Detailed Notes from PATH Workshop 3
Wenatchee, Washington
October 7-11, 1996

WORKSHOP AGENDA

Monday, October 7

Mon1. Review of Workshop Objectives, Agenda (David Marmorek)
Mon2. Summary of Peer Reviews (Larry Barnthouse)
Mon3. Plenary Discussion of Draft Conclusions Document (major comments)
Mon4. Revise Conclusions Document in Subgroups

Tuesday, October 8

Tues1. Subgroups to revise Conclusions Documents (continued)
Tues2. ISG presentation/discussion (Chip McConnaha, Chuck Coutant, Jim Lichatowich)
Tues3. Discussion of Harvest Chapter 13 (Olaf Langness)

Wednesday, October 9

Wed1. Review of FY97 Goals and Draft Work Plan (David Marmorek)
Wed2. Review of issues involved in applying decision analysis to PATH (David Marmorek)
Wed3. Review of progress on prospective analysis (Rick Deriso)
Wed4. Subgroups to plan tasks for Oct-Mar. period

Thursday, October 10

Thurs1. Subgroup discussions of Work Plan (continued)
Thurs2. Primer on Decision Analysis (Randall Peterman)
Thurs3. Review of Subgroup discussions of FY97 work plan
Thurs4. Discussion of Question 7 (Climate) Conclusions
Thurs5. Discussion of Research Needs
Thurs6. Task List

Friday, October 11

Field Trip
- Tumwater Canyon on Wenatchee River
- Video monitoring station on Tumwater Canyon Dam
- Lake Wenatchee
- Dryden Dam acclimation pond for natural supplementation
- Mission Creek habitat restoration

DETAILED NOTES

Monday October 7

Mon1. Review of Workshop Objectives and Agenda (D. Marmorek)

Objectives

1. Complete draft Conclusions Document on FY96 PATH work:
   - results/management implications
   - proposed research and monitoring activities.

2. Listen to reports from ISG and PATH Peer Review Panel.

3. Review progress on prospective analysis, discuss future directions.

4. Plan retrospective / prospective tasks for Oct/96-March/97 period.
   - assignments, deliverables and deadlines

Comments on Agenda and Objectives

Randall Peterman requested that in the future, more time should be allowed between delivery of documents and workshops so that people have time to read materials in sufficient detail. His concern was that it is difficult to draw conclusions from the retrospective analyses without having had enough time to read them thoroughly.

It was suggested that future Workplans should be less ambitious and should allow more time between completion of document and workshops.

Mon2. Summary of Peer Reviews (L. Barnthouse)

Larry reviewed the comments made by the Scientific Review Panel (Walters, Collie, Dennis, and Saila) on the Final Report on PATH Retrospective Analyses for FY96. Comments on the overall report were generally positive, and Larry summarized some of the comments on specific chapters:
<Note: Larry is preparing a detailed summary of SRP reviews.>

Chapter 1

Comments: Should be more focussed, lay groundwork for adaptive management, put PATH in a national/international perspective.

Response: Replace the current summaries in Ch. 1 with the conclusions once they are finalized.

Chapter 2

Comments: Potential time series bias in Ricker parameters.
Need better graphical representation of cluster analyses.

Response: C. Paulsen agreed with need for better graphical representation.

Chapter 3

Comments: Index stocks may not be representative of all stocks in a region.

Response: Other index stocks that covered a wider geographical range are available.

Chapter 4

Comments: Concern over multiple age class models.
Have not addressed autocorrelation problem.

Response: Multiple age class problem affects all analyses of recruitment data and has wide implications.
Autocorrelation is not a problem with the specific climate data and indicators used, but is a problem with dam and spawner variables.
Ch. 4 was a pilot analysis, and needs more stocks and data (particularly anthropogenic variables).

Chapter 5

Comments: Possible additions to the model:

- model covariance in measurement errors
- estimate μ for pre-1970 period

Response: Modelling covariance in measurement errors was suggested earlier, but is a time-consuming process.
There are not enough stocks to estimate pre-1970 μ, but it may be possible to estimate it as a bounded constant.

Chapter 6

Comments: Apparent conflict between estimates of reservoir survival and μ.

Response: This is difficult to resolve because of conflicting measurements of the same process.

Chapter 9

Comments: Statistical power of analyses is an issue.

Response: Authors have been in contact with the reviewer (Saila) that suggested the power analysis and have agreed that the approach to power taken in Ch. 9 addresses the reviewer's concerns. Saila's reply could be added as an Appendix to this chapter.

Chapter 10

Comments: Difficult to correlate habitat indices with population performance.
Habitat restoration provides opportunity for well-designed adaptive management experiments.
Integrate qualitative habitat rankings into stock-recruitment models in Chs. 3, 4, 5.

Response: Authors of Ch. 10 were not present.

Chapter 11

Comments: Construct non-linear model that accounts for hatchery removals in state dynamics; include parameters for differential survival and interactions between hatchery and wild fish.

Response: Will explore incorporating a Ch. 5-type model to do this.

Chapter 12, 13

Comments: No comments were presented for these chapters.

ACTION ITEM: Larry Barnthouse will ask J. Collie to review the chapters he has not yet reviewed (6, 11, 12, 13).
<Note: This has been done - Collie's review has now been distributed.>

Mon3. Plenary Discussion of Draft Conclusions Document

Discussion of the draft conclusions document ranged from the general structure of the document to precise wording of conclusions to various methodological issues. The objective of this session was not to resolve these issues, but to identify them for subgroups to resolve. Some issues were resolved and incorporated into the revised conclusions document while others were not. Some of the major topics of discussion are summarized here for each of the questions in the draft conclusions document.
<Note: All of these issues have been addressed in subsequent discussions of the Synthesis Group through conference calls and face-to-face meetings. The final version of the FY96 Conclusions Document is now being distributed.>

Question 1

- Chapter 2 and L. Botsford's analyses should be combined.
- differences between upstream and downstream stocks in their response/resiliency to large-scale forcing factors
- pros and cons of using St+4/St as a survival index
- need for precise definitions of survival, abundance, long-term, short-term in the conclusions document

Question 2

- need to justify temporal (pre-1970 vs post-1975) and spatial (upstream vs downstream) categorizations
- evidence relating to ocean conditions/distribution/survival and its relevance to this question

General Comments on Questions 3-7

- need to clarify definition of time periods
- should be several parts to these questions (evidence may not available for all of these parts, but using this framework will highlight where evidence is lacking):

1) Coincidence in time and space of change in factors with change in survival
2) Estimates of overall impact of factor on life cycle mortality
3) Estimates of overall impact of factor on mortality in specific life stage
4) Changes in stock indicator correlated with changes in factor

Question 3a

- temporal changes in hydro, ocean, other effects, and survival all coincided
- need to focus on differences due to hydro system (spatial/temporal scale of changes in survival vs changes in hydro, estimates of hydro mortality, other stressors due to hydro)
- assumptions in spawner-recruit data and potential bias in evidence for this question

Question 3b

- relationship between interim juvenile/smolt to returning adult survival goals and delayed mortality
- should develop a clear and consistent set of questions that are asked for all H's, focussing on effects of different actions on different life stages:

  Possible endpoints:
  - juvenile passage survival (LGR to BON)
  - smolt to returning adult (LGR to LGR)
  - spawner to spawner
  - ln[obs(R/S) / pred(R/S)]

  Suggested question structure for all H's:
  To what extent can _____ measure compensate for _____ effects on _____ life stage?

