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Southern Resident Killer Whale Workshop

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SOUTHERN RESIDENT KILLER WHALE WORKSHOP

National Marine Mammal Laboratory, Seattle, WA

1-2 April 2000

Compiled by

Marilyn Dahlheim, David Bain, Christy Sims, and Douglas DeMaster

Preface

Since 1974, a census of the southern resident community of killer whales (J, K, and L pods) of Puget Sound has been taken annually using photo-identification methodology. Based on this research, the southern resident killer whale population was shown to grow to nearly 100 individuals by the mid-1990s. However, during the last few years (1995-99), a decline in population level has been observed. In May 1995, the population count was 98 individuals. By October 1999 this number had dropped to 83 whales, a decline of more than 15%. Possible factors influencing the southern resident community of killer whales included high levels of contaminants, availability of prey resources, and increased whale watching activities in the San Juan Islands. Killer whale researchers believed a workshop was warranted to review the status of southern resident killer whales.

On 1 and 2 April 2000, a killer whale workshop was held at the National Marine Mammal Laboratory in Seattle, Washington. Sponsors of the workshop included the Alaska Fisheries Science Center (National Marine Mammal Laboratory), Center for Whale Research, Six Flags Marine World Vallejo, and The Whale Museum. Contributions were made by the Department of Fisheries and Oceans (DFO Canada) and the American Cetacean Society. The purpose of the workshop was to review the current status of southern resident killer whales and help the research community coordinate future research. The workshop focused on four areas of research to include: 1) Population Dynamics of Eastern North Pacific Killer Whales, 2) Stock Structure of Eastern North Pacific Killer Whales, 3) Possible Factors Influencing Killer Whale Populations, and 4) Cross-Border Stranding Protocol/Emergency Responses. In addition to several oral presentations covering these topics, background documents were also submitted.

Opinions presented in workshop report do not necessarily reflect the opinions of NMFS, but rather reflect the opinions of workshop participants. The authors of this report would like to thank each of the workshop participants for their efforts in making this workshop successful.

Workshop Agenda

1 APRIL (0900 - 1700)

0900 - 0920	Welcoming Remarks (Chair: Douglas DeMaster)

POPULATION DYNAMICS OF EASTERN NORTH PACIFIC KILLER WHALES

0920 - 0940	Southern Residents (Paul Wade)
0940 - 1010	Southern and Northern Residents (Peter Olesiuk)
1010 - 1030	BREAK
1030 - 1050	Southeast Alaska Residents (Marilyn Dahlheim)
1050 - 1110	Prince William Sound Residents (Craig Matkin)

STOCK STRUCTURE OF EASTERN NORTH PACIFIC KILLER WHALES

1110 - 1130	Genetic Structure of British Columbia/Alaskan killer whales (Lance Barrett- Lennard)
1130 - 1150	Overview of Killer Whale Population Genetics (Rus Hoelzel)
1150 - 1200	Open discussion on status of Southern Residents
1200 - 1300	LUNCH

POSSIBLE FACTORS INFLUENCING KILLER WHALE POPULATIONS

1300 - 1320	Contaminant Levels of Southern and Northern Residents (Peter Ross)
1320 - 1340	Contaminant Levels of Prince William Sound and Southern Residents (Gina Ylitalo)
1340 - 1400	Comparison of Analysis Techniques (IOS and Montlake Laboratories)
1400 - 1420	Whale-Watching Activities in the San Juan Islands (Rich Osborne and Jodi Smith)
1420 - 1440	Food Habits/Availability of Prey Resources (John Ford)
1440 - 1500	BREAK
1500 - 1700	Discussion of ESA Listing Criteria and Information Needs for Management
1700	ADJOURN

2 April (0900 - 1200) General Discussion

0900 - 1200	Discussions on Emergency Responses/Cross-Border Protocol 1. Stranding Protocol 2. Possible Rescue 3. Permits Required 4. Contacts (e.g., U.S. Coast Guard, Canadian Coast Guard, etc). 5. List of Key Contact People
1200	ADJOURN

