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# Proceedings of the Centre for Science Advice, Pacific Region Review of Ocean disposal in resident killer whale critical habitat

# Compte rendu de l'examen du Centre des avis scientifique de la Région du Pacifique sur l'immersion en mer dans l'habitat essentiel de l'épaulard résident

**March 25, 2010**

**Le 25 mars 2010**

**Institute of Ocean Sciences**
**Sidney, BC**

**Institut des sciences de la mer**
**Sidney, C.-B.**

**Marilyn Joyce, Chairperson**

**Marilyn Joyce, présidente**

Fisheries and Oceans Canada / Pêches et Océans Canada
Pacific Biological Station / Station biologique du Pacifique
Nanaimo, BC / C.-B.  V9T 6N7

**August 2010**

**Août 2010**

## Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

## Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu

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200, rue Kent Street
Ottawa, Ontario
K1A 0E6

http://www.dfo-mpo.gc.ca/csas/

CSAS@DFO-MPO.GC.CA

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## SUMMARY

A Regional Advisory Process (RAP) was held to review analytical approaches developed to explore hypothetical scenarios related to disposal at sea of dredged sediment material, evaluate the contaminant risks of polychlorinated biphenyls (PCBs) associated with possible disposal practices on Resident Killer Whale populations (Northern and Southern) and their habitat, and facilitate the development of risk management practices and protocols.

Participation in this meeting included Fisheries and Oceans Canada (DFO) Science, Habitat Management and Aquatic Management Sectors and external participants from the Provincial Government, non-governmental organizations, academia and professional consultants.

The results of this meeting are to be used to support management decisions related to the issuance of *Species At Risk Act permits.*

## SOMMAIRE

Un processus de consultation scientifique régional (PCSR) a eu lieu afin que l'on puisse passer en revue les approches analytiques élaborées pour examiner divers scénarios concernant l'immersion en mer de sédiments dragués, pour évaluer les risques de contamination par les biphényles polychlorés (BPC) associés à d'éventuelles pratiques d'immersion sur les populations d'épaulards résidents (du Sud et du Nord) et leur habitat ainsi que pour faciliter l'élaboration de pratiques et de protocoles de gestion du risque.

Parmi les participants à la réunion, mentionnons des représentants des secteurs des Sciences, de Gestion de l'habitat du poisson et de Gestion des pêches et de l'aquaculture de Pêches et Océans Canada (MPO) et des participants externes provenant du gouvernement provincial, d'organisations non gouvernementales, du milieu universitaire ainsi que des consultants professionnels.

Les documents découlant de cette réunion serviront à éclairer les décisions des gestionnaires liées à l'émission de permis en vertu de la *Loi sur les espèces en péril.*

## INTRODUCTION

SARA-listed killer whales in British Columbia are highly contaminated with several classes of environmental contaminants, including PCBs, as a result of their feeding on contaminated prey, their position in the marine food web, and their long lives. The Recovery Strategy identifies persistent contaminants, including PCBs, as a threat to the long term viability of killer whales. The contamination of killer whale food webs is due to a combination of proximity to pollution source, and the amplification of chemicals with persistent, bioaccumulative and toxic (PBT) properties in aquatic food webs. Contaminated sediments have been shown to contaminate adjacent aquatic food webs, and therefore, represent a source of contaminants to aquatic biota.

A Canadian Science Advisory Secretariat (CSAS) Regional Advisory Process (RAP) was held on March 25, 2010, at the Institute of Ocean Science in Sidney, British Columbia, to review one working paper (*Ocean disposal in resident killer whale (Orcinus orca) Critical Habitat: Science in support of risk management)* evaluating whether PCBs in dredge materials deposited in *SARA*-designated Critical Habitat increase the risk of adverse health effects in resident killer whales (northern and southern).

The Chair, Marilyn Joyce, welcomed participants and, as this was the first time many of the attendees had participated in a CSAS RAP, reviewed the role of CSAS in the provision of peer reviewed advice and gave a general overview of the CSAS process. The Chair discussed the role of participants, confidentiality requirements and the expected RAP document outputs (Science Advisory Report, Proceedings and Research Document) and their general purposes, as defined by CSAS.

Given a management-focussed Ocean Disposal Guidelines workshop was planned for the following day, the Chair confirmed that this was a science advisory meeting, which meant that it would be focused on the development of science advice, rather than on the management implications of that advice. Everyone was invited to participate fully in the discussion and contribute knowledge to the process, with the goal of delivering a scientifically defensible product. It was confirmed with participants that all had received copies of the RAP Terms of Reference (Appendix 3) and the working paper. The agenda was reviewed by participants. Dr. Chris Kennedy, from Simon Fraser University and Ms. Tatiana Lee, from Fisheries and Oceans Canada, were identified and acknowledged for agreeing to provide detailed reviews of the working paper.

