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Report of the PSARC Salmon Subcommittee Meeting December 1-5, 1997 and the Steering Committee Meeting January 6-7, 1998

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PACIFIC STOCK ASSESSMENT REVIEW COMMITTEE

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PACIFIC SALMON

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I. STEERING COMMITTEE REPORT

The Steering Committee met January 7th 1998 at the South Coast Division, 3225 Stephenson Point Road, Nanaimo, to review the Salmon Subcommittee report. The report was accepted, with the following comments and recommendations. The Steering Committee thanked the Subcommittee chair for a useful and well organized report.

Major Steering Committee Discussion and Concerns

1. Steering Committee endorses the development of multi-stock fisheries models that combine production of all salmon species in an area. Such models can be used to examine the consequences of alternative management actions.

2. Given the Subcommittee recommendations under working paper S97-11, Steering Committee notes the need for a review of all recreational catch monitoring requirements and programs. This review should include recreational catches of both salmonids and non-salmonids. In addition, DFO should obtain and maintain electronic copies of data collected under co-management programs. For example, the recreational catch data described in S97-11 are currently maintained by the stock assessment staff only in paper copy.

S97-8 Biological Escapement Goal for Klukshu River Chinook Salmon.

Steering Committee endorsed the recommendations. However, further analytical work should be conducted to explore the potential information gains from high and low escapement levels before active probing of these levels is conducted.

S97-9 Recommended Escapements to Secondary Sockeye Nursery lakes in the Skeena River System.

Steering Committee accepts the recommendations, but notes that minimum abundance reference points are meaningful only in the context of improved production and should not be interpreted as conservation goals.

S97-10 Babine Lake Sockeye Salmon: Stock Status and Forecasts for 1998

Steering Committee accepts the 1998 forecasts and the recommendations. Steering Committee emphasizes the need for assessments of the effects of disease on wild Babine Lake sockeye. The multi-stock production/management model is very important and should be developed by Stock Assessment staff in conjunction with Operations and Habitat and Enhancement Branch staff.

S97-11: Haida Gwaii Creel Survey of Ocean Sport Fisheries in Area 1, 2E, and 2W.

Steering Committee accepts the recommendations, but expressed concern about possible duplication of effort. For additional discussion, see Major Concerns above.

Steering Committee also noted that the methodology was judged to be sound, following "well known" practices in the Strait of Georgia creel survey executed by DFO. The Steering Committee concluded that pending completion of the revisions recommended by the Subcommittee, the estimates of catch would be accepted.

S97-12 A Biological Assessment of the Coho Salmon of the Skeena River, British Columbia, and Recommendations for Fisheries in 1998.

Steering Committee endorses the recommendations and acknowledges efforts by DFO to reduce exploitation on upper Skeena coho. However, Steering Committee advises that the conservation risk to upper Skeena coho will remain high even in the absence of a Canadian fishery because of the anticipated exploitation rate in Alaska. Furthermore, if marine survival continues to be poor in 1998, then conservation concerns for coho will spread to the entire Skeena system.

II. SALMON SUBCOMMITTEE REPORT

1. Introduction

The PSARC Salmon Subcommittee met December 2-5, 1997 at the Pacific Biological Station, Nanaimo. Six Working Papers were presented to the Subcommittee. Meeting participants and reviewers of Working Papers are listed in Appendices 1 and 2, respectively.

2. General Subcommittee Discussion and Concerns

(i) The Subcommittee recommends that development of assessment frameworks for other species be initiated. The Subcommittee noted that such frameworks would be very helpful in decisions involving the allocation of assessment resources between species and sub-regions.

(ii) The Subcommittee highlights the importance of the development of production/ management models for all salmon species. These models are seen as an important tool for decision making, negotiations and generation of policy and management advice.

(iii) The Subcommittee discussed the process for reviewing forecasts for 1998. There were no forecasts for southern or Fraser stocks presented at this PSARC session. This was intentional since the final data required to make these forecasts is not available until late February. It is anticipated that a one day PSARC session will be convened in March 1998 to review Fraser, and southern coho, chinook and chum forecasts. The Subcommittee noted that for North Coast stocks forecasts had been prepared and distributed to interested parties in early December. With a few exceptions, forecasts were made using PSARC approved methods where they existed and historic management forecast methods where they did not.

(iv) The Subcommittee noted that there have been requests to produce "forecasts" or "outlooks" extending as far as four years into the future. Some of these statements of expectations were contained in the Departmental "Stock Outlook" document, which was viewed by the Subcommittee. The Subcommittee stresses that any forecasts prepared by the Stock Assessment Division should utilise methods approved by PSARC, but that the Subcommittee has not reviewed methods of long-term forecasting. The Subcommittee also expressed concerns that there are currently multiple sources of "forecasts" within the Region, which may lead to situations of conflicting stock forecasts.

3. Working Paper Summaries, Reviews And Discussion

S97-8 Biological Escapement Goal for Klukshu River Chinook Salmon. McPherson, Etherton, and Clark. **Accepted Subject to Revisions**

This paper is a revision to a previous PSARC paper (S95-7) and includes all the changes requested in the previous review. This paper analysed available information on harvests, escapements and age composition of chinook salmon returning to the Klukshu River, a tributary of the Tatshenshini River on the Alsek River System, during the years 1976-1996. The analysis deals only with the Klukshu River tributary since escapements to the rest of the Alsek system are not available. The Klukshu River escapements were combined with estimated harvests of Klukshu River chinook salmon in Canadian and U.S. fisheries based upon three alternate assumptions concerning the Klukshu component of the chinook salmon harvested in the U.S. Alsek gillnet fishery. Estimated age-specific upstream runs (escapement plus Canadian harvests) of Klukshu River chinook salmon were added to the three alternate sets of U.S. harvests to estimate annual age-specific total runs for the years 1976-1996. Analyses included regression techniques, examination of measurement error and bias, tabulation of probabilities of return by spawning stock size in a Markovian approach, and calculations of loss functions given alternate spawner-recruit parameters. Spawner recruit relationships were used to estimate a range of escapements to provide near-maximum sustained yield. A biological escapement goal range of 1,100 to 2,300 chinook salmon spawners was recommended for the Klukshu River.

