An Evaluation of Salmon-Related Research at the Alaska Fisheries Science Center, Auke Bay Laboratory, Juneau, July 12-15, 2005

by

T.L. Marshall

CIE Reviewer
Pictou, NS Canada
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Executive Summary

A panel of four CIE reviewers was assembled at the AFSC's Auke Bay Laboratory, July 12-15, 2005 to ascertain program applicability to new ecosystem approach to management (EAM) research needs, recommend change or augmentations within existing resources and if needed, suggest additional research.

Ten areas of the Laboratory's programs were described by staff and scrutinized for relevance to:

i) AFSC's primary research mission of generating the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence,
ii) NOAA's strategic plan of "protecting, restoring and managing the use of coastal ocean resources through an ecosystem approach to management" (EAM) and
iii) AFSC's desire to increase its relevance to EAM research needs through baseline assessments, ecosystem indicators, decision tools, etc., within existing resources where possible.

With respect to the ten areas it was concluded/ recommended that:

- BASIS goals of understanding i) trophic dynamics, ii) climate effect and iii) development of indicators are clearly mission and 'strategic plan'-oriented and with some embellishment should be continued.
- Southeast Coastal Monitoring (SECM) has many of the elements of BASIS but requires additional consideration of increased nekton sampling.
- Little Port Walter and Auke Creek field stations are relevant to EAM research by way of current and historical perspectives on metrics associated with life cycle closure of wild juvenile pre-adult salmon cohorts sampled at sea.
- Differences between Unuk and Chickamin multi-generation hatchery and wild chinook founder counterparts do address the 'protection of coastal resources'. Management however, appears unlikely to be partial to the implications or a precautionary approach and for other than scientific merit, the effort may be largely academic.
- Sequestered population studies (i.e. steelhead) for ESA comply with both the mission and NOAA's strategic plan but are not relevant to Alaska; the Auke Bay Lab budget should not be implicated in any of the funding.
- Hatcheries as a threat (pinks) is now adequately demonstrated but the advice is likely of limited interest to the State/ industry, i.e., future work would seem unwarranted; the chum studies (also implicating a hatchery effect) do offer an ecosystem component and if need be, have some justification for continuation.
- Genetics for discrete stocks, migration pathways and forensics is essential for the conductance of mission and strategy of salmon and co-occurring species; the issue however is the degree to which the Auke Bay Lab must specialize (this reviewer suggests out sourcing of Pacific rim-wide issues thereby allowing specialization on local salmon and non salmon issues).
- Bycatch of prohibited species (GSI and CWTs) again is a management issue which lacks much visibility within the new mission and strategy, i.e., data bases of both entities could be considered for out sourcing.

It was also felt that Laboratory staff was unequivocally dedicated and talented but that the general lack of support staff and focused time impeded production. A combination of outsourcing and purging of perhaps less ecosystem oriented work could provide an opportunity to refocus available resources on new objectives.

Background

There is a long history behind Federally-based targeted research on salmon in Alaska waters dating to pre-statehood periods that involved 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's statehood in 1959, management of salmon fisheries within State jurisdictional waters became the purview of the State of Alaska. Management of salmon fisheries within the U.S. EEZ (between 3 and 200 miles) remains a Federal responsibility and is under the purview of the North Pacific Fishery Management Council.

A recent recasting of NOAA's mission statements to reflect an ecosystem approach to management (EAM) of coastal and ocean resources resulted in a subsequent shift in the research mission of the Alaska Fisheries Science Center (AFSC) "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". Salmon were recognized as an important *secondary* species because they are a significant component of major North Pacific marine ecosystems in terms of total biomass and trophic interactions and because of research responsibilities derived from international agreements and the receipt of direct funding from Congressional PPAs and NOAA research initiatives pertaining to Endangered Species Act-related issues.

In keeping with the AFSC's mission, the Auke Bay Laboratory (ABL), which has conducted the majority of federal research on salmon in Alaskan waters, recognized a need for research to maximize its relevance to new EAM priorities while meeting an ongoing Federal salmon research requirement. To further this goal the Laboratory requested an external evaluation of the relevance and appropriateness of: i) on-going research of the Marine Salmon Interactions [Early Ocean Salmon and Stock Enhancement Aquaculture], ii) Ocean Carrying Capacity inc. the Bering-Aleutian International Survey (BASIS) and iii) Stock Identification and Analysis programs. The objectives were to ascertain program applicability to new EAM research needs, recommend change or augmentations within existing resources and if needed, suggest additional research.

To this end, the AFSC contracted the University of Miami's Center of Independent Experts (CIE) to provide "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 panel selected by CIE was comprised of: Dr. Philip Hedrick, Arizona State University, Tempe, Arizona; Dr. Michael Bradford, Canada Department of Fisheries and Oceans, and Simon Fraser University, Vancouver British Columbia; Dr. Jim Carscadden, Canada Department of Fisheries and Oceans, St. Johns' Newfoundland; and this author. The review was conducted July 12-14, 2005 at the Auke Bay Laboratory near Juneau and facilitated by the Deputy Director, Program Heads and staff of the programs being reviewed.

The reviewers were provided with a 'Draft Agenda and Panel Discussion Questions' (Annex 2), Statement of Work (Appendix 1), 'Salmon Research Publications for Auke Bay Laboratory, 1995-2005' (Appendix 2), 'FY05 ABL Milestones – DRAFT', "ABL Research Summaries for the Salmon CIE Review, and 'Future AFSC Research Directions and ABL Research Priorities'.

Description of Review Activities

The formal portion of the 3-day review focused on Power point presentations (CD provided at the conclusion of the review) and 10 imbedded questions for consideration by reviewers and attending staff. Five of the questions pertained to Ocean Ecology and Climate issues while the other five focused on Conservation Biology and Genetics.

A record of discussion and this reviewer's impressions are provided in Annex 1 even though it was not included in the Statement of Work (App.1). The questions and a brief context were also contained in 'Draft Agenda and Panel Discussion Questions' provided by the CIE prior to the review and which is attached as Annex 2.

The titles, presenters and questions follow.

<u>DAY 1</u>

Introduction:

a) 'ABL Salmon Program CIE Review: Agenda, Structure, Focus, and Protocols, 12-14 July 2005'. Presented by Steve Ignell.
b) 'Auke Bay Laboratory: Overview of Programs and Components'. Presented by Steve Ignell.
c) 'History of Federal Salmon Research in Alaska the Auke Bay Lab'. Presented by Jack Helle.

Ocean Ecology and Climate

1. 'Alaska Fisheries Science Center Research in Support of an Ecological Approach to Management (EAM)'. Presented by Jack Helle.

2. 'CIE Review: Ocean Ecology and Climate Theme, Bering Aleutian Salmon International Survey'. Over view by Jack Helle, briefing by: Ed Farley on 'Climate Effects and Trophic Interactions'.

3 'CIE Review: Ocean Ecology and Climate Theme, Bering Aleutian Salmon International Survey'. Briefing by Ed Farley on 'Indicators'.

Q-1 Are we making progress on understanding *Climate effects* on: Distribution, Abundance, Growth, Condition Factors?
Does this project meet the objective?
What other research could/ should we do?

Q-2 Are we making progress on understanding *trophic effects* on: Distribution, Abundance, Growth, Condition Factors?
Does this project meet the objective?
What other research could/ should we do?

Q-3 Are we making progress on developing indicators to measure changes in *climate and ecosystem*?

Does this project meet the objective?
What other research could/ should we do?