The Chair referred to the Terms of Reference (TOR) for the meeting (Appendix 3), and highlighted the objectives of this meeting, which were to consider the general questions of whether PCBs in disposal material deposited in SARA-designated Critical Habitat increase the risk of adverse health effects in resident killer whales (northern and southern populations) The Chair noted that this question had been broken down into several sub-questions (see TOR) that the authors had addressed specifically in their working paper and would be reviewing in their presentation. It was confirmed that the "Management Questions" in the TOR would be deferred to discussions to occur the following day at the joint Fisheries and Oceans Canada (DFO) / Environment Canada (EC) Ocean Disposal Guidelines workshop.

The Chair noted that, while the *Request for Science Advice* had been advanced by the Fisheries and Oceans Canada (DFO) Species at Risk management unit, that it was understood that there could be implications stemming from this science advice to our colleagues in Environment Canada (EC). The Chair acknowledged the strong participation of EC staff and thanked them for their willingness to contribute to this work. The Chair also acknowledged the participation of United States colleagues who are also advancing a similar study and analysis, along with other non-government participants. In total, 33 participants participated in the RAP (Appendix 2).

## DETAILED COMMENTS FROM THE REVIEWS

### Ocean disposal in resident killer whale (*Orcinus orca*) Critical Habitat: Science in support of risk management

C.L. Lachmuth, J.J. Alava, B.E. Hickle, S.C. Johannessen, R.W. Macdonald, J.K.B. Ford, G.M. Ellis, F.A.P.C. Gobas, and P.S. Ross.

**Working paper accepted with revisions*

### Reviewers Comments

Dr. Chris Kennedy appreciated the complexity of the issues that the authors have endeavored to study to answer the question posed. He felt that the paper was well written and used progressive and modern tools and approaches in the analysis. His review focused on the approaches to bioaccumulation modeling and he noted that his expertise did not extend to the toxicology of contaminants on marine mammals. Dr. Kennedy raised several specific questions for discussion and clarification as follows.

Using tissue contaminant threshold levels that have demonstrated adverse health effects in other species, notably harbour seals and bottlenose dolphins as representative of thresholds for resident killer whales was questioned. The reviewer also sought clarification regarding the translation of individual adverse health level effect to a population level effect. It was noted that this concern is routinely raised and that where for ethical or logistical reasons, direct sampling or study is not achievable, using surrogate species for testing is regularly done. For example, in the evaluation of new pharmaceuticals, chemicals or other products for human safety, rodents and other species are routinely used. It is also possible in humans to look at human cohorts or separate populations. In vitro testing would provide the best available information, but for free ranging and even captive killer whales this is just not feasible or acceptable.

It was noted that killer whales are more contaminated that anything else on the planet. Given that they have thyroid glands and physiological processes common to other species, there should be concern when levels in killer whales exceed the levels of concern in other species that are used for testing. Generally, a collective weight of evidence, which is what we do with human health risks, it deemed acceptable. The authors agreed to provide further explanation in the document.

Regarding the applicability of the model, Dr. Kennedy noted that it may be possible to use the model to designate or suggest areas where the disposal of PCB contaminated material would have a more negligible effect. Dr. Ross noted that DFO would still be concerned if disposal of contaminated material outside of critical habitat was at levels to have an impact, but that the model assumes that the Southern Resident Killer Whales spends a percentage of time in Critical Habitat (CH) and outside of CH, so that the effect can be partitioned by area.

Dr. Kennedy agreed with the conclusions of the authors that more effort should be spent on the evaluation of the effects of PBDE contamination but questions whether the authors' dismissal of mercury is reasonable. Peter confirmed that marine mammalologists are generally not worried about mercury in marine mammals as they have evolved to sequester mercury and selenium. Mercury in tuna, swordfish, etc is a concern because of the consumption of these species by humans and the associated health risks. The authors agreed that further explanation on mercury and emerging risks around PBDE could be added to the working paper.

Dr. Kennedy agreed with the conclusions reached for question number five of the working paper, that it is possible to detect a contribution of ambient sediment-associated and/or disposal associated with PCB in killer whale critical habitat using the food web bioaccumulation modeling approach. However, he questioned whether it is possible to affect the toxin burden, as these animals are utilizing outer coastal areas and picking up PCBs unrelated to ocean disposal. The majority of PCBs in these areas are coming from other sources; Asia for example. It was pointed out that moving PCBs from one area to another can contribute to an elevated burden of PBCs, as these contaminants can be released in the process of dredging and potentially providing more exposure.

