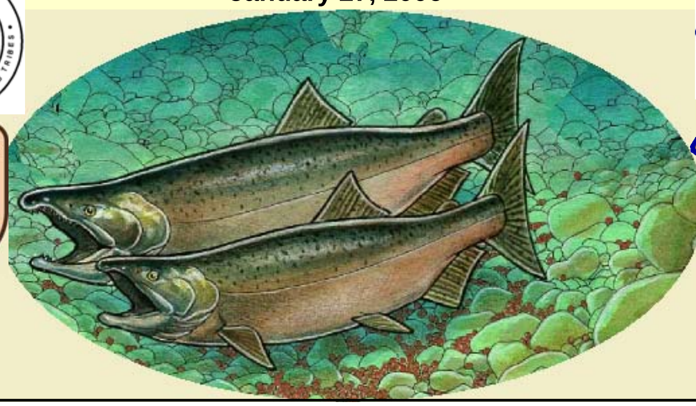
COMPARATIVE SURVIVAL STUDY (CSS) of PIT-tagged Spring/Summer Chinook and PIT-tagged Summer Steelhead

2005 Annual Report

Presentation to the ISAB

January 27, 2006

Fish Passage Center



Outline

– Background
– Organization
– Objectives and Tasks
– Rationale for approach
– ISAB Review History of CSS
– CSS modifications and responses
– Response to 2005 Report comments
– Future Direction

Background

- Study initiated in 1996 by states, tribes & FWS to estimate survival rates at various life stages
- Response to initial analysis by IDFG suggesting lower SARs for multiple bypass yearling chinook
- Develop a more representative control for transport evaluations
- Compare survival rates for chinook from 3 regions
- CSS information derived from PIT tags
- Collaborative scientific process was implemented to design studies and perform analyses
- CSS project independently reviewed and modified a number of times, primarily focusing on CIs about parameter estimates (ISAB, ISRP, etc.)

The CSS is a joint project of the

state, tribal fishery managers and the US Fish and Wildlife Service

Design
WDFW, CRITFC, USFWS, ODFW, IDFG

Review
Regional review, ISAB, ISRP, FPAC, NMFS

Implementation
FPC - logistics, coordination, e.g.
PITAGIS - data management

Data Preparation
FPC

Analysis
CSS Oversight Committee, FPC - coordinates

Review
Regional Review public review
Drafts posted on FPC and BPA websites

Final Report
Posted on BPA and FPC websites

Objectives

- **Develop long-term index of Transport and Inriver survival rates for Snake River Wild and Hatchery chinook and steelhead**
  - Mark at hatcheries >220,000 PIT tags
  - Smolts diverted to bypass or transport from study design
  - Inriver groups SARs from never detected & detected $\geq$ 1 times
  - SARs from Below Bonn for Transported & Inriver groups (T/I ratio and Differential delayed mortality-D)
  - Increase marks for wild chinook to compare hatchery & wild chinook > 23,000 added wild PIT tagged fish
  - Begin marking of steelhead populations in 2003
- **Develop long-term index of survival rates from release to return**
- **Compare overall survival rates for upriver and downriver spring/summer Chinook hatchery and wild populations**
- **Provide a time series of SARs for use in regional long-term monitoring and evaluation**

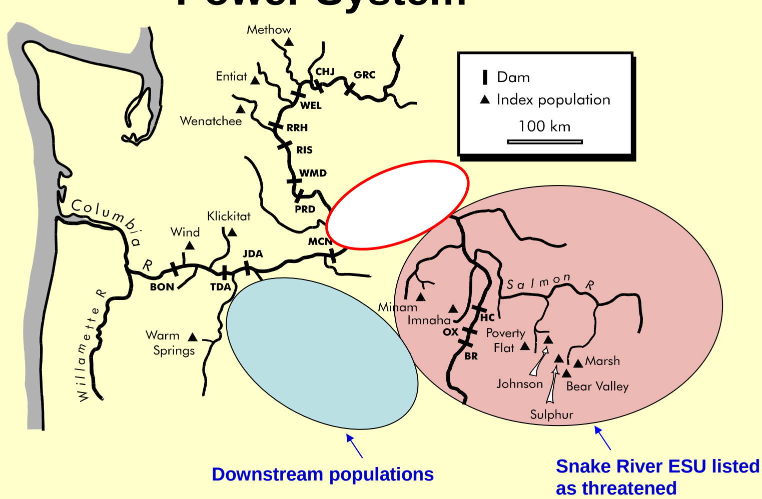
What does CSS project provide?

