Fall Chinook Work Group

Tuesday, 6 December 2011

Grant PUD Natural Resources Office

Ephrata, WA

Technical members

Paul Wagner, NMFS
Jeff Fryer, CRITFC
Holly Harwood, BPA
Keith Truscott, CPUD
Bill Tweit, WDFW
Marcie Mangold, WDOE
Russell Langshaw, GCPUD
Steve Hemstrom, CPUD
Joe Skalicky/Don Anglin, USFWS
Paul Ward/Bob Rose, YN
Brett Swift, American Rivers
Tom Kahler, DPUD
Paul Hoffarth, WDFW
John Clark, ADFG
Todd Pearsons, GCPUD

Attendees: (*Denotes Technical member)

Marcie Mangold, WDOE*
Tom Kahler, DCPUD* (on phone)
Todd Pearsons, GCPUD*
Joe Skalicky, USFWS* (on phone)
Paul Hoffarth, WDFW* (on phone)
Steve Hays, CPUD
Russell Langshaw, GCPUD*
Geoff McMichael, Battelle
Paul Wagner, NMFS* (on phone)
John Clark, ADFG* (on phone)
Jeff Fryer, CRITFC* (on phone)
Tracy Hillman, Chair

Action Items:

1. **Russell Langshaw will develop a protocol that will be followed when the USGS flow gage fails.**
2. **David Bernard will review Sharma's stock-recruitment report and possibly redo or revise the analyses.**
3. **Joe Skalicky will provide TAC contacts who can explain the age composition data used by the TAC.**
4. **Battelle will prepare a short paper on the pros and cons of the three different age-data sets. The FCWG will then evaluate the three approaches and determine which age data should be used in the S-R analyses.**

5. **Russell Langshaw will provide the draft dam-passage fallback report to the FCWG by Friday, 9 December.**
6. **Battelle will send the entrapment histories to Joe Skalicky and Steve Haeseker by Friday, 9 December.**
7. **Russell Langshaw will provide comments on the draft egg-fry survival paper by Thursday, 15 December. The draft report will then be distributed to the FCWG in January 2012.**
8. **Paul Hoffarth will send WDFW's 2011 sampling report to the FCWG by the end of December.**

Meeting Minutes

I. **Welcome and Introductions** – Tracy Hillman welcomed attendees to the meeting.

II. **Agenda Review** – Agenda was approved with no changes.

III. **Approval of Meeting Minutes**

- 1 November 2011 Meeting Minutes – Approved.

IV. **Review of Action Items** - Action items identified during the November meeting were discussed.

- Geoff McMichael will determine if fall Chinook recruitment estimates include fallback, and, if they do, how they were adjusted. **Complete: estimates do not include fallback.**
- Geoff will check if they have a final stock-recruitment data set for fall Chinook. **Complete: final data set is not yet available.**
- Geoff will provide documents to Tracy Hillman and Debbie Williams describing MASS1 and 2. These documents will be posted on the FCWG website. **Complete.**
- Geoff will find out if output from one component of the production simulation model serves as input into another component of the model (do the beads all connect on the chain?). **Complete: components are independent.**
- Russell Langshaw will develop a protocol that will be followed when the USGS flow gage fails. **Ongoing.**
- Joe Skalicky will find out who commissioned Hanford Reach aerial photography for 2004 and 2005. **Complete: the USFWS commissioned Walker to do the aerial photography.**

V. **Study Plan Updates**

A. **Productivity Assessment** – Geoff McMichael reported that Rishi Sharma recently provided results from the run reconstruction that estimated adult equivalents for each BY 1975-2004 and SMSY (spawning escapement required to achieve MSY). Rishi developed an estimate of SMSY = 26,295 (90% credible interval = 21,750 – 39,750) adults and alpha = 6.9. Attachment 1 contains Rishi's write-up including methods, results, and an alternative approach that uses normalized average smolt to adult survival rates (as suggested by the Expert Panel). However, the SMSY estimate using this approach was unreasonable (344,500 adults). The S-R analysis will not be conducted for years before BY 1975, because of the high level of uncertainty in recruit estimates generated using the PATH methods, whereby ocean impacts are not based on CWT recovery. Figure 1 shows the stock-recruit relationship.

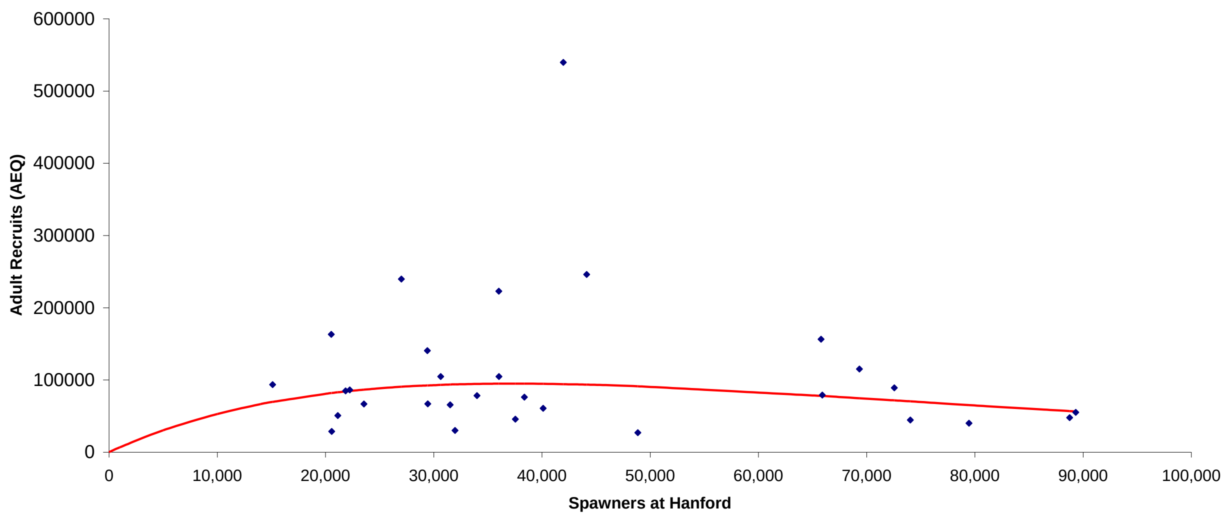


Figure 1. Relationship between Hanford Reach fall Chinook spawners and recruits (from Sharma 2011; see Attachment 1).

John Clark recommended that David Bernard review the document prepared by Rishi. John indicated that because Rishi was trying to move his family to Thailand, he was unable to do a thorough job on the analysis. It is not clear whether he included jacks in the analysis (typically jacks are included in recruits but not spawners). Also, it does not appear that he addressed the temporal correlation (autocorrelation) in the data. Hanford Reach fall Chinook are known to have a significant one-year-lag autocorrelation.

Geoff noted that WDFW escapement estimates were used for the S-R analyses (not those adjusted for re-ascension as determined by Mueller). Additionally, age proportions from the Technical Advisory Committee (TAC) were used for these analyses (not those obtained from WDFW carcass surveys of the Hanford Reach). It is unclear exactly how TAC age proportions were estimated and what data were used to make these estimates. Geoff asked if anyone knows someone within TAC who could describe how they estimated age proportions. Joe Skalicky said that he will provide appropriate contacts with TAC.

Geoff also stated that the carcass data appear to underestimate age-3 fish and overestimate age-4 and age-5 fish (see figures in Attachment 2). TAC age proportion data only dates back to 1980. Therefore, Rishi used average age proportions from BY 1980-2009 for BY 1975-1979. An alternative to using averages for BY 1975-1979 would be to use the age proportions of the upriver bright run estimated at the mouth of the river that are included in Harlan et al. (1998)[1]. For BY 1980-1997, the age proportions from Harlan et al. (1998) agree well with those from the TAC (see Attachment 2). Geoff asked the FCWG for direction on what age data to use in the analysis. The FCWG recommended that Battelle prepare a short paper on the pros and cons of the three age-data sets. The FCWG will then evaluate the methods and determine what age data to use in the S-R analyses.

