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Report of the PSARC Habitat Subcommittee Meeting, August 22, 2000

M. Stocker and J. Pringle (Editors)
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

September 2000

Canada

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE

PSARC ADVISORY DOCUMENT 2000-04
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HABITAT

Contents

SUMMARY

The PSARC Habitat Subcommittee met August 22, 2000, at the Institute of Ocean Sciences (IOS) in Sidney, B.C. The Subcommittee formally reviewed two Working Papers and one Habitat Status Update (Appendix 1). A third paper, scheduled for presentation, was withdrawn (Appendix 1).

INTRODUCTION

The Subcommittee Chair, Dr. John Pringle, welcomed Subcommittee members and introduced observers and external participants and explained rules for their participation. During the introductory remarks the objectives of the meeting were reviewed, as was the process to be followed. Participants (Appendix 3) were reminded, the meeting deliberations are confidential until publication of the meeting's Advisory Document. The Subcommittee accepted the meeting agenda (Appendix 2).

Eleven Subcommittee members attended the meeting along with a number of external participants and observers: Dr. Inja Yeom, visiting scientist, Korea, attended as an Observer; Dr. Angelica Piña attended the entire meeting as a Technical Expert; Dr. Josif Cherniawsky attended the Non-Indigenous Species Green Crab "update" session in the same capacity.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

H00-01: Persistent Organic Pollutants (POPs) in British Columbia marine mammals

R.F. Addison and P.S. Ross **Accepted subject to revisions**

Summary

Organochlorines (OC) represent a wide range of contaminants that have been introduced into the environment through a number of processes. OCs include the insecticide DDT, the industrial polychlorinated biphenyls (PCBs), and the polychlorinated dibenzo-p-dioxins (PCDDs) and –dibenzofurans (PCDFs). These chemicals are lipophilic and tend not to breakdown. They thereby accumulate in aquatic food chains, often reaching high concentrations in fish predators. Toxic effects observed in fish-eating animals and humans include reproductive impacts, and immuno- and neuro-toxicities. Despite regulations on use of several OCs over the past quarter-century, many persist in the environment thereby putting at risk, the health of top predators. OCs circulate widely via atmospheric processes, thereby compounding the influence of Regional sources. Recent evidence suggests even low-to-moderate contaminant levels are affecting

endocrine processes in B.C. harbour seals. This renders significant the finding that killer whales from B.C. waters now represent some of the most contaminated marine mammals in the world. This underscores the need to better understand the sources and fate of such chemicals in the environment, and their health effects on high trophic level organisms. Marine mammals as "sentinel" species, provide a measure of marine ecosystem contamination.

Reviewers' Comments

Reviewer 1

This Working Paper is an excellent, comprehensive review of organochlorines and their dynamics in the marine environment, and their toxicity and bio-accumulation in harbour seals and killer whales in British Columbia waters. It is obvious these contaminants are a serious environmental issue and much further study is required to address the many conservation concerns raised.

Concerns with the Working Paper are as follows:

1. The review deals with two marine mammal species though there are 29 known species in Regional waters. The title should thus reflect the fact that harbour seals and killer whales only were studied in the Working Paper;
2. The Working Paper should be modified to point out the fact that the two species studied, along with their respective contaminant loads, likely do not reflect levels present in the many other species of marine mammals, as is suggested in parts of the report; and
3. The Recommendations should strongly urge that similar studies to those reported here on harbour seals and killer whales be carried out on certain other marine mammal species.

Reviewer 2

The Working Paper is written by two of the world's foremost authorities on the topic, much of the knowledge available in the international literature has been contributed by them, thus both the data and conclusions are on a solid scientific footing. A few minor changes are suggested, none of which would change the conclusions or perspectives.

Despite a paucity of historical trends data, in part because of an unfortunate lack of fixed tissue, the authors have painted a proximal picture of the temporal distribution of organochlorines in Regional waters. It is unfortunate a tissue bank was not available to determine past distributions; DFO, along with Other Government Agencies (OGA) should now give serious consideration to the start of such a bank.

Reviewer 3

The Working Paper's purpose is clearly stated, but the author's should be challenged on their conclusion that the OCs concentrations provide "elevated risks" to killer whales. The impact should be defined, i.e. are the concentrations a significant impact to population viability or of little consequence and not worthy of further study?

