AFSC Pacific Salmon Research Review
Auke Bay Laboratory
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Review Report

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Executive Summary

- The review of Pacific salmon research at the Auke Bay Laboratory (ABL) of the Alaska Fisheries Science Center (AFSC) was conducted July 12-14, 2005 at ABL, Juneau, Alaska.

- The AFSC salmon research peer review committee was asked to evaluate the relevance and appropriateness of ongoing research by AFSC scientists focused on Pacific salmon resources occurring throughout the Gulf of Alaska, Bering Sea, and adjacent waters.

- This report provides a brief description of the review activities, an evaluation of the research on Pacific salmon conducted at ABL with particular relevance to research associated with the ecology of juvenile salmon in the marine environment and recommendations for research.

- Overall, the Pacific salmon research being conducted is extensive and the quality of the research is excellent.

- BASIS and SECM are major surveys of the epipelagic zones in the Bering Sea and the southeast coast of Alaska. Both are well-planned, well-executed and are providing and will continue to provide data useful for the management of exploited fish stocks and an understanding of interactions among the biological and physical components of the ecosystems.

- Both BASIS and SECM should be continued.

- For BASIS, AFSC should consider augmenting the survey by adding the collection of relevant acoustics data between stations to provide information on pelagic species and bottom types, adding process-oriented research during the survey and increasing the frequency of the survey. AFSC should also evaluate whether its expertise in dynamic modeling is adequate.

Background

On March 24, 2005, the Center for Independent Experts (CIE) contacted me and requested that I act as a reviewer for a review of the Pacific Salmon research program of the Alaska Fisheries Science Center (AFSC), operating out of the Auke Bay Laboratory (ABL) in Juneau, Alaska. The review was intended to evaluate ongoing research by AFSC scientists focused on Pacific salmon resources occurring throughout the Gulf of Alaska, Bering Sea, and adjacent waters. Expert advice was being sought in the following categories: salmon biology, population dynamics, genetics and marine ecology. Of these four categories, my expertise encompasses population dynamics and marine ecology and because of this, the following report concentrates on the Terms of Reference (Appendix 1) and an evaluation of the Pacific salmon research at ABL related to these research fields.

This review was originally scheduled for May 9-12 but was rescheduled to July 12-14, at the request of the Auke Bay Laboratory and with the concurrence of the Center for Independent Experts and the reviewers.

The statement of work (Appendix 1) defined the Terms of Reference and the responsibilities of the reviewers. This statement of work is a revised version; final revisions were sent to the reviewers on July 18, 2005. Appendix 1, then, contains the final version of the statement of work (corrections outlined by Steve Ignell in his e-mail (included as Appendix 2) have been incorporated in the statement of work provided here).

Description of Review Activities

Five background documents (Appendix 3) were received from Dr. Steve Ignell of ABL approximately one month prior to the meeting. This provided ample time for me to read the documents provided, as well as many of the references cited in the documents. In addition to these background documents, I consulted many websites relevant to the review, including AFSC, ABL, NPAFC and PICES. Part of the background material sent to the reviewers included questions to be addressed by the reviewers that were pertinent to the research programs to be discussed and to the terms of reference. These questions and the other reading that I did allowed me to formulate other questions to be posed during the review.

It should be noted that because of illness, my doctor advised against travel, so I was unable to attend the review in person. I was well enough by the time the review started to participate in the entire review by telephone. Each day, prior to the review I was provided with electronic copies of the power point presentations of each speaker and was able to listen and follow the presentations remotely. I was also able to fully hear and participate in all discussions.

The review was chaired by Dr. Steve Ignell, Acting Director of ABL. The review was divided into two categories that reflected two broad areas of research at ABL,

namely Ocean Ecology and Climate, and Conservation Biology and Genetics. Within each of these broad areas of research, several presentations were made by research staff at ABL (Appendix 4), followed by discussions. The discussions were open to all attendees. The power point presentations were well-prepared, succinct, well-timed and well-presented. There was ample time for discussion and this discussion was always lively. These presentations took about two and a half days, with the remaining half day reserved for discussions among the four CIE reviewers and with any of the ABL researchers that the reviewers wished to call for more in-depth discussions. All CIE reviewers were given CDs containing the power point discussions to aid in report preparation. In addition, a series of written questions were provided with the agenda (they were also included with the draft agenda provided to the CIE reviewers prior to the meeting) that were designed to aid in discussions following each presentation. Although these questions were not worded exactly the same as the questions in the Terms of Reference, they were designed to complement and supplement the Terms of Reference, and thereby aid the reviewers in their evaluations. These questions were highly relevant and were useful in discussions and evaluations.

It is not my intention to provide a summary of each presentation. In all there were a total of fourteen power point presentations, with three of these introductory in nature, ten describing Pacific salmon projects and one describing a steelhead trout project (Appendix 4). All presentations were well-done and succeeded in providing a good overview of the scientific activities of the programs under review. Most programs are complex, with many activities, and it was impossible to present details of each activity. Nevertheless, the researchers did provide good overviews as well as detailed examples of their research, the results and the relevance to the objectives of the specific program. In the following report, I will address each Term of Reference and associated questions; all of the presentations were useful in this evaluation and indeed, this evaluation would not have been possible without the excellent power point presentations and the ensuing discussions.

Summary of Findings

In the following evaluation, I have included the Terms of Reference and specific questions (from Appendix 1) *in italics* prior to each part my evaluation, in an effort to make the reader's job somewhat easier.

TOR #1: *The AFSC's primary research mission is to generate the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence. Primary species of interest are groundfish, crab, and marine mammal populations. Salmon are an important secondary species due to research responsibilities derived from international agreements. In addition, AFSC salmon programs receive direct funding from Congressional PPAs and NOAA research*

initiatives pertaining to ESA-related issues, the ecological role of salmon in the marine environment, and enhancement technology and impacts. The review panel should provide input on recommended directions in AFSC salmon related research in Alaska, and identifying appropriate levels of research directed at salmon management questions and at Alaskan ecosystem and habitat issues.

In general, I was impressed with the scope and quality of the research on Pacific salmon at ABL. My areas of expertise are ocean ecology and population dynamics. I focused on those areas but it was very easy to understand the emphasis on and importance of other areas of research pertaining to Pacific salmon. Given my expertise, I have restricted my detailed comments to those areas of research. This emphasis should not be construed by the reader to mean that the other research (eg. related to salmon genetics, hatchery versus wild fish, etc) is less valuable, merely that my comments reflect the application of my expertise to the research relevant to that expertise.