Reviewers' Comments

Reviewer #1

The reviewer acknowledged that the authors had included the additional information requested by the Subcommittee after the previous submission of this paper (S95-7) and had done a good job of documenting the information used in the paper. Two additional years of higher returns have increased the optimal escapement slightly, but it is still less than any observed escapement. The reviewer agreed that alternative approaches to model stock recruit data should be explored but indicated the Markovian approach would be inconclusive using 16 years of data. The reviewer believes there are possible explanations for the stock recruitment relationship other than the density dependent mortality indicated by the authors. Explanations could include catch that was unreported because some fisheries were not examined (although there is data to refute this theory) or that there had been a simultaneous decline in survival and exploitation rates. The reviewer suggests that the escapement goal should not be changed until 2001 when it is scheduled for revaluation. The reviewer also questioned the merits of a fixed escapement versus a fixed harvest rate management approach.

Reviewer #2

The reviewer agreed that the authors have provided ample data to justify revision of the escapement goal, and that the proposed goal of 1,100 to 2,300 is in the conservative range of spawning escapements. Often when salmon stocks fail to meet escapement goals there are several contributing factors such as habitat loss and degradation, high exploitation rates, and large coefficients of variation. None of these are apparent for the Klukshu. However, least squares regression of the Ricker stock-recruit equation has a well known bias, which leads to overestimation of stock productivity and underestimation of MSY spawning escapement. The bootstrap procedure used in this paper to estimate bias addresses only a small component of that bias. It is very likely that the spawning escapement that would result in the greatest average surplus production is greater than the 900 spawners indicated, and that a sustained exploitation rate in excess of 70% to achieve this would result in local extinction of less productive stocks in the Alsek system, which the Klukshu indexes. Despite these concerns, the reviewer believes that the escapement goal of 1,100 to 2,300 should be large enough to allay concerns about biological productivity and genetic integrity.

The reviewer also made the point that most of the data presented is from a time period when, in his opinion, it is now widely accepted that there has been a shift in oceanic conditions that has been less favourable for chinook and coho salmon. There is evidence, again in the opinion of the reviewer, that another shift has occurred in the 1990's. Arguing that because returns from the four largest spawning escapements on record will be enumerated over the next five years, the reviewer recommends that the escapement goal should be re-evaluated in 2002.

Subcommittee Discussion

The Subcommittee accepted the Working Paper with minor revisions but could not recommend acceptance of the revised escapement goal. The Subcommittee did acknowledge that the technical basis of the present escapement goal of 4,700 Klukshu chinook was weak, and that re-evaluation was appropriate.

There was extensive discussion about technical details of the assessments. The Subcommittee recognised that the authors had addressed comments from the Subcommittee on a previous version of this paper (Working Paper S95-7), that the assessment was based on good escapement counts to the Klukshu River and age composition data, that the authors' recommended escapement goal was now a range and that the mid-point of that range was larger than their previous recommendation.

The Subcommittee had concerns about the three assessment approaches used:

(a) All three of the assessments presented were based on 16 years of brood production data. However, the available data is clustered within a limited range (1,064 to 3,104 spawners), and escapement exceeded the present goal in only one year (1995 return) and returns from that year are yet to be observed.

(b) The Ricker stock-recruitment analysis yielded a sustainable exploitation rate of 75% for this spring chinook stock. An exploitation rate of that value would be considered extremely high for southern fall chinook stocks, which are presumed to be more productive. The authors did not comment on this result, and give no biological basis for it. Further, the Subcommittee could not agree with the assumption that this stock was not historically over-exploited since over-exploitation may have occurred many years ago and the stock has not successfully rebuilt.

(c) The Markovian assessment was based on only 16 data points, which is a very limited sample upon which to infer a non-parametric distribution for production from the observed escapements.

(d) The Loss function assessment is based on the same limited range of data and Ricker function.

The Subcommittee was also concerned that the data had been collected during a period of poor marine survival. Longer-term catch records from the Dry Bay net fishery (Table 17 in the Working Paper) imply periods of higher and lower production and, as one reviewer noted, the present data does not show evidence of increased production when the terminal harvest rates were substantially reduced. The authors' assessment implies that this is due to density dependence in spawning. However, neither juvenile production data nor marine survival rates are available to test these alternative explanations.

The Subcommittee was concerned that the current management system would be unable to maintain tributary specific escapements to the Alsek system (even if there were tributary-specific abundance forecasts and some stock identification ability).

The time series of Klukshu chinook exploitation rates looks more like the result of a fixed exploitation rate approach rather than a fixed escapement system. There is little variation in the annual exploitation rate. Prior to the last few years the Klukshu stock abundance has been relatively constant. Therefore, escapements had remained within a relatively narrow range, which failed to elucidate the existence and nature of density-dependent limits to freshwater production. The 1993 to 1996 abundance increased and the fixed exploitation approach resulted in higher escapements.

The Subcommittee wishes to note that examination of this paper has been particularly informative concerning what is required to technically assess a chinook escapement goal. The data collated for this tributary system are very good in comparison to those available for the vast majority of other chinook populations.

Concerning revision of the spawning escapement goal, the Subcommittee does not support revision of the current escapement goal to a fixed "optimal" level, in the sense of an MSY escapement calculated with a Ricker function. Instead the Subcommittee recommends the development of an assessment/management process that establishes and achieves, annually, a minimum escapement floor (consistent with the lower end of the escapement range presented in this paper) for Klukshu chinook. Within the management process, harvest rates should be set to share returns above the floor between catch and escapement. Increased knowledge of the dynamics of the Klukshu chinook can best be generated if managers actively probe low and high escapements. The assessment/ management process must also recognise the mixed-stock nature of these fisheries and protect the diversity and production from other spawning populations.

Given the importance of observing future returns, the Subcommittee supports the assessment programs recommended in the Working Paper.

Subcommittee Recommendations

(a) The Subcommittee acknowledges that the current escapement goal has a weak technical basis. However, given the deficiencies with the current data and the potential information gains to be had by observing returns from recent escapements, the Subcommittee recommends that re-evaluation of the escapement goal not be conducted until returns in 2001 are analysed.

(b) In the interim, the Subcommittee recommends the development of an assessment/ management process that results in a management plan that actively probes high and low escapement levels, while assuring a minimum escapement target is met.

S97-9 Recommended escapements to secondary sockeye nursery lakes in the Skeena River system. Shortreed, Hume, and Wood

Accepted Subject to Revisions

The main objectives of this report were to present:

1. past and present abundance and trends of adult sockeye stocks;
2. current status of juvenile sockeye stocks in the 10 largest secondary (non-Babine) Skeena nursery lakes;
3. current productivity and juvenile sockeye rearing capacity of the lakes and limiting factors;
4. recommended minimum and optimum escapements to the lakes; and,
5. suggested enhancement techniques for sockeye stocks in the study lakes.