With respect to the figure of the predicted and observed congeners (figure # xx in the working paper), it was questioned as to why only northern resident killer whale data was considered. Dr. Kennedy also queried whether there was a systematic over prediction of PCB's using the model. The authors clarified that the only data available for this comparison was for northern resident killer whales. It was confirmed that the metabolic rates for 40 different congeners were assessed then a weighted average was applied. There was good agreement for PCBs in the predicted versus empirical data from tissue samples, with a little over and under prediction for different congeners. The authors also noted that a second model (also in the primary literature and utilized on the St. Lawrence Beluga population (Hickie et al. 2000), Arctic ringed seals (Hickie et al. 2005), and resident killer whales (Hickie et al. 2007)) was presented as an Appendix, which also gave results consistent to those presented, adding further confirmation of the applicability of the model to answer the questions asked by managers.

Dr. Kennedy noted that the authors had made recommendations to improve Chinook Salmon and resident Killer Whale distribution and feeding ecology data, along with samples of PCB concentration from material disposed of in critical habitat, and wondered if that was necessary, given the performance of the current model. Since the model performed very well, further modifications are likely not necessary; however, the resident killer whale diet was improved upon by including chum and coho salmon, lingcod, and dover sole. Adding these species (in appropriate proportions) did not result in any significant differences in PCB concentrations in resident killer whales, which confirmed Dr. Kennedy's suggestion. Additional information on resident killer whale and Chinook salmon distributions are not available so that aspect could not be improved upon. Samples of material disposed in critical habitat were not provided to improve that aspect of the modeling.

The second reviewer, Ms. Lee, indicated that her review focused on the ecology of killer whales and whether the working paper adequately addresses the questions posed.

She commended the authors for analyzing such a volume of information and producing this report within the short timeline of the associated Request for Science Advice. The two-fold approach provides a description of possible pathways of bioaccumulation of contaminants from sediment to prey to killer whale and provides linkage between habitat impacts and potential effects on resident killer whales' survival and potentially population recovery. She noted that this analysis is a first step towards more comprehensive validation of approaches to meet protections required for resident killer whales under Section 32 and Section 58 of SARA.

She clarified that the report considers influences of sediment and food web contaminant loading both within and outside resident killer whale critical habitat in Canada. This is wider than the scope of the Request for Science Advice related to Canadian critical habitat, but remarked that it is appropriate, as it provides a holistic view of overall contamination and puts critical habitat in the context of potential exposure throughout the region.

Specifically related to the analysis, Ms. Lee noted that the model used an average resident killer whale diet of 96% Chinook, 2% halibut, 2% sablefish, and questioned why Chum Salmon was not included. The authors confirmed that some of the data on Chum Salmon was not incorporated because of time constraints and that there is some uncertainty in the year round data (particularly winter months), from the data published in the literature they are fairly confident that at least 75% of the diet consists of Chinook Salmon with some remaining fraction being chum and to a lesser extent other species. There is greater uncertainty around the non-Chinook prey consumption and that the quality of data diminishes when you choose local prey. The authors indicated that it is their intent to update this work with additional data that was not available at the time of the analysis. The authors indicated that Chum Salmon, Lingcod, and Dover Sole should be added, but felt that it would have little affect on the model outcomes, because bioaccumulation is mostly dependent on trophic level. It may change the results by 1% but not much. It was agreed that the authors would provide a fuller description of diet data and assumptions, including clarifying why sablefish was chosen.

Ms. Lee also raised the issue that adverse effects were not observed in the population, so it would be useful to provide some weight of evidence for potential effects using other marine mammal species as proxy for the discussion. Dr. Ross pointed out that PCB's aren't acute poisons, like arsenic. He confirmed that they are endocrine disrupting compounds and noted that for an animal of 90 years of age, it's rare that one individual is only exposed to only one toxin. You may not see an extra finger, but there may be a lower IQ or decreased immune function, which would make the animal weaker and reduce its ability to survive adverse environmental impacts or disease. For example, in 1987, there was zero reproduction of harbour seals in Europe. After they recovered in 1988, a new virus killed 60% of population because the immune system was vulnerable due the effects of PCBs.

The reviewer also asked for clarification on the source of Chinook salmon distribution and migration timing data. It was confirmed that these data were provided by the DFO Chinook Salmon assessment team, who were represented at the RAP, and that the time spent for various Chinook stocks in each of the habitat zones was approximated based on coded wire tags and genetic sampling of the fishery. It was felt that there was a fair degree of confidence in the Chinook distribution and timing data. Ms. Lee noted that the document states that "PCBs attributable to critical habitat were approximately 4% for

NRKW and 13% for SRKW" and suggested that this is important information that should be included earlier in the Abstract and other sections of the document to clarify relative impacts. Several other editorial suggestions were provided with respect to the language used in reference to the SARA Program and management implications. The authors agreed to work with the SARA program managers to improve this aspect of the document, prior to publishing.