DAY 2

4. 'CIE Review: Ocean Ecology and Climate Theme Southeast Coastal Monitoring (SECM) project'. Presented by Bill Heard et al. with Over View by Bill Heard and briefing by Joe Orsi on 'Field monitoring' and briefing by Molly Sturdevant on 'Trophic Process Studies".

Q-4 Are we making progress on understanding trophic dynamics and ocean conditions of epipelagic ecosystems of Southeast Alaska?
Does this project meet the objective?
What other research could/ should we do?

5. 'CIE Review Ocean Ecology and Climate Theme Field Stations and Long Term Data Sets'. Over View by Bill Heard on "LPW and Auke Creek Field Stations' and briefing by Jerry Taylor on 'Long Term Data Sets from Auke Creek Weir'

Q-5 Long Term Data sets on Climate Variability and Biological Production: Are we making progress?
Does this project meet the objective?
What other research could/ should we do?

Conservation Biology and Genetics

1. Part 1 'CIE Review: Conservation Biology and Genetics theme, Conservations issues: Hatchery / Wild Interactions'. Over View by Bill Heard on Hatchery / Wild stock Issues in Alaska with briefing by Alex Wertheimer on Hatchery/ Wild interaction in the marine environment.

1. Part 2 'CIE Review: Conservation Biology and Genetics theme Conservations issues: Hatchery / Wild interactions'. General Briefing: by Bill Heard - Hatchery/ Wild stock issues in Alaska, and briefing by Alex Wertheimer on 'Hatchery/ Wild interaction in the marine environment'.

Q-1 Do we understand Hatchery / Wild interactions, if any, in the marine environment?
Does this project meet the objective?
What other research could/ should we do?

2. CIE Review: 'Conservation Biology and Genetics theme, Conservations issues: Hatchery / Wild interactions'. Briefing by Bill Heard on 'Hatchery / Wild stock interactions: chinook' and briefing by John Joyce on 'Chinook research at LPW'.

Q-2 Do we understand Hatchery/ Wild interactions, if any, for chinook?
Does this project meet the objective?
What other research could/ should

3. ‘CIE Review: Conservation Biology and Genetics theme, Conservations issues: Hatchery / Wild interactions’. Briefing: by Frank Thrower on ‘Steelhead genetic research at LPW’.

Q-3 Can unique genetic gene banks be used in ESA recovery programs?
Does this project meet the objective?
What other research could/ should we do?

DAY 3

4. ‘CIE Review, Conservation Biology and Genetics theme: Genetic Issues’ by Dick Wilmot et al. with Over View by Jack Helle and briefing by Dick Wilmot on ‘Uses of Stock Identification’.

Q-4 Are the stock ID techniques adequate to:
separate out specific stocks
support forensic enforcement needs
aid in determining stock specific migration in BS.
Does this project meet the objective?
What other research could/ should we do?

5. ‘CIE Review, Conservation Biology and Genetics theme, By-Catch issues’. Briefing by Dick Wilmot on ‘By-Catch and Genetic Issues in Alaska’ and briefing by Adrian Celewycz on Use of Coded wire tags in By-Catch’.

Q-5 Are By-Catch issues supported by ABL research adequately?
Does this project meet the objective?
What other research could/ should we do?

Issue 10. ‘Monitoring and documenting bycatch of prohibited species: A Historical Perspective of the Recovery and Reporting of High Seas CWT recoveries’ by Adrian Celewycz.

Closing: Review Panel Discussions

Following the conclusion of the Laboratory presentations and general discussion, the panel (Hedrick, Bradford, Marshall and Carscadden) queried the Deputy Director on the Terms of Reference and expectations regarding responses to the Lab’s “Panel Discussion Questions” are affixed to the Draft Agenda (Annex 2) and on elements of the CIE TORs contained within the reviewer’s contracts.

The Deputy suggested that the reviewers meet the requirements of the “Statement of Work”; response to the Panel Discussion Questions of the preceding 2.5 days based on the discretion of each reviewer. Discussion then ensued on elements of the TORs on which the reviewers felt they were unqualified to respond. This led to the discovery that the reviewers TORs provided by the CIE were in fact an earlier draft and somewhat different than those provided to the CIE at a later date. The reviewers then examined the intended TORs and, at the suggestion of the Deputy, deleted a line from the verbiage of TOR #1 and specific questions D and F in TOR #1 and question C within TOR #2. Question B (TOR #2) was to be addressed to the extent possible. These changes were to be submitted to the CIE and are now reflected in Appendix 1 (attached)

and the ‘Summary of Findings’.

The reviewers then briefly engaged the Deputy on his thoughts on the strengths of the salmon projects and at his suggestions followed a similar line with Phil Rigby, Head of Groundfish Assessments. The reviewers then visited the Auke Creek weir which was not in operation and concluded their investigations at approximately 4:00 P.M on July 14th.

Summary of Findings *(i.e., TOR's and answers)*

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 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, identify appropriate levels of research directed at salmon management questions and at Alaskan ecosystem and habitat issues.

Guiding principles for Auke Bay Laboratory's salmon-related research include:
i) AFSC's primary research mission of generating the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence,
ii) NOAA's strategic plan of "protecting, restoring and managing the use of coastal ocean resources through an ecosystem approach to management" (EAM) and
iii) AFSC's desire to increase its relevance to EAM research needs through baseline assessments, ecosystem indicators, decision tools etc within existing resources where possible.

While Alaskan ecosystem and habitat issues are to be favoured over specific salmon management issues, salmon fisheries outside of three miles remains a federal responsibility under the purview of the North Pacific Fishery Management Council.

The order of the agenda set by the Laboratory was in retrospect a logical prioritization of the "fit" of ongoing "research" with the stated strategic plan and mission. The order of the agenda was:

1-3. BASIS: goals of understanding i) trophic dynamics, ii) climate effect and iii) development of indicators.
4. Southeast Coastal Monitoring (SECM).
5. Little Port Walter and Auke Creek.
. 6. Differences between Unuk and Chickamin multi-generation hatchery and wild chinook founder counterparts.
. 7. Sequestered population studies (i.e. steelhead) for ESA.
. 8. Hatcheries as a threat (pinks and chum).
. 9. Genetics for discrete stocks, migration pathways and forensics.
. 10. Bycatch of prohibited species (GSI and CWTs).

Projects 1-3 (OCC/BASIS) are clearly mission oriented; SECM (4) has many elements of the mission statements but a stronger focus on salmon at the expense of co-inhabiting species, and the field stations offer the potential for metrics associated with life cycle completion of wild juvenile pre-adult salmon cohorts sampled at sea. These projects should minimally retain, logically extend (SECM in particular) their research activities and OCC/SECM efforts warrant a

larger investment than the current 17 FTEs. Project 9 has the potential to be supportive of the preceding but as suggested (Annex 1) could be done more efficiently under contract to a larger and better established laboratory.

Projects 6 and 8 address salmon management issues and as suggested in Annex 1 have little probability of influencing a different outcome, i.e., the need for the research is questionable. Project 7 is opportunistic and interesting science but is targeted on Pacific Northwest issues (hopefully all costs including salary are covered by ESA). Project 10 is largely support/ service to fisheries management with admittedly some opportunistic insights to salmon research but is as well a candidate for out sourcing. Staff freed by outsourcing/ discontinuation of projects might better be engaged in less salmon oriented and more challenging ecosystem initiatives.

