modest) funding for monitoring. A step-wise approach to surveys of intertidal and subtidal zones has been initiated.
5. The Climate Change/Greenhouse Gas program has most of its focus in the Open Ocean ecozone.
6. NEPTUNE Canada is the only program that will provide ongoing monitoring in the existing MPA at Endeavor Ridge. A new MPA at Bowie Seamount has recently been proclaimed. Additional work is required to develop monitoring requirements for MPAs and these are to be developed as a deliverables for the Health of the Oceans (HOTO) program. These may be quite costly for remote MPAs (Bowie Seamount and Endeavour Ridge). While some opportunities exist for monitoring information to be collected by partners at low cost to DFO, where other parties are funding the activities, DFO may have to be flexible in what gets monitored.
7. The Marine Environmental Quality monitoring program is very weak. Existing efforts are *ad hoc*. DFO mandate in some of this area is vague.
8. Animal health monitoring for wild populations is largely *ad hoc* and opportunistic. Sampling under NAAHP will be for listed diseases only.

Some issues that are not obvious from this table include:

- Spatial coverage – Lower Trophic Levels – water column. While Table 1 shows a distribution across ecozones, the zooplankton data for PNCIMA is almost all located at the north end of Vancouver Island, very close to the data sources for WCVI. We do not have sufficient data elsewhere in the PNCIMA areas to assess whether this is representative of PNCIMA as a whole.
- Higher Trophic Level – fish (all ecozones). Although we have many entries in the master table, there are very limited data on forage fish (sandlance, juvenile eulachon; juvenile herring). In our review of Ecologically Significant Species for the PNCIMA ecosystem overview, experts advised us that this was thought to be a critical ecosystem component, but there are no data to support or refute this.
- Higher Trophic Level – fish and Lower Trophic level-benthos (all ecozones). Although we have many entries in the master table, there are very limited data on fishes and shellfish that are not targeted in fisheries. These components are receiving increased attention through COSEWIC and the Species at Risk program.
- Higher Trophic Level – mammals (all ecozones). Systematic surveys for marine mammals other than seals, sea lions and resident killer whales are very limited. Especially little is known of marine mammal distribution during winter season.

6. Discussion- What are the next steps?

6.1 Making the best use of what we have

Many of the monitoring activities summarized in Table 1 are included in the annual State of the Ocean report (http://www.pac.dfo-mpo.gc.ca/sci/psarc/OSRs/Ocean_SSR_e.htm), but not all. These entries should be reviewed to ensure that they are fully exploited for their secondary purpose of contributing to the State of the Ocean reports. This will require a review of the scope of this report, which does not currently encompass some of these components (e.g. MEQ, AIS, Animal Health). It may be necessary to change the approach from voluntary to required contributions from Science program areas.

6.2 Work with others (especially OGDs) to identify appropriate contributions from their mandated activities

DFO's Ecosystem-Based Management/Integrated Management direction is part of a broader federal government program to address national and international treaty requirements (http://www.sdinfo.gc.ca/s1_e.cfm and http://www.sdinfo.gc.ca/s15_e.cfm). In program areas where DFO leads (sustainable development of the oceans) and other Federal Departments have programs that can contribute, we should enter into negotiations to secure their information. Much of this is already in place on an *ad hoc* or informal basis, but it would be wise to formalize this. Some potential areas include:

- Environment Canada - Canadian Wildlife Service. Status and trend in marine birds as indicators of ocean status. This is already in place in the Pacific Region with excellent results, but it is based on informal scientist-to-scientist arrangements and is therefore subject to disruption.
- Environment Canada – Environment Protection. Status and trends in coastal contaminants. This is area that has been the subject of much debate over mandate and responsibility for many years. We should put this difficult debate to one side and focus on identification of opportunities to improve State of the Ocean/Ecosystem Status and Trend reporting.
- Canadian Food Inspection Agency. Status and trends in shellfish contamination. CFIA maintains a vigorous program in monitoring of seafood products for their mandate to protect human health. The same data (or possibly aggregates of these data) could be used as a MEQ indicator for limited additional cost.

- Department of National Defence – Vessel Identification and Tracking. Canada has made substantial investments in this area for improved security. DFO should explore with DND the possibility of aggregates or summaries of these data for use as an indicator of status and trends of marine transportation activity. This could likely be accomplished without jeopardizing the primary goal of improved security.

6.3 Exploiting opportunities to “fill in the gaps” with modest DFO investment

Where monitoring components carried out by others can be secured with modest investments from DFO, we should do this. Some examples might be:

- The North Pacific Continuous Plankton Recorder (CPR) Program. DFO has had the benefits of this program and incorporated it into State of the Ocean reporting without making any financial contribution. We have made modest “in kind” contributions. The program is at a stage where additional partners (like DFO) are now required to share some of the financial burden.
- While VENUS (particularly in the Strait of Georgia) and NEPTUNE (WCVI shelf, shelf break and Endeavour Ridge MPA) offer some “paid for” monitoring activities, additional work will be required to transform/manipulate the data to create useful ecosystem indicators. Given that VENUS/NEPTUNE has invested heavily in the infrastructure and data management component, a modest investment by DFO in data integration, analysis and interpretation could be very effective.

6.4 Work with internal clients who are developing new requirements to ensure that the implications for additional monitoring are considered

As program priorities and requirements evolve, there may be impacts on the requirements for monitoring. These may include some or all of the various “limiting resources” (ship time, staff time, staff expertise, capital equipment, O&M, laboratory space, laboratory equipment and data management systems). Additionally, new monitoring requirements involve new research to determine how monitoring should be done. To avoid conflict and client dissatisfaction, these requirements need to be identified and addressed early in the program planning process.

Where shortfalls exist, we need to consider the costs (see limiting resources above) and strategies to address these shortfalls. Not all the gaps are as “tractable” as others and new technologies, new funding sources and new partners may present opportunities to address the gaps.

6.5 Invest in new technologies to reduce the ongoing costs of monitoring or gain more (or better) data for the same investment

New technologies are one way in which costs for monitoring can be mitigated. DFO Science should periodically review options and should allocate some modest funding for evaluation of new technologies. Where research demonstrates that there are advantages, implementation plans are required to validate and “intercalibrate” between older and newer methodologies, ensuring a suitable period of measurement overlap and review before existing time series are terminated.

6.6 Evaluate monitoring program design and delivery to maximize cost effectiveness.

There are opportunities to reduce program costs while achieving essential levels of service. Pacific Region has already adjusted a number of programs consequent to the national Stock Assessment Review and the use-of-fish court decisions, including reduced frequency (e.g. every two or three years rather than annual surveys) or intensity (e.g. fewer dive surveys for herring spawn). Efforts have also been made to multi-task research surveys but more may be achievable here.

7. Recommendations

1. Review existing monitoring activities for use in the provision of scientific advice to resource managers, and in the Annual State of the Ocean report.
2. Work to ensure best use and integration of additional resources from external partners or through internal initiatives and programs (e.g. SARA, Invasive Species funding, etc.) toward delivery of the regional monitoring program.
3. Maintain an active research component for evaluation of technological advances that will improve monitoring program efficiency and effectiveness.
4. Continue to evaluate, and redesign monitoring programs as necessary, to provide essential levels of data and service. While essential levels of data and service have been developed for monitoring in support of harvest fisheries, these have not been developed for other aspects of ecosystem monitoring.
5. Complete the work in progress to identify key indicators. This may allow us to reduce some existing monitoring activities but a rigorous list of indicators is likely to increase the demand on the monitoring budget.

8. References:

DFO, 2006. Aquatic Monitoring in Canada. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2006/003.
http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2006/PRO2006_003_E.pdf

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<http://www.dfo-mpo.gc.ca/Library/224076.pdf>

Table 3: Monitoring Program matrix

Monitoring Program Elements to be addressed	Sub-elements	Strait of Georgia	WCVI (south of Brooks Peninsula; out to continental shelf edge)	PNCIMA (out to continental shelf edge)	Open Ocean
Physical/chemical environment	Winds, waves , currents, ice coverage/movement, temperature, salinity, oxygen , nutrients	1 a) Sea Level stations b) 7 Lighthouse stations c) 2 Ecological Buoys d) 3 Meteorological Buoys e) up to 400 SoG stations/yr f) Ocean Colour g) VENUS	2 a) Sea Level stations b) 4 Lighthouse stations c) 4 Meteorological Buoys d) >150 LaPerouse stations/yr e) 3 Line P/ Station P transects/yr f) Ocean Colour g) Neptune Canada h) Can-US hake survey (CTD, ADCP, O2) i) WCVI trawl survey CTD stations and Trawl Mounted CTD	3 a) Sea Level stations b) 5 Lighthouse stations c) 8 Meteorological Buoys d) >40 LaPerouse stations/yr f) Ocean Colour g) Neptune Canada h) Can-US hake survey (CTD, ADCP, O2) i) Hecate strait trawl survey, CTD stations and Trawl Mounted CTD	4 a) 3 Line P/ Station P transects /yr b) 3 Meteorological Buoys c) Sediment Traps d) Iron e) Drifting Buoys f) Ocean Colour g) Neptune Canada h) Can-US hake survey (CTD, ADCP, O2)
Greenhouse Gases	CO2, Alkalinity , C13, pCO2, pH, DOC, DMS, CFC's, SF6 and related measurements such as Iron and sediment traps	5	6	7	8 a) DIC, TA - 5 Line P profiles/yr b) pCO2 – 3 Line P transects/yr c) C13 – 3 Line P transects/yr d) DMS - 3 Line P Transects/yr underway sampling e) CFCs, SF6 - 3 Line P Transects/yr underway sampling f) pH - Ship of Opportunity underway sampling g) DOC – Ship of Opportunity underway sampling
Lower Trophic levels – water column	Abundance, distribution, composition of phytoplankton and zooplankton	9 a) 2-10 zooplankton stations/yr b) Sediment Traps c) Phytoplankton d) Ichthyoplankton survey e) Fraser River eulachon egg/larval survey	10 a) 25-30 zooplankton stations/yr b) Euphausiid population biology/productivity c) Can-US hake survey includes limited zooplankton sampling and distribution	11 a) 20-40 zooplankton stations/yr b) Can-US hake survey includes limited zooplankton sampling and distribution	12 a) 18 zooplankton stations/yr along Line P b) phytoplankton stations along Line P c) 4-6 CPR transects/yr North Pacific program d) Can-US hake survey includes limited zooplankton sampling and distribution
Lower Trophic levels - benthos	Abundance, distribution, composition of benthos	13 a) Shrimp survey time series Area 14, 15-16, 18, and 28 b) Crab survey Fraser river time series c) Seal Island clam survey d) Geoduck bed mapping and dive surveys e) Red urchin assessments f) Sea Cucumber dive surveys g) Prawn long-term study sites h) Green sea urchin surveys, Areas 18-20 (Gulf Islands) i) Intertidal clam surveys for depuration fishery	14 a) WCVI shrimp survey Areas 121-125 including Area 23. b) Abalone study sites in Barkley Snd c) Tofino crab studies d)Geoduck mapping and dive surveys e) Sea cucumber surveys f) Red urchin study sites	15 a) Red Urchin QCI study site b) Abalone index sites c) Shrimp survey QCS and PRD d) First nations clam surveys e) Aquaculture compliance monitoring f) Industry Sea Cucumber surveys g) Red urchin study sites assessments h) Geoduck bed mapping and dive surveys i) Green sea urchin surveys, Areas 11-13 (Queen Charlotte Strait) j) Razor clam assessment	16
Higher trophic levels fish	Abundance, distribution, age structure, biological condition factors	17 a) Lingcod dive, trawl and jig surveys b) Herring dive spawn survey/ biosample/test fishing charters c) Juvenile herring surveys d) Port sampling program e) Inshore rockfish hard bottom long-line survey f) Inshore rockfish Hard bottom jig surveys g) Hard bottom submersible survey h) Strait of Georgia Hake Biology i) SOG Dogfish Longline Survey	18 a) Sardine trawl survey b) Can/US Hake survey c) Herring dive spawn survey/ biosample/test fishing charters d) WCVI Multi-species Bottom trawl survey e) Sablefish Trap Survey f) Port sampling program g) At Sea Observer Program h) IPHC Coastwide fixed station longline Halibut survey i) Hard bottom longline rockfish survey j) WCVI Sardine Trawl Survey	19 a) Can/US Hake survey b) Herring dive spawn survey/ biosample/test fishing charters c) QCS trawl survey d) Hecate Strait Trawl Survey e) WCQCI Multi-species Bottom trawl survey f) Sablefish Trap Survey g) Port sampling program h) At Sea Observer Program i) Coastwide fixed station longline Halibut survey j) Hard bottom longline rockfish survey k) Submersible survey conducted in the Queen Charlotte Islands.	20 a) Deep water Ecosystem trawl survey. b) Can/US Hake survey c) WCVI Multi-species Bottom trawl survey d) QCS trawl survey e) WCQCI Multi-species Bottom trawl survey f) Sablefish Trap Survey g) Port sampling programs h) At Sea Observer Program i) Coastwide fixed station longline Halibut survey j) Hard bottom longline rockfish survey
Upper trophic Levels – Marine Mammals	Abundance, distribution, age structure, biological condition factor, consumption	21 a) Seal Assessment b)Sea lion Assessment c) Killer Whale assessment	22 a) Sea Otter population surveys b) Seal Assessment c) Sea Lion Assessment d) General cetacean surveys	23 a) Sea otter population surveys b) Seal Assessment c) Sea Lion Assessment d) General cetacean and killer Whale surveys	24 a) General Cetacean surveys
Aquatic Invasive Species	Detection, distribution, abundance of invasives	25 a) Sub-tidal survey	26 a) Intertidal surveys	27 a) Intertidal surveys	28
Aquatic Animal Health	Diseases, parasites – distribution and abundance	29 a) Pacific oyster & Manila clam NAAHP listed pathogen survey (with CFIA) -Fish Health Protection Regulations disease assessments -Directed research on various pathogens (viruses, protozoa, sea lice) -Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)	30 a) Pacific oyster & Manila clam NAAHP listed pathogen survey (with CFIA) -Fish Health Protection Regulations disease assessments -Directed research on various pathogens (viruses, protozoa, sea lice) -Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)	31 a) Pacific oyster & Manila clam NAAHP listed pathogen survey (with CFIA) -Fish Health Protection Regulations disease assessments -Directed research on various pathogens (viruses, protozoa, sea lice) -Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)	32 a) Sporadic opportunistic sampling in conjunction with DFO stock surveys
Marine Environmental Quality	Contaminants in sediments, biota and the water column	33 a) Marine Mammal Contamination b) TEQ, TDI closures c) Sediment contamination	34	35 a) Aquaculture Impacts	36
Marine Protected Area Monitoring		37	38	39	40 a) Neptune Canada Endeavour Ridge b) Submersible survey conducted at Bowie Seamount

APPENDIX A

1: Physical and Chemical Environment - Strait of Georgia

a) Monitoring sub-element:

Permanent Water Level Network/Tsunami Warning System (PWLN/TWS) Water Level Recorders

07120 Victoria Harbour	48 25.5N 123 22.3W
07277 Patricia Bay	48 39.2N 123 27.1W
07654 New Westminster	49 12.0N 122 54.6W
07735 Vancouver Harbour	49 17.2N 123 06.6W
07795 Point Atkinson	49 20.3N 123 15.2W
08074 Campbell River	50 02.5N 125 14.8W
08408 Port Hardy	50 43.3N 127 29.3W
08545 Bamfield	48 50.2N 125 08.2W
08575 Port Alberni	49 14.0N 124 48.8W
08615 Tofino	49 09.2N 125 54.8W
08735 Winter Harbour	50 30.8N 128 01.7W
08976 Bella Bella	52 09.8N 128 08.6W
09354 Prince Rupert	54 19.0N 130 19.4W
09850 Queen Charlotte City	53 15.1N 132 04.3W
09958 Henslung Cove	54 11.5N 133 00.2W

Years of Data:

07120	1909 to present
07277	1976 to present
07654	1969 to present
07735	1909 to present
07795	1914 to present
08074	1965 to present
08408	1964 to present
08545	1969 to present
08575	1970 to present
08615	1909 to present
08735	1989 to present
08976	1961 to present
09354	1909 to present
09850	1964 to present
09958	2006 to present

Frequency:

Hourly pre 1997
1 minute 1997 to present

Web site (if any):

<http://www-sci.pac.dfo-mpo.gc.ca/Charts/>

Recent Publication:

Detailed Program Description:

1 minute water level data

Program Linkages:

Stations jointly maintained by Canadian Hydrographic Service/Department of Fisheries and Oceans (CHS/DFO) and Environment Canada (EC).

On-going source of water level data for CHS, The Global Ocean Sea Level Observing System (GLOSS), the Provincial Emergency Program (PEP), the International Tsunami Information Center (ITIC), Pacific Tsunami Warning Center (PTWC), West Coast and Alaska Tsunami Warning Center (WCATWC), DFO, EC, fisheries and Coastguard operations.

Arctic/Atlantic/Pacific Equivalents:

Similar Central and Arctic, Quebec and Atlantic Region CHS offices

Monitoring Utility:

Useful for detection of storm surges/tsunami's and long term sea level changes.

Protocols and Standards:

GLOSS standard data

Data Management:

Data processed and archived at Institute of Ocean Sciences, Sidney, B.C. (IOS) and Integrated Science Data Management (ISDM) in Ottawa, On:

http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Home_e.htm

Challenges:

Requires twice annual service visits, with more occasional added visits as required to ensure data continuity

Options for Program Delivery:

None

1: Physical and Chemical Environment - Strait of Georgia

b) Monitoring sub-element :

Temperature and salinity at shore stations:	
Cape Mudge	1936-1984
Chrome Island	1961-present
Entrance Island	1936-present
ActivePass	1967-present
Departure Bay	1914-present (Beamish Gap of 1983-1987)
Race Rocks	1921-present
Sisters Island	1968-2005

Years of Data:

See above.

Frequency:

Daily at daylight high tide.

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/SearchTools/Searchlighthouse_e.htm

Recent Publication:

Detailed Program Description:

Measurements by lighthouse keepers or other locals.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Maritimes Coastal Shallow Water Temperature Program

Monitoring Utility:

These measurements form the longest oceanographic time series in the eastern Pacific Ocean North off Scripps Inst in San Diego.

Protocols and Standards:

Digital thermometer, and hydrometer for salinity. Early measurements used salinity bottle samples, which were discontinued to save money.

Data Management:

Data processed and archived at IOS.

Challenges:

We lose stations when the Canadian Coast Guard removes lighthouse keepers from stations. Sisters Island was lost for this reason. We require an automated method to measure salinity should this happen.

Options for Program Delivery:

Develop robust automated systems

1: Physical and Chemical Environment - Strait of Georgia – Details

c) Monitoring sub-element :

EC/DFO weather buoys with added “Ecobuoy” instrument package
46146 Halibut Bank 49.33N 123.73W
46134 Saanich Inlet 48.65N 123 49W

Years of Data:

46146 2000 to 2005
46134 1999 to present

Frequency:

Hourly

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/ecobuoys/default_e.htm#

Recent Publication:

Detailed Program Description:

Hourly chlorophyll, temperature and salinity at two depths (1 m and 8 m)
Hourly water optical properties, PAR in air

Program Linkages:

Used for spring bloom timing and other bloom and productivity studies
Has been used for satellite calibration and image interpretation

Arctic/Atlantic/Pacific Equivalents:

Similar Gulf of St Lawrence (IML) buoys

Monitoring Utility:

Useful for detection of phytoplankton daily to interannual variations

Protocols and Standards:

In house

Data Management:

Data processed and archived at IOS.

Challenges:

Requires regular servicing, about once per month
System at 46146 recently cancelled
Supported by externally funded (Canadian Space Agency) research program

Options for Program Delivery:

None

1: Physical and Chemical Environment - Strait of Georgia – Details

d) Monitoring sub-element :

EC/DFO weather buoys
46131 Sentry Shoal 49.90N 124.98W
46146 Halibut Bank 49.33N 123.73W
46134 Saanich Inlet 48.65N 123 49W

Years of Data:

46131 1993 to present
46146 1992 to present
46134 1999 to present

Frequency:

Hourly

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/ecobuoys/default_e.htm#

Recent Publication:

Detailed Program Description:

Hourly surface wind, wave and SST data

Program Linkages:

Jointly funded by Env. Canada and DFO
On-going source of weather data for EC, fisheries and Coastguard operations
Has been used for satellite calibration and image interpretation
Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar east-coast buoys

Monitoring Utility:

Useful for detection of interannual and decadal changes.

Protocols and Standards:

EC standard met data

Data Management:

Data processed and archived at IOS and MEDS.

Challenges:

Requires annual service cruise, with more occasional added visits as required to ensure data continuity

Options for Program Delivery:

None

1: Physical and Chemical Environment - Strait of Georgia

e) Monitoring sub-element :

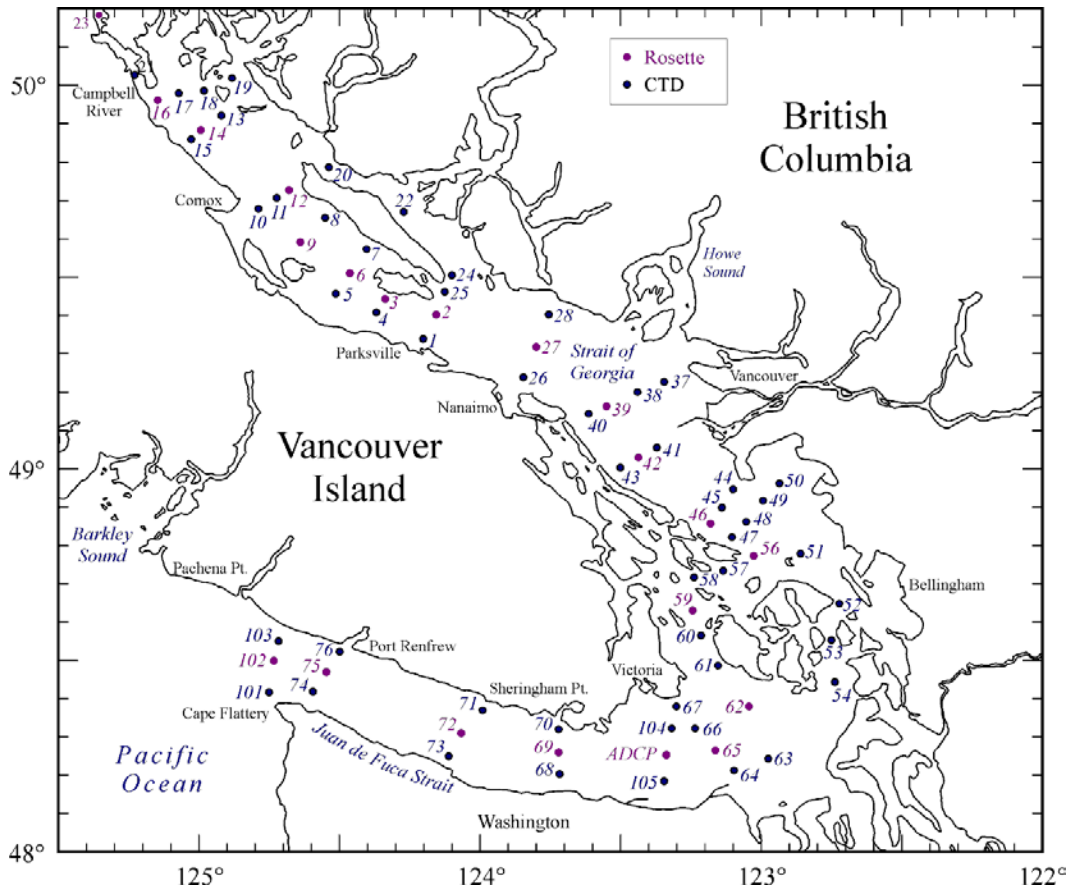
Water property surveys in the Strait of Georgia and Juan de Fuca Strait

Years of Data:

1999 - present

Frequency:

4x per year (April; June/July; Aug/September; December/January)



Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/straitofgeorgia/default_e.htm

Recent Publication:

Masson, D., 2006. Seasonal water mass analysis for the Straits of Juan de Fuca and Georgia, *Atmosphere-Ocean*, 44 (1), 1-15.

Detailed Program Description:

Physical, biological, biogeochemical sections ...

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

AZMP transects

Monitoring Utility:

Useful for detection of spring bloom, deep water renewal events as well as interannual and decadal changes.

Protocols and Standards:

WOCE standard for physical chemical parameters

Data Management:

Data processed and archived at IOS.

Challenges:

Each year, organizing and executing 4 seasonal cruises of about 5 days on a small budget and minimal technical support.

Options for Program Delivery:

1: Physical and Chemical Environment - Strait of Georgia – Details

f) Monitoring sub-element :

SeaWiFS, MODIS, MERIS ocean colour satellite imagery

Years of Data:

SeaWiFS 1997 to 2004

MODIS 1999 to present

MERIS 2002 to present

Frequency:

Daily

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/satelliteimages/Default_e.htm

Recent Publication:

Philip W. Boyd, Robert Strzepek, Shigenobu Takeda, George Jackson, C.S. Wong, R. Mike McKay, Cliff Law, Hiroshi Kiyosawa, Hiroaki Saito, Nelson Sherry, Keith Johnson, Jim Gower and Neelam Ramaiah, "The evolution and termination of an iron-induced mesoscale bloom in the northeast subarctic Pacific," *Limnology and Oceanography*, Volume 50, 1872-1886, 2005

Detailed Program Description:

Satellite ocean colour images have been widely used in DFO for physical, biological and fisheries management studies

Program Linkages:

Important source of data for Ecosystem-Based Management

Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar data use at IML and BIO

Monitoring Utility:

Only source of uniform, large-area chlorophyll-*a* and productivity coverage

Important source of data for Ecosystem-Based Management

Useful for detection of interannual and decadal changes.

Protocols and Standards:

Standard processing and archive maintained by NASA

Data Management:

Some data processed and archived at IOS, IML, BIO.

Challenges:

Requires some specialized knowledge and experience.

Relies on external funding

Options for Program Delivery:

None

1: Physical and Chemical Environment - Strait of Georgia – Details

g) Monitoring sub-element :

VENUS

Years of Data:

2006 to Present

Frequency:

Real-time or Near Real Time

Web site (if any):

<http://www.venus.uvic.ca/>

Recent Publication:

Detailed Program Description:

A cabled ocean observatory designed as an undersea laboratory for ocean researchers.

Program Linkages:

Many. Data is freely available to researchers and the public

Arctic/Atlantic/Pacific Equivalents:

NEPTUNE

Monitoring Utility:

Continuous, real-time data transmission from reconfigurable 'nodes' on the ocean floor and/or moorings

Protocols and Standards:

See website

Data Management:

Data processed and archived at UVic

Challenges:

Options for Program Delivery:

2: Physical/chemical environment - WCVI (south of Brooks Peninsula; out to continental shelf edge)

a) Monitoring sub-element

Permanent Water Level Network/Tsunami Warning System (PWLN/TWS) Water Level Recorders

See Monitoring sub-element 1A for details.