To predict rearing capacity of and optimum escapements to the study lakes, the authors used a rearing capacity model (the PR model) which has been described in detail elsewhere (Hume et al. 1996; Shortreed et al. 1997). Data suitable for applying this model were already available from four Skeena lakes (Alastair, Bear, Swan, and Morice) (Stockner and Shortreed 1979). In 1994 and 1995 the authors collected similar data from six additional lakes (Johanson, Kitsumkalum, Kitwanga, Lakelse, Morrison, and Sustut). All 10 of the secondary lakes examined provided suitable juvenile sockeye rearing habitat but they varied in productivity. All lakes are oligotrophic except for Kitwanga Lake, which is mesotrophic. Phosphorous was the major nutrient limiting productivity. The hypolimnion of Kitwanga Lake may be anoxic in the summer months and thus limit production. Fall fry sizes(4-6 g) in Bear, Lakelse and Morrison lakes were similar to those found in other B.C. lakes, while size in the other lakes was smaller than average. Morice Lake had the smallest fall size measured (0.8g). PR model predictions were modified to account for midwater competitors, two juvenile sockeye year classes, and available spawning habitat.

The results indicate that for each study lake, except Johanson Lake, maximum reported escapement over the last 10 years was less than our estimate of optimum escapement. In aggregate, maximum reported escapement over the last 10 years was less than one-third of the optimum. The authors recommended that, optimum or target escapement to Morice Lake should be established at 110,000 sockeye and to the other secondary lakes at 200,000 sockeye. A second recommendation was that minimum (limit reference) escapement points should be set at an achievable level that guarantees stock conservation. We recommend that the mean escapement over the last 10 years be used as a future minimum level. Thus, the minimum sockeye escapement "index" (as measured by current enumeration procedures) should be 15,000 for Morice Lake and 36,000 for the aggregate of other (non-Babine, non-Morice) Skeena lakes.

Reviewers' Comments

Reviewer #1

The reviewer indicated the paper was well organised and written and should be accepted with minor revisions. A series of specific concerns about the methods employed were outlined in the review. A point was made regarding the need to access information outside of the paper to evaluate some of the basic tenants of the paper. The reviewer suggests it would have been beneficial to have an explanation of how the model used in the paper, is an improvement over using just lake surface area as an indication of productive potential. The reviewer stressed the method used by the authors was particularly sensitive to the assumption that a 4.5 g smolt is the minimum size required to assure good smolt-to-adult survival. The model estimates of the potential smolt production and the number of spawners required are particularly sensitive to this assumption. Also, how realistic is the assumption that the non-sockeye biomass is independent of changing sockeye abundance? The reviewer also cautioned that potential enhancement opportunities associated with specific lakes should not be considered as recommended approaches without considerable further documentation and assessment. The reviewer did not support setting explicit escapement targets, but did indicate that the available information does identify considerable scope to increase production from non-Babine sockeye in the Skeena system.

Reviewer #2

The second reviewer felt the paper was a credible collection and review of the limnological and juvenile sockeye data that puts the status of Skeena (non-Babine) juvenile sockeye production in perspective relative to other sockeye producing lakes. Of particular concern however, was the use of adult escapement data that is potentially unreliable. It was noted that the regression in Working Paper Figure 5a was highly influenced by a few large data points and the reviewer also did some additional analysis to demonstrate the confidence limits are much wider than indicated because uncertainty in the accuracy of the juvenile sockeye biomass and total lake carbon production estimates. Additional comments were provided on the summary and recommendations including a specific concern about stating an escapement target that has a weak foundation because of the tenuous connection to the existing escapement record, and because future escapements cannot be easily measured. Target densities of juvenile sockeye were suggested as an alternative to escapement targets.

Subcommittee Discussion

The Working Paper was accepted subject to minor revisions.

The Subcommittee acknowledges that sockeye production from Skeena non-Babine lakes are currently below potential. The Subcommittee notes the Primary Production Rate (PR) model developed using Alaskan sockeye parameters may underestimate optimal escapement. However, the Skeena data still strongly supports the conclusion that lake

production potential is under-utilised. In most lakes, it is likely higher production could be achieved with increased escapements although in some cases spawning ground capacity could be the current limiting factor. Clarification and tabulation of the factors that limit production in each lake is required to clarify potential management options for increasing production (if this is deemed desirable). Potential production increases in each lake should be portrayed in units of juvenile or adult indices with ranges that encompass the uncertainty in the analysis.

Revisions should include more detail on the effect of applying factors derived from other studies to correct periphyton photosynthetic rates, and on the different acoustic methods used to estimate sockeye fry abundance.

The Subcommittee noted that reduced fisheries (as a consequence of expected low Babine Lake sockeye returns) will result in lower exploitation rates on the non-Babine stocks in 1998 and 1999 which should provide an opportunity to observe the effects of increasing escapements on subsequent smolt production.

The development of a Skeena watershed multi-lake production/management model that includes Babine Lake was discussed. A production/management model would be useful to explore the effect of alternative policy options on sockeye production. The Subcommittee agreed that not all factors needed as input into a production model are presently understood. Initially, modelling could help identify important information requirements.

Based on the abundance of juvenile sockeye, the Subcommittee agreed that non-Babine sockeye do not appear to be at levels that pose a conservation risk. Although current escapements appear to be low, recent trends are stable or increasing. Concerns were expressed that higher recent abundances may be a transient effect of a recent regime shift. However, the use of target spawning escapement reference points are not supported because of the very high uncertainty in estimates of sockeye spawning escapement.

Subcommittee Recommendations

1. The Subcommittee recommends that current non-Babine abundance be used as a minimum abundance reference point, and that assessment tools be developed to provide lake-specific indices of juvenile or adult abundance, which could be used to monitor trends in abundance.

2. The Subcommittee notes that increases in sockeye production from non-Babine lakes are possible, and that exploration of approaches to utilise that potential production could be explored with the development of a multi-lake production/management model.