B. **Dam Passage Fallback** – Geoff reported that the fallback report was revised slightly with the addition of some new material including updated otolith data, hatchery operations, and inter-dam conversion rates to determine if dam counts can be used to assess high fallback years at Priest Rapids Dam. Battelle also looked at the relationship of aerial redd counts to escapement to determine if these data can be used to predict escapement during years in which there is high uncertainty in adult counts at Priest Rapids Dam. Russell is currently reviewing the revised report. Russell will provide the draft report to the FCWG by Friday, 9 December.

C. **Hydrodynamic Model Synthesis** – Geoff stated that they have completed the water temperature calibration and validation work. Mean average errors for the Feb-July 2011 period were all less than 0.3°C, which is the accuracy of the temperature loggers. This was for the 30-m mesh, but they do not expect to see much difference for the 10-m mesh. Sara is currently doing the data extractions for the stranding points. She will send the entrapment histories to Joe Skalicky and Steve Haeseker by the end of the week. The rest of the production runs using the 30-m and 10-m mesh resolutions will begin this week and will proceed through those according the priority list identified in the November meeting notes.

D. **Egg to Fry Survival** – Geoff reported that additional data were collected on the early stages of fall Chinook development by collecting gametes from PRDH on 21 November and then mixing the gametes at the aquatic lab in Richland. Egg lots were then removed about every two hours for over 50 hours and were preserved in Stockard's solution. These will be examined to refine the development stages for this early period. This increased resolution in stage of development should allow for more precise determination of time of fertilization.

[1] Harlan, K., R. Roler, and R. Pettit. 1998. Run size forecast of the return of Columbia River fall Chinook salmon stocks in 1998. Columbia River Progress Report 98-01. WDFW.

Geoff said that the draft report on egg to fry survival was submitted to Russell on 21 November. Russell will provide comments on the draft report by 15 December. The draft report will then be distributed to the FCWG in January 2012.

E. **Production Simulation Model -** Geoff indicated that November was spent updating model code to functionalize the features discussed in the November update. This included allowing differential user inputs for hatchery vs. wild spawners and setting a hatchery-fish “handicap” and allowing the user to run individual life stages with different historic hydrologic data so that they can create their own hydrologic/life-cycle scenario. One of the model programmers also ran over 1,000 simulations of the IBM to determine bounds for the free-swimming juvenile movement parameters. They are using these data to calibrate downstream movement speed by fish length to ensure that the smallest fish are most likely to move slowly as they rear whereas larger fish will migrate downstream faster because of their later stage of development.

Testing of the adult spawning stage sub-models continued in November. Battelle is working on calibrating the start/end dates of the spawning period and also investigating their temperature-mortality function for the egg/alevin life stage. The function is based on data from Murray and McPhail (1988) (Figure 2) and may cause an unrealistic amount of mortality to eggs at relatively high temperatures (14°-17°C). This may be because the stock of Chinook salmon used in the Murray and McPhail (1988) study may have a different thermal tolerance than Hanford Reach fall Chinook. Therefore, Battelle is investigating if data from the Geist et al. (2006) paper on thermal tolerance of Snake River Chinook salmon could be used to create a more realistic function relating temperature and mortality for Hanford Reach fall Chinook salmon at the egg stage.

Battelle is also preparing to transfer the most recent version of the simulation model to GCPUD’s computer located at PNNL (computer name is “Briareus”[2]). Briareus will be the computer that ultimately runs the models once the software is delivered to GCPUD (i.e., when a user ‘submits’ a model run in the user interface, input variables will be transmitted via the internet to the PNNL network and then to Briareus). Briareus will also contain the years of MASS2 that are required for simulation runs.

[2] “Briareus” was one of the Hekantonkheries, three ancient storm giants with a hundred hands and fifty heads apiece. Briareus was more specifically a god of sea storms. He married Poseidon's daughter Kymopoleia ("Wave-Ranging") and made his home on the floor of the Aegean Sea. Briareus' name was derived from the Greek word *briaros* meaning "stout" or "strong."

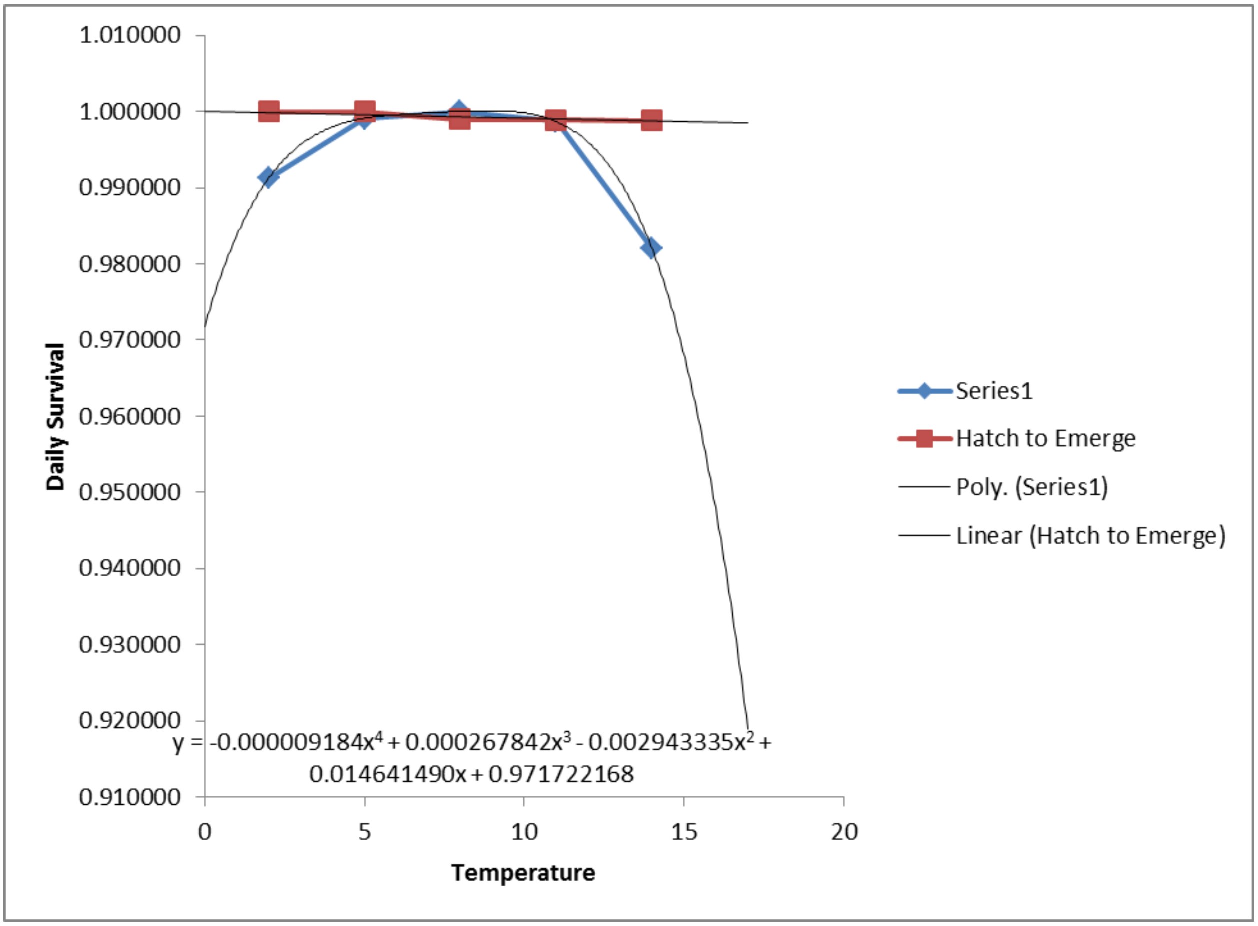


Figure 2. Current functional relationship between daily mean temperature and daily survival probability for Hanford Reach Chinook salmon in the egg (Series1) and alevin (Hatch to Emerge) stage of the Production Simulation Model.

VI. HRWG Activities

Update on Protections and Field Activities – Russell Langshaw reported that the surveys conducted on 20 November indicated 243 fall Chinook redds. He also noted that the post-hatch period will begin on Thursday, 8 December.