Question 4

- use 4-part framework suggested for questions 3-7 above

Question 5

- analysis is too preliminary to justify conclusions
- stars may be too ambiguous - use IPCC model "We conclude with low/medium/high confidence that ..."
- use 4-part framework suggested for questions 3-7 above

Question 6

- no conclusions until harvest work group finishes their analyses

<Note: Preliminary analyses have been completed since the workshop and interim conclusions for Question 6 are now included in the Conclusions document.>

Question 7

- use 4-part framework suggested for questions 3-7 above

Mon4. Revise Conclusions Document in Subgroups

Subgroup A: Q2, 3a, 6a and b, 7a and b	Subgroup B: Q1, 3b, 4a and b, 5a and b
Jim Anderson, U. Washington	Larry Barnthouse, McLaren Hart
Tom Cooney, WDFW	Ray Beamesderfer, ODFW
Peter Dygert, NMFS	A. Giorgi, Don Chapman Consultants
Jim Geiselman, BPA	*Mike Jones, ESSA*
Olaf Langness, WDFW	Calvin Peters, ESSA
David Marmorek, ESSA	Charlie Petrosky, IDFG
Chip McConnaha, NPPC	Chris Pinney, Corps of Engineers
Jim Peterson, NBS	Chris Toole, NMFS
Randall Peterman, SFU	Earl Weber, CRITFC
Howard Schaller, ODFW	John Williams, NMFS
Steve Smith, NMFS	Paul Wilson, CBFWA
Lou Botsford, UC Davis Rick Deriso, IATTC Charlie Paulsen, PER	

Subgroup A

Jim Anderson presented information showing that the PIT-TAG survival of hatchery fish diminishes with the distance upstream that the fish travel. However, the same survival measurement was uncorrelated with travel time. He then concluded that the mortality per mile is constant, which can also be expressed in terms of survival being related to velocity from the hatchery to Lower Granite Reservoir. He hypothesized that faster moving fish have fewer encounters with predators, though other participants suggested that there are many alternative factors that could cause survival to increase linearly with distance.

Jim also presented his comparison of CRiSP in-river mortality estimates with the μ mortality estimates over the complete life-cycle. This shows that CRiSP is consistently predicting lower mortality rates than the MLE method, with the exception of the early 1980s period. Jim postulated that changes in the distribution of arrival times of salmon overlaid with the distribution of survival probabilities is affecting how well fish do from year-to-year.
<Note: Jim has completed further work on this hypothesis subsequent to the workshop and has circulated a draft manuscript "The estuary hypothesis: A mechanism for delayed mortality".>

Subgroup B

The subgroup divided into 3 sub-subgroups to discuss questions 1 (Paulsen, Botsford, Williams), 4 and 5 together (Barnthouse, Beamesderfer, Petrosky, Pinney, Wilson) and 3b (Deriso, Giorgi, Toole, and Weber). The subgroup discussing 3b decided that refining the survival goal was important for drawing conclusions about hydro effects. The interim survival goal of 50-70% is probably an overestimate because it is based on historical survival rates that were estimated during years with large positive year-effects (1966-1968). The effect of the year-effect on the survival goal can be removed to show what the survival goal should be for an average year-effect).

The group discussed with Deriso how Ch. 5 estimates of μ could be combined with Ch. 6 information to separate direct and delayed mortality from juvenile passage. Given a Transport Benefit Ratio and an estimate of the percentage of smolts transported, it is possible to estimate what the direct survival of in-

river fish would have to be to achieve the direct survival goal given the estimated delayed mortality. (This is on the list of Tasks under Task R3 Hydro retrospective analyses).

Tuesday October 8

Tues1. Revise Conclusions Document in Subgroups (continued)

Tues2. ISG Presentation/Discussion (Chip McConnaha, Chuck Coutant, Jim Lichatowich)

Chip, Chuck, and Jim presented a summary of “Return to the River”, the report prepared for the NPPC by the Independent Scientific Group (ISG). Some of the major themes of the report and the approach taken by the ISG are summarized here.

Purpose

- review existing Fish and Wildlife Program (assumptions, beliefs, scientific foundation)

Themes

- focus on entire ecosystem, not just individual species/populations
- relies on natural processes to establish habitat, not technological “band-aids”
- wide-angle, top-down approach to habitat restoration
- used 1 to 5 scale to assess level of scientific support:
  1 = thorough, peer-reviewed, generally accepted
  5 = misleading or demonstrably wrong

Principles

1. Restoration must address entire natural and cultural ecosystem.
2. Habitat is a product of natural physical processes; a network of complex and interconnected habitats.
3. Salmon adapt to make full use of their habitat; diversity in life histories, genetics, and metapopulation organization allows them to cope with environmental variation.

Differences Between Fish and Wildlife Program and Return to the River

Fish and Wildlife Program	
• focus on segments of ecosystem and life history	• focus on entire ecosystems
• assumes simple relationships, ignores complexity	• protect/re-establish complex and connected habitats
• focus on quantity of fish only	• focus on quantity and quality (diversity, life histories, population structure
• passive migration	• fish interact with habitat during migration
• management doesn't consider ocean conditions	• link between management and response of fish to ocean conditions
• models focus on limited indices of quality	• models must broaden what are considered to be relevant qualities
• salmon reserves ignored	• reserves not ignored
• stocks treated as independent	• stocks interact

Implications for Restoration

- recovery intended to remove constraints on natural diversity (and therefore productivity)
- recovery should restore connections between diverse habitats
- region must decide how far towards "normative" conditions they should go if they want salmon to recover

Implications for PATH

The approach taken in Return to the River is a complementary process to PATH. The top-down approach of Return to the River can be combined with the more detailed and technical approach in PATH if the assumptions and perspectives are consistent.

