Appendix C. Chinook salmon bycatch-at-age methods and evaluation

1.1 Introduction

Currently, accurate in-season salmon abundance levels are unavailable and management must rely on analyses of historical data for developing alternatives. Developing regulations designed to reduce the impact of bycatch requires methods that appropriately relate these impacts to their respective salmon populations. A stochastic "adult equivalence" model was developed that accounts for sources of uncertainty. This extends from Witherell et al.'s (2002) evaluation and relaxes a number of assumptions. Such stochastic simulation approaches for evaluating management measures provide insight on the types of data required to better achieve objectives (e.g., Criddle 1996).

In 2007, the Council reviewed the methodology and encouraged refinements. In particular, these included:

a) Improving estimates of the salmon bycatch age composition,
b) Deriving realistic salmon maturation schedules which consider historical brood-year data,
c) Use of updated genetics information on stock origin,
d) Use of updated run size information, and
e) Refining the adult equivalent model to include a broader range of inputs (e.g., brood-year maturation rates and age specific natural mortality rates)

These updates and revisions were presented at the April 2008 Council meeting where further guidance for refinements was provided. This included explicit seasonal allocation of alternative cap levels and improved estimates of at sea survival. What follows is an update of the methods presented at the April 2008 Council meeting which describes the methods and data used to estimate AEQs and application to seasonal and sector allocations of cap levels currently proposed as alternative management actions.

1.2 Methods

Overall salmon bycatch levels are estimated based on extensive observer coverage. For the pollock fishery, the vast majority of tows are observed either directly at sea or based on offloading locations aboard motherships or shore-based processing plants. The observer data is used to allow inseason manager evaluate when to open and close all groundfish fisheries based on catch levels of prohibited species bycatch, such as salmon and halibut, and of target groundfish species. The process of applying observer data (in addition to other landings information) to evaluate fishery season length has relied on a pragmatic approach that expands the observed bycatch levels to extrapolate to unobserved fishing operations. More statistically rigorous estimators have been developed (Miller 2005) that can be applied to the North Pacific groundfish fisheries but these so far have not been implemented for inseason management purposes. Nonetheless, these estimators suggest that for the Eastern Bering Sea pollock fishery, the levels of salmon bycatch are precisely estimated with coefficients of variation of around 5%. This indicates that, assuming that the observed fishing operations are unbiased relative to unobserved tows, the total salmon bycatch levels are precisely estimated for the fleet as a whole. For the purposes of this analysis, imprecision on the total annual salmon bycatch is considered negligible.

1.2.1 Salmon catch-at-age estimation methods

In order to appropriately account for the impact of salmon bycatch in the groundfish fisheries it is desirable to correct for the age composition of the bycatch. For example, the impact a bycatch level of 10,000 adult mature salmon would have is likely greater than the impact of 10,000 incidentally caught salmon that just emerged from rivers and expected to return for spawning in several years time. Hence, estimation of the age composition of the bycatch (and the measure of uncertainty) is critical.

Estimates of both length and age composition and their variance estimates were approximated using at two-stage bootstrap method. For a given year the first stage samples, with replacement, among all tows from which salmon were measured. Given this collection of tows, the individual fish measurements were resampled with replacement and all stratum-specific information was carried with each record. A separate process was carried out on the samples from which age data were collected following a similar two-stage approach. Once a sample of lengths and ages were obtained, age-length keys were constructed and applied to the catch-weighted length frequencies to compute age composition estimates. This process was repeated 100 times and the results stored to obtain a distribution of both length and age compositions.

Three years of length-at-age data were available from Myers et al. (2003). These data are based on salmon scale samples collected by the NMFS groundfish observer program from 1997-1999 and processed for age determination (and river of origin) by scientists at the University of Washington (Table 1). Extensive salmon bycatch length frequency data are available from the NMFS groundfish observer program since 1991 (Table 2). The age data were used to construct age length keys for nine spatio-temporal strata (one area for winter, two areas for summer-fall, for each of three fishery sectors). Each stratum was weighted by the NMFS Regional Office estimates of salmon bycatch (Table 3). To the extent possible, sex-specific age-length keys within each stratum were created and where cells were missing, a "global" sex-specific age-length key was used. The global key was simply computed over all strata within the same season. For years other than 1997-1999, a combined-year age-length key was used (based on all of the 1997-1999 data). This method was selected in favor of simple (but less objective) length frequency slicing based on evaluations of using the combined key on the individual years and comparing age-composition estimates with the estimates derived using annual age-length keys. The reason that the differences were minor are partially due to the fact that there are only a few age classes in the salmon bycatch and these are fairly well determined by their length at-age distribution (Figure 1).

1.2.1 Genetics sample composition

Scientists with Alaska Department of Fish and Game have developed a DNA baseline to resolve the stock composition mixtures of Chinook salmon in the Bering Sea (Templin et al. In prep.). This baseline includes 24,100 individuals sampled from over 176 rivers from the Kamchatka Peninsula, Russia, to the Central Valley in California (Table 4). The genetic stock identification (GSI) study used classification criteria whereby the accuracy of resolution to region-of-origin is must be greater than or equal to 90%. This analysis identified 15 regional groups for reporting results. For this report, minor components in the bycatch are combined into the "other" category for clarity which results in a total of 9 stock units.

This study analyzed samples taken from the bycatch during the 2005 B season, both A and B seasons during 2006, and a sample from an excluder test fishery during the 2007 A season. Where possible, the genetics samples from the bycatch were segregated by major groundfish bycatch regions. Effectively, this entailed a single region for the entire fishery during winter (which is typically concentrated in space to the region east of 170°W) and two regions during the summer, a NW region (west of 170°W) and a southeast region (east of 170°W). The genetic sampling distribution varies considerably by season and region compared to the level of bycatch (as reported by NMFS Regional Office; Table 3).

The samples used in the analysis were obtained during a feasibility study to evaluate using scales and other tissues as collected by the NMFS observer program for genetic sampling. Unfortunately, during this feasibility study, the collected samples failed to cover the bycatch in groundfish fisheries in a comprehensive manner. For example, in 2005 most sampling was completed prior to the month (October) when most of the bycatch occurred (Figure 2).

For the purposes of assigning the bycatch to region of origin, the level of uncertainty is important to characterize. While there are many approaches to implement assignment uncertainty, the method chosen here assumes that the stratified stock composition estimates are unbiased and that the assignment uncertainty based on a classification algorithm (Seeb and Templin, In Prep; Table 6) adequately represents the uncertainty (i.e., the estimates and their standard errors are used to propagate this component of uncertainty). Inter-annual variability is also introduced in two ways: 1) by accounting for inter-annual variability in bycatch among strata; and 2) by using the point estimates (and errors) from the data (Table 6) over the different years (2005-2007) while weighting appropriately for the sampling intensity. The 2005 B-season results were given one third of the weight since sampling effort was low during October of that year (relative to the bycatch) while the 2006 B-season stock composition data was given two-thirds of the weight in simulating stock apportionments. For the A season, the 2007 data (collected from a limited number of tows) were given one fifth the weight while the 2006 was weighted 4 times that value.

The procedure for introducing variability in regional stock assignments of bycatch followed a Monte Carlo procedure with the point estimates and their variances used to simulate beta distributed random variables (which have the desirable property of being bounded by 0.0 and 1.0) and applied to the catch weightings (for the summer/fall (B) season) where areas are disaggregated. Areas were combined for the winter fishery since the period of bycatch by the fishery is shorter and from a more restricted area.

1.2.2 Estimating adult equivalence and impact rate

The impact of bycatch on salmon runs is the primary output statistic. This measure relates the historical bycatch levels relative to the subsequent returning salmon run *k* in year *t* as:

$$u_{t,k} = \frac{C_{t,k}}{C_{t,k} + S_{t,k}} \qquad (1)$$

where $C_{t,k}$ and $S_{t,k}$ are the bycatch and stock size (run return) estimates of the salmon species in question. The calculation of $C_{t,k}$ includes the bycatch of salmon returning to spawn in year *t* and the bycatch from previous years for the same brood year (i.e., at younger, immature ages). This latter component needs to be decremented by ocean survival rates and maturity schedules. This sum of catches (at earlier ages and years) can thus be represented as:

$$C_{t,k} = \sum_{a=1}^{A} c_{i,a,k}\, s_a \gamma_{a,k} \qquad i = t - A + a \qquad (2)$$

where $c_{i,a,k}$ is the catch of age *a* fish in year *i*, *A* is the oldest age of their ocean phase, $s_{i,a,k}$ is the proportion of salmon surviving from age *a* to *a+1*, and $\gamma_{a,k}$ is the proportion of salmon at sea that will return to spawn at age *a*. Maturation rates vary over time and among stocks detailed information on this is available from a wide variety of sources. For the purpose of this study, an average over putative stocks was developed based on a variety of studies (Table 7)

To carry out the computations in a straightforward manner, the numbers of salmon that remain in the ocean (i.e., they put off spawning for at least another year) are tracked through time until age 7 where for this model, all Chinook in the ocean at that age are considered mature and will spawn in that year.

Stochastic versions of the adult equivalence calculations acknowledge both run-size inter-annual variability and run size estimation error, as well as uncertainty in maturation rates, the natural mortality rates (oceanic), river-of-origin estimates, and age assignments. The variability in run size can be written as (with $\dot{S}_{t,k}$ representing the stochastic version of $S_{t,k}$):

$$\dot{S}_{t,k} = \bar{S}_k e^{\varepsilon_t + \delta_t} \qquad \varepsilon_t \sim N\left(0, \sigma_1^2\right), \quad \delta_t \sim N\left(0, \sigma_2^2\right) \qquad (3)$$

where σ_1^2, σ_2^2 are specified levels of variability in inter-annual run sizes and run-size estimation variances, respectively.

The stochastic survival rates were simulated as:

$$\dot{s}_{a,k} = 1 - \exp\left(-M_a + \delta\right), \qquad \delta \sim N\left(0, 0.1^2\right) \qquad (4)$$

whereas the maturity in a given year and age was drawn from beta-distributions:

$$\dot{\gamma}_{a,k} \sim B\left(\alpha_a, \beta_a\right) \qquad (5)$$

with parameters α_a, β_a specified to satisfy the expected value of age at maturation (Table 7) and a pre-specified coefficient of variation term (provided as model input).

Similarly, the parameter responsible for assigning bycatch to river-system of origin was modeled using a combination of years and "parametric bootstrap" approach, also with the beta distribution:

$$\dot{p}_k \sim B\left(\alpha_k, \beta_k\right) \qquad (6)$$

again with α_a, β_a specified to satisfy the expected value the estimates and variances shown in Table 6. For the purposes of this study, the estimation uncertainty is considered as part of the inter-annual variability in this parameter. The steps (implemented in a spreadsheet) for the AEQ analysis can be outlined as follows:

1. Select a bootstrap sample of salmon bycatch-at-age ($\phi_{t,a}$) for all years and strata;
2. Sum the bycatch-at-age for each year and proceed to account for year-of-return factors (e.g., stochastic maturation rates and ocean survival (Eqs. 2-5);
3. Partition the bycatch estimates to stock proportions (by year and area) drawn randomly from each parametric bootstrap;
4. Sum over all bycatch years and compare with run-size estimates for impact rate calculations;
5. Repeat 1-3 200 times;
6. Based on updated genetics results, assign to river of origin components ($\dot{p}_k$, Eq. 6).
7. Compile results over all years and compute frequencies from which relative probabilities can be estimated;

Sensitivity analyses on maturation rates by brood year were conducted and contrasted with alternative assumptions about natural mortality schedules during their oceanic phase as follows:

Model	3	4	5	6	7
1 - None	0.0	0.0	0.0	0.0	0.0
2 - Variable	0.3	0.2	0.1	0.05	0.0
3 - Constant	0.2	0.2	0.2	0.2	0.0

Evaluations of alternative Chinook salmon caps were done based on re-casting historical catch levels as if a cap proposal had been implemented. Since the alternatives all have specific values by season and sector, the effective limit on Chinook bycatch levels can vary for each alternative and over different years. This is caused by the distribution of the fleet relative to the resource and the variability of bycatch rates by season and years. To capture the effect of an alternative policy, the 2003-2007 mean "effective" cap for each alternative was computed and used as the seasonal limit for evaluation purposes (Table 8). These values were then used in the AEQ simulation model as season-specific caps. This means that the minimum of the historical season-specific bycatch and the effective cap level given in Table 8 was applied for estimating the AEQ for each policy.

1.3 Results

1.3.1 Chinook salmon catch-at-age

The uncertainty in the distribution of seasonal length frequencies have improved over time (Figure 3). Applying these length frequencies (and associated uncertainty based on bootstrap sampling) results in annual totals of Chinook salmon bycatch by age as shown in Table 9. When broken out by season there is some correlation between B season levels at one age and subsequent A season levels of the next age group (Table 10). Estimates of uncertainty due to age-specific bycatch sampling (for age and length) varied by season but showed some improvement (smaller values of coefficients of variation) for the main bycatch age groups in recent years (Table 11; Figure 4). For the evaluations of uncertainty in age assignments and impact analysis, the bootstrap samples of age composition were used and has the added advantage that the covariance structure is retained (e.g., Figure 5).

1.3.2 Chinook salmon bycatch stock composition

Application of GSI to estimate the composition of the bycatch by reporting region suggests that, if the goal is to provide estimates on the stock composition of the bycatch, there need is to adjust for the magnitude of bycatch occurring within substrata (e.g., east and west of 170°W during the B season, top panels of Figure 6). Applying the stock composition results presented in Table 6 over different years and weighted by catch gives stratified proportions that have similar characteristics to the raw genetics data (Table 12). Importantly, these stratified stock composition estimates can be applied to bycatch levels in other years which will result in overall annual differences in bycatch proportions by salmon stock region. This approach assumes that the salmon from early years were of similar stock composition, until planned investigations analyzing historical scale samples are complete, the degree of temporal variation in stock composition within season and spatial strata are unknown. These simulations can be characterized graphically in a way that shows the covariance structure among regional stock composition estimates (e.g., Figure 7).

Given the bycatch by strata estimates, it is possible to use the genetic composition data to estimate the historical expected stock proportions. **However, this assumes the genetics data collected from 2005-2007 adequately represents the historical pattern. Clearly, it is preferable to have genetics samples for the historical period analyzed rather than assuming the stratum-specific stock composition estimates from the recent period reflect the past.** That caveat stated, it is still interesting to note how historical annual bycatch composition varies depending on the locales of where Chinook are taken as bycatch (Figure 8) with median values presented in Table 13. To gain an appreciation of the impact, the Pacific Northwest group (PNW, also noted in some figures as BC+WA+OR) and the Upper Yukon River annual proportions in the bycatch are strongly affected by the locales and seasons of where the bycatch occurred (Figure 9). Myers et al. (2003) found similar area-specific patterns in their bycatch.

1.3.3 AEQ estimation

Using the weighted mean maturation schedule and the variable age-specific ocean mortality, the adult equivalents due to salmon mortality induced by the pollock fishery averaged about two thirds of the nominal (reported) annual bycatch in recent years (Figure 10). The AEQ model was shown to be sensitive to natural mortality assumptions but had little qualitative difference in the trend over time

(Figure 11). For the stochastic version, under Model 2 assumptions (decreasing mean age-specific natural mortality with age) results show a fair amount of uncertainty in the estimates of AEQ mortality (Figure 12).

Applying the stochastic (via the parametric bootstrap) time series of genetic stock components (**see caveat above about extending stock composition estimates over an earlier period**) to available run-size estimates allows computation of an *impact* or exploitation rate due to the pollock fishery bycatch. For the Upper Yukon River, this impact rate was well below 0.7% (Figure 13). For the "Coastal west Alaska" group, the impact rate estimates were considerably higher and have increased in recent years (Figure 14). Overall, from this analysis it appears that there is about a 10% chance that the coastal west Alaska group has experienced an exploitation rate greater than 3.5%. However, the apparent increasing trend (consistent with increases in overall bycatch levels) warrants further monitoring.