List of Participants

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Marilyn Dahlheim	NOAA, Alaska Fisheries Science Center, National Marine Mammal Laboratory, 7600 Sand Point Way N.E., Seattle, WA 98115
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Liana Lara	University of Washington, Seattle, WA 98195
Albert Shepard	The Whale Museum, 62 First Street North, Friday Harbor, WA 98250

Workshop Proceedings

For management purposes, the National Marine Fisheries Service has grouped Eastern North Pacific killer whales (*Orcinus orca*) into five stocks (SRKW8, SRKW9). Furthermore, the southern resident community, comprised of J, K, and L pods, has been shown to be genetically distinct (SRKW13). Given the recent decline noted in this southern resident community, killer whale researchers believed a workshop was warranted to review the status of this population. On 1 and 2 April 2000, a workshop was held at the National Marine Mammal Laboratory, Seattle, Washington. The workshop focused on four areas of research to include: 1) Population Dynamics of Eastern North Pacific Killer Whales, 2) Stock Structure of Eastern North Pacific Killer Whales, 3) Possible Factors Influencing Killer Whale Populations, and 4) Cross-Border Stranding Protocol/Emergency Responses. Information presented at the workshop reflected research from published and unpublished data. Douglas DeMaster served as the workshop chair. Marilyn Dahlheim and David Bain agreed to serve as rapporteurs.

Population Dynamics

The first agenda item focused on the southern resident killer whale community (J, K, and L pods). Survival rates for southern residents from 1974 to 1999 were reviewed by Paul Wade, David Bain, and Ken Balcomb (SRKW1, SRKW11). Survival rates were examined by age and sex and compared over time to look for patterns. Comparisons were also made among the three resident pods. Results of these analyses indicated that survival has changed over time, with an initial period of high survival, followed by a period of low survival, then a period of high survival, and finally a period of very low survival. The observed pattern of survival over time was similar across all age and sex categories.

This suggests the possibility of some sort of external environmental factor affecting the survival rates, but does not preclude an anthropogenic influence. Survival in the most recent 6 years (1993-98) was the lowest of any other previous period in the last 25 years. Age structure was unstable through most of the study period, but approached stability at the end. Thus, collections for public display affected the details of the population trajectory, but did not account for age and sex-specific changes in birth and death rates (SRKW11).

The next three presentations included an overview of the population status of the northern resident killer whale population (Peter Olesiuk, SRKW2), Southeast Alaskan resident killer whales (Marilyn Dahlheim), and Prince William Sound resident killer whales (Craig Matkin). Unlike the southern resident community, killer whale resident populations from these three geographical regions have increased in size over the time they have been observed. Details were provided for the northern resident community of killer whales as follows.

The northern resident population had increased at a maximum rate of almost 3% per year, but is apparently approaching its carrying capacity, as the current rate of the increase appears to be slowing. Others suggested an alternative explanation, where the population was not at carrying capacity, but that mortality had increased for unknown reasons. The northern resident population data imply that the maximum net productivity level of the population would occur at about 80% of carrying capacity, rather than 50%, as it does when $z = 1$. In addition, a correlation was found between population growth rate changes in "A" clan of the northern resident community and southern residents, suggesting these two populations are being driven by the same environmental factors rather than competing with each other. The presentation concluded by pointing out that a 27-year data set is not long enough to completely understand the population. SRKW10 provides supplementary information on the northern resident community.

Stock Structure

The next issue was the stock structure of Eastern North Pacific killer whales. Although resident populations of killer whales do occasionally overlap geographically, there is clear evidence of genetic distinctiveness among groups (SRKW13). Geneticists at the workshop (Lance Barrett-Lennard and Rus Hoelzel) agreed that the southern resident population of killer whales was genetically distinct from the northern resident killer whale population. Comparisons were made between the southern residents, northern residents, and transients based on both nuclear and mtDNA analyses (SRKW13). A maternal marker (mtDNA) showed a fixed difference between populations suggesting no recent female-mediated gene flow. Markers that reflect the movement of both males and females (microsatellite DNA) did not eliminate the possibility of low rates of male-mediated gene flow among all three local putative populations (northern residents, southern residents, and transients). It was suggested that an accurate assessment of gene flow and the effective size of the southern resident population would require a larger sample size. Based on the sampling of approximately 70 mother/calf pairs from the northern resident population, it appears that males do not mate with females from their own pod.