Tues3. Ch. 13 Harvest Presentation/Discussion (Olaf Langness)

Olaf presented a progress report on the Chapter 13 harvest retrospective analyses since only a very preliminary "intentions" document was included in the most recent retrospective report.

Progress to Date

- the harvest group is currently designing and conducting tests, and should have results analyzed and a draft report for internal review out by the end of October

<Note: this has been completed and is being reviewed by the harvest group.>

- preliminary results suggest that both harvest rates and conversion or upstream survival rates declined in the mid-1970s for most stocks

Future Analyses (Planned and Potential)

- the group is also conducting or planning to conduct analyses of harvest dynamics (e.g. CPUE vs effort, accuracy of pre-season estimates) and preliminary review/evaluations of suggested harvest strategies
- prospective analyses will focus on the improvement in survival that is required, and a harvest rate schedule that will achieve the target survival rate
- retrospective analyses could be extended to fall chinook, steelhead, and ocean-type stocks

Comments

- timing of changes in harvest rates relative to changes in escapement suggests that aggregate escapement does not appear to be affected by harvest rates
- given this preliminary conclusion, is it worth spending more time on the analyses?

Response

- Retrospective analyses should be continued because they will not take a lot more work to complete
  - the analyses can be shortened by looking at only some stocks
  - they will produce useful information for the prospective analyses

Comments

- some analyses by Mundy in ISG Report suggests that there may be a significant unreported ocean harvest, although Howard Schaller pointed out that there are some serious flaws in those analyses.
- should marine mammal predation be discussed in Ch. 13?

Response

Should not discuss in Ch. 13 because:

- not much data to do the analyses or make conclusions on significance
- PATH members do not have the expertise to assess this question
- marine mammal predation is subsumed in the year-effects in Ch. 5 (to the extent that predation effects are the same for both downstream and upstream stocks)

Wednesday October 9

Wed1. Review of FY97 Goals and Draft Work Plan (David Marmorek)

Dave presented goals and draft work plan (attached to these notes as Appendix 1) as a basis for the discussions during the rest of the workshop.

Discussion

- future retrospective, prospective, and decision analyses should be extended to other stocks (e.g. Mid-Columbia spring/summer, fall) that aren't currently being looked at (Boxes 2, 3, and 4 in Figure 1).

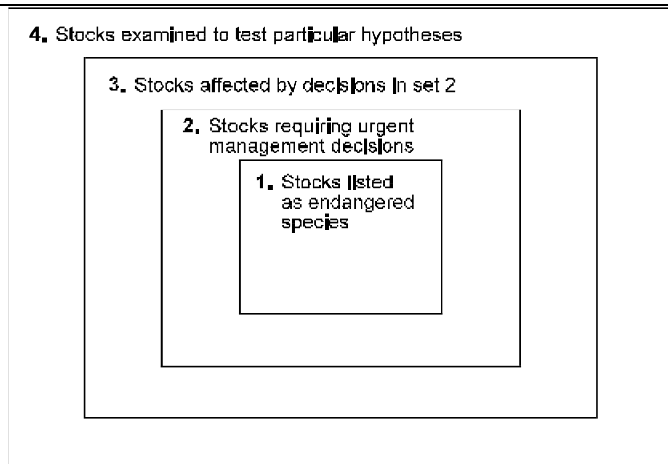

Figure 1. Nested stocks of concern.

Wed2. Review of Issues Involved in Applying Decision Analysis to PATH (David Marmorek)

Dave presented a list of issues (see Appendix 2) that will have to be resolved in the course of implementing a decision analysis framework in PATH. The intention was not to resolve these at this meeting, but to get PATH members thinking about the kinds of decisions, assumptions, and information that will go into the decision analysis. These issues will be further developed and resolved over time as the decision analysis is constructed.

Discussion

Performance Measures

- PATH should provide only biological input, not economic input into the decision.
- Under the ESA, the primary management objective under the ESA is survival/recovery - costs are secondary, but might be used to distinguish between actions with similar effects on biological indicators.
- NPPC is putting together an economic group that could provide economic inputs. This group should be brought in early in the process.
- ISG report might provide other performance measures (e.g. diversity in life history); these could be evaluated using qualitative decision-making tools (e.g. Analytical Hierarchy Process), but will still require quantitative indicators of these measures.

Role of Decision Analysis in Identifying Research Needs

- A major benefit of decision analysis will be the identification of what quantitative information from current and future research results will affect the conclusions.
- This can be done quantitatively using a Value of Information analysis (a common application of decision analysis) to identify and prioritize research priorities according to how they affect the decision.
- The whole PATH group should be kept aware of research that is either going on or planned that might provide evidence relevant to PATH.

Issues in Implementing Decision Analysis

- Other life cycle models besides Deriso's Bayesian prospective model could be used in the decision analysis, but some sort of composite model is desirable to avoid model conflicts and comparisons.
- Decision analysis is an iterative, hierarchical process - should start simply and be scoped at all stages to limit complexity.

Wed3. Review of Progress on Prospective Analysis (Rick Deriso)

Rick Deriso has been developing a model to estimate survival and recovery standards for Snake River stocks. The model incorporates uncertainties in 89 parameters in the model and uses a Bayesian approach to making probabilistic assessments of the jeopardy standards. The purpose of this presentation was to identify and discuss some of the key assumptions that Rick has made in building the prospective model. These assumptions and the major topics of discussion are summarized here.
<Note: A subsequent meeting was held December 4 to review all of these assumptions; notes from this meeting are being written up.>

1. Random selection of WTT to estimate Conversion factors
    - WTT will depend on the number of dams and on dam operations
    - use passage models to generate conversions based on specific spill, dam operation, and passage measure scenarios, then feed these conversions into the prospective model

2. Modelling exploitation rates
    - currently estimated as a linear function of total Snake River returns
    - could use methods other than linear relationship for projecting exploitation rates (e.g. some probabilistic assignment)

3. Modelling year-effects
    - currently based on autocorrelative structure
    - have estimates of year-effects from 1940-1990, so decadal effects could be modeled

4. Modelling WTT
    - selected at random from above average and below average WTT years

5. Maturity proportion
    - randomly selected from historical estimates

6. Stock-Recruitment model
    - current models uses both a 4-parameter model (to incorporate depensation) and a Ricker model. However, the 4-parameter model gives biologically unrealistic results. Suggestions:
      use Ricker model only
      change priors on B in 4-parameter model to constrain it to more realistic values
      try other forms of depensatory stock-recruitment models