- **Long term consistent information collaboratively designed and implemented**
- **Information easily accessible and transparent**
- **Long term indices:**
  - Travel Times
  - In-river Survival Rates
  - In-river SARs by route of passage
  - Transport SARs
- **Comparisons of SARs**
  - Transport to In-River
  - By geographic location
  - By hatchery group
  - Hatchery to Wild
  - Chinook to Steelhead

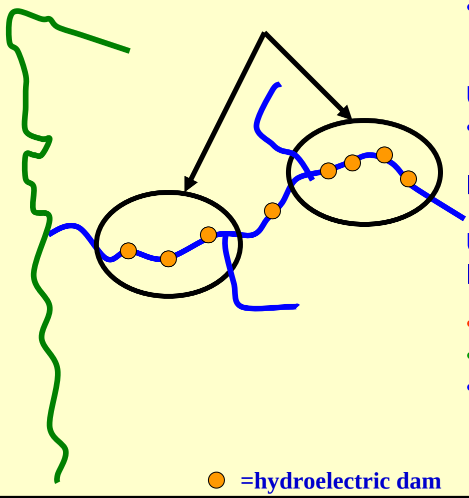
Quantities estimated for Snake River spring Chinook and steelhead

- Interested in SARs of different treatment groups, from different starting points, so need:
  - Passage histories of individual fish
  - Reach Survivals
  - LGR arrivals
  - T0, C1, C0
  - SAR(T0), SAR(C1), SAR(C0)
  - SAR(TLGR), SAR(TLGS), SAR(TLMN)
  - SAR(Overall)
  - $T/C = SAR_T/SAR_C$
  - *D*

Snake River salmon declined since completion of the Columbia River Power System



Spatial/Temporal Analyses



Compare Upstream to Downstream populations:

- 1-3 dams vs. 8 dams
- Similar life history
- Common estuary and early ocean environment

Update of Schaller et al. 1999:

- Survival indices for Snake & downstream populations

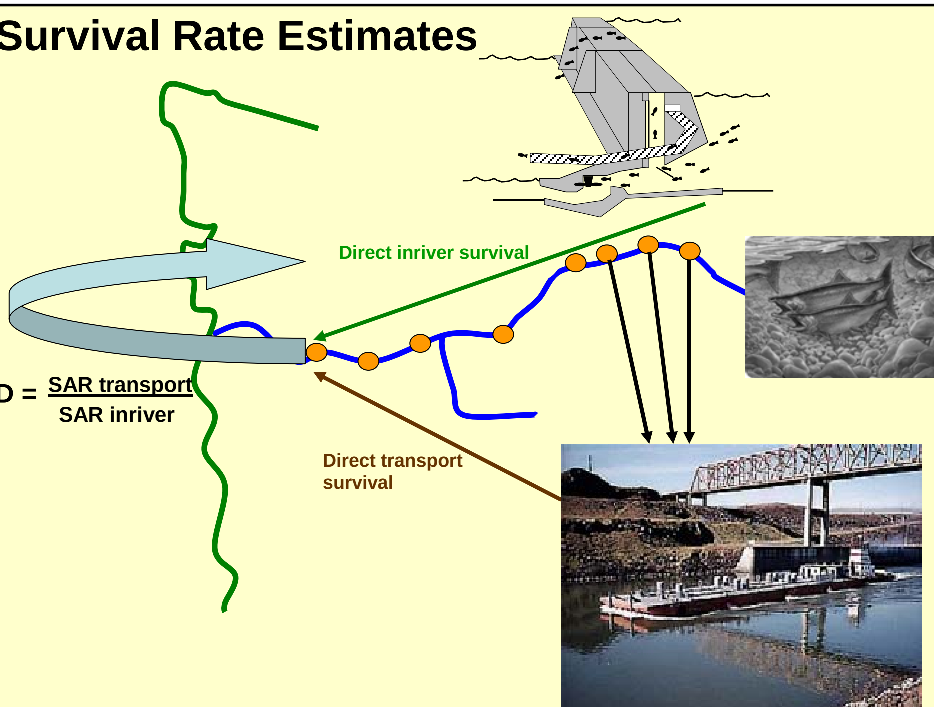
$$\ln(R/S)_{i,j} = \tau_i + a - \beta(S_{i,j} - \bar{S}_{..}) + \varepsilon_{i,j}$$