For groups of Chinook stocks where run size information is incomplete it is possible to simply present the estimates of total adult equivalent mortality due to bycatch. For example, the estimates of Chinook mortalities that originated from stocks south of Alaska (Canada and the lower 48 states) range from around 3,000 fish during 2000, to as high as 13,000 fish in recent years (Figure 15).

1.3.4 Application to alternative cap scenarios

In Chapter 5 above, application to the subset of 36 bycatch alternatives for evaluation were presented. For each cap alternative and option, the hypothetical Chinook AEQ mortality totals under each cap and management option for 2003-2007 shows a fair amount of variability over different options and years (Table 14**).** For the western Alaska stocks, Myers' et al. (2003) scale pattern results were used to further break down these to river of origin (also presented in Chapter 5). Additionally, based on tables presented in Chapters 2 and 4, the savings in Chinook bycatch can be plotted relative to forgone pollock to show the trade-offs among alternatives (Figure 16).

1.4 Discussion

Myers' et al. (2003) recommended that NMFS estimate the variance of bycatch-at-age. Miller (2006) developed estimators on total salmon bycatch by the EBS trawl fleet and found that the CVs (coefficients of variation) of the estimates under the current sampling regime were on the order of 5% (assuming that hauls from unobserved vessels had the same bycatch pattern as that of observed vessels). This study provides an additional component of sampling variability attributed to length and age collections.

The samples from which Myers' et al. (2003) estimated ages were out of proportion relative to the bycatch. For example, in 1997 some 51% of the scale samples were from the A season whereas this represented only about 23% of the overall bycatch for that year (Table 15). Myers et al. corrected for the bycatch levels and achieved proportions at age similar to what was found in this study. However, during this period (1997-1999) the observers sampled over 41,500 Chinook salmon for lengths (compared to the estimated total Chinook bycatch over this period of 107,500 salmon). In this study, these length frequencies are combined with the age data to have a more complete sampling frame. An added benefit of including the length frequency samples is that scale sampling is impacted by the size of the fish. Fish that lose scales more easily are more often rejected for sample quality and scale loss tends to be higher for smaller fish. Having a complete length frequency set (where such sample rejection is unlikely to occur) should enhance the reliability of the age composition estimates. Having age structures read over more years would improve the estimates shown here and would help if further multi-stock models are constructed.

The time series of bycatch age composition estimates have only been briefly evaluated. Application extensions to these data can be explored with in-river brood year variability (e.g., Figure 17).

The stock composition estimates based on the genetics are qualitatively very similar to the scale-pattern study presented by Myers et al. (2003). The age composition, genetics, and modeling approach presented here should help to provide some foundation for evaluating the EIS that is being developed by NMFS and the Council and provide guidance for decisions on appropriate measures to reduce bycatch impacts. For example, it is possible to examine how a cap would have changed the impact rates historically. This can serve to illustrate the expected result of future cap regulation alternatives.

1.5 Literature Cited

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FIGURES

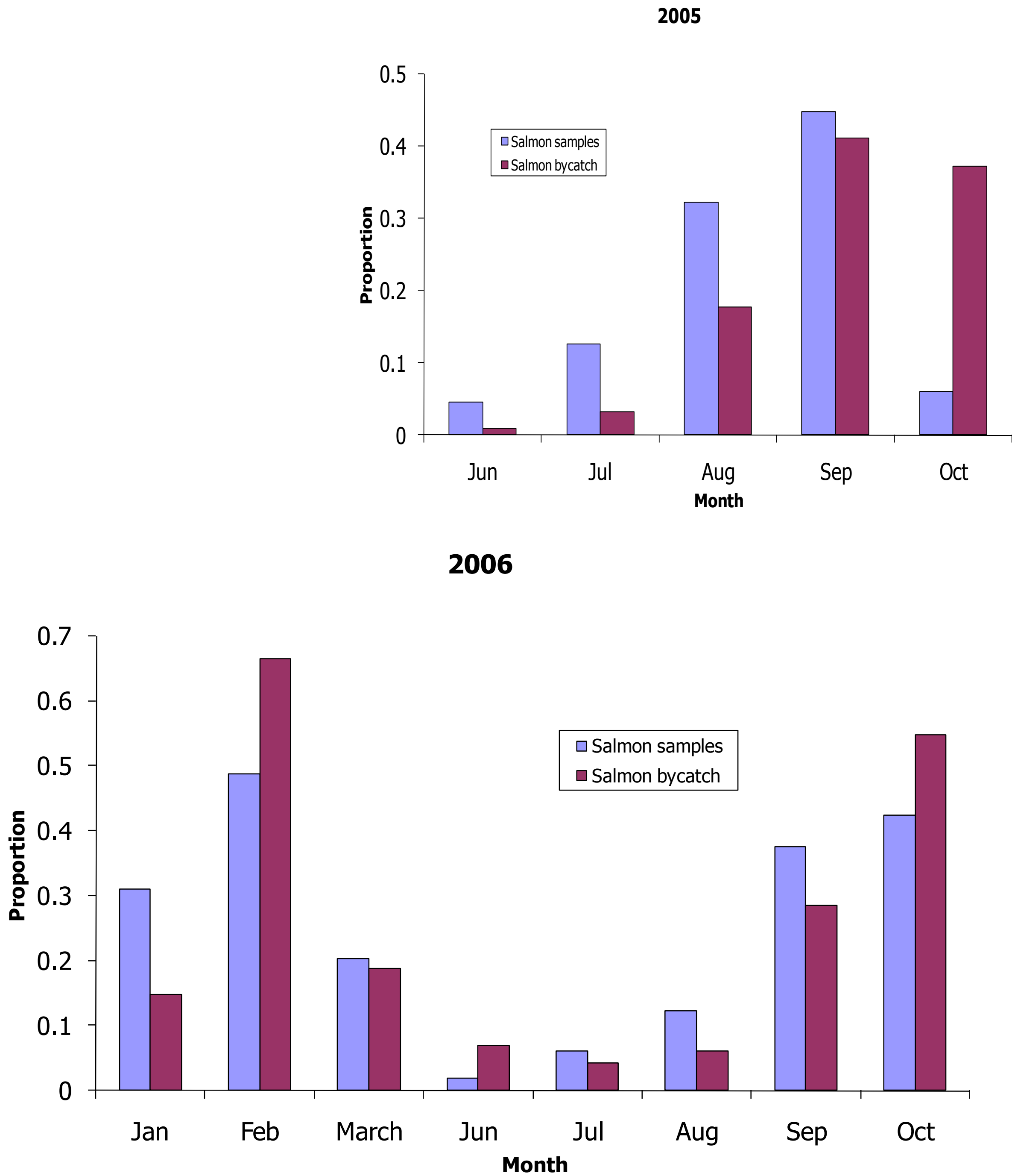


Figure 1. Proportion of Chinook salmon samples collected for genetics compared to the proportion of bycatch by month for 2005 B-season only (top panel) and 2006 A and B season combined (bottom panel).

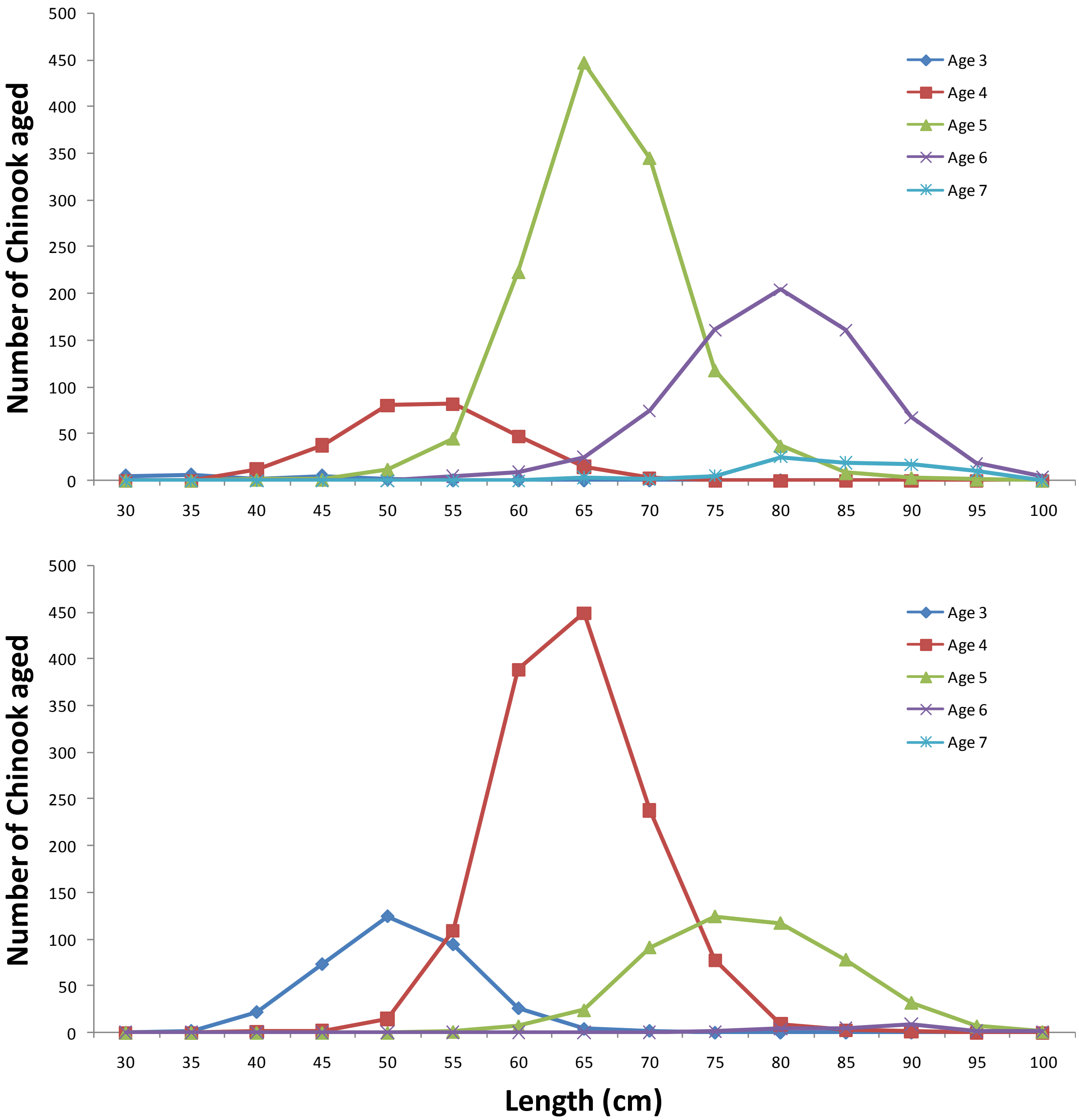


Figure 2. Summary distribution of age samples by length collected by the NMFS groundfish observer program during 1997-1999 and analyzed by University of Washington scientists (Myers et al. (2003) for the A-season (top panel) and B season (bottom panel).

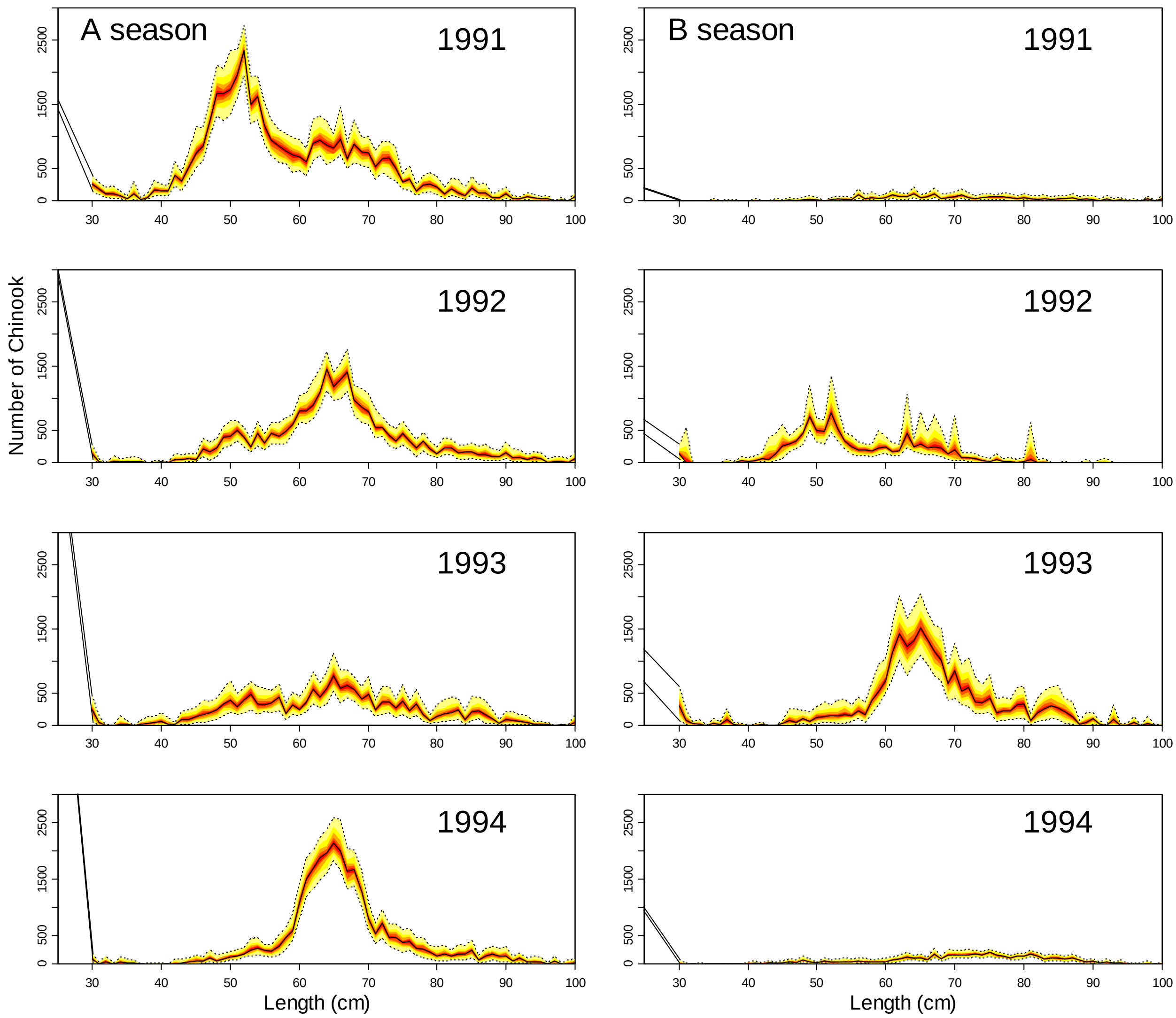


Figure 3. Length frequency by season and year of Chinook salmon occurring as bycatch in the pollock fishery. Error distributions based on two-stage bootstrap re-sampling procedure.