Possible Factors Influencing Killer Whale Populations

Contaminants

Possible factors influencing killer whale populations included contaminant levels, whale-watching activities, and availability of prey resources. Contaminant levels in free-ranging killer whales were presented by Peter Ross and Gina Ylitalo. SRKW4 summarizes the results obtained from congener-specific PCB, PCDD and PCDF concentrations in 47 individuals from three populations (northern and southern residents; transients). Ylitalo (SRKW3) presented results from congener specific PCB analyses for resident and transient whales from Prince William Sound. These results

establish the transients and southern residents as among the most chemically contaminated marine mammals in the world. The chemists agreed that the levels of PCBs present represent a tangible health risk to these populations.

Transient whales were far more contaminated than southern resident whales. However, southern resident whales had higher PCB levels than northern residents or Prince William Sound residents. This implies that these populations of whales are eating different species of prey or prey species from different areas. Females typically have lower levels of PCBs than do males, a result of contaminant transfer by females to their offspring. SRKW12 was submitted after the workshop but is included in this report as reference material.

Some concern was raised that, if different analytical laboratories were involved with the contaminant analysis of tissues, the results between laboratories would not be comparable because of technique differences (rather than differences in contaminant levels). After some discussion regarding the procedures used by the two different laboratories involved, there was general agreement that the reported results were comparable at least for those congeners analyzed by both laboratories. Further, it was noted that both laboratories routinely checked their techniques by using standard reference materials (i.e., tissue samples where the specific contaminant levels are known).

It was noted that the southern resident population of killer whales was observed increasing throughout most of the 1980s and early 1990s. During this period, the level of contamination in their prey was likely as high or higher on average than the period from 1995 to 2000. Concerning the impact of contaminants on the southern resident population, it was agreed that information on the dynamics of transient whales with much higher levels of contamination would be very important in understanding the current decline in abundance of southern residents. Unfortunately, information on trends in abundance in transient populations of killer whales is very difficult and expensive to obtain

(relative to resident killer whales) and is currently not available. One final point raised was the likely synergistic effects of high contaminant levels and food stress in compromising the immune systems of killer whales. Animals with elevated PCB levels that were food stressed might be unable to recover from certain infections or other illnesses that under other circumstances would not have been lethal.

Whale Watching

A second possible factor influencing killer whale populations is the impact of whale watching activities on the southern resident community of whales. Background documents were provided for this section (SRKW6, SRKW7). There has been a documented growth in the number of whale watching vessels in the San Juan Islands (primarily Haro Strait). Survey data on whale watching activities date back to 1976 to the current time. Reports on the possible impact of whale watching on killer whale behavior, energetics, survival, and reproduction were presented by Rich Osborne, Jodi Smith, and Dave Bain. It was noted that initially this industry was dominated by U.S. vessels. However, currently the industry is dominated by Canadian vessels. It was also noted that the increase in the number of vessels that were participating in this industry was apparently leveling off. It was also reported that all of the available data to date indicate that the whales are not leaving the area in which they are being observed. A brief description of on-going research activities to document vessel impact on killer whales was presented by Osborne. At present, the whale watching industry has agreed to maintain a quarter-mile buffer from the shoreline along the west central coastline of San Juan Island (Eagle Point) to Henry Island (Kellett Bluff). There is also a 1/2 mile radius around Lime Kiln Lighthouse. In the buffer zone area, operators of commercial whale watching boats have agreed not to follow whales into these waters. In addition, recreational boaters are informed of this buffer zone by both commercial boat operators and volunteers from the Sound Watch program. Data collected by Jodi Smith indicated that most commercial whale watchers honor the buffer, although there were

substantial numbers of commercial whale watchers and a large number of private whale watchers inshore of the 1/4 mile line. There was also a concentration of whales 1/4 mile offshore, suggesting that if the intent is to create a separation between whales and whale watching boats, a 1/2 mile buffer zone would be more productive.