Russell said that all temperature and flow data are displayed in the Fixed Site Monitoring – Monthly Summary files on the Grant PUD Water Quality Website (http://www.gcpud.org/naturalResources/fishWaterWildlife/waterqualityMonitoring.html). The temperature unit tracking spreadsheet is found under "Fixed Site Monitoring – Monthly Summary." Finally, Russell shared with the group a PowerPoint presentation that he will be giving to the Technical Management Team in Portland.

Paul Hoffarth reported that WDFW collected 7,000 adult fall Chinook for the Ringold Hatchery and 20,000 adults for the Priest Rapids Hatchery. They finished carcass surveys on Monday, 5

December. They were able to collect fecundity information on some Chinook. Paul noted that the estimated fall Chinook escapement to the Reach was over 60,000 fish and about 12,000 were harvested.

- **Update Stranding and Entrapment** – Geoff stated that they ran into some technical issues during the analysis of stranding loss that made it more complicated than originally anticipated. Those issues have been addressed. They are nearing completion of the stranding estimate, and hope to finish a draft report on stranding loss by the end of December 2011 or early January 2012.

  Battelle worked with Bill Perkins and WDFW to QC and revise the entrapment locations that were sampled this year. This is because Bill discovered that the locations that WDFW sent them had significant problems. Battelle received revised locations from WDFW in the middle of November and sent those to Bill. Geoff indicated that as far as he knows, the entrapment histories have not been delivered to USFWS. Battelle intends to deliver the entrapment histories (without temperature for now) to USFWS by next week.

  Battelle will combine the stranding report and the entrapment report into one larger document.

  In an effort to prepare for the next field season, the Stranding and Entrapment Small Workgroup will reconvene during the afternoon on Tuesday, 3 January, following the FCWG meeting.

VII. Next Meeting: Tuesday, 3 January 2012 at Grant PUD's Ephrata office.

ATTACHMENT 1

Report from Rishi Sharma on Hanford Reach Fall Chinook Stock and Recruitment

To: Ryan Harnish, PNNL Labs, Russell Langshaw, Grant PUD

From: Rishi Sharma

CC: Fall Chinook Work Group

Date: 18th November, 2011

Data from the August 3rd memo was used to estimate the adult (only in AEQ's) recruitment from the BY 1975-2004. Methods to calculate adult recruitment are given in CTC, TC-ChInook 99-3. These methods indicate that jack data are discounted as it will artificially increase productivity for the stock. The data derived are attached in the spreadsheet (cohortreconstructionv2usingHancleanedupforPNNL.xls).

Table 1: Brood Year Spawners and Adult Recruitment (AEQ's) for Hanford URB stocks

Year	Spawners	Ad Recruits	Pred recruits	ssq	Likelihood
1975	22,242	86278.77	84708.29	0.000337	0.58862
1976	21,140	50743.32	82925.98	0.241247	0.34812
1977	31,527	65602.82	93606.13	0.126364	0.44721
1978	20,578	28787.53	81947.12	1.094392	0.05419
1979	23,558	66761.9	86609.34	0.067743	0.50818
1980	21,861	84809.13	84112.22	6.81E-05	0.58897
1981	15,115	93436.73	69688.2	0.085998	0.48835
1982	20,543	163086.9	81884.56	0.474684	0.20927
1983	36,022	222910.7	94807.34	0.730896	0.11971
1984	41,982	539568.5	94173.52	3.047226	0.00077
1985	65,796	156401.8	77935.29	0.485182	0.20453
1986	72,559	89068.51	71691.23	0.047105	0.53156
1987	88,762	47819.28	56794.5	0.029588	0.55226
1988	74,034	44626.13	70311.85	0.20668	0.37537
1989	65,913	78956.05	77829.31	0.000207	0.58879
1990	40,117	60800.78	94604.85	0.195458	0.38467
1991	31,971	30129.89	93800.93	1.289717	0.03540
1992	29,449	66909.37	92446.82	0.104519	0.46902
1993	30,650	104753.1	93167.7	0.013737	0.57168
1994	48,857	26949.65	91144.03	1.484671	0.02314
1995	38,381	76128.69	94823.98	0.048223	0.53027

1996	37,548	45681.39	94861.41	0.533961	0.18390
1997	34,007	78360.08	94473.19	0.03497	0.54582
1998	29,410	140619.8	92420.99	0.176153	0.40121
1999	27,012	239644.3	90522.96	0.947804	0.07460
2000	36,027	104677	94807.79	0.009806	0.57660
2001	44,140	246060.3	93447.26	0.937371	0.07632
2002	69,342	115022.8	74685.34	0.186492	0.39226
2003	89,322	55088.66	56300.99	0.000474	0.58845
2004	79,464	40026.97	65242.63	0.238691	0.35007

Using standard MLE techniques, we optimized a solution to estimate the optimal solution for alpha and beta in equation (1) below:
We used the Ricker model, namely

(1)
$$R = aSe^{(\frac{-S}{b})}$$

where R stands for recruits from the spawners (S) in a particular brood year. The parameters a and b are the density independent and dependent parameters, respectively. For the best parameter fit on this model, we used an optimizer to find optimal spawning stock size.

The results for the analysis are shown below (Figure 1, Table 1)

Parameters	Value
alpha	6.9
beta	37292
sig	0.68
Product likelihood	-43.87
SMSY at Reach	**26295**
Sums of Squares	12.84
MSY At Bonneville	**37993**

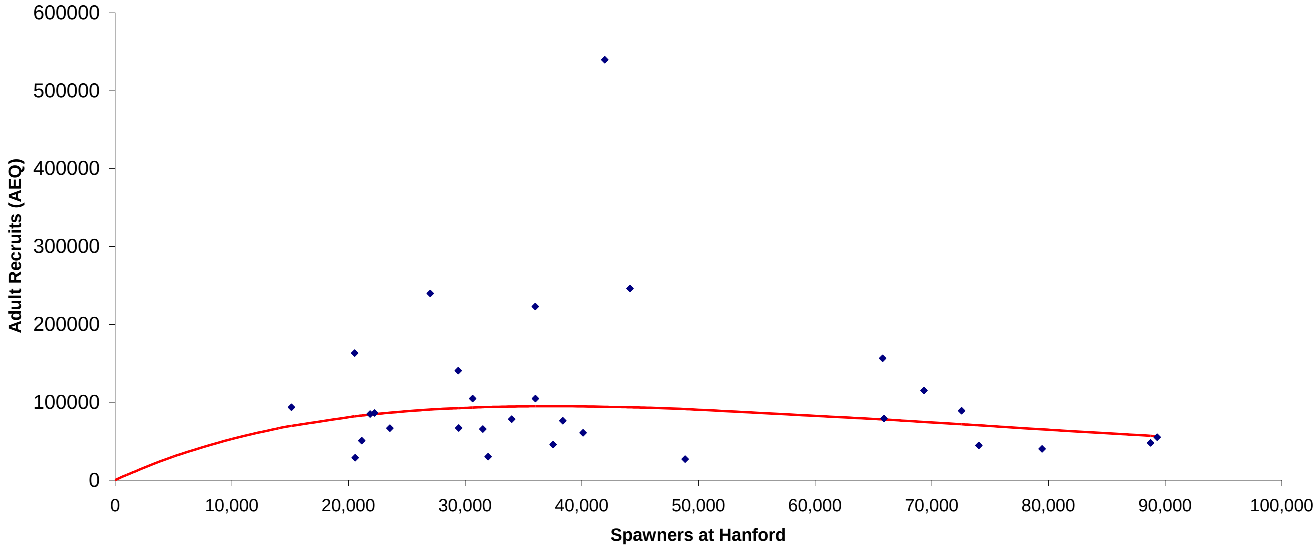


Figure 1: Hanford URB SR Relationship

Further details of the analysis and the spreadsheet used for the data are in attached spreadsheet with the data. Confidence intervals on the derived parameter can be generated using bootstrap or SIR techniques.