Subcommittee Discussion

Contamination of dioxins in marine mammals has recently declined due to regulatory activities.

The authors should note and make the following changes in the revised paper:

- That the Port Alice pulp mill, though it uses chlorine in the bleaching process, does not result in significant dioxin/furan formation because of the process used; and
- Chlorophenol is not used to treat chips. Chips from sawmills using chlorophenol antisapstain treatments have been illegal for use in pulp mills since the Canadian Environment Protection Act (CEPA) Regulations were promulgated in 1992. Chlorophenol is still used as a heavy-duty wood treatment chemical, however.

The source of sampled seals (shot by salmon farmers) and their approximate ages (mean age of four months) should be included in the revised paper. Interestingly, these seals had just weaned, thus their contaminant loads reflect that of their respective mothers. When available, adults should be sampled in future studies.

Little information was presented in the Working Paper on these seals food. Harbour seals show high philopatry – ranging only ~50 sq km in a lifetime. The differences in contaminant loads between Quatsino Sound and Strait of Georgia seals was large even though all animals were shot at salmon farms, suggesting their diets, while perhaps of similar species, had different toxic loads.

The discussion on sampling technology included the limitations of biopsy darts for sampling blubber of live animals. Organochlorines are distributed evenly within seal blubber, thus a dart provides a representative sample, but yields only ~ 100 mg of tissue; 2-3 g is desirable, thus live-capture with the attendant removal of a cube of blubber followed by suturing, is a superior methodology. With whales there is an assumption the top layer can fairly represent the blubber mass.

PCB contaminants degrade much more slowly than dioxins, thus the levels in marine mammals have remained somewhat constant over time.

The incidence of DDTs in marine mammals on Canada's east and west coasts has declined since their ban in the early 1970s. However, there is continuous loads delivered via atmospheric transport from Asia, and this dumping is greater along the Pacific coast through to the Rockies than in the Arctic.

Effects of toxins are not being seen at the population level in seals, but the levels, based on Peter Ross' work on captive European animals, suggests levels at 200 ppt TEQ (Toxic Equivalent Quotient) compromise immune systems. Strait of Georgia animals are 500 ppt TEQ, thus susceptibility to disease would not be surprising. One such epidemic in Europe was the impact of the phocine distemper virus on European seals. It is hypothesized that the impact was exceptionally large because their immune systems were compromised. A contaminant/food web study is underway, which includes spatial and temporal variables, with particular attention being paid to species, sex and geographic location.

The local population of killer whales is declining for reasons that are not understood. Compromised immune and/or reproductive systems may in part be the reason. The complexity around the source of contaminants in killer whales was discussed. Comparable levels in known *O. orca* food has not been observed. It was pointed out by one reviewer that local killer whales eat squid as well as fish, suggesting that they need consideration as a contaminant source.

Lessons learned from the Beluga contamination in the St. Lawrence Estuary were discussed. There are six to twelve strandings per year from a population of 300 to 600 Belugas. Their situation is worse than that of the B.C. killer whales, though the latter population size is declining, with no definitive explanation.

Two key actions to be taken are contaminant control at source and monitoring.

Subcommittee Recommendations

1. The Subcommittee recommended the Working Paper be accepted subject to revisions.
2. The study to discern OC sources to marine mammals in Regional waters should continue by:
   (a) Discerning the major prey species, their trophic levels, and the sources and routes whereby they accumulate contaminants; and by
   (b) Recognizing the significance of LRTAP (Long Range Atmospheric Transport of Pollutants) in introducing OCs to the Pacific Region. Regional/NCR DFO staff should work with OGAs to quantify the scale of offshore input in comparison with that from local sources.
3. In co-operation with partners, develop a Regional tissue bank, as outlined in the Working Paper, by making initial capital funds (~$25K) available and by guaranteeing annual A-base O+M funds (~$10K) to maintain the bank.