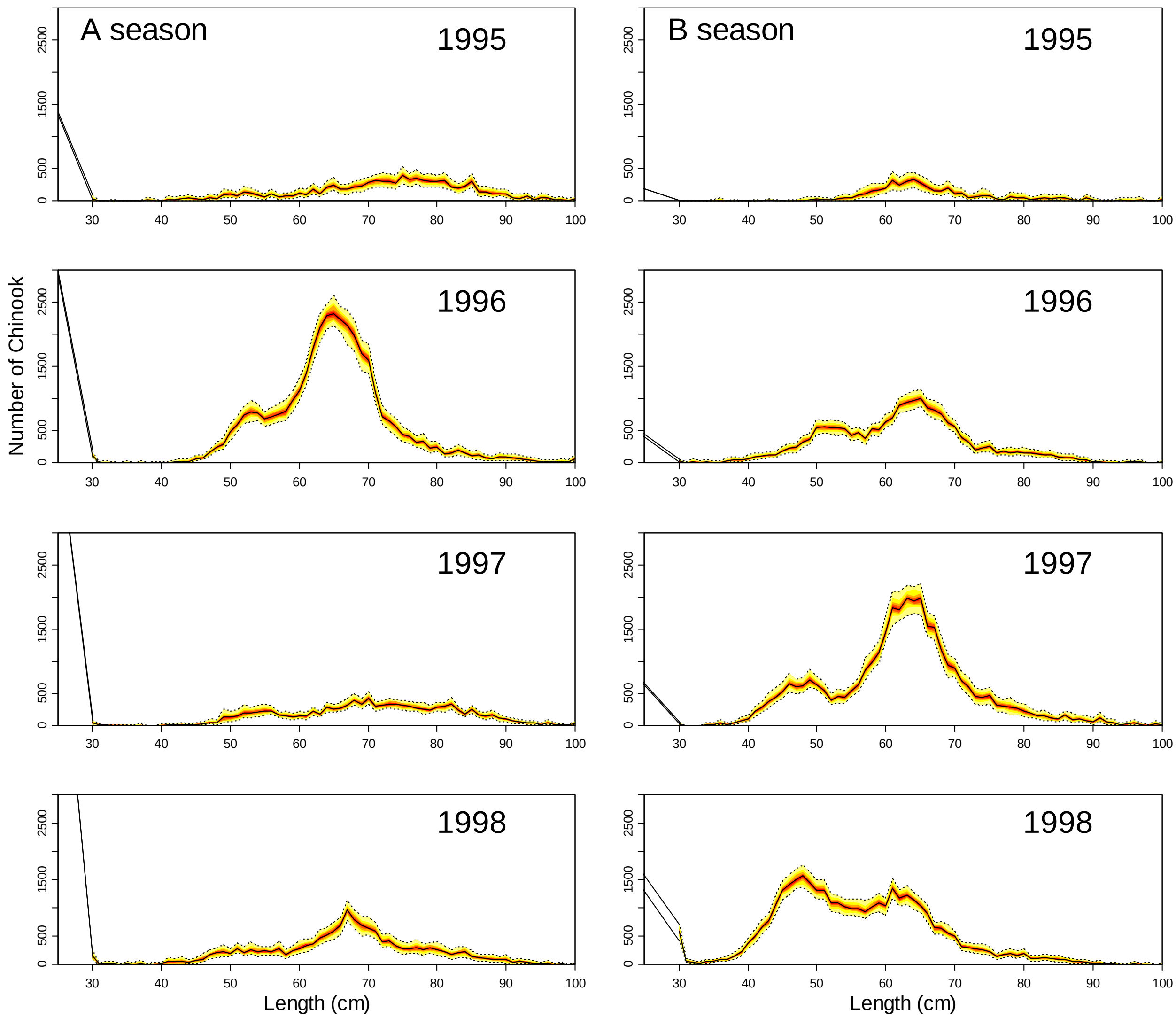


Figure 3. (continued) Length frequency by season and year of Chinook salmon occurring as bycatch in the pollock fishery. Error distributions based on two-stage bootstrap re-sampling procedure.

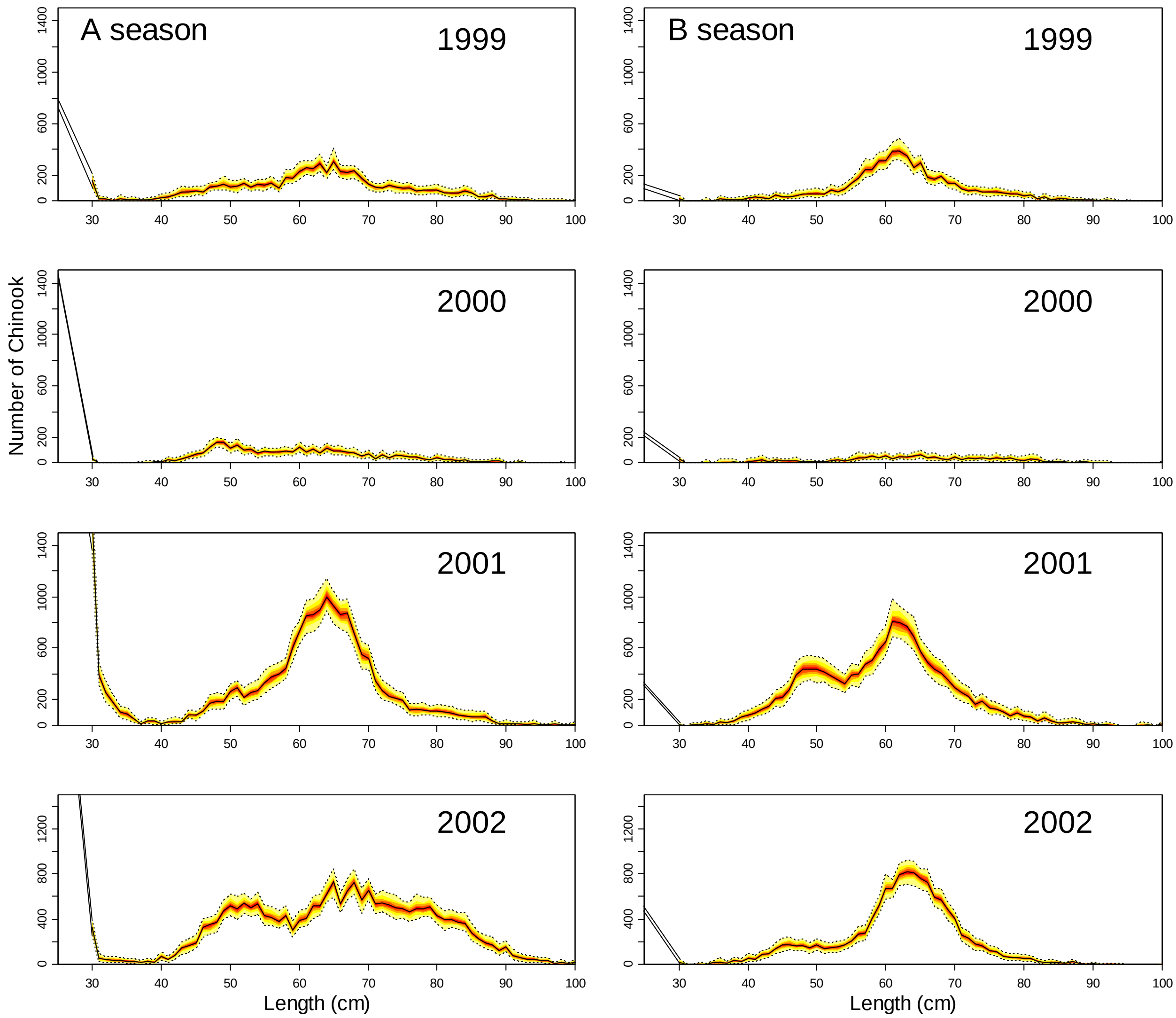


Figure 3. (continued) Length frequency by season and year of Chinook salmon occurring as bycatch in the pollock fishery. Error distributions based on two-stage bootstrap re-sampling procedure.

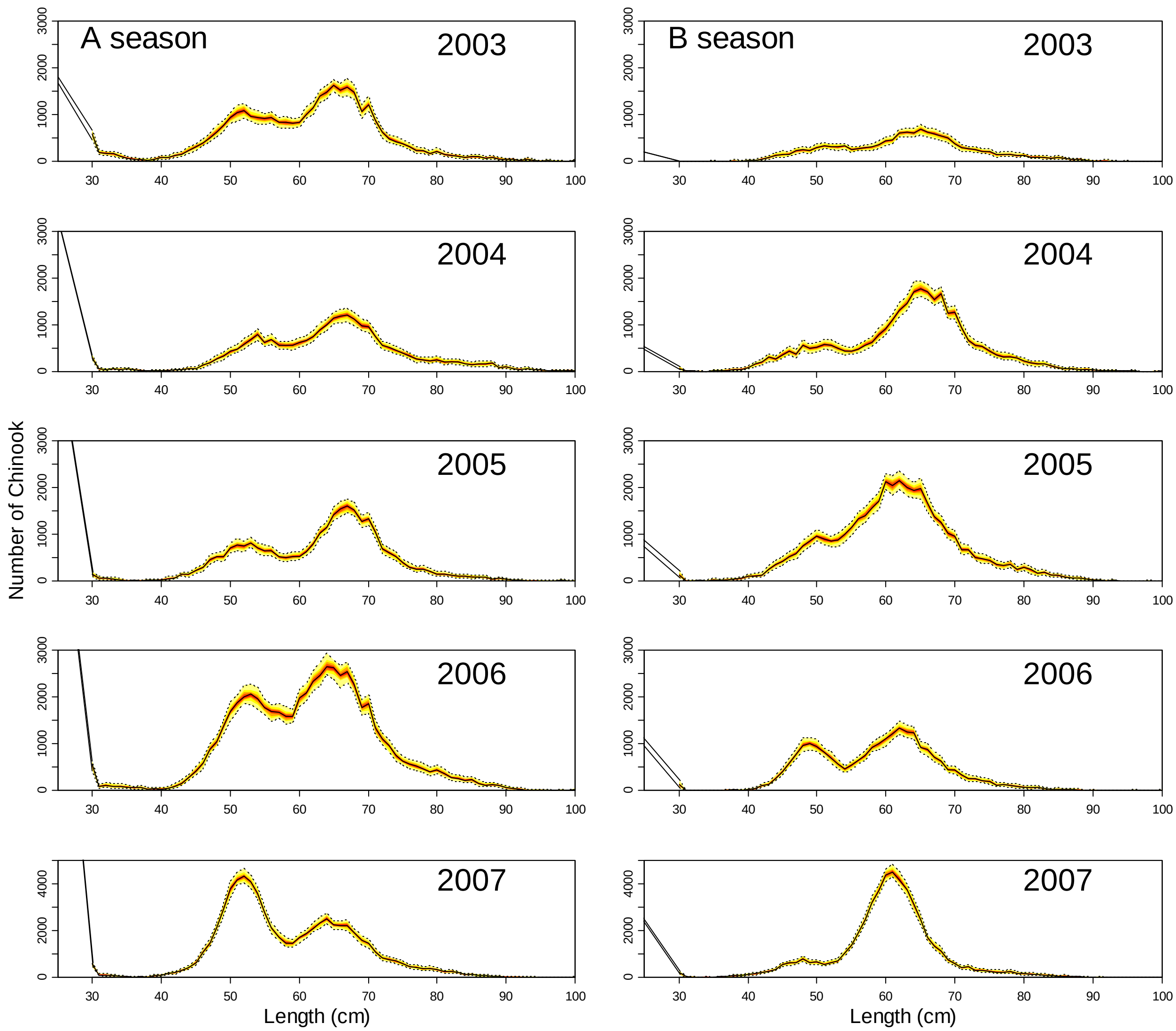


Figure 3. (continued) Length frequency by season and year of Chinook salmon occurring as bycatch in the pollock fishery. Error distributions based on two-stage bootstrap re-sampling procedure.

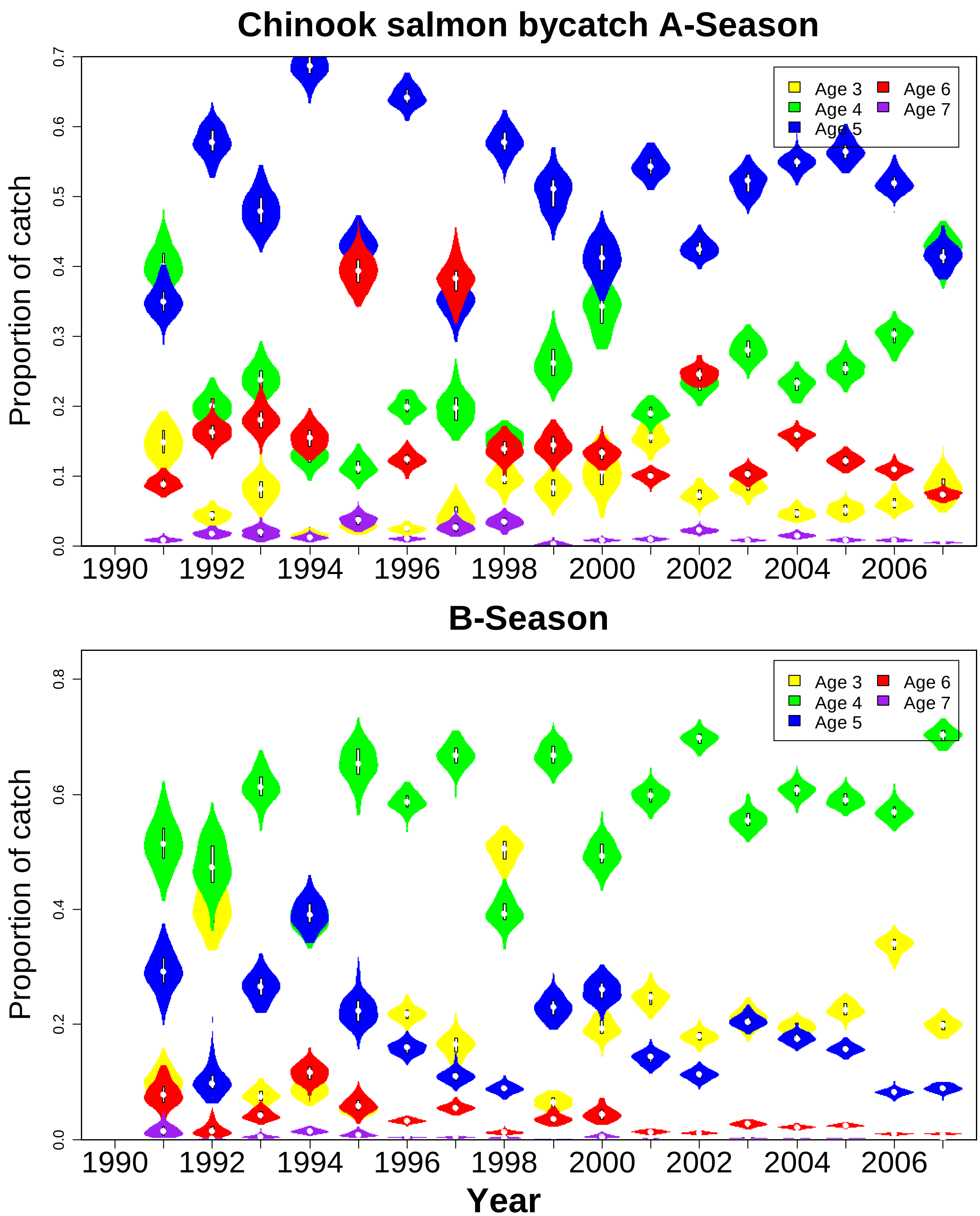
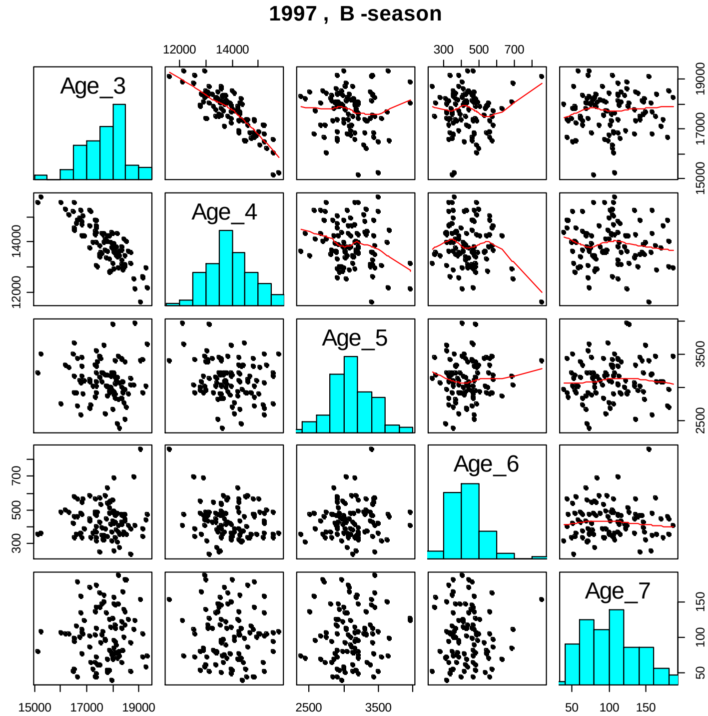


Figure 4. Chinook salmon bycatch age composition by year and A-season (top) and B-season (bottom). Vertical spread of blobs represent uncertainty as estimated from the two-stage bootstrap re-sampling procedure.