Sample Importance resampling techniques (Rubin 1988) were used to generate distributions around the management parameters. We ran simulations that picked 100,000 pairs of randomly selected values of α and β for the Ricker curve. We used non-informative priors, namely, the uniform distribution for the adult data were α □~□U [0,30] return per spawner and β □□□~U[0,200,000] adult returns.We calculated a likelihood of S_{MSY} for each alpha and beta □pair from the products of the likelihoods (equation 2)

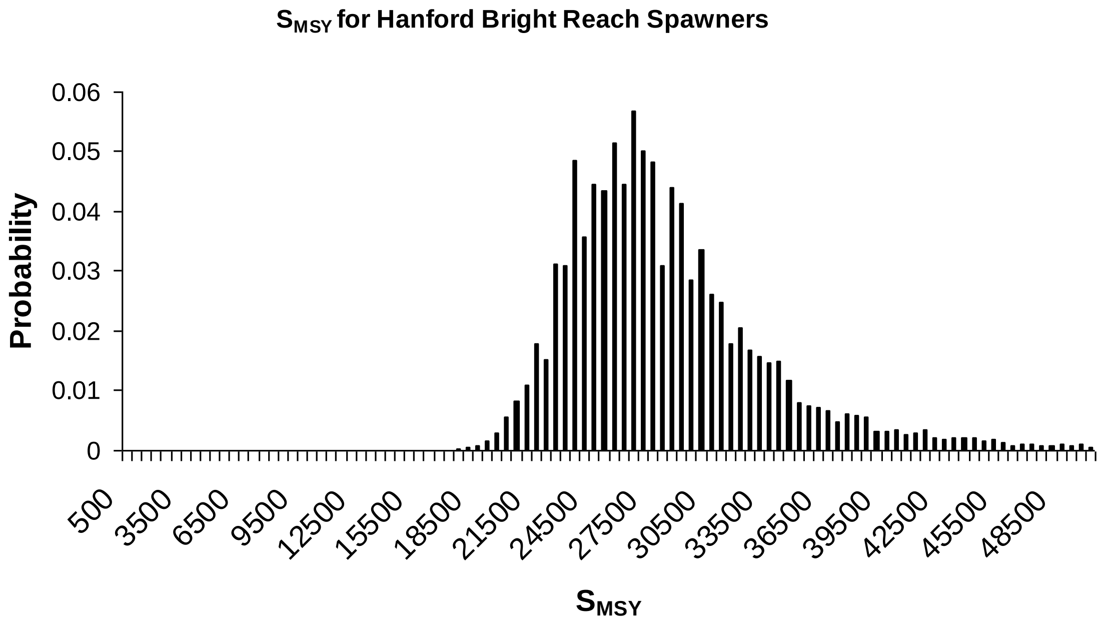
(2) $$L(S_{msy} \mid \alpha, \beta, R_i) = \prod_{i=1}^{n} \frac{1}{\sqrt{2\pi\sigma^2}} \frac{1}{(R_i)} \exp\left[-\frac{\left(\log_e(R_i) - \log_e(\hat{R}_i)\right)^2}{2\sigma^2} \right]$$

where *n* = the number of data points in the escapement-adult return. These likelihood values were accumulated in increments of 500 between zero and 50,000 (100 bins of S_{MSY} values) over the 100,000 randomly selected pairs.

The posterior probability function was a rescaled likelihood in each S_{MSY} bin divided by all the likelihood values generated through the simulation, where *i* through *n* indicates the number of S_{MSY} bins (equation (24)).

(3) $$P\left(S_{msy_i} \mid \alpha, \beta, R\right) = \frac{\sum L\left(S_{msy_i} \mid \alpha, \beta, R\right)}{\sum_{i=1}^{n} \sum L\left(S_{msy_i} \mid \alpha, \beta, R\right)}$$.

The results of this analysis are shown in Figure 3 below. 90% credible intervals are between 21,750 and 39,750 with a posterior mode of 26,250.



If a normalized average survival was applied to the juvenile estimate to not account for any effects of the hydropower system and ocean, and to use an average smolt to adult number in the estimated return, the fit is almost linear (Figure 3). If we used a SIR on this dataset with α □~□U [0,30] return per spawner and β □□□~U[0,1000000] then the fit uncertainty is much larger and the estimate can be anywhere from 104,500 to 512,000 with a mode of 344,500 Spawners (Figure 4).

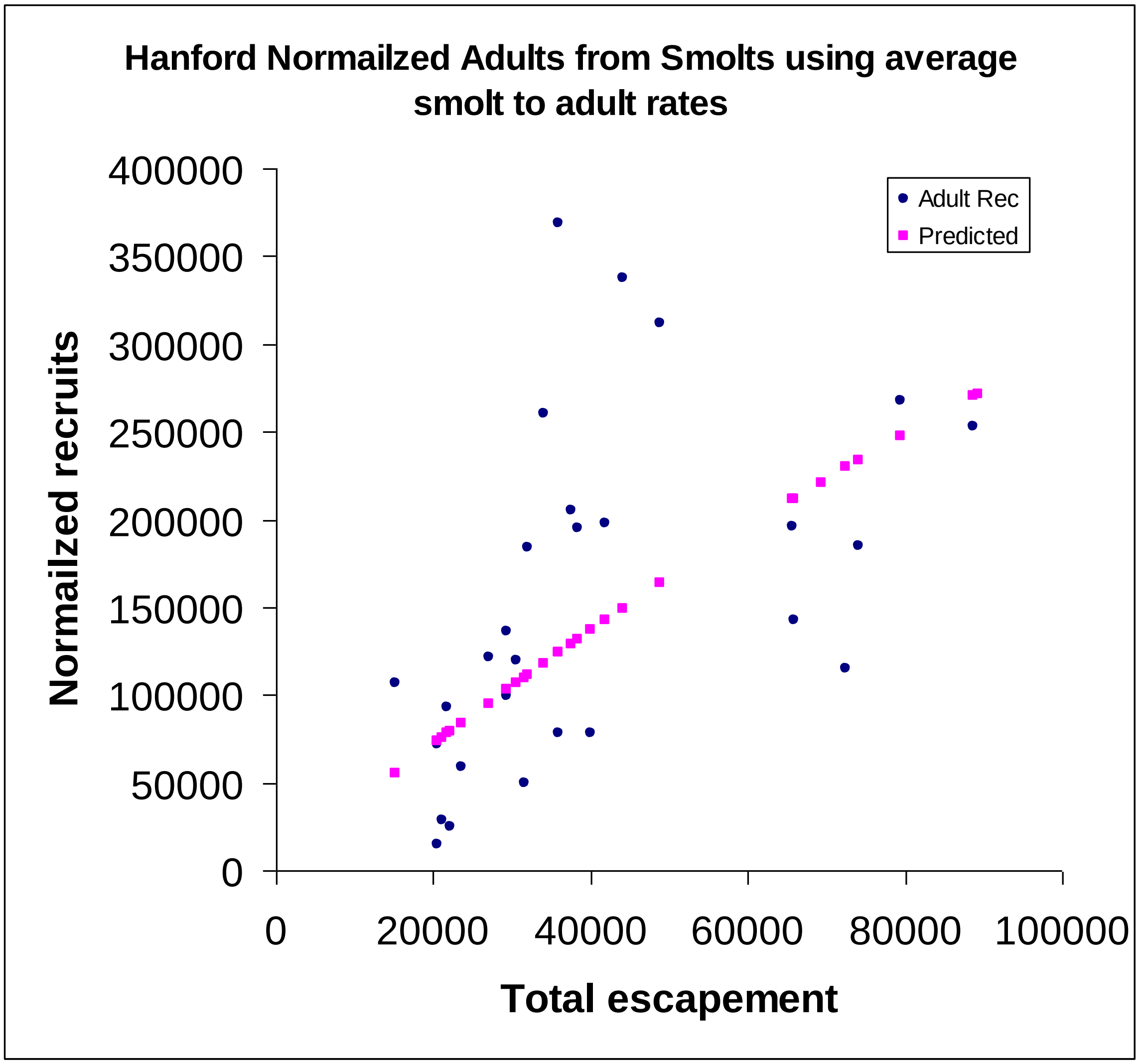


Figure 3: Adult Recruitment relationships using Hanford smolt estimate and an average smolt to adult recruitment rate (derived from Table 2 below)