The ongoing research on ocean ecology of juvenile salmon, especially through BASIS and SECM is particularly impressive and highly relevant to understanding the role of Pacific salmon in the ecosystems. With similar aims and approaches they complement each other very well. The SECM program has been ongoing for several years and is already yielding useful information regarding the ecology of juvenile salmon in the coastal environment of the Gulf of Alaska. BASIS is newer and also well-designed and even with a short history, it is providing useful data. As it moves along, it will continue to provide additional insights into Pacific salmon in the Bering Sea and into the ecology of other species in the area as well. Both are international and collaborative in scope, SECM through GLOBEC and BASIS through NPAFC. I believe that ABL has done a good job on maximizing the extraction of information from all of the samples (eg, retrospective analysis of scale samples, isotope analysis, fatty acid analysis). Also, in spite of my caveat above regarding my bias towards ocean ecology activities, it is encouraging to see that many applications of other activities (eg. salmon genetics) are being integrated with the ocean ecology activities. For example, there are genetics studies on the juvenile salmon sampled at sea to determine their origins.

I have no recommendations to make any serious change in research direction or focus. In TOR #2, I have provided suggestions on how BASIS might be augmented and the reader is referred to these suggestions.

Specific questions to be addressed by the review panel in regards to this TOR include the following:

A. What applications of marine salmon research at AFSC best provide an understanding on the effects of climate/physical drivers that may cause changes in aspects of North Pacific ecosystems such as trophic food webs and forage fish populations?

In general terms, the components of the Pacific salmon research at ABL that directly derive data on the biological and physical attributes of the sea offer the best possibilities of understanding the relationships between the physical climate and the biological domain. In this, I include all components of both BASIS and SECM as well as the use of satellites to record sea surface temperatures and coccolithophore blooms. There is no substitute for collecting data at sea and as result, SECM and BASIS (and other associated programs under the Ocean Carrying Capacity Research Program at ABL) are the appropriate programs to test relationships between climate and biology.

B. Given that hatchery operations in the Pacific Northwest are identified as one of many causes for the decline in wild stock abundance (leading to multiple ESA listings), and given that Alaska, with generally abundant and healthy wild stocks also has a significant large-scale hatchery program, what level and types of hatchery-wild stock interaction studies are needed to address present and future Alaska salmon issues?

Hatchery programs are outside my expertise so my comments should be taken with that caveat. It appeared to me that ABL has an intelligent approach to the hatchery versus wild salmon question. Alaska is unique in still having apparently generally healthy wild stocks and with the large hatchery program, testing interactions between the two sources of salmon before problems happen is prudent. Given this situation, I would suggest that the program should not be scaled back in any way, however, except for that conclusion, my lack of expertise precludes any more detailed comment.

I would mention that the steelhead research, although perhaps outside of the direct mandate of Pacific salmon research, seems to be very good and may have application to Pacific salmon problems.

C. What GSI research is needed to support ecosystem research in the North Pacific Ocean and forensic or enforcement activities? Are the technical methods used at ABL appropriate for the task?

This research is also outside of my area of research but I will make one observation. Forensic work in aid of legal matters (i.e. helping the Coast Guard in high seas seizures) was noted to have taken a significant amount of time However, it was also mentioned that increased patrols at sea had resulted

in a reduction of this type of request. I would recommend, though, that ABL remain vigilant and monitor the amount of time these requests take in the future. While these tasks do have some scientific merit in that they provide some information on country of origin and application of the techniques, I expect they are also urgent, meaning that ongoing research must be delayed when requests from the Coast Guard are made. There is little obvious payoff to a scientist's career (as opposed to publications) so I would recommend that if the frequency of these requests increases, then a dialogue with the Coast Guard be initiated in an effort to reduce the amount of work. Although it might not help with career progression for a scientist, this might mean recovering costs if work cannot be reduced. Alternatively, the Coast Guard might have to seek the services of an outside source of expertise or create their own applied forensic laboratory.

D. *The North Pacific Anadromous Fish Commission (NPAFC), a five nation International Convention focused principally on salmon resources of the North Pacific Ocean, encourages coordinated and cooperative research by member parties in both Convention Area waters and adjacent territorial seas. As the NPAFC Science Plan calls for research focused on early marine life of salmon, how can ABL research on juvenile salmon best provide a better understanding of the role salmon play in various components of the North Pacific ecosystem?*

I have already addressed this question in my responses to other questions. ABL is already participating in coordinated and cooperative research through BASIS (NPAFC) and SECM (GLOBEC). The collaborations are already impressive and both are and will provide valuable information on the early marine life of salmon.

SECM is centered on coastal waters of southeast Alaska and therefore is investigating factors affecting the success of juvenile salmon. It is worth noting that ABL has (data from the late 1990s were presented to the review committee) conducted surveys in the Gulf of Alaska to collect data on maturing salmon. The question above specifically refers to juvenile salmon. However, if NPAFC is also interested in maturing salmon on the high seas, and other nations are not performing this research, there is an opportunity for ABL to consider implementing research in this area. However, this would require significantly more resources and the review panel was told that current personnel are fully utilized.

In a sense, BASIS is more international in scope since several nations provide research vessels and the survey area is divided geographically. By virtue of the bathymetry, the area covered by ABL is relatively shallow and is an important area for juvenile salmon. However, other nations survey over deeper waters and as result, maturing salmon are also sampled.

The present SECM and BASIS programs are executing valuable research programs on juvenile salmon in two ecosystems and as such, they are meeting the mandate in the NPAFC research plan, as summarized above. I have made suggestions in the questions relating to TOR#2 as to how BASIS might be augmented.