Update of Deriso et al. 2001:

$$\ln(R/S)_{i,t} = a_i - b_i S_{i,t} - (M_t + \mu_t) + \delta_t + \varepsilon_{i,t}$$

- Differential mortality, μ
- Common year effect, δ
- Environmental correlates & other salmon populations

Survival Rate Estimates



$$D = \frac{\text{SAR transport}}{\text{SAR inriver}}$$

Partitioning differential mortality, μ (Snake versus downstream)

Direct (LGR-BON):

in-river survival rate

transport survival rate

Delayed (BON to adult return):

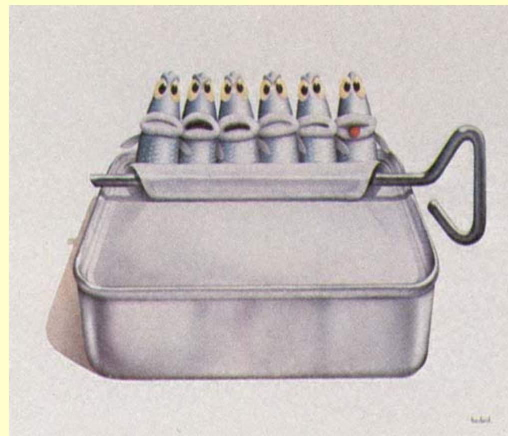
differential delayed mortality of transported fish = D =

transport SAR / in-river SAR

Delayed in-river mortality

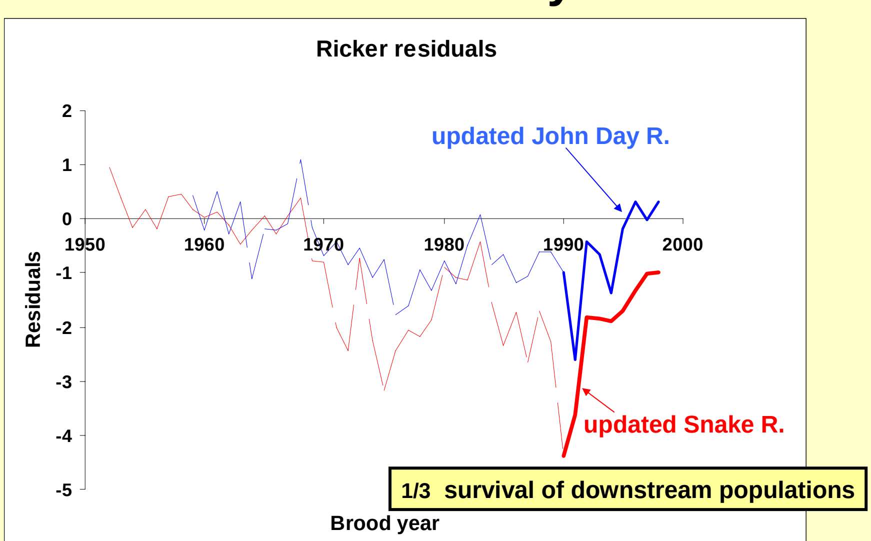
= μ - (direct mort.)

- (delayed transport mort.)