General Discussion

- hydrosystem has changed, therefore recent conditions (1975-1990) may not reflect current (post-1990) conditions (although μ's have not changed that much in recent years - see Fig. 5-5)
- current conditions difficult to model because there no estimates of μ after 1990 - therefore would have to make assumptions and postulate scenarios to estimate post-1990 μ
- however, could examine the sensitivity of results to different recent conditions (e.g. 1980-1985, 1985-1990)
- results seem to be in same ballpark as ELCM and SLCM

- what is needed is an estimate of how much life cycle survival would have to increase to achieve the survival and recovery standards (Deriso will do this)

Wed4/Thurs1. Subgroups to Plan Tasks for Oct-Mar. Period

Subgroup A	Subgroup B
Work Plans retrospective/prospective analyses: hydro, harvest, climate retrospective analyses: fall chinook decision analysis, synthesis	**Work Plans** retrospective/prospective analyses: hydro, habitat, hatcheries retrospective analyses: steelhead decision analysis, synthesis
Jim Anderson, U. Washington Lou Botsford, UC Davis Tom Cooney, WDFW Chuck Coutant, ORNL Peter Dygert, NMFS Jim Geiselman, BPA Olaf Langness, WDFW *David Marmorek, ESSA* Chip McConnaha, NPPC Jim Peterson, NBS Randall Peterman, SFU Howard Schaller, ODFW Steve Smith, NMFS	Larry Barnthouse, McLaren Hart Ray Beamesderfer, ODFW A. Giorgi, Don Chapman Consultants *Mike Jones, ESSA* Jim Lichatowich, ISG Charlie Paulsen, PER Calvin Peters, ESSA Charlie Petrosky, IDFG Chris Pinney, Corps of Engineers Chris Toole, NMFS Earl Weber, CRITFC John Williams, NMFS Paul Wilson, CBFWA
Rick Deriso, IATTC	

NOTES FROM SUBGROUP A
Wednesday October 9 - Thursday October 10, 1996

1. Spring/Summer Chinook: Retrospective and Prospective Tasks

A. Complete Chapter 13 on Spring/Summer Chinook Harvest

B. Hydro Tasks

Clarify the potential sources of delayed mortality of both in-river and transported fish. Transportation began in about 1973, and by around 1984 roughly 50% of smolts were being transported. The Chapter 5 MLE analysis implies a significant amount of delayed mortality in transported fish, and possibly also for in-river fish. The subgroup discussed the possibility of having μ separated into two components: a μ_t for transported fish and a μ_{ir} for in-river fish. However Rick pointed out that since there are not separate recruitment estimates for transported fish it would not be possible to accurately estimate these two different parameters. There would be a range of possible combinations of μ_t and μ_{ir} which would both be possible (e.g. high μ_t associated with low μ_{ir} and vice versa). The group discussed the possibility of exploring different hypotheses for combinations of direct and delayed mortality in transported and nontransported fish (see Table below).

		Delayed Mortality
Transported fish	Low	Moderate High
In-river fish	Moderate High	High Low

The group proposed at least three alternative hypotheses:

H1: High, relatively constant delayed mortality in transportation alone;
H2: High, relatively constant delayed mortality in both transported and in-river fish;
H3: High, variable delayed mortality (presumably in both groups) related to flow or other variables.

The other Hydro task discussed by subgroup A was to attempt to understand the causes for the dip in μ during the early 1980s. At this time, both the numbers of Snake River spawners decreased, and the recruitment increased, leading to a sharp increase in recruits per spawner. This period did not appear to have an unusual series of year effects (δ; Figure 5-7, page 5-28). 1980 and 1982 were average years in terms of year effects; 1981 was a slightly below average year (δ= -0.4) and 1983 was a very good year (δ= 0.6). The water transit times were quite fast during 1980 to 1982, though average in 1983 (Figure 5-6). Therefore, it is possible that during 1980 to 1982 the low water transit times were largely responsible for the good performance of the up-river stocks, while in 1983 a beneficial climate regime or year effect was the cause of better than average passage survival. These speculations are perfectly accurate in hindsight, but need to be examined more closely for counter examples where similarly good conditions applied, but the passage mortality remained high. The most obvious example is in 1972, which had a very fast water transit time (the fastest in the 1970 to 1990 record) but had the third highest μ value. Gas supersaturation was likely a problem for the 1972 brood year. This year (1972) had average year effects (Figure 5-7 in FY96 Final Report on Retrospective Analyses).

C. Climate

The first step is to lay out alternative hypotheses regarding the effects of climate on population behaviour or stock indicators, such as ln(r/s), the residuals from the stock recruitment curve, and the year effect δ. This would involve an extension of the Chapter 4 analysis, while being careful to specify *a priori* hypotheses and not go hunting for significant relationships.

The second step under the climate analyses would be to do sensitivity analyses of the distribution of values, and assess how much influence that has on the selection of alternative decisions in the decision analysis framework. Presumably selecting poorer climate years would lower the performance of all management alternatives, but would not necessarily change their rankings.

The third step would only be undertaken if the second step demonstrates some significant effect on decisions. This would be to integrate some of the work done by Dan Ware and Bob Francis into prospective analyses, so that longer frequency periodicities in climatic conditions would be considered.

There could also be more work done to examine whether or not there is a climatic effect in delayed mortalities, and also to assess what factors appear to influence the year effect (e.g. PNI, flow, the timing of the spring transition relative to arrival times of fish, and the oceanic origin of water in the estuary).

D. Prospective Analyses

Changes in μ could be implemented in the prospective model by considering changes to direct and delayed mortality of both in-river and transported groups as well as harvest mortality, assuming that these mortality sources can be disaggregated. Changes in habitat and hatchery effects would probably be represented by changes in the Ricker 'a' or 'β' parameters. Subgroup B addressed this question more thoroughly (see below).

Fall Chinook Tasks

1. Complete run reconstructions of fall chinook. This would also involve analysis of the harvest data. (Olaf, Jim Norris, Howard, Ray Beamesderfer, Mary Ann Johnson).

2. Complete graphical, not statistical summaries of the fall chinook information, doing a Chapter 3 style analysis. A Chapter 6 type of analysis could also be completed using CRiSP and FLUSH to estimate in-river mortalities during the migration corridor. Completing more than this level of sophistication of analysis (e.g. an MLE style analysis for Chapter 5, or a Chapter 4 multi-variate approach) is not likely to be possible given the small number of stocks:

    2 upstream stocks
    - the Snake River aggregate stock which goes through 8 dams and has data back to 1970
    - the Hanford stock which goes through 4 dams and has data back to the early 1960s but has relatively poor estimates of harvest during 1960s

    2 mid-to-downstream stocks
    - the Lewis River stock which has data back to 1967 and goes through 0 mainstem dams, though it has a small hydro dam above the spawning area
    - the Deschutes Mid-River stock which goes through 2 dams

    In addition to the lack of stocks for Chapter 4 and Chapter 5 type analyses, sub-basin land use practices are likely to be somewhat less relevant for fall chinook than for spring/summer chinook in that fall chinook spawn in the free-flowing portion of the mainstem. However dams have very likely reduced the mainstem spawning area. Note that although the aged fish only go back to 1970, there are redd count data back to the 1940s (see ISG report, data originally from Dave Geist at Batelle). These data indicate that redd counts increased after the Priest Rapids dam was put in place. The assumption is that the Hanford stock absorbed other stocks.