Prey Availability

Next the issue of prey availability was addressed by a number of workshop participants (John Ford, Dave Bain, Ed Lochbaum, and Steve Jeffries). It was noted that the diet of the southern resident whales consists primarily of salmonid prey, although several caveats to this generalization were discussed (e.g., seasonal biases in sampling regime and observability of prey). From the available data, it appears that chinook salmon, *Oncorhynchus tshawytscha*, (i.e., blackmouth salmon), is the preferred prey species by southern resident whales when feeding in the waters of Puget Sound and Northwest Straits. There was also agreement that given the observed decline in abundance in the population of southern residents that more dietary information was needed. In particular, information on the diet during the winter months was of critical importance. It was also noted that within the population of southern residents, different pods may have different dietary preferences.

David Bain led an overview of the situation of the salmon stocks in the Puget Sound noting that long-term data exist for chinook, coho, pink, and sockeye in the Puget Sound area. Ed Lochbaum noted that similar data were available from the Canadian Department of Fisheries and Oceans (DFO) for waters off British Columbia. It was noted that there was a drop in chinook salmon abundance in the early 1980s, as well as an overall drop in salmon abundance in general in the early 1990's. Fred Felleman distributed data on the status of Cherry Point herring stocks which documented a decline in spawning escapement from 5,734 short tons in 1973 to 1,200 in 1999. The proposed listing of Puget Sound herring under the Endangered Species Act (ESA), the impact of the proposed dock extension at

the ARCO refinery on the Cherry Point stock and the importance of herring to the recovery of Puget Sound chinook and killer whale populations was briefly discussed. It was also noted that sockeye abundance experienced a bad year in 1980. However, this stock is only available to the southern residents in the summer and the period of decline was relatively short. Therefore, it is not clear whether the decline in sockeye salmon, *Oncorhynchus nerka*, abundance had any affect on the southern resident whales. On the other hand, pink salmon, *Oncorhynchus gorbusha*, abundance has shown a general trend of increasing abundance in recent years. Rich Osborne noted the observed increase in pink and sockeye salmon abundance in the early 1980s has continued and that the recent decline in abundance in southern resident whales indicates that pink and sockeye salmon are not critical prey species, as chinook salmon are thought to be.

ESA Listing Criteria and Information Needs for Management

Following the research presentations, the group discussed criteria required for listing a species or stock under the U.S. Endangered Species Act (ESA) (i.e., endangered or threatened) or under the U.S. Marine Mammal Protection Act (MMPA) (i.e., depleted). In addition, workshop participants discussed the classification of killer whale stocks as endangered or threatened under Canadian law. It was noted that the definition of endangered and threatened in legal terms in the U.S. and Canada were not the same (SRKW5).

For an ESA listing in the United States, it was noted that NMFS must consider five specific criteria in making a listing determination: overexploitation, loss of habitat, disease/predation, lack of regulations, and other factors. Five stocks of eastern North Pacific killer whales are currently identified by NMFS; none of them are listed at this time under the ESA or MMPA (SRKW8 & SRKW9).

Wade distributed the "Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act". The policy states that three elements are considered in a decision whether to list a population within a species: discreteness, significance, and status. Southern residents could probably qualify as discrete due to genetic discontinuity between them and other killer whale populations. Significance addresses whether 1) the population inhabits an unusual ecological setting, 2) loss of the population would result in a significant gap in the range of the species, 3) the population is the only surviving natural population, 4) the population differs "markedly" in the genetic characteristics from other populations. Status is the status of the population if it were treated as a species.

The discussion noted that the southern resident population is small relative to other populations already listed. It was further recognized that a listing decision and the development of a recovery plan are lengthy processes.

Doug DeMaster noted that the management of continuously distributed species like the killer whale, harbor seal, and harbor porpoise was confounded by a lack of agreement about what the appropriate management unit should be. NMFS and most agencies responsible for the management of marine resources manage at the sub-specific level and manage in a way that is considered precautionary. In defining a management unit appropriate for marine mammal management, NMFS is trying to avoid the local extirpation of any species. Regarding resident killer whales, it is not clear how to define the unit most appropriate for management.