E. *The AFSC presently operates two permanent field stations in Southeast Alaska, at Little Port Walter (LPW) on Baranof Island and Auke Creek (AC) near the Auke Bay Laboratory. Research on a broad range of resource issues has been conducted for many years where each station, located on or near streams with healthy natural runs of anadromous salmonids, have experimental hatchery capabilities. Research at both stations has typically included cooperative involvement with other federal and state agencies, universities, and constituent groups. The review panel should provide input on the usefulness and relevance of research at these two stations in helping NOAA Fisheries develop a better understanding of the role salmonids play in regional North Pacific ecosystems and in helping to maintain healthy, viable salmon populations and their associated fisheries.*

Hatcheries are outside my area of expertise. However, it seems that these two stations offer advantages that provide opportunities to perform unique scientific investigations. Both stations have a long history with good records, both are near natural runs of salmon and both have hatchery capabilities. The review panel was presented with several examples of some of the data available (eg. long time series of run timings in relation to environmental variables) which must be the envy of many other laboratories. As a scientist viewing these types of data for the first time and not knowing much about these aspects of salmon, I would think that these stations must be considered very valuable resources and should be maintained. Both seem highly relevant to understanding environmental factors affecting run timings to and from the river as well as other aspects of early life history of salmon.

Although the program appears to be a lot of work in terms of "book keeping", I believe the Coded Wire Tag Program is also a valuable time series of data and I would recommend that it should be continued.

TOR #2: *Three years ago, the NPAFC initiated BASIS (Bering-Aleutian Salmon International Survey), a yearly, basin-scale survey of the Bering Sea's pelagic ecosystem using survey vessels from Russia, Japan, and the USA. This international research program was developed by ABL scientists who continue to maintain a strong leadership role in this program. Although BASIS studies ostensibly address salmonid issues in the Bering Sea, research on forage fishes and the Bering Sea ecosystem have been key components of the national BASIS research programs. The review panel should provide input to the AFSC on the utility of BASIS research programs.*

Specific questions to be addressed by the review panel in regards to this TOR include the following:

A. What is the potential for BASIS surveys to address current Bering Sea non-salmonid management and ecosystem research needs: what key management and scientific questions/hypotheses could be addressed by BASIS, either in its current form or through an augmented program?

BASIS is an excellent survey. A review of the draft plan (North Pacific Anadromous Fish Commission, 2001) indicates that the survey was designed to address important ecological questions. The survey was well conceived and the methodology as proposed in the draft plan and now used is appropriate to address the objectives. BASIS also has the potential to provide information on other scientific and management questions as described below.

1) Ecological indicators- During the discussions with ABL scientists, it was noted that NOAA's ecosystem approach to management was consistent with the definition and recommendations of the U.S. Commission on Ocean Policy and one of the needs was the development of ecosystem indicators. In addition, within NOAA, one of the research priorities within HEPR is the development of ecosystem and climatic indicators. Clearly, there are already indicators in existence that signaled changes within the Bering Sea ecosystem. For example, BASIS was conceived because there were several indications that the Bering Sea had been undergoing change. Several examples were cited in the draft plan for BASIS (North Pacific Anadromous Fish Commission, 2001) and they will not be detailed here. For the most part, these indicators emerged from long databases and allowed researchers to determine that the Bering Sea had undergone dramatic changes over a long time period (eg. changes in salmon food availability since the 1960s) and that these changes may be continuing. It is obvious that many of these indicators will continue to be collected and changes in the Bering Sea will continue to be monitored.

However, BASIS offers the potential to add to this suite of indicators. BASIS will add additional systematic weather and physical oceanographic data to the world database. Large-scale global climate models use historical databases to forecast future climate. Global climate models now in use generally do not provide projections for the physical oceanographic variables, such as water temperature and salinity throughout the water column, ice extent and duration, vertical stratification, current strength and sea level, each of which may influence the distribution and productivity of fish stocks. In fact, the only relevant variable available is surface air temperature. Furthermore, because of the spatial resolution of the global climate models, the predictions of basic climatic variables, such as air temperatures, are considered unreliable at the regional level (Anderson et al. 1999), thereby adding further

uncertainty to predictions of changes in regional fish stocks and fisheries (Lilly and Carscadden, 2002). Thus, additional oceanographic as well as atmospheric data from all oceans, including the Bering Sea, will be useful in large-scale climate predictions.

Data from BASIS may even offer the opportunity to detect changes in the ecosystem earlier than now exists. The fishing gear used during BASIS is designed to catch small fish of all species, including salmon and other forage species. For the forage species such as capelin and pollock, these are pre-recruits and even at this stage, their relative abundance may be indicative of abundance at the adult stage. Thus, relative abundance data on these species, collected during BASIS surveys, has the potential to observe changes in these populations before they reach the adult stage. This information could be useful for management (pollock, for example) as well as for knowledge about changes in the ecosystem (eg. dramatic changes in the forage of salmon and marine mammals). Even shifts in distribution of these young fish in the epipelagic zone may be indicative of changes in ocean climate. For example, in the Newfoundland area, capelin have exhibited rapid and dramatic changes in distribution, moving within as well as occurring outside the normal distribution area (Frank et al., 1996). At one time it was concluded that these distribution changes were the result of changes in oceanographic conditions, but even when the ocean climate returned to normal, the unusual capelin distribution patterns persisted. Exploitation of these capelin is low such that over-exploitation is not considered to have had any effect on the population biology (Carscadden et al. 2001), including the shifts in distribution. While the exact causes have not been determined, the changes in distribution were undoubtedly related to events other than a fishery. Small pelagic forage fish are known to be highly mobile (Springer and Speckman, 1997) and this capelin example shows that a large and rapid change in one character might be indicative of a significant change in the ecosystem.

It seems reasonable to assume that most of the physical oceanographic metrics that are likely to be useful as ecosystem indicators are already being collected (although augmentation of these metrics in space and time should be encouraged as noted above) so that new ecosystem indicators might be biological in nature. I have already mentioned that biological characteristics of forage fish should be considered. However, key to the selection of any biological indicator is the fact that the organism should be only lightly exploited or better still, not exploited at all. It has proven extremely difficult to demonstrate the relative effects of fishing and the environment on the population characteristics of many exploited fish populations. Clearly, changes in an unexploited population would be due to environmental effects. Choosing an unexploited species as a potential ecosystem indicator avoids the problem of accounting for the effects of direct over exploitation on its population dynamics. Under this scenario, pollock may not be the ideal

species, even though there is likely to be a wealth of data on it because it is exploited and extensively studied.