Update of Peters and Marmorek 2001

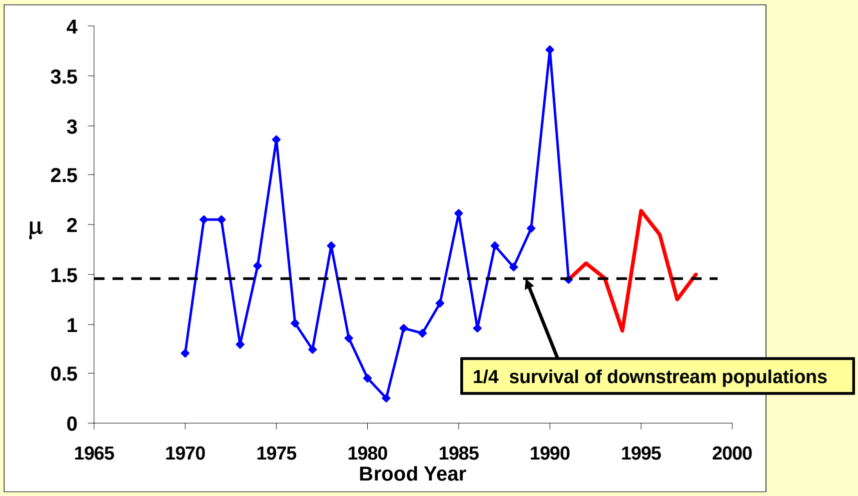
Updated survival rate indices, 1991-1998 brood years



Update of Schaller et al. 1999

Snake River populations continue to show greater mortality than downriver stocks (μ>0)

$$\ln(R/S)_{i,t} = a_i - b_i S_{i,t} - (M_t + \mu_t) + \delta_t + \varepsilon_{i,t}$$



Update of Deriso et al. 2001

History of ISAB/ISRP Reviews of CSS

- **ISAB – Jan. 14, 1997 review of CSS followed by face-to-face meeting in Spokane Mar. 10, 1997**
- **ISAB – Jan. 6, 1998 review of CSS**
- **ISRP – July 16, 2002 held review meeting of CSS where a CSS presentation was made followed by responses by CSS to ISRP Aug. 23, 2002.**
- **ISRP – Sept. 18, 2002 additional questions to CSS which were addressed in face-to-face meeting in Seattle Sept. 24, 2002**

Outcome of 1997 reviews

- ISAB was briefed on the rationale for upstream/downstream comparison approach applied in CSS.
- Oversight committee had initially requested NMFS participation in study - ISAB reinforced this point in their review.

Outcome of 1998 review

- ISAB recommended adding other species of salmon including steelhead – to date CSS has not been able to get BPA funding for steelhead, but is attempting to add steelhead again in 2007 – 2009.
- ISAB concurred with shift from proportional tagging to PIT tagging minimum 45,000 at study hatcheries for assessing hatchery-specific SARs
- ISAB recommended resampling or other methods for variances of SAR; thereafter CSS began work on a non-parametric bootstrap approach.

Outcome of 2002 reviews

- **Briefed ISRP on estimation formulas plus bootstrap used for estimating confidence interval. Based on ISRP recommendation, added chapter comparing the bootstrap with likelihood-based confidence intervals to the 2002 Annual Report.**
- **Briefed ISRP on importance of T/C ratios and D in assessing management actions.**
- **Began programming to implement ISRP recommended *Monte Carlo* simulation to assess validity of bootstrap confidence interval coverage.**

Status of simulation computer program

- **2003/04 CSS Annual Report (April 2005) shows flowchart of simulation program in Chapter 6.**
- **Year 2005 – saw completion of programming and initial trials to test the program logic.**
- **Year 2006 – planning series of simulation runs to evaluate validity of T_0, C_0 and C_1 SAR estimates and coverage of confidence intervals resulting from bootstrap program.**

Q1: Is estimated SAR(T_0) biased?

- **CSS uses smolts "destined" for transport (expands transport # by survival rate from LGR to downstream transport facility)**
- **BPA recommends using only fish actually placed in transport barges or trucks**
- **Higher CSS transport # gives lower SAR, but this doesn't mean CSS is biased**

Q2: Is estimated SAR(C_0) biased?

- **CSS uses smolts estimated passing 3 Snake River transport dams undetected to tailrace of LMN, then expands the tagged fish to LGR-equivalents as starting number for C_0 study group.**
- **Skalski (5/2/2000 review of first CSS annual report) recommends not expanding the undetected fish to LGR-equivalents, and instead uses estimate of tags in LMN tailrace as starting number for C_0 study group.**

Q3: How is T/C ratio affected?