Table 2: Derived and Standardized data used in analysis normalizing the effects of dam operations and ocean variation

Year	Hanford Production	Hanford Production (in M)	Spawners	Sm/Sp	Ad Recruits using Coshak Methods	Ad recruits using average Survival relationships
1975	3404241	3.4	22242	153	86279	24821
1976	3941263	3.9	21140	186	50743	28737
1977	6753058	6.8	31527	214	65603	49239
1978	1966674	2.0	20578	96	28788	14340
1979	8012164	8.0	23558	340	66762	58419
1980	12786087	12.8	21861	585	84809	93227
1981	14592646	14.6	15115	965	93437	106399
1982	9872810	9.9	20543	481	163087	71986
1983	10752384	10.8	36022	298	222911	78399
1984	27129434	27.1	41982	646	539568	197809

1985	26879546	26.9	65796	409	156402	195987
1986	15805624	15.8	72559	218	89069	115243
1987	34735254	34.7	88762	391	47819	253265
1988	25351654	25.4	74034	342	44626	184846
1989	19574946	19.6	65913	297	78956	142727
1990	10699446	10.7	40117	267	60801	78013
1991	25283292	25.3	31971	791	30130	184348
1992	13639034	13.6	29449	463	66909	99446
1993	16393612	16.4	30650	535	104753	119531
1994	42729760	42.7	48857	875	26950	311555
1995	26767863	26.8	38381	697	76129	195172
1996	28086149	28.1	37548	748	45681	204784
1997	35655767	35.7	34007	1048	78360	259977
1998	18654382	18.7	29410	634	140620	136015
1999	16684739	16.7	27012	618	239644	121653
2000	50574934	50.6	36027	1404	104677	368756
2001	46307724	46.3	44140	1049	246060	337643
2002	55681586	55.7	69342	803	115023	405991
2003	48972671	49.0	89322	548	55089	357074
2004	36670815	36.7	79464	461	40027	267378
			average from Smolt to Adult		0.00729129	

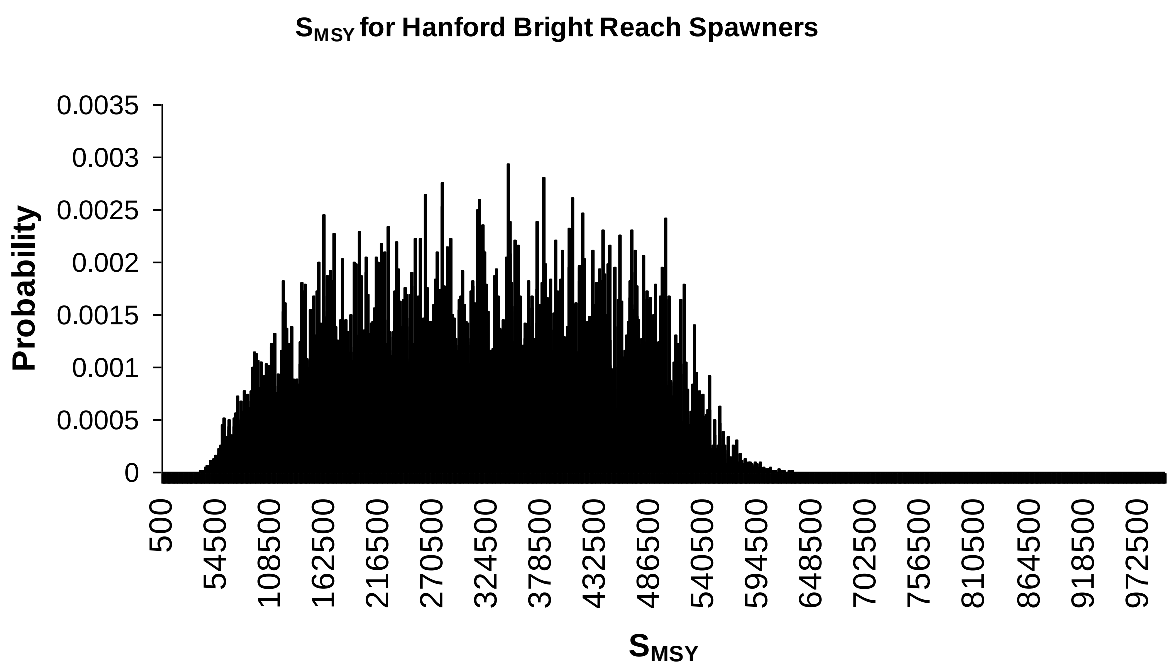
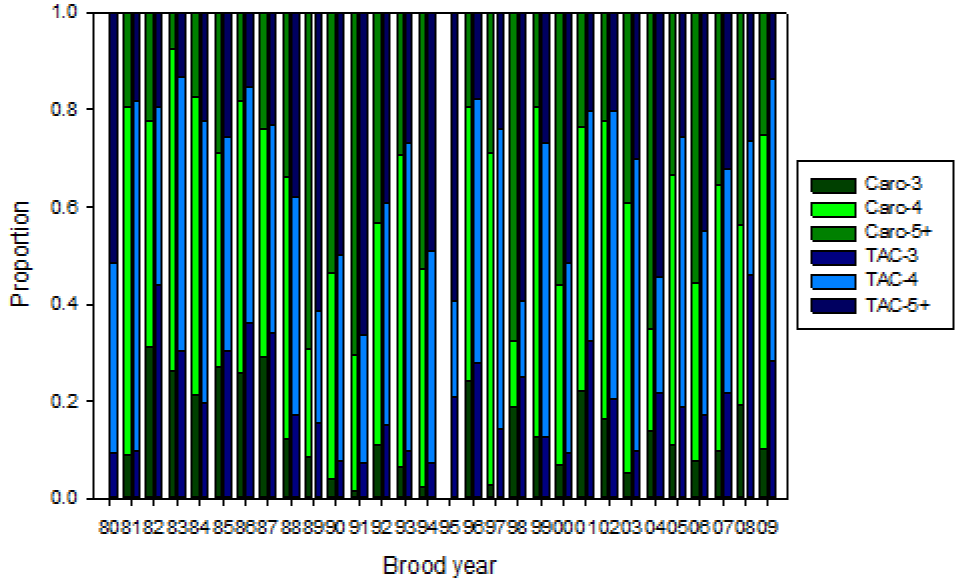
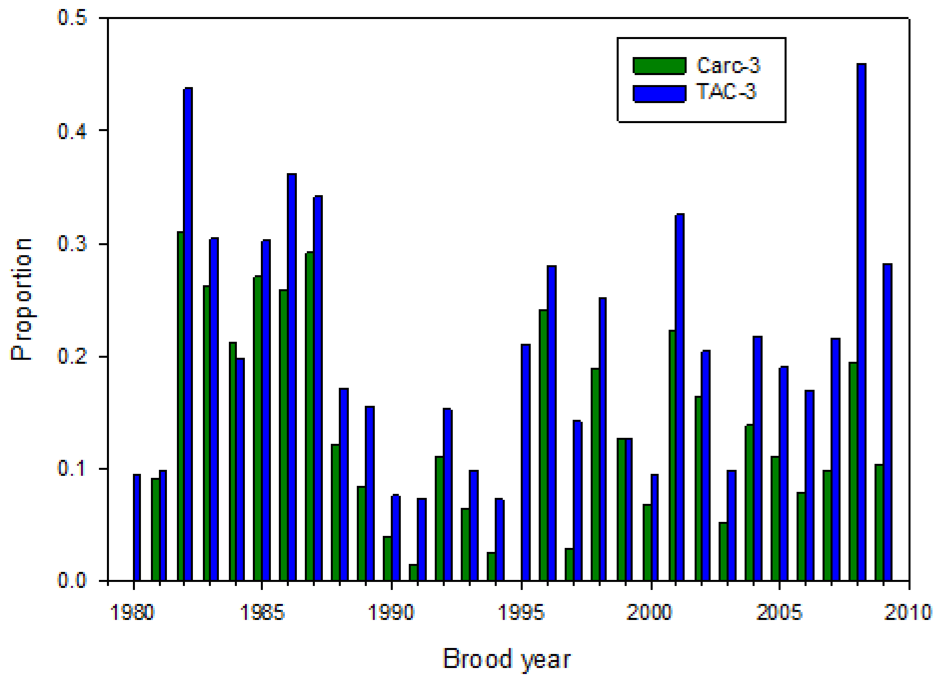