    The Hanford stock has more than 100,000 returning fish, and therefore is probably the only wild stock with some chance of assessing differences among years in ocean distribution and survival differences between transported and nontransported fish. It is also probably the best stock for assessing the scale and magnitude of delayed mortality in both transported and nontransported fish. Hanford Reach wild fall chinook are tagged and then either transported or released at McNary Dam. There are about 5 years worth of data available to examine changes amongst these two groups.

    With respect to a Chapter 6 type analysis, one could use the CRiSP/FLUSH models for fall chinook (which are closer to one another than the CRiSP/FLUSH models for spring/summer chinook) to estimate in-river survival and then compare them to differences to upstream and downstream stocks in ln(r/s). It is unlikely to be possible to compute a μ for these stocks as mentioned above. Jim Peterson has done considerable amount of work with his group at the National Biological Survey, including work on distribution, survival, growth, and predation of fall chinook in the John Day, McNary, Hanford and Lower Snake Reservoirs.

3. Climate
    Unlike spring/summer chinook, the substantial harvest on fall chinook provides more data on ocean distributions which could potentially allow discrimination amongst upstream and mid-downstream

stocks, as well as assessing differences in ocean survival. Note that these differences would confound or be more likely to confound an MLE style analysis of upriver/downriver differences. In addition to having different ocean distributions, the fall chinook go out as subyearlings rather than yearlings, and therefore are likely to be influenced by different ocean and climate variables. A graduate student of Jim Anderson, Sang-Yoon-Hyun has examined differences between the Hanford and Snake River fall chinook stocks in both ocean distribution and climate influences. This is obviously critical work to incorporate into PATH.

NOTES FROM SUBGROUP B
Wednesday October 9 - Thursday October 10, 1996

Objectives

1. Identify prospective and additional retrospective analyses required for spring/summer chinook:
    - habitat
    - hatcheries
    - hydro
2. Discuss issues and tasks relevant to decision analysis.
3. Identify retrospective analyses needed/possible for steelhead.

1. Retrospective/Prospective Analyses of Spring/Summer Chinook

Retrospective and prospective analyses of spring/summer chinook were considered together because many extensions and modifications to existing retrospective analyses were suggested in the context of providing additional information relevant to prospective tasks. Three levels of prospective analyses were discussed:

A. Set an overall survival goal.

Attaining the NMFS survival and recovery standard is the overall objective of potential management actions.

B. Determine the improvement in overall survival rate necessary to achieve the NMFS jeopardy standards.

Deriso's prospective model can be used to estimate this increase in survival rate. The plan is to use the model to simulate μ^*, the overall survival rate that will allow each stock to attain the jeopardy standards. This survival rate assumes that future environmental conditions will be the same as average historical conditions, although μ^* can be adjusted if environmental conditions are expected to different from the historical average in the future (or multiple μ^*'s could be calculated, one for each hypothesized environmental regime).

Rather than selecting a single ratio of present to historical probability such as 70%, Deriso will generate μ^* for a range of ratios. Once μ^* is determined, Deriso will analytically determine the change in μ relative to some base case that is necessary to achieve μ^* ($\Delta\mu$). Because the base case μ may depend on the particular time period that is chosen (e.g. post-1975 period vs post-1985 period), $\Delta\mu$ will be provided as a function of base case μ so that all possible base case conditions and the sensitivity of $\Delta\mu$ to base case conditions can be considered.

e μ is an indicator of how the change in any life stage survival rate and over any time period affects the ability of a stock to reach the survival goal. Some concern was expressed about the implications of density-dependent effects on the interpretation of μ, since increases in survival may not be additive at higher densities. However, this is probably not a problem given the low numbers of fish in the listed Snake River stocks.

C. Estimate the potential contribution of changes in the habitat, harvest, and hydro to Δ μ.

1. General

   This requires a Chapter 6-like approach to estimating the potential effects of different actions in each of these areas on survival rates. There are specific concerns and difficulties associated with doing this for habitat and hatcheries actions because there is considerably less data available for these actions than for hydro actions. There was concern (Lichatowich) about the lower standards of admissibility of data for habitat and hatchery issues than the standards that were employed to determine the acceptability of hydro data. In general, the same standard should be applied and it should be made clear to managers that data necessary for answering this question is lacking but needed. Experimental management actions should also be recommended.

   Deriso suggested that where data is missing, probabilities of possible effects of different management actions based on expert opinion will be required, with sensitivity analyses to assess the implications of using this approach. This approach using subjective probabilities fits nicely into the prospective model.

   The group came up with several possible analyses and sources of data for estimating the potential increase in survival rates resulting from habitat and hatchery actions. Not all of these analyses or data will provide quantitative information necessary to make confident estimates. However, the information that is obtained may be useful in identifying potential relationships and variables, providing bounds on plausible parameter estimates, and facilitating the assignment of probabilities if that strategy is used.

2. Habitat

   i) Develop a set of standardized rules for assigning ratings of habitat quality.

   ii) Compare changes in Ricker 'a' over time among stocks with different habitat ratings. This approach requires further retrospective analyses to generate the necessary habitat data.

   iii) Use case studies, literature, etc, to identify possible cases where changes in survival have been related to changes in habitat conditions. There is low confidence in the ability of this approach to generate useful information, but it should be pursued.

   iv) Analysis of changes in productivity parameters relative to habitat in stocks other than index stocks (e.g. upper Salmon River).

   v) Measure differences between good and bad habitats using parr data base.

   vi) PIT-tag parr-to-smolt data (Ch. 10 Appendix 4).

   In general, the utility of looking at changes in habitat is constrained because there are currently no habitat improvement actions being considered. However, prospective analyses are still worthwhile to at least set bounds on a reasonable range of improvements.