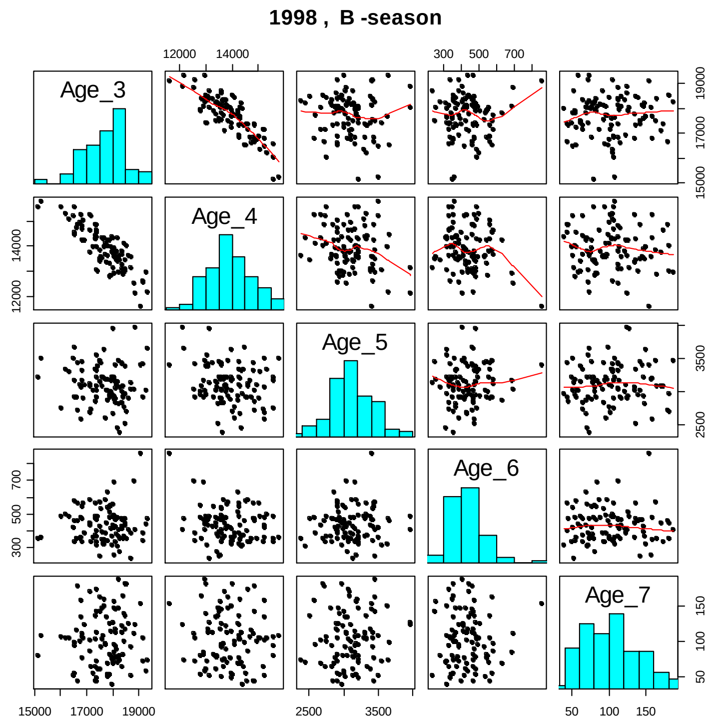


Figure 5. Bootstrap estimates of Chinook salmon bycatch example showing correlation of bycatch at different ages for the B-season in 1997 (top) and 1998 (bottom).

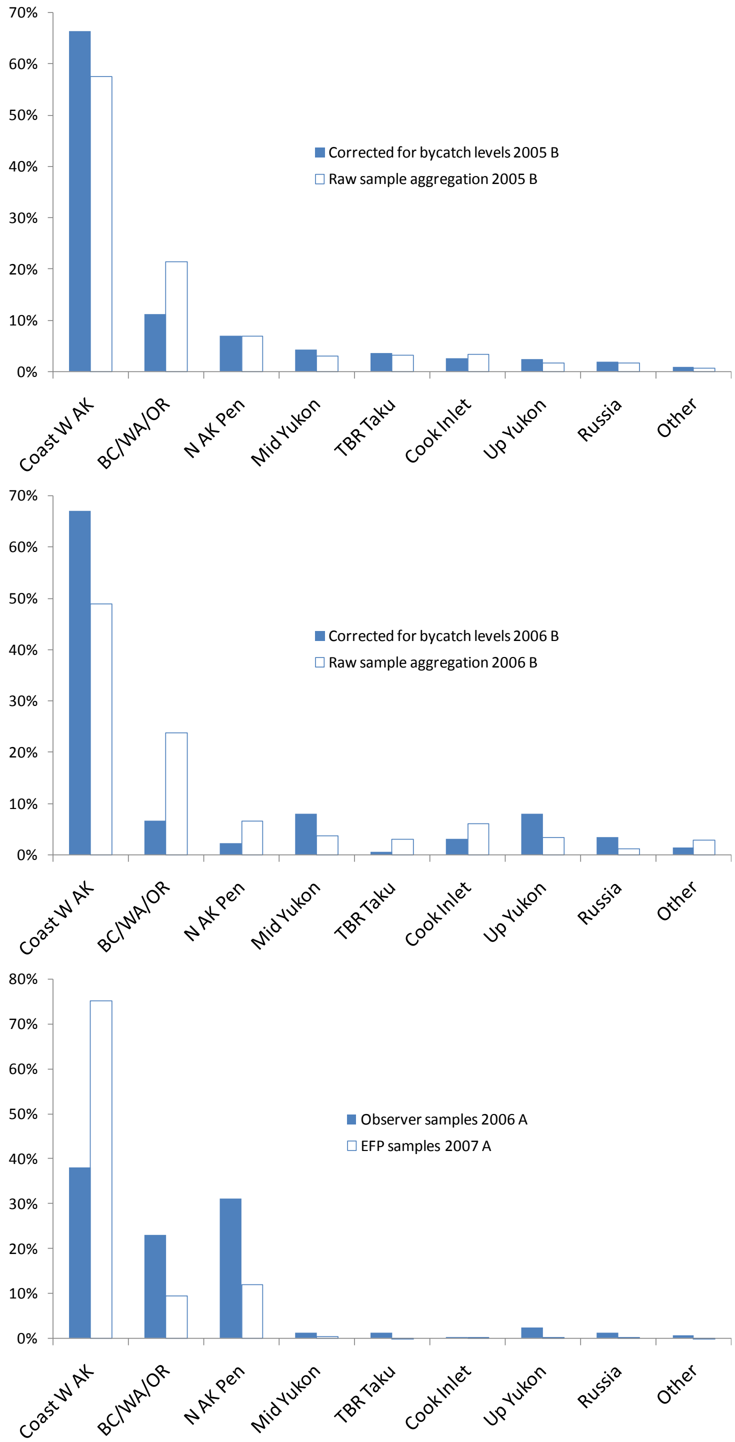
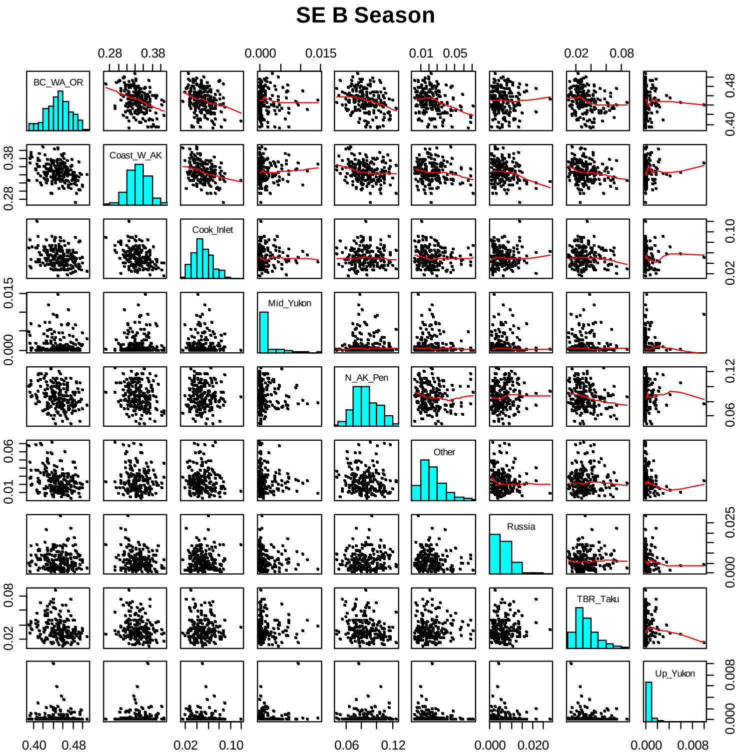


Figure 6. Chinook salmon bycatch results by reporting region for 2005 B season (top), 2006 B season (middle), and the 2006 and (partial sample) of 2007 A seasons (bottom). The top two panels include uncorrected results where bycatch differences between regions (east and west of 170°W) are ignored (empty columns).



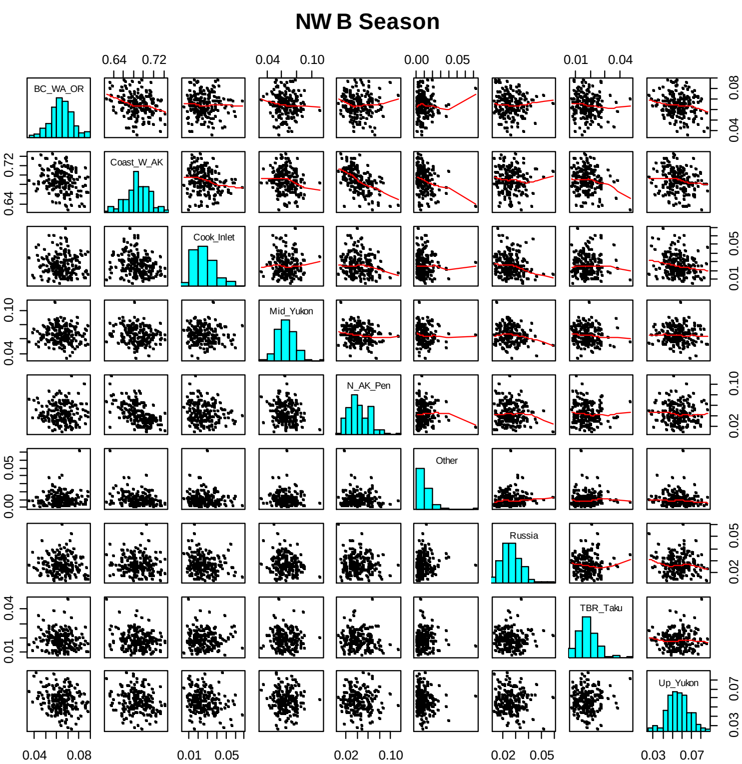


Figure 7. Simulated Chinook salmon stock proportion by region for the B season based on reported standard error values from ADFG analyses and assuming that the 2006 data has better coverage and is hence weighted 2:1 compared to the 2005 B-season data.

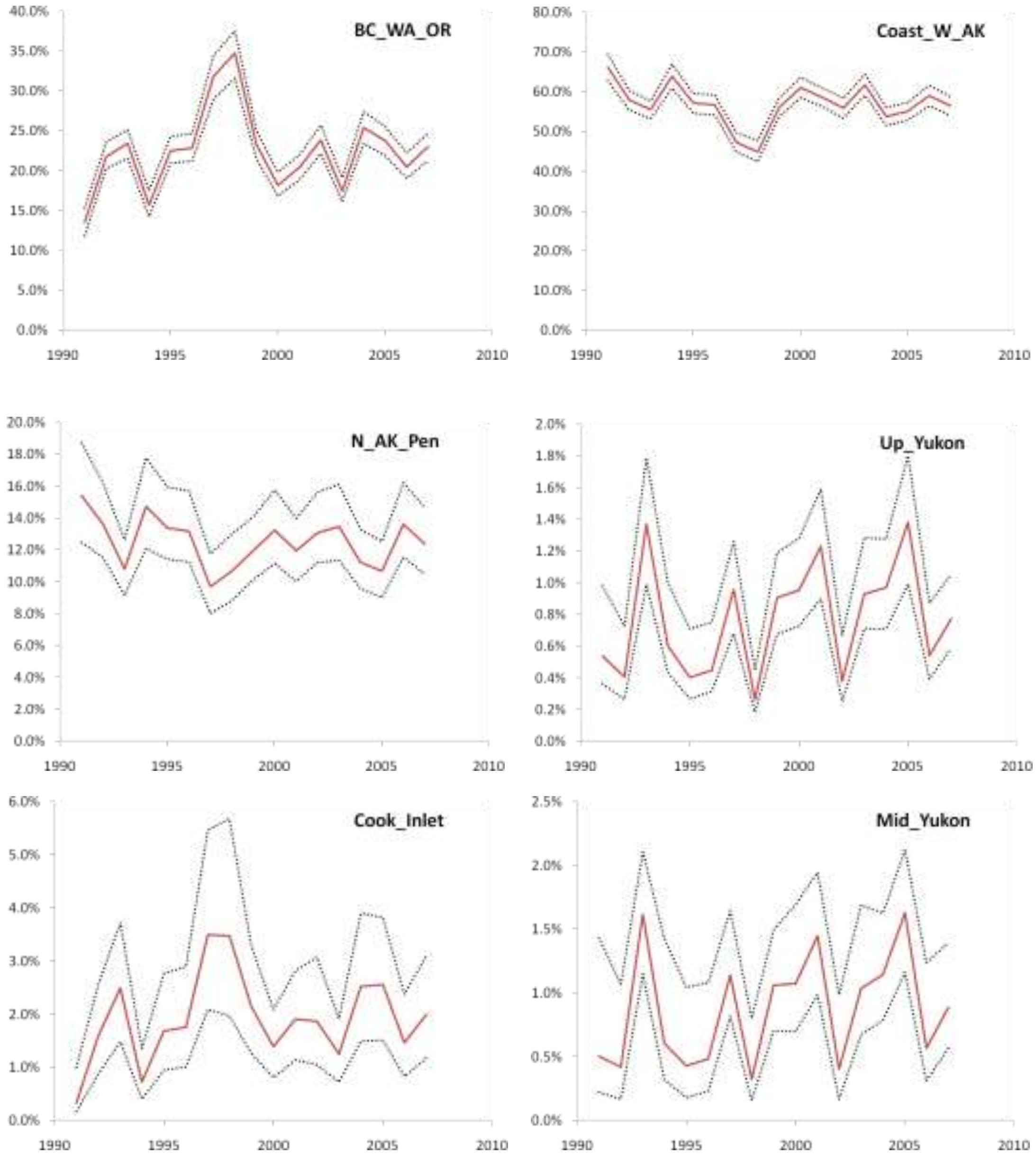


Figure 8. Chinook salmon bycatch results by genetics reporting regions for 2005 B season (top), 2006 B season (middle) and 2006 and (partial sample) of 207 season (bottom). The top two panels include uncorrected results where bycatch differences between regions (east and west of 170°W) are ignored (empty columns).