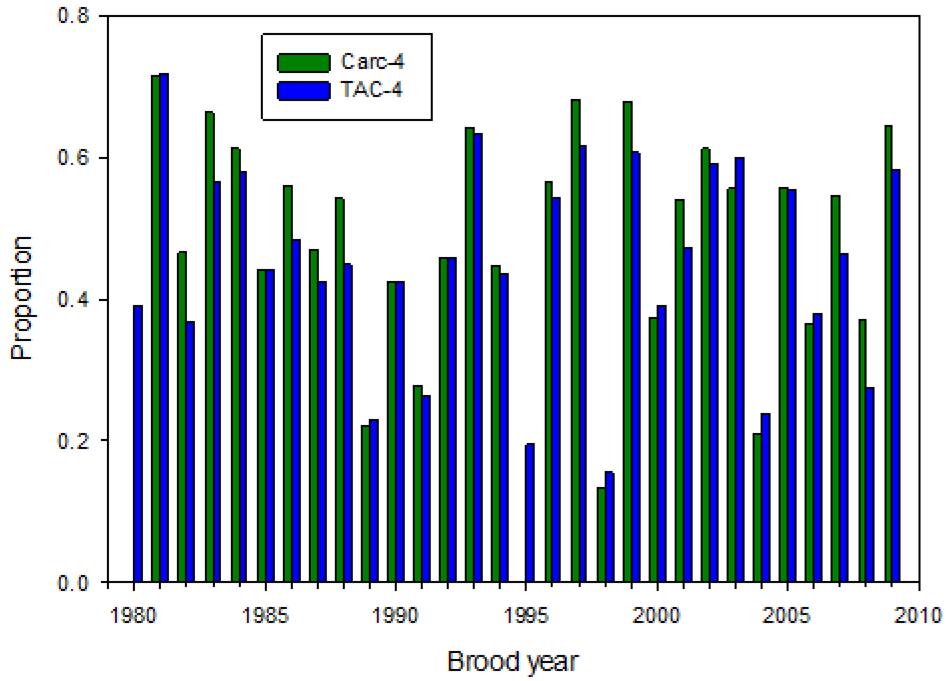
Figure 4: SMSY estimated for Hanford Bright stocks using normalized survival estimates applied to juvenile smolts estimated on the reach

ATTACHMENT 2

Figures for Productivity Assessment






0.8
0.6
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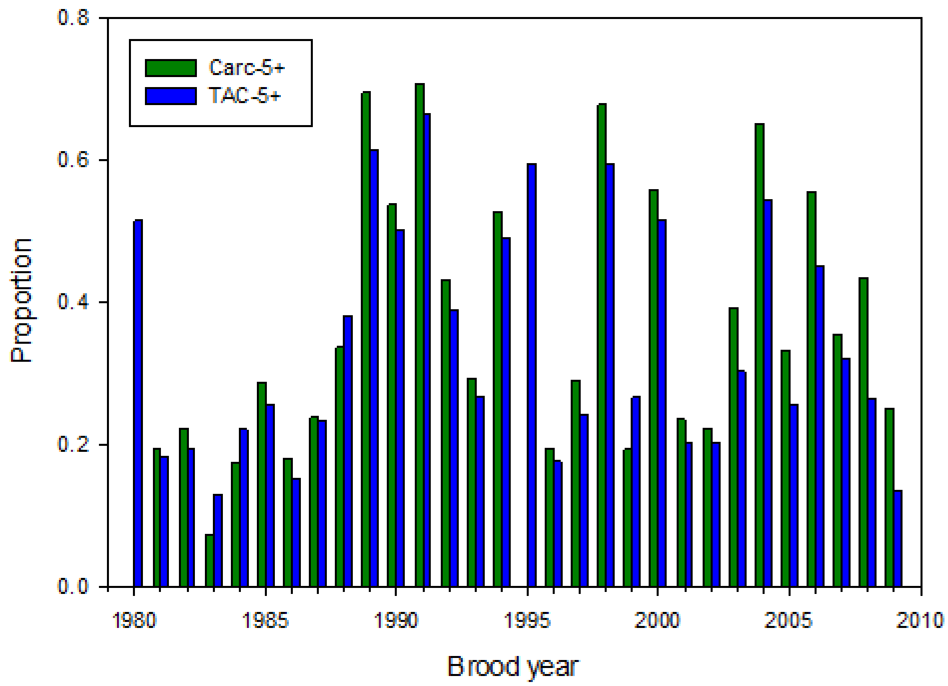
Proportion
Carc-4
TAC-4
1980
1985
1990
1995
2000
2005
2010
Brood year


0.8
0.6
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0.0
Proportion
Carc-5+
TAC-5+
1980
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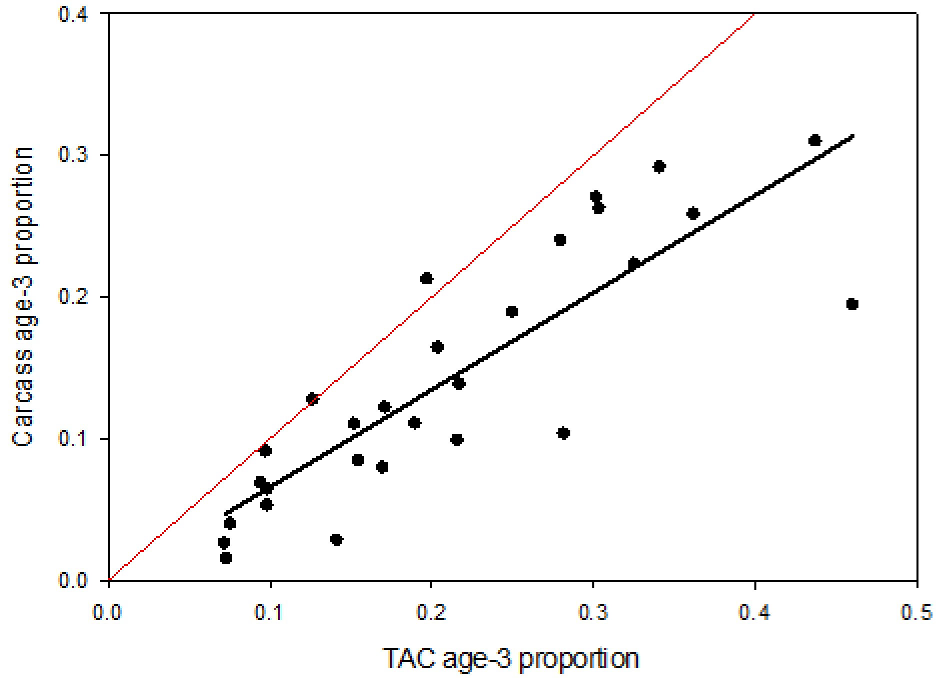
Brood year