Ms. Lee summarized that given available data on food web, sediment and biota contaminant loading, and distributions (killer whales and prey) within and outside critical habitat, the report addresses the questions as thoroughly as is possible at this time. Ms. Lee felt that the uncertainties that remain due to data gaps should be more clearly incorporated into conclusions. Ms. Lee agreed with the authors recommendations that further collaborative research is needed to provide clarity on chemical contamination and habitat impacts as they relate to SARA critical habitat protection and long-lived mammals.

## General Discussion

The Chair opened the floor for comments and discussion by all RAP participants. The following represents the nature of the discussion organized by topic.

*Sampling and Data Quality*

It was noted that the PCBs concentrations for salmon in Puget Sound were higher than what would be expected, based on the US sediment sampling and levels found in Chinook, suggesting some bias in these data. After some discussion it was concluded that only a limited number of sediment samples for Puget Sound were used in the model, and almost all came from "hot spots" in urban areas. It was also noted that there are additional samples from 2008 that focused on PCBs from non-urban areas which, if added to the model, may address this bias.

Questions were raised about the manner in which the model accounted for differential bioaccumulation in resident killer whales when they are outside the study area, versus within the study area or Critical Habitat. Samples were obtained from individual resident killer whales of known age and sex, and information is available on the time these individuals spend in the different modeled areas in this report. This lead to further discussion regarding the quality of the sampling of sediments and biota in and outside the study area and the data used to determine the time spent by the killer whales in various coastal regions. It was concluded that, while further sampling would assist in refining the outputs, data was adequate to assess the questions posed.

There were also questions about the source of the sediment data used to model the potential bioaccumulated contaminant levels in resident killer whales. Sediment PCB data come from several DFO and US studies (cited in Table 4 and text). An Environment Canada participant noted that additional data on contaminant levels in disposal sediments could be provided to ensure the modeling is as realistic as possible.

*Model Performance & Results*

Questions arose around the application of the sediment sample data being applied broadly through the zones considered. There were seven zones considered in total, and a major effort was conducted to include all available sediment PCB data. However, some available data had to be disregarded due to problems with sampling and analytical techniques, as well as other issues. This resulted in some zones having several sediment PCB concentrations (which were averaged) while other zones had very few samples, and one zone had no samples but was assumed to be the same as the zone beside it. The only way the applicability of the sediment data could be improved would be for additional collection of sediment samples. Unfortunately, there was not enough time for this to occur, and the averaging of sediment concentrations is a widely used and accepted technique when limited empirical data is available.

There were questions on the pattern of PCB congeners in biota, and if the pattern could be linked to the source. The food web model was mainly affected by PCBs in sediments, as atmospheric PCB concentrations used in the model were extremely low. Furthermore, the congeners considered were chosen based on availability of data, and consistency between data sets. Thus, the model was unable to distinguish if higher congeners are linked to the ambient sediments or to disposal at sea areas. Since the model did not account for metabolism, the congener pattern was not affected by this.

There were questions raised related to the accuracy of the model and some of the assumptions used. The authors explained that the model output was very similar to empirically measured PCB concentrations in biota, which confirms that the model was driven by input concentrations and there was little overall systematic bias with the model. The model assumed that killer whales had 100% absorbency of PCBs from their diet, which has been shown empirically. However, this is not the case for uptake directly from sediments as this is affected by the concentration of organic carbon in the sediments and this was taken into account by the model. The model assumed that there was no transformation (metabolism) of PCB congeners by killer whales and this was tested with Hickie model (included in the working paper as an appendix). The model used salt water $K_{OW}$'s that were derived from fresh water $K_{OW}$'s, and this derivation process was described in previously published and peer-reviewed studies and was validated experimentally. Each PCB congener has a different $K_{OW}$ value, thus certain congeners will bioaccumulate more than others and it is not a linear response for all congeners.

One question focused on model uncertainties and if any assumptions would be validated. This was done with the resident killer whale diet, by including more species and the sensitivity analysis found that there was no significant difference. Further disposal scenarios were run after the peer-review to provide more concrete answers to the questions posed in the Terms of Reference. Furthermore, both the Gobas food web bioaccumulation model and the Hickie killer whale model obtained similar results, which validate the results, and there was good agreement found between the model results compared to observed (empirically determined) concentrations.

Given the number of questions raised regarding the assumptions and data an analysis in the model, at the request of participants, the authors agreed to conduct some sensitivity analysis to confirm their verbal representation that the issues raised (particularly around the feeding ecology) would not have a significant bearing on the conclusions. This was conducted and there were no significant differences found when more species were included in the diet. In addition, the authors agreed to review the section on the model description to provide a fuller description of why this model was chosen. Further, given that both the presentation of the second modeling approach in the Appendix, provides validation of the primary model, it was recommended that this should be incorporated into the main body of the working paper. The second model (the Hickie killer whale model) found very similar results to the Gobas food web bioaccumulation model, which indicates that the model output is indeed accurate, and that metabolism of PCB congeners does not have a significant impact on the PCB concentrations in killer whales.