S97-10 Babine Lake sockeye salmon: Stock status and forecasts for 1998. Wood, Rutherford, and Bailey. **Accepted Subject to Revisions**

This Working Paper provides a comprehensive assessment of sockeye production from the Babine system in that it brings together recently compiled information on trends in spawning escapements by run timing group, fry recruitment, smolt production, adult returns, harvest rate, and surplus production from Babine Lake Development Project (BLDP) facilities. Prespawning mortality at the BLDP sites in 1994 and 1995 caused by parasitic infections has significantly reduced fry recruitment and smolt production for these brood years. Consequently, adult returns are expected to be low until the year 2001. Major conclusions from the report are as follows:

1. Escapements to enhanced sites in Babine Lake continue to exceed spawning requirements such that on average, over a third of the Babine fence count is BLDP fish that are surplus to its spawning requirements. In contrast, escapements to the unenhanced Morrison River continue to be low relative to pre-enhancement levels. Recent escapements to the unenhanced early-timing and late-timing sub-populations are not statistically different from pre-enhancement levels.

2. Smolt production from the main basin of Babine Lake has increased dramatically as a result of enhancement. BLDP fry now account for about 90% of fry recruitment to the main basin. Even so, all the available data suggest that fry recruitment is still below levels required to yield maximum smolt biomass and maximum adult returns.

3. Smolt production from Nilkitkwa Lake and the north arm of Babine Lake, as inferred from enumeration of early-migrant smolts, has declined to less than a quarter of the level observed before exploitation of enhanced returns began in 1970. However, data for this system are less reliable than for Babine Lake, and further investigation is warranted.

4. Increased smolt production from the Babine-Nilkitkwa system has led to dramatic increases in adult returns. However, the relationship between adult returns and smolt abundance is non-linear, presumably reflecting competition among smolts. Recent returns have been higher than expected based on the density-dependent model, suggesting that favourable conditions have led to relaxed density-dependence after emigration. Despite density-dependence, increased adult production could be expected from increased smolt production, especially if current conditions continue.

5. The outlook for 1998-2000: Near record low smolt production and age 4 returns from the 1993 brood, together with near record low smolt production and jack returns from the 1994 brood, provide clear signals that adult returns in 1998 will be much lower than in recent years. Accordingly, the 5 year mean forecast used in previous years (because of its superior performance under typical conditions) was deemed inappropriate for forecasting (atypical) returns in 1998. Two alternative models that utilise information about smolt production or sibling age class strength, produced

almost identical forecasts for 1998 (Table 1). Of these, the smolt forecast is recommended because of its slightly superior performance in retrospective analyses using the RMSE criterion. The smolt model gives a 75% chance that adult returns to the Skeena River will exceed 820 thousand sockeye, and a 50% chance that returns will exceed 1.42 million sockeye. Because smolt production has continued to decline to 1997, forecasts for 1999 and 2000 based on the smolt model will be even lower than for 1998. Fry recruitment to Babine Lake returned to above-average levels last spring, but another outbreak of the Ich parasite caused pre-spawning mortality in 1997, so that fry recruitment is expected to be 20 - 30% below target levels in next spring. Until the sporadic problems arising from parasite infection can be addressed, the prognosis for future fry recruitment remains uncertain.

Reviewers' Comments

Reviewer #1

The first reviewer recommended acceptance with minor revisions and reported the paper was an excellent, comprehensive assessment although a few sections required clarification. The reviewer noted the lack of recommendations and suggested the section on estimating fry recruitment be rewritten and expanded for clarification. Additional minor concerns discussed in detail include: fry recruitment assumptions and definitions, environmental variables in 1998 forecasting models and low fry to smolt survival rates in the same brood years affected by parasitic infections.

Reviewer #2

The second reviewer recommended acceptance with minor revisions and reported the paper was well written and fully documented and appreciated having all the relevant data clearly tabled and appended. The reviewer felt the conclusion that increased adult production to the Babine system would be expected from increased smolt production was justified by the data, but noted the lack of a specific target escapement recommendation in the paper. The authors conclusions 1 to 4 are supported but the reviewer cautions not to lose sight of the assumptions and data constraints. The forecasts for 1998 and 1999 are also accepted.

Subcommittee Discussion

The paper was accepted with minor revisions.

The Subcommittee noted that the data presented in the Working Paper indicate the juvenile rearing capacity of Babine Lake is under-utilised.

The Subcommittee was concerned about the effects of increasing exploitation rates on non-enhanced Babine Lake sockeye. The recent decade appears to have been a period of better than average marine survivals. Total exploitation of Skeena River. sockeye has risen to 70% of the total return. Increases are in part the result of increased 'selective'

fishery harvests in ocean and river fisheries. The Subcommittee noted that selective fisheries were generally only species-selective. Selective fisheries may harvest both enhanced and wild sockeye of Babine and non-Babine origin.

Further increasing sockeye production from Babine Lake could impact non-Babine Lake sockeye and wild Babine Lake sockeye if mixed stock (within or among species) fishery exploitation rates are increased. The enhanced component from the BLDP is harvested at the same time as the wild mid-timing run to the Morrison River (tributary of Babine Lake) and the stock is particularly at risk. The abundance of the Morrison River component has been low but stable in recent years.

The Subcommittee did not identify any immediate conservation issues, the Subcommittee was concerned about a range of issues affecting Babine Lake sockeye. There has been a significant drop in smolt production in recent years linked to repeated serious outbreaks of disease ('ich') at BLDP channels that caused massive prespawning mortality in 1994 and 1995 when water temperatures were high. In addition, fry to smolt survival appears to have declined in recent years. In 1995 there were reports of wild spawners with 'ich' but few details are known. The Subcommittee was concerned that although 1997 river temperatures were normal, there were again pre-spawning mortalities in the BLDP channels from 'ich' and perhaps a second pathogen. Finally, there was concern over the decreasing trend in the abundance of early migrating wild smolts from Babine Lake, as this represents the smolt production from the largest wild component, the Babine River.

The Subcommittee was concerned that the ecosystem effects of enhancing sockeye production have not been assessed, and at present it was not possible to assess how/if Babine Lake has changed in response to increased sockeye production. Limnological data indicate that primary productivity in the lake has risen by about 30% since the 1970s.

The Subcommittee noted that the heavy emphasis on Skeena sockeye production from Babine Lake (approximately 90%) created both biological and policy complexities because of concerns for wild populations within and outside of Babine Lake in the Skeena watershed. The development of a multi-stock production model as a focus for policy discussion on Skeena watershed management options was seen as a potentially important tool for decision making, negotiations, generation of policy and management advice.