- CSS transport SAR < BPA estimate
- CSS inriver C_0 SAR < Skalski estimate
- Expansion to LGR-equivalents uses:
  - Survival expansion for transport fish is {Prop(lgr)*1+Prop(lgs)*S2+Prop(lmn)*S2S3}
  - Survival expansion for inriver fish is {S2S3}
- CSS T/C ratio > BPA T/C ratio
- CSS evaluates Transport to Inriver survival through the entire hydrosystem to address this question – not “biased”

Q4: Is T_0 vs C_0 comparison biased if size differences exist?

- Tagged T_0 fish mimic untagged collected fish and tagged C_0 fish mimic untagged uncollected fish.
- If a fish size difference truly exists, inriver survival rates & smolt #s in T_0 and C_0 may be affected, but simulation studies could look at this potential impact.
- If this fish size differential is small, then the impact on estimated SARs for T_0 and C_0 fish should also be small.

Q5: Is T_0 vs C_1 (collected fish) better comparison?

- **NOAA Fisheries says comparing transported fish to bypassed fish is better since they are of similar size range.**
- **True if question of interest is “what to do with the collected fish at dams?”**
- **But CSS was initially designed to compare transported to non-bypassed inriver fish (C_0 Group) since under full transport strategy all collected fish are transported.**
- **CSS design evaluates - How the system is managed?**

Q6: Why no CI on SARs in upstream/downstream chapter?

- **Bootstrap CI and likelihood CI methods for SARs in upstream/downstream comparisons are being evaluated**
- **Anticipate having CI for all comparisons made in future CSS annual reports**

Q7: Why no seasonal SARs?

- **CSS Workshop in 2004 showed seasonal differences in point estimate SARs for Chinook transported or bypassed at LGR.**
- **Further work on the question of seasonality effects is warranted, and is planned for inclusion in subsequent CSS reports.**
- **Programming is planned to develop technique to estimate seasonally blocked SARs and confidence intervals.**
- **Seasonality needs to be evaluated over series of years – for consistent pattern.**

Annual *D*, T/C, SAR estimates which don't show within-season pattern are misleading

- **Annual estimates needed to fit retrospective models and test hypotheses (seasonal trend not only important hypothesis)--other metrics of hydrosystem performance are estimated annually, though they have seasonal component (e.g. in-river survival)**
- **Annual estimates allow investigation of the magnitude of inter-annual variation in these parameters, which has consequences for future population viability, and to compare to target values of these parameters**
- **Impossible to assign true control in-river (C0) fish a passage date at LGR, making it impossible to estimate seasonal trends in SARs for this group.**
- **Patterns of survival may differ between different species (or origins) which are transported contemporaneously, making optimization problematic, anyway.**

Effectiveness of the transport system is better assessed by T/C ratios than *D*

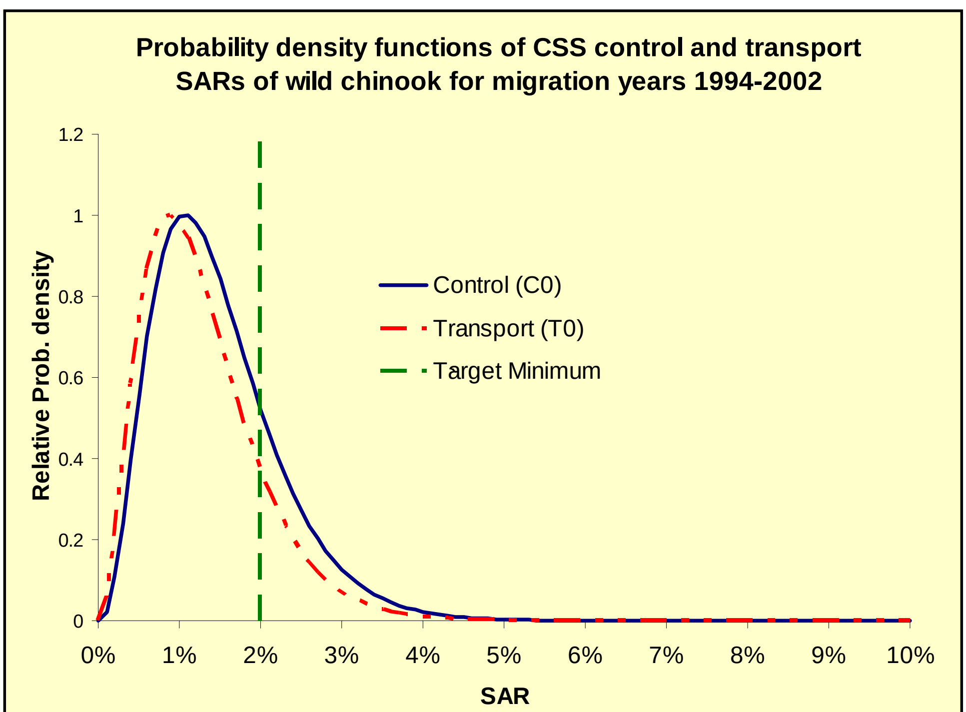
- Both are useful for different purposes; it depends on what management question is posed and what hypotheses are being considered
- *D* parameter helps isolate mortality occurring outside hydrosystem from mortality occurring within hydrosystem (“direct mortality”), useful for hypothesis generation & testing
- *D* is a parameter in a number of modeling efforts (PATH, Karieva et al. matrix) which considered effectiveness of dam breaching
- NOAA’s technical memorandum on the effects of the FCRPS expounds on the implications of different *D* values for hydrosystem management