Recommendations:

- Expand and incorporate a greater degree of ecosystem monitoring into the SECM project (see Q 2B).
- Consider outsourcing the development of baseline microsatellite DNA and the diagnostics of survey samples (see Q 1C and Annex 1).
- Consider reducing the effort in "hatcheries as a threat" as it would appear to be undeniable that genetics of wild stocks will be affected in the long run and that advice on the topic (especially when the practice is likely to continue by foreign competitors) is unlikely to be heeded by the industry (see Q 1B).
- Ensure that ESA projects irrelevant to Alaska cover Laboratory salaries and operations.
- Consider outsourcing GSI bycatch issues to an already established lab (see Q 1C).

Q 1A. 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?

An understanding of 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 is best derived through components of the BASIS research. Most directly related is the research within the 'Indicators of Ecosystem Change' in this case, the Bering Sea, i.e. mapping of the major frontal boundaries, characterization of the water column structure, and description of the nutrient, phytoplankton, zooplankton and forage fish distributions for selected regions of the eastern Bering Sea shelf. Inter-annual comparisons are expected to assist in the derivation and evaluation of useful indices for assessing the effects of ocean conditions on growth and survival of juvenile salmon and associated marine nekton. Concurrent BASIS research on Bristol Bay sockeye salmon ecology and the documentation of, for example, changes in i) threshold size and size selective mortality of juveniles, ii) estimates of spatial abundance and iii) survival could provide the ancillary evidence of change.

The SECM survey as well has potential to embellish an understanding on the effects of climate/physical drivers that may cause changes in aspects of North Pacific ecosystems (trophic food webs and forage fish populations). It is suggested that consideration be given to the expansion of the area and number of stations and that in addition to juvenile salmon consideration be given to the distribution, abundance, feeding, bioenergetics, and migratory behavior patterns of co-inhabiting fish species.

Recommendations:

- Maintain/ expand the capacity of BASIS (see TOR #2).
- Expand the SECM surveys to sample more of the ecosystem.

Q 1B. 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?

The Auke Bay Lab cites four principle areas of research on hatchery-wild stock interaction:

i) real time studies on possible competition for food or available habitat of juvenile hatchery and wild chum salmon in the early marine environment in Southeast Alaska (yr 1 of 4),
ii) retrospective modeling studies of hatchery-wild interaction of pink salmon in Prince William Sound,
iii) comparisons between two hatchery stocks of LPW chinooks transplanted from mainland streams in 1976 and the original parental wild stocks, and
iv) effect of 70 years of isolation on an anadromous-origin population of steelhead in a freshwater lake, and the implications for ESA recovery programs in the Pacific Northwest.

Given that salmon issues are secondary to other fish and that the current mission prescribes an ecosystem approach to management it is reasonably clear that the chum investigations in southeast Alaska are the most deserving of continuation. The chinook studies are interesting but without a strong ecosystem component; the steelhead studies are without an ecosystem component and not an Alaskan issue. The retrospective studies on the pink salmon interaction issue remain unresolved and are now likely of little value in influencing management. (see Annex 1, CSB Q 1, Q 2 and Q 3).

There are well documented differences in survival, reproductive, foraging and social behaviors, habitat preference, response to predators, morphological and physiology between hatchery and wild Pacific salmon in the Pacific Northwest (Flagg et al., 2000). The point-counterpoint debate over the degree to which hatchery pink salmon may have replaced rather than enhanced wild stock production in Prince William Sound and Kodiak Island Alaska (Wertheimer et al., 2001 and Hilborn and Eggers, 2001) elucidates recent wild production responses. The issue should not only be the degree to which production has been influenced but the longer term impact on the genetics of the wild stock. Based on current information a risk assessment and application of the 'Precautionary Approach' would seem the best advice for managers advocating the continued practice of massive supplementation of fisheries. If a precautionary approach is conceded by management and is contingent on continued demonstration that hatchery fish have some impact on wild stocks, the best studies to continue are i) the ecosystem-based and opportunistic Southeast Alaska chum competition studies and, to a lesser degree iii) the chinook studies out of LPW. Extension of the other two projects should not be at the expense of the AFSC.

Recommendations:

- Consider making a case for dropping the ongoing program.
- Failing the ability to drop the program, continue the chum and if necessary the chinook studies.

- Ensure that any continuation of the pink and steelhead studies are fully supported (including salaries) by outside funding.

Q 1C. 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?

Genetic stock identification research identified by the Laboratory (Research Summaries for CIE Review) was:

1. Re-analysis of the chum salmon bycatch and the chinook bycatch from the BSAI groundfish fishery using the new DNA markers to obtain more precise stock origin estimates.
2. **Using the new DNA markers, analyze catches of juvenile and immature salmon caught by the BASIS cruises in the Bering Sea to determine stock specific migration timing and pathways.
3. Develop new DNA-based genetic baselines for southeast Alaska and northern British Columbia salmon stocks for use in negotiations on management of mixed-stock fisheries under auspices of the Pacific Salmon Treaty.
4. In cooperation with the above agencies, develop new Pacific-rim DNA-based genetic baselines for salmon.
5. **Use mitochondrial DNA variation for species identification of larval rockfish species.
6. **Use microsatellite DNA variation to determine the genetic stock structure of various forage fish species in the North Pacific Ocean.

Those projects that focus directly on ecosystem research include numbers 2, 5, and 6. Project number 1 could contribute in a retrospective manner to both ecosystem and enforcement/ forensics and project number 4 is essential to the conductance of projects 2 and 6. Project number 3 is essentially a forensic study.

Projects 2, 5 and 6 are "needed" to support ecosystem research, i.e. develop an understanding of population structure, possible migratory pathways of salmon and co-occupying rockfish and forage species. Project number 4 is required to establish the genetic baseline for microsatellite DNA analyses. Project number 3 would seem essential to management while project number 1 would now seem the least essential to either objective.

According to the information provided, the Auke Bay Lab has begun the process of gaining the personnel and equipment to do single nucleotide polymorphisms (SNPS) and expand the genetic baseline and capacity to support ecosystem research and salmon forensic/ enforcement activities with microsatellite DNA analyses. It is the opinion of this reviewer (Annex 1) that resources required to duplicate efforts of laboratories already well versed in the use of salmon microsatellite DNA and having a broad genetic baseline of the Pacific Rim, would be better spent in enhancing the genetic baseline of that lab with regional DNA extracts. DNA extracts from broad scale salmon issues could then be outsourced to that lab for analysis. The Auke Bay Lab could then specialize in regional scale salmon issues and studies (including SNPs) and possibly expand their endeavours into co-occurring species with salmon (projects 5 and 6).

<u>Recommendations</u>: (by project)

- 1. Low priority; diagnostics on DNA extracts should be outsourced.
- 2. High priority; but diagnostics on DNA extracts should be outsourced.

- 3. High priority but through partnering with an already well established lab (having a Pacific rim-wide baseline).
- 4. High priority but through partnering with an already well established lab (having a Pacific rim-wide baseline).
- 5. High priority; to be augmented and conducted at the Auke Bay Lab.
- 6. High priority; to be augmented and conducted at the Auke Bay Lab.

Q 1D. 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 current ABL research on juvenile salmon be modified or changed to provide a better understanding of the role salmon play in various components of the North Pacific ecosystem?

Undoubtedly, the BASIS project under the NPAFC best exemplifies the Laboratory's thrust to combine salmon and ecosystem objectives in the North Pacific. This is in large part because the project was designed to monitor the effects of ocean conditions on growth, migration and distribution of juvenile salmon in Bristol Bay; in effect, the project's objectives were devised at about the same time as research into ecosystem processes and management were coming to the fore.