Carcass age-3 proportion
TAC age-3 proportion
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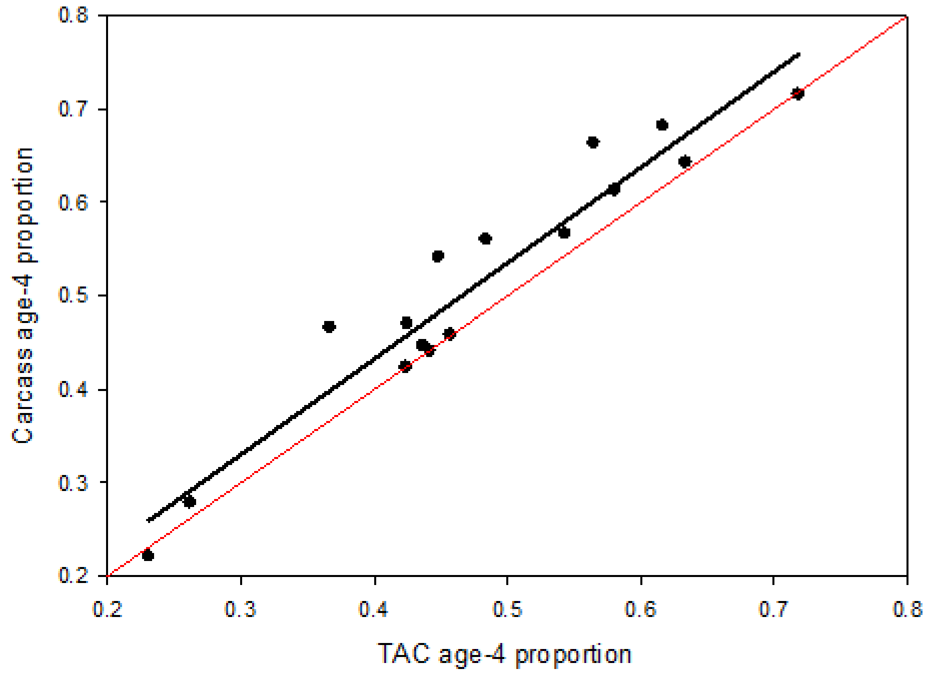
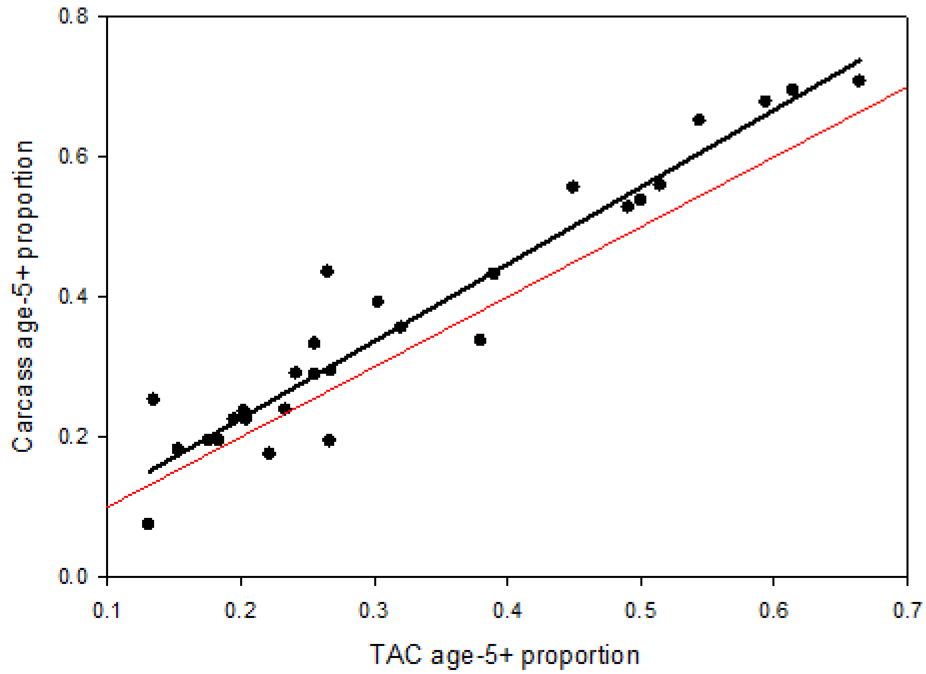
0.4
0.5


Carcass age-4 proportion
TAC age-4 proportion
0.2
0.3
0.4
0.5
0.6
0.7
0.8


0.8
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0.0
Carcass age-5+ proportion
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0.2
0.3
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0.5
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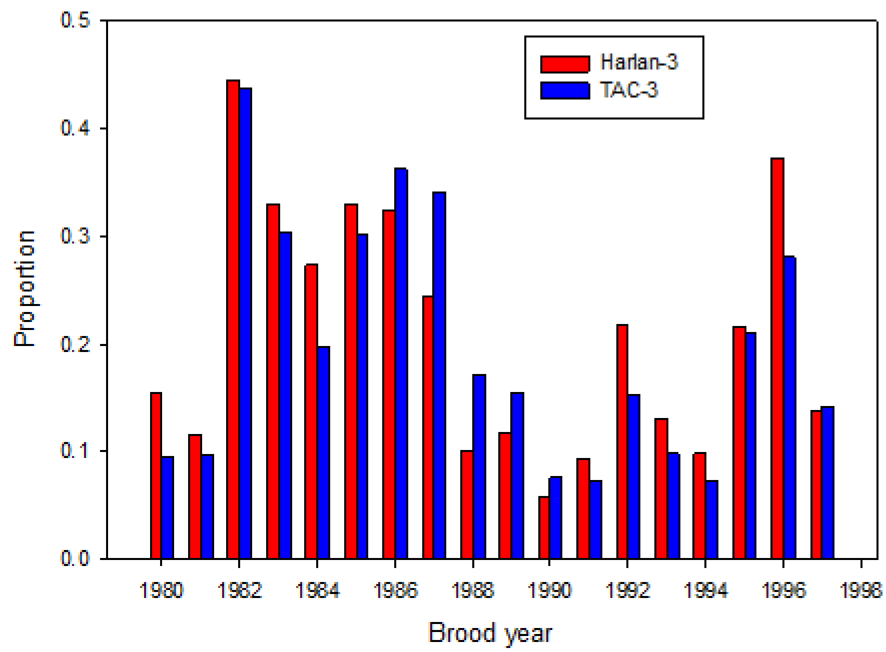
0.7
TAC age-5+ proportion


0.5
0.4
0.3
0.2
0.1
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Proportion
Harlan-3
TAC-3
1980
1982
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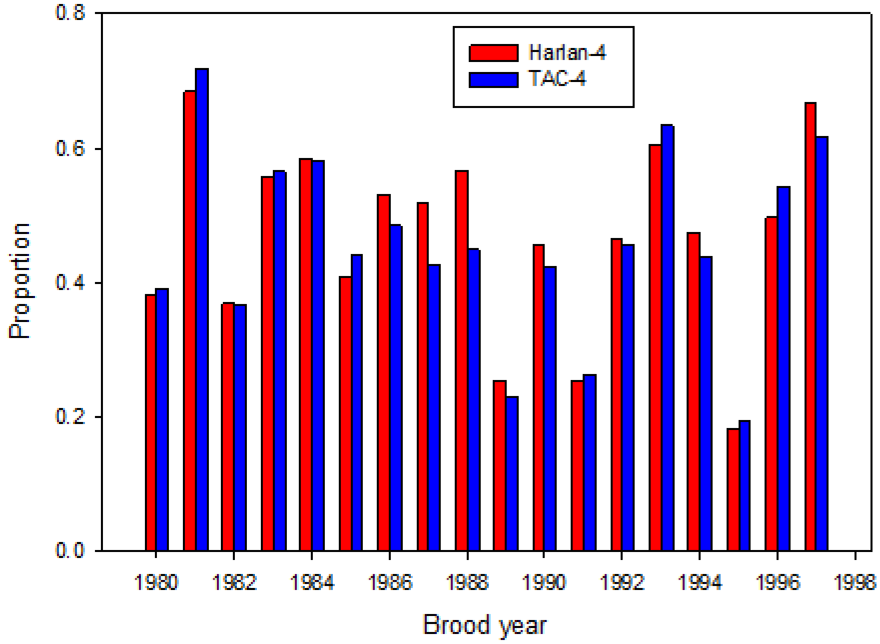
1992
1994
1996
1998
Brood year