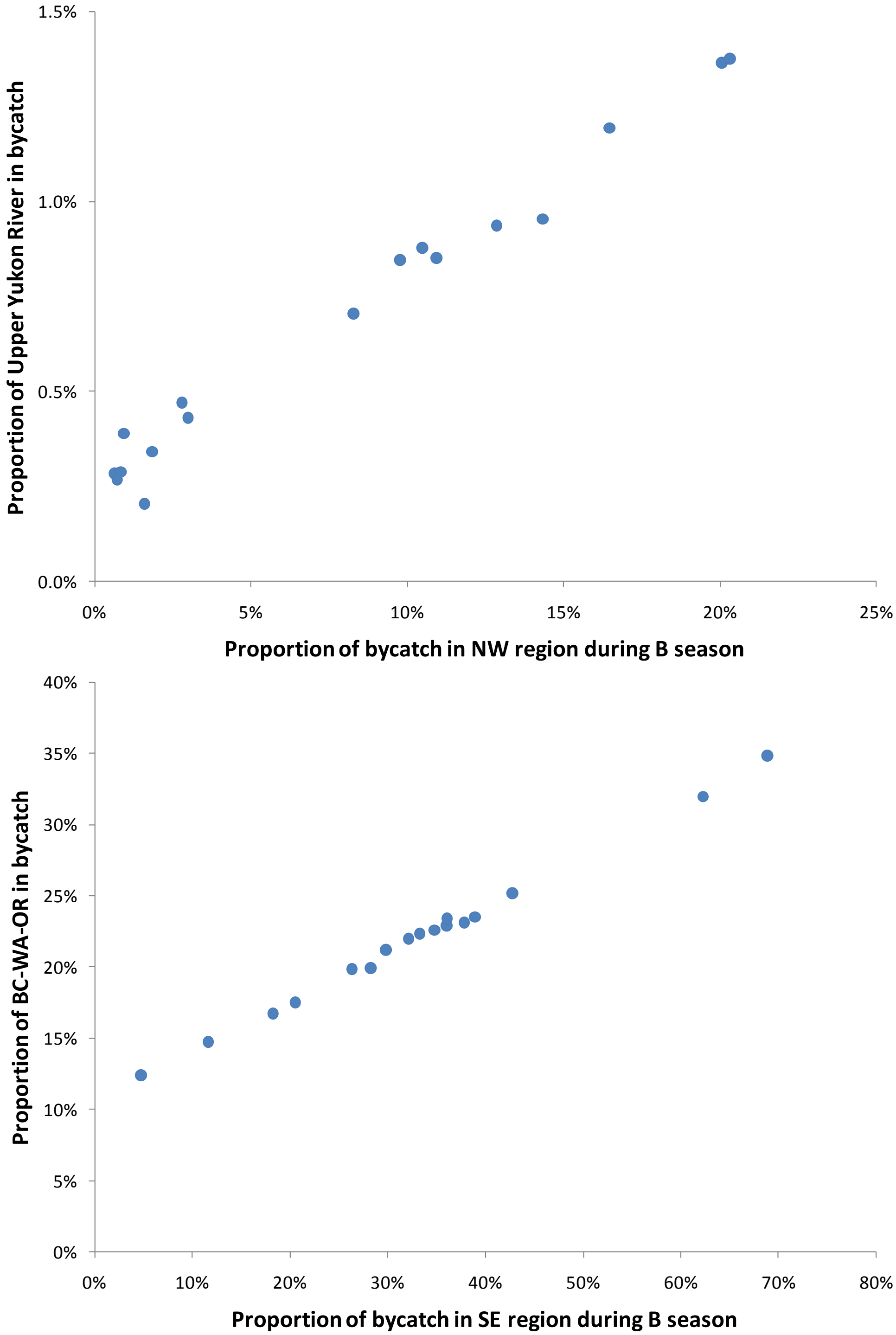


Figure 9. Figure showing how the overall proportion of Upper Yukon River relates to the bycatch proportion that occurs in the NW region (west of 170°W; top panel) and how the proportion of the BC-WA-OR (PNW) relates to the SE region (east of 170°W; bottom panel) during the summer-fall pollock fishery, 1991-2007.

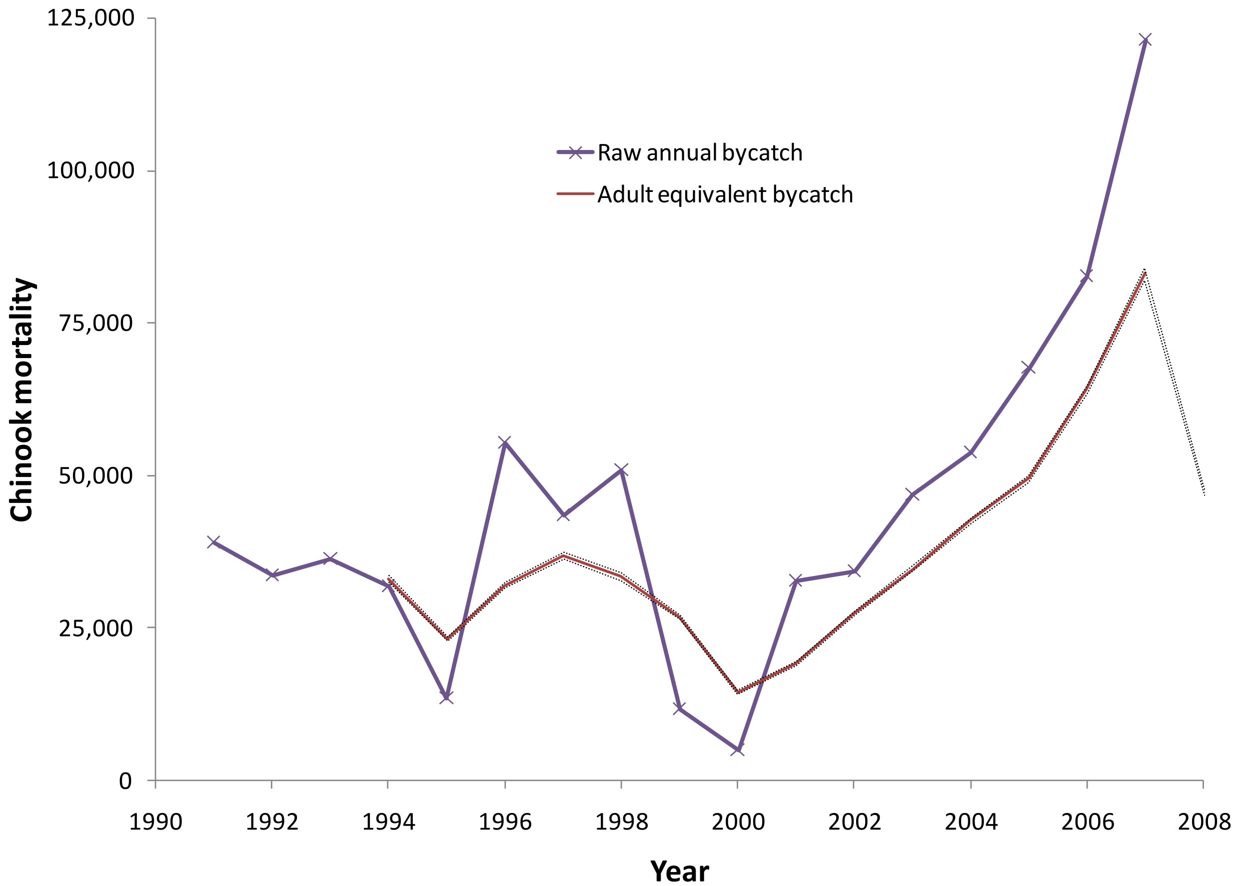


Figure 10. Time series of median Chinook adult equivalent bycatch from the pollock fishery, 1991-2007 compared to the annual totals. Dashed lines show the uncertainty due to the bootstrap age compositions of Chinook bycatch.

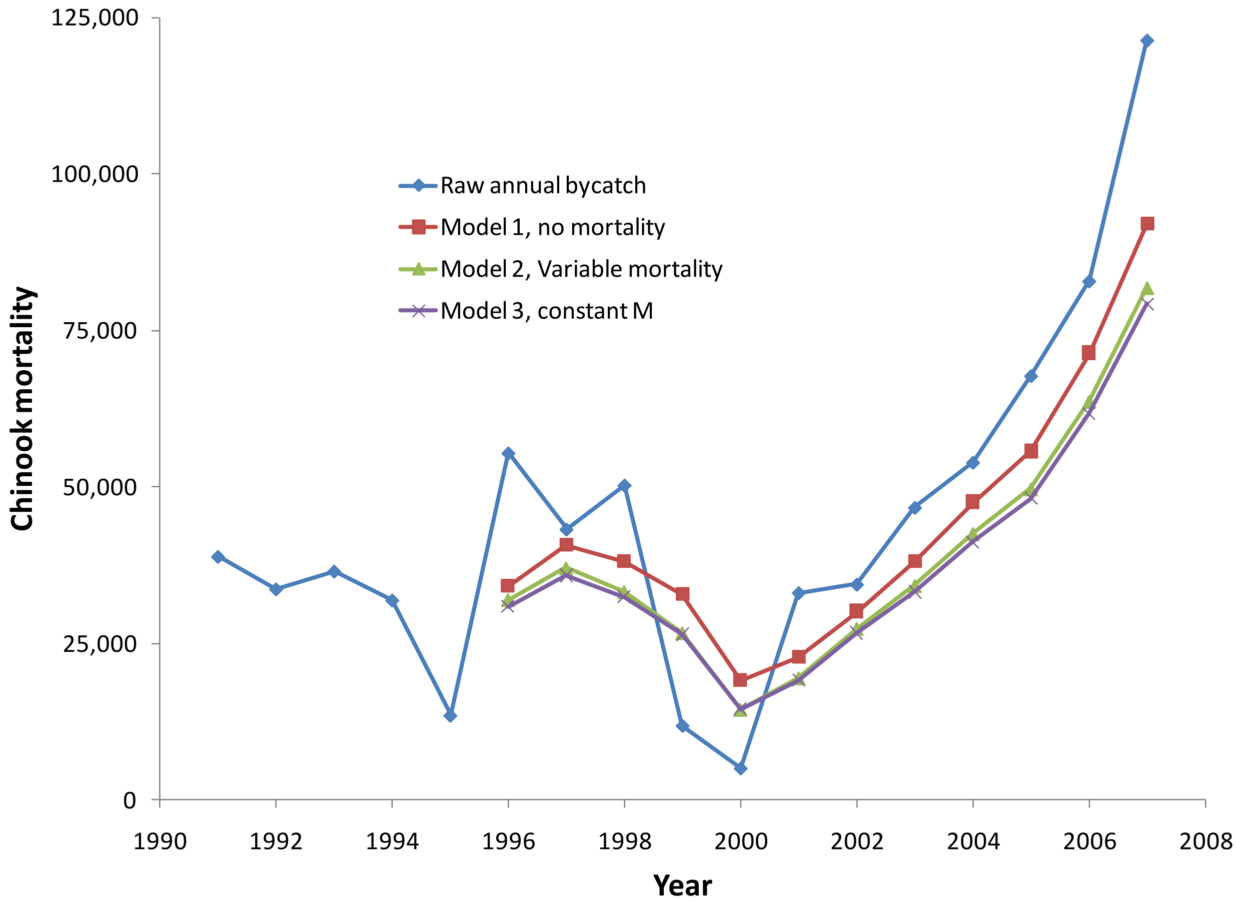


Figure 11. Time series of Chinook adult equivalent bycatch from the pollock fishery, 1991-2007 compared to the annual totals under different assumptions about ocean mortality rates.

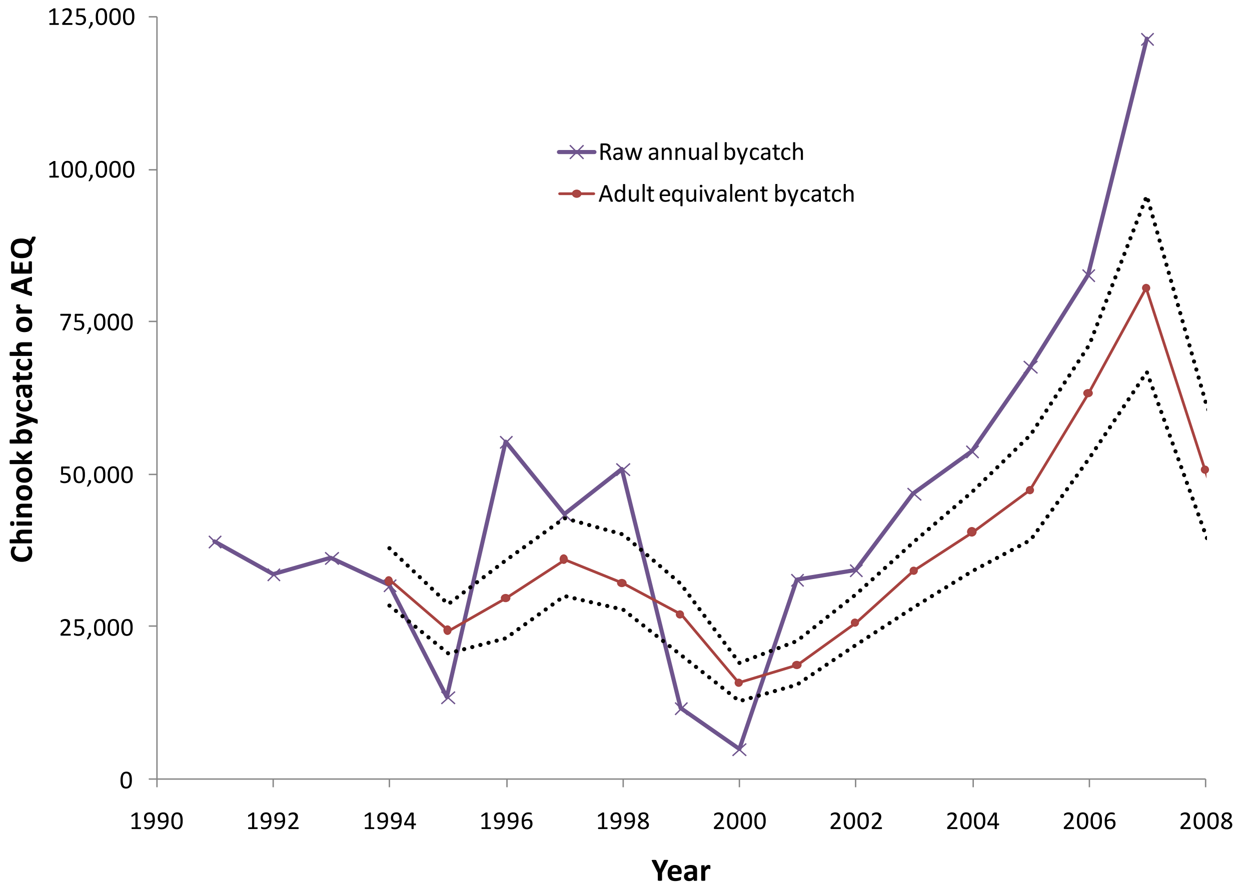


Figure 12. Time series of Chinook adult equivalent bycatch from the pollock fishery, 1991-2007 compared to the annual totals with stochasticity in the bycatch age composition (via bootstrap samples), maturation rate (CV=0.1), natural mortality (Model 2, CV=0.1).