BASIS intensively samples fish and their stomachs, zooplankton, phytoplankton and physical and chemical characteristics of the water column during the (albeit) brief survey period. These data contribute to the parameterization of forage models from experiments conducted in the laboratory, their application to conditions measured during field surveys to quantify consumption rates during summer months, and their use with bioenergetics models to estimate the amount of growth an individual or cohort of fish may enjoy if they were to occupy a specific location.

Suggested modifications to this program for a better understanding of the role of salmon in the ecosystem include: an increased number of transects, northward expansion of the survey, extended seasons of survey, diurnal sampling, concurrent acoustic surveys and sampling of the complete water column (TOR #2 Q1 and Q2; Annex OCE Q1, Q2, Q3). A recommendation by the NPAFC to extend the life of the survey would as well be beneficial to all emerging data sets and model building.

The SECM project has as well a strong focus on the early marine life of wild and hatchery-origin salmon in corridors leading to the high seas (Annex OEC Q4). On this project, resources including people/ scientists appear to be limited, effort (number of stations) has been reduced and sampling is largely restricted (there however being broader seasonal coverage) to the epipelagic zone. Night trawling and acoustic surveys would as well be complimentary to existing data.

Recommendation:

- Embellish both the BASIS and SECM surveys (see TOR #2 Q1 and Q2)

Q1E The AFSC presently operates two permanent field stations in Southeast Alaska, at Little Port Wallace(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.

The Auke Creek Station and weir in particular, is essential to the understanding of life closure and stock and recruit events. The long time series of data on salmon productivity, life history parameters, and climate contribute to the understanding of climate effects on biological variability, resultant biological productivity, and potential consequences of future climate change. These data appear to be the only source of potential long-time stock and recruit relationships for Alaskan salmon and as such provide opportunity to retrospectively explore climate effects on freshwater (temperature, ice-out, discharge), recruitment of salmon, their size, condition, abundance and time of emigration. The latter factors are important background information to understanding subsequent survival at sea, e.g. run timing in / out of synchrony with prey / predators upon sea entry, physical parameters of the sea at time of entry, SSTs, potential marine productivity, their early growth for enhanced survival etc. All of these factors are important sources of variability necessary for the understanding of marine ecosystem processes and relationships.

The Little Port Walter facility on Sashin Creek was historically used to understand stock and recruit mechanisms for pink salmon. More recently the station has focused on enhancement technologies and brood stock development, especially with chinook and coho salmon. Hatchery-wild salmon interactions including population genetics studies on chinooks and steelhead are within the current focus. The latter trials are dependent on the freshwater and saltwater culture facilities.

The LPW's weir serves to monitor relative survival of released products, the differences between experimental and control groups tending to be more important than the presumed constant of the ecosystem effects operating on groups simultaneously. This reviewer has concern over science's ability to influence Alaskan hatchery practices with science from the longer term chinook or other studies (and relevance of the interesting steelhead studies to Alaska) and suggests that in the light of potential genetic effects on wild stocks that a precautionary approach should be taken by reducing the superimposition of hatchery products on wild stocks. It is unclear to this reviewer if monitoring of wild populations on Sashin Creek would be value-added to that of Auke Creek.

Recommendations:

- Maintain the Auke Creek weir, facility and time series; insure that the data are fully exploited in all modeling scenarios, e.g. early life history, meta analyses involving multiple indexes of stocks, their strengths and environmental variables etc. and consider increased collection of physical parameters associated with the lake and atmospheric environment. Also consider the deployment of archival tags to learn more about where salmon are when (Annex OCE Q 5).

- Decide on the future of hatchery/ wild "interaction" research by scoping the possibility that any of the advice so derived could be adopted by policy-makers.
- If hatchery/ wild interaction studies could be abandoned and the steelhead study could be concluded, review the value-added by the LPW weir data relative to the Auke Creek weir data and decide with cost/benefit analyses, the future of the LPW station.

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.

The BASIS program meets the objectives of an international commitment to the NPAFC by contributing to an understanding of "the mechanisms underlying the effects of environmental variation and density-dependence on the salmon carrying capacity of the Bering Sea for sustainable conservation of salmon stocks in the North Pacific" (Azumaya, 2005) and to NOAA's mission of

-ecosystem based management (salmon as a secondary species of concern).

The major components of BASIS are:
1) research on the distribution and migration of juvenile, immature, and maturing salmon and associated marine species in coastal and offshore waters,
2) monitoring of age and size at maturity and abundance of salmon populations,
3) retrospective studies on changes in age and growth of salmon populations and,
4) open lines of communication and collaboration with Japanese and Russian investigators conducting similar research in the central and eastern parts of the Bering Sea.

Elements of the utility of components 1-3 under the headers of understanding how trophic dynamics and climate affect fishes and, the development of indicators that measure climate and ecosystem change, have been addressed in response to OEC 1, 2 and 3, (Annex 1). One utility not previously addressed is the economy of the program relative to the scale of knowledge gained when national (university and state) and international investigators focus their efforts on common parameters in a single basin. It should not go unnoticed that Auke Bay investigators collaborated with outside investigators in 7 of 9 presentations at "BASIS-2004: Salmon and Marine Ecosystems in the Bering Sea and Adjacent Waters". It is fair to speculate that ensuing synthesis documents in future workshops will entail even broader collaboration between nations.

Recommendation:

- Urge continued international support and embellishment of time at sea and data collection towards an understanding of ecosystem process in an apparently rapidly changing environment.

Q 2A. 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?

The current BASIS surveys provide data to address Bering Sea non-salmonid management and ecosystem research through late-summer and fall trawling and sampling of epipelagic nekton to a depth of 15 m. Length and weight data, diets, scales, otoliths, and tissue samples are collected from all species. Tissue samples can be used for genetic, stable isotope, and fatty acid analysis. Oceanographic data are also collected and with the help of other agencies / GLOBEC the suite include temperature, salinity, density, nutrients, chlorophyll a, zooplankton, and phytoplankton taxonomic characteristics. Oceanographic data will permit the pursuit of research on how nekton responds to reduced sea ice and recent warming along the eastern Bering Sea shelf.

Current research activities were noted to include PCB contaminates in pollock, capelin genetic studies, and through collaborative efforts with other scientists, juvenile pollock energetics. Locations of coccolithophore blooms on the shelf are being mapped and their impact on the feeding ecology of salmon and other nekton species are also being studied. The development of bioenergetic, food web, and other synthesis models of epipelagic fish species are expected to contribute to robust indicators of the eastern Bering Sea shelf ecosystem.

The potential for BASIS surveys to better address Bering Sea management and ecosystem research needs would be facilitated with the use of hypothesis based sampling in order to expand the sampling area northward, more vessel time to augment the window of observation, diurnal sampling, the use of acoustic gear to enhance trawl data (as in going between stations), especially for walleye pollock, complete trawl coverage of the water column where depths exceed 15 meters benthic sampling, deployment of additional moorings for CTDs, and acquisition of temperature data from ‘ships of opportunity’.

Key non-salmonid management and scientific questions/hypotheses that could be addressed by BASIS include a fuller appreciation of how trophic dynamics affect distribution, abundance, growth, and condition of fishes of the epipelagic as well as middle and deeper waters, where they exist. This would follow from the successful parameterization of foraging models using results from experiments conducted in the laboratory, their application to conditions measured during field surveys to quantify consumption rates during summer months, and their use with bioenergetics models to estimate the amount of growth an individual or cohort of fish may enjoy if they were to occupy a specific location.