2) Collection of additional information between fishing stations- As in many surveys in which the primary sampling tools are nets, whether they are fishing or zooplankton nets, there appears to be no data collection between stations. I would recommend that some investigation be made into the types of data that could be collected while the research vessel is steaming between stations. It appears from the discussions during the review that the types of vessels now used may not be amenable to the collection of additional data in this way. However, assuming that BASIS is continued (and I recommend that it should be), the investigators should be researching methods to maximize data collection between stations so that ship requirements can be identified well in advance of research vessel procurement. Three types and uses of additional data that might be collected are as follows:

i) The use of acoustics as one of the primary sampling tools for pelagic fish is now routinely accepted in many jurisdictions. In the north Atlantic, it is used routinely for capelin and herring. In BASIS, it would be necessary to be able to fish on acoustic targets seen between the stations so some additional ship time would have to be allotted for extra fishing. The extra processing of the additional samples from the trawling would also have to be taken into account. Other factors to be considered would be acquisition of scientific sounders, the installation of the acoustics equipment on the vessel, and ensuring that the vessel was "acoustically quiet".

ii) Acoustics could also be used to collect data that could be used for bottom mapping. Selection of the appropriate acoustic system would allow collection of these data at the same time that acoustics data to be used to assess pelagic targets were being collected. Bottom mapping has been emerging as an important area of research, especially as a means of determining habitat requirements of many fish and invertebrate species, as well as measuring changes in habitat due to fishing activities. In this respect, it is becoming very important in biodiversity and ecosystem studies. Collection of acoustics data for bottom mapping should be considered for future BASIS studies. It is my understanding that some countries routinely collect these data during every survey.

Data from feeding studies in the survey area covered by ABL surveys indicate that both sand lance and gadids (mainly pollock) are important food for juvenile sockeye salmon. Bottom type is probably critical to the distribution of sand lance and it may also be important to pollock as well. Thus a better understanding of bottom habitat and how it might be changing over time (eg. through trawling), could be a key derivative of acoustic bottom mapping and would be important in understanding any changes in distribution of these key forage species.

iii) Data of zooplankton might also be routinely collected using automatic collecting devices towed behind the vessel or by collecting water through the ship's intake. This is an area of research with which I have little

familiarity except through the Continuous Plankton Recorder program in the Atlantic. In the Atlantic, plankton samples are collected automatically using commercial shipping vessels that are transiting the north Atlantic. It is possible that the same principle might be useful on the future BASIS research vessel.

3) Indices of abundance for use in management and/or ecosystem studies- Data from BASIS surveys could potentially provide indices of abundance for several species, including salmon, which could be used for management. The review panel was shown that the catch per unit effort of juvenile pink salmon during the SECM surveys in southeast Alaska was positively correlated with the catch of pink salmon in Southeast Alaska the following year and using this regression, the catch for 2004 had been predicted with reasonable accuracy. This time series is short but it is a logical use of the information from surveys such as those conducted in both the coastal area of Southeast Alaska and the Bering Sea. By the time these surveys are conducted, the relative abundance of the maturing salmon has been established so that a well-executed survey (which both the SECM and Bering Sea surveys are) should be capable of detecting the relative abundance of maturing salmon. In both areas, several years of data are needed to test these potential relationships.

The data from the BASIS surveys on the relative abundance for Alaska pollock may also be useful in management. It was clear from the results presented to the review panel that the BASIS surveys conducted by ABL are successfully sampling juvenile pollock in the eastern Bering Sea and these data may well provide an estimate of recruitment. It does not matter if other estimates of recruitment are already available. It has been recommended that there should be as many estimates of abundance and/or recruitment as possible when performing stock assessments because forage fish are generally challenging to assess (Springer and Speckman, 1997).

The estimates of abundance may also prove useful for other non-commercial forage species as well, both for future management and for ecosystem studies. An example of this is capelin. In the northwest Atlantic a similar epipelagic survey was conducted over a wide geographical area from 1994 to 1999. The survey was discontinued after 1999 because of reduced budgets but for the years from which relative abundance data were available, these data were used in capelin stock assessments as indices of abundance of recruiting year classes. Other indices of abundance were also available from other sources but the estimates for ages 0 and 1 from this survey were assumed to be indicative of year class strength and used in the assessment for a number of years. (For a description of this survey and the methodology of capelin assessment in the northwest Atlantic the reader is referred to Anderson et al., 2002 and Evans and Nakashima, 2002.)

While the above discussion generally centers around the use of these indices of abundance in the management context, there is an equally strong argument that these indices will prove invaluable in an ecosystem context as well. Many ecosystem models require estimates of the abundance of key species, whether the abundance is expressed in absolute or relative terms, and the data from BASIS offer the potential of providing these indicators of abundance that will be useful for enhancing our understanding of the ecosystem.

No matter what the use of the data, there will be a necessity to establish a long time series and to conduct a great deal of analysis to determine the ultimate utility and for which species. It is possible that the data from BASIS will not be useful for all species, perhaps because the timing of the surveys will not sample all species at the appropriate time in their life history. However, ongoing analyses and testing hypotheses will eventually identify the key species and the use of the data. An increase in the number of annual surveys would undoubtedly provide more information and increase the end uses of the data, but even at the current level of sampling, I have no doubt that this survey offers great potential to provide data that will be useful in both a management and an ecosystem context.

B. How can the AFSC best utilize BASIS as part of its research mission in Alaska?

As stated in TOR #1, "the AFSC's primary research mission is to generate the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence." To this end, this review has shown that BASIS will provide an abundance of excellent quality scientific data. If properly used in management, conservation should follow. Therefore, I would recommend that AFSC should look upon BASIS as a key element of its research program. Within the US zone, BASIS does and will continue to provide seasonal data on salmon and many other important species in the eastern Bering Sea. From the entire international BASIS program, AFSC will gain insight into salmon while they are in international waters and the zones of other north Pacific nations. I have already cited in the response to the previous question several ways that AFSC could benefit by increasing scientific activities within the existing program and through an augmented program. Briefly, I would suggest the use of acoustics throughout the survey to gain additional information on pelagic species and to determine bottom types. BASIS should be viewed as a potential source of relative abundance information for both management and ecosystem studies. Continuing analyses to identify the relevant species should be continued.

To achieve these ends, it is imperative to continue BASIS, at least at the current level and preferably at a greater level of activity. As good as the present survey is and as valuable as the data sets will be when this phase ends, it will be necessary to continue the program to achieve maximum benefit from the data, especially as they might be used for management and understanding the ecosystem.