*Guidelines and Use of Regulatory Language*

It was noted that the working paper does not define what constitutes “destruction of Critical Habitat” (as defined by *SARA*), which is necessary to evaluate whether current ocean disposal activities “destroy” Critical Habitat, as is posed in the objectives. It was clarified that the determination of “destruction” is a policy or legal decision. Therefore, the goal in providing this science advice should be to identity what the impacts on the habitat disposal activities are and the potential risk to the resident killer whales. By developing a bioaccumulation model, outcomes can be evaluated with known data and for various scenarios under consideration by managers.

It was noted that only by evaluating each application for ocean dumping on a case by case basis can decisions to permit be made. For example, in some areas the disposal material may be less contaminated than the ambient sediment levels. It was pointed out that by having a model that we believe adequately represents the bioaccumulation process, case by case evaluations can be done.

Additionally, there was some discussion as to the relevance of using the established guidelines currently in practice to assess their validity for resident killer whale protection. There was some concern as to whether guidelines established for macro-benthic biota are relevant. The authors explained that the use of existing guidelines was to provide some reference point to compare model outputs, not to advise on what an appropriate guideline should be. It was made clear, that there was no intent to imply that current ocean disposal of contaminated materials was below, at, or exceeding these levels.

It was noted that Washington State uses 130 $\mu g \cdot kg^{-1}$ for protection of benthic habitat. There is a recognition that there can be effects below this level, but that is the current practice, nonetheless. It was also noted that because dredging can mobilize contaminants, most remedies are composite approaches developed on a case by case basis. In Washington State, enhanced natural recovery (i.e. dilute/ attenuate concentrations) is often used as a remedial measure to address contaminated habitats. The US goal is to meet 130 $\mu g \cdot kg^{-1}$ within 10 years and it was stated that contaminant levels at most US dredging sites have not deterioriated since the program was initiated. US participants offered to provide more information on some of the US sites, e.g. Port Townsend, Port Angeles, Rosario State to assist in this analysis. The authors stated that the best available data or evidence was used to provide the best estimation in the short time provided to do the analysis. Improvements can be made and the authors are committed to work with managers to refine scenarios, and consider case by case examples.

It was suggested that the authors provide some explanation in the working paper about what environment quality guidelines are, how they are used, and why they are used

(Canadian Environmental Protection Act (CEPA), Environment Canada Action Levels, Canadian Council of Ministers of the Environment (CCME) etc). It was also noted that various units are used through out the document to describe contamination levels and that this should be reviewed for consistency.

It was also noted that the language around *SARA* terms and policies should be reviewed to ensure consistency and accuracy. SARA managers agreed to provide authors with input to improve the document.

**Conclusions**

- Modeled bioaccumulation of PCBs from sediments within and, in some cases, outside the critical habitat of resident killer whales is consistent with actual measurements of PCB levels from the tissue of both killer whale and their primary prey (Chinook Salmon).

- The bioaccumulation models provide a tool for evaluating risk-management decisions related to ocean dumping of PCB contaminated sediments and these findings provide a basis for DFO Habitat (SARA) managers to better understand the implications of ocean disposal operations under SARA.

- While specific data or analysis on the health effects of PCBs on resident killer whales are not presented, the weight of evidence based on the study of surrogate species as cited in the paper and discussed during the RAP supports the advice provided that PCBs, at the levels presented, represent a threat to resident killer whales.

- The disposal of sediments, compliant with the current CEPA guidelines for ocean disposal, would result in a bioaccumulation of PCBs to such a level, as to potentially cause adverse health affects in resident killer whales.

- Ocean disposal applications will have to be evaluated on a case by case basis, as both ambient PCB levels, along with the local sedimentation, bio-perturbation and oceanographic conditions, affect whether a particular site will have a net increase or decrease in PCB levels.

- Sediments and dredged materials contain many other contaminants. Of these, PBDEs (flame retardants) were also identified as a concern for resident killer whales, given that they have similar immune, reproductive and other endocrine health effects as PCBs. Further, they are increasing rapidly in the environment, despite recent regulatory prohibitions.

**Recommendations**

- The working paper was accepted with revisions as noted in the preceding text. In particular, inclusion of additional sediment data from Environment Canada (Strait of Georgia) and NOAA (Puget Sound) has been recommended to address potential bias in the sediment data samples.

- Further simulations to test the sensitivity of the assumptions regarding dietary intake and habitat partitioning are recommended to confirm that refining the feeding ecology information would not significantly change the results and conclusions.

- Using the bioaccumulation modeling as presented, Science Branch will work with managers to evaluate case and site specific ocean disposal applications.