2: Physical and Chemical Environment - West Coast Vancouver Island – Details

b) Monitoring sub-element :

Temperature and salinity at shore stations:

Amphitrite Point 1934-present

Cape Beale 1971-1998

Kains Island 1935-present

Nootka Point 1934-1953, 1987-present

Years of Data:

See above.

Frequency:

Daily at daylight high tide.

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/SearchTools/Searchlighthouse_e.htm

Recent Publication:

Detailed Program Description:

Measurements by lighthouse keepers or other locals.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Maritimes Coastal shallow water temperature program

Monitoring Utility:

These measurements form the longest oceanographic time series in the eastern Pacific Ocean North of Scripps Inst in San Diego.

Protocols and Standards:

Digital thermometer, and hydrometer for salinity. Early measurements used salinity bottle samples, which were discontinued to save money.

Data Management:

Data processed and archived at IOS.

Challenges:

We lose stations when the Canadian Coast Guard removes lighthouse keepers from stations. Sisters Island was lost for this reason. We require an automated method to measure salinity should this happen.

Options for Program Delivery:

Develop robust automated system

2: Physical and Chemical Environment - WCVI – Details

c) Monitoring sub-element :

EC/DFO weather buoys

46132 South Brooks 49.732N 127.923W

46206 La Perouse Bank 48.835N 126.0 W

Years of Data:

46132, 1994 to present

46206, 1989 to present

Frequency:

Hourly

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/ecobuoys/default_e.htm#

Recent Publication:

Detailed Program Description:

Hourly surface wind, wave and SST data

Program Linkages:

Jointly funded by DFO and Environment Canada.

On-going source of weather data for EC, fisheries and Coastguard operations.

Has been used for satellite calibration and image interpretation.

Used in climate studies.

Arctic/Atlantic/Pacific Equivalents:

Similar east-coast buoys

Monitoring Utility:

Useful for detection of interannual and decadal changes.

Protocols and Standards:

EC standard met data

Data Management:

Data processed and archived at IOS and MEDS.

Challenges:

Requires annual service cruise, with more occasional added visits as required to ensure data continuity

Options for Program Delivery:

None

2: Physical and Chemical Environment - WCVI Circulation and Water Properties

d) Monitoring sub-element :

West coast of Vancouver Island from Brooks Peninsula to Central Juan de Fuca

Strait and out to the seaward edge of the continental slope. Shipboard CTD surveys off the west coast together with current meter moorings at selected sites that are representative of major circulation features, including the Vancouver Island Coastal Current, the seasonally varying Shelf-break Current, the California Undercurrent, and the Juan de Fuca Eddy.

Years of Data:

1985 – present (with major gaps)

Frequency:

Water property recording at 30 minute intervals. Also, 2x cruises per year (May and October); additional CTD surveys by PBS fishery biologists.

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/SearchTools/SearchProfiles_e.asp

Recent Publication:

Thomson, R. E., S. F. Mihály, and E. A. Kulikov (2007), Estuarine versus transient flow regimes in Juan de Fuca Strait, *J. Geophys. Res.*, 112, C09022, doi:10.1029/2006JC003925

Detailed Program Description:

Physical and chemical sections; long-term current meter moorings at selected sites.

Program Linkages:

ECOHAB-PNW in conjunction with NOAA and University of Washington;

Late-run sockeye salmon return study in conjunction with the Pacific Salmon Commission, University of BC, and SFU.

Operational Oceanography program in conjunction with DND and the Provincial Ministry of the Environment. Was a major focus for Canada GLOBEC and Covariability Program.

Arctic/Atlantic/Pacific Equivalents:

AZMP transects

Monitoring Utility:

Maintenance of a 20 year time series of in situ temperature, salinity and currents for the west coast of Vancouver Island.

Provision of realtime data for determining the in-migration timing of Late-run sockeye salmon; provision of near realtime and calibration/verification data for the DFO/DND/MOE Operational Oceanography program (northeast Pacific circulation and upper ocean properties; storm surge prediction and long-term sea level rise); detection of changes in seasonal to decadal variability in coastal circulation and water property structure, deepwater renewal in the Strait of Georgia, harmful algal blooms at the entrance to Juan de Fuca Strait, and late-run sockeye salmon return behaviour, and their relationship to meteorological and buoyancy forcing.

Protocols and Standards:

WOCE standard for physical chemical parameters

Data Management:

Data processed and archived at IOS. Loaded into MEDS.

Challenges:

High cost of ship time

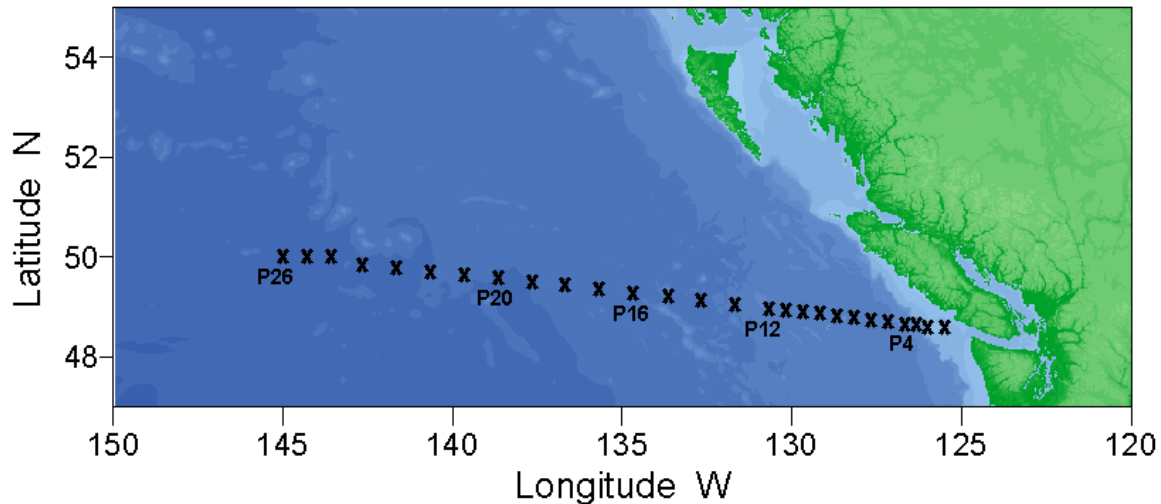
Options for Program Delivery:

The southern mooring could be replaced by NEPTUNE Barkley Canyon profiler but there is no guarantee that this is going to work or be reliable. There is no replacement for the Estevan Point mooring which is monitoring the VICC.

2: Physical and Chemical Environment - West Coast Vancouver Island – Details

e) Monitoring sub-element :

Line P: Stations P1, P2, P3, P4 are on the continental shelf of the West Coast of Vancouver Island

**Years of Data:**

1954 - present

Frequency:

3 times per year (May/June; August/September; February)

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/linep/linepselectdata_e.htm

Recent Publication:

http://www.pices.int/meetings/international_symposia/2006_symposia/Line-P/publication.aspx (Line P special issue of Progress in Oceanography is in preparation, due to be published in late 2007). About 100 other papers in past 50 years

Detailed Program Description:

Physical/Chemical:

CTD data (discrete): Temperature, Conductivity (Salinity), Transmissivity, Fluorescence, Dissolved Oxygen, Photosynthetic Available Radiation (PAR).

Underway surface data (continuous): Temperature, Conductivity (Salinity), Fluorescence

Water samples (discrete): Salinity, Dissolved Oxygen, Nutrients (Nitrate, Phosphate, Silicate), Chlorophyll, DIC, Alkalinity, C13, DMS.

Program Linkages:

A Canadian contribution to the Global Climate Observing System

Was a major focus for C-SOLAS (SERIES Experiment 2002) and Canada GLOBEC in 1990s

Arctic/Atlantic/Pacific Equivalents:

Labrador Sea line

Monitoring Utility:

With fifty years of observations of all significant ocean properties along 1500 km and samples to ocean bottom, this is Canada's best ocean climate time series, and one of the three best in the world. It is also needed for detection of interannual and decadal changes. It provides the "vehicle" to get to mooring sites for continuous measurements (mooring recovery and deployment).

Protocols and Standards:

WOCE standard for physical and chemical parameters

Data Management:

Data processed and archived at IOS. Loaded into BIOCHEM at MEDS.

Data are also available on website mentioned above.

Challenges:

Each cruise requires 14- 20 days of ship time; The recent decline in PERD funding ended the long time series for sediment trap data. Reduction in seagoing DFO staff is another problem.

Options for Program Delivery:

Hard to imagine this one!

2: Physical and Chemical Environment - West Coast Vancouver Island – Details

f) Monitoring sub-element :

SeaWiFS, MODIS, MERIS ocean colour satellite imagery

Years of Data:

SeaWiFS 1997 to 2004

MODIS 1999 to present

MERIS 2002 to present

Frequency:

Daily

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/satelliteimages/Default_e.htm

Recent Publication:

Philip W. Boyd, Robert Strzepek, Shigenobu Takeda, George Jackson, C.S. Wong, R. Mike McKay, Cliff Law, Hiroshi Kiyosawa, Hiroaki Saito, Nelson Sherry, Keith Johnson, Jim Gower and Neelam Ramaiah, "The evolution and termination of an iron-induced mesoscale bloom in the northeast subarctic Pacific," Limnology and Oceanography, Volume 50, 1872-1886, 2005

Detailed Program Description:

Satellite ocean colour images have been widely used in DFO for physical, biological and fisheries management studies

Program Linkages:

Important source of data for Ecosystem-Based Management

Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar data use at IML and BIO

Monitoring Utility:

Only source of uniform, large-area chlorophyll-*a* and productivity coverage

Important source of data for Ecosystem-Based Management

Useful for detection of interannual and decadal changes.

Protocols and Standards:

Standard processing and archive maintained by NASA

Data Management:

Some data processed and archived at IOS, IML, BIO.

Challenges:

Requires some specialized knowledge and experience.

Relies on others for major capital investment in launch and data management.

Program activity is largely supported by external funds (Canadian Space Agency)

Options for Program Delivery:

None

2: Physical and Chemical Environment - West Coast Vancouver Island – Details

g) Monitoring sub-element :

NEPTUNE Canada monitoring sites in the northeast Pacific.

Years of Data:

NA- scheduled to begin late 2008.

Frequency:

Continuous at approximately 1 Hz

Web site (if any):

Google “Neptune Canada”

Recent Publication:

NA. Instruments not in the water.

Detailed Program Description:

Cabled observatory network in the northeast Pacific extending across the southern Vancouver Island continental shelf and slope. Major Junction Boxes are to be installed at the following West Coast sites: (1) Folger Passage, Barkley Sound (currents, T&S, pressure, ADCPs,...); (2) bottom sensor packages (including upward looking ADCPs and bottom pressure recorders) and a CTD/bioacoustics Profiler to be deployed several kilometers northwest of Barkley Canyon in 400 m of water; and (3) continental slope site ODP889 to be equipped with T&S, bottom pressure and current meters.

Program Linkages:

See (a) above. Also linked to the NOAA DART system for detection and study of tsunamis in the northeast Pacific.

Atlantic/Pacific Equivalents:

Memorial University has a shallow cabled site similar to the VENUS site in Saanich Inlet.

Monitoring Utility:

Near-realtime oceanographic data available on the NEPTUNE Canada website.

Protocols and Standards:

To be established by the University of Victoria

Data Management:

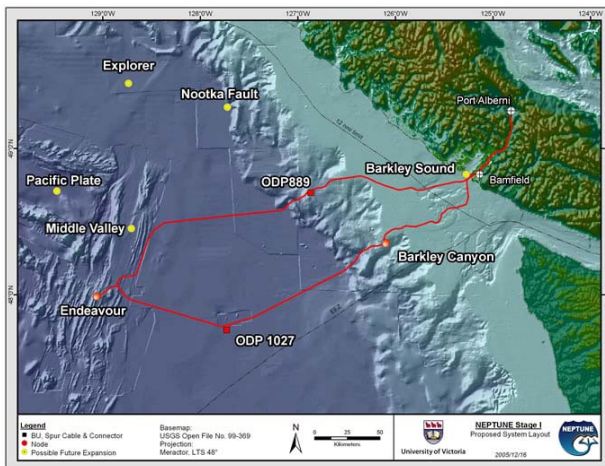
Data processed and archived by NEPTUNE Canada at the University of Victoria.

Challenges:

This is a new cabled observatory network and is likely to encounter numerous start up problems; profiler may have a limited operational life due to the harsh environment and damage from commercial fisheries. Canadian and US Navies have option to shut down data flow for national security reasons.

Options for Program Delivery:

No other options.



2: Physical/chemical environment – WCVI (south of Brooks Peninsula; out to continental shelf edge)

h) Monitoring sub-element

Can/US Hake Survey

See Monitoring sub-element 14E for details.

2: Physical/chemical environment – WCVI (south of Brooks Peninsula; out to continental shelf edge)

i) Monitoring sub-element 2B:

West coast Vancouver Island Multi-species Bottom Trawl Survey

Years of Data:

2004, 2006

Frequency:

Once every two years

Web site (if any):

Recent Publication:

Detailed Program Description:

This multi-species bottom trawl survey includes two oceanographic components, 1) completion of CTD casts at established locations that are part of a 20+ year time series (LaPerouse Stations)
2) in addition a CTD is deployed on the head rope of the trawl for every tow providing high resolution water properties data associated observed fish distributions, diversity and density.

Program Linkages:

Oceanographic data is used by the ocean sciences group at IOS as well as staff at PBS

Arctic/Atlantic/Pacific Equivalents:

Grand Banks multi-species bottom trawl survey also employs a CTD for each bottom trawl tow.

Monitoring Utility:

Monitor changes in water properties off the west coast of Vancouver Island, once every two years
Observer changes in fish abundance/distribution relative to oceanographic conditions

Protocols and Standards:

CTD casts are performed according to IOS standard procedures. Reference water samples are collected.

Data Management:

CTD data processed by Staff at IOS and uploaded to regional data archive.

Challenges:

Overall one additional person needs to be taken to perform the CTD casts at night and download the Trawl Mounted CTD.

Options for Program Delivery:

None

3: Physical/chemical environment – PNCIMA - Details

a) Monitoring sub-element

Permanent Water Level Network/Tsunami Warning System (PWLN/TWS) Water Level Recorders

See Monitoring sub-element 1A for details.

3: Physical and Chemical Environment - PNCIMA – Details

b) Monitoring sub-element :

Temperature and salinity at shore stations:
Egg Island 1970-present
Cape St. James 1934-1992
Langara Island 1936-present
McInnes Island 1954-present
Pine Island 1937-present

Years of Data:

See above.

Frequency:

Daily at daylight high tide.

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/SearchTools/Searchlighthouse_e.htm

Recent Publication:

Detailed Program Description:

Measurements by lighthouse keepers or other locals.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Maritimes Coastal Shallow Water Temperature Program

Monitoring Utility:

These measurements form the longest oceanographic time series in the eastern Pacific Ocean North of Scripps Inst in San Diego.

Protocols and Standards:

Digital thermometer, and hydrometer for salinity. Early measurements used salinity bottle samples, which were discontinued to save money.

Data Management:

Data processed and archived at IOS.

Challenges:

We lose stations when the Canadian Coast Guard removes lighthouse keepers from stations. Sisters Island was lost for this reason. We require an automated method to measure salinity should this happen.

Options for Program Delivery:

Develop robust automated system

3: Physical and Chemical Environment - PNCIMA – Details

c) Monitoring sub-element :

EC/DFO weather buoys
46205 East Dixon Entrance 54.17N 134.29W
46208 West Moresby 52.52N 132.69W
46147 South Moresby 51.822N 131.22W
46207 East Dellwood Knolls 50.88N 129.925W
46145 Central Dixon Entrance 54.383N 132.427W
46183 North Hecate 53.617N 131.105W
46185 South Hecate, 52.410N 129.785W
46204 West Sea Otter 51.37N 128.75W

Years of Data:

46205, 1989 to present
46208, 1991 to present
46147, 1994 to present
46207, 1990 to present
46145, 1992 to present
46183, 1992 to present
46185, 1991 to present
46204, 1990 to present

Frequency:

Hourly

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/ecobuoys/default_e.htm#

Recent Publication:

Detailed Program Description:

Hourly surface wind, wave and SST data

Program Linkages:

Funded through agreement between DFO and Env. Canada
On-going source of weather data for EC, fisheries and Coastguard operations
Has been used for satellite calibration and image interpretation
Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar east-coast buoys

Monitoring Utility:

Useful for detection of interannual and decadal changes.

Protocols and Standards:

EC standard met data

Data Management:

Data processed and archived at IOS and MEDS.

Challenges:

Requires annual service cruise, with more occasional added visits as required to ensure data continuity

Options for Program Delivery:

None

3: Physical and Chemical Environment - PNCIMA – Details

f) Monitoring sub-element :

SeaWiFS, MODIS, MERIS ocean colour satellite imagery

Years of Data:

SeaWiFS 1997 to 2004

MODIS 1999 to present

MERIS 2002 to present

Frequency:

Daily

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/satelliteimages/Default_e.htm

Recent Publication:

Perry, R.I., W.R. Crawford, A. Sinclair: Chapter 1, Ecosystem Description, *Pacific North Coast Integrated Management Ecosystem, Ecosystem Overview and Assessment Report*, Vol. 1, Fisheries and Oceans Canada, Pacific Region, 52 p.

Detailed Program Description:

Satellite ocean colour images have been widely used in DFO for physical, biological and fisheries management studies

Program Linkages:

Important source of data for Ecosystem-Based Management

Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar data use at IML and BIO

Monitoring Utility:

Only source of uniform, large-area chlorophyll-*a* and productivity coverage

Important source of data for Ecosystem-Based Management

Useful for detection of interannual and decadal changes.

Protocols and Standards:

Standard processing and archive maintained by NASA

Data Management:

Some data processed and archived at IOS, IML, BIO.

Challenges:

Requires some specialized knowledge and experience.

Relies on others for major capital investment in launch and data management.

Options for Program Delivery:

None

3: Physical/chemical environment - WCVI (south of Brooks Peninsula; out to continental shelf edge)

h) Monitoring sub-element

Can/US Hake Survey

See Monitoring sub-element 18E for details.

3: Physical/chemical environment - WCVI (south of Brooks Peninsula; out to continental shelf edge)

i) Monitoring sub-element

Hecate Strait Multi-species Bottom Trawl Survey

Years of Data:

1984, 1985, 1987, 1989, 1991, 1993, 1995, 1996, 1998, 2000, 2002, 2003, 2005

Frequency:

Once every two years, approximately.

Web site (if any):

Recent Publication:

Detailed Program Description:

Historically this survey has conducted a CTD cast after every bottom trawl tow, commencing in 2003 a new oceanographic sampling program was instituted and in 2007 the following protocol will be followed.

1) completion of CTD casts at established locations that are part of a long standing time series (Hecate Strait Stations)

2) in addition a CTD is deployed on the head rope of the trawl for every tow providing high resolution water properties data associated observed fish distributions, diversity and density.

Program Linkages:

Oceanographic data is used by the ocean sciences group at IOS as well as staff at PBS

Arctic/Atlantic/Pacific Equivalents:

Grand Banks survey also employs a CTD for each bottom trawl tow.

Monitoring Utility:

Monitor changes in water properties in Hecate Strait and Dixon Entrance once every two years.

Observer changes in fish abundance/distribution relative to oceanographic conditions

Protocols and Standards:

CTD casts are performed according to IOS standard procedures. Reference water samples are collected.

Data Management:

CTD data processed by Staff at IOS and uploaded to regional data archive.

Challenges:

Overall one additional person needs to be taken to perform the CTD casts at night and download the Trawl Mounted CTD.

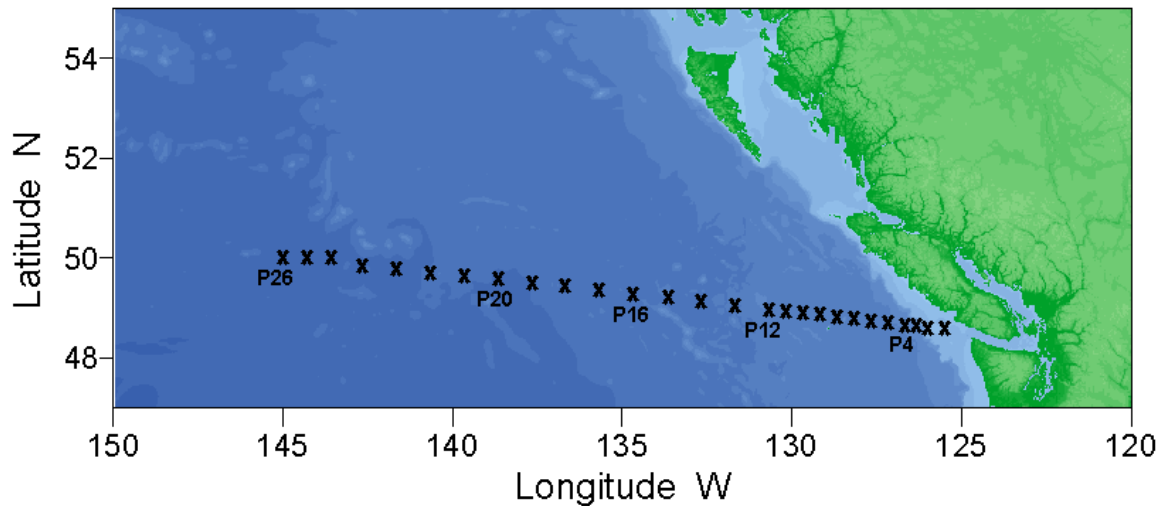
Options for Program Delivery:

None

4: Physical and Chemical Environment - Open Ocean – Details

a) Monitoring sub-element :

Line P and Ocean Station Papa



Years of Data:

1954 - present

Frequency:

3 times per year (May/June; August/September; February)

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/osap/data/linep/linepselectdata_e.htm

Recent Publication:

http://www.pices.int/meetings/international_symposia/2006_symposia/Line-P/publication.aspx (Line P special issue of Progress in Oceanography is in preparation, due to be published in late 2007). About 100 other papers in past 50 years

Detailed Program Description:

Physical/Chemical:

CTD data (discrete): Temperature, Conductivity (Salinity), Transmissivity, Fluorescence, Dissolved Oxygen, Photosynthetic Available Radiation (PAR).

Underway surface data (continuous): Temperature, Conductivity (Salinity), Fluorescence

Water samples: (discrete): Salinity, Dissolved Oxygen, Nutrients (Nitrate, Phosphate, Silicate), Chlorophyll, DIC, Alkalinity, C13, DMS.

Program Linkages:

A Canadian contribution to the Global Climate Observing System

Was a major focus for C-SOLAS (SERIES Experiment 2002) and Canada GLOBEC in 1990s

Arctic/Atlantic/Pacific Equivalents:

Labrador Sea line

Monitoring Utility:

With fifty years of observations of all significant ocean properties along 1500 km and samples to ocean bottom, this is Canada's best ocean climate time series, and one of the three best in the world. It is also needed for detection of interannual and decadal changes. It provides the "vehicle" to get to mooring sites for continuous measurements (mooring recovery and deployment).

Protocols and Standards:

WOCE standard for physical and chemical parameters

Data Management:

Data processed and archived at IOS. Loaded into BIOCHEM at MEDS.

Data are also available on website mentioned above.

Challenges:

Each cruise requires 14- 20 days of ship time; The recent decline in PERD funding ended the long time series for sediment trap data. Reduction in seagoing DFO staff is another problem.

Options for Program Delivery:

Hard to imagine this one!

4: Physical and Chemical Environment - Open Ocean – Details

b) Monitoring sub-element :

EC/DFO weather buoys
46184 North Nomad 53.933 N, 138.803W,
46004 Middle Nomad 50.938N 135.865W,
46036 South Nomad 48.297N 133.865W

Years of Data:

46184 1988 to present
46004 1980 to present
46036 1988 to present

Frequency:

Hourly

Web site (if any):

http://www-sci.pac.dfo-mpo.gc.ca/ecobuoys/default_e.htm#

Recent Publication:

Detailed Program Description:

Hourly surface wind, wave and SST data

Program Linkages:

Funded through agreement between DFO and Env. Canada
On-going source of weather data for EC, fisheries and Coastguard operations
Has been used for satellite calibration and image interpretation
Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar east-coast buoys

Monitoring Utility:

Useful for detection of interannual and decadal changes.

Protocols and Standards:

EC standard met data

Data Management:

Data processed and archived at IOS and MEDS.

Challenges:

Requires annual service cruise, with more occasional added visits as required to ensure data continuity

Options for Program Delivery:

None

4: Physical and Chemical Environment - Open Ocean – Chemistry

c) Monitoring sub-element :

SEDIMENT TRAP FLUXES

Years of Data:

OSP: 1982-2006

P04: 1986-2006

Frequency:

Deployed and recovered once per year with sampling over the entire year via 21 sequential cup sampler. Up to 30 minute sampling rate.

Web sites:

Recent Publications:

1. Seasonal and spatial variability in particle flux to the interior of the North Pacific Ocean. D.A. Timothy¹, C.S. Wong², F.A. Whitney², Janet Barwell-Clarke², John Page² and Linda White² in preparation. Wong, C.S., Waser, N.A.D., Whitney, F.A., Johnson, W.K. and Page, J.S., 2002a. Time-series study of the biogeochemistry of the North East subarctic Pacific: reconciliation of the C_{org}/N remineralization and uptake ratios with Redfield ratios. *Deep-Sea Research II*, 49: 5717-5738.
2. Wong CS, Whitney FA, Crawford DW, Iseki K, Matear RJ, Johnson WK, Page JS, Timothy D. Seasonal and interannual variability in particle fluxes of carbon, nitrogen and silicon from time series of sediment traps at Ocean Station P, 1982-1993: relationship to changes in subarctic primary productivity. *Deep-Sea Research II* 1999;46:2735-2760.
3. Wong C.S.; Waser N.A.D.; Whitney F.A.; Johnson W.K.; Page J.S. 2002, Time-series study of the biogeochemistry of the North East subarctic Pacific: reconciliation of the C_{org}/N remineralization and uptake ratios with the Redfield ratios, *Deep-Sea Res. II*, , Volume 49(24) 5717-5738(22)
4. Denman KL, Voelker C, Pena MA, Rivkin RB. Modelling the ecosystem response to iron fertilization in the subarctic NE Pacific: The influence of grazing, and Si and N cycling on CO₂, *Deep-Sea Res.* In press.
5. Manuscript in preparation with David Timothy as main scientist.

Detailed Program Description:

Conical Parflux sediment traps with sequential sampling bottles from Maclean Research (Honjo Mark VII) with 21 sampling cups. The traps are pre-programmed prior to deployment so that each cup collects sedimenting particles for approximately 2+ weeks. Parameters measured include fluxes of total dry weight, BSi, POC, CaCO₃ and organic nitrogen as well as some trace metals on select deployments. Sample identification is also undertaken to determine composition. Requests for sample portions have come from California state universities and Caltec

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Station BATS in the Sargasso Sea, and Station ALOHA in the subtropical North Pacific Ocean

Monitoring Utility:

Very important for determination of carbon sequestration in the deep ocean.