Extension of the survey area northward and a more complete sampling of the ecosystem of the full water column in winter and spring would as well present opportunities to assess more broadly the impacts of ‘climate change’ as expressed through expanding coccolithophore blooms, declining ice coverage and rising temperatures in the Bering and Bristol and apparently, Chukchi, Seas. The rapid change in these parameters should provide good contrast for multiple correlation

analyses with potentially, a broad array of biological indicators.

Although this reviewer does not have a full appreciation of the quantity and quality of data being collected under BASIS it would be well for investigators to review Helle et al. (2005) as to the possibility of:

- increasing the oceanographic data collection, especially investigations of diurnal and vertical distribution of plankton and the availability and caloric content of non-salmon target species,
- continue the calibration of BASIS plankton and trawl gear,
- develop schemes and models reflecting the place and role of forage and competing species (to salmon) in the trophic structure of the Bering Sea pelagic community and ecosystem and to the extent possible, and
- emphasize ecosystem research on how climate change in the Bering Sea will affect NPAFC nations and in the case of non salmonid fish, such as the yields of groundfish.

Recommendation:

- Augment the US scope of BASIS so as to capture the response of an ecosystem to an apparently rapidly changing environment. Modelling and lessons learned over perhaps as little as a decade may be important harbingers of the rapid impacts of climate change and have the potential to contribute to national policies on greenhouse gases.

Q 2B How can AFSC best utilize BASIS, as part of its research mission in Alaska?

As indicated in the remarks following TOR #2, BASIS provides the opportunity to address both the Lab's mission statement and NPAFC's salmon issues. The 'mission' is largely addressed through the substantive non salmonid line of questioning and response above. The NPAFC salmonid mandate (and AFSC's historical strength) provides ample opportunity to:

- build on existing salmonid knowledge,
- use salmonids and their response in the ecosystem as indicators of ecosystem change,
- access international expertise and concurrent studies addressing factors affecting salmon survival at sea and which remain within the Lab's mandate through PPA funding initiatives,
- contribute through meaningful exchange to an international study and at the same time and
- be a party to the development of advice for salmon management.

One of the more exciting opportunities would seem to be the possible expansion of BASIS surveys to the Chukchi Sea for real time monitoring of response to ongoing rapid changes in ice cover and temperatures.

Recommendations:

- Support the continuation of the International survey; a meaningful time series, especially under a scenario of rapid climate change will be advantageous to the derivation of working models to explain changes in abundance of biological entities and could serve as a real time warning regarding the impacts of greenhouse gas.
- Consider methods by which the area of the survey can be extended northward, by which additional seasonal coverage can be acquired and by which all layers of the water column can be sampled with fishing gear.
- Consider the use of acoustics in concert with trawling and sampling and acoustic surveys between stations in the development of abundance estimates.
- Consider the deployment of additional CTDs.

- Consider where feasible, the short-lived pink salmon as the indicator of environmental change.
- Seek new moneyed partners (aboriginals?) to help fund initiatives that have the potential of addressing climate change in the approaches to the Arctic Ocean.
- Address each of the eight concerns highlighted by Helle at. al. (2005) in "BASIS-2004: Salmon and Marine Ecosystems in the Bering Sea and Adjacent Waters".

Conclusions/Recommendations

Of the Lab's ten theme areas jointly scrutinized by staff and CIE reviewers for confirmation to i) AFSC's primary research mission of generating the best scientific data available for understanding, managing, and conserving living marine resources in Alaskan waters and the environmental quality essential for their existence,
ii) NOAA's strategic plan of "protecting, restoring and managing the use of coastal ocean resources through an ecosystem approach to management" (EAM) and
iii) AFSC's desire to increase its relevance to EAM research needs through baseline assessments, ecosystem indicators, decision tools etc within existing resources, it is possible to conclude that:

- BASIS goals of understanding i) trophic dynamics, ii) climate effect and iii) development of indicators are clearly mission and 'strategic plan'-oriented and with some embellishment should be continued.
- Southeast Coastal Monitoring (SECM) has many of the elements of BASIS but requires additional consideration of increased nekton sampling.
- Little Port Walter and Auke Creek field stations are relevant to EAM research by way of current and historical perspectives on metrics associated with life cycle closure of wild juvenile pre-adult salmon cohorts sampled at sea.
- Differences between Unuk and Chickamin multi-generation hatchery and wild chinook founder counterparts do address the 'protection of coastal resources'. Management however, appears unlikely to be partial to the implications or a precautionary approach and for other than scientific merit, the effort may be largely academic.
- Sequestered population studies (i.e. steelhead) for ESA comply with both the mission and NOAA's strategic plan but are not relevant to Alaska; the Auke Bay Lab budget should not be implicated in any of the funding.
- Hatcheries as a threat (pinks) is now adequately demonstrated but the advice is likely of limited interest to the State/ industry, i.e., future work would seem unwarranted; the chum studies (also implicating a hatchery effect) do offer an ecosystem component and if need be, have some justification for continuation.
- Genetics for discrete stocks, migration pathways and forensics is essential for the conductance of mission and strategy of salmon and co-occurring species; the issue however is the degree to which the Auke Bay Lab must specialize (this reviewer suggests out sourcing of Pacific rim-wide issues thereby allowing specialization on local salmon and non salmon issues).
- Bycatch of prohibited species (GSI and CWTs) again is a management issues which lacks much visibility within the new mission and strategy; in effect, data bases of both entities could be considered for out sourcing.

In general, Laboratory investigators appear to have taken on onerous projects with a minimum of "help". Partnering / cooperative agreements by which help is gained (such as with academia)

leave the host agency with most of the caretaking and little of the glamour, (e.g. Auke Creek weir).

Baseline monitoring is essential to research and one must not overlook the importance of retrospective analyses (especially those using new techniques) on long term data sets to advance knowledge and rest it in primary journals. On that note, demands on professional staff with little technical support may be the reason why so few of the salmon research publications for the Auke Bay Laboratory, 2000-05 (Salmon Research Publications for Auke Bay Laboratory, 1995-2005; App. 2) were in primary journals. A cursory look at the last 5 years reveals fewer than 4 primaries per year (excludes papers in symposia which are unlikely to be rejected by referees) which in some laboratories would be the expected output of no more than three research scientists seeking promotion. The high proportion of non-primary publications is more indicative of a resource ‘management- oriented’ agency rather than a research agency. A possible purging of support / non-mission or non- strategic plan efforts would allow potential for a renewed focus on ecosystem science and primary publication.

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ANNEX 1
Commentary pertaining to 'Panel Discussion Questions'

Ocean Ecology and Climate (OEC)

1. *The Bering-Aleutians Salmon International Survey (BASIS) project examines the ocean ecology and climate of the Bering Sea. Trophic interactions occur between gadids, salmonids, and clupeids in the epipelagic ecosystem of the Bering Sea. An objective of this project is to understand how trophic dynamics affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem of the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?*

The BASIS project best exemplifies the Laboratories thrust to address salmon ecosystem objectives. This is in large part because the project (founded in 2002) has its roots in a 1999 thrust to monitor the effects of ocean conditions on growth, migration and distribution of juvenile salmon in Bristol Bay, i.e., the project's objectives were devised at about the same time as research into ecosystem processes and management were coming to the fore. The BASIS label opened the doors to collaboration with Japanese and Russian investigators to achieve a Basin-scale study of salmon and forage fish populations throughout the Bering Sea.