Target minimum SAR on the graph is inappropriate (it’s *ad hoc*)

- **2-6% range adopted as an interim target by the Northwest Power and Conservation Council, mainstem amendments of 2003**
- **PATH modeling found this range corresponded well with meeting survival and recovery targets**
- **Other analyses, with different assumptions, support a similar minimum SAR for recovery (matrix model)**

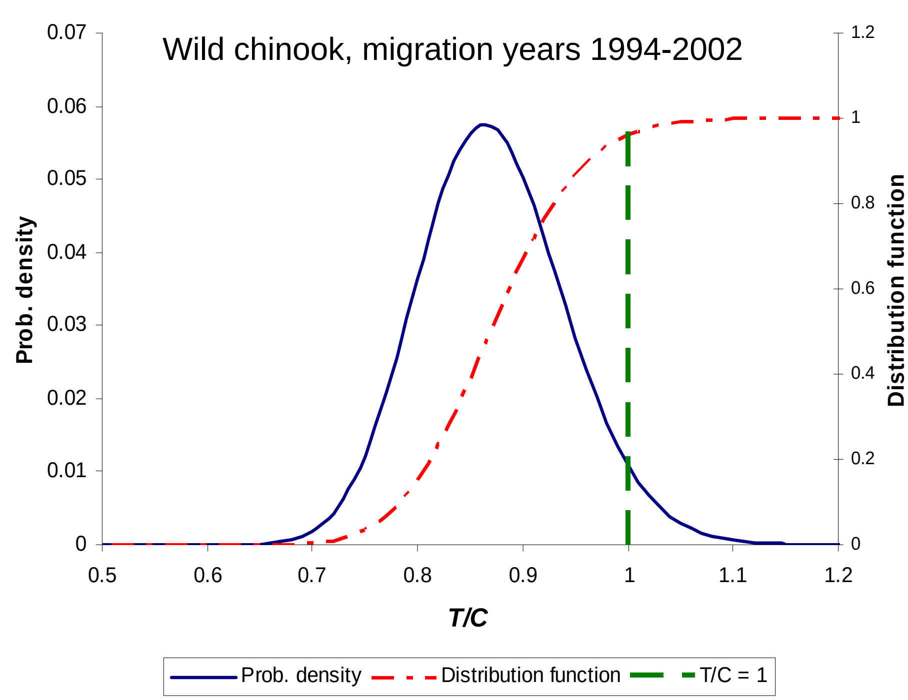
Further analysis of of wild chinook SARs and T/C ratios

- Uncertainty in SARs, T/Cs and *D*s due to both process and measurement error
- How to best estimate process error (inter-annual environmental variation) in the true value of these parameters?
- Assuming SAR measurement error is binomial sampling error, can remove from time series of estimates to get estimate of environmental variance alone. Assume beta distribution.
- Method of weighting data from different years influential; goal is to represent the untagged population as well as possible