Protocols and Standards:

Compliant with internationally accepted methods.

Data Management:

Data entered into IOS archive.

Challenges:

Termination of PERD funding in 2006 has resulted in the cancellation of this component

Options for Program Delivery:

Presently searching for academic or foreign partner to support this activity

4: Physical and Chemical Environment - Open Ocean – Chemistry

d) Monitoring sub-element :

Iron

Years of Data:

1997-2006

Frequency:

Two or 3 times per year, but stating 2004 once per year as funding permitted.

Web sites:

http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/dsr2/page/Johnson/johnson_e.html

Recent Publications:

Johnson, K., L.A. Miller, N.E. Sutherland and C.S. Wong. 2005. Iron transport by mesoscale Haida eddies in the Gulf of Alaska. *Topical Studies in Oceanography: Haida Eddies: mesoscale transport in the Northeast Pacific. Deep-Sea Research II*. **52(7-8)**:933-954

Wong, C.S., W.K. Johnson, N.E. Sutherland, J. Nishioka, M. Robert, and S. Takeda. 2005. Iron speciation and dynamics during SERIES. *Deep-Sea Research II*.

Detailed Program Description:

Iron is normally analyzed at sea using a chemiluminescent flow injection analyzer built at IOS. Samples are normally collected from surface (via Zodiac – hand sampling) down to 1000m using either a Teflon pump for 10 to 40 m and/or trace metal clean Go-Flo samplers. Dissolved iron and labile iron are analyzed immediately with total iron analyzed later.

Program Linkages:

We have been working closely with Japanese colleagues formally of CRIEPI in Abiko Japan: Jun Nishioka (Hokkaido University, Institute of Low-Temperature Science) and Shigenobu Takeda (The University of Tokyo, Department of Aquatic Bioscience, Graduate School of Agricultural and Life Sciences). Included participation in SEEDS II experiment in NW Pacific.

More recently we have been collaborating with Maiti Muldonato of UBC and Jay Cullen of U Vic.

C-SOLAS (SERIES 2002 Iron fertilization Experiment)

Possibly GEOTRACES

Arctic/Atlantic/Pacific Equivalents:

None

Monitoring Utility:

Iron is an important parameter when considering climate change as it plays a large role in the ability of plankton to utilize existing macronutrients. As a micronutrient iron controls productivity in much of the world's oceans including the NE Pacific/Alaskan Gyre

Protocols and Standards:

Compliant with internationally accepted methods.

Data Management:

Data management needs to be improved and data entered into IOS archive.

Challenges:

Lack of funding may prevent the continued analysis of these tracers.

Contamination of extremely low level iron concentrations.

Options for Program Delivery:

Look for academic partner to continue these measurements

4: Physical and Chemical Environment - Open Ocean – Details

e) Monitoring sub-element :

Argo

Years of Data:

2001-present

Frequency:

Global surveys at 10-day intervals, ocean surface to 200 metres depth.

Web site (if any):

For NE Pacific: http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/Gak_e.htm

Global Program: <http://wo.jcommops.org/cgi-bin/WebObjects/Argo>

Recent Publication:

Argo-A new tool for environmental monitoring and assessment...

<http://www.pac.dfo-mpo.gc.ca/sci/osap/people/howard/pdfs/FreelandPiO2005.pdf>

Variability of the NE Pacific....

<http://www.pac.dfo-mpo.gc.ca/sci/osap/people/howard/pdfs/C&F2006.pdf>

Detailed Program Description:

Argo uses robotic submersible profilers that measure ocean temperature and salinity from 2000 metres depth to the ocean surface once every 10 days. Measurements are transmitted to data centres immediately after each profile, and almost all data are placed on public servers within 24 hours. An increasing number of floats are now reporting dissolved oxygen and there is increasing interest in other novel sensors particularly those of biological interest. A total of 25 nations are now launching floats and all have agreed to a single data policy, so data are available from two global data inventories (USA and France) with one stop-shopping for all data, with a single data format and a single approach to quality control. Thus Canadian scientists can monitor changing conditions in the NE Pacific in real-time using whatever floats happen to report in the area of interest, Canadian, US, Japanese, etc.

Program Linkages:

Argo is listed as a pilot program of the Global Ocean Observing System and is an integral part of the operations of operational centres such as the European Centre for Medium Range Weather Forecasting, UK Met Office, NOAA, JMA, Mercator(France) and others. This is not yet integral to seasonal climate forecast systems in Canada, but plans exist for creating the systems to use Argo data in forecast models.

Arctic/Atlantic/Pacific Equivalents:

Argo is a global program with floats in all oceans of the world, including the Arctic Ocean. The target is to have 3000 floats reporting. Presently (March 2007) there are about 2500.

Monitoring Utility:

Useful for detection of interannual variability and eventually for longer term changes. The real-time nature means that in principle we always know what the ocean is doing and so can assess the current behaviour of the NE Pacific and its relationship to biological changes. It is also critical for the development of ocean forecast tools.

Protocols and Standards:

Standard sampling equipment (SeaBird CTD developed in WOCE) is used on all floats, though innovative new sensors are becoming available. Of special note is the new optical sensor for observing dissolved oxygen. Protocols for processing data in real-time and in delayed-mode are discussed and standardised at annual meetings of the international investigators.

Data Management:

Argo has a data-management committee. The basic processing system was designed by Bob Keeley at MEDS and is now run by 2 data managers based at IFREMER (Brest, France) and at the US Naval Post Graduate School (Monterey, California). All nations who contribute to Argo follow the same data management system rigorously. We monitor the delivery of data to the global data systems to ensure that data delivery remains timely and meets the requirements of operational agencies.

Challenges:

The biggest challenge is the establishment of long-term secure funding. In Canada Argo is funded on an ad hoc basis each year. The USA has 4½ years left on the current round of funding with the intention of "operationalising Argo" afterwards. The European agencies are in the process of developing an aggressive program that will rapidly move the EU contribution

from 18% of the array to 25% of the global array and maintain that with a horizon of about 10 years. Australia has long-term funding for about 50 deployments/year extending 5 years away and then another 5 years following a successful review. India has an impressive program funded with a horizon estimated at about 10 years. China has a long-term program established, we believe, but it is a little hard to get details. Japan also contributes significantly.

Options for Program Delivery:

It seems appropriate that a monitoring program like Argo be supplied through a Government Agency. Within Canada the program is managed and funded by Fisheries and Oceans Canada, as one of its few programs funded from Ottawa rather than through the regions. In the USA, Argo has been delivered thus far through the Universities, which seems odd for a program that is intrinsically "operational". That said, the US intention is to move the program to an operational agency at the end of the current funding round.

4: Physical and Chemical Environment - Open Ocean – Details

f) Monitoring sub-element :

SeaWiFS, MODIS, MERIS ocean colour satellite imagery

Years of Data:

SeaWiFS 1997 to 2004

MODIS 1999 to present

MERIS 2002 to present

Frequency:

Daily

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/satelliteimages/Default_e.htm

Recent Publication:

Philip W. Boyd, Robert Strzepek, Shigenobu Takeda, George Jackson, C.S. Wong, R. Mike McKay, Cliff Law, Hiroshi Kiyosawa, Hiroaki Saito, Nelson Sherry, Keith Johnson, Jim Gower and Neelam Ramaiah, "The evolution and termination of an iron-induced mesoscale bloom in the northeast subarctic Pacific," Limnology and Oceanography, Volume 50, 1872-1886, 2005

Detailed Program Description:

Satellite ocean colour images have been widely used in DFO for physical, biological and fisheries management studies

Program Linkages:

Important source of data for Ecosystem-Based Management

Used in climate studies

Arctic/Atlantic/Pacific Equivalents:

Similar data use at IML and BIO

Monitoring Utility:

Only source of uniform, large-area chlorophyll-*a* and productivity coverage

Important source of data for Ecosystem-Based Management

Useful for detection of interannual and decadal changes.

Protocols and Standards:

Standard processing and archive maintained by NASA

Data Management:

Some data processed and archived at IOS, IML, BIO.

Challenges:

Requires some specialized knowledge and experience.

Relies on others for major capital investment in launch and data management.

Options for Program Delivery:

None

4: Physical and Chemical Environment - Deep Ocean

g) Monitoring sub-element :

NEPTUNE Canada monitoring sites at locations in the northeast Pacific, from the southern continental shelf to Endeavour Ridge 300 km offshore.

Years of Data:

NA- scheduled to begin late 2008.

Frequency:

Continuous at better than 1 Hz

Web site (if any):

<http://www.neptunecanada.ca>

Recent Publication:

NA

Detailed Program Description:

Cabled observatory network in the northeast Pacific extending across the southern Vancouver Island continental shelf and slope, out to Endeavour Ridge. Major deep ocean Junction Boxes are to be installed at the following sites: (1) The 2500 m deep abyssal plain site ODP1027 to be instrumented with a star-shaped array of bottom sensors radiating out roughly 6 km from the central Junction Box. Sensors to include current meters, T&S sensors, and bottom pressure recorders; and (2) two mooring lines across the central Axial Valley at Endeavour Ridge (see MPA).

Program Linkages:

See (a) above

Atlantic/Pacific Equivalents:

None

Monitoring Utility:

Near-realtime oceanographic data available on the NEPTUNE Canada website.

Protocols and Standards:

To be established by the University of Victoria

Data Management:

Data processed and archived by NEPTUNE Canada at the University of Victoria.

Challenges:

This is a new cabled observatory network and is likely to encounter numerous start up problems; profiler may have a limited operational life due to the harsh environment and damage from commercial fisheries. Canadian and US Navies have option to shut down data flow for national security reasons.

Options for Program Delivery:

No other options.

4: Physical/chemical environment – PNCIMA (out to continental shelf edge)

h) Monitoring sub-element

Can/US Hake Survey -See Monitoring sub-element 18E for details.

8 Greenhouse gases and related parameters to climate chemistry – Open Ocean

a) Monitoring sub-element :

DIC (TCO₂) and TA (total alkalinity)

Years of Data:

1970's to present, significant improvements in methods in 1985 for DIC and 1994 for Alkalinity

Frequency:

Three times annually as part of the line P Station P program

Ship of Opportunity program: 6 crossings per year between Japan and Vancouver with samples collected twice per day on the MV Skaugran. A second ship (MV *Pyxis*) is not very reliable at present as it mainly goes to the east coast of the US and thus we are not able to retrieve our samples and restock the ship very often (only when it comes into Portland) This ship is used in collaboration with NIES in Japan who run a number of analysis onboard including pCO₂

Web sites:

Recent Publications:

Wong, C.S., D.A. Timothy, C. Law, Y. Nojiri, L. Xie, S.-K.E. Wong, and J.S. Page. 2005. Carbon flux, distribution and budget with special reference to the fugacity of carbon dioxide (fCO₂) in the SERIES iron fertilization experiment. *Deep-Sea Research II*.

"Variations in nutrients, carbon and other hydrographic parameters related to the 1976-77 and 1988-89 regime shifts in the sub-arctic northeast Pacific" by CS Wong, Liusen Xie and William W Hsieh. Submitted revised copy March 27, 2007 to Progress in Oceanography -Line P special issue

Detailed Program Description:

Profiles from surface to bottom are collected at major Line P stations P04, P12, P16, P20, & P26. Samples are collected and returned to shore for analysis and analyzed within a year of collection. Data is processed and archived OSD archives.

Program Linkages:

-Part of Line P station P ongoing time series; Upcoming NOAA mooring program at Station P. SOO program on *Pyxis* is in collaboration with Dr. Nojiri of NEIS Japan.

Arctic/Atlantic/Pacific Equivalents:

BIOS Laborador Timeseries; IOS Arctic repeat Station A

Monitoring Utility:

Determining feedbacks between the seawater carbonate system and increased greenhouse gases.

Protocols and Standards:

Compliant with the DOE Handbook of Methods for the Analysis of the Various Parameters of the Carbon dioxide System in Sea Water. Standardized with Certified Reference material from Andrew Dickson's lab, Scripps Calif.

Data Management:

Data processed and archived at IOS.

Challenges:

High precision and accuracy required

Both systems are very old. Alkalinity system is in the process of being updated.

Termination of PERD funding in 2006 puts this program in jeopardy

Options for Program Delivery:

8 Greenhouse gases and related parameters to climate chemistry – Open Ocean

b) Monitoring sub-element :

pCO₂

Years of Data:

1970's – present (along line P)

Frequency:

~3 surveys per year, along line P

Web sites:

Recent Publications:

Detailed Program Description:

An underway pCO₂ system (equilibrator and IR detector) is installed on all line P trips and sampled from Saanich Inlet out to Station P and back. Weather data is also collected to allow for flux calculations of pCO₂.

Program Linkages:

-Part of Line P station P ongoing time series; Upcoming NOAA mooring program at Station P. SOO program on Pyxis of Dr. Nojiri of NEIS Japan.

Arctic/Atlantic/Pacific Equivalents:

Amundsen often carries an underway pCO₂ analyzer during Arctic surveys, but not routinely..

Monitoring Utility:

Determining pCO₂ drawdown and productivity

Protocols and Standards:

Compliant with the DOE Handbook of Methods for the Analysis of the Various Parameters of the Carbon dioxide System in Sea Water. Calibration of primary standards provided EC (Greenhouse Gas Measurement Laboratory, Meteorological Service of Canada)

Data Management:

Data processing needs improvement but is slowed due to lack of personnel to process data. A contract now is in place to review, check and prepare older data for archiving at IOS

Challenges:

- We have no on-site expert in the software (Labview) in OSD. Training is recommended. Feedback on data and problems is slow due to lack of personnel available for this task.
- Termination of PERD funding in 2006 puts this program in jeopardy

Options for Program Delivery:

8: Greenhouse gases and related parameters to climate chemistry– Open Ocean

c) Monitoring sub-element:

C13

Years of Data:

1980's to

Frequency:

~2-3 surveys per year at OSP (~Feb, May-June, Aug-Sept)

Web sites:

Recent Publications:

Quay, P., Tillbrook, B. and Wong, C.S. (1992) Oceanic uptake of fossil fuel carbon dioxide: carbon-13 evidence *Science*, **256**, 74-79.

Detailed Program Description:

Samples are returned to the shore laboratory for extraction and analysis. Samples are extracted using a method pioneered by C.S. Wong. An updated automated system designed by NIWA (N.Z.) is presently used. The extracted samples are sealed in a break-seal glass tube until analysis on the Nuclide light isotope mass spectrometer.

Program Linkages:

Line P station P; Upcoming NOAA mooring program at Station P

Arctic/Atlantic/Pacific Equivalents:

Atmospheric Air C13 in Arctic. Samples collected biweekly.

Monitoring Utility:

C13 allows calculation of anthropogenic CO2 penetration into the oceans

Protocols and Standards:

NBS standards are used to calibrate the instrument.

Data Management:

Data management stream required

Challenges:

-Instrumentation is old, and parts are hard to acquire, making repairs are difficult.

Options for Program Delivery:

8: Greenhouse gases and related parameters to climate chemistry– Open Ocean

d) Monitoring sub-element :

DMS

Years of Data:

1980's to present

Frequency:

1 to 3 times per year

Web sites:

Recent Publications:

Wong, C.S., A. Pena, and M. Levasseur. 2005. Climatic effect on DMS producers in the NE subarctic Pacific. *Tellus*

Levasseur, M., M.G. Scarratt, S. Michaud, A. Merzouk, C.S. Wong, M.D. Arychuk, W.A. Richardson, E. Wong, A. Marchetti, and H. Kiyosawa. 2005. DMSP and DMS dynamics during a mesoscale iron fertilization experiments in the NE Pacific. Part I: Temporal and vertical distributions. *Deep-Sea Research II*

Le Clainche, Y., M. Levasseur, A. Vezina, A. Merzouk, S. Michaud, M.G. Scarratt, C.S. Wong, R.-C. Bouillo, R. Rivkin, P.W. Boyde, P.J. Harrison, W.L. Miller, and F.J. Saucier. 2005. Modeling analysis of the effect of iron enrichment on dimethyl sulfide dynamics in the NE Pacific (SERIES experiment). *Journal of Geophysical Research* **111**(C01011), doi: 10.1029/2005JC002947

Detailed Program Description:

Dimethyl sulphide (DMS) is analyzed on an ongoing time series basis. It is collected three times annually on major line P stations with profiles down to 200m. In addition three profiles are collected at Station P at morning, noon and evening. All analysis are completed onboard the ship.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Linking the anti-greenhouse gas DMS production with biological activity.

Protocols and Standards:

Compliant with internationally accepted methods.

Data Management:

Data management stream required

Challenges:

Termination of PERD funding in 2006 puts this program in jeopardy

Options for Program Delivery:

8: Greenhouse gases and related parameters to climate chemistry– Open Ocean

e) Monitoring sub-element :

CFC's (freons) and SF6

Years of Data:

CFC's: 1992 to present; SF6 2002 to present

Frequency:

CFC's: 1 to 2 times per year, reduced to once every 2 years in the 21st century

SF6 : once every 2 years

Web sites:

Recent Publications:

R.Matear, Wong,C.S., and L.Xie. 2003. Can CFC's be used to determine anthropogenic CO2? *Global Biogeochemical Cycles* Vol. 17, NO. 1, 1013, doi:10.1029/2001GB001415,2003.

Detailed Program Description:

CFC analysis were carried out onboard ship using a commercial Gas Chromatographic analyzer coupled with an extraction system built by Centre for Ocean Climate Chemistry, Institute of Ocean Sciences. The COCC analytical system is a modified version of the one described by Bullister and Weiss (1988).

Similarly to CFC's, SF6 is analyzed at sea using a GC with an in-house built extraction system.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

CFC's and SF6 are tracer gases. Their analysis reveals the penetration of gases into the oceans and allows calculation of anthropogenic CO2 penetration into the oceans.

Protocols and Standards:

Compliant with internationally accepted methods.

Data Management:

Data management stream required

Challenges:

Termination of PERD funding in 2006 puts this program in jeopardy

Options for Program Delivery:

8: Greenhouse gases and related parameters to climate chemistry – Open Ocean

f) Monitoring sub-element :

pH

Years of Data:

Sporadic since 1999, minimal data

Frequency:

Opportunistic basis. Less than once per year

Web sites:

Recent Publications:

Detailed Program Description:

Both spectrophotometric and electrodes (no liquid junction) have been tested. Both look promising but need funding and personnel if program is to be implemented.

Program Linkages:

Line P station P; Upcoming NOAA mooring program at Station P

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Ocean acidification is an important parameter for monitoring climate change and should be given a higher priority.

Protocols and Standards:

Compliant with the DOE Handbook of Methods for the Analysis of the Various Parameters of the Carbon dioxide System in Sea Water.

Data Management:

Data management stream required

Challenges:

- Personnel
- Funding;

Options for Program Delivery:

8: Greenhouse gases and related parameters to climate chemistry– Open Ocean

g) Monitoring sub-element:

Dissolved Organic Carbon (DOC)

Years of Data:

Sporadic since 1980's, minimal data

Frequency:

Opportunistic basis. Less than once per year

Web sites:

Recent Publications:

Detailed Program Description:

High temperature catalytic combustion analyses are in place and working well. Only funding is needed to implement the measurements routinely.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Linking the inorganic carbon system with biological activity.

Protocols and Standards:

Compliant with internationally accepted methods. Standardized with seawater standards and blanks provided by the University of Miami.

Data Management:

Data management stream in place for when routine data collection begins.

Challenges:

- Personnel
- Funding;

Options for Program Delivery:

9: Lower trophic levels – water column – Strait of Georgia - Details

a) Monitoring sub-element :

Zooplankton monitoring stations

Years of Data:

1990 – 2005 (recent years by UBC/UVic in collaboration with DFO)

Frequency:

quite variable; recently ~ biweekly to monthly from early spring to autumn by universities; semi-annual by IOS staff (Romaine); seasonal by PBS staff (Beamish-Sweeting)

Web sites:

- (STRATOGEM) <http://www.stratogem.ubc.ca/science.html>
- (COPRA) http://www.pac.dfo-mpo.gc.ca/SCI/osap/people/~romaine/default_e.htm

Recent Publications:

- Campbell, R.W., Boutillier, P., Dower, J.F. (2004) Ecophysiology of overwintering in the copepod *Neocalanus plumchrus*: changes in lipid and protein contents over a seasonal cycle . Mar. Ecol. Prog. Ser. 280, 211-226.
- Romaine, S.J., K. Cooke, R. Keiser, S. McFarlane, and M. Saunders. 2002. Hake and euphausiid acoustic studies in the Strait of Georgia. Proc. Puget Sound Research 2001.

Detailed Program Description:

Vertical-integrated net tows analyzed for zooplankton biomass and species/stage composition. Most surveys also collect water property data (CTD, fluorescence, oxygen, pigments, nutrients)

Program Linkages:

- Beamish-Sweeting juvenile salmon surveys in the Strait of Georgia (these also collect zooplankton samples, but raw data are not broadly available)

Arctic/Atlantic/Pacific Equivalents:

AZMP fixed stations

Monitoring Utility:

Useful for tracking interannual variability of zooplankton productivity and seasonality

Protocols and Standards:

Compatible with SCOR, ICES, and NOAA-NMFS zooplankton protocols.

Data Management:

- zooplankton data from UBC-UVic are included in IOS zooplankton data base.
- zooplankton data collected by Beamish-Sweeting are held in off-line archives

Challenges:

- Time-varying (& semi-competitive?) mix of lead investigators and sampling locations/frequency
- Limited data archival, no assurance of ongoing accessibility

Options for Program Delivery:

- ?

9: Strait of Georgia, lower trophic levels-water column

b) Monitoring sub-element:

Sediment trap time series

Years of Data:

1996-1999

Frequency:

8-20 days

Recent Publication:

Johannessen SC, O'Brien MC, Denman KL, Macdonald RW. Seasonal and spatial variations in the source and transport of sinking particles in the Strait of Georgia, Canada. Mar Geol 2005;216:59-77.

Detailed Program Description:

Biogeochemical time series through chemical analyses (C,N,P,Si, etc) of settling particles in the Strait of Georgia

Program Linkages:

Was a contribution to the ESSRF/ESSF programs

Arctic/Atlantic/Pacific Equivalents

Station P time series (Pacific); Station A time series (Arctic)

Monitoring Utility:

The only practicable method to monitor the quality and quantity of organic and inorganic particle production in the system. Useful to detect interannual and decadal changes in timing, quantity and quality of primary production in relation to other climate parameters like ENSO or Fraser River flow.

Protocols and Standards:

JGOFS for sediment trap work

Data Management:

Samples analyzed at IOS and by contract; data and sample archives maintained at IOS.

Challenges:

Require ship time (two deployment/recoveries per year) which take about 1 day and funding to support subsampling and analysis

Options for Program Delivery:

Measure primary production using standard ¹⁴C transects plus satellite imagery for ocean colour (neither practicable nor cheap).

9: Lower Trophic levels – water column - Strait of Georgia – Details

c) Monitoring sub-element :

Abundance, distribution and composition of phytoplankton

Years of Data:

Phytoplankton biomass 2002 – present

Phytoplankton composition 2004 - present

Frequency:

4 x per year (April; June; September; November)

Web site (if any):

none

Recent Publication:

none

Detailed Program Description:

Water sampling for chlorophyll concentration and pigment composition at several depths along a transect of 20 stations in the center of the Strait of Georgia and Juan de Fuca Strait.

Program Linkages:

Important source of data for Ecosystem-Based Management

It is carried out during SoG monitoring transects (Masson)

Arctic/Atlantic/Pacific Equivalents:

Similar data use at IML and BIO

Monitoring Utility:

Important source of data for Ecosystem-Based Management

Useful for detection of interannual changes.

Protocols and Standards:

Standard methodology for chlorophyll and pigment analysis

Data Management:

Data processed and archived at IOS.

Challenges:

Each cruise requires 5-7 days of ship time; Requires some specialized knowledge and experience; Relies on continuation of Masson' SoG monitoring; Reduction in DFO staff compromises sampling and analysis.

Options for Program Delivery:

None

9: Lower Trophic levels – water column– St. of Georgia Details

d) Monitoring sub-element

A: Abundance and distribution of ichthyoplankton Areas 13-20

Years of Data:

2005-2006;

Frequency:

April each year to begin in 2008 after preliminary analyses completed

Web site (if any):

None

Recent Publication:

None

Detailed Program Description:

Bongo and neuston net tows from Vector, in association with IOS survey conducted in April;

Program Linkages:

Research for ecosystem-based assessment; fisheries oceanography and climate forcing; Strait of Georgia Ocean

Productivity programs

Arctic/Atlantic/Pacific Equivalents:

Unknown

Monitoring Utility:

Early indication of year class strength for various fish species; ecosystem linkages between climate forcing, oceanographic conditions and fish population dynamics

Protocols and Standards:

Standardized plankton gear, tow locations and larval preservation

Data Management:

Data processed and archived at PBS in the groundfish unit.

Challenges:

Enumeration of samples is time consuming and dependent on contractor availability.

Options for Program Delivery:

None

9: Lower Trophic levels – water column– St. of Georgia Details

e) Monitoring sub-element

Fraser River eulachon egg/larval survey

Years of Data:

1995-present.

Frequency:

Every spring for spawn, bio-sample & egg/larval surveys.

Web site (if any): http://www.pac.dfo-mpo.gc.ca/sci/herring/default_e.htm

Recent Publication:

Detailed Program Description:

Plankton tows for egg/larval and euphausiid assessments.

Program Linkages:

Estimate coast-wide herring and FR eulachon spawning stock biomass (SSB). **Arctic/Atlantic/Pacific Equivalents:**

Monitoring Utility:

Eulachon surveys provide the basis for the stock assessment and harvest recommendations.

Protocols and Standards:

Data Management:

Data processed, analyzed and archived at PBS within pelagic unit.

Challenges:

Uncertainty about AFS funding availability at end of fiscal year

Options for Program Delivery:

None

10: Lower trophic levels – water column – WCVI - Details

a) Monitoring sub-element :

Zooplankton monitoring stations

Years of Data:

1985 – present (at standard stations, useful regional averages back to 1979)

Frequency:

~4 surveys per year (range 3-6), timing variable but most dense from April-October

Web sites:

-Time series update included in annual PSARC FOWG State of the Ocean report: http://www.pac.dfo-mpo.gc.ca/sci/psarc/OSRs/Ocean_SSR_e.htm

-IOS Plankton website (interpretive), with links to data archive:

http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/plankton/default_e.htm

Recent Publications:

Mackas, D.L., S. Batten, and M. Trudel. 2007. Effects on zooplankton of a warming ocean: recent evidence from the North Pacific. *Progr. Oceanogr.* (Line P Symposium special issue)

Mackas, D. L., W. T. Peterson, M. D. Ohman, and B. E. Lavanigos (2006), Zooplankton anomalies in the California Current system before and during the warm ocean conditions of 2005, *Geophys. Res. Lett.*, 33, L22S07, doi:10.1029/2006GL027930.