The current BASIS surveys conducted by ABL could also be augmented by increasing the number of annual surveys. The original draft plan (North Pacific Anadromous Fish Commission, 2001) proposed that four surveys per year throughout the Bering Sea should be conducted. This is ambitious and the fact that ABL has been able to conduct two per year is in itself commendable. However, now that BASIS is demonstrating its utility, a similar survey (SECM) has also demonstrated it's utility and other similar surveys in other jurisdictions have proven useful (see discussion about capelin above), I would recommend that AFSC seek funding to increase the number of surveys each year. The principal investigators should be the individuals to determine the best time of year to add one or more additional surveys, dependent on the ongoing analysis of existing data and the long-term goals of the project. Assuming that BASIS will be re-funded, I also recommend that some consideration be given to incorporating process-oriented (hypothesis testing) projects within the monitoring structure of the surveys. At the end of the present series of surveys (2006) there should be enough data to develop hypotheses that might be tested during future BASIS surveys. This is probably very challenging logistically because the long term goals of the BASIS surveys as they relate to salmon will probably still be retained. However, the incorporation of adaptive survey designs (eg. increased coverage in an area where a particular hypothesis is to be tested and decreased coverage in other areas) might be considered.

The observations that sand lance and pollock are important fish components of juvenile sockeye diets, in conjunction with my previous speculations regarding bottom types, might form the basis of hypothesis testing that could be incorporated in an adaptive design in future surveys.

The timing of the surveys might also be investigated; does the present timing answer the questions being posed or would different timings answer more questions? In this context, an important consideration might be the timing of the surveys as they coincide with the production cycles.

AFSC should consider the data from BASIS as an integral part of addressing part of NOAA's strategic plan, namely, to "Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management". Although the concept of an ecosystem approach is being promoted in many countries, the actual implementation of this ecosystem approach to management is still being developed. However, there are

jurisdictions that already take into account tropho-dynamic interactions when setting fishing quotas, especially for important forage species. (I do not know whether the individual countries overtly call this "ecosystem management" but clearly, management is attempted, taking into account interactions between species and as such, the resulting management plan is not single-species management.) Examples can be found in the establishment of the Total Allowable Catch (TAC) for two separate stocks of capelin, one in the Barents Sea and the other around Iceland. In both areas, the fishery occurs mainly on maturing fish that will spawn and die. Thus, an estimate of recruiting year classes is the key piece of data in setting the TAC. Acoustic surveys provide these estimates of recruiting year classes of capelin, several months in advance of the spawning season. These estimates are then used to project the abundance of the spawning stock, taking into account the amount of capelin required to satisfy predator demands during the months prior to capelin spawning. A pre-determined amount of capelin is required to be left to spawn and once both the predator requirements are satisfied and the spawning biomass has been protected, the remainder is available for a fishery. Although this is a simplified explanation, the calculations involved in the final determination of the TAC are much more complicated (Gjosaeter et al., 2002; Gudmundsdottir and Vilhjalmsson, 2002) and they require both a considerable body of data and modeling expertise. However, the logic behind the approach is simple and takes into account the importance of capelin as a forage species. I have provided this example to support a recommendation that AFSC should evaluate its present modeling capability and/or the capabilities of its collaborating institutions. In the capelin example provided, only the TAC of capelin is being considered, making it a fairly simple species-interaction situation. However, there have been considerable amounts of data collected and modeling performed on these data in both Norway and Iceland over the years. If AFSC has been mandated to manage in an ecosystem context, BASIS will undoubtedly form an important part of the database and there will be a need for modelers, including dynamic modelers, to meet the mandate.

Conclusions and Recommendations

The scope of the research being conducted by scientists at ABL on Pacific salmon is impressive. While my expertise is in only one aspect (ocean ecology) of the entire Pacific salmon research program at ABL, there appears to be a significant amount of integration of the different research programs, such that the scientists are attempting to maximize the information that can be extracted from their activities.

BASIS and SECM are excellent field-based programs which are already and will continue to produce a significant amount of data towards increasing our understanding of the ecology of juvenile Pacific salmon in the epipelagic zone of the two ecosystems. I recommend that both surveys be continued; both are relatively short and it is imperative that a longer time-series of data be collected in

order to understand the interrelationships among the various biological and physical components of the ecosystems. The current BASIS is scheduled to end in 2006 and assuming that this survey will be continued past this date, I recommend that some consideration be given to increasing the survey frequency to four seasons per year, as proposed in the original planning document. BASIS offers the potential of contributing to management of many exploited species such as Pacific salmon and pollock. It is clear that a great deal of the data will also be useful to understand the interactions among currently unexploited species such as sand lance and capelin. Additional activities that might be added in a renewed BASIS, assuming that personnel, equipment and an appropriate vessel are available, include the continuous collection of acoustics data between stations to yield information both on all species throughout the entire water column and on bottom types. These surveys have the potential to yield ecosystem indicators in addition to those already collected. New biological indicators that might be examined could include biological characteristics from unexploited species; this would avoid having to determine the relative effects of changing climate and fisheries. Some consideration should also be given to incorporating special process studies in a continuing BASIS. AFSC should also evaluate the strength of its expertise in dynamic modeling, either in-house or collaboratively, to take maximum advantage of the large amounts of data which will accumulate if these programs continue.

References

Anderson, J.C., Craine, I., Diamond, A.W. and Hansel, R. 1999. Impacts of climate change and variability on unmanaged ecosystems, biodiversity, and wildlife. Canada country study, climate impacts and adaptation, Vol. VII, National Sectoral Volume, pp. 122-188.

Anderson, J.T., Dalley, E.L., O'Driscoll, R. L. 2002. Juvenile capelin (*Mallotus villosus)* off Newfoundland and Labrador in the1990s. ICES Journal of Marine Science. 59:917-928.

Carscadden, J.E., Frank, K.T., and Leggett, W.C. 2001. Ecosystem changes and The effects on capelin (*Mallotus villosus*), a major forage species. Canadian Journal of Fisheries and Aquatic Sciences, 58: 73-85.

Evans, G. T. and Nakashima, B. S. 2002. A weighted muntiplicative analysis to estimate trends in year-class size of capelin. ICES Journal of Marine Science. 59: 1116-1119.

Frank, K.T., Carscadden, J.E., and Simon, J.E. 1996. Recent excursions of capelin (*Mallotus villosus*) to the Scotian Shelf and Flemish Cap during anomalous hydrographic conditions. Canadian Journal of Fisheries and Aquatic Sciences, 53: 1473-1486.