There was some discussion, but no agreement, about what a listing of southern residents would mean regarding the need to list other "populations" of killer whales. For example, some participants argued that a listing of southern residents should be tied with a listing of a pod of transient killer whales in Alaska (i.e., AT1 pod) and a pod of killer whales referred to as the "LA pod" in the southern

California bight area. It was also noted that an ESA listing would allow for, but not necessarily require, the establishment of critical habitat and the development of a recovery plan. Some of the workshop participants suggested that an ESA listing might raise the level of concern for this stock, which NMFS or some other agency might translate into increased support for research and management. Others noted that several stocks of endangered large whales had been listed since the ESA was passed in 1973, yet support for research and management activities had not been forthcoming (e.g., fin whale, sperm whale). It was also noted that the number of southern resident killer whales had fluctuated in the past and that part of the current decline was likely related to the loss of forage caused to some unknown degree by large-scale environmental changes (e.g., Pacific decadal oscillation). Finally, given the unexpected movement pattern recently observed for two of the three pods that comprise the southern resident population, a satisfactory assessment of the status of this population could not be undertaken until this summer when (presumably) all of the pods return to the Puget Sound area. After some discussion, there was agreement that the status of this stock (i.e., less than 100 animals and currently declining in abundance) was of considerable concern; however, there was no consensus as to whether it was appropriate to pursue an ESA listing for the southern resident population at this time.

Regarding a depleted listing under the MMPA, it was noted that NMFS defines a depleted stock as a stock with a population size of less than 60% of its carrying capacity (K). It was recognized that an estimate of K is often not available for marine mammal stocks. Therefore, in practice stocks are defined as depleted when current abundance is less than 60% of the maximum estimate of abundance. Rich Osborne commented that there was ongoing research supported by the Whale Museum in Friday Harbor to try to determine the number of killer whales in the Puget Sound area that were shot in the mid-20th century as a result of fishery interactions. These data would be used to try to reconstruct (i.e., back-calculate) historical abundance. It was agreed that the data would be very useful, as at present

the maximum abundance estimate for southern residents would have to suffice as a minimum estimate of carrying capacity for southern residents in an assessment of their depletion level.

Emergency Responses and General Discussion

The second day of the workshop included discussions on emergency responses and cross-border protocols. That is, workshop participants were concerned that the ability of rehabilitation programs might be compromised by legal restrictions imposed by the statutes of Canada and the United States, which would not allow all of the resources at hand to be used in responding to a live stranding. Graeme Ellis gave a brief description of circumstances surrounding the stranding of killer whale L51. The carcass of this animal was found in Canada and left on the beach. L51 was a female whale with a prolapsed uterus. Her milk production had been compromised and apparently she had not been able to nurse her live-born offspring. The orphaned calf (L97) was observed alive as of 1 October 1999 and was apparently feeding with the help of a sibling whale. At the time, the option of bringing the young whale into captivity was considered, but rejected given the orphaned calf was still associated with its pod and was apparently feeding. L97 was last seen on 2 October 1999 and reported missing on 3 October 1999. By 24 October 1999, the calf was confirmed absent from the pod.

This experience had caused killer whale biologists on both sides of the border to consider options for a response that included: 1) transporting an animal from Canada to the United States, where a temporary holding facility could be established, 2) transporting an animal from the United States to Canada, where a temporary holding facility could be established,
3) transporting an animal from Canada to a U.S. oceanarium for temporary holding and subsequent return to the wild, 4) transporting an animal from the U.S. to a Canadian oceanarium for temporary holding and subsequent return to the wild, 5) euthanasia, and 6) transport of U.S. or Canadian experts

across international borders to help with rehabilitation. The concern was raised that while there were ways to meet all the procedural requirements imposed by U.S. or Canadian law, the time frame needed for a successful response is measured in hours not weeks. After some discussion, it was agreed that a protocol for a rehabilitation response was needed by both Canadian and U.S. officials, where the issues related to the above scenarios were addressed and where response time for any of the above actions was minimized. Ed Lochbaum noted that his office was in the process of updating existing response protocol and that he agreed to address the issues raised at this workshop in the revised document. He also agreed to make the document available to Brent Norberg, NMFS. Norberg agreed to assist in developing a response protocol for U.S. interests in the Puget Sound area.