Detailed Program Description:

Vertical-integrated net tows analyzed for zooplankton biomass and species/stage composition, individual stations grouped in clusters representative of 'shelf', 'shelf break-slope', and 'JdeF eddy' subregions. Most surveys also collect water property data (CTD, fluorescence, oxygen, pigments, nutrients)

Program Linkages:

-Time series backbone for continental margin biological oceanography process studies (CGLOBEC, CJGOFS, La Perouse,)

-Comparison/integration with US Ocean Observing System

-Data available as inputs to fishery assessments

-key component of SCOR WG 125 "Global Comparison of Zooplankton Time Series":

<http://www.st.nmfs.gov/plankton/scor/>

Arctic/Atlantic/Pacific Equivalents:

AZMP zooplankton monitoring stations (however, a big difference is our use of within-region spatial replicates to filter-out noise added by small scale patchiness; our approach is a closer match to the line/grid designs used by US and Japan)

Monitoring Utility:

Useful for tracking occurrence and ecosystem-wide consequences of interannual and longer term climate fluctuations and trends

Input to design and maintenance of potential "Big Eddy" MPA off southern Vancouver Island

Protocols and Standards:

Compatible with SCOR, ICES, and NOAA-NMFS zooplankton protocols.

Data Management:

Data processed and archived at IOS. Loaded into BIOCHEM at MEDS.

Challenges:

Each survey requires 5-10 days of ship time;

Limited long-term DFO A-base support

Salary for critical taxonomic expertise is supported from external funding sources.

Options for Program Delivery:

-Increased use of DFO platforms of opportunity for sample collection (SAR, fishery enforcement, security-sovereignty patrols)

-Switch entirely to Continuous Plankton Recorder transect lines (but a bad idea because CPR samples only at 10 m depth)

10: Lower Trophic levels –water column –WCVI Details

b) Monitoring sub-element

A: Euphausiid population biology/productivity

Years of Data:

1991 - present

Frequency:

10 times annually

Web site (if any):

Recent Publication:

Tanasichuk (1998 a, b); Tanasichuk (2002)

Detailed Program Description:

Oblique bongo tows at four stations in Barkley Sound

Program Linkages:

WCVI wild coho, and Barkley Sound and Central Coast sockeye forecasts are used by Fisheries Management; provides the biological basis for understanding production variability in all five major herring stocks

Arctic/Atlantic/Pacific Equivalents:

Unknown

Monitoring Utility:

Provides forecasts of WCVI wild coho one year in advance and forecasts of WCVI and Central Coast sockeye 1 to 3 years in advance; interannual variations in herring recruitment, growth and adult natural mortality rates can be predicted

Protocols and Standards:

Standardized sampling gear and tow locations

Data Management:

Data processed and archived at PBS

Challenges:

Funding and technical support

Options for Program Delivery:

None

10: Lower Trophic levels –water column –WCVI Details

c) Monitoring sub-element

Can/US Hake Survey -See Monitoring sub-element 18E for details.

11: Lower trophic levels – water column – PNCIMA - Details

a) Monitoring sub-element :

Zooplankton monitoring stations

Years of Data:

1996 – present (Brooks Peninsula-Scott Islands)

1998-present (Hecate Strait)

Frequency:

~4 surveys per year (range 3-6), timing variable but most dense from April-October

Web sites:

-Time series update for northern Vancouver Island included in annual PSARC FOWG State of the Ocean report:

http://www.pac.dfo-mpo.gc.ca/sci/psarc/OSRs/Ocean_SSR_e.htm

-IOS Plankton website (interpretive), with links to data archive:

http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/plankton/default_e.htm

Recent Publications:

- PNCIMA 2007 (Overview document, appendix D?)

- Mackas, D.L., W.T. Peterson and J.E. Zamon. 2004. Comparisons of interannual biomass anomalies of zooplankton communities along the continental margins of British Columbia and Oregon. *Deep-Sea Res. II* 51, 875-896.

- Bertram, D.F., D.L. Mackas, and S.M. McKinnell. 2001. The seasonal cycle revisited: Interannual variation and ecosystem consequences. *Progr. Oceanogr.* 49:283-307.

Detailed Program Description:

Vertical-integrated net tows analyzed for zooplankton biomass and species/stage composition, individual stations grouped in clusters representative of 'shelf', and 'shelf break-slope'. Some surveys also collect water property data (CTD, fluorescence, oxygen, pigments, nutrients)

Program Linkages:

-Time series backbone for continental margin biological oceanography process studies (CGLOBEC, CJGOFS, La Perouse,)

-DFO-BPA High Seas Salmon Program surveys (growth/survival/migration of juvenile salmon)

-Comparison/integration with US Ocean Observing System

-Data available as inputs to fishery assessments

Arctic/Atlantic/Pacific Equivalents:

AZMP zooplankton monitoring stations (however, a big difference is our use of within-region spatial replicates to filter-out noise added by small scale patchiness; our approach is a closer match to the line/grid designs used by US and Japan)

Monitoring Utility:

Useful for tracking occurrence and ecosystem-wide consequences of interannual and longer term climate fluctuations and trends

Key input to design (and maintenance) of new Scott Islands Marine Wildlife Area

Protocols and Standards:

Compatible with SCOR, ICES, and NOAA-NMFS zooplankton protocols.

Data Management:

Data processed and archived at IOS. Loaded into BIOCHEM at MEDS.

Challenges:

Each survey requires 3-5 days of ship time;

Limited long-term DFO A-base support;

Salary for critical taxonomic expertise is supported from external funding sources.

Climatology for Hecate Strait sub-region is not fully established (time series too short and sparse)

Options for Program Delivery:

-Increased use of DFO platforms of opportunity (SAR, fishery enforcement, security-sovereignty patrols) for sample collection. Already underway for Scott Islands sub-region.

-Switch entirely to Continuous Plankton Recorder transect lines (but a bad idea because CPR samples only at 10 m depth)

11: Lower Trophic levels –water column – PNCIMA (out to the continental shelf edge)

b) Monitoring sub-element

Can/US Hake Survey -See Monitoring sub-element 18E for details.

12: Lower trophic levels – water column – Open Ocean - Details

a) Monitoring sub-element :

Zooplankton monitoring stations

Years of Data:

1997 – present in current form (also available are archived data from the Weathership program, and from intensive but short term SUPER, CIGOFS, and SOLAS programs)

Frequency:

~2-3 surveys per year (~Feb, May-June, Aug-Sept)

Web sites:

-IOS Plankton website (interpretive), with links to data archive:

http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/plankton/default_e.htm

Recent Publications:

Mackas, D.L., S. Batten, and M. Trudel. 2007. Effects on zooplankton of a warming ocean: recent evidence from the North Pacific. *Progr. Oceanogr.* (Line P Symposium special issue)

Mackas, D.L. and M. Galbraith. 2002. Zooplankton community composition along the inner portion of Line P during the 1997-98 El Niño event. *Progr. Oceanogr.* 54: 423-437.

Detailed Program Description:

Vertical-integrated net tows analyzed for zooplankton biomass and species/stage composition. Surveys also collect water property data (see item 4)

Program Linkages:

-Time series backbone for Alaska Gyre biological oceanography process studies (SUPER, CGLOBEC, CIGOFS, SOLAS,)

Arctic/Atlantic/Pacific Equivalents:

Labrador Sea line

Monitoring Utility:

Useful for tracking occurrence and ecosystem-wide consequences of interannual and longer term climate fluctuations and trends

Protocols and Standards:

Compatible with SCOR, ICES, and NOAA-NMFS zooplankton protocols.

Data Management:

Data processed and archived at IOS. Loaded into BIOCHEM at MEDS.

Challenges:

-Each survey requires 14-20 days of ship time;

-Salary for critical taxonomic expertise is supported from external funding sources.

Options for Program Delivery:

-None?

12: Lower Trophic levels – water column – Open Ocean

b) Monitoring sub-element :

Abundance, distribution and composition of phytoplankton along Line P transect: Stations P4, P12, P16, P20 and OSP

Years of Data:

2006 - present

Frequency:

3 times per year (May/June; August/September; February)

Web site (if any):

None with this data

Recent Publication:

Peña, M.A. and Varela, D. "Seasonal and interannual variability in phytoplankton and nutrient dynamics along Line P in the NE subarctic Pacific" Progress in Oceanography (accepted), 2007.

Detailed Program Description:

Water sampling at several depths for pigment composition at five main stations

Program Linkages:

Important source of data for climate change studies

Arctic/Atlantic/Pacific Equivalents:

Labrador Sea line

Monitoring Utility:

Important source of data for detection of interannual changes in phytoplankton composition

Protocols and Standards:

Standard methodology for pigment analysis

Data Management:

Data processed and archived at IOS.

Challenges:

Requires some specialized knowledge and experience; Relies on continuation of Line P program; Reduction in seagoing DFO staff compromises sampling.

Options for Program Delivery:

None

12: Lower trophic levels – water column – Open Ocean - Details

c) Monitoring sub-element :

North Pacific Continuous Plankton Recorder surveys

Years of Data:

1998 + 2000-present

Frequency:

~4-6 surveys per year (most in spring-early summer)

Web sites:

http://www.pices.int/projects/tcprstnp/CPR_Data_Analysis.pdf

<http://www.pices.int/projects/tcprstnp/default.aspx>

Recent Publications:

Mackas, D.L., S. Batten, and M. Trudel. 2007 in press. Effects on zooplankton of a warming ocean: recent evidence from the North Pacific. *Progr. Oceanogr.* (Line P Symposium special issue)

Batten, S.D., Freeland, H.J., 2007 in press. Plankton populations at the bifurcation of the North Pacific Current. *Fisheries Oceanography*.

Detailed Program Description:

Near-surface transect sampling of the Alaska Gyre using a Continuous Plankton Recorder towed by commercial ships-of-opportunity; each sample filters ~ 3 cubic meters of water from an 18 km along-track segment. DFO is a collaborative partner with SAHFOS (Sir Alister Hardy Foundation for Ocean Science), providing lab space, servicing of gear, and partial sample processing.

Program Linkages:

-Canadian Line P/Station P surveys

-PICES North Pacific

-SAHFOS programs in other ocean regions

Arctic/Atlantic/Pacific Equivalents:

CPR lines off Maritimes and Newfoundland regions

Monitoring Utility:

Provides an extent and density of open ocean coverage unavailable from dedicated research cruises. Also allows comparison with very long (50+ year) time series from the Atlantic. However, because CPR is a unique sampling method, for various reasons (depth coverage, mesh size, taxonomic resolution, processing methods) the CPR data are not quantitatively comparable with time series based on conventional plankton net tows.

Protocols and Standards:

SAHFOS CPR protocols.

Data Management:

Data processed and archived at both SAHFOS and IOS.

Challenges:

-Funding is entirely external (EVOS and NPRB) and uncertain from year to year

-Limited intercomparability with other methods (see above)

Options for Program Delivery:

-Partial DFO funding buy-in would help to ensure program continuity

12: Lower Trophic levels –water column –Open Ocean

d) Monitoring sub-element

Can/US Hake Survey -See Monitoring sub-element 18E for details.

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

a) Monitoring sub-element:

Shrimp survey Time Series, Pacific Fisheries Management Areas 14, 18, 19, 28 and 29

Years of Data:

1996- present

Frequency:

Annual

Web site (if any):

Survey Bulletins posted to:

<http://www-ops2.pac.dfompo.gc.ca/xnet/content/shellfish/shrimp/Surveys/surveys.htm>

Recent Publication:

CSAS documents 99/124 and 2004/026

Detailed Program Description:

Area sweep trawl biomass surveys for *P. borealis*, *P. jordani*, *P. danae*, *Pandalopsis dispar* using in-shore fisheries research vessel and excluder gear on net.

Program Linkages:

Estimates are used by FAM for in-season quota adjustments for the shrimp by trawl fisheries

Arctic/Atlantic/Pacific Equivalents:

Gulf and Nova Scotia *P. borealis* surveys

Monitoring Utility:

Provides indices of shrimp abundance, trends in abundance, year class strength, biological data collected for determining recruitment and mortality parameters. Biomass index used for in-season adjustment of the TAC for the shrimp trawl fisheries in this area

Protocols and Standards:

Standardized gear and methodology used

Data Management:

Extensive data management component. Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

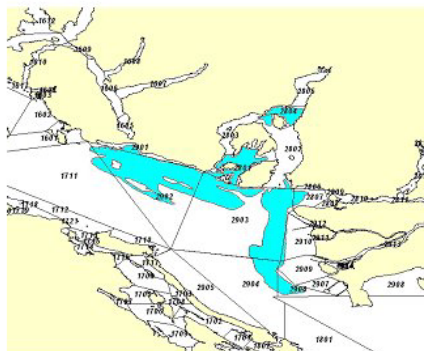
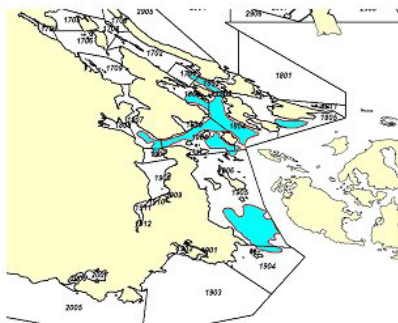
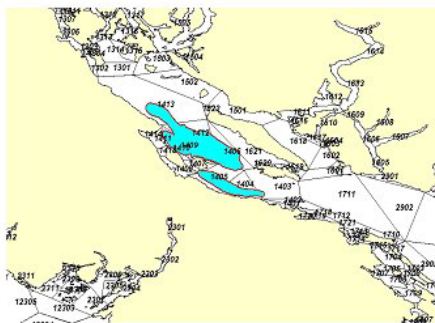
Challenges:

Each cruise requires 14- 20 days of ship time; funding for the personnel is covered by industry

Options for Program Delivery:

None

Map:



13: Higher trophic levels of fish and shellfish– St. of Georgia Details

b) Monitoring sub-element:

Crab surveys of Areas 28 and 29 (Fraser River Delta)

Years of Data:

1989 - present

Frequency:

twice per year ; spring (April – June); fall (Oct. – Dec.)

Web site (if any): <http://www.dfo-mpo.gc.ca/csas>

Recent Publication:

Zhang, Z., W. Hages, A. Phillips and J.A. Boutillier 2004. Use of length-based models to estimate biological parameters and conduct yield analyses for male Dungeness crab (*Cancer magister*) Can. J. Fish. Aquat. Sci. **61**: 2126-2134

Phillips, Antan and Zane Zhang 2004. Potential implications of differential size limits in the Dungeness crab fisheries of British Columbia. Canadian Science Advisory Secretariat Research Document 2004-134

Detailed Program Description:

Trap survey of Dungeness Crab population on the Fraser Delta including Boundary Bay , Vancouver harbour and Indian Arm. Data collected includes growth rates, mortality rates, moult timing of adults, injury rates, relative CPUE, population structure, seasonal depth distribution and population trends.

Program Linkages:

Estimates are used for confirming calendar opening dates for the commercial fishery and contribute biological knowledge necessary to the management of the resource throughout the B.C. coast.

Arctic/Atlantic/Pacific Equivalents:

N/A

Monitoring Utility:

Allows fishery opening based upon softshell component of the legal width male crabs and monitors exploitation rates.

Protocols and Standards:

Standardized fishing Gear locations and depths

Data Management:

Data processed and archived at PBS in the shellfish data unit. **Challenges:**

Each cruise requires 10 - 12 days of ship time; funding for the personnel is A-base budgeted.

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

c) Monitoring sub-element:

Intertidal clam surveys at Seal Island

Years of Data:

1940- present

Frequency:

Triennial

Web site (if any):

Recent Publication:

Kingzett, B.C. and N.F. Bourne. 1998. Assessment of intertidal clam population surveys at Seal Island, British Columbia, 1940-1992. p. 47-126. *In*: B.J. Waddell, G.E. Gillespie and L.C. Walthers [eds.]. Invertebrate working papers reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 1. Bivalves. Can. Tech. Rep. fish. Aquat. Sci. 2214.

Detailed Program Description:

Assessment surveys for butter clams (*Saxidomus giganteus*) and associated intertidal clam species delivering abundance and biomass estimates, length and age structure and growth rates.

Program Linkages:

Used informing managers as to stock status and accumulating data for population analyses.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Biomass estimates used to inform decisions regarding commercial and First Nation FSC fisheries.

Protocols and Standards:

Gillespie, G.E. and A.R. Kronlund. 1999. A manual for intertidal clam surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2270. 144 p.

Data Management:

Data processed and archived at PBS in the Shellfish Data Unit.

Challenges:

Costs of field collection, laboratory processing and analyses borne primarily by DFO. Some economies through using survey as training opportunity for First Nations groups.

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

d) Monitoring sub-element:

Geoduck bed mapping and dive surveys

Years of Data:

1995 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Detailed Program Description:

Geoduck beds are mapped using single-beam acoustic data processing software (QTCView) to calculate area. Randomly-placed transects are completed by divers to estimate density.

Program Linkages:

Bed area and density estimates are used to calculate biomass and quota options for geoduck fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in biomass estimates of geoducks

Protocols and Standards:

Systematic tracklines overlaid on known geoduck beds and backscatter data collected. Transect dive surveys use a stratified random design and observations are recorded from systematically-spaced quadrats.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader and partial field expenses is covered by industry, for acoustic work. Dive surveys coordinated and overseen by DFO and completed by industry divers aboard commercial vessels.

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

e) Monitoring sub-element:

- (1) Red sea urchin SCUBA diving assessment surveys

Years of Data:

- (1) 1998 to present

Frequency:

- (1) once per 4-5 years

Web site (if any):

Recent Publications:

Campbell, A., D. Tzotzos, W. C. Hajas, and L. L. Barton. 2001. Quota options for the red sea urchin fishery in British Columbia for fishing season 2002/2003. Can. Stock Assessment Secretariat Res. Doc. 2001/141.

Detailed Program Description:

- (A) SCUBA line transect surveys for densities, size and habitat type per survey.

Program Linkages:

- (A) Estimates are used for quota estimates per management area.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

- (A) Assist yearly quota management process for red sea urchin fishery.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each survey cruise requires (A) 7-10 days - funding for the personnel is covered by industry

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

f) Monitoring sub-element:

Sea cucumber fishery experiments and dive surveys

Years of Data:

1998 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Hand, C.M. and J. Rogers. Sea Cucumber Phase 1 Fishery Progress Report. Canadian Stock Assessment Secretariat Research Document 1999/141: 32p.

Detailed Program Description:

Range of exploitation rates applied to surveyed populations are assessed using time-series of density estimates

Program Linkages:

Results to be used for the development of sound fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in our understanding of sea cucumber response to fishing

Protocols and Standards:

Pre-fishery transect surveys using stratified random design. Five study plots fished at different harvest rates: 0%, 2%, 4%, 8% and 16%.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader is covered by industry; diving and harvest conducted by industry participants aboard commercial vessels.

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

g) Monitoring sub-element:

Prawn long-term study sites PFMA 28

Years of Data:

1985- present

Frequency:

Annual

Web site (if any):

Recent Publication:

CSAS documents 99/202 and 2004/015

Detailed Program Description:

Semi-annual survey of prawn stocks (*Pandalus platycerous*) using trap gear. A fixed station sampling design is used.

Program Linkages:

Results are used by FAM for management actions

Arctic/Atlantic/Pacific Equivalents:

Gulf and Nova Scotia *P. borealis* surveys

Monitoring Utility:

Prawn Stock Assessment trap survey provides estimates of key biological parameters (e.g. natural mortality, recruitment, spawner abundance) which are used in the development and refinement of the spawner escapement index for prawns. This index forms the basis of the assessment and management of prawn stocks. The prawn survey in Howe Sound is an ongoing assessment program (index site) that provides data necessary to assess and manage all prawn stocks along the British Columbia Coast.

Protocols and Standards:

Standardized trap gear and methodology used

Data Management:

Data processed and archived at PBS in the shellfish data unit

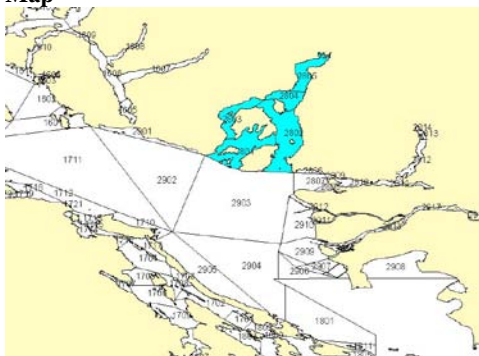
Challenges:

Each cruise requires 10- 12 days of ship time; partial funding for personnel is covered by industry

Options for Program Delivery:

None

Map



13: Higher trophic levels of fish and shellfish– St. of Georgia Details

h) Monitoring sub-element:

Green sea urchin diver surveys, Areas 11-13, 18-20

Years of Data:

1996- present

Frequency:

Once per year for each Queen Charlotte Strait until 2004; every two years since 2004. Gulf Islands surveys are annually from 1998-2004

Web site (if any):

Recent Publication:

Waddell, B.J. and R.I. Perry. 2006. Survey results of green sea urchin (*Strongylocentrotus droebachiensis*) populations in Queen Charlotte Strait, British Columbia, October 2003 and November, 2004. Can. Tech. Report Fish. Aquat. Sci. 2633: 73 p.

Detailed Program Description:

Diver-conducted transect-quadrat surveys for abundance, biomass, size-age structure, condition, plus habitat variables.

Program Linkages:

Estimates are used for stock assessments

Arctic/Atlantic/Pacific Equivalents:

Periodic Nova Scotia and New Brunswick *Strongylocentrotus droebachiensis* (green sea urchin) surveys

Monitoring Utility:

Year class strength and biomass estimates are used for stock assessment of population status and provision of management advice

Protocols and Standards:

See Tech Report (reference above)

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Each survey is conducted collaboratively with Industry participation and cost-sharing. With recent poor markets, Industry is finding it very difficult to participate and co-fund.

Options for Program Delivery:

None

13: Higher trophic levels of fish and shellfish– St. of Georgia Details

h) Monitoring sub-element:

Intertidal clam surveys in support of depuration and First Nations fisheries

Years of Data:

1994- present

Frequency:

Annual for some beaches, intermittent for others

Web site (if any):

Recent Publication:

Gillespie, G.E., W.C. Hajas and J.S. Dunham. 2005. Evaluation of assessment and management frameworks in the British Columbia depuration fishery for intertidal clams. Can. Sci. Advisory Secret. Res. Doc. 2005/052. 95 p.

Detailed Program Description:

Assessment surveys for Manila (*Venerupis philippinarum*) and littleneck (*Protothaca staminea*) clams delivering abundance and biomass estimates, length and age structure and growth rates.

Program Linkages:

Used for setting TACs for specific beaches and accumulating data for population analyses.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Biomass estimates used for setting TACs for depuration and First Nation pilot fisheries.

Protocols and Standards:

Gillespie, G.E. and A.R. Kronlund. 1999. A manual for intertidal clam surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2270. 144 p.

Data Management:

Data processed and archived at PBS in the Shellfish Data Unit.

Challenges:

Significant training required for new participants in joint First Nation / Industry / DFO surveys; time required for QA/QC of data and analyses submitted; time required for ageing of samples; survey field and laboratory costs borne by industry or First Nations. Loss of industry support through JPA resulted in discontinuance of model development for forecasting capability to reduce survey requirements and thus costs to industry and First Nations.

Options for Program Delivery:

None

14: Higher trophic levels of fish and shellfish–WCVI Details

a) Monitoring sub-element:

WCVI shrimp survey Areas 121-125 including Area 23.

Years of Data:

1973-present for Areas 124-125

1996-present for Areas 121-123 and Area 23

Frequency:

Annual

Web site (if any):

Survey Bulletins posted to:

<http://www-ops2.pac.dfompo.gc.ca/xnet/content/shellfish/shrimp/Surveys/surveys.htm>

Recent Publication:

CSAS Document 2000/149

Detailed Program Description:

Area sweep trawl biomass surveys for *Pandalus jordani*, and *Pandalopsis dispar*. The PFMA 121-125 component conducted using offshore fisheries research vessel. PFMA 23 component conducted using in-shore fisheries research vessel and excluder gear on net.

Program Linkages:

Estimates are used by FAM for in-season quota adjustments for the shrimp by trawl fisheries

Arctic/Atlantic/Pacific Equivalents:

Gulf and Nova Scotia P. borealis surveys

Monitoring Utility:

Provides indices of shrimp abundance, trends in abundance, year class strength, biological data collected for determining recruitment and mortality parameters. Biomass index used for in-season adjustment of the TAC for the shrimp trawl fisheries in this area

Protocols and Standards:

Standardized fishing gear and tow locations

Data Management:

Extensive data management component. Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

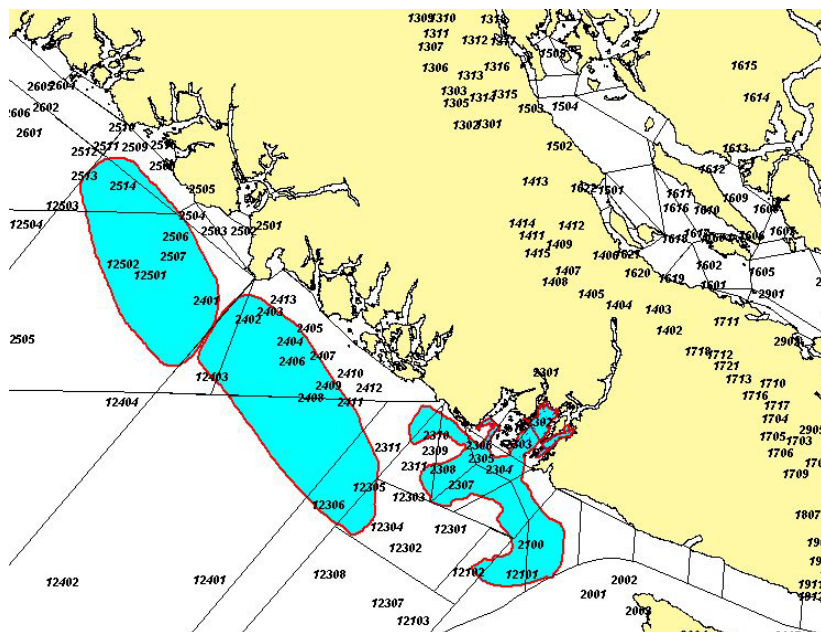
Challenges:

Each cruise requires 23 days of ship time; funding for the personnel is covered by industry

Options for Program Delivery:

None

Map



14: Higher trophic levels of fish and shellfish–WCVI Details

b) Monitoring sub-element:

WCVI including Barkley Sound

Years of Data:

2000 - present

Frequency:

Annually

Web site (if any):

Recent Publications:

Detailed Program Description:

SCUBA diving transect/quadrat survey for density and size of abalone at permanent index sites

Program Linkages:

Monitoring and research on methods rebuilding of abalone populations

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Examining success of rebuilding efforts.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each cruise requires about 10 days of field time, equipment and personnel are covered by A-base, SARA and IRF funds.