Gjosaeter, H., Bogstad, B., and Tjelmeland, S. 2002. Assessment methodology For Barents Sea capelin, *Mallotus* villosus (Muller). ICES Journal of Marine Science. 59: 1086-1095.

Gudmundsdottir, A. and Vilhjalmsson, H. 2002. Predicting total allowable catches for Icelandic capelin, 1978-2001. ICES Journal of Marine Science. 59: 1105-1115.

Lilly, G. R. and Carscadden, J. E. 2002. Predicting the future of marine fish and fisheries off Labrador and eastern Newfoundland under scenarios of climate change; information and thoughts for the Arctic Climate Impact Assessment. CSAS Res. Doc. 2002/111, 37 p.

North Pacific Anadromous Fish Commission. 2001. Draft plan for NPAFC Bering-Aleutian Salmon International Survey (BASIS). (NPAFC Doc. 579) 27p.

Springer, A. M. and Speckman, S. G. 1997. A forage fish is what? Summary of the symposium. P. 773-805. In Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01. University of Alaska Fairbanks, 1997.

Acknowledgements

As noted in the description of the review process, I was unable to travel to attend the review on-site but I was able to participate fully by conference telephone. This proved to be a satisfactory solution for an emergency situation, although I would not recommend it as a replacement for future face-to-face reviews.
I wish to thank Manoj Shivlani and Tom Barry of the CIE for suggesting and facilitating this alternate arrangement. I also wish to thank Dr. Steve Ignell of ABL and his staff for coordinating this arrangement at ABL. In addition, it was clear that the staff at ABL had spent considerable time preparing for this review and their participation throughout was professional.

APPENDIX 1: Statement of Work (as per e-mail from Steve Ignell, July 18, 2005. Changes identified by Steve Ignell have been made in the following statement of work)

STATEMENT OF WORK

General

Most salmon-related research at the Alaska Fisheries Science Center (AFSC) is currently conducted by scientists at the Center's Auke Bay Laboratory (ABL) near Juneau, Alaska. There is a long history behind Federally-based salmon research in Alaska waters dating to pre-statehood periods involving predecessor agencies of NOAA Fisheries (the original Bureau of Fisheries in the Department of Commerce and the Bureau of Commercial Fisheries in the Department of Interior). Following Alaska statehood in 1959, management of salmon fisheries within state jurisdictional waters became the purview of the State of Alaska. During the first 20 years of statehood, NOAA Fisheries (then the Bureau of Commercial Fisheries, Department of the Interior) supported state management with extensive basic research on many aspects of freshwater and early marine salmon life history. This research was conducted at the ABL and its five field stations located from Bristol Bay to Southeast Alaska. Outside of state waters and within the U.S. EEZ (between 3 and 200 miles), management of salmon fisheries remained a Federal responsibility and is now under the purview of the North Pacific Fishery Management Council (NPFMC). It should be noted that NOAA Fisheries spends over $50 million annually on salmon issues in the Pacific Northwest and about $3 million in Alaska, not counting pass through funds to states and other entities.

International treaties and accords requiring conservation and management of Pacific salmon on the high seas among North Pacific Rim countries have provided an additional Federal element requiring active participation in these arenas by NOAA scientists. As a result, research focused on Alaska salmon resources and related issues by NOAA Fisheries has continued to the present day and is centered on the overriding need for wise use and conservation of these resources plus the rationale that Pacific salmon, a vital keystone living U.S. marine resource, are a significant component of major North Pacific marine ecosystems in terms of total biomass and trophic interactions. AFSC salmon related research also involves a broad range of cooperative partnerships with international fora, academia, other Federal agencies, private sector, and industry constituents.

Four Programs are involved in salmon research at ABL; Marine Salmon Interactions (MSI), Ocean Carrying Capacity (OCC), Stock Identification and Analysis (SIDA) and Habitat Investigations (HI).

Marine Salmon Interactions (MSI) research involves two broad areas, Early Ocean Salmon (EOS) and Stock Enhancement Aquaculture (SEA). The EOS component is focused on early marine ecology of juvenile salmon and associated species. This

research considers effects of biophysical parameters, climate fluctuations and inter-annual variability on the abundance and distribution of salmonids within various marine habitats and development of year-class strength leading to recruitment and ultimate adult production. EOS maintains a long-term time series of five research cruises conducted annually with repeated sequential sampling at 13 stations along a major migration corridor as young salmon move through different habitats from inshore to offshore waters. The SEA component of MSI is focused on enhancement technology, brood stock development, hatchery-wild stock interactions, and Endangered Species Act related research for listed stocks of salmonids. MSI operates and manages two field stations: Little Port Walter (LPW) Station on Baranof Island and Auke Creek (AC) Station near ABL. Both stations have well developed experimental hatchery capabilities for anadromous studies and operate permanent counting weirs on significant salmon streams. AC maintains a long-term time series of involving environmental and climatic data along with freshwater and marine survival profiles on 7 species of endemic salmonids. MSI also operates and co-manages a modern food habitats, stomach content, and plankton analysis laboratory, an image-analyses laboratory, and a coded-wire tag laboratory.

The Ocean Carrying Capacity (OCC) Program conducts research in the Gulf of Alaska and the Bering Sea to learn what marine conditions limit production of salmon and associated marine species. After the Ocean Regime Change of 1976-77, salmon populations in North America from central British Columbia northward throughout Alaska and in Asia increased to record levels. However, research at the Auke Bay Laboratory showed that by the mid-1980's most species of salmon had become significantly smaller in size and older in age: e.g., by the early 1990's chum salmon had become about 46% smaller in weight than they were in the early 1970's in both North America and Asia. These size and age changes suggested that carrying capacity for salmon in the North Pacific Ocean was limited under certain conditions. The OCC Program was initiated in 1995 to address these issues about carrying capacity. The research strategy for this Program has three major components: 1) research on the distribution and migration of juvenile, immature, and maturing salmon and associated marine species in coastal and offshore waters; 2) monitoring age and size at maturity and abundance of salmon populations; 3) retrospective studies on changes in age and growth of salmon populations. In 2002, the OCC Program became involved in a basin-scale ecosystem study of salmon and forage fish populations throughout the Bering Sea in collaboration with Japan and Russia. This study is called the Bering-Aleutian Salmon International Survey (BASIS) and is coordinated through the North Pacific Anadromous Fish Commission which is made up of the USA, Canada, Japan, Russia, and Korea.