3. Hatchery

   i) Measure declines in survival due to overproduction of hatcheries (e.g. decline in steelhead since 1987 because of hatchery production).

   ii) Incorporate hatchery production variables (e.g. # of releases, #of releases/wild spawner, method and timing of release) into Ch. 5 MLE model. Hatchery data should be available; other details on hatchery operations (e.g. from CIS) may not be. Since hatcheries were instituted in response to declines in populations, there will be some automatic confounding of hatchery effects and dam effects. However, there may be some time separation of hatchery and hydro effects to allow partitioning.

iii) Literature review as already started in Ch. 11. This approach may not generate any useable quantitative information, but may suggest what possible variables etc. should be looked at in the quantitative analyses (low priority).

iv) Extension of Ch. 11 analyses to include other indicator variables, stocks, and species (to include interspecies interactions). This can be used as an exploratory tool to identify variables to use in the MLE-type analysis (# ii) above).

v) There is limited hatchery data from outside of Columbia Basin (e.g. post-1975 chinook escapement data from Alaska). The group felt that only published data should be used to avoid inheriting problems in data.

4. Hydro

i) Complete retrospective analyses in Ch. 6.

ii) Combine Ch. 6 information with Ch. 5 μ estimates to estimate delayed mortality.

2. Discussion of Decision Analysis

There was some concern in the group that the decision analysis will be too complex to produce useable results because of the complexity of management and adaptive management actions considered. Toole suggested that a subgroup of PATH members should meet with Peterman or another expert to discuss decision analysis and how it can be applied to PATH in more detail. This meeting might involve conducting a pilot decision analysis to further demonstrate its application. (Randall Peterman presented a short primer on decision analysis on Thursday afternoon in response to these concerns.)

3. Retrospective Analyses for Steelhead

The group generally felt that there was little data for doing run reconstructions for Steelhead. Several potential data sources were identified:

1. General aggregate dam counts provide limited escapement data for Snake River steelhead. These counts are hampered by:
    - problems with estimating smolt ages
    - the existence of 2 different run types (A and B) that differ in their run timing and size of adults at ocean stage (although A run and B run data are separate in some dam counts)
    - overwintering in pools by some proportion of stocks

2. Data from Clearwater stock (mostly B-run) when Lewiston Dam was in place from 1950s-1972.

3. Aggregate data for partitioning wild and hatchery stocks from about 1980; assumptions will be required to partition prior to 1980. Dworshak hatchery started in 1972, but most hatcheries started in 1980s.

4. Few long-term data on redd counts. Counts are sloppier than spring/summer chinook because steelhead spawn in smaller tributaries, at the peak of the hydrograph, and over a longer period. There are long-term redd count time series since 1960s from Joseph Creek (wild A-run).

5. Wier counts of Rapid River (wild A-run) since 1964. There is also age-structure data for this stock.

6. Estimates of smoltification age from Joseph Creek and Rapid River wild A-run stocks.

7. Data from other stocks:

   Upper Colombia: some attempts at run reconstruction

   Lower Columbia: more run reconstructions, spawner/recruit data, lower Columbia dam counts give abundance indices and age data for index stocks

   Southwestern Washington: spawner/recruit data

8. Al Giorgi noted that Don Chapman Consultants had just completed a review on this topic and is a potential source of information.

The steelhead workgroup (Petrosky (lead), Beamesderfer, someone else from WDFW, Chris Toole will look into getting someone from NMFS) will inventory these data and evaluate their potential for run reconstruction at a technical meeting to be held sometime in November.

4. Habitat Issues for Fall Chinook

Subgroup B also discussed two issues relating to habitat of fall chinook.

1. Habitat loss due to blockage by Hell's Canyon Dam and effects of reservoirs on spawners and juveniles.

2. Effects of water temperature on emergence, development, and timing of outmigration of juveniles. Both retrospective (documentation of a change in thermal regime and its effects on run reconstructions) and prospective (implications of change in thermal regime for proposed management actions) analyses are needed.

Thursday October 10

Thurs1. Subgroup discussions of Work Plan (continued)

See notes from Wednesday, item Wed4.

Thurs2. Primer on Decision Analysis (Randall Peterman)

Randall Peterman presented a short primer on decision analysis, showing the basic structure of a decision analysis framework (decision table and decision tree) and example decision analyses applied to forest management (Cohan et al. 1984) and development of an adaptive fisheries management experiment in Australia (Sainsbury 1988, 1991, 1996). Discussion focussed on potential difficulties in applying this framework to the Columbia River. To illustrate how the framework might be applied to PATH, ESSA, Peterman, and perhaps an outside expert will perform a very rough pilot decision analysis that will be discussed in November or December. The pilot analysis should include a strategic-level list of possible options, and should be flexible enough to accommodate changes in input components.

Thurs3. Review of Subgroup Discussions of FY97 Workplan

No major discussions- any modifications discussed have been incorporated into the task list.

Thurs4. Discussion of Question 7 (Climate) Conclusions

Deriso presented results of additional analyses of the environmental indicators used in Ch. 4, showing that there was no correlation between upwelling indices from different months (e.g. between May upwelling and June upwelling). He used these results to point out that results of statistical tests can depend on the particular environmental variable selected, and urged caution in using the results of such tests to make conclusions about the effects of environmental variables on survival rate.

Thurs5. Discussion of Research Needs

Research needs should provide general direction needed for research (including approximate time required to produce useable results and relative priority), rather than specific research designs. Specific modifications to research needs arising from this discussion of research needs have been incorporated into the conclusions document.

Thurs6. Task List

The task list generated by these discussions (included as Appendix 3) has been updated since the Wenatchee workshop. Note that the proposed reopening of the NPPC Fish and Wildlife Program in February or March could put a wrench in our schedule.

Appendix 1 - FY97 Draft Work Plan

1. Oct/Nov: Consolidate Results of Workshop 3

- quarterly work plan (Oct 30)
- conclusions document:
  to SRP (Oct 21)
  revised version circulated to all (Oct 30); finalized Nov 30
  different version for the general public?

2. Post-Workshop 3 Technical Mtgs / Analyses

Work Groups:
- synthesis
- prospective / decision analysis
- habitat, hatchery, harvest, hydrosystem
- fall chinook and steelhead data

Publish:
- submit journal papers on retrospective analyses by Dec. 31/97
- FY96 results on WWW site by ???;

Spring/Summer Chinook
- develop prototype decision analysis framework (Nov. 30/96)
- follow-up retrospective analyses chinook (Feb. 15/96)
- draft prospective analyses for spring summer chinook (P1 - Nov 15; and P2 - Jan 30)

Fall Chinook and Steelhead
- data assembly (Dec. 15/96)
- pilot retrospective analyses for fall chinook (Feb. 15/96)

- all sections for draft report received by: February 15, 1997
- out to review March 1-15, 1997

3. PATH Workshop 4 (late March 1997)

Fall Chinook
- review pilot analyses; determine remaining steps required to complete.