Options for Program Delivery:

None

14: Higher trophic levels of fish and shellfish–WCVI Details

c) Monitoring sub-element:

Crab surveys area 24 (Tofino) by skiff

Years of Data:

1984 - present

Frequency:

Quarterly until 1993; annually until 1998, intermittently to present

Web site (if any):

Recent Publication:

Detailed Program Description:

Crab trap surveys Dungeness crab including a small beam trawl to sample juveniles.

Program Linkages:

Biological information collected including growth, mortality, injury and exploitation rates influences the management of Dungeness crab stocks on the B.C. coast.

Arctic/Atlantic/Pacific Equivalents:

N/A

Monitoring Utility:

Determine relative catch rates, degree of exploitation and injury rates; effects of increasing sea otter abundance, changes in species composition and invasive species (Green crab) interactions.

Protocols and Standards:

Standardized fishing gear locations and depths.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Each cruise requires 3-5 days of skiff work; funding for the personnel is covered by A-base or is volunteered.

Options for Program Delivery:

None

14: Higher trophic levels of fish and shellfish–WCVI Details

d) Monitoring sub-element:

Geoduck bed mapping and dive surveys

Years of Data:

1995 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Detailed Program Description:

Geoduck beds are mapped using single-beam acoustic data processing software (QTCView) to calculate area. Randomly-placed transects are completed by divers to estimate density.

Program Linkages:

Bed area and density estimates are used to calculate biomass and quota options for geoduck fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in biomass estimates of geoducks

Protocols and Standards:

Systematic tracklines overlaid on known geoduck beds and backscatter data collected. Transect dive surveys use a stratified random design and observations are recorded from systematically-spaced quadrats.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader and partial field expenses is covered by industry, for acoustic work. Dive surveys coordinated and overseen by DFO and completed by industry divers aboard commercial vessels.

Options for Program Delivery:

None

14: Higher trophic levels of fish and shellfish–WCVI Details

e) Monitoring sub-element:

Sea cucumber fishery experiments and dive surveys

Years of Data:

1998 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Hand, C.M. and J. Rogers. Sea Cucumber Phase 1 Fishery Progress Report. Canadian Stock Assessment Secretariat Research Document 1999/141: 32p.

Detailed Program Description:

Range of exploitation rates applied to surveyed populations are assessed using time-series of density estimates

Program Linkages:

Results to be used for the development of sound fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in our understanding of sea cucumber response to fishing

Protocols and Standards:

Pre-fishery transect surveys using stratified random design. Five study plots fished at different harvest rates: 0%, 2%, 4%, 8% and 16%.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader is covered by industry; diving and harvest conducted by industry participants aboard commercial vessels.

Options for Program Delivery:

None

14: Higher trophic levels of fish and shellfish–WCVI Details

f) Monitoring sub-element 14O:

Red sea urchin (A). SCUBA diving assessment surveys, and (B) Research study sites –Tofino

Years of Data:

(A). 1996-present, (B)1994-present

Frequency:

once per (A) 4-5 years, (B) year

Web site (if any):

Recent Publications:

Atkins, M., A. Campbell, W. C. Hajas, and D. Tzotzos. 2006. Survey of red sea urchin populations in the area of Campania Island, British Columbia, 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2750: 21 pp.
Campbell, A., D. Tzotzos, W. C. Hajas, and L. L. Barton. 2001. Quota options for the red sea urchin fishery in British Columbia for fishing season 2002/2003. Can. Stock Assessment Secretariat Res. Doc. 2001/141.

Detailed Program Description:

(A) SCUBA line transect surveys for densities, size and habitat type per survey.
(B) SCUBA line transects per 9 permanent sites/area for , size and habitat type.

Program Linkages:

(A)Estimates are used for quota estimates per management area.
(B) Data are used for growth, mortality and recruitment estimates.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

(A)Assist yearly quota management process for red sea urchin fishery.
(B) Growth and mortality parameters for modeling populations, and effect of year class strength and recruitment on biomass estimate trends.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each survey cruise requires (A) 7-10 days - funding for the personnel is covered by industry, and (B) 5-10 days of ship time funding for the personnel is partially covered by industry, DFO and FN.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

a) Monitoring sub-element:

Red sea urchin (A). SCUBA diving assessment surveys QCI and central Coast, and (B) Research study sites – QCI

Years of Data:

(A) 1993-present, (B) 1995-present

Frequency:

one per (A) 1-3 years, (B) year

Web site (if any):

Recent Publications:

Atkins, M., A. Campbell, W. C. Hajas, and D. Tzotzos. 2006. Survey of red sea urchin populations in the area of Campania Island, British Columbia, 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2750: 21 pp.

Campbell, A., D. Tzotzos, W. C. Hajas, and L. L. Barton. 2001. Quota options for the red sea urchin fishery in British Columbia for fishing season 2002/2003. Can. Stock Assessment Secretariat Res. Doc. 2001/141.

Detailed Program Description:

(A) SCUBA line transect surveys for densities, size and habitat type per survey.

(B) SCUBA line transects per 9 permanent sites/area for , size and habitat type.

Program Linkages:

(A) Estimates are used for quota estimates per management area.

(B) Data are used for growth, mortality and recruitment estimates.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

(A) Assist yearly quota management process for red sea urchin fishery.

(B) Growth and mortality parameters for modeling populations, and effect of year class strength and recruitment on biomass estimate trends.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each survey cruise requires (A) 7-10 days - funding for the personnel is covered by industry, and (B) 5-10 days of ship time funding for the personnel is partially covered by industry, DFO and FN.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

b) Monitoring sub-element:

Northern abalone surveys at index sites PFM areas 2, 5 and 6

Years of Data:

1978 – present

Frequency:

Once per 4-5 years for each area during April/May

Web site (if any):

Recent Publications:

Atkins, M., J. Lessard & A. Campbell. 2004. Resurvey of northern abalone, *Haliotis kamtschatkana*, populations in southeast Queen Charlotte Islands, British Columbia, April, 2002. *Can. Man. Rep. Fish. Aquat. Sci.* 2704: 32 pp.

Lessard, J., M. J. Atkins & A. Campbell. 2007 (in press). Resurvey of northern abalone, *Haliotis kamtschatkana*, populations along the central coast of British Columbia, April 2001. *Can. Manuscr. Rep. Fish. Aquat. Sci.* 2791: 42 pp.

Detailed Program Description:

SCUBA diving transect/quadrat survey for density and size of abalone at permanent index sites

Program Linkages:

Estimates are used to monitor abundance of abalone which is on the SARA list

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Year class strength and biomass estimates are used to determine status of distribution and abundance.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each cruise requires 14- 20 days of ship time; funding for vessel and personnel is covered by A-base and SARA funds.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

c) Monitoring sub-element:

Shrimp survey Area 9, QCS and PRD

Years of Data:

1996-present

Frequency:

Annual

Web site (if any):

Survey Bulletins posted to:

<http://www-ops2.pac.dfompo.gc.ca/xnet/content/shellfish/shrimp/Surveys/surveys.htm>

Recent Publication:

CSAS Document 2004/026

Detailed Program Description:

Area sweep trawl biomass surveys for *Pandalus jordani*, and *Pandalopsis dispar*. The PFMA 9 and Queen Charlotte Sound component conducted using offshore fisheries research vessel. Prince Rupert District (PRD) component conducted using in-shore fisheries research vessel and excluder gear on net.

Program Linkages:

Estimates are used by FAM for in-season quota adjustments for the shrimp by trawl fisheries

Arctic/Atlantic/Pacific Equivalents:

Gulf and Nova Scotia *P. borealis* surveys

Monitoring Utility:

Provides indices of shrimp abundance, trends in abundance, year class strength, biological data collected for determining recruitment and mortality parameters. Biomass index used for in-season adjustment of the TAC for the shrimp trawl fisheries in this area

Protocols and Standards:

Standardized fishing gear and tow locations

Data Management:

Extensive data management component. Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

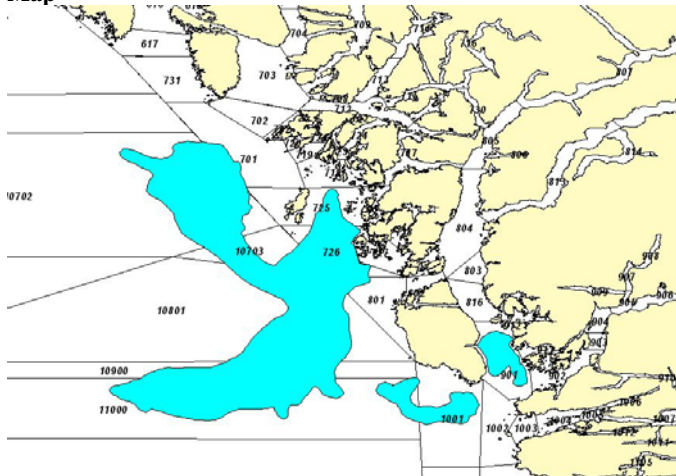
Challenges:

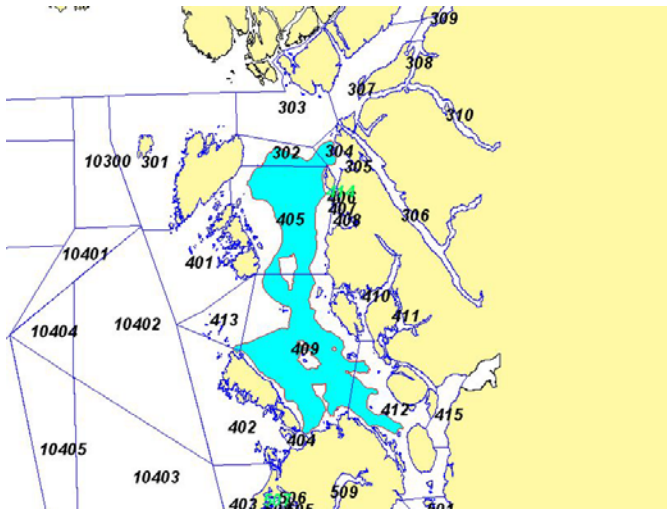
Each cruise requires 10 days of ship time; funding for the personnel is covered by industry

Options for Program Delivery:

None

Map





15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

d) Monitoring sub-element:

Intertidal clam surveys in support of First Nations commercial clam harvests in Area 7.

Years of Data:

1992-present

Frequency:

Annual for selected beaches in each Statistical Subarea

Web site (if any):

Recent Publication:

Gillespie, G.E., T.C. Norgard and F.E. Scurrah. 2001. Status of Manila clam (*Venerupis philippinarum*) stocks in Area 7, with a proposal for active management of a data-limited fishery. Can. Stock Assess. Secret. Res. Doc. 2001/089. 59 p.

Detailed Program Description:

Assessment surveys for Manila (*Venerupis philippinarum*) and littleneck (*Protothaca staminea*) clams delivering abundance and biomass estimates, length and age structure and growth rates.

Program Linkages:

Closure thresholds for Statistical Subareas are set using annual assessment and landings information in a feedback model. Continuing to accumulate data for population analyses.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Biomass estimates used for setting closure thresholds for First Nation commercial fisheries.

Protocols and Standards:

Gillespie, G.E. and A.R. Kronlund. 1999. A manual for intertidal clam surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2270. 144 p.

Data Management:

Data processed and archived at PBS in the Shellfish Data Unit.

Challenges:

Time required for QA/QC of data and analyses submitted; survey field and laboratory, analytical and report writing costs borne by First Nation.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

e) Monitoring sub-element:

Hard bottom fish farm aquaculture site monitoring

Years of Data:

1996 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Emmett, B., P. Thuringer, S. Cook and B. Burd, 2006, The Development of ROV Video Survey and Data Collection Protocols for Monitoring Hard Seabed Substrates. CSAS report in November 2006 in revision.

Detailed Program Description:

Hard bottom assessment of fish farm aquaculture site is a joint monitoring program between B.C. Ministry of the Environment and DFO

Program Linkages:

This program is looking at developing decision rules for habitat managers in the management of fish farms located on hard bottom.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Develop decision rules for near-field effects of fish farm aquaculture on hard-bottom environments

Protocols and Standards:

Video and still photography is present used along transect and within assigned quadrat distances from the farm.

Data Management:

Data processed and archived at PBS in the shellfish data unit and within MOE Waste Management Branch.

Challenges:

There is a requirement for industry to provide this monitoring program but the video quality, location, interpretation and analysis is so poor there is little that can be done with the present monitoring data.

Options for Program Delivery:

More refined standards are required to insure that proper data is being collected and analyzed properly

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

f) Monitoring sub-element:

Sea cucumber fishery experiments and dive surveys

Years of Data:

1998 - present

Frequency:

Annually

Web site (if any):

Recent Publication: Hand, C.M. and J. Rogers. Sea Cucumber Phase 1 Fishery Progress Report. Canadian Stock Assessment Secretariat Research Document 1999/141: 32p.

Detailed Program Description:

Range of exploitation rates applied to surveyed populations are assessed using time-series of density estimates

Program Linkages:

Results to be used for the development of sound fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in our understanding of sea cucumber response to fishing

Protocols and Standards:

Pre-fishery transect surveys using stratified random design. Five study plots fished at different harvest rates: 0%, 2%, 4%, 8% and 16%.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader is covered by industry; diving and harvest conducted by industry participants aboard commercial vessels.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish–WCVI Details

g) Monitoring sub-element:

Red sea urchin (A). SCUBA diving assessment surveys, and (B) Research study sites –Tofino

Years of Data:

(A). 1996-present, (B)1994-present

Frequency:

once per (A) 4-5 years, (B) year

Web site (if any):

Recent Publications:

Atkins, M., A. Campbell, W. C. Hajas, and D. Tzotzos. 2006. Survey of red sea urchin populations in the area of Campania Island, British Columbia, 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2750: 21 pp.
Campbell, A., D. Tzotzos, W. C. Hajas, and L. L. Barton. 2001. Quota options for the red sea urchin fishery in British Columbia for fishing season 2002/2003. Can. Stock Assessment Secretariat Res. Doc. 2001/141.

Detailed Program Description:

(A) SCUBA line transect surveys for densities, size and habitat type per survey.
(C) SCUBA line transects per 9 permanent sites/area for , size and habitat type.

Program Linkages:

(A)Estimates are used for quota estimates per management area.
(C) Data are used for growth, mortality and recruitment estimates.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

(A)Assist yearly quota management process for red sea urchin fishery.
(C) Growth and mortality parameters for modeling populations, and effect of year class strength and recruitment on biomass estimate trends.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the shellfish data unit. Loaded into Maritimes VDC and GBIF.

Challenges:

Each survey cruise requires (A) 7-10 days - funding for the personnel is covered by industry, and (B) 5-10 days of ship time funding for the personnel is partially covered by industry, DFO and FN.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

h) Monitoring sub-element:

Geoduck bed mapping and dive surveys

Years of Data:

1995 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Detailed Program Description:

Geoduck beds are mapped using single-beam acoustic data processing software (QTCView) to calculate area. Randomly-placed transects are completed by divers to estimate density.

Program Linkages:

Bed area and density estimates are used to calculate biomass and quota options for geoduck fishery management

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Improvement in biomass estimates of geoducks

Protocols and Standards:

Systematic tracklines overlaid on known geoduck beds and backscatter data collected. Transect dive surveys use a stratified random design and observations are recorded from systematically-spaced quadrats.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Funding for project leader and partial field expenses is covered by industry, for acoustic work. Dive surveys coordinated and overseen by DFO and completed by industry divers aboard commercial vessels.

Options for Program Delivery:

None

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

i) Monitoring sub-element:

Green sea urchin diver surveys, Areas 11-13.

See monitoring sub-element 17K for details

15: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

j) Monitoring sub-element:

Razor clam surveys in support of First Nations commercial clam harvests in Clam Management Area A.

Years of Data:

1994-present

Frequency:

Annual

Web site (if any):

Recent Publication:

Jones, R., C. Schwarz, B. DeFreitas and L. Lee. 2001. Results of surveys of intertidal razor clams (*Siliqua patula*) on beaches near Massett, Haida Gwaii and recommendations on fishery management. Can. Stock Assess. Secret. Res. Doc. 2001/152. 40 p.

Detailed Program Description:

Assessment surveys for razor clams (*Siliqua patula*) delivering abundance and biomass estimates, length and age structure and growth rates.

Program Linkages:

Annual surveys provide estimates of biomass and recruitment to which harvest rates derived from population analyses are applied to develop TAC for the fishery.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Biomass and recruitment estimates used to set TAC for fishery.

Protocols and Standards:

Jones, R.R., C. Schwarz and L. Lee. 1998. Intertidal population estimate of razor clams () at beaches near Massett, Haida Gwaii/Queen Charlotte Islands, and applications to fishery management. p. 199-211. In: G.S. Jamieson and A. Campbell [eds.]. Proceedings of the North Pacific Symposium on Invertebrate Stock assessment and management. Can. Spec. Publ. Fish. Aquat. Sci. 125.

Data Management:

Data archived by Haida Fisheries Program.

Challenges:

Time required for QA/QC of data and analyses submitted, meetings to consult on fishery management; survey field and laboratory, analytical and report writing costs borne by First Nation.

Options for Program Delivery:

None

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

a) Monitoring sub-element:

Lingcod egg mass and reef fish density dive survey Area 17;
Lingcod young of year trawl survey Areas 13-20; Neocaligus;
Lingcod and reef fish jig survey Areas 13-20.

Years of Data:

1991; 1994; 2000-present
1991; 2004-2006
1991; 2004-2006

Frequency:

Now rotating once every 3 years for each survey

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/sa-mfpd/lingcod/ling_SOG_overview.htm

Recent Publication:

Haggarty, D.R., and J.R. King. 2006. Hook and Line Survey of Lingcod (*Ophiodon elongatus*) and Rockfish (*Sebastes* spp.) in Southern Strait of Georgia (Statistical Areas 18 and 19) June 19-29, 2005. Canadian Technical Report of Fisheries and Aquatic Sciences 2623. 42 p.
Surry, A.M., D.R. Haggarty and J.R. King. 2006. Bottom Trawl Survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 26 – August 8, 2005. Canadian Data Report of Fisheries and Aquatic Sciences 1170. 45 p.
Haggarty, D.R., and J.R. King. 2007. Lingcod Egg Mass and Reef Fish Density SCUBA Survey in the Strait of Georgia, February – March, 2006. Canadian Technical Report of Fisheries and Aquatic Sciences 2691. 27 p.
Surry, A.M., D.R. Haggarty and J.R. King. 2007. Bottom Trawl Survey of Young-of-the-Year Lingcod (*Ophiodon elongatus*) in the Strait of Georgia, July 28 – August 9, 2006. Canadian Technical Report of Fisheries and Aquatic Sciences *In press*. 61 p.

Detailed Program Description:

Fishery independent estimates of relative abundance for Strait of Georgia lingcod for several life history stages; additional information on relative abundance for inshore rockfish populations; additional information on relative abundance of juvenile flatfish populations.

Program Linkages:

Applicable to Strait of Georgia lingcod management framework.

Arctic/Atlantic/Pacific Equivalents:

Unknown

Monitoring Utility:

Fishery independent estimates of relative abundance for lingcod

Protocols and Standards:

SCUBA visual counts in standardized area at specific sites, February-March;
Swept area trawl estimates in random stratified sampling at specific sites, July-August
Handline CPUE using standardized fishing techniques, gear, bait with depth strata.

Data Management:

Data processed and archived at PBS in the groundfish unit. Loaded into GFBIO.

Challenges:

Dive surveys require DFO certified divers and are dependent on weather; 14 days of ship time is required aboard the Neocaligus for trawl survey; handline surveys require 4 staff for 20-30 days.

Options for Program Delivery:

None

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

b) Monitoring sub-element:

- herring dive spawn survey on mainly Areas 14 and 17, but can also be in Areas 13, 15-16, 18-19.
- herring biosample/test fishing charters

Years of Data:

- Herring Dive Spawn Data: 1985 - present, Herring Surface Spawn Data : 1928 - present
- Herring Biosample Data: 1946- present, data used in stock assessment model begins in 1950-1951 season.

Frequency:

- once per year for each area during herring season March – April.

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/herring/bulletin_e.htm

Recent Publication:

- Schweigert, J., and Haist, V. 2006. Stock assessment for British Columbia herring in 2006 and forecasts of the potential catch in 2007. PSARC Working Paper.
- Midgley, P., and Schweigert, J. 2006. Summary of British Columbia herring biological sampling data for the 2003-2004 season. Can. Data Rep. Fish. Aquat. Sci. 1180: v + 81 p.

Detailed Program Description:

- Dive surveys conducted along the length of herring egg beds. Quadrat observations along transects set 350m apart perpendicular to shore to quantify width, length, and intensity of herring spawning.
- Biosampling charters collect samples of herring to assess length, weight, age, sex, and gonad maturity.

Program Linkages:

- spawn survey data and biosample data are components of the data used in the stock assessment model to assess current abundance and forecast stock size for management.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

- Year class strength and biomass estimates are used for herring stock assessment.

Protocols and Standards:

- Fort, C., Daniel, K., and Thompson, M. 2007. Herring Spawn Survey Manual. <http://www.pac.dfo-mpo.gc.ca/sci/herring/hertags/2007SurveyManual.pdf>
- Hamer, L. 1989. Procedures for Collecting and Processing British Columbia Herring Samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27p.

Data Management:

- Herring dive spawn survey data processed and archived in Regional Access database at PBS by Charles Fort.
- Biosample data processed offsite by a contractor. Aging is completed at PBS by the Fish Ageing Lab. All the data is then processed and archived in Regional Access database at PBS by a herring technician.

Challenges:

- Funding for boat charters and divers to perform the survey.
- Funding for the biosample/test fishing charters, port sampling, and processing contracts.

Options for Program Delivery:

- Contracting with industry or First Nations to conduct surveys

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

c) Monitoring sub-element:

Juvenile herring surveys areas 14-18

Years of Data:

- 1991 - present

Frequency:

- once per year for each area during September - October.

Web site (if any):

Recent Publication:

- Haegele, C.W.; Hay, D.E.; Schweigert, J.F.; Armstrong, R.W.; Hrabok, C.; Thompson, M.; Daniel, K.. 2005. Juvenile herring surveys in Johnstone and Georgia Straits, 1996 to 2003. Can. Data Rep. Fish. Aquat. Sci. 1171: xi + 243 p.

Detailed Program Description:

- Three to five seine sets at night spaced 1 km apart along 10 transects in areas 14-18 preserving juvenile herring and salmon samples which are then processed in the lab at PBS.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

- provides an empirical forecast of herring recruitment 3 years in the future for stock assessment.

Protocols and Standards:

- Thompson, M., Hrabok, C., Hay, D.E., Schweigert, J., Haegele, C., and Armstrong, B. 2003. Juvenile herring surveys : methods and database. Can. MS. Rep. Fish. Aquat. Sci. 2651: vi + 31p.

Data Management:

- samples processed by a herring technician. Data is then maintained and archived in a database at PBS by Matt Thompson.

Challenges:

- Funding to hire a skipper to operate the vessel. Technical staff to conduct the survey and process the samples and maintain the database.

Options for Program Delivery:

- Contracting skipper to conduct fishing

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

d) Monitoring sub-element:

Port Sampling Program

Years of Data:

1942 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

DFO Port samplers interview commercial fishermen at the dock as they land their catch and collect biological samples from selected species.

Program Linkages:

Port sampling data is used by all investigators in the groundfish section here at PBS

Arctic/Atlantic/Pacific Equivalents:

Newfoundland region port sampling program

Monitoring Utility:

Biological condition factors (age, growth, mean size, mortality) from the commercial catch are used in a variety of stock assessment models for all commercial groundfish species.

Protocols and Standards:

Sampling procedures are standardized and consistent between samplers.

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

With declining commercial catch and offloading at remote ports it is becoming increasingly difficult to collect samples.

Options for Program Delivery:

Contracted port sampling staff

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

e) Monitoring sub-element:

Hard Bottom Longline survey

Years of Data:

2003, 2004, 2005, 2007

Frequency:

Northern portion surveyed since 2003 on a 3 year cycle, southern portion surveyed in 2005 on a 3 year cycle.

Web site (if any): none

Recent Publication:

Lochead, J.L. and Yamanaka, K.L. 2007. Summary report for the inshore rockfish (*Sebastes spp.*) longline survey conducted in Statistical Areas 14 to 20, 28 and 29, August 11 – September 6, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2690: viii + 53 p.

Detailed Program Description:

This is a random depth stratified survey covering ~ 1/2 of the area of the Strait of Georgia in a year and conducting these surveys in two of three years. It uses standardized longline gear, 2 hour soak times, and is conducted aboard a Coast Guard Science vessel (CCGS Neo-Caligus). This survey is fully A-base funded by DFO.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Standardized catch rates index the relative abundance of species encountered.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on Inshore Rockfish.

Inshore rockfish are a species aggregate of concern, this survey ensures the department is able to track future declines or recoveries for these species in the Strait of Georgia.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

With the loss of b-base funded staff positions it has become increasingly difficult to staff surveys.

The survey vessel is single crewed with a few additional crewing cycles in the summer, competition for this platform make it difficult to secure sufficient vessel time to complete the survey.

Options for Program Delivery:

Charter vessel and contracted at sea technical staff - although there is insufficient core funding to do this.

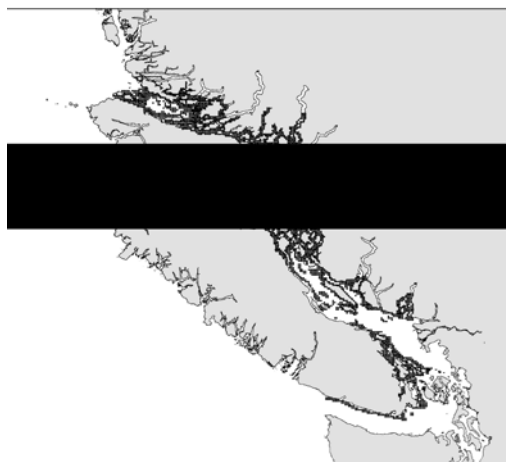


Figure 2: Strait of Georgia, inshore rockfish hard bottom longline survey station grid. Survey stations within the grid are depth stratified and randomly allocated.

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

f) Monitoring sub-element:

Inshore rockfish Hard Bottom Jig Survey

Years of Data:

1984, 1985, 1986, 1987, 1988, 1992, 2004

Frequency:

intermittent

Web site (if any):

Recent Publication:

Yamanaka, K. L. and L. C. Lacko. *in press*. 2004 Research catch and effort data on Nearshore reef-fishes in British Columbia Statistical Area 12. Can. Fish. Aquatic Sci. Tech. Rep.

Detailed Program Description:

Research fishers fish for fixed period of time using a rod and reel and a standardized bait load at each of three depth strata within each selected survey block. The goal is to develop CPUE index to track inshore rockfish abundance. The entire catch is biologically sampled. This survey is A-base funded using DFO staff and vessels.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Standardized catch rates index the relative abundance of species encountered.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on Inshore Rockfish.