In general, an understanding of how trophic dynamics affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem is likely to be achieved. This is due in part to the reasonably intensive sampling of fish and their stomachs, zooplankton, phytoplankton and physical and chemical characteristics of the water column during the (albeit) brief survey period, the successfully parameterization of foraging models from experiments conducted in the laboratory, their application to conditions measured during field surveys to quantify consumption rates during summer months, and their use with bioenergetics models to estimate the amount of growth an individual or cohort of fish may enjoy if they were to occupy a specific location. For example, partnering with U of A to analyze zooplankton is critical, as the Lab does not have the resources to do the complete package.

Limitations include modeling capacity within the group, the narrow August-September window for sampling, and the restricted area of sampling. Considerations included use of hypothesis based sampling to permit expansion of area (to the north) use of acoustic gear to enhance trawl data ,especially for walleye pollock (as in going between stations), complete trawl coverage of the water column, benthic sampling deployment of addition CTDs, and acquisition of temperature data from 'ships of opportunity'.

2. *Large-scale changes in the Bering Sea ecosystem have been attributed to climate changes, such as loss of sea ice and warmer sea temperatures. Another objective of BASIS is to understand how these changing ocean conditions and climate affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem of the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?*

Per question 1, the BASIS project, its survey/ sampling, partnering with GLOBEC and association with Russian and Japanese investigators makes it well positioned to

understand how changing ocean conditions and climate affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem. The fortuitous variability seen in the few years of data for coccolithophore blooms, rising temperatures and declining ice coverage in the Chukchi, Bering, and Bristol Seas all provide contrast for correlation analyses with abundance of walleye Pollock, salmon and prey species, such as zooplankton. Water temperatures at depth, zooplankton and phytoplankton assemblages should as well contribute to the analyses and reveal insights which are often masked by the more simplistic but longer standing 'traditional' measures of salmon abundance and climate.

Limitations are the 6 year (at most) time series of data collected by OCC/BASIS, the absence of earlier (and later) season data (pre-August and post September), different gear types for sampling measures of productivity, additional moorings for expanded coverage, a longer term commitment to the project and limited capacity to deploy and recover archival tags. The pending winter survey of the Bering Sea 2005-06 by the Japanese is expected to provide interesting information, if not begin a new time series.

3. *Climate and ecosystem indicators can be used to support an ecosystem approach to management. Examples of such indicators are time series of fish growth and abundance, zooplankton abundance, and episodic phytoplankton blooms. Another objective of BASIS research is to develop indicators that measure climate and ecosystem change in the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?*

The exploration of indicators that measure climate and ecosystem change in the Bering Sea should be possible with integration of the array of physical, chemical and biological measures included in the BASIS project. The short life cycle of pink salmon makes them especially attractive as a measurable indicator, especially if population recruitment were measured in terms of escapement and harvest. A meaningful time series, however is requisite.

It was suggested that additional baselines to the north (to follow warming trends, among other indicators), that transects in the Chukchi Sea would be especially important given the rapid macro scale measures of warming trend and that cooperative approaches should be explored to enable the extension of current research (aboriginal communities?). A more complete picture of fish assemblage data, i.e., outside of the current August-September window and at all depths, as well as a greater degree of sampling at the lower trophic levels would as well be instructive. Many of the issues raised in respect of questions 1 and 2 were applicable across all questions.

4. *The Southeast Coastal Monitoring (SECM) project examines the ocean ecology and climate of southeast Alaska. Research cruises include multiple time series of observations of epipelagic trawling and associated biophysical measurements in an important migration corridor for juvenile salmon. Other important species competing for the same resources include gadids, clupeids, and cetaceans. Objectives of this project are to develop an understanding of the trophic dynamics and ocean conditions of the epipelagic ecosystem of southeast Alaska and to compare the Southeast ecosystem with the Gulf of Alaska and the Bering Sea. Does this project meet this objective and why? What other research could be*

conducted to address this objective?

(A) This project has potential to explore an understanding of the trophic dynamics and ocean conditions of the epipelagic ecosystem of southeast Alaska and possibly, compare it with the Gulf of Alaska and the Bering Sea. Other objectives of the project are salmon oriented and include 'building long-term time series of seasonal growth, distribution, abundance, and habitat utilization of juvenile salmon, and associated marine organisms' and, 'examination of relationships between biophysical indices and variations in long-term data that may indicate ecosystem change'. The project is financially under resourced and with a staff of only four persons (and a few co operators) appears to lack an individual with quantitative/ modeling skills with which to extend the current descriptive relationships to the development of trophic interactions.

Limitations to the trophic dynamics project include the limited number of stations (reduced from 24 to 13) the absence of mid water trawling, night trawling, and acoustic surveys especially as they relate to the apparently significant herring biomass. Co-ordination with groundfish surveys and Alaska Fish and Game would seem to offer additional scope for the attainment of missing parameters necessary for a trophic dynamics model.

5. *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. The stations provide long time series of data on salmon productivity, life history parameters, and climate. The objective of these time series is to add to our understanding of climate variability, biological productivity, and potential consequences of future climate change. Does this project meet this objective and why? What other research could be conducted to address this objective?*

The long time series of data on salmon productivity, life history parameters, and climate at the Auke Creek in particular, and Little Port Walter facilities do add to our understanding of climate variability, biological productivity, and potential consequences of future climate change. These data appear to be the only source of potential long-time stock and recruit relationships for Alaskan salmon and as such provide opportunity to explore climate effects on freshwater (temperature, ice-out, discharge), recruitment of salmon, their size, condition, abundance and time of emigration. The later factors are important background information to understanding subsequent survival at sea, e.g. run timing in/out of synchrony with prey/ predators upon sea entry/ physical parameters of the sea at time of entry, SSTs, potential marine productivity, their early growth for enhanced survival etc. All of these factors are important sources of variability necessary for the understanding of marine ecosystem processes and relationships.

Little was offered on the topic of additional research in part because the numerous theses completed by University graduate students at these facilities were not reviewed. The value of the facilities is in fact in the monitoring which of course rests by-and-large with government agencies. Additional parameters for possible inclusion in a continuing long term data base particularly at Auke Creek (resources being available) include stream discharge, water quality and limnology of Auke Lake, climatic conditions as possibly recorded at the Juneau airport, such as precipitation, days of cloud cover/ sunshine/ rain.

Both facilities also offer opportunities to explore the possible impact of abundance of one salmon species on the other, abundance of co-occurring non-salmonids and other components of the ecosystem (SECM projects) as well as deployment and potential recovery of archival tags etc., for purposes of better describing the habitats of salmon at sea.

Conservation Biology and Genetics (CBG)

1. *Chinook salmon hatchery programs in Southeast Alaska, a region with a limited number of relatively small wild stocks of Chinook salmon, were developed to compensate for catch limitations imposed under US-Canada salmon treaty accords even though hatcheries in other areas have been identified as one significant cause of stock declines and ESA listings. ABL conducts research on two experimental hatchery stocks of Chinook salmon at a remote field station by making comparisons with multi-generations of hatchery fish and their wild founder counterparts that are unaffected by habitat loss, introductions of other fishes, or hatchery influences. The objective of this research is to understand if, how, and why changes in hatchery stocks differ from their wild founders and to help avoid pitfalls related to hatchery-caused declines in wild stocks. Does this project meet this objective and why? What other research could be conducted to address this objective?*

   The Unuk and Chickamin multi-generation hatchery and wild founder counterparts provide a unique opportunity to research/ground truth in the wild, changes in hatchery stocks from their wild founders. Most studies hereto are largely laboratory based. Studies indicating a strong tendency toward early female maturation in hatchery stocks, different adjusted fecundities for the two wild stocks, similarity of egg sizes in hatchery and wild stocks and differences between hybrids and their wild counterparts have been revealing. Continuing studies on ages 4, 5, 6 returning adults evaluated by cross-type, female maturation timing by age, fecundity adjusted for female size, egg size among cross-types and morphological differences among cross-types should also prove interesting. The generation of advice from this unique opportunity however, will take time given the long life history strategy of chinooks. However the reaction by US commercial hatcheries, to whatever advice is generated from these studies, may well be useless without minimal state or US federal legislation. A precautionary approach based on a wealth of literature would already suggest that hatchery programs should utilize wild origin stocks to maintain genetic variability, avoid domestication and in turn avoid any possibility of adverse effects from natural crosses of hatchery and wild fish.