4. Encourage studies on marine mammals to assess the sub-lethal effects of OCs, especially to quantify effects on immune and reproductive function.
5. Continue analyses of OCs in marine mammals to demonstrate temporal trends, which may result from changes to the inputs of OCs to the environment, reflecting regulatory or other actions.
6. To date the marine mammals studied have been high trophic level species. Sampling of other high trophic as well as lower trophic level species is urged and should include Steller sea lion (*Eumetopias jubatus*), California sea lion (*Zalophus californianus*), Pacific white-sided dolphin (*Lagenorthynchus obliquidens*), Dall's (*Phocoenoides dalli*) and Harbour (*P. phocoena*) porpoises, and Gray (*Eschrichtius robustus*) and Humpback (*Megaptera novaeangliae*) whales.

H00-02: Cadmium in B.C. farmed oysters: A review of available data, potential sources, research needs and possible mitigation strategies

G. Kruzynski **Accepted subject to revisions**

Summary

The Canadian Food Inspection Agency (CFIA) contacted DFO Science for assistance in investigating reported elevated cadmium (Cd) levels in B.C. farmed oysters [Hong Kong rejected several shipments that were in excess of 2 ppm (2 μg/g tissue) wet weight, their import limit]. Further investigation discerned that several international bodies were considering lowering the tolerance limit for cadmium in shellfish to 1 ppm. To put these figures in perspective, the Total Daily Intake (TDI) of Cd recommended by World Health Organization (WHO) and the US Food & Drug Administration is in the range 55-60 μg/d; food (other than shellfish), water and breathing would usually account for about 12 μg/d, and smoking one pack of cigarettes would account for a further 10 μg/d. One meal of oysters (6 animals at 50g each, with a Cd concentration of 2 μg/g) would account for about 600 μg - more than one week's worth of the recommended TDI. It should be noted that many Canadian oysters have 3-4 μg/g wet tissue. DFO agreed to investigate potential causes with the aim of identifying possible mitigative measures. This Working Paper summarizes the results of data gathering, a limited literature search, discussions with researchers, BC Ministry of Agriculture, Food and Fisheries (MAFF), The BC Shellfish Growers Association and independent oyster growers. In summary, the following were noted:

1. There are no historical data that would permit comparison of temporal changes in Cd residues in oysters as currently cultured;
2. Historic beach oyster survey data suggests that at certain locations in the central and northern reaches of the Strait of Georgia, there were elevated Cd levels in the early 1970's;
3. It is unlikely that anthropogenic inputs are responsible for current Cd levels on

Vancouver Island's west coast. Potential sources of Cd in the Strait of Georgia are offered; and

4. Recent CFIA data showed only 3 of 39 samples passed the <2 ppm standard. Study sample design prevented identification of sample location, hence speculation on cause is difficult.

Cd concentrations in Pacific oysters have been measured by various agencies at different times over about the last 25 years. These data have been compiled and examined, and have led to the following *preliminary* inferences:

- Pacific oysters from various sources in the Region sampled at various times contain Cd concentrations significantly higher than most other shellfish (except scallops), finfish and crustacea;
- In general, cultured oysters appear to contain higher Cd concentrations than "wild" oysters from nearby sites (although this inference is confounded by an 11-year interval between sampling the two groups); and
- Spatial differences between patterns of Cd accumulation seem to exist in Jervis Inlet. Here wild and cultured samples seemed not to differ, in contrast to the trend seen at other sites. There may be an increase in Cd concentrations in more samples north of Jervis Inlet. Consideration of physiological and environmental factors, and of the known geo-chemical behaviour of Cd, suggest that any of the following factors could affect Cd exposure:
    - Surface geology, possibly combined with logging practices (contributing to Cd in surface run-off) e.g. Zn ores contain ~0.3% Cd;
    - Municipal waste sources (though this was unlikely in many of the more remote northern Strait of Georgia sites);
    - Agricultural run-off via the Fraser River plume (since Cd may be associated with fertilizer and pesticide use);
    - Oceanographic conditions (since Cd is associated with phosphate in the water column and may follow nutrient upwelling; Cd uptake may be increased at lower salinities);
    - Oyster culture methods (including the possibility of Cd contamination of plastic ropes and trays); and
    - Local disposal of Ni-Cd batteries (which may contain up to ~18% Cd), may have been disposed of near remote lighthouse and buoy sites.