The Subcommittee noted that the authors had selected a different forecasting model for Skeena sockeye in 1998. In 1996 PSARC evaluated alternative models to forecast Skeena sockeye returns. A retrospective analysis of historical returns indicated that the model with the best performance was the simple average of the last 5 years of returns. A model based on average returns performed best when the independent variables that are used to forecast abundance (jack returns, 4 year old abundance, smolt and fry abundance) are near mean levels. In 1997, all of these indicators fell to very low levels suggesting that the preferred model would not likely be risk averse. Of the alternative models, forecasts developed from brood year smolt abundance performed the best. All

indicators suggest that Skeena sockeye returns in 1998 are expected to be far below the mean. The Subcommittee accepts these Skeena sockeye forecasts.

Subcommittee Recommendations

1. The Subcommittee accepts the 1998 Skeena sockeye forecast of (50% 1,420,000; 75% 820,000; 90% 530,000) based on observed smolt production (Table 1). The Subcommittee notes that because of further declines in smolt production in 1997, forecasts for 1999 and 2000 based on smolt production will be lower than the forecast for 1998.

2. The Subcommittee recommends that additional study of the effects of disease on wild and enhanced Babine Lake sockeye be conducted to determine the extent of impacts on wild Babine sockeye.

3. Because of the complexities involved in optimising overall sockeye production while minimising risk to wild sockeye and other species, the Subcommittee recommends that a multi-stock production/management model be developed to examine production, enhancement, and harvesting scenarios that will be risk averse and offer optimum benefits.

S97-11 Haida Gwaii Creel Survey of Ocean Sport Fisheries in Area 1, 2E, and 2W 1995-1996. Searing and Bocking. **Accepted Subject to Revisions**

This paper was submitted to PSARC by the Haida Fisheries Program through a report prepared in May of 1997 by LGL Limited (Sidney, B.C.). The paper describes systematic surveys of the recreational fisheries in Statistical Area 1, 2E and 2W in 1995 and 1996 and includes extensive appendices that include: monthly data reports, boat count survey timing, DFO estimates of catch and effort, and the methods and equations used in the analysis of catch and effort. The study area for both 1995 and 1996 included the north coast of Graham Island (a portion of Area 1); and Skidegate Inlet, Skidegate Channel and Cartwright Sound (a portion of Areas 2E and 2W). The Haida Fisheries Program creel survey is comprised of two independent surveys: angler interviews and boat survey counts. Angler interviews provide data on sport fishing catch per unit effort and daily activity patterns. Boat count surveys provide estimates of the total sport fishing effort in the study area at the time of the boat survey. These data are combined to provide monthly estimates of the total sport fishing effort and total catch of salmon and select groundfish species. The study was concentrated between May and September to coincide with the large summer ocean fisheries that concentrate on chinook and coho salmon and halibut. There were a number of improvements to the 1996 program over 1995 and the authors anticipate that the program will continue to be refined. The report includes details on boat counts, angler interviews, angler characteristics, catch statistics and biological sampling. A summary, with specific recommendations for improving the surveys is included. The Haida survey provides estimates of chinook and coho caught and released, adipose mark rates and size and age of chinook salmon.

Reviewers' Comments

Reviewer #1

The reviewer recommended the paper be accepted with minor revisions as an understandable and credible report. The reviewer agreed with the recommendations in the paper to improve the surveys and provided a number of minor corrections and items for clarification.

Reviewer #2

The reviewer noted that the approach described in the report is similar to the one that has been used in the Strait of Georgia Creel Survey since 1980. That approach is both well documented and acknowledged to be an acceptable method for determining ocean sport catch and effort. The reviewer did call attention to some important differences in the two surveys. Surveys of fishing effort in Haida Gwaii were made from boats rather than aircraft which introduces complications into the expansion to a total effort estimate. A second concern was on-water CPUE sampling in some areas as this sampling method is known to underestimate CPUE as the trip is incomplete. A remedy used in other areas was provided. The reviewer also suggested other approaches to be considered to improve the methods used in these surveys.

Subcommittee Discussion

The Subcommittee recommended acceptance of the Working Paper with minor revisions, but limits the inferences from the paper to a description of the methods and results.

The Subcommittee was pleased to receive this description of the creel survey programs being developed by the Haida Gwaii fisheries program. It should be noted that the PSARC Chairman received a detailed report of the surveys from LGL Ltd.(Sidney, B.C.) including comprehensive appendices. Copies of the complete report were provided to the Subcommittee chair and each reviewer, but Subcommittee members did not receive the appendices.

The paper described an evolving program of sport fishery monitoring in six sub-areas of the Queen Charlotte Islands, between June 1 and September 15: Skidegate Inlet, Skidegate Channel, Cartwright Sound, McIntyre Bay, Naden Habour/Virago Sound, and Langara Island. Survey methods within these areas changed between years as these programs developed. For accurate estimation of the total catch by species, the methods require a daily effort profile (proportion of the total effort in a day that was fishing in a specific hour), an instantaneous count of fishing effort (the number of boats fishing at a specific time in the day), and the estimated catch per boat trip (by species, and average over interviews). The survey also collected information on the number of rods per boat and the numbers of chinook and coho salmon released during a trip. Effort profiles are determined from interviews with fishers and are determined for each area and month.

The Subcommittee reviewed each survey area by year to ensure an understanding of the program and the quality of survey data.

Skidegate Inlet and Channel (sampling areas 2A and 2B):
The fishery in this area was described as small relative to other locations. The authors acknowledged two concerns in this area. There is an acknowledged catch of chinook previous to the survey beginning, and catch estimates during the survey period likely over-estimate the actual catch. The latter concern was addressed by using a roving interview survey in 1997.

Cartwright Sound (sampling area 2C):
Results of the 1995 survey were likely inaccurate due to the extended time periods during effort counts and limited interviews. However, the 1996 survey provided improved accuracy as aircraft were used for effort counts and the number of interviews were substantially increased.

McIntyre Bay (sampling area 1A):
Surveys in this area met sampling requirements and were considered accurate. Boat counts were collected over short periods (approx. 2 hr.), interviews were of completed trips and of adequate number, and the estimated effort profile was representative of the fishing patterns out of Masset.

Naden Habour/Virago Sound (sampling area 1B):
Surveys in this area also met sampling requirements and are considered accurate. There were numerous interviews, boats fishing tend to be clustered and easily counted, and effort profiles were well defined. A concern identified was that the interviews occur at one of three lodges in the area and may not be representative of the other lodges.