Norberg commented that while no formal rescue protocol was currently in place in the Northwest, other Regions in the United States have developed release protocols. For example, the NMFS Southeast Regional Office has established "tagging and push off procedures". These procedures have minimized unwanted interactions with both the media and local (and Federal) enforcement. Norberg added that it would be useful if the protocol addressed several issues related to implementation. For example, what is the definition of a stranded animal and who makes the final decision as to whether the animal should be "assisted". It was noted that the legal definition of what a stranded marine mammal is in the United States includes the following: 1) any marine mammal that is dead, 2) a cetacean that is on the beach, and 3) a cetacean that is in shallow water and can not return to the water on its own power. In addition, the protocol should address the situation where an orphaned calf is in the vicinity of its dead mother, but still attended to by other pod members in deep water.

Another issue that should be addressed in release protocols developed by NMFS in the United States and Department of Fisheries and Oceans in Canada is the issue of transporting specimens (e.g.,

blood samples) from the stranded animal across international boundaries. Norberg commented that in the United States there were emergency allowances under the MMPA that allowed for rapid authorization of biological samples from marine mammals into or out of the United States However, it was noted that as the United States and Canada are members of (Convention on International Trade in Endangered Species) CITES, import and export permits were legally required to transport killer whale tissues across the border between the United States and Canada. It was agreed that similar emergency allowances should be developed for CITES permits.

Regarding the situation where rehabilitation is required, Brent Norberg commented that the Northwest Regional Office maintains a list of aquaria willing to house stranded marine mammals. In the event of a live stranding where rehabilitation in captivity was considered appropriate, Norberg would, upon being notified, contact the nearest facility set up to handle the rehabilitation of a particular species. Ed Lochbaum commented that a similar list for Canadian institutions was maintained by DFO.

There was a discussion that did not lead to consensus regarding the appropriate magnitude of responses to assist stranded (in the general sense) killer whales. It was pointed out that the killer whale rescue at Barnes Lake, was quick, inexpensive, and that at least three whales exhibited long-term survival (including one that had produced a new calf). In contrast, some rehabilitation efforts require removal of the individual from its habitat for a long period of time, during which it would receive expensive care, and it may never become well enough to return to the wild (e.g., Miracle). Some felt this latter level of effort was needed due to the small population size, while others felt it would be better to let nature take its course in such cases.

Kelley Balcomb-Bartok summarized his experience with the killer whales in Dyes Inlet, WA. Several issues pertained to the development of a comprehensive rehabilitation/release protocol for killer whales in the Puget Sound area. These issues included: 1) who has the responsibility to monitor the whales, 2) who has the responsibility for traffic and crowd control, and 3) who coordinates the multitude of State and Federal agencies (e.g., in the United States, the U.S. Coast Guard gets involved in the management of vessel traffic; so does the county). It was agreed that NMFS and DFO should work together to address these issues as soon as possible.

Lochbaum noted that responding to a stranded whale (or whales) in Canada is not as complex as in the United States as there is only one agency responsible for a response (DFO), while in the United State, several layers of state, Federal, and local agencies are involved. In the case of a mass stranding of whales in Canada, crowd control and public safety is all under federal jurisdiction and handled by federal staff. The Canadian Coast Guard has the gear, talent, and experience to assist on the water. There is also a framework for having a plan in place (a decision tree) that decides who is first, second, and third in command.

Currently, in the event of a killer whale stranding in the U.S. Northwest Region and in Canada's British Columbia coast, key contact personnel are already identified. In the United States, Brent Norberg, Steve Jeffries, Marilyn Dahlheim, Rich Osborne, Ken Balcomb, and John Calambokidis are to be contacted. In Canada, Ed Lochbaum, John Ford, and Graeme Ellis are to be contacted. Agencies or researchers interested in obtaining samples, measurements, or photographs from stranded killer whales should be in contact with Norberg (U.S.) or Lochbaum (Canada). At present, stranding coordinators are responsible for maintaining lists of tissue samples, measurements, etc. that the research community has interest in being collected.