Inshore rockfish are a species aggregate of concern, this survey ensures the department is able to track future declines or recoveries for these species in the Strait of Georgia.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

A-base funding is often insufficient to fund this program and staff are difficult to recruit

Options for Program Delivery:

Contracted science staff and vessels, but again this would require a large infusion of a-base funding.

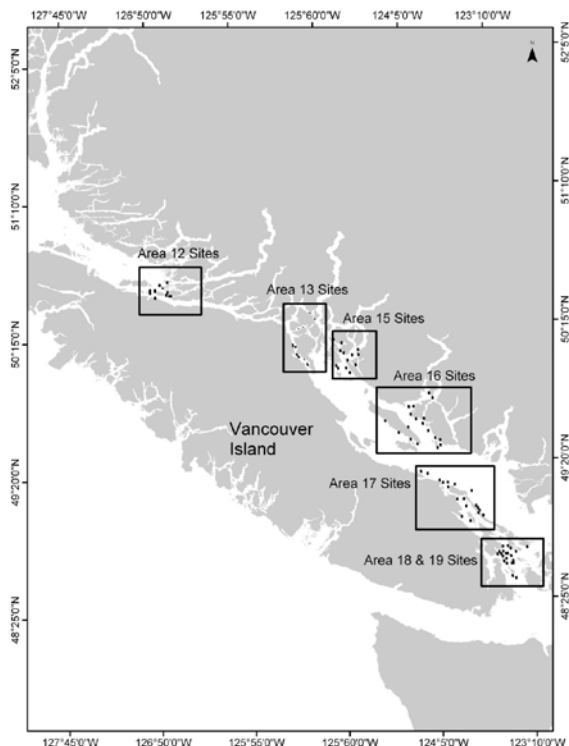


Figure 3: Strait of Georgia inshore rockfish hard bottom jig survey sites.

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

g) Monitoring sub-element:

Submersible surveys

Years of Data:

1985, 2003, 2005

Frequency:

Intermittent

Web site (if any):

Recent Publication:

Detailed Program Description:

Submersible dives are conducted at selected sites to assess the abundance of inshore rockfish, other fish species, invertebrates and to assess habitat. Observers count the number of fish encountered and estimate the size of each fish. This program is almost entirely funded with b-base moneys.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Visual abundance estimates for inshore rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Submersible time is very expensive and post processing of data can be time consuming, this program is challenged by a lack of on going funding.

Options for Program Delivery:

None.

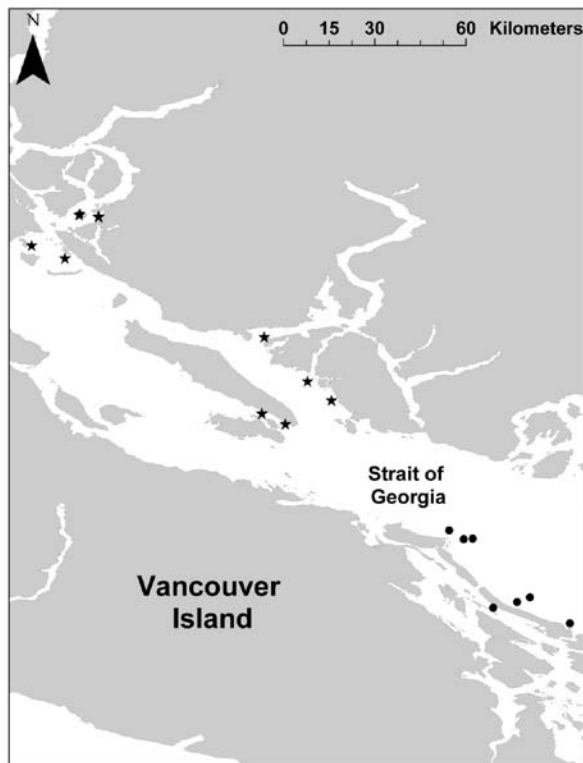


Figure 4: Strait of Georgia inshore rockfish submersible survey dive sites.

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

h) Monitoring sub-element:

Strait of Georgia Hake Biology

Years of Data:

1981-2006

Frequency:

Annual

Web site (if any):

Recent Publication:

King, J.R. and G.A. McFarlane. 2006. Shift in size-at-age of the Strait of Georgia population of Pacific Hake (*Merluccius* production). CalCOFI Rep., Vol.37:111-118.

Detailed Program Description:

Female Pacific Hake in the Strait of Georgia are sampled annually (Feb-April), to monitor changes in size-at-age. Samples are obtained from both research and commercial fisheries. The goal is to test whether density-dependent mechanisms, environmental controls or both are responsible for changes. In addition, the utility of using these changes as a predictor of ecosystem change will be explored.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Changes in biological parameters (age, growth, size at age, maturity)

Protocols and Standards:

Data Management:

Data processed and maintained at PBS (contact B.Andrews / G.McFarlane).

Challenges:

A-base funding insufficient to fund program. Sampling and analysis conducted in conjunction with other programs.

Options for Program Delivery:

Contracted staff.

17: Higher trophic levels of fish and shellfish– St. of Georgia Details

i) Monitoring sub-element:

Strait of Georgia Longline Dogfish survey

Years of Data:

1986,1989, 2004 and 2005

Frequency:

Triannual in future

Web site (if any):

Recent Publication:

McFarlane, G.A., J.R. King and V.R. Hodes. 2006. Biological results of the Strait of Georgia Spiny Dogfish Longline survey, October 18-31.2005. Can. Data. Rep. Fish. Aqua. Sci. 1182; 24p.

Detailed Program Description:

Standardized catch rates used to monitor relative abundance of Dogfish in the strait of Georgia, for use in stock assessments. Changes in sex ratio, size composition and age composition at 4 depths at each of 11 sites are also monitored.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Relative abundance

Biological condition factors (sex ratio, age comp; length comp; growth and maturity)

Protocols and Standards:

Data Management:

Data processed and archived at PBS (contact B.Andrews/G. McFarlane)

Challenges:

A-base funding limited. Survey vessel time is difficult to secure due to competition with other programs.

Options for Program Delivery:

Possible cooperative work with the Dogfish industry.

18: Higher trophic levels of fish and shellfish–WCVI Details

a) Monitoring sub-element :

Sardine relative abundance, distribution, age structure, and size and maturity are assessed.

Years of Data:

Sardine trawl survey 1995-present.

Frequency:

One cruise annually in early August.

Web site (if any): http://www.pac.dfo-mpo.gc.ca/sci/herring/default_e.htm

Recent Publication:

McFarlane et al. 2006. Recent Distribution and Biology of Sardines off British Columbia. CalCOFI Sci. Rep.

Detailed Program Description:

Surface beam trawls are conducted at stations along transects from shore seaward within six strata located from the US border to the northern tip of Vancouver Island

Program Linkages:

Data are provided to US scientists for the coastwide sardine assessment.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Provides information on the distribution and size of sardine for fishery managers.

Protocols and Standards:

Data collected using methods developed for standard groundfish trawls.

Data Management:

Data processed, analyzed and archived at PBS within groundfish database.

Challenges:

Access to vessel time to conduct the survey and P/Y resources man the survey and process the data.

Options for Program Delivery:

Could be done using a charter vessel

18: Higher trophic levels of fish and shellfish–WCVI Details

b) Monitoring sub-element:

Pacific hake Canada-US continental shelf biomass survey from >50m to <1500m depth (Canadian zone and SE Alaska)

Years of Data:

1992- present

Frequency:

Triennial 1992-2001; bienneial 2001-2005

Web site (if any):

Recent Publication:

Guttormsen, M.A., C.D. Wilson, K. Cooke, M.W. Saunders, D.R. McKelvey, and R. Kieser. 2003. Echo integration-trawl survey of Pacific hake, *Merluccius productus*, off the Pacific coast of the United States and Canada during June-August 2001. Alaska Fish. Sci. Center, U.S. Dept. of Commerce, AFSC Processed Report 2003-12. Dec 2003. 81p.

Fleischer, G.W., Ken D. Cooke, Patrick H. Ressler, Rebecca E. Thomas, Stephen K. deBlois, and Lawrence C. Hufnagle. 2006. The 2005 integrated acoustic and trawl survey of Pacific hake, *Merluccius productus*, in U.S. and Canadian waters off the Pacific coast. NOAA-NMFS Technical Memorandum (in prep).

Detailed Program Description:

Acoustic echointegration trawl survey for biomass, distribution of Pacific hake with incidental information on plankton distribution and species interaction

Program Linkages:

Biomass estimates are used for international stock assessment in support of International Hake Treaty (IHT); distributions used to examine climate change impact on species.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Year class strength and biomass estimates are used for biennial adjustment of the IHT-TAC for the coastwide international hake fishery

Protocols and Standards:

Data Management:

Data processed and archived in Region (PBS, IOS) in the Applied Technology (acoustic data), Groundfish (GFBio), and OSAP (oceanography data).

Challenges:

Each cruise requires 90days joint ship time (72 US, 28 Can); Canadian program O&M is A-base;

Options for Program Delivery:

Joint Canada-US survey could be operated from single vessel (W.E. Ricker or NOAA Miller Freeman); Single vessel use would require offsetting science programs in each country impacted by single vessel dedicated to survey for 90days

18: Higher trophic levels of fish and shellfish–WCVI Details

c) Monitoring sub-element:

- herring dive spawn survey on mainly Areas 23-25, and 27.
- herring biosample/test fishing charters

Years of Data:

- Herring Dive Spawn Data: 1985 - present, Herring Surface Spawn Data : 1929 - present
- Herring Biosample Data: 1945- present, data used in stock assessment model begins in 1950-1951 season.

Frequency:

- once per year for each area during herring season March – April.

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/herring/bulletin_e.htm

Recent Publication:

- Schweigert, J., and Haist, V. 2006. Stock assessment for British Columbia herring in 2006 and forecasts of the potential catch in 2007. PSARC Working Paper
- Midgley, P., and Schweigert, J. 2006. Summary of British Columbia herring biological sampling data for the 2003-2004 season. Can. Data Rep. Fish. Aquat. Sci. 1180: v + 81 p.

Detailed Program Description:

- Dive surveys conducted along the length of herring egg beds. Quadrat observations along transects set 350m apart perpendicular to shore to quantify width, length, and intensity of herring spawning.
- Biosampling charters collect samples of herring to assess length, weight, age, sex, and gonad maturity.

Program Linkages:

- spawn survey data and biosample data are components of the data used in the stock assessment model to assess current abundance and forecast stock size for management.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

- Year class strength and biomass estimates are used for herring stock assessment.

Protocols and Standards:

- Fort, C., Daniel, K., and Thompson, M. 2007. Herring Spawn Survey Manual. <http://www.pac.dfo-mpo.gc.ca/sci/herring/hertags/2007SurveyManual.pdf>
- Hamer, L. 1989. Procedures for Collecting and Processing British Columbia Herring Samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27p.

Data Management:

- Herring dive spawn survey data processed and archived in Regional Access database at PBS by Charles Fort.
- Biosample data processed offsite by a contractor. Aging is completed at PBS by the Fish Ageing Lab. All the data is then processed and archived in Regional Access database at PBS by a herring technician.

Challenges:

- Funding for boat charters and divers to perform the survey.
- Funding for the biosample/test fishing charters, port sampling, and processing contracts.

Options for Program Delivery:

- Contracting with industry or First Nations to conduct surveys

18: Higher trophic levels of fish and shellfish–WCVI Details

d) Monitoring sub-element:

West coast Vancouver Island Multi-species Bottom Trawl Survey

Years of Data:

1996, 2004, 2006

Frequency:

Once every two years

Web site (if any):

Recent Publication:

In Prep.

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during the last week of May and the first three weeks of June aboard the RV WE RICKER between the Canada US board in the south and Top Knot Island off the northwest coast of Vancouver island in the North. Approximately 170 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys.

Monitoring Utility:

Inter-annual and spatial differences in relative abundance for 50 – 100 species;
Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth
Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Each cruise requires 28 days of ship time; generally staffed by DFO with some funding from industry

Options for Program Delivery:

Chartered commercial vessel and contracted at sea staff.

18: Higher trophic levels of fish and shellfish–WCVI Details

e) Monitoring sub-element:

Sablefish Trap Survey

Years of Data:

1988 - present

Frequency:

Once every year in the fall, October - November

Web site (if any):

Recent Publication:

Wyeth, M.R., A.R. Kronlund and M. Elfert. 2006. Summary of the 2004 British Columbia Sablefish (*Anoplopoma fimbria*) Research and Assessment survey. Can. Tech. Rep. Fish. Aquat. Sci. 2660: ix + 74p.

Detailed Program Description:

The sablefish trap survey indexes the abundance of sable fish coastwide. In 2003 an area-depth stratified random survey was initiated to run in parallel to the existing (1988-2006) standardized survey. Four years of overlapping surveys have been completed. The catch rates per trap by numbers and weight are used as abundance indices in annual assessments. A portion of the catch from every set is biologically sampled, and a portion is tagged with spaghetti tags and released live for the purposes of studying fish movement and generating a tagging-based estimate of abundance.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Relative abundance

Biological condition factors (age, growth, mean size, mortality)

Fish movement/migration

Protocols and Standards:

Data Management:

Data processed by Sablefish Program staff and via contract prior to archiving at PBS in the groundfish biological data database (GFBIO), PacHarvSable, and PacSableTag.

Challenges:

The surveys are subject to Laroque implications and as such future funding of the surveys is undetermined at this time.

Options for Program Delivery:

Options range from DFO funding, low probability of continued industry support.

18: Higher trophic levels of fish and shellfish–WCVI Details

f) Monitoring sub-element:

Port Sampling Program

Years of Data:

1942 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

DFO Port samplers interview commercial fishermen at the dock as they land their catch and collect biological samples from selected species

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Newfoundland region port sampling program

Monitoring Utility:

Biological condition factors (age, growth, mean size, mortality) from the commercial catch are used in a variety of stock assessment models for all commercial groundfish species.

Protocols and Standards:

Sampling procedures are standardized and consistent between samplers.

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

With declining commercial catch and offloading at remote ports it is becoming increasingly difficult to collect samples.

Options for Program Delivery:

Contracted port sampling staff

18: Higher trophic levels of fish and shellfish–WCVI Details

g) Monitoring sub-element:

At Sea Observer Program

Years of Data:

1996 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

The at sea observer program covers almost all groundfish fisheries on the west coast including bottom trawl, mid-water trawl, hook and line, as well as trap, jig and troll. Certified observers are deployed aboard commercial fishing vessel to monitor catch of both permitted and non-permitted species, collect biological samples, monitor fishing locations and assess the survival of released catch. Depending on the fishery, gear and vessel size almost all vessels are required to carry either a human observer or an electronic monitoring device.

Program Linkages:

Data are used by fish management in season to track harvest and ensure compliance with the harvest plan. Data are also used by conservation and protection branch to prosecute violations.

Arctic/Atlantic/Pacific Equivalents:

Newfoundland, Maritimes and Gulf regions observer programs

Monitoring Utility:

Distribution of fishing effort
Biological condition factors (age, growth, mean size, mortality)
Commercial catch rates
Compliance with the management plan

Protocols and Standards:

Data collection procedures are standardized by the Contractor providing service.

Data Management:

Data processed by the contractor and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Staff retention has proven very difficult for the contractor. Inconsistency between observers has also been a problem.

Options for Program Delivery:

Contracted port sampling staff

18: Higher trophic levels of fish and shellfish–WCVI Details

h) Monitoring sub-element:

IPHC Halibut Longline survey

Years of Data:

1963 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Yamanaka, K.L., Lochead, J.K., Cooke K., Lacko, L.C. and Dykstra, C. 2007. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 31 to July 24, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2689: vii + 55 p.

Detailed Program Description:

This survey has been used by the International Pacific Halibut commission to assess the abundance of Pacific Halibut along the west coast of North America since 1963. This is a fixed station survey with a spacing of approximately 10 nautical miles. Since 2003 there has been the opportunity to deploy additional staff aboard these vessels to collect hook by hook catch data and collect biological samples from the Non-halibut catch.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Standardized catch rates index the relative abundance of species encountered.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on Inshore Rockfish.

Protocols and Standards:

Data Management:

Fishing location are processed by the IPHC and archived in their data base, a copy is stored in the Pacific region Groundfish database, GFBio. Non-halibut biological data is processed by the groundfish data unit and stored in GFBio.

Challenges:

The halibut fishing industry has paid for the technical staff deployed on the surveys to collect data for DFO. Since the Laroque Decision, it is unclear whether industry will fund this activity.

Options for Program Delivery:

None

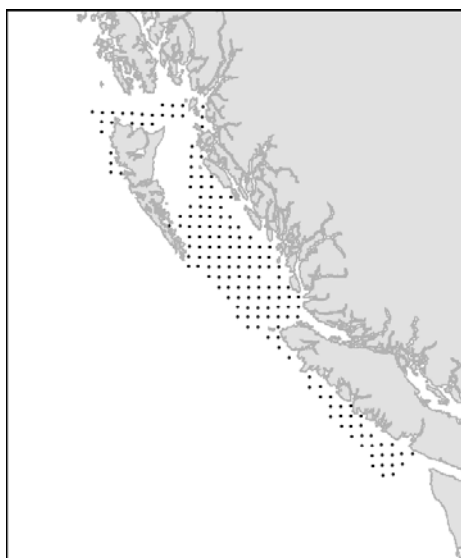


Figure 5: Coastwide International Pacific Halibut Commission longline survey stations.

18: Higher trophic levels of fish and shellfish–WCVI Details

i) Monitoring sub-element:

Industry Sponsored Hard Bottom Longline survey

Years of Data:

2006 northern BC, 2007 southern BC

Frequency:

Annually, covering the entire BC coast in two years.

Web site (if any):

Recent Publication:

Detailed Program Description:

This is a random depth stratified survey covering one half of the near shore hard bottom habitat of the entire BC coast each year. Commercial vessels using standardized gear and contracted at sea technician are hired by industry to complete the survey. With the exception of some data processing this survey is fully funded by industry.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Abundance of near shore rockfish is monitored with standardized catch rate indices.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

This survey is fully funded by the halibut fishing industry. Since the Laroque Decision, it is unclear whether it will proceed.

Options for Program Delivery:

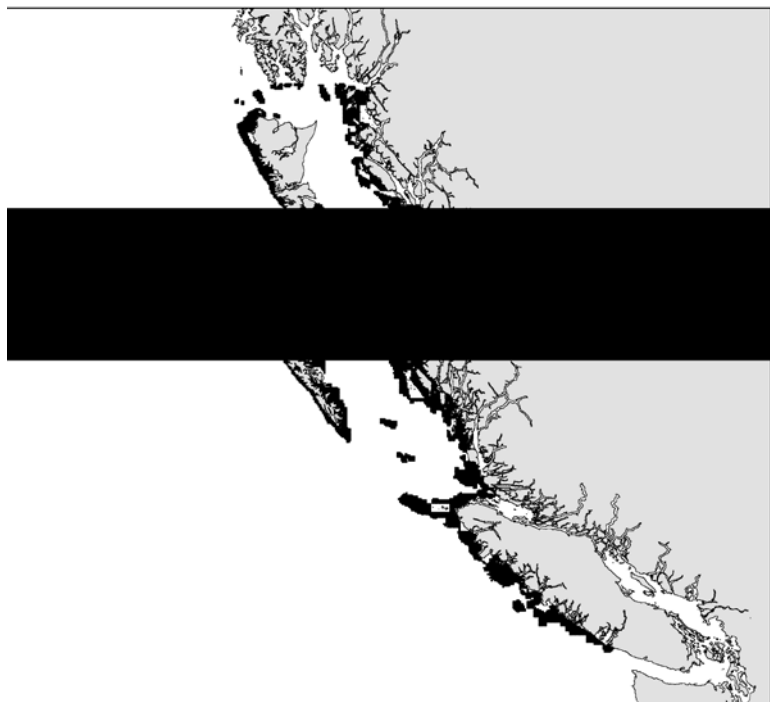


Figure 6: Coastwide Pacific Halibut Management Association's hard bottom longline survey station grid. Survey stations within the grid are depth stratified and randomly allocated.

18: Higher trophic levels of fish and shellfish–WCVI Details

j) Monitoring sub-element:

Sardine Abundance and Biology survey

Years of Data:

1996- 2006

Frequency:

Annual

Web site (if any):

Recent Publication:

McFarlane, G. A. , J. Schweigert, L. MacDougall and C. Hrabok. 2005. Distribution and biology of Pacific Sardines off British Columbia. CALCOFI Rep. 46: 144-160..

Detailed Program Description:

Surface water trawl survey conducted annually (July-August) off the WCVI to monitor abundance of Pacific sardines. The survey follows fixed onshore-offshore transects with 7-9 set locations per transect. The goal is to monitor relative abundance, offshore and northward distribution, and biological parameters (length, sex, weight, age, maturity, diet). All incidental species are identified and sampled.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Relative abundance

Offshore/onshore, northward distribution

Biological condition factors (age, growth, maturity, diet)

Protocols and Standards:

Data Management:

Data processed and maintained at PBS (contact B.andrews/G.McFarlane)

Challenges:

Program is partially funded by industry. Funds often delayed causing staffing issues.

Options for Program Delivery:

Fully fund from DFO.

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

a) Monitoring sub-element:

Can/US Hake Survey -See Monitoring sub-element 18E for details.

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

b) Monitoring sub-element:

- herring dive spawn surveys in QCI (Areas 2E and 2W), PRD (Areas 3-5) and CC (Areas 6-8)
- herring biosample/test fishing charters QCI (Areas 2E and 2W), PRD (Areas 3-5) and CC (Areas 6-8)

Years of Data:

- Herring Dive Spawn Data: 1986 – present (PRD and CC) and 1988 – present (QCI), Herring Surface Spawn Data : 1931 – present (PRD and CC), 1940 – present (QCI)
- Herring Biosample Data: 1951- present, data used in stock assessment model begins in 1950-1951 season.

Frequency:

- once per year for each area during herring season March – April.

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/herring/bulletin_e.htm

Recent Publication:

- Schweigert, J., and Haist, V. 2006. Stock assessment for British Columbia herring in 2006 and forecasts of the potential catch in 2007. PSARC Working Paper
- Midgley, P., and Schweigert, J. 2006. Summary of British Columbia herring biological sampling data for the 2003-2004 season. Can. Data Rep. Fish. Aquat. Sci. 1180: v + 81 p.

Detailed Program Description:

- Dive surveys conducted along the length of herring egg beds. Quadrat observations along transects set 350m apart perpendicular to shore to quantify width, length, and intensity of herring spawning.
- Biosampling charters collect samples of herring to assess length, weight, age, sex, and gonad maturity.

Program Linkages:

- spawn survey data and biosample data are components of the data used in the stock assessment model to assess current abundance and forecast stock size for management.

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

- Year class strength and biomass estimates are used for herring stock assessment.

Protocols and Standards:

- Fort, C., Daniel, K., and Thompson, M. 2007. Herring Spawn Survey Manual. <http://www.pac.dfo-mpo.gc.ca/sci/herring/hertags/2007SurveyManual.pdf>
- Hamer, L. 1989. Procedures for Collecting and Processing British Columbia Herring Samples. Can. MS Rep. Fish. Aquat. Sci. 2030: 27p.

Data Management:

- Herring dive spawn survey data processed and archived in Regional Access database at PBS by Charles Fort.
- Biosample data processed offsite by a contractor. Aging is completed at PBS by the Fish Ageing Lab. All the data is then processed and archived in Regional Access database at PBS by a herring technician.

Challenges:

- Funding for boat charters and divers to perform the survey.
- Funding for the biosample/test fishing charters, port sampling, and processing contracts.

Options for Program Delivery:

- Contracting with industry or First Nations to conduct surveys

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

c) Monitoring sub-element:

Queen Charlotte Sound Multi-species bottom trawl survey

Years of Data:

2003, 2004, 2005, 2007

Frequency:

Initially three years in then once every two years

Web site (if any):

Recent Publication:

Olsen, N, Workman, G. D., and Stanley, R. D. 2007. Queen Charlotte Sound Groundfish Bottom Trawl Survey July 5th to August 19th, 2005. Can. Manuscr. Rep. Fish. Aquat. Sci. 2784: 58 p.

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during July and August in Queen Charlotte Sound aboard a chartered commercial fishing vessel. Approximately 240 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition. This survey is almost entirely funded by the commercial groundfish trawl industry. Each cruise requires 32 - 38 days to complete; generally staffed with two DFO staff and three industry funded at sea technicians.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Ensuring consistent fishing performance between chartered vessels

Options for Program Delivery:

Entirely DFO funded with a Coast Guard Vessel.

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

d) Monitoring sub-element:

Hecate Strait Multi-species Bottom Trawl Survey

Years of Data:

1984, 1985, 1987, 1989, 1991, 1993, 1995, 1996, 1998, 2000, 2002, 2003, 2005

Frequency:

Once every two years, approximately.

Web site (if any):

Recent Publication:

Choromanski, E.M., G.D. Workman, and J. Fargo. 2005. Hecate Strait multi-species bottom trawl survey, CCGS W.E. Ricker, May 19 to June 7, 2003. Can. Data Rep. Fish. Aquat. Sci. 1169.

Detailed Program Description:

This survey was initially designed to study species interactions, ecosystem structure assemblages using a depth stratified systematic survey design to distribute fishing effort across all areas of Hecate Strait, in 2005 the survey was changed to a random depth stratified design with the primary objective of indexing species abundance. Approximately 200 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. This survey is almost entirely a-base funded by DFO and conducted aboard a coast guard science vessel.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Newfoundland region Grand Bank multi-species bottom trawl survey. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Ensuring consistent fishing performance between chartered vessels

Options for Program Delivery:

Chartered commercial vessel and contracted staff

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

e) Monitoring sub-element:

West Coast of Queen Charlotte Islands Multi-species bottom trawl survey

Years of Data:

1997, 2006

Frequency:

Once every two years now that the series is initiated

Web site (if any):

Recent Publication:

In Prep.

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during September off the west coast of the Queen Charlotte Islands aboard a chartered commercial fishing vessel. Approximately 125 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition. This survey is almost entirely funded by the commercial groundfish trawl industry. Each cruise requires 22 - 24 days to complete; generally staffed with two DFO staff and three industry funded at sea technicians.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Ensuring consistent fishing performance between chartered vessels

Options for Program Delivery:

Entirely DFO funded with a Coast Guard Vessel.

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

f) Monitoring sub-element:

Sablefish Trap Survey

Years of Data:

1988 - present

Frequency:

Once every year in the fall, October - November

Web site (if any):

Recent Publication:

Wyeth, M.R., A.R. Kronlund and M. Elfert. 2006. Summary of the 2004 British Columbia Sablefish (*Anoplopoma fimbria*) Research and Assessment survey. Can. Tech. Rep. Fish. Aquat. Sci. 2660: ix + 74p.