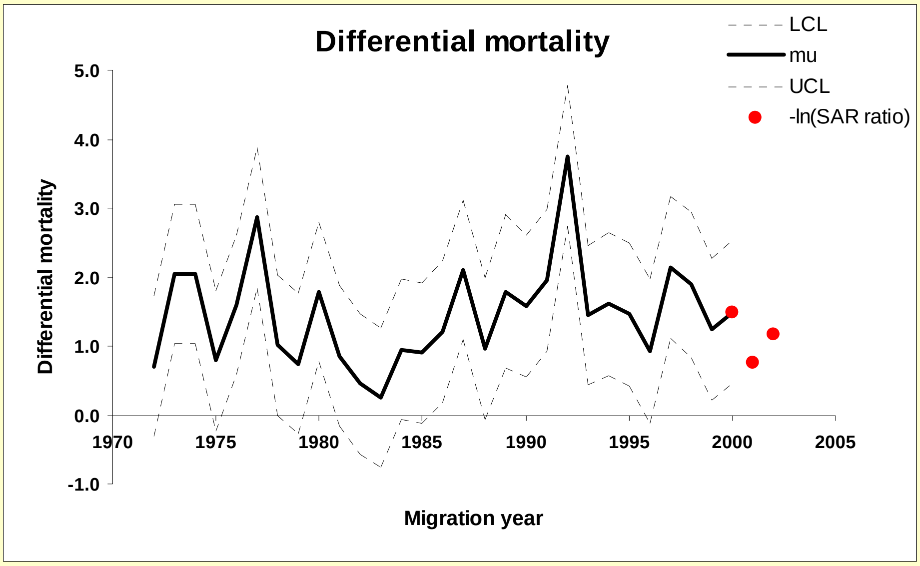


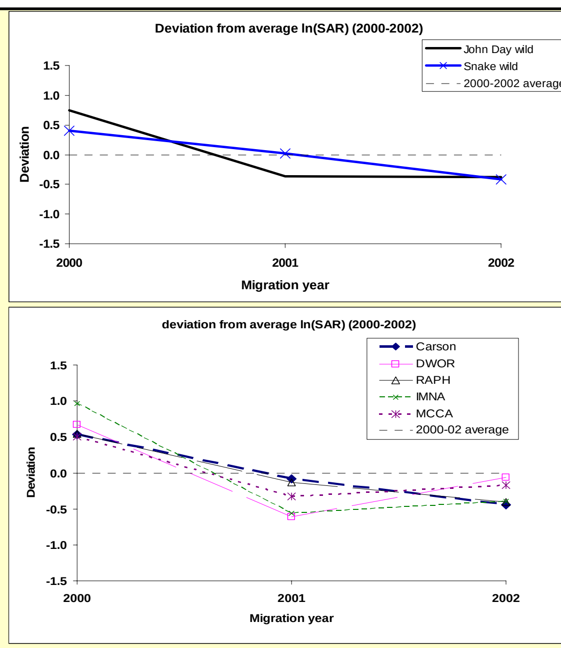
T/C distribution

- Can use mean and variance of transport and control SARs to estimate distribution of T/C
- Assume log-normal distribution
- Annual estimates of SAR_T & SAR_C highly correlated
- Calculate covariance between SARs; reduces estimated variance of ln(T/C)