Langara Island (sampling area 1C):
The accuracy of the catch data for this area is uncertain. Data on catch per trip is good but effort counts were conducted from a boat and require an extended time period to survey around the Island. Further, the time of day for effort surveys was not consistent. The combined effect of these problems is a potential for substantial under-estimation of monthly effort. The authors noted that consideration was being given to sub-dividing this area to reduce these potential problems.

Given the evolving nature of the survey methods and the need to reanalyse some aspects of the data, the Subcommittee could not endorse the catch estimates, as presented. However, the Working Paper is an important step in establishing sport catch estimation methods for QCI and the Haida Fisheries Committee is encouraged to continue to operate and refine the program. The Subcommittee encourages the authors to estimate confidence bounds on their estimates in order to represent the uncertainty in the results.

Subcommittee Recommendations

1. The Subcommittee recommends acceptance of the creel survey methods, while acknowledging improvements will continue to be made. The specific catch estimates could not be endorsed as presented because reanalyses are required.

2. The Subcommittee encourages DFO to complete a written description of their sport survey methods for the Queen Charlotte Islands and to submit this for the spring, 1998 PSARC meetings.

S97-12 A biological assessment of the Coho salmon of the Skeena River, British Columbia, and recommendations for fisheries in 1998. Holtby and Finnegan. **Accepted Subject to Revisions**

This assessment covers coho salmon of the Skeena River. Assessing the more than 100 coho populations of the river is a formidable task. We rely on two indices of aggregate abundance, two hatchery indicator populations, two wild indicators, one associated with a hatchery and the other not actually in the Skeena but close by, and surveys of juvenile densities that were made in 45 to 52 streams throughout the Skeena watershed.

Conservation concerns for coho populations in the upper Skeena (above Terrace) were first raised by PSARC in 1986 (Stocker 1987). Coho populations throughout most of the interior zone continue to be severely depressed and heavily exploited, a combination which makes them extremely vulnerable to episodes of poor marine survival. The near-zero ocean survival that appears to have occurred in the 1996 smolt year (1997 returns) has produced a situation in the interior, particularly the upper Bulkley, the Babine and the high interior, that can only be described as perilous. Coastal populations appear to be more productive and have been stable despite high exploitation rates, probably because of a prolonged period of good marine survival. The status of Skeena coho epitomises the problems faced in attempting to manage the coho salmon of a large and varied geographic region when nearly all of the exploitation is exerted in mixed-stock ocean fisheries. Although coastal populations may be able to withstand the prevalent exploitation rates even during episodes of relatively poor marine survival, the interior populations clearly cannot.

The marine survival rate for Lachmach is predicted to be 9.0% (95%CI: 4.5%–17.7%). For a variety of reasons, the most important being that survival was over-predicted in 1996, we recommend that the forecast for 1998 be treated with caution. Three approaches are outlined to provide recommended exploitation rate targets for 1998 fisheries. The approaches yield target exploitation rates that range from 6% to 87% for coastal populations and 0% to 88% for interior populations. The lowest recommended harvest rate came from an approach designed to protect the genetic viability of populations. The indicator populations used to generate these recommended exploitation rates are among the most productive of some 45 streams where fry

densities have been routinely surveyed, and the status of the most interior systems was judged to be considerably worse than the interior indicator (Toboggan Creek).

Consequently the authors recommend there be no fisheries mortality on Skeena coho in 1998 and caution that this recommendation is likely to continue to at least 2001. They further recommend the development of additional sites in the Skeena and particularly in the interior, where wild smolt production can be measured and their survival determined, as well as the development of more effective forecasting tools for Skeena coho.

Reviewers' Comments

Reviewer # 1

The reviewer recommended acceptance with minor revisions and indicated the paper was a logical, thorough compilation of the available data on Skeena coho. The reviewer requested more detail of the components of CWT exploitation analysis, further explanation of the 1997 catch by gear and further discussion on the effects on catch of management actions versus low abundance. The need to clarify the effects of adjustments to the test fishery index were identified. The reviewer recommended clear statements concerning relative expected returns to indicator stocks depending on management actions (with the uncertainty portrayed, for fishery managers to select their own risk levels). The need for wild stock production information and the need to continue juvenile surveys was supported. The reviewer stated that the authors recommendations for no fisheries mortality in 1998 is supported by the data, however it was noted that even if net fisheries proceed as in 1997 there would be little net mortality (as long as the estimated low net exploitation rates are accurate).

Reviewer # 2

The reviewer found the paper to be a well written and comprehensive analysis of the stock assessment data available for Skeena River coho salmon. The authors have produced a credible assessment of the status of this stock aggregate and the reviewer believes that the available data and the authors analyses support the Working Paper's recommendations and conclusions. The reviewer noted two serious reservations concerning the data available for analysis and the assessment structure. The first concern is the reliance on a number of critical assumptions regarding the applicability of the data and the uncertainty this fosters. The reviewer recommends the paper clarify what is known with certainty, what conclusions can be drawn from what is known, and that the results of other analyses while less certain, largely support these conclusions. Secondly, the reviewers impression is the Skeena coho assessments appear to be an opportunistic utilisation of available information rather than the result of an explicit detailed assessment framework which the reviewer states is required. A series of specific detail questions and suggestions were also provided.

Subcommittee Discussion

The paper was accepted with minor revisions.

The Subcommittee acknowledged there are conservation concerns for Skeena coho throughout the watershed in 1998 because off widespread low escapements in 1997 that resulted from low ocean survivals. The Subcommittee stressed the importance of avoiding back to back years of extremely low escapement that would significantly lengthen any rebuilding program.

There was consensus among the Subcommittee with respect to the serious conservation concerns for the upper Skeena area stocks (Bear-Sustut, Babine and Upper Bulkley subareas indicated on Figure 1). The Subcommittee is particularly concerned that spawning escapements have been in decline since the 1960's (Figure 2, Babine Fence escapement index) and virtually all measures of escapement in 1997 indicate a major reduction from the recent already very low spawner levels. Estimates of juvenile coho densities (Figure 1) for the upper Skeena area stocks indicate conservation concerns for coho based on juvenile densities derived from escapements to 1995 which were at levels much higher than the 1997 levels. The Subcommittee also acknowledged that the long term progressive decline in upper Skeena area escapements as indicated by the Babine Fence counts and supported by overall escapement trends, indicated that exploitation rates for these stocks has been too high for an extended period.