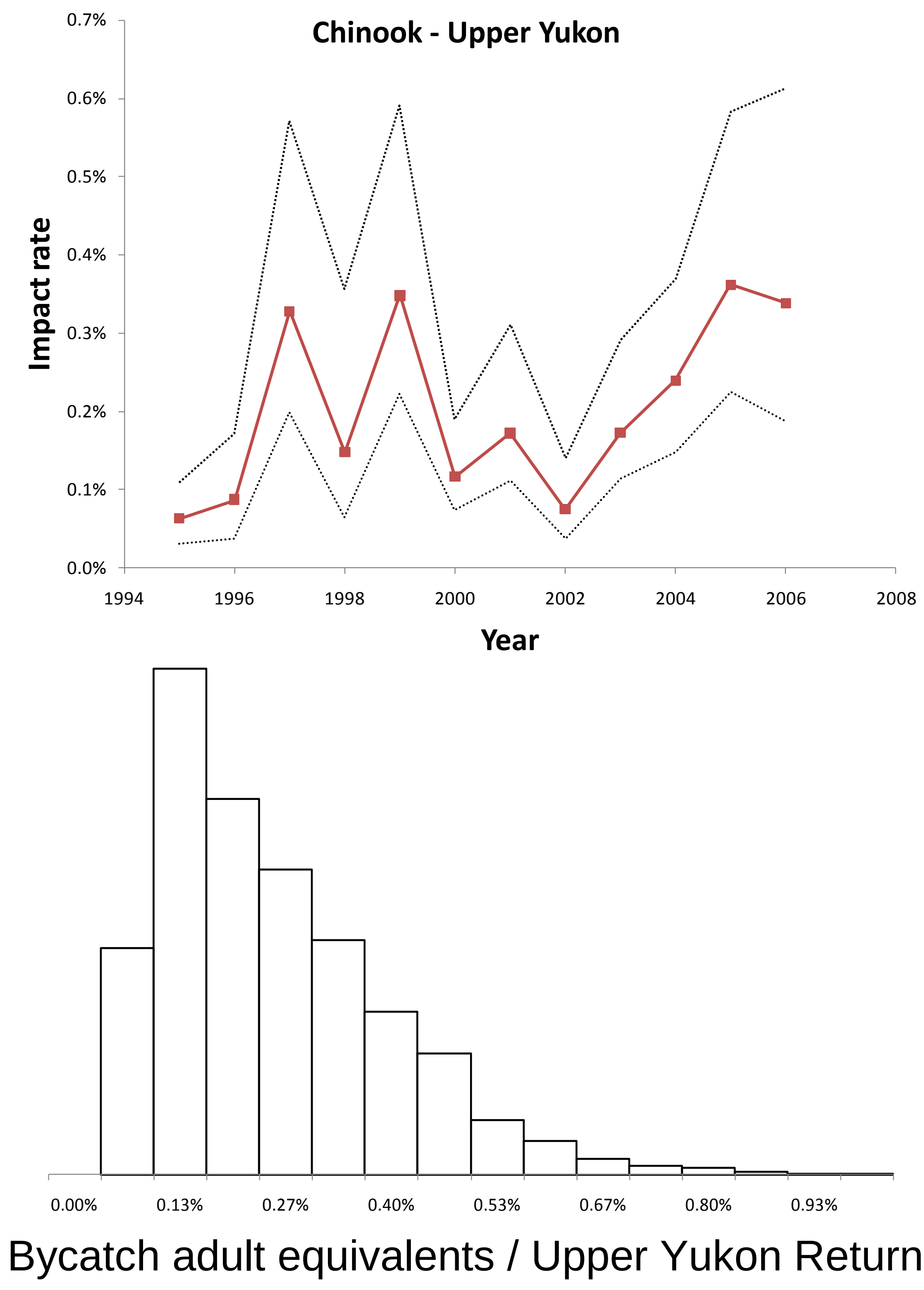
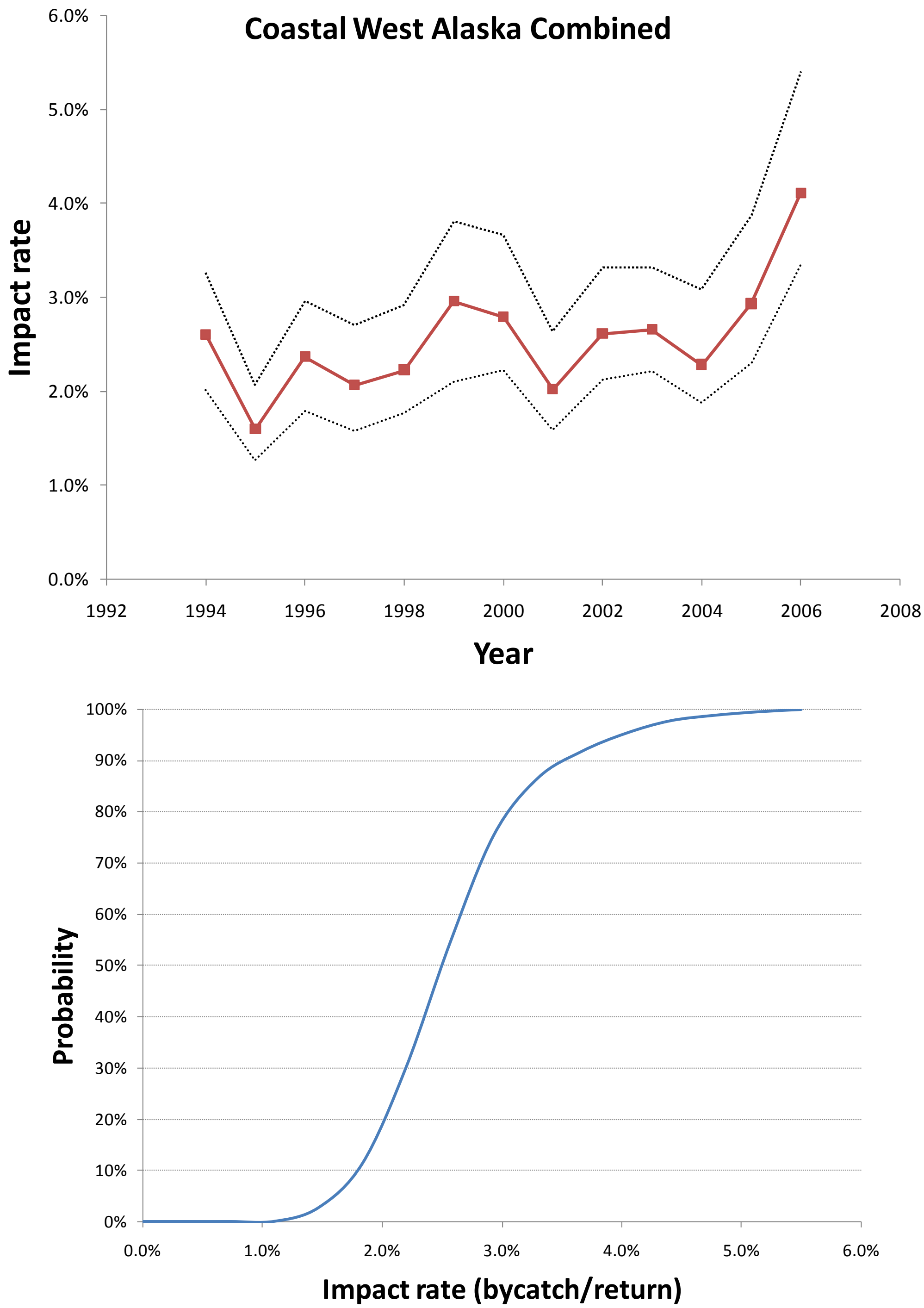


Figure 13. Annual estimates of pollock fishery impacts on Upper Yukon returns, 1995-2006 (top panel) with stochasticity in natural mortality (Model 2, CV=0.1), maturation rate (CV=0.1), stock composition (as detailed above), and run size. The lower panel shows relative frequency of different impact levels given the simulations and bycatch history.



Bycatch adult equivalents / Coast W AK Return

Figure 14. Annual estimates of pollock fishery impacts on Coastal west Alaska returns, 1994-2006 (top panel) with stochasticity in natural mortality (Model 2, CV=0.1), bycatch age composition (via bootstrap samples), maturation rate (CV=0.1), stock composition (as detailed above), and run size. The lower panel shows cumulative frequency of different impact levels given the simulations and bycatch history.

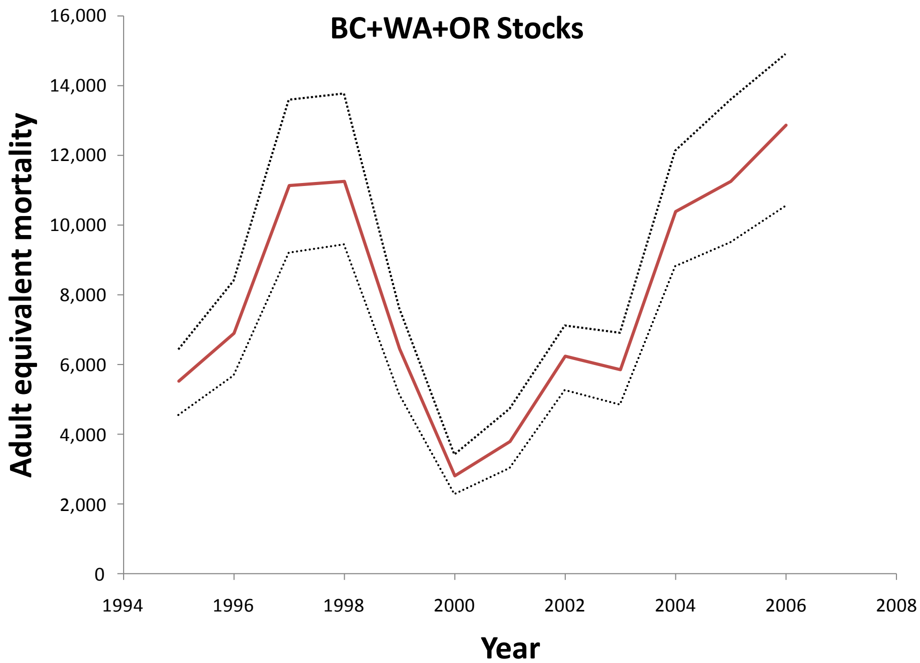


Figure 15. Annual estimated pollock fishery adult equivalent removals on stocks from the BC, WA, and Oregon returns, 1995-2007 with stochasticity in natural mortality (Model 2, CV=0.1), bycatch age composition (via bootstrap samples), maturation rate (CV=0.1), and stock composition (as detailed above).

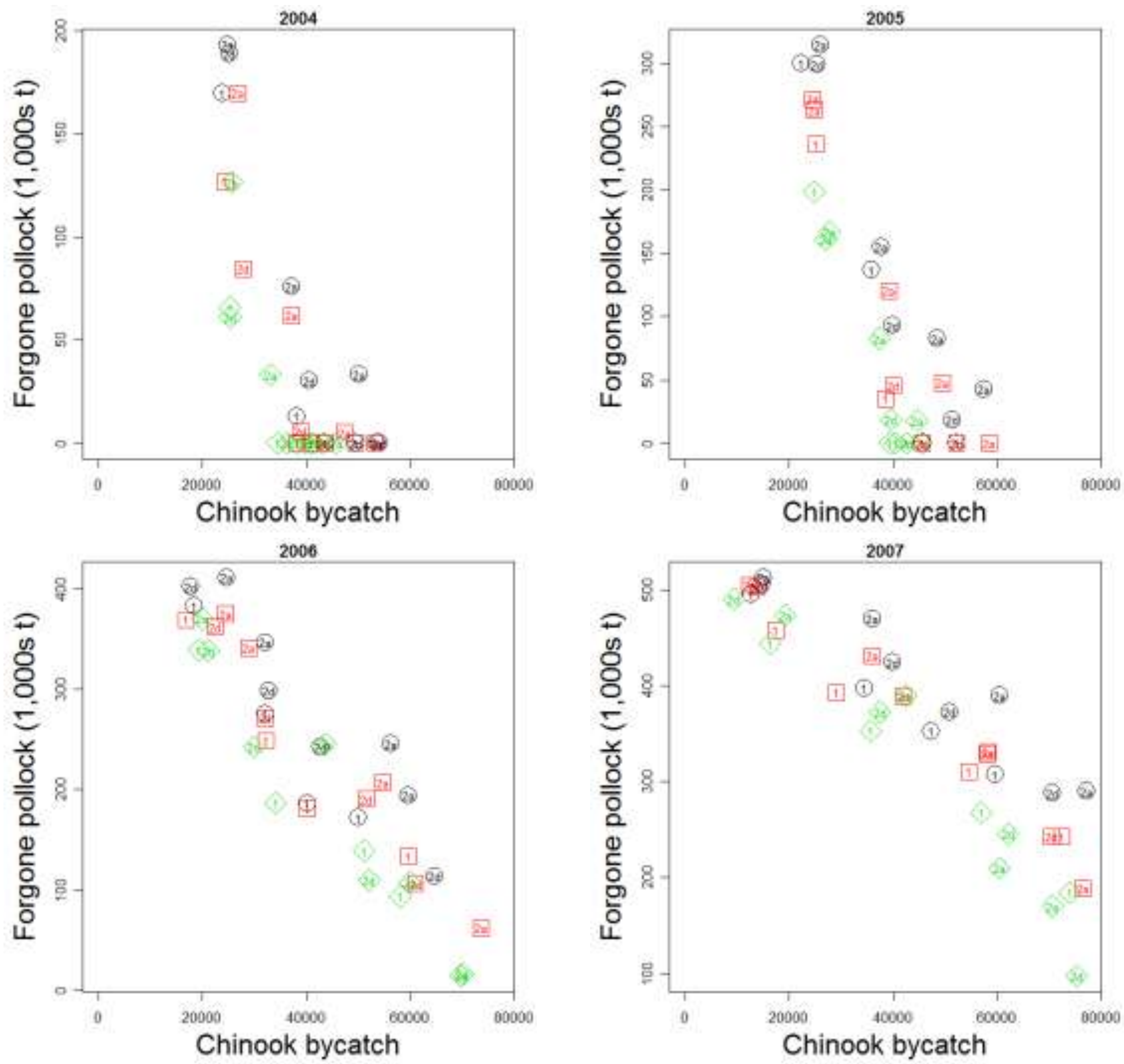


Figure 16. Examples of trade-offs in hypothetical Chinook AEQ bycatch (horizontal axis) and forgone pollock (vertical axis) had the suite of 36 management options been in place for 2004 (upper left) through 2007 (lower right). The text plotted denote the sector split options and the symbols (and colors) represent A-B season splits: circle=50:50, square=58:42, diamond=70:30.

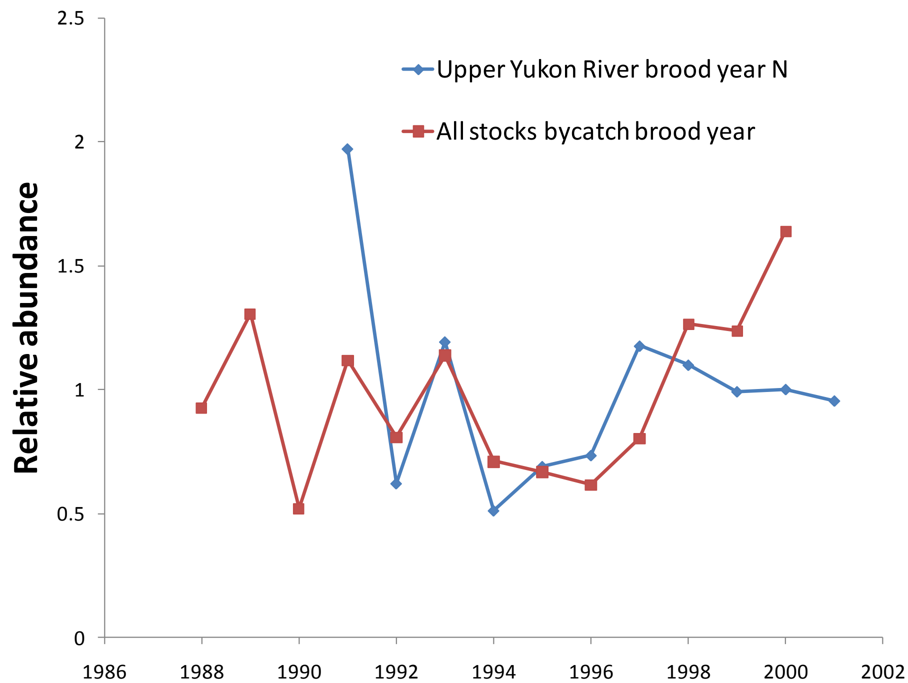


Figure 17. Chinook bycatch brood-year relative strength compared to the brood year variability observed in the Upper Yukon.

TABLES

Table 1. Summary of Chinook salmon bycatch age data from Myers et al (2003) used to construct age-length keys for this analysis.