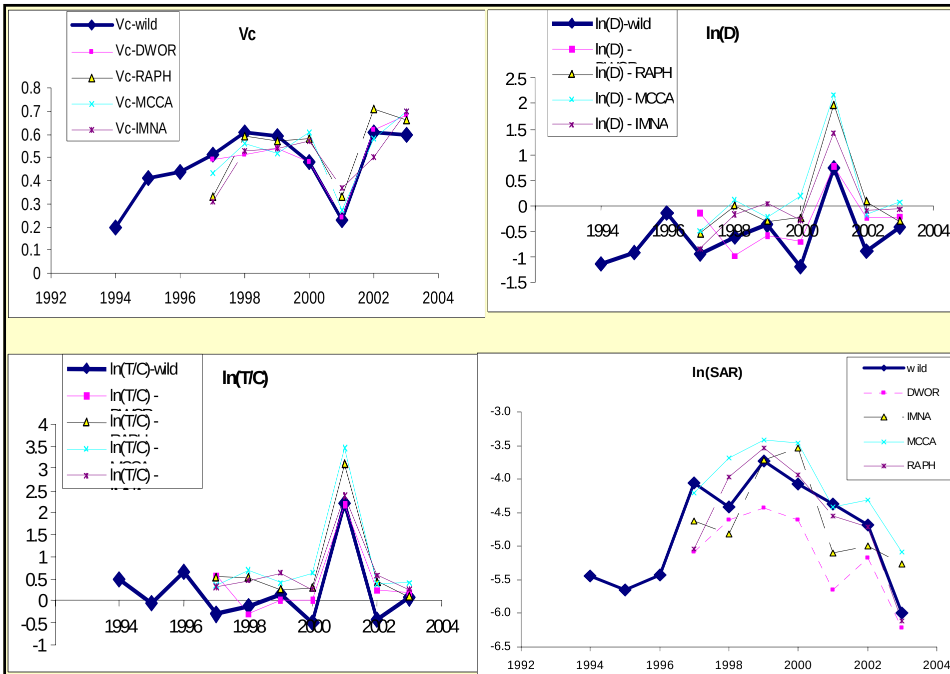


Response to Chapter 6 comments





Deviations in ln(SAR) from the 2000-2002 average for Snake River and John Day wild spring/summer Chinook (upper panel), and for Snake River (DWOR, RAPH, IMNH, MCCA) and downriver (Carson) hatchery spring/summer Chinook (lower panel).

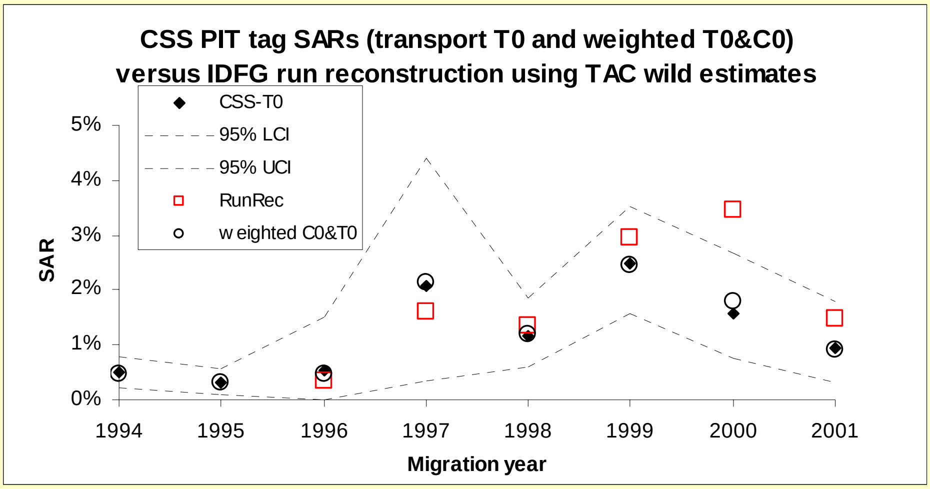


Parameter estimates for Snake River wild and hatchery spring/summer Chinook.

CSS Chapter 6 CONCLUSIONS

- **Differential mortality estimated from SARs correspond with estimates from R/S for wild populations. Deviations in PIT-tag SARs suggest common annual survival patterns during 2000-2002 for Snake River and John Day populations**
- **Differential mortality estimates from SAR ratios of hatchery populations - less than those of wild populations. SARs among populations show common annual pattern - consistent with common year effect**
- **Wild and hatchery populations differed for some parameters (T/C, D and SARs), though the annual patterns of these parameters were highly correlated**
- **In years of low abundance – Need to rely on hatchery fish**

Estimated SARs for wild Snake River spring/summer chinook, for the run-at-large (untagged; IDFG), and for PIT-tagged smolts from CSS



Future Direction

- **Continue to maintain long-term indices of survival for Chinook & Steelhead**
- **Expand PIT tag groups for Steelhead**
- **Complete simulation runs to evaluate T_0, C_0 and C_1 SAR estimates and confidence intervals from bootstrapping**
- **Develop distributions for SARs, T/C, and D**
- **Further work on seasonality effects is planned for inclusion in CSS:**
  - **Develop technique to estimate seasonally blocked SARs and confidence intervals**
  - **Evaluate seasonality over series of years for consistent patterns in SARs, T/Cs and Ds**


Its smooth sailing from here
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