Detailed Program Description:

The sablefish trap survey indexes the abundance of sable fish coastwide. In 2003 an area-depth stratified random survey was initiated to run in parallel to the existing (1988-2006) standardized survey. Four years of overlapping surveys have been completed. The catch rates per trap by numbers and weight are used as abundance indices in annual assessments. A portion of the catch from every set is biologically sampled, and a portion is tagged with spaghetti tags and released live for the purposes of studying fish movement and generating a tagging-based estimate of abundance.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Relative abundance

Biological condition factors (age, growth, mean size, mortality)

Fish movement/migration

Protocols and Standards:

Data Management:

Data processed by Sablefish Program staff and via contract prior to archiving at PBS in the groundfish biological data database (GFBIO), PacHarvSable, and PacSableTag.

Challenges:

The surveys are subject to Laroque implications and as such future funding of the surveys is undetermined at this time.

Options for Program Delivery:

Options range from DFO funding, low probability of continued industry support.

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

g) Monitoring sub-element:

Port Sampling Program

Years of Data:

1942 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

DFO Port samplers interview commercial fishermen at the dock as they land their catch and collect biological samples from selected species

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Newfoundland region port sampling program

Monitoring Utility:

Biological condition factors (age, growth, mean size, mortality) from the commercial catch are used in a variety of stock assessment models for all commercial groundfish species.

Protocols and Standards:

Sampling procedures are standardized and consistent between samplers.

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

With declining commercial catch and offloading at remote ports it is becoming increasingly difficult to collect samples.

Options for Program Delivery:

Contracted port sampling staff

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

h) Monitoring sub-element:

At Sea Observer Program

Years of Data:

1996 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

The at sea observer program covers almost all groundfish fisheries on the west coast including bottom trawl, mid-water trawl, hook and line, as well as trap, jig and troll. Certified observers are deployed aboard commercial fishing vessel to monitor catch of both permitted and non-permitted species, collect biological samples, monitor fishing locations and assess the survival of released catch. Depending on the fishery, gear and vessel size almost all vessels are required to carry either a human observer or an electronic monitoring device.

Program Linkages:

Data are used by fish management in season to track harvest and ensure compliance with the harvest plan. Data are also used by conservation and protection branch to prosecute violations.

Arctic/Atlantic/Pacific Equivalents:

Newfoundland, Maritimes and Gulf regions observer programs

Monitoring Utility:

Distribution of fishing effort
Biological condition factors (age, growth, mean size, mortality)
Commercial catch rates
Compliance with the management plan

Protocols and Standards:

Data collection procedures are standardized by the Contractor providing service.

Data Management:

Data processed by the contractor and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Staff retention has proven very difficult for the contractor. Inconsistency between observers has also been a problem.

Options for Program Delivery:

Contracted port sampling staff

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

i) Monitoring sub-element:

IPHC Halibut Longline survey

Years of Data:

1963 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Yamanaka, K.L., Lochead, J.K., Cooke K., Lacko, L.C. and Dykstra, C. 2007. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 31 to July 24, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2689: vii + 55 p.

Detailed Program Description:

This survey has been used by the International Pacific Halibut commission to assess the abundance of Pacific Halibut along the west coast of North America since 1963. This is a fixed station survey with a spacing of approximately 10 nautical miles. Since 2003 there has been the opportunity to deploy additional staff aboard these vessels to collect hook by hook catch data and collect biological samples from the Non-halibut catch.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Standardized catch rates index the relative abundance of species encountered.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on Inshore Rockfish.

Protocols and Standards:

Data Management:

Fishing location are processed by the IPHC and archived in their data base, a copy is stored in the Pacific region Groundfish database, GFBio. Non-halibut biological data is processed by the groundfish data unit and stored in GFBio.

Challenges:

The halibut fishing industry has paid for the technical staff deployed on the surveys to collect data for DFO. Since the Laroque Decision, it is unclear whether industry will fund this activity.

Options for Program Delivery:

None

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

j) Monitoring sub-element:

Industry Sponsored Hard Bottom Longline survey

Years of Data:

2006 northern BC, 2007 southern BC

Frequency:

Annually, covering the entire BC coast in two years.

Web site (if any):

Recent Publication:

?

Detailed Program Description:

This is a random depth stratified survey covering one half of the near shore hard bottom habitat of the entire BC coast each year. Commercial vessels using standardized gear and contracted at sea technician are hired by industry to complete the survey. With the exception of some data processing this survey is fully funded by industry.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Abundance of near shore rockfish is monitored with standardized catch rate indices.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

This survey is fully funded by the halibut fishing industry. Since the Laroque Decision, it is unclear whether it will proceed.

Options for Program Delivery:

19: Higher trophic levels of fish and shellfish – PNCIMA (out to the continental shelf edge)

k) Monitoring sub-element:

Submersible surveys in the Queen Charlotte Islands

Years of Data:

2000, 2005

Frequency:

Intermittent

Web site (if any):

Recent Publication:

Yamanaka, K.L. 2005. Data report for the research cruise onboard the *CCGS John P. Tully* and the *F/V Double Decker* to Bowie Seamount and Queen Charlotte Islands July 31th to August 14th 2000. Can. Data Rep Fish. Aquatic Sci. 1163: vii + 46 p.

Detailed Program Description:

Submersible dives are conducted at selected sites to assess the abundance of inshore rockfish, other fish species, invertebrates and to assess habitat. Observers count the number of fish encountered and estimate the size of each fish. This program is almost entirely funded with b-base moneys.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Visual abundance estimates for inshore rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Submersible time is very expensive and post processing of data can be time consuming, this program is challenged by a lack of on going funding.

Options for Program Delivery:

None.

20: Higher trophic levels of fish and shellfish –Open Ocean

a) Monitoring sub-element:

Deep water ecosystem surveys

Years of Data:

1999 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Boutillier, J.A. and G.E. Gillespie. 2005. A phased approach to fishery development in the deep sea – a case study for the grooved Tanner crab (*Chionoecetes tanneri*). p. 235-246. In: R. Shotton [ed.]. Deep Sea 2003: Conference on the governance and management of deep-sea fisheries. Pt. 1: Conference reports. FAO Fisheries Proceedings 3/1.

Gillespie, G.E., K.H. Fong, A.C. Phillips, G.R. Meyer, J.A. Boutillier. 2004. Development of a New Fishery for Tanner Crabs (*Chionoecetes tanneri* Rathbun, 1893) off British Columbia: 2003 Status Report. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/132

Detailed Program Description:

Systematic area swept trawl of the B.C. continental slope and abyss (500-2400m). Trapping and video data is collected during these surveys

Program Linkages:

Biodiversity of this regions invertebrates and fish is assessed and detailed biological information is collect on all potentially commercial crabs and fish species.

Arctic/Atlantic/Pacific Equivalents:

Maritime corridor of discovery has many of the same elements

Monitoring Utility:

Assessment have been used in the evaluation of commercially exploited fish such as long-spined thornyheads and two species of commercial tanner crab. There have been a number of new records and species discovered as a result of this work.

Protocols and Standards:

Depth stratified systematic tows are place along the continental slope and abyssal region of B.C. coastline in depths ranging from 500-2400 m. The tow lengths are tracked with bottom sensors, net mensuration systems or video.

Data Management:

Data processed and archived at PBS in the shellfish data unit.

Challenges:

Identification of the unique species has been a problem as there is not the taxonomic expertise available for many of these phyla. In addition the quantification of the tow length and width is problematic as most of the standard systems for net measurements do not function at some of these depths.

Options for Program Delivery:

None at this time but there is potential for video or still photographic assessments as the technology improves.

20: Higher trophic levels of fish and shellfish –Open Ocean

b) Monitoring sub-element:

Can/US Hake Survey -See Monitoring sub-element 18E for details.

20: Higher trophic levels of fish and shellfish –Open Ocean

c) Monitoring sub-element:

West coast Vancouver Island Multi-species Bottom Trawl Survey

Years of Data:

1996, 2004, 2006

Frequency:

Once every two years

Web site (if any):

Recent Publication:

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during the last week of May and the first three weeks of June aboard the RV WE RICKER between the Canada US board in the south and Top Knot Island off the northwest coast of Vancouver Island in the North. The depth range covered is 50 – 500 m which spans the continental shelf break so this survey is present in the WCVI and open ocean sections of this summary. Approximately 170 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Each cruise requires 28 days of ship time; generally staffed by DFO with some funding from industry

Options for Program Delivery:

Chartered commercial vessel and contracted at sea staff.

20: Higher trophic levels of fish and shellfish –Open Ocean

d) Monitoring sub-element:

Queen Charlotte Sound Multi-species bottom trawl survey

Years of Data:

2003, 2004, 2005, 2007

Frequency:

Initially three years in then once every two years

Web site (if any):

Recent Publication:

Olsen, N, Workman, G. D., and Stanley, R. D. 2007. Queen Charlotte Sound Groundfish Bottom Trawl Survey July 5th to August 19th, 2005. Can. Manuscr. Rep. Fish. Aquat. Sci. 2784: 58 p.

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during July and August in Queen Charlotte Sound aboard a chartered commercial fishing vessel. The survey covers all of Queen Charlotte Sound from the northern end of Vancouver Island northward into Southern Hecate Strait. The depth range covered is 50 – 500 m which spans the continental shelf break so this survey is present in the PNCIMA and Open Ocean sections of this summary. Approximately 240 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition. This survey is almost entirely funded by the commercial groundfish trawl industry. Each cruise requires 32 - 38 days to complete; generally staffed with two DFO staff and three industry funded at sea technicians.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Ensuring consistent fishing performance between chartered vessels

Options for Program Delivery:

Entirely DFO funded with a Coast Guard Vessel.

20: Higher trophic levels of fish and shellfish –Open Ocean

e) Monitoring sub-element:

West Coast of Queen Charlotte Islands Multi-species bottom trawl survey

Years of Data:

1997, 2006

Frequency:

Once every two years now that the series is initiated

Web site (if any):

Recent Publication:

In Prep.

Detailed Program Description:

A random depth stratified bottom trawl survey is conducted during September off the west coast of the Queen Charlotte Islands aboard a chartered commercial fishing vessel. Area coverage is from the Canada/US border in the North to Chad Point, approximately halfway down the west coast of the Queen Charlotte Islands.

The depth range covered is 50 – 1500 m which spans the continental shelf break so this survey is present in the PNCIMA and Open Ocean sections of this summary. Approximately 125 bottom trawl tows are completed, all species encountered are enumerated, most are biologically sampled for size and approximately half are further sampled for weight, maturity and age. The primary purpose of these surveys is to produce relative abundance indices that over time will accurately track changes in stock abundance and condition. This survey is almost entirely funded by the commercial groundfish trawl industry. Each cruise requires 22 - 24 days to complete; generally staffed with two DFO staff and three industry funded at sea technicians.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Eastern Scotian Shelf and Grand Banks Multi-species bottom trawl surveys. **Monitoring Utility:**

Inter-annual and spatial differences in relative abundance for 50 – 100 species;

Biological condition of the species/stock, evidence of recruitment or ageing, changes in growth

Biodiversity in the ecosystem within the limitation of the fishing gear employed.

Protocols and Standards:

Standardized fishing gear and survey design, standardized bio-sampling protocol and procedures.

Data Management:

Data processed and archived at PBS in the groundfish biological database (GFBio).

Challenges:

Ensuring consistent fishing performance between chartered vessels

Options for Program Delivery:

Entirely DFO funded with a Coast Guard Vessel.

20: Higher trophic levels of fish and shellfish –Open Ocean

f) Monitoring sub-element:

Sablefish Trap Survey

Years of Data:

1988 - present

Frequency:

Once every year in the fall, October - November

Web site (if any):

Recent Publication:

Wyeth, M.R., A.R. Kronlund and M. Elfert. 2006. Summary of the 2004 British Columbia Sablefish (*Anoplopoma fimbria*) Research and Assessment survey. Can. Tech. Rep. Fish. Aquat. Sci. 2660: ix + 74p.

Detailed Program Description:

The sablefish trap survey indexes the abundance of sable fish coastwide. In 2003 an area-depth stratified random survey was initiated to run in parallel to the existing (1988-2006) standardized survey. Four years of overlapping surveys have been completed. The catch rates per trap by numbers and weight are used as abundance indices in annual assessments. A portion of the catch from every set is biologically sampled, and a portion is tagged with spaghetti tags and released live for the purposes of studying fish movement and generating a tagging-based estimate of abundance.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Relative abundance

Biological condition factors (age, growth, mean size, mortality)

Fish movement/migration

Protocols and Standards:

Data Management:

Data processed by Sablefish Program staff and via contract prior to archiving at PBS in the groundfish biological data database (GFBIO), PacHarvSable, and PacSableTag.

Challenges:

The surveys are subject to Laroque implications and as such future funding of the surveys is undetermined at this time.

Options for Program Delivery:

Options range from DFO funding, low probability of continued industry support.

20: Higher trophic levels of fish and shellfish –Open Ocean

g) Monitoring sub-element:

Port Sampling Program

Years of Data:

1942 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

DFO Port samplers interview commercial fishermen at the dock as they land their catch and collect biological samples from selected species. This program spans all depth ranges, areas, and multiple gears and licenses, this is why it appears in all sections of this summary.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Newfoundland region port sampling program

Monitoring Utility:

Biological condition factors (age, growth, mean size, mortality) from the commercial catch are used in a variety of stock assessment models for all commercial groundfish species.

Protocols and Standards:

Sampling procedures are standardized and consistent between samplers.

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

With declining commercial catch and offloading at remote ports it is becoming increasingly difficult to collect samples.

Options for Program Delivery:

Contracted port sampling staff

20: Higher trophic levels of fish and shellfish –Open Ocean

h) Monitoring sub-element:

At Sea Observer Program

Years of Data:

1996 - present

Frequency:

Year round every year

Web site (if any):

Recent Publication:

Detailed Program Description:

The at sea observer program covers almost all groundfish fisheries on the west coast including bottom trawl, mid-water trawl, hook and line, as well as trap, jig and troll. Certified observers are deployed aboard commercial fishing vessel to monitor catch of both permitted and non-permitted species, collect biological samples, monitor fishing locations and assess the survival of released catch. Depending on the fishery, gear and vessel size almost all vessels are required to carry either a human observer or an electronic monitoring device.

Program Linkages:

Data are used by fish management in season to track harvest and ensure compliance with the harvest plan. Data are also used by conservation and protection branch to prosecute violations.

Arctic/Atlantic/Pacific Equivalents:

Newfoundland, Maritimes and Gulf regions observer programs

Monitoring Utility:

Distribution of fishing effort
Biological condition factors (age, growth, mean size, mortality)
Commercial catch rates
Compliance with the management plan

Protocols and Standards:

Data collection procedures are standardized by the Contractor providing service.

Data Management:

Data processed by the contractor and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Staff retention has proven very difficult for the contractor. Inconsistency between observers has also been a problem.

Options for Program Delivery:

Contracted port sampling staff

20: Higher trophic levels of fish and shellfish –Open Ocean

i) Monitoring sub-element:

IPHC Halibut Longline survey

Years of Data:

1963 - present

Frequency:

Annually

Web site (if any):

Recent Publication:

Yamanaka, K.L., Lochead, J.K., Cooke K., Lacko, L.C. and Dykstra, C. 2007. Summary of non-halibut catch from the Standardized Stock Assessment Survey conducted by the International Pacific Halibut Commission in British Columbia from May 31 to July 24, 2005. Can. Tech. Rep. Fish. Aquat. Sci. 2689: vii + 55 p.

Detailed Program Description:

This survey has been used by the International Pacific Halibut commission to assess the abundance of Pacific Halibut along the west coast of North America since 1963. This is a fixed station survey with a spacing of approximately 10 nautical miles. Since 2003 there has been the opportunity to deploy additional staff aboard these vessels to collect hook by hook catch data and collect biological samples from the Non-halibut catch.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Standardized catch rates index the relative abundance of species encountered.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on Inshore Rockfish.

Protocols and Standards:

Data Management:

Fishing location are processed by the IPHC and archived in their data base, a copy is stored in the Pacific region Groundfish database, GFBio. Non-halibut biological data is processed by the groundfish data unit and stored in GFBio.

Challenges:

The halibut fishing industry has paid for the technical staff deployed on the surveys to collect data for DFO. Since the Laroque Decision, it is unclear whether industry will fund this activity.

Options for Program Delivery:

None

20: Higher trophic levels of fish and shellfish –Open Ocean

j) Monitoring sub-element:

Industry Sponsored Hard Bottom Longline survey

Years of Data:

2006 northern BC, 2007 southern BC

Frequency:

Annually, covering the entire BC coast in two years.

Web site (if any):

Recent Publication:

?

Detailed Program Description:

This is a random depth stratified survey covering one half of the near shore hard bottom habitat of the entire BC coast each year. Commercial vessels using standardized gear and contracted at sea technician are hired by industry to complete the survey. With the exception of some data processing this survey is fully funded by industry.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Abundance of near shore rockfish is monitored with standardized catch rate indices.

Biological condition factors (age, growth, mean size, mortality) from all species encountered with an emphasis on rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

This survey is fully funded by the halibut fishing industry. Since the Laroque Decision, it is unclear whether it will proceed.

Options for Program Delivery:

21: Upper trophic Levels – Marine Mammals –St. of Georgia

a) Monitoring sub-element:

Abundance, distribution, diet and prey consumption of seals

Years of Data:

1970s- present

Frequency:

Annually in various subareas, with specific subareas monitored at 2-10 year intervals

Web site (if any):

Recent Publication:

Olesiuk (1999) available at: http://www.dfo-mpo.gc.ca/csas/Csas/publications/ResDocs-DocRech/1999/1999_033_e.htm

Detailed Program Description:

Aerial surveys at low tide towards end of pupping season using digital photography to census number of seals at haulout sites.

Program Linkages:

Estimates are used for development of ecosystem models.

Arctic/Atlantic/Pacific Equivalents:

Estimates are component of National pinniped program

Monitoring Utility:

Provides indication of ecosystem health. Consumption rates have impact on commercial and recreational fisheries.

Protocols and Standards:

Surveys conducted using standardized census methods calibrated with methods used along west coast North America.

Data Management:

Data processed and archived at PBS in Pinniped Program unit.

Challenges:

Obtaining funding and qualified personnel to participate in the survey

Options for Program Delivery:

Contract to consultants or academics

21: Upper trophic Levels – Marine Mammals –St. of Georgia

b) Monitoring sub-element:

Abundance, distribution, diet and consumption for sea lions

Years of Data:

1970s- present

Frequency:

once every 4-5 years

Web site (if any):

Recent Publication:

Pitcher, Olesiuk, et al. available at: <http://fishbull.noaa.gov/1051/1051toc.htm>

Detailed Program Description:

Aerial surveys or boat censuses at breeding rookeries and haulout sites using digital photography.

Program Linkages:

Estimates are used for development of ecosystem models.

Arctic/Atlantic/Pacific Equivalents:

Estimates are component of National pinniped program

Monitoring Utility:

Provides indication of ecosystem health. Consumption rates have impact on commercial and recreational fisheries.

Protocols and Standards:

Surveys conducted using standardized census methods used throughout North Pacific for sea lions

Data Management:

Data processed and archived at PBS in Pinniped Program unit.

Challenges:

Obtaining funding and qualified personnel to participate in the survey

Options for Program Delivery:

Contract to consultants or academics

21: Upper trophic Levels – Marine Mammals –St. of Georgia

c) Monitoring sub-element:

Killer whales surveyed during opportunistic encounters

Years of Data:

1973- present

Frequency:

Unpredictable; varies seasonally and annually

Web site (if any):

Recent Publication:

Detailed Program Description:

Photo-identification of individuals using natural markings; skin and blubber biopsy sampling for genetics and contaminant studies. Whales encountered primarily when passing through Nanaimo area

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Similar photo-identification surveys for killer whales starting in Arctic and Atlantic regions

Monitoring Utility:

Fulfills need for on-going population status assessment as per SARA requirements and Recovery Strategy objectives

Protocols and Standards:

Data Management:

Data processed and archived by Cetacean Research Program at PBS

Challenges:

Success of monitoring in this area dependent on sightings reported by mariners and waterfront residents; encounters only undertaken during favourable sea conditions

Options for Program Delivery:

None

22: Upper trophic Levels – Marine Mammals - WCVI (south of Brooks Peninsula; out to continental shelf edge)

a) Monitoring sub-element:

Sea Otter population surveys WCVI Areas 24-27, North coast VI Area 111, East coast VI Area 11. Areas to be surveyed will be added as sea otter range expands.

Years of Data:

2001- present (surveys were conducted 1977 to 2000, but typically not led by DFO)

Frequency:

Index area surveys once per year, Checelset Bay and Kyuquot Sound and various other segments of the range. Population wide survey to be conducted at least every 5 years. Next survey anticipated in 2008.

Web site (if any):

Recent Publication:

Nichol, L.M., J.C. Watson, G.E. Ellis and J.K.B. Ford. 2005. An assessment of abundance and growth of the sea otter (*Enhydra lutris*) population in British Columbia. Canadian Science Advisory Secretariat, Research Document #094, Fisheries and Oceans Canada. 27 pp.

Detailed Program Description:

Small boat and aerial surveys. Sea otters counted directly and from photographs taken on aerial surveys.

Program Linkages:

Results used to assess status of sea otters

Arctic/Atlantic/Pacific Equivalents:

Sea otters occur only in the Pacific. Equivalent surveys are made in Alaska, Washington and California where otters occur

Monitoring Utility:

Results used to track population growth trend, population range and provide an index of abundance.

Protocols and Standards:

Range divided into survey segments, standardized procedures for conducting survey and reporting otter counts. Personnel with sea otter survey experience used.

Data Management:

Data processed and archived at PBS

Challenges:

The range of sea conditions suitable for surveys is limited. Sea otters occupy exposed remote rugged coastal areas. Surveys require sufficient numbers of days to allow for travel to the area to be surveyed and for weather days. Large vessel (coast guard ship) support is invaluable for accessing particularly remote areas for small boat surveys. With large vessel support the survey team and small vessel can be taken to the start point of the survey and later picked up, thereby reducing the logistics of long travel by small boat from land based accommodations. The further advantage of large vessel support is that surveys can be conducted when there is only a narrow window of opportunity due to sea conditions. Survey teams should have a consistent level of experience conducting sea otter surveys.

Aerial surveys are similarly constrained by weather and sea conditions and observer experience.

Options for Program Delivery:

None

22: Upper trophic Levels – Marine Mammals - WCVI (south of Brooks Peninsula; out to continental shelf edge)

b) Monitoring sub-element:

Abundance, distribution, diet and prey consumption of seals

See Monitoring sub-element 21A for details

22: Upper trophic Levels – Marine Mammals - WCVI (south of Brooks Peninsula; out to continental shelf edge)

c) Monitoring sub-element:

Abundance, distribution, diet and consumption for sea lions

See Monitoring sub-element 21A for details.

22: Upper trophic Levels – Marine Mammals - WCVI (south of Brooks Peninsula; out to continental shelf edge)

d) Monitoring sub-element:

General cetacean surveys

Years of Data:

2002-present

Frequency:

Generally once per year, early summer

Web site (if any):

Recent Publication:

Detailed Program Description:

General cetaceans: Systematic visual surveys using CCG Science vessels, primarily John P. Tully, Vector, or Tanu; deployment of onboard skiff for photo-identification, prey fragment sampling, and biopsy sampling when conditions allow

Program Linkages:

WCVI area included as part of coast-wide visual survey

Arctic/Atlantic/Pacific Equivalents:

Shipboard and aerial cetacean surveys in Quebec and Newfoundland/Labrador

Monitoring Utility:

Fulfills need for on-going population status assessment as per SARA requirements and Recovery Strategy objectives

Protocols and Standards:

Standardized survey methodology for Distance sampling, using Big-Eye binoculars

Data Management:

Data processed and archived by Cetacean Research Program, PBS.

Challenges:

Each cruise requires several days of shiptime, usually as part of 10-15 day long coast-wide survey

Options for Program Delivery:

None

23: Upper trophic Levels – Marine Mammals - PNCIMA (out to continental shelf edge)

a) Monitoring sub-element:

Sea otters

See Monitoring sub-element 22 A for details.

23: Upper trophic Levels – Marine Mammals - PNCIMA (out to continental shelf edge)

b) Monitoring sub-element:

Abundance, distribution, diet and prey consumption of seals

See Monitoring sub-element 21A for details.

23: Upper trophic Levels – Marine Mammals - PNCIMA (out to continental shelf edge)

c) Monitoring sub-element:

Abundance, distribution, diet and consumption for sea lions

See Monitoring sub-element 21A for details.

23: Upper trophic Levels – Marine Mammals - PNCIMA (out to continental shelf edge)

d) Monitoring sub-element:

General cetacean surveys

Killer whale surveys

Years of Data:

General cetaceans: 2002-present

Killer whales: 1973-present

Frequency:

General cetaceans: three surveys per year – spring, summer, fall

Killer whales: annual, May-October

Web site (if any):

Recent Publication:

Detailed Program Description:

General cetaceans: Systematic visual surveys using CCG Science vessels, primarily John P. Tully, Vector, or Tanu, and/or charter vessel; deployment of onboard skiff for photo-identification (humpback whales, blue whales), prey fragment sampling, and biopsy sampling when conditions allow

Killer whales: surveys primarily of areas 1-12 using Cetacean Research Program research vessels; primarily photo-identification, prey fragment sampling, biopsy sampling

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Shipboard and aerial cetacean surveys in Quebec and Newfoundland/Labrador

Monitoring Utility:

Fulfills need for on-going population status assessment as per SARA requirements and Recovery Strategy objectives

Protocols and Standards:

Standardized survey methodology for Distance sampling, using Big-Eye binoculars; photo-identification and biopsy sampling utilize rigid sampling protocols

Data Management:

Data processed and archived by Cetacean Research Program, PBS.

Challenges:

General cetaceans: each cruise requires 10-15 days of shiptime

Killer whales: requires 6-8 weeks of dedicated small vessel time per year

Options for Program Delivery:

None

24: Upper Trophic Levels – Marine Mammals (Open Ocean details)

a) Monitoring sub-element:

General cetacean surveys

Years of Data:

2002-present

Frequency:

One survey per year, early summer

Web site (if any):

Recent Publication:

Detailed Program Description:

Systematic visual surveys using CCG Science vessels, primarily John P. Tully, Vector, or Tanu, and/or charter vessel; deployment of onboard skiff for photo-identification (humpback whales, blue whales), prey fragment sampling, and biopsy sampling when conditions allow; photo-identification, prey fragment sampling, biopsy sampling

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Shipboard and aerial cetacean surveys in Quebec and Newfoundland/Labrador

Monitoring Utility:

Fulfills need for on-going population status assessment as per SARA requirements and Recovery Strategy objectives

Protocols and Standards:

Standardized survey methodology for Distance sampling, using Big-Eye binoculars; photo-identification and biopsy sampling utilize rigid sampling protocols

Data Management:

Data processed and archived by Cetacean Research Program, PBS.