# Assessing risks associated with disposal at sea within resident killer whale habitat: Science in support of SARA protections

A half-day Canadian Science Advisory Secretariat (CSAS) peer review of a draft working paper developed in response to a request for science advice from SARA managers

hosted by
the Centre for Science Advice Pacific (formerly PSARC)

25 March 2010
1.00 – 4.30 pm
Institute of Ocean Sciences (Milne Room)
Sidney BC

**Terms of Reference:** Attached or at CSAS website
http://www.meds-sdmm.dfo-mpo.gc.ca/csas/applications/events/eventIndex_e.asp#March

**Chairperson:** Marilyn Joyce

**Objective:** Peer review of the draft CSAS working paper: *Assessing risks associated with disposal at sea within resident killer whale habitat: Science in support of SARA protections* by *Ross, Lachmuth, Alava, Gobas, Hickie, Johannessen, Ford and Macdonald*.

| | |
|---|---|
| 1:00 | Welcome & Instructions/Comments of the Chair (Marilyn Joyce) |
| 1:10 | Presentation of Working Paper |
| 1:50 | Presentation of Review #1 and Authors' Response |
| 2:10 | Presentation of Review #2 and Authors' Response |
| 2:30 | Refreshment break |
| 2:50 | Discussion |
| 3:45 | Develop Conclusions and Advice |
| 4:20 | Closing comments and next steps of the Chair |

## Appendix 2.  List of Attendees

| Last Name | First Name |
|---|---|
| Alabster | Jenniffer |
| Aguis | Suzanne |
| Alava | Juan Jose |
| Barre | Lynne |
| Brown | Gayle |
| Calla | Karen |
| Conway | Kim |
| Coopper | Tola |
| Dinn | Pamela |
| Frouin | Heloise |
| Gobas | Frank |
| Hickie | Brendan |
| Hill | Phil |
| Hutton | Karen |
| Johannessen | Sophie |
| Johnson | Lyndan |
| Joyce | Marilyn |
| Kennedy | Chris |
| Lachmuth | Cara |
| Lee | Tatiana |
| Leung | Roanna |
| Lewis | Scott |
| Li | Michelle |
| Lunn | Amber |
| Macdonald | Robie |
| O'Hara | Patrick |
| Porebski | Linda |
| Ross | Andrew |
| Ross | Peter |
| Spry | Doug |
| Standing | Sean |
| Wakeman | John S. |
| Yunker | Mark |

The reviewers for the Centre for Science Advice Pacific (CSAP) working paper presented at this meeting are listed below.  Their assistance is invaluable in making the CSAP process work.

| | |
|---|---|
| Lee, Tatiana | Fisheries and Oceans Canada |
| Kennedy, Chris | Simon Fraser University |

## Science Advisory Process on Sediment contaminant criteria, disposal at sea, and killer whale Critical Habitat

## DATE: Thursday, March 25, 2010 1:00 to 4:30 pm
## LOCATION: Institute of Ocean Sciences, Sidney BC Canada

## Terms of Reference

### Context

SARA-listed killer whales in British Columbia are highly contaminated with several classes of environmental contaminants, including PCBs, as a result of their feeding on contaminated prey, their position in the marine food web, and their long lives. The Recovery Strategy identifies persistent contaminants, including PCBs, as a threat to the long term viability of killer whales. The contamination of killer whale food webs is due to a combination of proximity to pollution source, and the amplification of chemicals with persistent, bioaccumulative and toxic (PBT) properties in aquatic food webs. Such chemicals are hydrophobic and therefore readily attach to particles (suspended solids, organics, detritus, sediments) and/or to lipids at the bottom of the food web (membranes of phytoplankton, bacteria). These two environmental matrices, however, are connected, with contaminated sediments delivering PCBs and other persistent chemicals into aquatic food webs. Contaminated sediments have been shown to contaminate adjacent aquatic food webs, and therefore represent a source of contaminants to aquatic biota. Given the special vulnerability of killer whales to contamination by PCBs and related contaminants, and their associated health effects, it is important that current CEPA 1999 guidelines and regulations be critically evaluated in this regards, with an emphasis on contamination within the species' Critical Habitat (CH). Four ocean disposal sites exist within killer whale CH, including Johnstone Strait (2), Sand Heads (1), and Victoria (1).

### Objectives

*Based on initial teleconference June 17, 2009 (DFO: Al Cass, Karen Calla, Peter S. Ross, Robie W. Macdonald, Patrice Simon, Ghislain Chouinard, Simon Nadeau, and Atef Mansour; absent: Robin Brown; EC: Sean Standing and Barry Jeffries)*

*General question:*

Do PCBs in disposal materials deposited in *SARA*-designated Critical Habitat increase the risk of adverse health effects in resident killer whales (northern and southern)?