Since the data currently available do not allow the effects of any of these variables to be evaluated, a further sampling has been undertaken to isolate some of these variables. To compare the effects of culture methods (suspension culture followed by beach tray "hardening" v. "wild" intertidal samples), to examine oyster-size/Cd concentration relationships; and to examine possible spatial differences based on local surficial geology, five sites were sampled in August 2000, in co-operation with BC MAFF and certain oyster growers. These samples will be sorted and sent for metal analysis to Institute Maurice Lamontagne; expected completion is late October.

Reviewers' Comments

Reviewer 1

This Working Paper has compiled the available information on the potential sources of Cd present in the tissue of the Pacific oyster *Crassostrea gigas*, and data related to Cd inclusion in oysters collected from a range of B.C. waters. It accurately represents the state of knowledge of Cd contamination in oysters. The proposed research is most worthwhile in support of an industry with considerable socio-economic impact along coastal B.C. It is clear substantially more information is required to fully understand the magnitude of the Cd contamination in farmed oysters, the sources of contamination, and where possible, development of mitigation strategies. Cd exists in one of two forms in oysters; in the ionic state or covalently bonded as a metallothionein (MT) complex: the former allows for simple depuration procedures, the latter does not. The author, when choosing future study sites (Short Term Study 1a), should ensure a match with the Fraser River plume flow. It is recommended that a lower Strait of Georgia site (Gulf Islands) be added. For Short Term Study 1b, subtidal oysters should be included, where possible, in the sample design. As well, it is urged that a range of size classes from a single culture area be assessed for Cd release under depuration conditions. Long Term Study 2 should include as many sites from as many culture areas as is feasible.

Reviewer 2

The author has done a good job of scoping the issue and shedding light on probable causes. The proposed research will provide important information on whether a small measure, such as changing culture equipment, will assist or whether the problem is indeed from natural sources. Overall, the study should be placed in a high category of high priorities for habitat initiatives.

Reviewer 3

This is a most worthy project because of the importance of B.C.'s shellfish industry, and because of the human health implications.

The author will have to develop specific experiments to evaluate the contribution of each of the potential sources of Cd noted in the Working Paper. CFIA will continue to share survey data with DFO's Science Branch personnel. The latest results will be available in early-mid September 2000.

Subcommittee Discussion

K. Schallie (CFIA) stated that at present, there is no single international standard for Cd in shellfish, though (see above) this is now under discussion by international government agencies, and the United States Food and Drug Administration (US FDA) and WHO have recommended weekly ingestion rates for humans. Although this is not strictly a concern for this Subcommittee, it was recognised that these negotiations were an important "context" for consideration of the scientific aspects of the issue. Schallie further stated that Health Canada would undertake a formal health risk assessment of Cd in oysters as has been done by US FDA. The latter agency concluded that in some circumstances, concentrations of 4 μg/g (4 ppm) wet oyster flesh would be acceptable, though the assumed frequency of oyster consumption is not known. It would therefore behoove Canada to carry out its own study. (For further information see Adams et al. 1993, Guidance Document for Cadmium in Shellfish, US Food & Drug Administration, Center for Food, Safety & Applied Nutrition, 200 C St., S.W. Washington, DC, 20204). It should be noted that the 4 μg/g is a simplification of the US FDA recommendations. The acceptable weekly intake for Cd is clearly related to body mass; international standards reflect this. The US FDA document, which is only one of several, in fact does state that these weekly intakes are based on representative US consumption, which bears no resemblance to that of Asian countries.)

Subcommittee Recommendations

1. The Subcommittee recommended the Working Paper be accepted subject to revisions; the analytical Cd data from the August study, if available, be included as an addendum to the revised paper.
2. When the analytical data emerging from the most recent sampling (August 2000) have been assessed, a workshop be held for interested parties [representatives from BC MAFF, BC MOELP, BC Mines, DFO (Fisheries and Oceans Canada), NRCan (Natural Resources Canada) , Agriculture Canada, Health Canada's CFIA, Environment Canada and the BC Shellfish Growers Association and other growers and/or co-operatives] to:
    - Provide up-to-date information, and to receive input from industry and regulators regarding future plans on industry expansion; and to
    - Permit inter-agency co-operation and provision of fiscal support to address high priority issues (see Recommendation 3 below).
3. A multi-disciplinary team (to be led by DFO, but open to interested scientific staff from OGAs and university-based scientists) develop a research proposal in an attempt to garner funding to address the key, high priority questions. This team would include chemists, toxicologists, and physical and biological oceanographers, geologists, shellfish biologists and GIS specialists. The proposal will take into account comments made by reviewers of this Working Paper.
4. That a one-year, or longer, grow-out study be undertaken immediately (to take

