REVISIONS TO THE OFFICIAL DFO COMMERCIAL PACIFIC SALMON CATCH ESTIMATES FOR 1996-2004

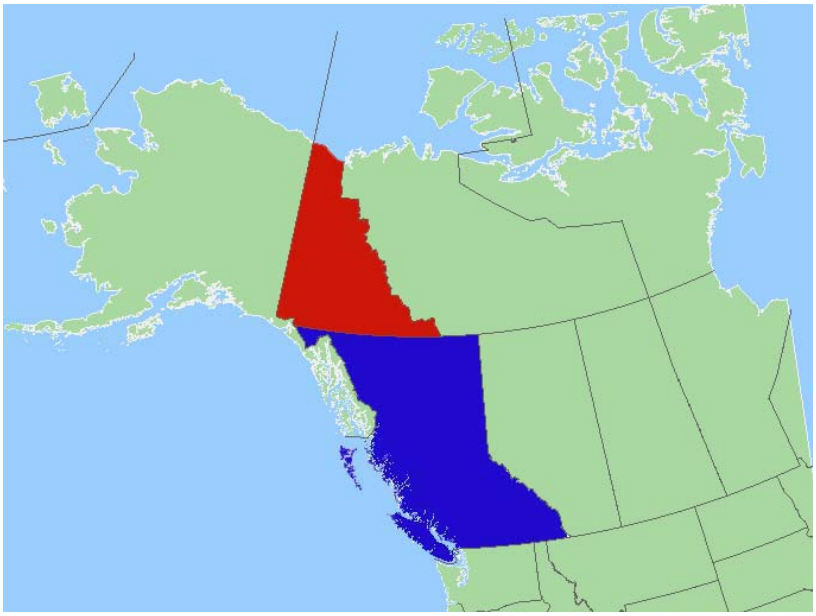

Figure 1: The Pacific-Yukon Region of Western Canada consists of the Yukon Territory (red) and the province of British Columbia (blue). This document pertains to those portions of this Region inhabited by anadromous Pacific Salmon.

Context :
Commercial catch estimates for Pacific salmon have not been finalized since 1995. The Department's official estimates, maintained by the Regional Data Unit, are based on sale slips, and are known to underestimate total catch. Total commercial catches were re-estimated using the best information available and compared with sale slip-based estimates. Advice is needed so that future catch reporting can be completed in a timely way.

SUMMARY

- Commercial salmon catch estimates, for the entire Pacific Region from 1996 to 2004, have been revised, using all available data sources.
- Revised estimates have been endorsed as "Final" by area authorities.
- Revised estimates are compared with sale slip-based estimates maintained by the Regional Data Unit (RDU).
- Differences between revised and RDU estimates are usually small to moderate, but revised estimates generally exceed RDU estimates, and differences tend to increase with time.

- Revised estimates are more accurate than those of the RDU. The precision of both the revised estimates and those of the RDU is generally unknown, but the precision of the revised estimates is expected to be as high or higher in most cases.
- We recommend that the revised estimates be adopted as the official estimates for the Pacific Region, replacing those currently held by the RDU.

BACKGROUND

Commencing in 1951, sale slips that recorded transactions between commercial fishermen and fish buying companies were used to account for commercial catch. Annual summaries, known as Blue Books since their covers were originally blue, were published until 1995. Sale slips record gear type, location of catch, date of landing, species, volume or landed weight, pieces, and value. Since sale slips are required to be completed for all fish caught, sale slips should generate an accurate estimate of the total landed catch. Since pieces are not usually used to determine payment to the fisherman, there is less incentive to report pieces as accurately as landed weights. Pieces are usually estimated by the fish buyer who applies an arbitrary estimated fish average weight to the landed weight, especially for high volume net landings (L. Bijsterveld, pers. comm.).

Commercial catch estimates for the Pacific Region have not been finalized since 1995. Similarly, estimates provided to the North Pacific Anadromous Fish Commission (NPAFC) by DFO have been labeled as “preliminary”. The reason is the recognition that there are numerous problems with the sale slip program including non-compliance and misreporting. A detailed review of the 2000 South Coast salmon season found that sale slips routinely underestimated catch, sometimes by large amounts (Bijsterveld et al. 2002). These authors made numerous recommendations to improve our ability to cost effectively monitor catch, including the discontinuation of the sale slip program.

Sale slips are not the only means to estimate catch. Data from log books, interviews, and observers are routinely used to generate catch estimates. As a result, there are various sources of catch estimates within the Pacific Region including some that are area-based. Very different estimates of catch sometimes exist for the same gear/species/time strata. While some organizations including the Pacific Salmon Commission use final in-season catch estimates to reflect total salmon landings (M. Lapointe, pers. comm.), other organizations use sale slip-based estimates since these are the Department’s official estimates.