Stock Identification and Analysis (SIDA) research at ABL is centered around the development of genetic markers to identify discreet stocks or geographic groupings of Pacific salmon and several rockfish species and to identify species of larval rockfish. Most of the research is directed at salmon issues which include identification of stocks or groups of stocks of salmon harvested in various mixed stock fisheries, caught as bycatch in U.S. groundfish fisheries, seized from illegal high-seas

driftnetters by the U.S. Coast Guard, or migrating through the Bering Sea and the Gulf of Alaska. Techniques used are allozymes, mtDNA, microsatellite DNA and single nucleotide polymorphisms (SNP). These markers are being developed in cooperation with U.S. State and Federal Agencies and universities, and fisheries agencies of Canada, Japan, Russia, and the Republic of Korea. SIDA researchers are also actively involved in the development of statistical methods for stock identification analyses, the most recent of which is a new Bayesian statistical technique that allows estimation of stock structure in mixed-stock samples without the knowledge of baseline information.

The Habitat Investigations (HI) Program emphasizes chemical and ecological processes that occur in a variety of habitats ranging from coastal, to tidal, to watershed habitats. Current research focuses on contaminants, habitat utilization, bioenergetics, and habitat restoration. Contaminants research quantifies threats from polycyclic aromatic hydrocarbons (PAH) to reproductive, nursery, and feeding habitats for various life stages of salmon, herring, and groundfish. Much of this work has focused on assessing the long term effects of the Exxon Valdez oil spill, but there is PAH research on other issues such as monitoring releases of pollutants from 2-stroke recreational water craft. Research on nearshore habitats is used to identify essential fish habitat, particularly by sensitive life stages of many different fish, and to identify the chemical or physical impacts of human development on quality of eelgrass and kelp bed habitats. Bioenergetic research assesses the nutritional value of forage species, including juvenile salmon, as measured by changes in lipid class, fatty acid, and caloric composition of these forage species. Such studies seek to evaluate how habitat quality changes seasonally and spatially by understanding how a prey organism allocates energy between growth, reproduction, and fat storage. Habitat restoration research focuses on restoring an urban salmon stream to a productive state.

The AFSC salmon research peer review will evaluate the relevance and appropriateness of ongoing research by AFSC scientists focused, at least partially, on Pacific salmon resources occurring throughout the Gulf of Alaska, Bering Sea, and adjacent waters. Due to differing life histories and varied migration patterns salmon involved in these marine waters originate not only from Alaska streams and lakes but also from Pacific Northwest states and other countries around the North Pacific Rim including Canada, Russia, Japan, China, and Korea. This CIE review should evaluate current salmon studies at AFSC, and, if needed, recommend changes in their scope and direction, along with suggested levels of funding and personnel to accomplish this research.

The AFSC salmon research review will require 3-4 nationally and internationally recognized authorities in one or more of the following disciplines: marine ecology, Pacific or Atlantic salmon biology, animal behavior, population dynamics, fisheries genetics, international fisheries treaties and accords, salmon hatchery issues, and freshwater and marine salmon habitat issues.

The AFSC will provide a detailed background document on current salmon-related research at AFSC/ABL along with a set of relevant papers, publications and documents of recent research results to support this review.

Terms of Reference

The terms of reference for the AFSC salmon research review are as follows:

TOR #1: The AFSC's primary research mission is to generate the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence. Primary species of interest are groundfish, crab, and marine mammal populations. Salmon are an important secondary species due to research responsibilities derived from international agreements. In addition, AFSC salmon programs receive direct funding from Congressional PPAs and NOAA research initiatives pertaining to ESA-related issues, the ecological role of salmon in the marine environment, and enhancement technology and impacts. The review panel should provide input on recommended directions in AFSC salmon related research in Alaska, and identifying appropriate levels of research directed at salmon management questions and at Alaskan ecosystem and habitat issues.

Specific questions to be addressed by the review panel in regards to this TOR include the following:

A. What applications of marine salmon research at AFSC best provide an understanding on the effects of climate/physical drivers that may cause changes in aspects of North Pacific ecosystems such as trophic food webs and forage fish populations?
B. Given that hatchery operations in the Pacific Northwest are identified as one of many causes for the decline in wild stock abundance (leading to multiple ESA listings), and given that Alaska, with generally abundant and healthy wild stocks also has a significant large-scale hatchery program, what level and types of hatchery-wild stock interaction studies are needed to address present and future Alaska salmon issues?
C. What GSI research is needed to support ecosystem research in the North Pacific Ocean and forensic or enforcement activities? Are the technical methods used at ABL appropriate for the task?
D. The North Pacific Anadromous Fish Commission (NPAFC), a five nation International Convention focused principally on salmon resources of the North Pacific Ocean, encourages coordinated and cooperative research by member parties in both Convention Area waters and adjacent territorial seas. As the NPAFC Science Plan calls for research focused on early marine life of salmon, how can ABL research on juvenile salmon best provide a better

understanding of the role salmon play in various components of the North Pacific ecosystem?

E. The AFSC presently operates two permanent field stations in Southeast Alaska, at Little Port Walter(LPW) on Baranof Island and Auke Creek (AC) near the Auke Bay Laboratory. Research on a broad range of resource issues has been conducted for many years where each station, located on or near streams with healthy natural runs of anadromous salmonids, have experimental hatchery capabilities. Research at both stations has typically included cooperative involvement with other federal and state agencies, universities, and constituent groups. The review panel should provide input on the usefulness and relevance of research at these two stations in helping NOAA Fisheries develop a better understanding of the role salmonids play in regional North Pacific ecosystems and in helping to maintain healthy, viable salmon populations and their associated fisheries.

TOR #2: Three years ago, the NPAFC initiated BASIS (Bering-Aleutian Salmon International Survey), a yearly, basin-scale survey of the Bering Sea's pelagic ecosystem using survey vessels from Russia, Japan, and the USA. This international research program was developed by ABL scientists who continue to maintain a strong leadership role in this program. Although BASIS studies ostensibly address salmonid issues in the Bering Sea, research on forage fishes and the Bering Sea ecosystem have been key components of the national BASIS research programs. The review panel should provide input to the AFSC on the utility of BASIS research programs.