Spring/summer chinook
- review follow-up retrospective analyses, draft prospective analyses

Decision Analysis
- examine pilot decision analysis framework
- develop experimental designs, management action packages
- apply in decision analysis framework
  - simulations at various scales to explore possible outcomes,
  - statistical procedures to analyze these simulations

Planning
- short workshop report; quarterly work plan

4. Post Workshop 4 Statistical and Modeling Analyses

- retrospective analyses for fall chinook (and steelhead?)

- prospective analyses for spring/summer chinook (P3):
  - amount of learning and hypothesis testing possible under different management actions, climate, monitoring/experimentation.
  - evaluate alternatives {learning vs. risk}
    - transportation, flow augmentation, drawdown, habitat improvement, harvest management and hatcheries.
  - recommend research, monitoring and adaptive management strategy

- all analyses completed by August 15
- draft final report out to reviewers by August 30

5. PATH Workshop 5: Consolidation of Results (September 1997)

- review and finalize reports on previous activities
- include responses to Draft Final Report by the Scientific Review Panel
- prepare succinct set of recommendations
  - management actions
  - future research and monitoring activities

- Final Report for FY 97 (October 31, 1997)

Appendix 2 - Applying Decision Analysis to PATH - Issues to be Resolved

1. Alternative management actions

- what management actions should be included or excluded on the basis of the retrospective results?
- what adaptive management designs could/should be considered?
- can some preliminary scoping of adaptive management actions be done?
- should packages of actions include hydro, habitat, hatchery and harvest components or do separate analyses on each H first?
- who should be involved in recommending packages (IT? which committee?)

2. Performance Measures

- performance measures are quantitative indicators of management objectives
- performance measures for survival and recovery standards have already been set
  - the output of the decision analysis can go beyond these standards by showing the absolute values of these probabilities.
  - NMFS doesn't have to define what they mean by "moderate to high likelihood", except to set some minimum level because each of the actions can be ranked according to their actual probability.
- what quantitative measures should be used for the learning objective (e.g. change in probability distribution for uncertain parameters)?
- are there other performance measures besides survival/recovery and learning that should be considered? Cost? Social and economic impacts? (If not provided by PATH, then by whom ?)
- will different performance measures be combined into a single criterion to rank management actions or be kept separate?
- will decisions be made on individual stocks or basin-wide (objectives and alternative management actions will be different for different stocks or groups of stocks)
- maybe do two separate decision analyses:
  1 for endangered Snake River stocks where stock recovery is the only objective (i.e. no adaptive management)
  1 for healthier stocks that will be subjected to an adaptive management program

3. Uncertain states of nature

- it is usually desirable to limit the number of uncertain states of nature.
- is it feasible to develop alternative hypotheses by life stage, or is it better to look at impacts on overall life-cycle survival?

- possible uncertainties to consider:
  effects of habitat quality/quantity on life-cycle survival
  passage JMC survival
  variability in EOS survival
  up-river passage survival
  existence/magnitude of depensatory mechanisms
  others specific to alternative management actions (e.g. delayed mortality effects of transportation)

- the focus should be on selecting those uncertainties that have the greatest effect on the outcomes of management actions (e.g. it may not be important to include uncertainties in the survival in all life stages)

- what do the retrospective analyses indicate about these key uncertainties?

- is there a way to represent alternative forms of key functional relationships (e.g. flow-survival, transport survival) without using an entire passage model?

4. Calculate probabilities for uncertain states of nature

- method for quantifying uncertainties will depend on which uncertainties are considered

- if data exists, MLE/Bayesian methods or quantitative comparison of model output to different data sets (discussed in Kah-Nee-Tah workshop) could be used for JMC/hydro actions

- can subjective probabilities be used for alternative habitat/hatchery hypotheses? How?

5. Model to calculate outcomes

- structure of model to simulate outcomes will depend on objectives, actions, and uncertainties

- may require some sort of composite model

- can Deriso prospective model be used? Is it flexible enough?

- Can a series of nested models be used:
  mgmt action ---> passage model 1 ---> Deriso's model
  mgmt action ---> passage model 2 ---> Deriso's model

6. Decision tree

- the decision tree constructed in the last workshop is a reasonable starting point

- may also consider structure without separate life history stages

- can be modified as issues relating to objectives, actions, and uncertainties are resolved

7. Rank actions

- it may not be possible to get a single answer out of the decision analysis that is satisfactory to everyone because disagreements over assumptions, objectives, methods, etc. are bound to occur

- the process of looking at these issues in a decision-analysis context can at least provide some common ground for discussion and help to clarify major uncertainties and assumptions

8. Sensitivity analyses

- the complexity of the biological and management system virtually guarantees that not everyone will agree with certain assumptions, approaches, or parameter values.

- sensitivity analyses will be an essential component of the decision analysis to identify those points of contention that most affect the decision.

- example sensitivity analyses:
    weightings of different data sets used to estimate probabilities
    subjectively assigned probabilities

Implementation

- management objectives and performance measures, management actions, and key uncertainties should be identified first

- need to involve decision-makers in identifying management objectives, performance measures, and actions

- work-groups to work on these components

Appendix 3 - Task List

Task	Group	Status	By when (Revised)	Priority
A. Spring/summer chinook retrospective analyses				
R1. Publish selected FY96 chapters in peer-reviewed literature	Contact journal - ESSA Ch. 1 - ESSA (*) Ch. 2 - Paulsen & Botsford Ch. 3 - Schaller (*) Ch. 4 - Paulsen Ch. 5 - Deriso (*) Ch. 9 - Petrosky (*) Ch. 12 - Anderson (already in press)		Contact journals (CJFAS or TAFS) by Dec. 31 submit * chapters by Jan 15 1997	H
R2. Complete documentation of S-R data (including response to comments received on S-R data)	Beamesderfer et al.	In progress; adding index stocks for habitat task group	Jan. 15	H
Complete conclusions document --> input to 5 yr research plans by end of October	ESSA + Planning group + Paulsen + Barnthouse	**Completed**		
R3. Hydro Retrospective . extend Chapter 3 analyses to other stocks (Willamette, N. Umpqua spring-type) to strengthen conclusions about geographical differences . running average ANCOVA for Ch. 3 to look for point in time where stock parameters change	Schaller, Langness, Petrosky	In progress	Feb 28 mid-Dec.	H (Will. R - Low.)
. estimate magnitude of delayed mortality of transported and non-transported fish post-1975 . reconcile Ch. 6 survival targets with Ch. 5 μ estimates (measure of delayed mortality)	Toole, Anderson, Deriso	Some progress (Anderson's estuary work)	Feb 28	H
. attempt to explain year-to-year variation in delayed mortality as a function of climate and other variables	Hinrichsen		Feb 28	H
. clarify dip in μ during early 1980s . estimate μ for mid-Columbia stocks (Wenatchee, Entiat, Methow) . get MLE code distributed and documented	Deriso, Anderson, Langness, Schaller	 **Completed**	Feb 28	H
. CRiSP/FLUSH "#3" (new versions incorporating hypotheses about delayed mortality): compare to MLE.	ESSA, Anderson, Wilson, Schaller		Feb 28	L
. finish Ch. 6 retrospective tasks	Toole, Giorgi, Weber		Feb 28	H