We initiated this project in response to the acknowledged weaknesses of the current catch reporting system, and the assumption that current sale slip-based estimates were inadequate. Our objectives were:

- Using all available information (sale slips, log books, interview and observer information), to re-estimate commercial catch for salmon in BC/Yukon for 1996-2004;
- To compare these estimates with existing Regional Data Unit (RDU) estimates (similar to those provided to, and published by, the NPAFC);
- To try to understand reasons for differences; and
- To recommend a process to annually finalize catch estimates.

ANALYSIS

The catch review process began with a meeting between regional science, area stock assessment, and fishery management staff to discuss the need for revision, agree on roles and responsibilities, bound the study, and develop detailed specifications for the review. It was agreed that area staff (stock assessment or fishery management, depending on area) should recommend changes to catch estimates following a comprehensive effort to discover all relevant catch and effort data and thorough analysis. Further, Area Chiefs of Stock Assessment were to be accountable for reviewing and "sign-off" of estimates for their Area.

To ensure consistency across areas, the units, scope and resolution of the revised estimates were carefully specified. All estimates were to be in pieces. The scope was all salmon catch kept within the following bounds:

Time period: 1996-2004, inclusive
Area: entire Pacific Region, including salt and fresh water catches
Species: sockeye, pink, coho, Chinook, and chum salmon
Fishery/Licence: all salmon directed commercial fishing, defined as including all the conventional commercial salmon licences (salmon troll, gill net and seine) in authorized and protest fishing, salmon directed scientific fishing by commercial gears (including exploratory selective gears intended for use by commercial licences), salmon directed test fisheries, and First Nations fishing under economic opportunity licences ("FNEO"; e.g., "Pilot Sales", "ESSR" fisheries).
Catch component: all kept catch sold, eaten on board and 'take home'. Catch estimates do not reflect total fishing mortalities because they do not include salmon killed in fisheries targeting other species, or salmon caught but discarded or released who died.

Salmon sold from hatcheries, after swimming into the hatchery, were considered outside of the scope, as they were not 'fished'.

Separate estimates were to be developed for each Statistical Week ("Statweek"), Management Area, species, gear and license type (hereafter, "catch cell") for which there was fishing. Thus, for example, fishing in the same Statweek and management area under commercial salmon seine, commercial salmon troll, salmon test fishing, and FNEO type licences would lead to four separate estimates for each species. While estimates at finer resolution were welcome, estimates at coarser resolution were accepted only if the data did not permit estimation at the prescribed resolution. For example, certain troll fishing records specified Statistical Area, but not Management Area; in those cases, estimates at the Statistical Area level were accepted.

The types of kept catch data potentially available for developing a particular catch estimate include i) sale slip, ii) logbook/phone-in, iii) on-water interviews ("hails"), and iv) DFO observers (on water or dockside). The first three are fisher or industry *reported* catch and thus may be subject to strategic or other biases and also may be relatively imprecise, whereas *monitored* catch is expected to be more accurate and precise (Table 1).

The extensive time period and geographical scope of this exercise, along with the many different types of data and approaches used to generate catch estimates including variability in the quality of the various data sets made it impossible for Science to specify methodologies to apply. Rather, we discussed the general approaches that should be followed, and relied on the local knowledge and expertise of area reviewers to determine the best approach in each situation. Science staff were available for consultation and emphasized that when reliable effort

estimates exceeded the effort for which catch was reported, catch estimates should be expanded accordingly. This requirement distinguishes this review from estimates generated by the RDU based on sale slips; the latter estimates were not expanded for vessels known (or estimated) to have fished for which no sale slips were received. A summary of the general analytical approaches, grouped by Region, follows. More detailed descriptions are provided in an appendix that is available on request from the Centre for Science Advice – Pacific (psarc@pac.dfo-mpo.gc.ca).

Yukon Transboundary (YTB) Commercial Salmon

Commercial gill net and test gill net fisheries occur in Canadian portions of the Taku, Stikine and Yukon rivers. Fisheries tend to be small, with intense scrutiny of reported catch and catch estimates due in part to Canada/US treaty obligations. There were no new analyses done for this region during the revision process. Thus, any differences between revised catch and RDU catch, in the Taku and Stikine rivers, will be the result of incomplete delivery of catch estimates to the RDU. Note the RDU has catch estimates for the Taku and Stikine rivers, but not for the Yukon River in the period of study; therefore, Yukon River catch estimates were excluded from the revised estimates before the comparisons between the two sets of estimates (below) were conducted.

North Coast (NC) Commercial Salmon

Salmon fishing is spatially and temporally widespread. Revised commercial salmon gill net and seine catches were estimated by tallying all sale slips within each year, and then apportioning the totals among Management Area and Statweek strata based on the fraction of total on-water interview and logbook-based estimated catch in each stratum. This approach to apportioning was employed to correct for known errors in area and period reporting on the sale slips. Sale slips are regarded as an adequate data source for estimating total kept catch because sale slips are submitted by virtually all participating vessels. This high compliance with reporting requirements occurs because the department has continued to commit required resources to ensuring industry submits slips, and this approach has been effective because of the relatively small number of processors. Because these estimates are based on sale slips, we anticipated that revised annual total catch estimates for NC net fisheries would be similar to those held by the RDU.