Workshop participants agreed that it was important to develop and implement stranding response protocol, which included a response protocol where rehabilitation of one or more stranded animals was possible. Lochbaum and Norberg will coordinate the development of such a protocol within their respective agencies and will also work together to coordinate the response protocols between the United States and Canada. It was recognized that part of the response protocol must involve contacting other agencies (e.g., U.S. Coast Guard, key county and state personnel) and working out permit requirements prior to stranding events to ensure successful and timely response plans.

Future Work

Finally, there was a discussion of directions for future work. There was a consensus that photo-identification work should continue, along with all the studies based on these data. Additional work to determine whether historical population levels exceeded the recent maxima of about 100 was encouraged. Work identifying the relation between prey base and population status was noted as important, especially work on feeding during the winter months and even during the summer when whales are at depth. There were mixed opinions about whether additional biopsy darting to address contaminants and genetics would be valuable. There was a sense that existing samples should be fully analyzed, the post-darting survival of the large number of individuals that have been sampled should be reviewed to assess the safety of the procedure, and specific hypotheses to be tested should be developed before additional darting is carried out. The importance of understanding the population dynamics of transients was also recognized since this population is more contaminated than southern

residents. Effects of whale watching and anthropogenic noises were identified as areas that deserved additional work. The correlation of A and J clans/pods population dynamics merits additional attention as it could help clarify what is contributing to the decline of southern residents.

List of Documents

SRKW1 Bain, D. and K. C. Balcomb. 1999. Population Trends Of Southern Resident Killer Whales (*Orcinus orca*) from 1960-1999. Unpublished report submitted to November 1999 Scientific Review Group meeting in Maui, Hawaii (November 1999).

SRKW2 Olesiuk, P., M. Bigg, and G. Ellis. 1990. Life History and Population Dynamics of Resident Killer Whales (*Orcinus orca*) in the Coastal Waters of British Columbia and Washington State. Rep. Int. Whal. Commn. Special Issue 12: 209-243.

SRKW3 Matkin, C., G. Ellis, L. Barrett-Lennard, H. Jurk, D. Sheel, and E. Saulitis. 1999. Comprehensive Killer Whale Investigation - Environmental Contaminants. *Exxon Valdez* Oil Spill Restoration Project 98012 Annual Report. p. 36-40.

SRKW4 Ross, P., G. Ellis, M. Ikonomou, L. Barrett-Lennard, and R. Addison. 2000. High PCB Concentrations in Free-ranging Pacific Killer Whales (*Orcinus orca*): effects of age, sex and dietary preference. Mar. Pollut. Bull. 40(6):504-515.

SRKW5 Baird, R. 1999. Status of Killer Whales In Canada. Final report submitted to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 42 p.

SRKW6 Swartz, S. 1999. Whale-Watching as a Means to Assess the Status of Whales. Working document submitted to the International Whaling Commission. SC/51/WW1: 3 p.

SRKW7 Anonymous. 1999. Report of the Scientific Committee. 51st Meeting of the IWC, Grenada, May 1999. Section 13: Whalewatching: pp. 68-72.

SRKW8 Hill, P.S. and D. P. DeMaster. 1999. Alaska Marine Mammal Stock Assessments. Killer Whale: Eastern North Pacific Northern Resident Stock. pp. 87-98

SRKW9 Forney, K., M. Muto, and J. Baker. 1999. U. S. Pacific Marine Mammal Stock Assessments. Killer Whale: Eastern North Pacific Offshore Stock (pp. 34-37) and Killer Whale: Eastern North Pacific Southern Resident Stock (pp. 38-43).

SRKW10 OrcaLab. 2000. Northern Resident Population Information. Compiled for Killer Whale Workshop by Paul Spong. 16 p.

SRKW11 Wade, P., D. Bain, and K. Balcomb. 2000. Population Dynamics of Southern Resident Killer Whales. Draft report.

SRKW12* Hayteas, D. L., and D. A. Duffield. 2000. High Levels of PCBs and DDE Found in the Blubber of Killer Whales (*Orcinus orca*). Mar. Pollut. Bull. 40(6):558-561.

SRKW13* Hoelzel, A.R., M. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the Eastern North Pacific and genetic differentiation between foraging specialists. Journal of Heredity 89: 121-128.

*Not available during workshop proceedings.