Harlan-4
TAC-4
Proportion
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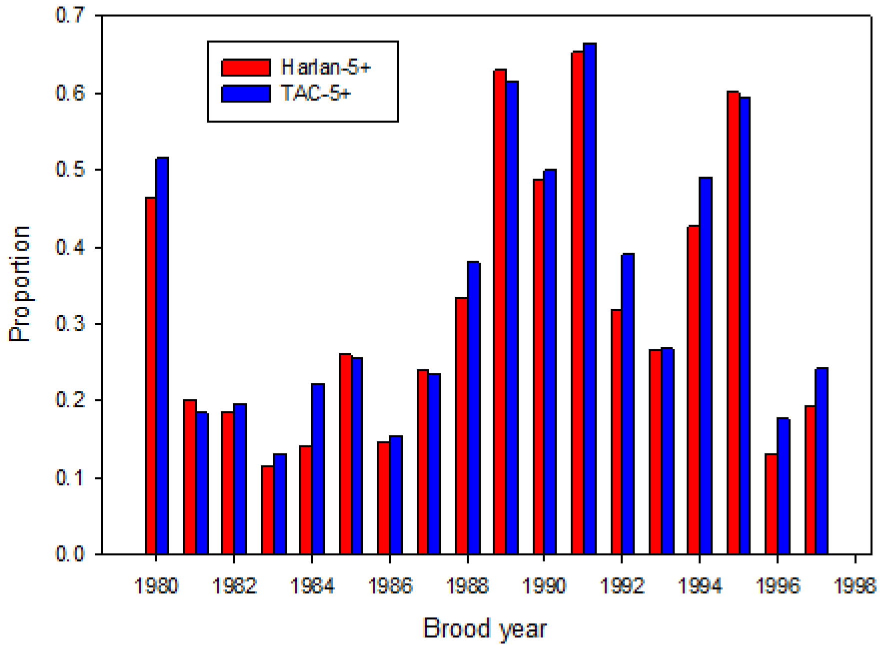
Brood year


Harlan-5+
TAC-5+
Proportion
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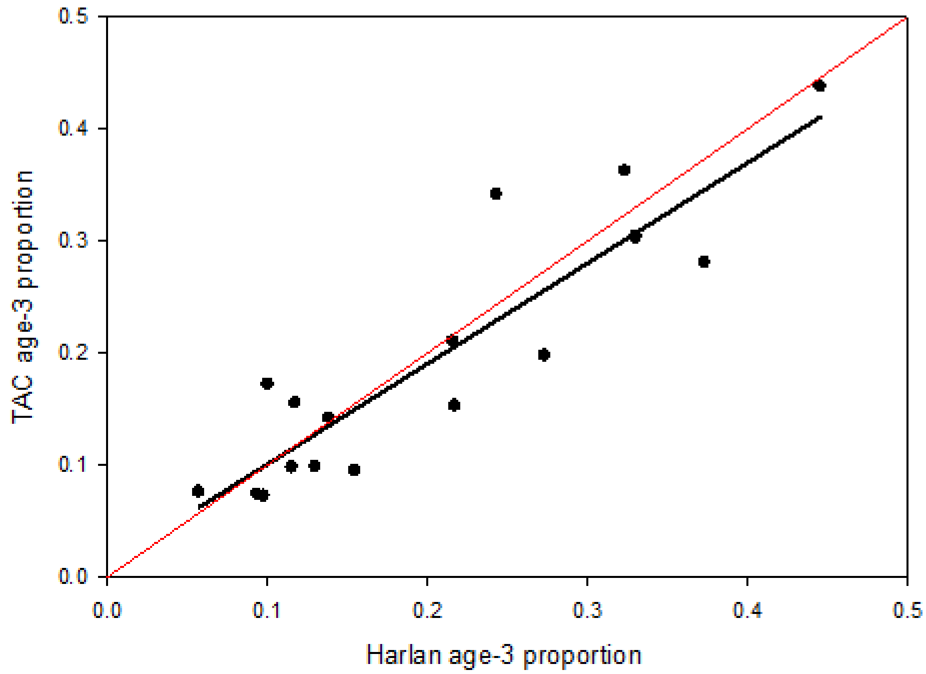
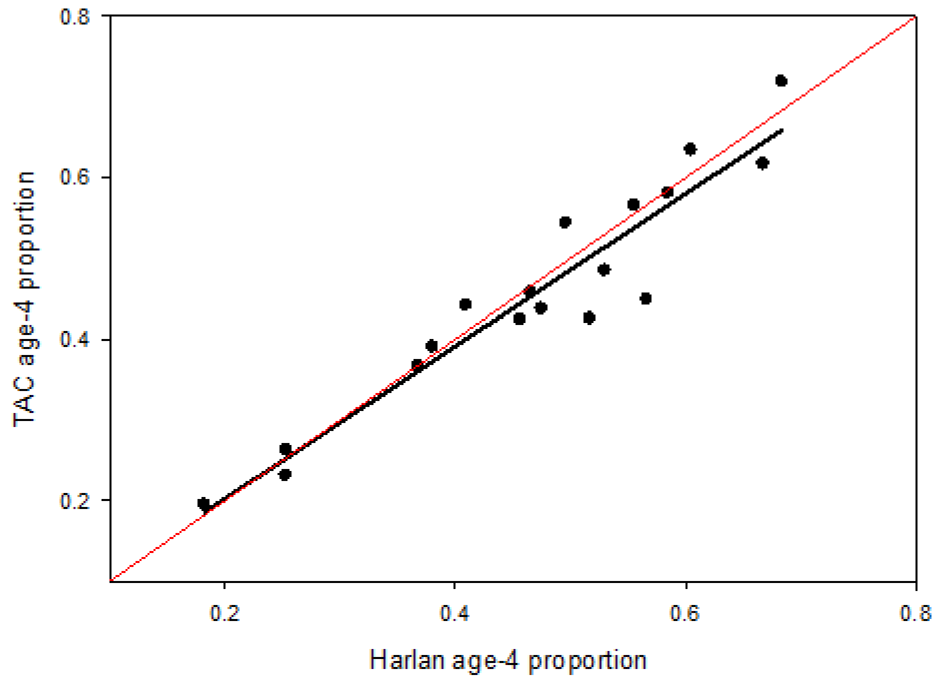
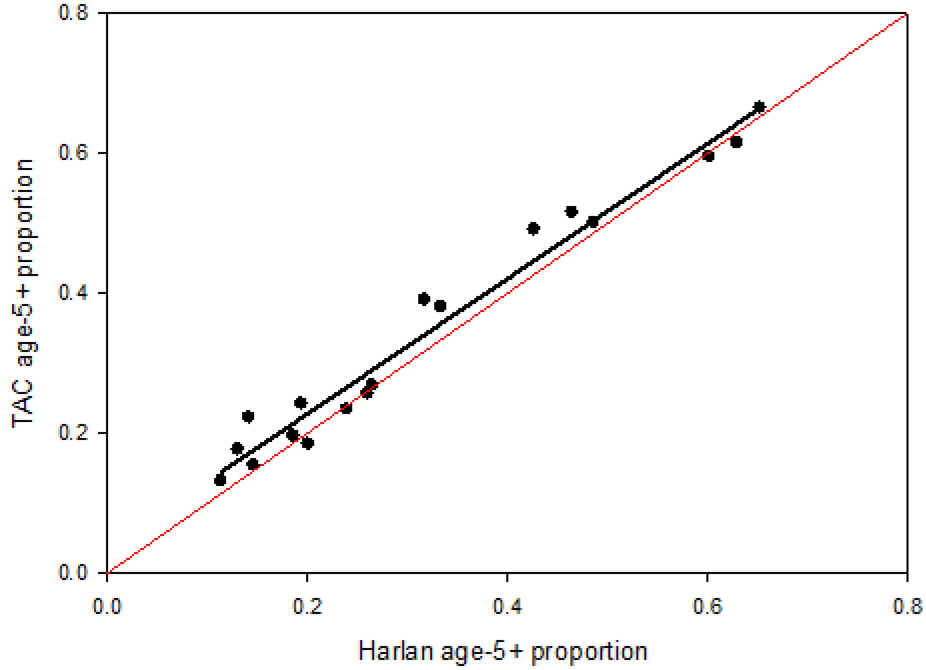
0.6
0.7
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
Brood year


TAC age-3 proportion
Harlan age-3 proportion
0.0
0.1
0.2
0.3
0.4
0.5


TAC age-4 proportion
Harlan age-4 proportion
0.2
0.4
0.6
0.8


0.8
0.6
0.4
0.2
0.0
TAC age-5+ proportion
0.0
0.2
0.4
0.6
0.8
Harlan age-5+ proportion