*Science questions to be addressed:*

- What disposal materials represent a concern to the health of killer whales and killer whale Critical Habitat?
- What are 'acceptable' concentrations of contaminants (notably PCBs) in sediments or disposal materials for the protection of killer whale health?
- Are current *Disposal at Sea* rejection/screening limits for environmental contaminants (including PCBs) in disposal materials under *CEPA 1999* sufficient to protect the Critical Habitat of resident killer whales as defined by *SARA*?
- Are current analytical and monitoring standards as required by CEPA 1999 of sufficient calibre to enable defensible science-based advice with regards to

impacts of Disposal at Sea on killer whale health, and especially within killer whale Critical Habitat?
- Are there other contaminants of concern in dredge/disposal materials that are either presently screened under CEPA (mercury, cadmium, hydrocarbons, PCBs, and persistent plastics other persistent synthetics) or not screened (PBDEs) under CEPA that may present a risk to killer whales?

*Management questions:*
- Should new sediment quality objectives (to complement or replace rejection/screening limits as set forth by CEPA 1999) be developed for the protection of killer whale health to guide disposal at sea permitting in killer whale Critical Habitat under SARA?
- Can guidance on disposal site selection and disposal practices be provided that would reduce contaminant risks to killer whales and killer whale Critical Habitat?

A two-stage evaluation is proposed. In the first-stage (described herein), an initial "rapid" assessment will be undertaken to scope out the impact by site using existing information and models where appropriate. The outcome of this first-stage scoping session will determine the potential next steps for the second and longer term effort as required depending on the outcome of stage one. A working paper based on the stage-one assessment will be produced and it will be the basis for a formal science peer-review by the Pacific Scientific Advice Review Committee (PSARC) in March of 2010.

**Outputs**

Expected outputs at the end of the meeting will include a Research Document, a Science Advisory Report and a Proceedings Document following CSAS format and timeline guidelines.

**Participation**

Invited participants will include DFO Science, OHEB, Environment Canada, NRCan, Province of BC, State of Washington, USEPA, academics and ENGOs, based on information and/or expertise to be contributed through this advisory process.

## Appendix 4: Working Paper Summary

**Ocean disposal in resident killer whale (*Orcinus orca*) Critical Habitat: Science in support of risk management**

C.L. Lachmuth, J.J. Alava, B.E. Hickle, S.C. Johannessen, R.W. Macdonald, J.K.B. Ford, G.M. Ellis, F.A.P.C. Gobas, and P.S. Ross.

Resident killer whales in the coastal waters of British Columbia and Washington are heavily contaminated with persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs). In an effort to protect the whales and their Critical Habitat, Fisheries & Oceans Canada is tasked with evaluating and mitigating the threats they face under the *Species at Risk Act* (SARA), notably Sections 32 and 58 (see Appendix I). Contaminants, reduced prey, and noise and disturbance were identified by the Resident Killer Whale Recovery Team as threats to population recovery. At present it is unclear whether disposal of dredged material into Critical Habitat might increase the exposure of killer whales to contaminants of concern. Environment Canada regulates disposal at sea operations under the *Canadian Environmental Protection Act* (CEPA). Sediments often contain complex mixtures of contaminants, and material intended to be disposed of at sea is screened for a select list contaminants. Because killer whales are long-lived and occupy a very high trophic level, they are at particular risk to accumulating high concentrations of persistent organic pollutants. At present, PCBs represent a dominant toxicological concern in killer whales. However, the emergence of another class of POP, the flame retardant polybrominated diphenyl ethers (PBDEs), highlights the need for new tools to understand the fate and effects of chemicals in killer whale habitat. Another challenge for regulating PBDEs relates to the current lack of sediment guidelines or screening levels that provide appropriate protection from disposal operations.

This report represents a response to the following Request for Advice solicited by Fisheries and Oceans Canada**:** *Are current Ocean Disposal Rejection/Screening Limits for environmental contaminants (including PCBs, dioxins/furans, mercury and PAHs) under CEPA 1999 adequate to prevent northern and southern resident killer whale Critical Habitat from destruction, as required by SARA Section 58?* A secondary question concerning threats to individual resident killer whales listed under SARA followed: *Do PCBs in materials deposited in killer whale habitat, outside of designated Critical Habitat areas, increase the risk of harm or mortality of northern and southern resident killer whales, as required by SARA Section 32?*

During the early phase of our exercise, we drafted the following technical questions to guide the design of modeling scenarios and provide guidance on the Request for Advice:

- What contaminants (listed under CEPA or otherwise) in disposal materials might represent a destruction of killer whale Critical Habitat as per SARA Section 58, or present a risk of harm or mortality to individuals as per SARA Section 32?
- Are current analytical and monitoring standards as required by CEPA 1999 for Disposal operations in killer whale Critical Habitat sufficient to enable science-based advice under the terms of SARA protection orders and/or permitting?
- What are the estimated threshold concentrations of contaminants (notably PCBs) in sediments or disposal materials that would be considered as adequate to prevent negative effects on killer whale health?