R3. Harvest Retrospective Complete Ch 13 DRAFT REVIEWED FINAL	<u>Langness</u>	In progress	Completed draft by Feb. 15	M
R3. Habitat (as identified at Walla Walla meeting) . derive rules for assigning habitat rating to index stocks and apply (Petrosky, Beamesderfer) . add other stocks beyond index stocks to dataset (Petrosky, Beamsesderfer) . incorporate EA analyses into Ch. 10 (Lee, Horan) . reconcile EA / index stock spatial scales (Petrosky, Beamesderfer, Lee, Horan) . compare Ch 5 among stocks with differing habitat ratings (Jones, Deriso) . look at parr density data versus habitat variables (Griswald, Petrosky, Lee, Horan) . incorporate EA analyses into Ch. 10 (Lee, Horan) . summarize PIT tag results (Paulsen, Fisher) . add land use data to Ch. 4 analysis (Paulsen) . revise chapter 10 (Jones, Pinney)	<u>Pinney</u>, <u>Jones</u>, Beamesderfer, Langness, Lee, Paulsen, Petrosky, Strach (NMFS), Ries (NMFS)	**Habitat Task Group Meeting held Nov. 12 - 13. in Walla Walla** Habitat tasks / revision of Ch. 10 in progress Compiling land-use data	Drafts of revised sections of Ch. 10 circulated by Dec. 31 Other analyses completed, draft methods and results for inclusion in revised Ch. 10 by Jan. 31	H
R3. Hatcheries . add other stocks to data set, refine Ch. 11 analyses (incl. corrections for autocorrelation bias) . measure decrease in survival due to hatchery [over]production . include hatchery production in MLE analysis (chinook, all stocking) . add other hatchery production variables to Ch. 11 analysis . look at data from outside Columbia basin (published data only) . compare ln(R/S) for hatchery component of stock to ln(R/S) for entire stock (wild and hatchery spawners)	<u>Wilson</u>, Deriso (for MLE task), Foster, Geiselman, Langness, Matylewich, Mundy, NMFS rep, ODFW rep, Paulsen, Peters, Petrosky/Cannamela, Pinney	Pursuing further regression analyses; will do pilot analyses and circulate for comment; lacking data for some tasks literature review low priority	Draft analyses to elicit feedback by Feb 28	H
R3. Climate . year effect (δ): test for correlations with, e.g., PNI, flow, water of origin, timing of spring transition relative to arrival times	<u>Deriso</u>, Anderson	**Correlations completed for δ, PNI, flows, timing of spring transition (Anderson)**		

. extend Ch. 2 analyses to other stocks (non-Columbia, ocean-type chinook)	Paulsen, Botsford		Feb 28	L
. extend Ch. 4, with *a priori* hypotheses (ln(R/S) correlation with timing of spring transition, sea surface temperature	Paulsen, Botsford, Fisher	Compiling land-use data	Feb 28	M
B. Fall Chinook Retrospective Analysis				
R4. Run reconstructions (six stocks) and documentation . includes two ocean-type spr/sum mid-Columbia stocks	Schaller, Langness, Beamesderfer, Mary Ann Johnson, Jim Norris, Wilson, Rich Zabel	In progress	Jan 30	HH
R4. Harvest analysis	Schaller, Langness, Beamesderfer, Mary Ann Johnson, Jim Norris, Wilson, Rich Zabel	waiting for run reconstructions	Preliminary work plan by Feb 28	H
R4. Hydro . Ch. 3 graphical analysis	Schaller, Langness, Beamesderfer, Mary Ann Johnson, Jim Norris, Wilson, Rich Zabel	waiting for run reconstructions	March 15	H
. Ch.6 style analysis	Toole, Giorgi, Peterson, Weber		Feb 28	H
. Hanford Reach transported/non-transported comparison (assess delayed mortality?)	Toole, Hinrichsen, WDFW		Feb 28	L-M
R4. Climate . Effects of ocean distribution/climate on recent trends in stocks	Geiselman, Anderson, Sang-Yoon Hyun, Mary Ann Johnson, Jim Norris, Schaller	delayed; Sang-Yoon Hyun unavailable until Jan.	March 15	H
R4. Habitat . examine trends in Snake R. thermal regime to relate to run reconstructions	Petrosky, Pinney et al.	waiting for run reconstructions	March 15	H
C. Steelhead retrospective analyses				
R5. Assemble spawner escapement and smolt age data and assess potential for run reconstructions	Petrosky, Beamesderfer, NMFS person, WDFW person	gathering data	Jan 31	H
D. Spring/summer chinook prospective analyses				
P1. Estimate required life-cycle survival to achieve survival/recovery goals . agree on prospective model assumptions; assess consistency with ELCM/SLCM	Marmorek, Deriso, Paulsen, Petrosky, Schaller, Wilson, Weber, Smith, Anderson, Geiselman, Lee, Hinrichsen	**Prospective model meeting held Dec. 4**	Next meeting Jan. 15-16	H

. review depensatory effects literature	Botsford, Wilson, Paulsen	in progress	Jan 10	H
. compute μ* from MLE model	Deriso		Jan 10	H
P2. Prototype decision analysis framework	Marmorek*, Peterman*, Peters*, Anderson, Cooney, Deriso, Geiselman, R. Gregory, Lee, Petrosky, Schaller, Toole, Weber	**Met with Robin Gregory (decision analysis expert) Dec 11**; Further meeting planned for Jan. 9	"Thought paper" by Dec 20 Prototype analysis by Jan 31	H
P2. For each H, determine possible changes in life cycle survival (μ) that could result from H actions	Hydro - Toole Habitat - Pinney/Jones Hatchery - Wilson Harvest - Schaller Climate - Deriso		Methods papers by Feb 15	H
P2. Climate - sensitivity analysis of distribution - effect on decisions	Deriso	**Discussed at Prospective model meeting Dec 4**	Jan 30	M