advantage of the late summer growth period and to provide advice that will assist in the placement of future farm sites), in which a common oyster spat is to be suspended under a range of environmental conditions.

H00-03: The importance of considering ocean habitat in the management of Pacific salmon – the critical size, critical period hypothesis

R.J. Beamish and C. Mahnken

Working Paper withdrawn, and postponed to December Subcommittee meeting.

HABITAT UPDATE

Green Crab (*Carcinus maenas*) in British Columbia – An update and research proposal

Summary

The European green crab *Carcinus maenas* (Decapoda: Portunidae) is extending its range much more rapidly on the Pacific coast of North America than on the Atlantic coast. This crab was first observed on the Pacific coast in 1989 in San Francisco Bay. Southward dispersal has been limited, probably because of lethally high temperatures. Since, this species has extended its range northward in California at a rate of ~55km y^{-1}. Northward dispersion quickened when in 1997 adult crabs were found in Coos Bay, Oregon, 300km north of Humbolt Bay, CA; and in 1998 in Grays Harbour, Washington, 425km northward, and finally in Barkley Sound, British Columbia, a further 250km northward. Green Crab have been found this year (2000) in both Clayoquot and Nookta Sounds on the west coast of Vancouver Island. Washington State is establishing a comprehensive monitoring program along both its inner and outer coasts, and it is recommended that Canada immediately establish a complementary program, using the same protocols. Benefits would be a much larger and therefore, more credible database, useful for understanding crab dispersal, documenting population abundance trends, and the development of effective, and cost-effective mitigation procedures, if they are ultimately deemed necessary.

Subcommittee Discussion

Dr. Jamieson's background and rationale for a Washington State financed plan (3K US) to monitor the presence/abundance of Green Crab along the Canadian side of Juan de Fuca Strait was discussed, along with his request for additional Canadian funds to expand monitoring beyond Juan de Fuca Strait. He sought PSARC's support for the proposed Canadian-financed expansion of the sampling program which would be centered on the west coast of Vancouver Island and along the inner coast (e.g. Strait of Georgia), where major shellfisheries could be

impacted by Green Crab. It was noted that impacts on North American Atlantic coast shellfisheries are not too relevant as these operations developed in the presence of green crab (this species was introduced here in the 1800s) and the indigenous species complex is different.

The purpose of Green Crab dispersal and abundance monitoring would be:

- To more accurately document the distribution of Green Crab in Pacific Regional waters;
- To improve our understanding of the dispersal of future non-indigenous species using the Green Crab as a model; and
- To develop an understanding of Green Crab population dynamics and factors affecting its carrying capacity in the Region as Green Crab populations become established.

Discussion of the proposal included suggestions for obtaining complimentary or alternate funding (e.g. Province of BC, Shellfish industry, Office of the Commissioner of Aquaculture Development) for Green Crab work. Discussion centered around the use of volunteers using defensible sampling protocols (DFO's Shorekeepers), or the methodology currently being used in Washington State (Washington has recently initiated a 750K per year study of Green Crab), as strategies to reduce costs. Data base management must be included. There was discussion about:

1. Whether a full-blown study was premature; a few sightings does not make an invasion, and that we might merely monitor the Washington State study;
2. Whether a risk assessment only is warranted here now; that a full-blown study could only be justified on the Atlantic coast; and
3. If it was decided the concern is real and that a study be undertaken, then it should not just include an assessment of Green Crab incidence, but a research study that would include ecologically important species in the community.