- Can we detect a contribution of ambient sediment-associated and/or disposal-associated PCBs in killer whale Critical Habitat using a food web bioaccumulation modeling approach?
- Can we attribute PCBs in northern and southern resident killer whales to different habitat areas used by killer whales and their prey?

Questions considered that have more bearing on management and policies include:

- Are new thresholds for sediment quality and/or disposal screening necessary to protect resident killer whale Critical Habitat (SARA Section 58) and/or health of individuals (SARA Section 32)?
- Is there adequate information to develop a set of basic guiding principles for disposal practices and/or disposal site selection that would reduce contaminant risks to killer whale Critical Habitat to avoid Section 58 destruction and/or killer whale health to avoid Section 32 harm or mortality?

Our effort here included the following components i) the designation of seven geographic areas that relate to management-related priorities (e.g. Critical Habitat) and/or international boundaries; ii) a biologically-based assignment of time spent in each of these areas by southern and northern resident killer whales and their prey (Chinook salmon and non-salmonid species) based on best available information; iii) the adaptation of sediment-biota PCB bioaccumulation models to killer whales and their prey; iv) a compartmentalized approach to modeling sediment-food web uptake of PCBs within each of the seven areas identified so as to be able to evaluate site-specific impacts of disposal operations; and v) a comparison of model outcomes to three established health effects thresholds for PCBs in marine mammals. The basic modeling approach is based on characterizing the distribution of PCBs between sediments, the water column, and biota, and estimates concentrations that will be achieved in animals throughout a life time of exposure. In all seven areas investigated, including the Critical Habitats of both northern and southern resident killer whales, predicted PCB concentrations in Chinook salmon from measured PCB concentrations in sediments exceeded the tissue residue guideline for PCBs in fish-eating wildlife (50 $\mu g \cdot kg^{-1}$, wet weight).

In addition, modeled sediment PCB concentrations equivalent to the Canadian Council of Ministers of the Environment (CCME) sediment quality guidelines (34.1 $\mu g \cdot kg^{-1}$, dry weight) and CEPA Action Levels for disposal at sea (100 $\mu g \cdot kg^{-1}$, dry weight) resulted in PCB concentrations in Chinook salmon that exceeded tissue residue guidelines for fish-eating wildlife (50 $\mu g \cdot kg^{-1}$, wet) derived by Hickie *et al.* (2007). Scenarios based on BSAF values in each of the seven areas predicted that Lower Fraser River and South Thompson Chinook salmon also exceeded the Action Level, and tissue residue and sediment quality guidelines evaluated.

We predicted that more than 95% of resident killer whales would exceed all established health effect thresholds (1.3, 10, 17 $mg \cdot kg^{-1}$, lipid weight in marine mammals) should their prey be exposed throughout their lives to PCB concentrations in sediments that are equivalent to the sediment quality guidelines and action levels tested. Realistic scenarios reflecting estimated time spent by killer whales and their prey across all seven areas revealed that PCB concentrations in both populations of killer whales exceed toxicity health effect thresholds established for marine mammals, consistent with measured observations of PCBs in killer whales. In most areas, measured sediment PCB concentrations are below sediment quality guidelines; however, we consider the SQGs to be inadequate to protect resident killer whales. These scenarios highlight the notion that current sediment quality guideline (CCME) and Action Level (CEPA) values for PCBs do not protect resident killer whales.

In the absence of measured PCB concentrations for dredge materials, we used measured sediment PCB concentrations from Burrard Inlet as a surrogate for disposal material to characterize risks associated with disposal into Critical Habitat. Model results indicate that 100% of Chinook would exceed tissue residue guidelines for fish-eating wildlife and 95 - 100% of killer whales would exceed established effects thresholds in marine mammals.

We used the model to estimate the PCB concentration in sediments that would protect 95% of the resident killer whales, with a resulting range of 0.012 to 0.150 $\mu g \cdot kg^{-1}$, dry weight. These values can be used as guidelines to assess the impact of disposal of PCB containing sediments in killer whale habitat. Results reveal the profound vulnerability of killer whales to contamination by persistent contaminants, since only 2/61 (3.3%) sediment sites for which we have PCB measurements fall below the least protective of these sediment values (0.15 $\mu g \cdot kg^{-1}$, dry weight). While we could not evaluate PBDE risks using present models, the doubling of this class of POP every 3.5 years in coastal British Columbia represents an emerging concern.

Additional information on sediment PCB concentrations across a wider geographic area in coastal British Columbia, improved understanding of the feeding ecology and habitat use of killer whales and their primary prey, and on sediment and sedimentation features in killer whale habitat will improve the workings of this approach. Nonetheless, this exercise does identify the need for improved analytical approaches to PCB measurements and disposal activities as they relate to Critical Habitat.