Year	A	B	Total
1997	842	756	1,598
1998	873	826	1,699
1999	645	566	1,211
Total	2,360	2,148	4,508

Table 2. The number of Chinook salmon measured for lengths in the pollock fishery by season (A and B), area (NW=east of 170°W; SE=west of 170°W), and sector (S=shorebased catcher vessels, M=mothership operations, CP=catcher-processors). *Source: NMFS Alaska Fisheries Science Center observer data.*

Season	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	
Area	**All**	**All**	**All**	**NW**	**NW**	**NW**	**SE**	**SE**	**SE**	
Sector	**S**	**M**	**CP**	**S**	**M**	**CP**	**S**	**M**	**CP**	**Total**
1991	2,227	302	2,569		25	87	221	10	47	5,488
1992	2,305	733	889	2	4	14	1,314	21	673	5,955
1993	1,929	349	370	1	11	172	298	255	677	4,062
1994	4,756	408	986	3	93	276	781	203	275	7,781
1995	1,209	264	851		8	31	457	247	305	3,372
1996	9,447	976	2,798		17	161	5,658	1,721	493	21,271
1997	3,498	423	910	12	303	839	12,126	370	129	18,610
1998	3,124	451	1,329		38	191	8,277	2,446	1,277	17,133
1999	1,934	120	1,073		1	627	1,467	97	503	5,822
2000	608	17	1,388	4	40	179	564	3	120	2,923
2001	4,360	268	3,583		25	1,816	1,597	291	1,667	13,607
2002	5,587	850	3,011		23	114	5,353	520	494	15,952
2003	9,328	1,000	5,379	258	290	1,290	4,420	348	467	22,780
2004	7,247	594	3,514	1,352	557	1,153	8,884	137	606	24,044
2005	9,237	694	3,998	4,081	244	1,610	10,336	45	79	30,324
2006	17,875	1,574	5,716	685	66	480	12,757	3	82	39,238
2007	16,008	1,802	9,012	881	590	1,986	21,725	2	801	52,807

Table 3. Chinook salmon bycatch in the pollock fishery by season (A and B), area (NW=east of 170°W; SE=west of 170°W), and sector (S=shorebased catcher vessels, M=mothership operations, CP=catcher-processors). *Source: NMFS Regional Office, Juneau.*

Season	**A**	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	
Area	**All**	**All**	**All**	**NW**	**NW**	**NW**	**SE**	**SE**	**SE**	
Sector	**S**	**M**	**CP**	**S**	**M**	**CP**	**S**	**M**	**CP**	**Total**
1991	10,192	9,001	17,645	0	48	318	1,667	103	79	39,054
1992	6,725	4,057	12,631	0	26	187	1,604	1,739	6,702	33,672
1993	3,017	3,529	8,869	29	157	7,158	2,585	6,500	4,775	36,619
1994	8,346	1,790	17,149	0	121	771	1,206	452	2,055	31,890
1995	2,040	971	5,971		35	77	781	632	2,896	13,403
1996	15,228	5,481	15,276		113	908	9,944	6,208	2,315	55,472
1997	4,954	1,561	3,832	43	2,143	4,172	22,508	3,559	1,549	44,320
1998	4,334	4,284	6,500		309	511	27,218	6,052	2,037	51,244
1999	3,103	554	2,694	13	12	1,284	2,649	362	1,306	11,978
2000	878	19	2,525	4	230	286	714	23	282	4,961
2001	8,555	1,664	8,264	0	162	5,346	3,779	1,157	4,517	33,444
2002	10,336	1,976	9,481	0	38	211	9,560	1,717	1,175	34,495
2003	16,488	2,892	14,428	764	864	2,962	6,437	1,076	1,081	46,993
2004	12,376	2,092	9,492	2,530	1,573	2,844	21,171	503	1,445	54,028
2005	14,097	2,111	11,421	8,873	744	4,175	26,113	144	168	67,847
2006	36,039	5,408	17,306	936	175	1,373	21,718	25	178	83,159
2007	35,458	5,860	27,943	1,672	3,494	4,923	40,079	50	2,225	121,704

Table 4. Table of Chinook baseline collections used in analysis of bycatch mixtures for genetics studies (from Templin et al. In Prep.).

No.	Region	Location	Years	N
1	Russia	Bistraya River	1998	94
2		Bolshaya River	1998, 2002	77
3		Kamchatka River (Late)	1997, 1998	119
4		Pakhatcha River	2002	50
5	Norton Sound	Pilgrim River	2005, 2006	82
6		Unalakleet River	2005	82
7		Golsovia River	2005, 2006	111
8	Coast W AK (Lower Yukon)	Andreafsky River	2002, 2003	236
9		Anvik River	2002	95
10		Gisasa River	2001	188
11		Tozitna River	2002, 2003	290
12	Middle Yukon	Henshaw Creek	2001	147
13		S. Fork Koyuk	2003	56
14		Kantishna River	2005	187
15		Chena River	2001	193
16		Salcha River	2005	188
17		Beaver Creek	1997	100
18		Chandalar River	2002, 2003, 2004	175
19		Sheenjek River	2002, 2004, 2006	51
20	Upper Yukon	Chandindu River	2000, 2001, 2003	247
21		Klondike River	1995, 2001, 2003	79
22		Stewart River	1997	99
23		Mayo River	1992, 1997, 2003	197
24		Blind River	2003	134
25		Pelly River	1996, 1997	140
26		Little Salmon River	1987, 1997	100
27		Big Salmon River	1987, 1997	117
28		Tatchun Creek	1987, 1996, 1997, 2002, 2003	369
29		Nordenskiold River	2003	55
30		Nisutlin River	19,871,997	56
31		Takhini River	1997, 2002, 2003	162
32		Whitehorse Hatchery	1985, 1987, 1997	242
33	Coast W AK (Kuskokwim)	Goodnews River	1993, 2005, 2006	368
34		Arolik River	2005	147
35		Kanektok River	1992, 1993, 2005	244
36		Eek River	2002, 2005	173
37		Kwethluk River	2001	96
38		Kisaralik River	2001, 2005	191
39		Tuluksak River	1993, 1994, 2005	195
40		Aniak River	2002, 2005, 2006	336
41		George River	2002, 2005	191
42		Kogrukluk River	1992, 1993, 2005	149
43		Stony River	1994	93
44		Cheeneetnuk River	2002, 2006	117
45		Gagaryah River	2006	190
46		Takotna River	1994, 2005	176
47	Upper Kuskokwim	Tatlawiksuk River	2002, 2005	191
48		Salmon River (Pitka Fork)	1995	96
49	Coast W AK (Bristol Bay)	Togiak River	1993, 1994	159
50		Nushagak River	1992, 1993	57
51		Mulchatna River	1994	97
52		Stuyahok River	1993, 1994	87
53		Naknek River	1995, 2004	110
54		Big Creek	2004	66
55		King Salmon River	2006	131
56	N. AK Peninsula	Meshik River	2006	42
57		Milky River	2006	67
58		Nelson River	2006	95
59		Black Hills Creek	2006	51
60		Steelhead Creek	2006	93
61	S. AK Peninsula	Chignik River	1995, 2006	75
62		Ayakulik River	1993, 2006	136
63		Karluk River	1993, 2006	140

Table 4. (continued) Table of Chinook baseline collections used in analysis of bycatch mixtures for genetics studies (from Templin et al. In Prep.).

No.	Region	Location	Years	N
64	Cook Inlet	Deshka River	1995, 2005	251
65		Deception Creek	1991	67
66		Willow Creek	2005	73
67		Prairie Creek	1995	52
68		Talachulitna River	1995	58
69		Crescent Creek	2006	164
70		Juneau Creek	2005, 2006	119
71		Killey Creek	2005, 2006	266
72		Benjamin Creek	2005, 2006	205
73		Funny River	2005, 2006	220
74		Slikok Creek	2005	95
75		Kenai River (mainstem)	2003, 2004, 2006	302
76		Crooked Creek	1992, 2005	306
77		Kasilof River	2005	321
78		Anchor River	2006	200
79		Ninilchik River	2006	162
80	Upper Copper River	Indian River	2004, 2005	50
81		Bone Creek	2004, 2005	78
82		E. Fork Chistochina River	2004	145
83		Otter Creek	2005	128
84		Sinona Creek	2004, 2005	157
85	Lower Copper River	Gulkana River	2004	211
86		Mendeltna Creek	2004	144
87		Kiana Creek	2004	75
88		Manker Creek	2004, 2005	62
89		Tonsina River	2004, 2005	75
90		Tebay River	2004, 2005, 2006	68
91	Northern SE AK	Situk River	1988, 1990, 1991, 1992	143
92		Big Boulder Creek	1992, 1993, 1995, 2004	178
93		Tahini River	1992, 2004	169
94		Tahini River (LMH) Pullen Creek Hatchery	2005	83
95		Kelsall River	2004	96
96		King Salmon River	1989, 1990, 1993	144
97	Coast SE AK	King Creek	2003	143
98		Chickamin River	1990, 2003	56
99		Chickamin River - Little Port Walter	1993, 2005	126
100		Chickamin River - Whitman Lake Hatchery	1992, 1998, 2005	331
101		Humpy Creek	2003	94
102		Butler Creek	2004	95
103		Clear Creek	1989, 2003, 2004	166
104		Cripple Creek	1988, 2003	143
105		Genes Creek	1989, 2003, 2004	95
106		Kerr Creek	2003, 2004	151
107		Unuk River - Little Port Walter	2005	150
108		Unuk River - Deer Mountain Hatchery	1992, 1994	147
109		Keta River	1989, 2003	144
110		Blossom River	2004	95
111	Andrew Cr	Andrews Creek	1989, 2004	152
112		Crystal Lake Hatchery	1992, 1994, 2005	397
113		Medvejie Hatchery	1998, 2005	273
114		Hidden Falls Hatchery	1994, 1998	155
115		Macaulay Hatchery	2005	94
116	TBR Taku	Klukshu River	1989, 1990	174
117		Kowatua River	1989, 1990	144
118		Little Tatsemeanie River	1989, 1990, 2005	144
119		Upper Nahlin River	1989, 1990	130
120		Nakina River	1989, 1990	141
121		Dudidontu River	2005	86
122		Tahltan River	1989	95

Table 4. (continued) Table of Chinook baseline collections used in analysis of bycatch mixtures for genetics studies (from Templin et al. In Prep.).

No.	Region	Location	Years	N
123	BC/WA/OR	Kateen River	2005	96
124		Damdochax Creek	1996	65
125		Kincolith Creek	1996	115
126		Kwinageese Creek	1996	73
127		Oweegee Creek	1996	81
128		Babine Creek	1996	167
129		Bulkley River	1999	91
130		Sustut	2001	130
131		Ecstall River	2001, 2002	86
132		Lower Kalum	2001	142
133		Lower Atnarko	1996	144
134		Kitimat	1997	141
135		Wannock	1996	144
136		Klinaklini	1997	83
137		Nanaimo	2002	95
138		Porteau Cove	2003	154
139		Conuma River	1997, 1998	110
140		Marble Creek	1996, 1999, 2000	144
141		Nitinat River	1996	104
142		Robertson Creek	1996, 2003	106
143		Sarita	1997, 2001	160
144		Big Qualicum River	1996	144
145		Quinsam River	1996	127
146		Morkill River	2001	154
147		Salmon River	1997	94
148		Swift	1996	163
149		Torpy River	2001	105
150		Chilko	1995, 1996, 1999, 2002	246
151		Nechako River	1996	121
152		Quesnel River	1996	144
153		Stuart	1997	161
154		Clearwater River	1997	153
155		Louis Creek	2001	179
156		Lower Adams	1996	46
157		Lower Thompson River	2001	100
158		Middle Shuswap	1986, 1997	144
159		Birkenhead Creek	1997, 1999, 2002, 2003	93
160		Harrison	2002	96
161		Makah National Fish Hatchery	2001, 2003	94
162		Forks	2005	150
163		Upper Skagit River	2006	93
164		Soos Creek Hatchery	2004	119
165		Lyons Ferry Hatchery	2002, 2003	191
166		Hanford Reach	2000, 2004, 2006	191
167		Lower Deschutes River	2002	96
168		Lower Kalama	2001	95
169		Carson Stock - Mid and Upper Columbia spring	2001	96
170		McKenzie - Willamette River	2004	95
171		Alsea	2004	93
172		Siuslaw	2001	95
173		Klamath	1990, 2006	52
174		Butte Creek	2003	96
175		Eel River	2000, 2001	88
176		Sacramento River - winter run	2005	95

Table 5. NMFS regional office estimates of Chinook salmon bycatch in the pollock fishery compared to genetics sampling levels by season and region, 2005-2007 (SE=east of 170°W, NW=west of 170°W).

			Area			Area	
		Season	SE	NW	Total	SE	NW
Bycatch	2005	B	26,425	13,793	40,217	66%	34%
	2006	B	21,922	2,484	24,405	90%	10%
	2006	A			58,753		
	2007	A			69,261		
Genetic Samples	2005	B	489	282	771	63%	37%
	2006	B	286	304	590	48%	52%
	2006	A			801		
	2007	A			360		

Table 6. ADFG estimates of stock composition based on genetic samples stratified by year, season, and region (SE = east of 170°W, NW = west of 170°W). Standard errors of the estimates are shown in parentheses and were used to evaluate uncertainty of stock composition. *Source: ADFG preliminary data.*

Year / Season / Area	PNW	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Russia	TBR	Upper Yukon	Other
2005 B SE	45.3%	34.2%	5.3%	0.2%	8.8%	0.6%	3.3%	0.0%	2.4%
N = 282	(0.032)	(0.032)	(0.019)	(0.003)	(0.021)	(0.005)	(0.016)	(0.001)	(0.015)
2005 B NW	6.5%	70.9%	2.2%	4.7%	6.7%	2.0%	3.5%	2.8%	0.7%
N = 489	(0.012)	(0.047)	(0.011)	(0.013)	(0.042)	(0.007)	(0.012)	(0.009)	(0.008)
2006 B SE	38.4%	37.2%	7.5%	0.2%	7.0%	0.6%	4.3%	0.1%	4.7%
N = 304	(0.029)	(0.032)	(0.020)	(0.004)	(0.019)	(0.005)	(0.017)	(0.002)	(0.020)
2006 B NW	6.4%	67.3%	3.0%	8.0%	2.1%	3.3%	0.5%	8.0%	1.4%
N = 286	(0.016)	(0.035)	(0.020)	(0.020)	(0.016)	(0.013)	(0.007)	(0.019)	(0.014)
2006 A All	22.9%	38.2%	0.2%	1.1%	31.2%	1.1%	1.1%	2.3%	1.9%
N = 801	(0.015)	(0.038)	(0.004)	(0.005)	(0.039)	(0.004)	(0.007)	(0.006)	(0.011)
2007 A All	9.4%	75.2%	0.1%	0.5%	12.0%	0.2%	0.1%	0.1%	2.4%
N = 360	(0.016)	(0.031)	(0.004)	(0.005)	(0.025)	(0.003)	(0.002)	(0.003)	(0.014)

Table 7. Range of estimated mean age-specific maturation by brood year used to compute adult equivalents. The weighted mean value is based on the relative Chinook run sizes between the Nushagak and Yukon Rivers since 1997. *Sources: Healey 1991, Dani Evenson (ADFG, pers. Comm.), Rishi Sharma (CRITFC, pers. Comm.).*

	Weight	Age 3	Age 4	Age 5	Age 6	Age 7
Yukon	2.216	1%	13%	32%	49%	5%
Nushagak since 82	1.781	1%	21%	38%	39%	2%
Nushagak since 66	0	0%	17%	36%	43%	3%
Goodnews	0	0%	20%	31%	45%	4%
SE Alaska (TBR)	0.3	0%	18%	40%	37%	5%
BC, WA, OR, & CA	0.7	3%	28%	53%	14%	1%
Weighted mean		1%	18%	37%	40%	3%

Table 8. Chinook salmon effective bycatch "caps" in the pollock fishery by season (A and B) based on average values of the caps (if they occurred) had they been applied from 2003-2007.