   Future research on inbreeding and outbreeding depression will be informative and is on the Lab's list of "continuing research items".

2. *The experimental conditions for steelhead research at ABL, broadly supported by cooperative participation with partners including NOAA scientists and others from the Pacific Northwest (including in some cases funding support), are not available in other regions. Unique genetic gene banks exist in Alaska such as 70 years of freshwater isolation of an anadromous-origin population of steelhead in a lake, which may be useful in ESA recovery programs in the Pacific Northwest where, for example, ten Evolutionarily Significant Units (ESUs) of steelhead are listed under ESA. The objective is to determine if these unique genetic gene banks can be used in the ESA recovery programs. Does this project meet this objective and why? What other research could be conducted to address this objective?*

   Like the chinook project, credit must also be given to staff for seizing on a made-to-order opportunity at the doorstep of the LPW station to help determine if long-term freshwater sequestration is a biologically and genetically useful tool in the recovery of steelhead and other anadromous salmonids and, to help determine the ecological and genetic relationships between resident rainbow trout and steelhead. The latter was to assist in the appropriate risk determinations for steelhead ESUs. The project seems well designed (presumably peer reviewed for continued funding from ESA sources) and positioned with quality fresh and salt water "raceways" for controlled experiments and as well, the Sashin Creek for the comparison of marine survival of smolts produced by anadromous or resident populations, of mating behavior and spawning success of captive and ranched adults and comparison of fry production between captive and ranched steelhead. In summary, this project must be considered one of the all-encompassing and doable of the Labs ongoing projects. (It is however largely irrelevant to Alaskan fisheries management issues.)

3. *Large scale hatchery programs for pink salmon in Prince William Sound and chum salmon in Southeast recently have been implicated in declines in wild stock productivity for these species in those regions. ABL scientists participate and take leadership roles, along with university, state, and private sector partners, in related research programs in these regions, including retrospective modeling studies, to examine if and how these hatchery programs may be affecting productivity of wild stocks. One objective of ABL hatchery-wild stock interaction research is to better understand if hatcheries pose a threat to healthy wild stocks, including through ecosystem change. Does this project meet this objective and why? What other research could be conducted to address this objective?*

   Large scale hatchery programs for pink salmon in Prince William Sound and chum salmon in Southeast do provide evidence of the threats of hatchery stocks to wild stock productivity. The approach for pinks have been retrospective (most notable being spawners, parent size, summer Gulf SSTs at age 0 and marine survival indices); for chum the impacts have been explored through SECM bioenergetic modeling using field temperature data zooplankton biomass, chum catch data from trawling, stock composition, growth in weight, diet composition, whole body energy density and a number of values characterized within the literature. Some of the impacts on pinks have been published resulting in point and counterpoint arguments, the counterpoint interpretation being that the impact on production was greater than indicated.

   The current and ongoing research is apparently relatively inexpensive but additional

research is unlikely to resolve the present debate. The additional and richly published concerns re: potential changes in wild stock genetics through straying and interbreeding or through competitively impacting the relative survival of differing wild run components is likely of equal or greater long term concern, i.e. the degree to which hatchery activities impact: costs and benefits or increase production while minimizing impacts is a social rather than scientific concern. The genetic impacts, for which there is voluminous support in the literature would seem to trump even the process and retrospective findings, i.e., there is more than enough information to ascertain long term impacts by hatchery fish on wild stocks and from a scientific perspective, stand down.

4. *Objectives of the salmonid portion of the fish genetics research unit at ABL, using allozyme, mtDNA, microsatellite DNA, and single nucleotide polymorphisim (SNP) techniques, are to: 1) identify discrete stocks or unique geographic groupings of salmon stocks caught in mixed stock fisheries; 2) make forensic determinations of stock origins of salmon caught in illegal fisheries; and 3) determine stock-specific migration pathways of salmon in oceanic waters. Does this project meet this objective and why? What other research could be conducted to address this objective?*

   Information provided indicates that the Laboratory had an expertise and significant data base for allozyme mtDNA which enabled determinations of stock origin on a broad geographical basis, (e.g. for chum salmon, there are 8 or 9 unique geographic entities around the Asian and North American Pacific Rim) but was largely incapable of identifying discrete stocks and their stock specific migration pathways. Microsatellite DNA and SNP techniques available over the last several years permit a finer resolution of population identification. Limited and late entry into the newer field has taken the Lab with its large allozyme data base from a position of strength among Pacific Rim laboratories to a minor player. Current attempts with a compliment of 5 people, an ABI SNP Detector, 2 LI-COR gene sequencers and 2 MJ Research stations to develop new DNA based genetic baselines for southeast Alaska, northern British Columbia and the Pacific-rim appear to have proven challenging. The frustration stems from the difficulty in standardizing results across labs, null alleles and many rare alleles that can cause statistical problems, and the large sample sizes required because of the large number of alleles. Nevertheless progress has been made, especially on Southeast Alaska and northern BC and Glacier Bay National Park populations.

   The addition of a new DNA lab tech, 2 contract techs and 3 new ABI's in the fall of 2005 is apparently designed to augment the Lab's capabilities and stature among State, university, national and international labs. New research to facilitate capacity might best be directed to increasing with statistical procedures the resolution of stock identification when baselines are incomplete (Pella and Masuda, 2005).

5. *A major management concern for NOAA Fisheries in Alaska is monitoring and documenting bycatch of prohibited species, including salmon, in large groundfish fisheries in the Gulf of Alaska and Bering Sea. The numbers and stock origins of salmon bycatch become important issues for the management and continuance of the groundfish fishery as well as the well being of salmon stocks involved. Two ABL research programs, the use of genetic stock identification (GSI) techniques and coded wire tags (CWT), are currently utilized in monitoring and documenting stock origins of salmon bycatch in these fisheries. The objective of this work is to determine the stock origin of salmon bycatch in these fisheries. Does this*

project meet this objective and why? What other research could be conducted to address this objective?

Based on coded-wire tag recoveries in the Bering Sea Aleutian Islands and Gulf of Alaska, substantial numbers of Pacific Northwest chinook salmon, including ESA listed stocks among others are caught as bycatch. Efforts to develop genetic baselines for SNP's and/or microsatellites in cooperation with ADF&G and UAF are ongoing, including new funding to begin a new stock identification study on the chum and chinook bycatch from the Bering Sea. In that regard, training has been provided to the Observer Program for the collection of tissue and scale samples from both chum and chinook salmon from the 2005 fall fishery, and chinook samples from the spring 2006 fishery.

To better document bycatch with limited resources it was suggested that perhaps only the major producing rivers would be needed for the genetic baseline data. It was also noted that the migration routes and exploitation rates for CWT fish (essentially all of hatchery origin) were likely surrogates for those of wild fish and that hence release numbers by facility and stock may provide meaningful data with which to derive relative abundance of wild or at least non ad-clipped fish caught with CWT counterparts at sea.