Dr. Jamieson noted that the Green Crab is a successful invasive species, thus further spread is likely. Comments were then made on possible control measures that might be utilized to protect the wild clam resource and bivalve aquaculture (e.g. off bottom culture). It was also pointed out that if the invasion was successful, the Green Crab could affect the ecological integrity of ecosystems. This highlighted the need for baseline data in conservation areas such as marine protected areas. Predation by Green Crab on fish and bird food organisms was also mentioned as a possible impact. In turn, the Green Crab could be prey for mink, other crabs, fish, birds, etc. In this vein, it was noted that the Fisheries Research Board's 1968 intensive transplant experiment of the American lobster, *Homarus americanus*, to Barkley Sound's Fatty Basin failed. Green Crab could possibly be parasitized by a rhizocephalan parasite (found in local shrimp and crab), which castrates the organism, and if infected, Green Crab might become a disease reservoir with affects on other species. Whether these predators and parasites could control Green Crab in our waters is unknown.

Subcommittee Recommendations

1. Redraft the paper as a "Status Report", as per similar documents in PSARC's stock assessment series.

2. That a proposal for both a monitoring survey and a study of ecological impacts and Green Crab biology (to be conducted at locations where Green Crab appear to be established) be developed by a multi-disciplinary team for submission to DFO's Environmental Sciences Strategic Research Fund for funding in 2001/02. Parks Canada's Cliff Robinson expressed interest in participating, particularly if Pacific Rim National Park Reserve was a study site. Use of DFO's Shorekeepers technique to provide Green Crab impact information in a cost-effective manner should be considered.

3. That if sufficient data are available, both locally and elsewhere, that a proposal to conduct a risk assessment to describe the potential impact of Green Crab on ecosystems and fishery stocks in the Region be developed, in the context of its present and likely future distribution and abundance. The risk assessment should also consider possible control or mitigative options.

Appendix 1: PSARC Habitat Working Papers for August 2000.

No.	Title	Authors
H00-01	Persistent Organic Pollutants (POPs) in British Columbia marine mammals	R. Addison P. Ross
H00-02	Cadmium in BC farmed oysters: A review of available data, potential sources, research needs and possible mitigation strategies	G. Kruzynski
H00-03	The importance of considering ocean habitat in the management of Pacific salmon – the critical size, critical period hypothesis (withdrawn)	R. Beamish C. Mahnken

Appendix 2: PSARC Habitat Subcommittee Meeting Agenda, August 2000

PSARC HABITAT SUBCOMMITTEE

August 22nd, 2000

MILNE ROOM, IOS

Starting Time, 0930 h

1. Review Agenda

2. Review Minutes of December meeting

3. Review of WP #H00-01, "Persistent Organic Pollutants (POPs) in British Columbia marine mammals." R.F. Addison and P.S. Ross

4. Review of WP #H00-02, "Cadmium in BC farmed oysters: A review of available data, potential sources, research needs and possible mitigation strategies." G. Kruzynski.

5. Review of WP #H00-03, (Tentative) "The importance of considering ocean habitat in the management of Pacific salmon – the critical size, critical period hypothesis." R. J. Beamish and C. Mahnken.

6. “Green Crab in British Columbia – An update and Research Proposal”. G. Jamieson

7. Review of agenda for December, 2000 meeting.

Appendix 3: Participants at Habitat Subcommittee Meeting, August 2000.

Fisheries and Oceans Participants

(* Subcommittee Members)

Name	Affiliation
J. Pringle *	DFO, MEHSD
A. Peña	DFO, OSAP
L. Chew	DFO, MEHSD
M. Foreman *	DFO, OSAP
J. Cherniawsky	DFO, OSAP
R. Lauzier *	DFO, Stock Assessment Division
G. Ennis *	DFO, Habitat and Enhancement Branch
I. Birtwell *	DFO, MEHSD
G. Kruzynski	DFO, MEHSD
R. Addison *	DFO, MEHSD
G. Jamieson *	DFO, MEHSD
S. Samis *	DFO, Habitat and Enhancement Branch
C. Levings *	DFO, MEHSD
R. Macdonald	DFO, MEHSD
I. Yeon	Visiting Scientist, Korea

External Participants

Name	Affiliation
C. Robinson *	Parks Canada
V. Barrie *	Natural Resources Canada
K. Schallie	Agriculture Canada, Canadian Food Inspection Agency