The Subcommittee accepted that juvenile density data up to 1996 (1995 brood year) indicated that lower and middle coho stocks of the Skeena were not conservation concems, however the 1997 escapements to most of these areas are estimated to be a well below recent escapement levels, because of the widespread low survivals for coho that returned in 1997. Juvenile coho densities from the 1997 escapements are expected to indicate severe conservation problems in many areas of the lower and middle Skeena watershed.

The only coho forecast is from the coastal (Lachmach) indicator sibling forecast that predicts a smolt survival of 0.090, which is the average survival, but the range of uncertainty around this estimate is high (95% CI 0.045 to 0.177). Further, the 1997 Lachmach forecast overestimated survivals after a series of years of good predictions and the Skeena indicator stock smolt survivals were the lowest on record in 1997 with the upper Skeena indicators showing a much greater decline (86% for Toboggan compared to 1989 to 1996 average, and 79% for Babine from the 1994-1996 average) than Lachmach (45% decline from 1989 to 1996 average). The Subcommittee cautions that the reasons for the poor ocean survival of coho returning in 1997 are unknown and may recur in 1998.

There was a detailed discussion regarding 1998 exploitation rate targets for the upper Skeena area coho stocks. Three approaches to estimate target exploitation rate were presented in the paper, however the results were highly divergent and uncertain. The

Subcommittee could not recommend a specific approach or a specific target exploitation rate.

The Subcommittee noted that the large majority of the 1997 exploitation occurred in Alaskan fisheries and to achieve significant reductions in exploitation, Alaskan participation will be required. Exploitation rates in Canadian troll fisheries have declined significantly in recent years and Canadian net fisheries exploitation dropped to a very low level in 1997 based on CWT recoveries. Further contributions from Canadian fisheries above 1997 levels would at best result in modest increases in escapement since Canadian exploitation rates are already reduced to low levels. It was noted however that Canadian seine fishery exploitation based on CWT recoveries is an underestimate since seine fisheries were non-retention for coho, and release mortalities are not included in the exploitation rate estimations for these or any other fisheries. These non catch mortalities need to be minimized in the fisheries and accounted for in the analysis.

The Subcommittee noted that a precautionary approach is in part necessitated by the lack of data, in particular a wild interior indicator stock. The juvenile synoptic surveys of the Skeena have been a key tool in evaluating subarea specific coho status and should be continued. The current low abundance creates an even greater need for this assessment information.

Subcommittee Recommendations

1. Given the continuing conservation concerns for upper Skeena area coho, the alarming further decline in abundance in 1997, and uncertainty in survival rates for coho returning in 1998, the Subcommittee cautions that any exploitation of upper Skeena area coho (Bear-Sustut, Babine and upper Bulkley subareas) poses a high risk to the viability of coho populations in this area.

2. Although conservation problems for lower and middle area Skeena coho were not indicated to 1996, because of the precipitous decline in abundance in 1997 and uncertainty in survival rates for coho returning in 1998, the Subcommittee recommends a more conservative approach to the harvest of these coho stocks.

Table 1 Skeena sockeye run size forecasts for 1998

	Probability Reference Points		
Model	0.50	0.75	0.90
5-year Mean	4,350,000	3,350,000	2,500,000
Smolt	**1,420,000**	**820,000**	**530,000**
Sibling	1,220,000	820,000	600,000

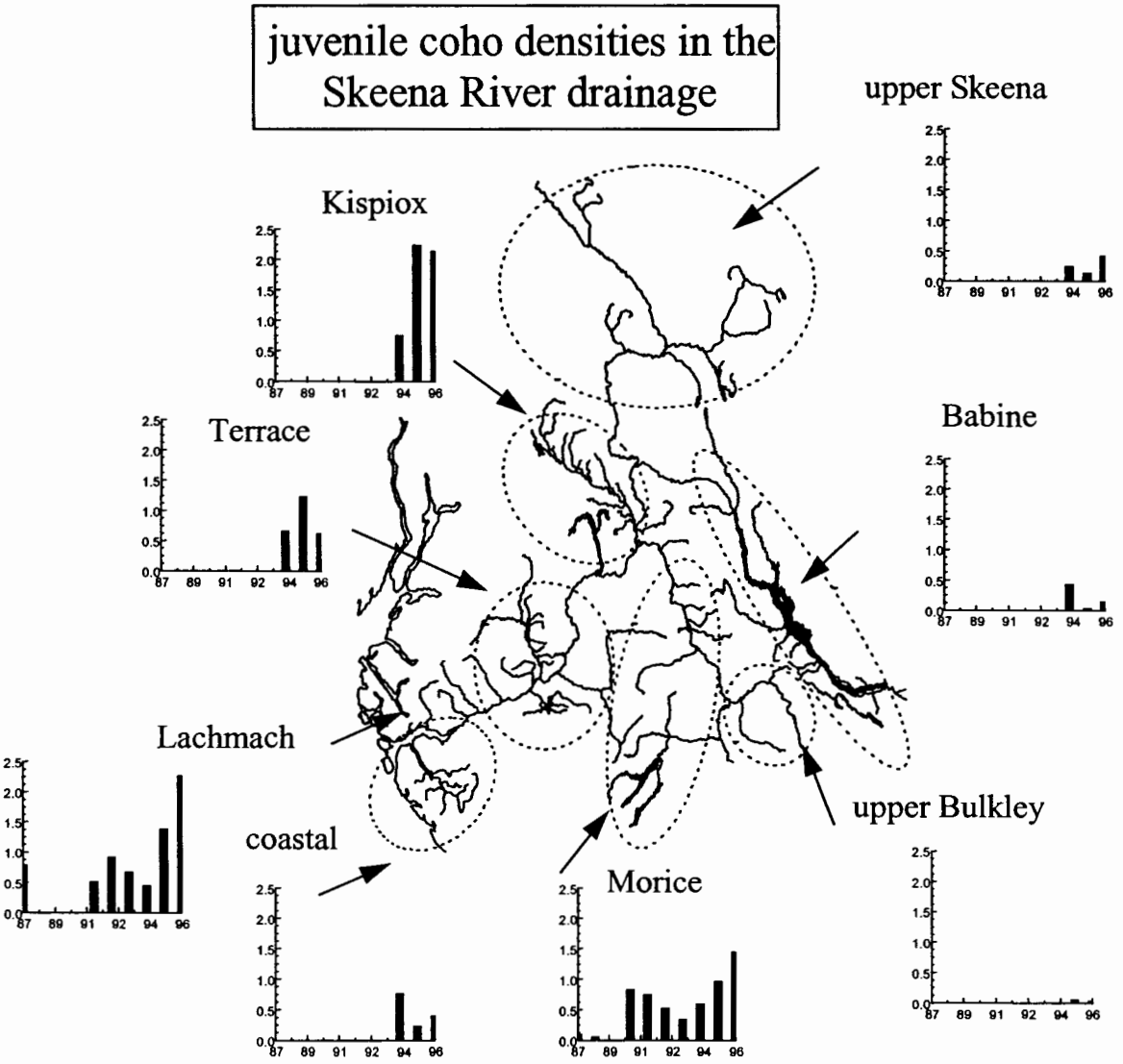

Fig. 1. Coho densities (number per square meter) over time are shown for the regions of the Skeena watershed indicated by the dotted lines. The coastal zone includes the Lachmach River, which is located at the head of Work Channel. All of the graphs are drawn to the same vertical scale to emphasise the differences in density between regions.