Cap, A/B, sector	A season	B season	Total
87,500 50/50 opt1	31,099	24,339	55,438
87,500 50/50 opt2a	31,950	32,844	64,793
87,500 50/50 opt2d	36,899	28,791	65,690
87,500 58/42 opt1	44,118	20,321	64,439
87,500 58/42 opt2a	41,653	30,463	72,116
87,500 58/42 opt2d	42,234	24,258	66,492
87,500 70/30 opt1	49,368	16,277	65,644
87,500 70/30 opt2a	44,665	18,427	63,092
87,500 70/30 opt2d	55,376	17,815	73,191
68,100 50/50 opt1	27,784	18,272	46,056
68,100 50/50 opt2a	26,459	28,264	54,723
68,100 50/50 opt2d	25,196	24,258	49,455
68,100 58/42 opt1	29,569	17,581	47,150
68,100 58/42 opt2a	28,587	21,247	49,834
68,100 58/42 opt2d	32,676	19,997	52,674
68,100 70/30 opt1	41,021	13,253	54,274
68,100 70/30 opt2a	35,980	15,495	51,475
68,100 70/30 opt2d	42,234	14,640	56,874
48,700 50/50 opt1	19,292	16,196	35,488
48,700 50/50 opt2a	18,053	17,439	35,493
48,700 50/50 opt2d	21,242	16,725	37,966
48,700 58/42 opt1	21,142	13,253	34,394
48,700 58/42 opt2a	19,592	15,495	35,087
48,700 58/42 opt2d	23,610	14,640	38,250
48,700 70/30 opt1	27,784	10,225	38,009
48,700 70/30 opt2a	26,459	12,262	38,721
48,700 70/30 opt2d	25,196	11,612	36,809
29,300 50/50 opt1	9,761	10,225	19,985
29,300 50/50 opt2a	10,637	12,262	22,900
29,300 50/50 opt2d	10,070	11,612	21,682
29,300 58/42 opt1	12,725	8,740	21,465
29,300 58/42 opt2a	12,177	10,520	22,697
29,300 58/42 opt2d	12,031	10,634	22,665
29,300 70/30 opt1	15,120	6,885	22,005
29,300 70/30 opt2a	17,010	7,065	24,074
29,300 70/30 opt2d	14,859	6,775	21,634

Table 9. Calendar year age-specific Chinook salmon bycatch estimates based on the mean of 100 bootstrap samples of available length and age data. Age-length keys for 1997-1999 were based on Myers et al. (2003) data split by year while for all other years, a combined-year age-length key was used.

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Total
1991	5,624	15,901	13,486	3,445	347	38,802
1992	5,136	9,528	14,538	3,972	421	33,596
1993	2,815	16,565	12,992	3,673	401	36,446
1994	849	5,300	20,533	4,744	392	31,817
1995	498	3,895	4,827	3,796	367	13,382
1996	5,091	18,590	26,202	5,062	421	55,366
1997	5,855	23,972	7,233	5,710	397	43,167
1998	19,168	16,169	11,751	2,514	615	50,216
1999	870	5,343	4,424	1,098	21	11,757
2000	662	1,923	1,800	518	34	4,939
2001	6,512	12,365	11,948	1,994	190	33,009
2002	3,843	13,893	10,655	5,469	489	34,349
2003	5,703	16,723	20,124	3,791	298	46,639
2004	6,935	23,740	18,371	4,406	405	53,858
2005	10,466	30,717	21,886	4,339	304	67,711
2006	11,835	31,455	32,452	6,636	490	82,869
2007	16,174	66,024	33,286	5,579	357	121,419

Table 10. Age specific Chinook salmon bycatch estimates by season and calendar age based on the mean of 100 bootstrap samples of available length and age data.

Year/season	Age 3	Age 4	Age 5	Age 6	Age 7	Total
1991	**5,624**	**15,901**	**13,486**	**3,445**	**347**	**38,802**
A	5,406	14,764	12,841	3,270	313	36,593
B	218	1,137	646	174	34	2,209
1992	**5,136**	**9,528**	**14,538**	**3,972**	**421**	**33,596**
A	1,017	4,633	13,498	3,798	408	23,355
B	4,119	4,895	1,040	174	13	10,241
1993	**2,815**	**16,565**	**12,992**	**3,673**	**401**	**36,446**
A	1,248	3,654	7,397	2,778	290	15,368
B	1,567	12,910	5,595	895	111	21,078
1994	**849**	**5,300**	**20,533**	**4,744**	**392**	**31,817**
A	436	3,519	18,726	4,211	326	27,218
B	413	1,781	1,807	533	66	4,599
1995	**498**	**3,895**	**4,827**	**3,796**	**367**	**13,382**
A	262	1,009	3,838	3,534	327	8,969
B	236	2,885	989	263	40	4,413
1996	**5,091**	**18,590**	**26,202**	**5,062**	**421**	**55,366**
A	863	7,187	23,118	4,431	349	35,947
B	4,228	11,403	3,085	632	71	19,418
1997	**5,855**	**23,972**	**7,233**	**5,710**	**397**	**43,167**
A	456	2,013	3,595	3,899	271	10,234
B	5,399	21,958	3,638	1,811	126	32,933
1998	**19,168**	**16,169**	**11,751**	**2,514**	**615**	**50,216**
A	1,466	2,254	8,639	2,079	512	14,950
B	17,703	13,915	3,112	435	103	35,266
1999	**870**	**5,343**	**4,424**	**1,098**	**21**	**11,757**
A	511	1,639	3,151	898	18	6,217
B	360	3,704	1,272	200	3	5,540
2000	**662**	**1,923**	**1,800**	**518**	**34**	**4,939**
A	365	1,167	1,406	453	26	3,416
B	298	757	395	66	8	1,522
2001	**6,512**	**12,365**	**11,948**	**1,994**	**190**	**33,009**
A	2,840	3,458	9,831	1,798	171	18,098
B	3,672	8,907	2,117	196	19	14,910
2002	**3,843**	**13,893**	**10,655**	**5,469**	**489**	**34,349**
A	1,580	5,063	9,234	5,328	478	21,683
B	2,263	8,830	1,421	141	11	12,666
2003	**5,703**	**16,723**	**20,124**	**3,791**	**298**	**46,639**
A	2,941	9,408	17,411	3,437	267	33,464
B	2,763	7,315	2,713	354	31	13,175
2004	**6,935**	**23,740**	**18,371**	**4,406**	**405**	**53,858**
A	1,111	5,520	13,090	3,763	354	23,838
B	5,824	18,220	5,282	643	51	30,020
2005	**10,466**	**30,717**	**21,886**	**4,339**	**304**	**67,711**
A	1,407	6,993	15,563	3,361	226	27,550
B	9,059	23,724	6,323	978	78	40,161
2006	**11,835**	**31,455**	**32,452**	**6,636**	**490**	**82,869**
A	3,604	17,574	30,447	6,404	465	58,494
B	8,231	13,881	2,005	232	25	24,374
2007	**16,174**	**66,024**	**33,286**	**5,579**	**357**	**121,419**
A	5,791	29,269	28,648	5,059	317	69,084
B	10,384	36,755	4,638	520	40	52,336

Table 11. Estimates of coefficients of variation of Chinook salmon bycatch estimates by season and calendar age based on the mean of 100 bootstrap samples of available length and age data.

A season	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**
1991	14%	6%	6%	10%	31%
1992	20%	9%	4%	9%	27%
1993	22%	9%	5%	10%	37%
1994	27%	12%	3%	10%	30%
1995	25%	12%	5%	6%	22%
1996	19%	6%	2%	9%	21%
1997	35%	12%	6%	7%	28%
1998	16%	9%	3%	10%	23%
1999	19%	10%	5%	11%	91%
2000	25%	9%	6%	9%	27%
2001	10%	6%	3%	7%	22%
2002	15%	6%	3%	4%	16%
2003	14%	6%	3%	8%	21%
2004	15%	6%	2%	5%	20%
2005	18%	6%	3%	7%	23%
2006	17%	5%	3%	7%	22%
2007	22%	5%	4%	8%	25%
B season	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**
1991	23%	8%	12%	27%	67%
1992	9%	9%	25%	69%	87%
1993	19%	4%	9%	20%	65%
1994	17%	6%	6%	14%	27%
1995	21%	5%	12%	23%	48%
1996	6%	3%	7%	11%	29%
1997	12%	3%	10%	12%	39%
1998	5%	6%	9%	23%	36%
1999	16%	3%	8%	22%	149%
2000	9%	5%	8%	25%	49%
2001	7%	3%	8%	20%	52%
2002	6%	2%	8%	17%	43%
2003	8%	3%	5%	15%	32%
2004	6%	2%	5%	12%	30%
2005	5%	2%	5%	10%	23%
2006	4%	3%	8%	15%	33%
2007	6%	2%	7%	13%	28%

Table 12. Mean values of catch-weighted stratified proportions of stock composition based on genetic sampling by season, and region (SE=east of 170°W, NW=west of 170°W). Standard errors of the estimates (in parentheses) were derived from 200 simulations based on the estimates from Table 6 and weighting annual results as explained in the text.

Season / Area	PNW	Coast W AK	Cook Inlet	Middle Yukon	N AK Penin	Russia	TBR	Upper Yukon	Other
B SE	45.0%	34.7%	5.1%	0.1%	8.6%	0.6%	3.4%	0.0%	2.4%
	(0.025)	(0.024)	(0.017)	(0.002)	(0.016)	(0.004)	(0.014)	(0.001)	(0.014)
B NW	6.4%	68.9%	2.6%	6.6%	4.4%	2.7%	1.8%	5.6%	1.0%
	(0.010)	(0.023)	(0.012)	(0.011)	(0.019)	(0.007)	(0.006)	(0.012)	(0.008)
A All	12.1%	67.7%	0.1%	0.6%	16.0%	0.4%	0.2%	0.6%	2.3%
	(0.012)	(0.021)	(0.003)	(0.004)	(0.019)	(0.002)	(0.002)	(0.003)	(0.010)

Table 13. Median values of stochastic simulation results of AEQ Chinook mortality attributed to the pollock fishery by region, 1994-2007. These simulations include stochasticity in natural mortality (Model 2, CV=0.1), bycatch age composition (via bootstrap samples), maturation rate (CV=0.1), and stock composition (as detailed above). **NOTE: these results are based on the assumption that the genetics findings from the 2005-2007 data represent the historical pattern of bycatch stock composition (by strata).**

	BC, WA, OR, and CA	Coastal W. AK	Cook Inlet	Middle Yukon	N. Alaska Peninsula	Other	Russia	Upper Yukon	TBR (SE)	Total
1994	5,198	21,518	242	201	4,898	714	147	194	198	33,310
1995	5,635	14,084	415	104	3,302	532	112	96	279	24,559
1996	6,974	17,025	520	154	3,939	632	142	137	364	29,886
1997	11,376	16,895	1,276	413	3,364	715	277	343	783	35,442
1998	10,967	14,218	1,110	103	3,382	696	165	87	711	31,439
1999	6,429	15,099	573	297	3,193	561	188	245	387	26,973
2000	2,815	9,383	219	167	2,106	330	99	147	152	15,418
2001	3,694	10,473	349	260	2,141	375	149	221	238	17,899
2002	6,236	14,516	509	106	3,467	609	117	96	341	25,997
2003	5,743	20,065	398	356	4,424	679	207	311	292	32,475
2004	10,164	21,904	1,018	466	4,592	859	305	393	685	40,386
2005	11,169	25,462	1,203	767	5,107	923	439	645	772	46,487
2006	12,719	36,337	892	363	8,355	1,348	290	339	633	61,275
2007	18,079	44,380	1,597	694	9,743	1,688	485	608	1,069	78,344

Table 14. Hypothetical adult equivalent Chinook salmon bycatch mortality **totals** under each cap and management option, 2003-2007**.** Numbers are based on the median AEQ values with the original estimates shown in the second row. Right-most column shows the mean over all years relative to the estimated AEQ bycatch. The shadings and the pies relate to the relative AEQ bycatch for each policy and year.

	2003	2004	2005	2006	2007	
No Cap	**33,215**	**41,047**	**47,268**	**61,737**	**78,814**	
Cap, AB, sector						
87,500 70/30 opt2d	32,903	38,255	38,479	49,058	56,397	82%
87,500 70/30 opt2a	33,081	38,485	38,753	49,986	54,164	82%
87,500 70/30 opt1	32,864	37,582	36,635	43,381	51,106	77%
87,500 58/42 opt2d	33,368	39,856	42,197	47,135	51,981	82%
87,500 58/42 opt2a	32,143	39,887	44,402	54,960	59,119	88%
87,500 58/42 opt1	33,108	38,163	38,153	44,338	51,012	78%
87,500 50/50 opt2d	33,010	40,943	42,928	49,228	51,971	83%
87,500 50/50 opt2a	30,747	38,967	43,140	47,977	53,212	82%
87,500 50/50 opt1	33,151	39,747	41,912	43,139	43,599	77%
68,100 70/30 opt2d	33,162	36,866	36,314	40,583	45,112	73%
68,100 70/30 opt2a	29,981	34,695	36,854	44,290	47,643	74%
68,100 70/30 opt1	32,948	36,791	35,507	39,891	42,666	72%
68,100 58/42 opt2d	32,364	37,417	37,704	40,948	43,194	73%
68,100 58/42 opt2a	30,023	36,658	39,105	43,534	45,139	74%
68,100 58/42 opt1	33,108	37,477	37,402	35,895	38,137	69%
68,100 50/50 opt2d	30,769	37,607	41,249	38,952	38,063	71%
68,100 50/50 opt2a	30,084	37,224	39,182	43,200	45,144	74%
68,100 50/50 opt1	32,342	37,659	38,203	36,334	35,679	69%
48,700 70/30 opt2d	29,249	33,665	33,408	30,077	28,277	59%
48,700 70/30 opt2a	28,798	31,431	31,021	33,765	34,297	61%
48,700 70/30 opt1	30,155	33,547	33,374	31,735	29,376	60%
48,700 58/42 opt2d	29,987	33,692	34,121	30,697	30,120	61%
48,700 58/42 opt2a	27,722	31,175	32,007	28,025	27,065	56%
48,700 58/42 opt1	28,349	33,201	33,788	30,543	25,454	58%
48,700 50/50 opt2d	28,797	33,773	33,600	30,876	29,647	60%
48,700 50/50 opt2a	26,949	30,859	31,139	28,650	27,215	55%
48,700 50/50 opt1	26,854	31,947	31,278	29,530	26,716	56%
29,300 70/30 opt2d	19,200	22,679	23,095	20,513	13,338	38%
29,300 70/30 opt2a	21,115	23,813	23,825	20,612	17,220	41%
29,300 70/30 opt1	19,252	22,524	21,886	19,101	15,220	37%
29,300 58/42 opt2d	18,963	23,646	22,393	20,476	15,041	38%
29,300 58/42 opt2a	19,376	23,043	22,132	20,827	15,039	38%
29,300 58/42 opt1	18,259	21,267	21,286	18,331	14,924	36%
29,300 50/50 opt2d	19,122	22,130	21,382	18,665	14,048	36%
29,300 50/50 opt2a	19,123	21,927	21,513	20,925	16,004	38%
29,300 50/50 opt1	17,104	20,672	19,676	17,542	13,161	34%

Table 15. Comparison of sampling levels from Myers' et al. (2003) study and NMFS regional office estimates of Chinook bycatch levels from the pollock fishery, 1997-1999.

Year	Area	Season	Myers' age samples	Bycatch Estimate	Myers' age samples	Bycatch Estimate
1997	All	A	874	10,347	51%	23%
1997	SE	B	651	27,616	39%	62%
1997	NW	B	158	6,358	9%	14%
1998	All	A	906	15,118	51%	30%
1998	SE	B	730	35,307	41%	69%
1998	NW	B	138	820	8%	2%
1999	All	A	652	6,352	53%	53%
1999	SE	B	456	4,317	37%	36%
1999	NW	B	122	1,310	10%	11%