ANNEX 2

AFSC Salmon Research CIE Review

Draft Agenda and Panel Discussion Questions

Day	Topic	Duration (h)	Presenter
Day 1 8:30 am – 5:30 pm	Introduction 8:30-10:30	Welcome (15 min) Rules (10 min) Lab overview (AFSC) (20 min) Salmon: history (abundance, politics, research: build to WHY we are here NOW) (1/2 hour) Problems (1/2 hour): State management/Federal research/International Management Direction from AFSC on salmon management	Steve
	Ocean Ecology and Climate 10:45 – 5:30 *(Lunch provided)*		
	BASIS overview	0.5 h	Jack
	Ocean Ecology and Climate Question 1	2 h overview 10 min discussion 50 min answer questions 30 min	Jack
	Ocean Ecology and Climate Question 2	1-1/2 h overview 10 min discussion 40 min answer questions 20 min	Jack
	Ocean Ecology and Climate Question 3	1 h overview 10 min discussion 30 min answer questions 15 min	Jack
	No-host dinner 7:00 pm - TBA		

Day 2 8:30 am – 6:00 pm	SECM overview	½ h	
	Ocean Ecology and Climate Question 4	1-1/2 h overview 10 min discussion 40 min answer questions 20 min	Bill
	Ocean Ecology and Climate Question 5	1 h overview 10 min discussion 30 min answer questions 15 min	Bill
	Conservation Biology and Genetics 11:30 – 6:00 *(Lunch provided)*		
	Conservation Biology and Genetics Question 1	1 h overview 10 min discussion 30 min answer questions 15 min	Bill
	Conservation Biology and Genetics Question 2	1 h overview 10 min discussion 30 min answer questions 15 min	Bill
	Conservation Biology and Genetics Question 3	1 h overview 10 min discussion 30 min answer questions 15 min	Alex
	4 Conservation Biology and Genetics Question 4	1 h overview 10 min discussion 30 min answer questions 15 min	Jack
	Conservation	1 h	Jack/Bill

	Biology and Genetics Question 5	overview 10 min discussion 30 min answer questions 15 min	
	Dinner on own		
Day 3 8:30 am – 5:30 pm	Panel discussion *(Lunch provided)*	2-1/2	
	Panel followup questions with staff	1	
	Panel discussion and writeup	4	
	Closeout	½	
	TOTAL HOURS	24	

Ocean Ecology and Climate Questions

1. The Bering-Aleutians Salmon International Survey (BASIS) project examines the ocean ecology and climate of the Bering Sea. Trophic interactions occur between gadids, salmonids, and clupeids in the epipelagic ecosystem of the Bering Sea. An objective of this project is to understand how trophic dynamics affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem of the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?
2. Large-scale changes in the Bering Sea ecosystem have been attributed to climate changes, such as loss of sea ice and warmer sea temperatures. Another objective of BASIS is to understand how these changing ocean conditions and climate affect distribution, abundance, growth, and condition of fishes of the epipelagic ecosystem of the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?
3. Climate and ecosystem indicators can be used to support an ecosystem approach to management. Examples of such indicators are time series of fish growth and abundance, zooplankton abundance, and episodic phytoplankton blooms. Another objective of BASIS research is to develop indicators that measure climate and ecosystem change in the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?

4. The Southeast Coastal Monitoring (SECM) project examines the ocean ecology and climate of southeast Alaska. Research cruises include multiple time series of observations of epipelagic trawling and associated biophysical measurements in an important migration corridor for juvenile salmon. Other important species competing for the same resources include gadids, clupeids, and cetaceans. Objectives of this project are to develop an understanding of the trophic dynamics and ocean conditions of the epipelagic ecosystem of southeast Alaska and to compare the Southeast ecosystem with the Gulf of Alaska and the Bering Sea. Does this project meet this objective and why? What other research could be conducted to address this objective?

5. 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. The stations provide long time series of data on salmon productivity, life history parameters, and climate. The objective of these time series is to add to our understanding of climate variability, biological productivity, and potential consequences of future climate change. Does this project meet this objective and why? What other research could be conducted to address this objective?

Conservation Biology and Genetics Questions

6. Chinook salmon hatchery programs in Southeast Alaska, a region with a limited number of relatively small wild stocks of Chinook salmon, were developed to compensate for catch limitations imposed under US-Canada salmon treaty accords even though hatcheries in other areas have been identified as one significant cause of stock declines and ESA listings. ABL conducts research on two experimental hatchery stocks of Chinook salmon at a remote field station by making comparisons with multi-generations of hatchery fish and their wild founder counterparts that are unaffected by habitat loss, introductions of other fishes, or hatchery influences. The objective of this research is to understand if, how, and why changes in hatchery stocks differ from their wild founders and to help avoid pitfalls related to hatchery-caused declines in wild stocks. Does this project meet this objective and why? What other research could be conducted to address this objective?

7. The experimental conditions for steelhead research at ABL, broadly supported by cooperative participation with partners including NOAA scientists and others from the Pacific Northwest (including in some cases funding support), are not available in other regions. Unique genetic gene banks exist in Alaska such as 70 years of freshwater isolation of an anadromous-origin population of steelhead in a lake, which may be useful in ESA recovery programs in the Pacific Northwest where, for example, ten Evolutionarily Significant Units (ESUs) of steelhead are listed under ESA. The objective is to determine if these unique genetic gene banks can be used in the ESA recovery programs. Does this project meet this objective and why? What other research could be conducted to address this objective?

8. Large scale hatchery programs for pink salmon in Prince William Sound and chum salmon in Southeast recently have been implicated in declines in wild stock productivity for these species in those regions. ABL scientists participate and take leadership roles, along with university, state, and private sector partners, in related research programs in these regions,

including retrospective modeling studies, to examine if and how these hatchery programs may be affecting productivity of wild stocks. One objective of ABL hatchery-wild stock interaction research is to better understand if hatcheries pose a threat to healthy wild stocks, including through ecosystem change. Does this project meet this objective and why? What other research could be conducted to address this objective?

9. Objectives of the salmonid portion of the fish genetics research unit at ABL, using allozyme, mtDNA, microsatellite DNA, and single nucleotide polymorphisim (SNP) techniques, are to: 1) identify discrete stocks or unique geographic groupings of salmon stocks caught in mixed stock fisheries; 2) make forensic determinations of stock origins of salmon caught in illegal fisheries; and 3) determine stock-specific migration pathways of salmon in oceanic waters. Does this project meet this objective and why? What other research could be conducted to address this objective?

10. A major management concern for NOAA Fisheries in Alaska is monitoring and documenting bycatch of prohibited species, including salmon, in large groundfish fisheries in the Gulf of Alaska and Bering Sea. The numbers and stock origins of salmon bycatch become important issues for the management and continuance of the groundfish fishery as well as the well being of salmon stocks involved. Two ABL research programs, the use of genetic stock identification (GSI) techniques and coded wire tags (CWT), are currently utilized in monitoring and documenting stock origins of salmon bycatch in these fisheries. The objective of this work is to determine the stock origin of salmon bycatch in these fisheries. Does this project meet this objective and why? What other research could be conducted to address this objective?

APPENDIX 1

STATEMENT OF WORK

Consulting Agreement between the University of Miami and Dr. Larry Marshall

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 June 10, 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

BACKGROUND MATERIAL

1. AFSC future research directions.
2. ABL Salmon program research summaries.
3. CIE Agenda and questions (which appears as Appendix A above)
4. ABL 2005 Milestones
5. ABL 1995-2005 salmon publication list.