Challenges:

Each cruise requires 10-15 days of shiptime

Options for Program Delivery:

None

25: Aquatic Invasive Species – St. of Georgia

a) Monitoring sub-element:

Sub-tidal AIS surveys

Years of Data:

2006 -present

Frequency:

Subtidal collectors deployed in the spring, removed at various time intervals through the year; intertidal sampling during daylight low tides (April through September)

Web site (if any):

Detailed Program Description:

Monitoring of AIS settlement on new collectors, AIS presence and abundance in established subtidal and intertidal benthic communities

Program Linkages:

Data will be used for UBC and U.Vic graduate degrees

Arctic/Atlantic/Pacific Equivalents:

Comparative studies are being conducted in Atlantic Canada through both CASIN and DFO-funded AIS projects

Monitoring Utility:

Data will be used to evaluate extent of AIS occurrence, likely vectors, and factors influencing AIS spatial distribution, abundance and population dynamics

Protocols and Standards:

Data Management:

Data processed and archived at PBS.

Challenges:

Species identification to determine AIS and sample sorting is proving very time-consuming and costly; collaboration is required with marina operators and aquaculture operations to allow monitoring at their locations, and the logistics of deploying and retrieving widely-dispersed collectors is complex.

Options for Program Delivery:

None

26: Aquatic Invasive Species – WCVI

a) Monitoring sub-element:

Intertidal and trap surveys to determine current distribution of Aquatic Invasive Species, monitor continued dispersal and identify previously undocumented populations.

Years of Data:

1990-present

Frequency:

Annual surveys in rotating areas (all areas not covered annually)

Web site (if any):

Recent Publication:

Gillespie, G.E., A.C. Phillips, D.L. Paltzat and T.W. Therriault. 2007. Status of the European green crab, *Carcinus maenas*, in British Columbia – 2006. Can. Tech. Rep. Fish. Aquat. Sci. 2700: 39 p.

Detailed Program Description:

Assessment surveys for non-indigenous intertidal invertebrates (bivalves, gastropods, crustaceans) and marine plants delivering distribution, relative abundance and some biological characteristics of populations.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

National Aquatic Invasive Species Program, National Risk Assessment Program

Monitoring Utility:

Documentation of current distribution and monitoring of spread provides information to assess risk of related species establishment and dispersal potential.

Protocols and Standards:

Exploratory intertidal bivalve protocols were adapted for other invertebrate groups and plants, see:

Gillespie, G.E. and N.F. Bourne. 2005. Exploratory intertidal bivalve surveys in British Columbia – 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2734. 144 p.

Data Management:

Data processed and archived at PBS in the Shellfish Data Unit, linkages being established to provide georeferenced qualitative and quantitative data to National database systems.

Challenges:

Taxonomic expertise, securing CCG vessel time, intensive summer field schedule, limited budget to hire students or finance term employees to assist with field, laboratory and data management tasks.

Options for Program Delivery:

None

27: Aquatic Invasive Species – PNCIMA (to the edge of the continental shelf)

a) Monitoring sub-element:

Intertidal and trap surveys to determine current distribution of Aquatic Invasive Species, monitor continued dispersal and identify previously undocumented populations.

See Monitoring sub-element 26A for details

29: Aquatic Animal Health– St. or Georgia

a) Monitoring sub-element:

1. Pacific oyster & Manila clam NAAHP listed pathogen survey (formal disease surveillance conducted in collaboration with CFIA)
2. Fish Health Protection Regulations disease assessments (formal disease surveillance)
3. Directed research on various pathogens (viruses, protozoa, sea lice)
4. Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)

NOTE: significantly less monitoring in WCVI and PNCIMA

Years of Data:

1. Initiated Fall 2006
2. Mid 1970s - present for aquaculture facilities participating in the FHPR certification program
3. Variable and sporadic depending on nature of research program
4. Mid 1970s – present; variable

Frequency:

1. According to disease surveillance plan designed by CFIA
2. Twice per year - requirement of certification program
3. Variable
4. Variable

Web site (if any):

http://www.pac.dfo-mpo.gc.ca/sci/shelldis/title_e.htm

<http://www-sci.pac.dfo-mpo.gc.ca/geoduck/>

Recent Publication:

List for appropriate years can be obtained from 0844 Records of Scientific Reports.

Detailed Program Description:

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Aquatic Animal Health programs at the Freshwater Institute (Central and Arctic Region) and Gulf Fisheries Center (Atlantic)

Monitoring Utility:

Protocols and Standards:

Fish Health Protection Regulations

Working towards ISO 17025 international accreditation.

Data Management:

1. Data processed and archived at PBS in the shellfish data unit. Summary reports sent to CFIA. 2007-08 implementation of Laboratory Information Management System (LIMS).
2. Fish Health Database managed and archived at PBS, linked to National Fish Health Database, plans for incorporation into LIMS.
3. Some data incorporated into Fish Health Database. Most data in records held by researchers. Plans for incorporation into LIMS.
4. Data incorporated into Fish Health Database. Paper version of shellfish data records to end of 2005 all digitally scanned. Both are linked to National Fish Health Database. Plans for incorporation into LIMS.

Challenges:

Options for Program Delivery:

None

30: Aquatic Animal Health– WCVI (south of Brooks Peninsula; out to continental shelf edge)

a) Monitoring sub-element:

5. Pacific oyster & Manila clam NAAHP listed pathogen survey (formal disease surveillance conducted in collaboration with CFIA)
6. Fish Health Protection Regulations disease assessments (formal disease surveillance)
7. Directed research on various pathogens (viruses, protozoa, sea lice)
8. Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)

NOTE: significantly less monitoring in WCVI and PNCIMA

See monitoring sub-element 29A for details

31: Aquatic Animal Health– PNCIMA (out to the continental shelf edge)

a) Monitoring sub-element:

9. Pacific oyster & Manila clam NAAHP listed pathogen survey (formal disease surveillance conducted in collaboration with CFIA)
10. Fish Health Protection Regulations disease assessments (formal disease surveillance)
11. Directed research on various pathogens (viruses, protozoa, sea lice)
12. Numerous other opportunistic sampling of finfish (public hatcheries and wild stocks) and shellfish (certifications and mortality investigations)

NOTE: significantly less monitoring in WCVI and PNCIMA

See monitoring sub-element 29A for details

32: Aquatic Animal Health– Open Ocean

a) Monitoring sub-element:

Sporadic opportunistic sampling in conjunction with DFO fish stock surveys

Years of Data:

1996 - 2004

Frequency:

Sporadic

Web site (if any):

Recent Publication:

Kent, M.L., G.S. Traxler, D. Kieser, J. Richard, S.C. Dawe, R.W. Shaw, G. Prosperi-Porta, J. Ketcheson, and T.P.T. Evelyn. 1998. Survey of salmonid pathogens in ocean-caught fishes in British Columbia, Canada. *Journal of Aquatic Animal Health*, Vol. 10, No. 2, pp. 211-219.

Detailed Program Description:

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

None known.

Monitoring Utility:

Protocols and Standards:

Data Management:

Raw data (histopathology observations) in note book. Analysis of preserved samples incomplete - samples archived and available for future analysis as required.

Challenges:

Staff initially directed towards this effort now fully occupied meeting the new National Aquatic Animal Health Program (NAAHP) requirements. As the NAAHP rolls-out, there may be opportunities to continue with this work.

Options for Program Delivery:

None

33: Marine Environmental Quality – Strait of Georgia

a) Monitoring sub-element:

Harbour seals as sentinels of marine ecosystem contamination

Years of data:

1996 to present

Frequency:

Collect samples every 3-5 years for contaminant monitoring and health research

Recent Publications:

Cullon,D.L., Jeffries,S.J., and Ross,P.S. 2005. Persistent Organic Pollutants (POPs) in the diet of harbour seals (*Phoca vitulina*) inhabiting Puget Sound, Washington (USA) and the Strait of Georgia, British Columbia (Canada): A food basket approach. *Environ.Toxicol.Chem.* **24**: 2562-2572.

Mos,L., Morsey,B., Jeffries,S.J., Yunker,M., Raverty,S., De Guise,S., and Ross,P.S. 2006a. Both chemical and biological pollution contribute to immunological profiles of free-ranging harbor seals. *Environ.Toxicol.Chem.* **25**: 3110-3117.

Mos,L., Tabuchi,M., Dangerfield,N., Jeffries,S.J., Koop,B.F., and Ross,P.S. 2006b. Contaminant-associated disruption of vitamin A and its receptor (retinoic acid receptor) in free-ranging harbour seals (*Phoca vitulina*). *Aquat.Toxicol.*

Ross,P.S., Jeffries,S.J., Yunker,M.B., Addison,R.F., Ikonomou,M.G., and Calambokidis,J. 2004. Harbour seals (*Phoca vitulina*) in British Columbia, Canada, and Washington, USA, reveal a combination of local and global polychlorinated biphenyl, dioxin, and furan signals. *Environ.Toxicol.Chem.* **23**: 157-165.

Tabuchi,M., Veldhoen,N., Dangerfield,N., Jeffries,S.J., Helbing,C.C., and Ross,P.S. 2006. PCB-related alteration of thyroid hormones and thyroid hormone receptor gene expression in free-ranging harbor seals (*Phoca vitulina*). *Environ.Health Perspect.* **114**: 1024-1031.

Detailed Program Description:

This research generates information on the source, transport and fate of persistent environment contaminants in aquatic food webs, and on the health effects of these in upper trophic level wildlife (harbour seals). The live-capture of harbour seals, use of minimally-invasive techniques to obtain samples, the measurement of contaminants in blubber biopsies, and the development of numerous assays to measure health of harbour seals, contribute to the utility of the harbour seals as an ecosystem indicator.

Program Linkages:

Research has led to numerous collaborations (WDFW, EC, HC, BC MOE), and has been formally incorporated into three published Ecosystem Indicator efforts (BC, Washington, and Georgia Basin-Puget Sound).

Arctic/Atlantic/Pacific Equivalents

This effort has some parallel research into monitoring of contaminant levels (regulated and unregulated chemicals) in the Arctic and St Lawrence, although the PAC effort comprises an important health effects component.

Monitoring Utility:

At the top of the food chain, non-migratory, and widely distributed, the harbour seal provides an effective means to develop integrated contaminant signals from the environment. In addition, where contaminant levels cause adverse health effects, results can be delivered to regulators, risk assessors and policymakers of different agencies and partners. The harbour seal is instructive in providing information on 'local killer whale habitat quality', thereby guiding Recovery Team efforts.

Protocols and Standards:

New and existing methods are published in a timely manner, and are therefore widely available.

Data Management:

Samples and archived electronic data are stored at IOS, and are published in the scientific literature.

Challenges:

Small craft and skilled marine mammal staff are required to ensure human, animal and boat safety.

Options for Program Delivery:

DFO is the only agency working with marine mammals in BC, but considerable assistance has been provided by the State of Washington and the province of BC.

33: Marine Environmental Quality – Strait of Georgia

b) Monitoring sub-element:

Dioxins, furans and PCBs in biota, identification of contaminated areas and regulation of fisheries closures based on TEQ and TDI guidelines.

Years of data:

1990 to present

Frequency:

Collect target biota samples in suspect areas every two to three years

Recent Publications:

Addison, R.F.; Ikonomou, M.G. and Smith T.G. PCCDD/F and PCB in Harbour Seals (*Phoca Vitulina*) from British Columbia: Response to Exposure to Pulp-Mill Effluents. *Marine Environ. Research.*, **2005**, 59(2), 165-176.

Yunker, M.B.; Cretney, W.J. and Ikonomou, M.G. Assessment of Chlorinated Dibenzo-p-dioxin and Dibenzofuran Trends in Sediment and Crab Hepatopancreas from Pulp Mill and Harbour Sites Using Multivariate-and index-based Approaches. *Environ. Sci. Technol.* **2002**, 36(9), 1869-1878.

Ikonomou, M.G.; Fernandez, M.; Knapp, W. and Sather, P. PCBs in Dungeness Crab Reflect Distinct Source Fingerprints Among Harbour/Industrial Sites in British Columbia. *Environ. Sci. Technol.*, **2002**, 36(12), 2545-2551.

Bright, D.A.; Cretney, W.J.; Macdonald, R.W.; Ikonomou, M.G. and Grundy, S.L. Differentiation of Polychlorinated Dibenzo-p-Dioxin and -Furan Sources to Howe Sound and the Strait of Georgia British Columbia. *Environ. Toxicol. Chem.*, **1999**, 18(6), 1097-1108.

Detailed Program Description:

The Pacific region has had a comprehensive dioxin/furan monitoring program and we have data that go back some 17 years. Through this program fisheries closures have been regulated for dioxin contamination. This program should be identified as a separate item in the table. The need to continue this program is more urgent now than ever before for the following reasons:

a) The TDI regulations for dioxin/furan TEQ has changed from 10 pg TEQ per kg body weight per day to 2.3 pg TEQ. Additionally, this new TEQ is to include TEQs from dioxins/furans **plus** the dioxin-like PCBs. This means that many fisheries that were open for fishing, based on the old regulations, will need to be re-evaluated and closures may have to be implemented.

b) Over the years the pulp and paper mills have been responsible to analyze selected samples to show levels of D/Fs in target organisms in the ecosystem impacted by discharges. In recent years, many pulp and paper mills have gone out of business and the associated monitoring program has been discontinued. However, in many instances the D/F problem is still there. Nobody is monitoring these sites as there are no provisions on who is responsible to undertake such work. DFO has done some random follow-up measurements in some areas but nothing systematic.

In addition to D/F monitoring associated with the pulp and paper industry, DFO has been doing D/F monitoring in harbours and some other hot spots that we have identified over the years. DFO has assumed monitoring for some of these hot spots as there have been no obvious ways to assign the responsibility to somebody else.

Considering the new TDI, the fact that there are increasing areas contaminated by D/Fs that nobody is monitoring, and the fact that our minister has been questioned at least once about D/F contaminated fisheries in BC we need to continue and enhance the dioxin/furan monitoring program in BC. With the new TDI we are running the risk of having fisheries open in BC where the level of D/F contamination exceeds the new guidelines.

Program Linkages:

The Pacific region dioxin monitoring program has been part of the national dioxin monitoring program, has linkages to EEM and ESSRF.

Arctic/Atlantic/Pacific Equivalents

Dioxin monitoring programs have been implemented in all regions and the arctic. The major focus has been on regions impacted by direct sources, the pulp and paper industry in particular.

Monitoring Utility:

Assess the dioxin/furan and dioxin-like PCB contamination in target monitoring organisms. Identify sources of dioxin/furan contamination and regulate fisheries closures based on guidelines established by Health Canada. Continuously re-assess the level of contamination and fisheries closures based on the HC guidelines as they get updated. Archived

samples have been used to assess trends in dioxins/furans and PCBs profiles and other emerging contaminants such as PBDEs and other BFRs.

Protocols and Standards:

Follow standard methods for analyzing tissue samples for target contaminants. There are protocols (models) for identifying sources of the target contaminants.

Data Management:

Samples (frozen tissue) and electronic records are maintained at IOS.

Challenges:

Ship time requirement is modest and can fit in opportunistically.

Options for Program Delivery:

DFO has a responsibility to monitor fisheries for dioxin contamination and implement fisheries closures as necessary. Biota samples collected for the dioxin monitoring program have been used to identify profiles and sources of emerging contaminants. No other obvious means for delivery of this program.

33: Marine Environmental Quality – Strait of Georgia

c) Monitoring sub-element:

Sediment cores for contaminant and biogeochemical proxy histories

Years of data:

Depending on core depth 1800s to present

Frequency:

Collect cores every 10 years

Recent Publications:

Bright DA et al, 1999. Differentiation of polychlorinated dibenzo-*p*-dioxin and dibenzofuran sources to Howe Sound and the Strait of Georgia, Coastal British Columbia. *Environmental Toxicology and Chemistry*, 18:1097-1108.
Johannessen SA et al., 2005. Historical trends in mercury sedimentation and mixing in the Strait of Georgia, Canada. *Environmental Science and Technology*, 39:4361-4368.
Krümmel EM et al., 2005. Concentrations and fluxes of salmon--derived polychlorinated biphenyls (PCBs) in lake sediments. *Environmental Science and Technology* 2005;39:7020-7026.
Yunker MB and Macdonald RW. Alkane and PAH depositional history, sources and fluxes in sediments from the Fraser River Basin and Strait of Georgia. *Organic Geochemistry* 2003;34:1429-1454.

Detailed Program Description:

Sediment cores are collected strategically from the Greater Strait of Georgia, dated using radiochemical techniques and then contaminant flux histories are reconstructed by analyzing sediment horizons for contaminants of interest (so far we have PAH, PCDD/F, PCBs, PBDEs, TBTs, Pb, Hg, NPEOs).

Program Linkages:

Has been part of Fraser River Action Plan, ESSF, ESSRF, Georgia Basin-Puget Sound Transboundary transport.

Arctic/Atlantic/Pacific Equivalents

Coring programs also maintained in the Gulf of St Lawrence (Gobeil and others), the Scotian Shelf (Smith and others) and the Arctic (Macdonald, Gobeil, Smith).

Monitoring Utility:

Probably the most economical means to assess trends in contaminant fluxes and to estimate inventories for coastal regions. Sediment cores can also provide proxy records for other correlated biogeological parameters (e.g. fish escapement; organic loadings from logging). Sediment core records also predate all monitoring schemes allowing one to set the present into the near and distant past. Archives of dated core material provide a basis to assess new chemicals identified or emerging.

Protocols and Standards:

Follow standard methods for analyzing sediment matrices for chemicals (well-developed). There are protocols (models) for interpreting mixing and sedimentation processes using radiochemical tracers.

Data Management:

Samples (frozen sediments and dried sediments) and electronic records are maintained at IOS.

Challenges:

Shiptime requirement modest and can fit in opportunistically; funding required to date and analyze core sections (15-20/core).

Options for Program Delivery:

For gathering historical data on new chemicals, or to understand trends, their causes and implications for chemicals that are not/have not been monitored, there is no other substitute.

35: Marine Environmental Quality –PNCIMA

a) Monitoring sub-element:

Near and far field impacts of aquaculture

Years of data:

Some sporadic data since 1999

Frequency:

Collect representative samples once a year

Recent Publications:

Sather, P. Ikonomou, M.G.; and Haya, K. Occurrence of Persistent Organic Pollutants in Sediments Collected Near Fish Farm Sites. *Aquaculture*, **2006**, 254, 234-247.

Detailed Program Description:

British Columbia is by far the major producer of farmed salmon in Canada and the fourth largest producer in the world. With the continuously growing of the aquaculture industry in BC there is need to have a program in place to monitor the impact of nutrients and contaminants in the ecosystem near aquaculture sites using sediment, sediment trap and biota samples. A systematic study of this kind does not exist at the moment.

Program Linkages:

Program linkages with equivalent programs in the Atlantic region and projects conducted under ESSRF, ESSF and ACRDP.

Arctic/Atlantic/Pacific Equivalents

Pacific and Atlantic region specific projects conducted under ESSRF, ESSF and ACRDP.

Monitoring Utility:

Assess trends in nutrients and contaminant fluxes and inventories in the vicinity of aquaculture operations in British Columbia. Examine site specific dynamics and link those to depositions observed. Model the deposition and provide feedback to the industry for site selection and remediation.

Protocols and Standards:

Follow standard methods for analyzing representative samples for nutrients and target contaminants. There are protocols for calculating fluxes and deposition.

Data Management:

Samples and electronic records to be maintained at IOS.

Challenges:

One to two days ship time per year for sample collection and deployment.

Options for Program Delivery:

Nutrients and contaminants are known to enter the marine ecosystem surrounding aquaculture sites. These could impact adversely the marine ecosystem and corresponding measurements are needed to put things into perspective. DFO needs to assume leadership in such work as specific species and or fisheries may be at risk.

40: Physical and Chemical Environment - Endeavour Ridge MPA

a) Monitoring sub-element :

DFO has been involved with physical oceanographic mooring programs within the 2200 m deep Axial Valley and vicinity of Endeavour Ridge (300 km offshore of Vancouver Island) since 1984. Most of this work was funded through collaborative agreements with US funding agencies. Recent work, funded by NSF, was completed in the summer of 2006. DFO also conducted extension bioacoustic tows in the region and we have published extensively on zooplankton biomass through the full depth range of 2200 m.

NEPTUNE Canada has funded monitoring sites within the Axial Valley beginning in 2008. University scientists are planning to conduct ecological studies in the vicinity of the main hydrothermal vent fields. There is no biological component for the water column.

Years of Data:

NA- scheduled to begin late 2008.

Frequency:

Continuous at better than 1 Hz

Web site (if any):

Google "Neptune Canada"

Recent Publication:

Thomson, R.E., S.F. Mihaly, A.B. Rabinovich, R.E. McDuff, S.R. Veirs, and F.R. Stahr. 2003. Constrained circulation at Endeavour Ridge facilitates colonisation by vent larvae. *Nature* 424, 545-549 (July 31, 2003); doi:10.1038/nature01824.

Thomson, R.E., Marina M. Subbotina, and Mikhail V. Anisimov. 2005. Numerical simulation of hydrothermal vent-induced circulation at Endeavour Ridge. *J. Geophys Res.-Oceans*, 110 doi:10.1029/2004JC002337, C01004 1-14.

Detailed Program Description:

Cabled observatory network consisting of four permanent current meter moorings with the axial valley midway between the major vent sites and biogeochemical studies by university researchers at the main hydrothermal vent sites. Major Junction Boxes are to be installed at Main Endeavour and Mothra vent sites. IOS is funded through the University of Victoria to install moorings at the following sites in 2200 m of water in the Axial Valley: (1) "North" mooring array located 3 km north of the Main Endeavour Field with two moorings separated across channel by 600 m and extending 250 m up into the water column from the seafloor; and (2) "South" mooring array located 1 km north of the Mothra vent site (1 km south of the MEF) with two moorings separated across channel by 600 m and extending 250 m up into the water column from the seafloor. Moorings to have single-point 2 MHz Nortek current meters, SeaBird microcat C&T recorders, and downward looking 75 KHz RDI acoustic current meters.

Program Linkages:

See (a) above

Atlantic/Pacific Equivalents:

None

Monitoring Utility:

Near-realtime oceanographic data available on the NEPTUNE Canada website.

Protocols and Standards:

To be established by the University of Victoria

Data Management:

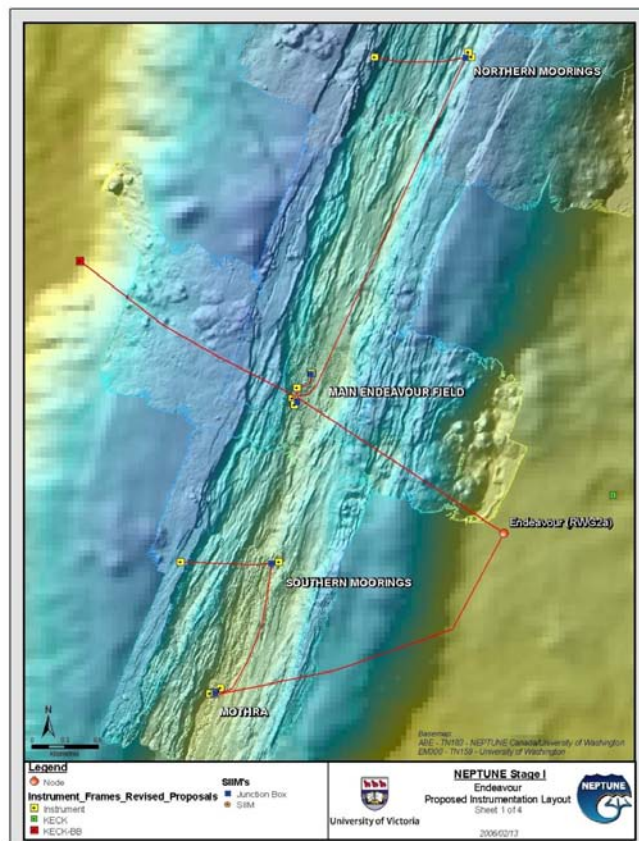
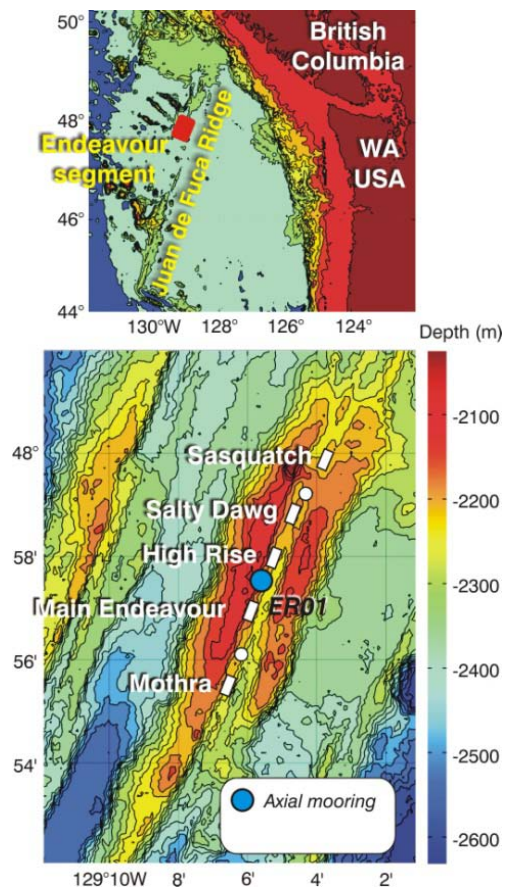
Data processed and archived by NEPTUNE Canada at the University of Victoria.

Challenges:

This is a new cabled observatory network and is likely to encounter numerous start up problems; profiler may have a limited operational life due to the harsh environment and damage from commercial fisheries. Canadian and US Navies have option to shut down data flow for national security reasons.

Options for Program Delivery:

No other options.



40: Higher trophic levels of fish and shellfish –Open Ocean

b) Monitoring sub-element:

Submersible survey of Bowie Seamount

Years of Data:

2000

Frequency:

Intermittent

Web site (if any):

Recent Publication:

Yamanaka, K.L. 2005. Data report for the research cruise onboard the *CCGS John P. Tully* and the *F/V Double Decker* to Bowie Seamount and Queen Charlotte Islands July 31th to August 14th 2000. Can. Data Rep Fish. Aquatic Sci. 1163: vii + 46 p.

Detailed Program Description:

Submersible dives are conducted at selected sites to assess the abundance of inshore rockfish, other fish species, invertebrates and to assess habitat. Observers count the number of fish encountered and estimate the size of each fish. This program is almost entirely funded with b-base moneys.

Program Linkages:

Arctic/Atlantic/Pacific Equivalents:

Monitoring Utility:

Visual abundance estimates for inshore rockfish.

Protocols and Standards:

Data Management:

Data processed and archived at PBS in the groundfish biological data database (GFBIO).

Challenges:

Submersible time is very expensive and post processing of data can be time consuming, this program is challenged by a lack of on going funding.

Options for Program Delivery:

None.