Specific questions to be addressed by the review panel in regards to this TOR include the following:

A. What is the potential for BASIS surveys to address current Bering Sea non-salmonid management and ecosystem research needs: what key management and scientific questions/hypotheses could be addressed by BASIS, either in its current form or through an augmented program?

B. How can the AFSC best utilize BASIS as part of its research mission in Alaska?

The report generated by the consultant(s) should provide recommendations addressing each of the terms of reference and specific questions stated in this statement of work.

Specifics

The consultant's tasks consist of the following:

1) Become familiar with the AFSC salmon research program and other pertinent literature.
2) Attend the salmon research peer review meeting in Juneau-Auke Bay, Alaska from July 11-14, 2005.
3) Develop a report based on the terms of reference for the review.
4) No later than July 28, 2005, submit a written report consisting of the findings, analysis, and conclusions (see Annex I for further details), addressed to the "University of Miami Independent System for Peer Review," and sent to Dr. David Die, via e-mail to ddie@rsmas.miami.edu, and to Mr. Manoj Shivlani, via e-mail to mshivlani@rsmas.miami.edu.

Submission and Acceptance of Reviewer's Report

The CIE shall provide via e-mail the final reports of the consultants in pdf format to Dr. Lisa L. Desfosse for review by NOAA Fisheries and approval by the COTR, Dr. Stephen K. Brown by August 11, 2005. The COTR shall notify the CIE via e-mail regarding acceptance of the report. Following the COTR's approval, the CIE shall provide the COTR with pdf versions of the final report with digitally signed cover letters.

APPENDIX 2: Copy of e-mail from Steve Ignell describing changes in Statement of Work which have been incorporated in Appendix 2.

-------- Original Message --------
Subject: SOW Issues
Date: Mon, 18 Jul 2005 08:46:19 -0800
From: Steve Ignell <steve.ignell@noaa.gov>
To: 'Lisa Desfosse' <Lisa.Desfosse@noaa.gov>
CC: Manoj Shivlani <mshivlani@rsmas.miami.edu>
References: <200507081919.j68JJNuv015340@noaaspam04.newworldapps.com>

Lisa,

The CIE review was completed last week after a full three days of presentations, panel discussions, and reviewer deliberations. It was a lot of hard work, both on our part and on theirs, but I think it was well worth the effort. We appreciate the dedication of the reviewers to partner with us in this programmatic review of our salmon research.

Prior to the review, I distributed a draft agenda along with a set of panel questions that we formed to guide review discussions. That agenda was implemented as drafted and we were able to keep on point and on schedule throughout the three days. To accomplish this, there were several items in the statement of work that we did not address during our review period and I am requesting that the SOW be amended, removing them from the contract, or that by the transmittal of this email, the CIE is given permission for not addressing these items in their written review.

The stricken SOW items were:
A small portion of the TOR #1;
TOR #1(D);
TOR #1(F); and
TOR #2(C)

These items were stricken either because they dealt with internal policy issues or because of limited time and the extensive background on AFSC and other regional research programs needed to address TOR #1(F) and TOR #2(C). In addition to these SOW deletions, the CIE reviewers and I jointly recognized that limited panel discussions were directed at TOR

#2(B), which reduced their ability to fully address this particular TOR.

As you may recall, we revised the SOW several times since the first draft was given to you, reflecting a changed scope due to leadership changes at ABL since January and reflecting an evolution in our thinking
on how to be structure a programmatic review of ABL research. In essence, the SOW changes given above reflect the final set of changes
that arose during the execution of the review. All of the changes were
are our request and we appreciate the CIE reviewers for being amenable
to our directions.

I have attached a revised SOW that reflects these changes. Please let
me know if you have any questions or need further information.
Thanks,
Steve

APPENDIX 3: List of written materials provided to CIE Reviewers by CIE and staff of Auke Bay Laboratory.

1) AFSC Salmon Research CIE Review: Draft Agenda and Panel Discussion Questions.

2) FY05 ABL Milestones - DRAFT AKC0601 - ABL Program Management

3) AFSC Salmon CIE-Research Summaries

4) AFSC Salmon CIE- Salmon Publications 1995-2005.

5) AFSC Salmon CIE- AFSC Future Research Directions

APPENDIX 4: List of PowerPoint presentations by Auke Bay Laboratory staff to the Review Committee, July 12-14, 2005.

July 12

1) ABL Salmon Program CIE Review Agenda, Structure, Focus and Protocol
   - Steve Ignell
2) ABL Overview for CIE 2005
   - Steve Ignell
3) Alaska Fisheries Science Centre Research in Support of an Ecological Approach to Management (EAM)
   -Steve Ignell
4) History of Federal Salmon Research in Alaska
   - Jack Helle
5) CIE Salmon review-Ocean Ecology and Climate Theme (2 parts)
   - Jack Helle
   -Ed Farley

July 13

1) CIE Salmon Review: Ocean Ecology and Climate Theme
   Southeast Coast Monitoring (SECM) Project
   -Bill Heard
   -Joe Orsi
   -Molly Sturdevant
2) CIE Salmon Review: Ocean Ecology and Climate Theme
   Field Stations and Long-term Data Sets
   -Bill Heard
   -Jerry Taylor
3) CIE Salmon Review: Conservation Biology and Genetics
   Conservation Issues/Wild Interactions
   -Bill heard
   -Alex Wertheimer
4) CIE Salmon Review: Conservation Biology and Genetics Theme
   Conservation Issues/Wild Interactions
   -Bill Heard
   -Alex Wertheimer
5) CIE Salmon Review: Conservation Biology and Genetics Theme
   Conservation Issues/Wild Interactions
   -Bill Heard
   - John Joyce
6) CIE Salmon Review: Conservation Biology and Genetics Theme
   Conservation Issues/Wild Interactions
   Steelhead Genetics Research at LPW
   - Frank Thrower

July 14

1) CIE Salmon Review: Conservation Biology and Genetics Theme
   - Jack Helle
   - Dick Wilmot
2) CIE Salmon Review: Conservation Biology and Genetics Theme
   Bycatch Issues
   - Dick Wilmot
   - Adrian Celewycz
3) Issue 10: Monitoring and Documenting Bycatch of prohibited Species.
   A Historical Perspective of the Processing and Reporting of High Seas CWT Recoveries
   - Adrian Celewycz