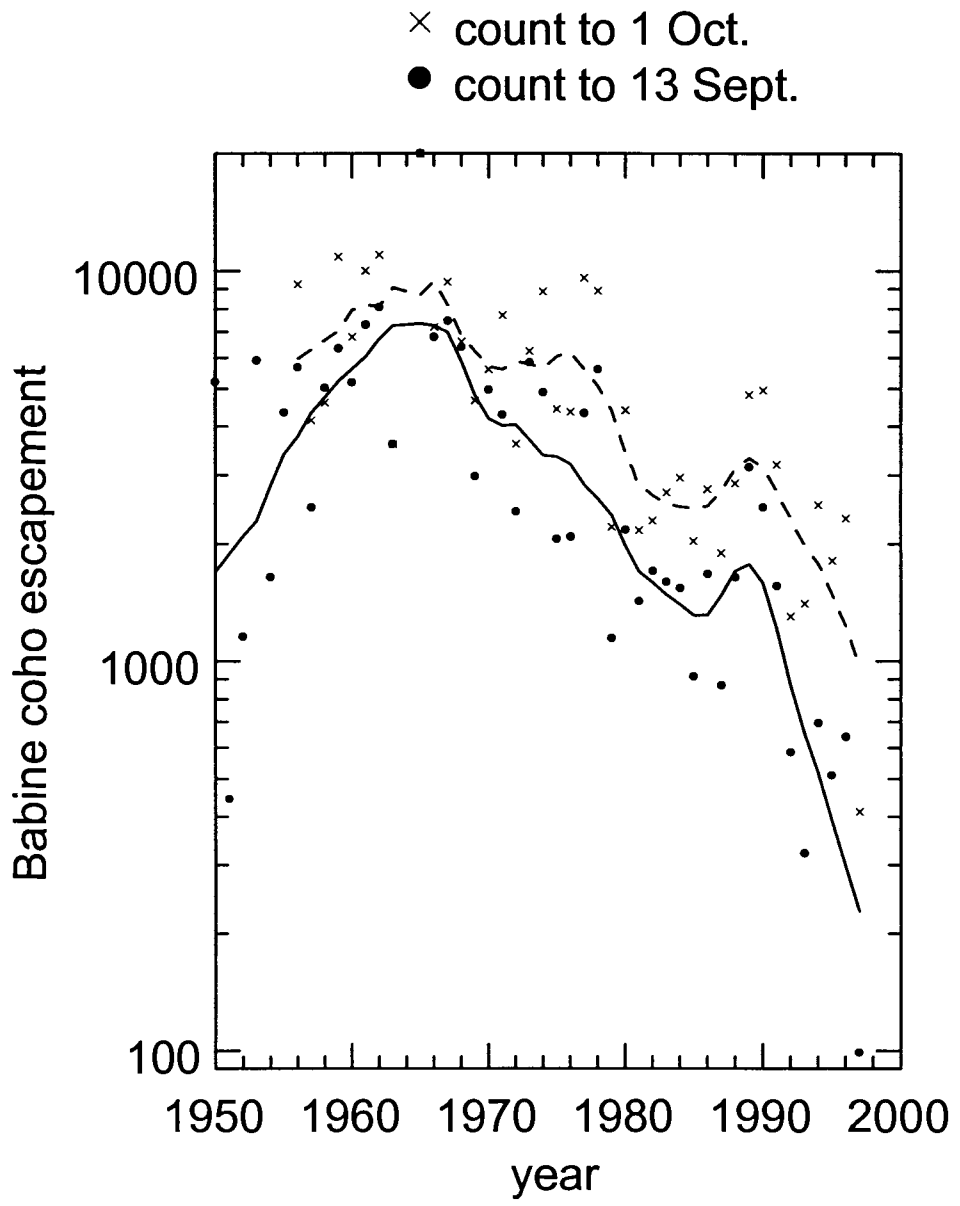

Fig. 2. Babine fence coho counts to the two index dates. The lines shown are LOWESS smoothes.

4. APPENDIX 1 Participants at the Dec. 2-5, 1997 meeting of the Salmon PSARC Subcommittee.

Subcommittee Chair:	Dave Peacock
PSARC Chair:	Max Stocker
Head Stock Assessment:	Laura Richards

Subcommittee Members:

Sandy Argue	Don Anderson
Don Bailey	Mike Bradford
Al Cass	Brent Hargreaves
Blair Holtby	Kim. Hyatt
Jim Irvine	Ron Kadowaki
Skip McKinnell	Dave Meerburg
Brian Riddell	Melanie Sullivan
Art Tautz	Chris Wood

Authors/Reviewers:

Dave Blackburn	Peter Etherton
Pat Fairweather	Barry Finnegan
Jeremy Hume	Scott McPherson
Dennis Rutherford	Neil Schubert
Gary Searing	Tom Shardlow
Ken Shortreed	

Observers:

Richard Bailey	Steve Baille
Susan Bates	Cole Shirvell
Kent Simpson	Barb Snyder
Dan Ware	

5. APPENDIX 2 Reviewers of Working Papers

Working Paper	Reviewer #1	Reviewer #2
S97-8	Al Cass	Robert Kope (NMFS, Seattle)
S97-9	Kim Hyatt	Skip McKinnell
S97-10	Dave Blackburn (Nanaimo)	Steve Cox-Rogers
S97-11	Brian Spilsted	Tom Shardlow
S97-12	Dave Meerburg	Neil Schubert
S97-13	Brent Hargreaves	Ian Perry