Various methods were used to estimate commercial salmon troll catches (described in the detailed appendix available on request at the Centre for Science Advice – Pacific (psarc@pac.dfo-mpo.gc.ca)); these methods group into two general types. The first type is a minor variation of the method described above for NC net catches. The second type involved summing the catch estimate for each reporting vessel; there was no expansion for catch of non-reporting vessels. Catches for each reporting vessel were estimated by evaluating all available data sources for that particular vessel, which would have included one or more of sale slips, on-water interviews and logbook/phone-in reports (the latter available after 1999; Table 1). For Chinook and some coho catch estimates after 1999, sale slips providing only landed weight were converted to pieces using an average weight estimate appropriate for the particular catch stratum. Although interview and phone in data have a daily-management area resolution, sale slips are generated at landing, and thus typically represent catch for multiple fishing days and possibly areas. Further, slips may only capture an unknown fraction of the catch from a trip, if part of the catch is held over for subsequent delivery (especially in freezer vessels). Combined with the problem of missing sale slips, this makes the exercise to determine the best estimate for each vessel very challenging. Differences from the RDU estimates would result from i)

inclusion of catch for vessels that did not report via sale slip, but did report in at least one other manner, ii) choosing another report type as the best catch estimate for particular boats that also submitted sale slips, and iii) differences in the average weight conversion factors.

South Coast (SC) and Lower Fraser (LF) Commercial Salmon

The commercial salmon logbook/phone-in program was initiated, in part as an alternative to sale slips, for which there were declining submission rates. Observer programs were also in some fisheries to assess the accuracy and precision of fisher reported estimates (especially of non-retainable catch components). Thus, area catch reviewers were presented with a large variety of catch rate data and thus of multiple possible approaches to estimate catch rate. Estimates of reported catch, for all commercial fisheries, were revised with a procedure similar to that used in NC for troll catch estimates. All data available for a particular catch cell were assembled, and catch was estimated for vessels with adequate data. These estimates were used to calculate average catch per vessel-day for that catch cell.

Further, for many fisheries, independent and reliable estimates of total vessels fishing enabled expansions to account for catches from non-reporting vessels. Two methods estimated total vessels participating (i.e. total “effort”). Boats fishing were counted from a vessel or aircraft (ideally near the peak of fishing) on most fishing days for net fisheries, but only a small portion of open days for troll fisheries. Such counts were either used as is, or expanded in cases where counts were known to be incomplete because of partial spatial coverage; such expansions were based on typical distribution patterns. For troll fisheries, as the majority of fishing days had no survey, total effort was estimated as the number of vessels making phone-in catch reports divided by a phone-in compliance rate estimate. This compliance rate was calculated for each day on which effort counts were made as the number of vessels that made a phone-in catch report for that day divided by the effort count. In practice, the compliance rate was a rough running-average of these single-day estimates. Total catch for each catch cell was calculated as the product of the average catch per vessel-day and the total effort estimate for that cell. For these regions, differences between revised estimates and those held by the RDU result for the same reasons as described for NC Troll, but also from the expansion for catch of non-reporting vessels.

Test and Scientific Fishing

Catch estimates for test and scientific license fisheries, for the entire region, are regarded as accurate for various reasons: i) known number of participating vessels, ii) participating fishers typically are proficient at species identification and record catch conscientiously, iii) there are often independent observers on board, iv) record keeping is thorough, and v) data collection and analysis is conducted soon after fishing. Thus, the current review exercise did not require re-analysis of catch data for test and scientific fisheries. Rather, what was required was assembling estimates for all fisheries in these categories, including departmentally run test fisheries and those conducted by the Pacific Salmon Commission, and a large number of relatively small scientific license fisheries. Assembled catch estimates for these fisheries are expected to differ from those held by RDU because estimates for all of these fisheries have not consistently been provided to the RDU.

First Nations Economic Opportunity Fishing

FNEO fisheries, which have occurred in South Coast (SC) and Lower Fraser (LF) regions over most of the period of review, have been required to have dockside monitoring of all catch landed. Thus, for these fisheries, catch estimates are also considered to be accurate, and were not revised. Again, the review exercise consisted of ensuring all catch estimates were assembled, and any differences compared to the RDU estimates are expected to be the result of incomplete submissions to the RDU.

Results

In total, 42,069 estimates were provided for each species (Table 2). This count includes 18,863 estimates for commercial salmon licences, as well as 22,501 estimates for test fishing licenses. Counts of test fishing estimates are large in part because many of these estimates are for catch in a single set.

Revised and RDU estimates of annual, province-wide salmon kept catch by species are compared in Table 3 and Figure 2. (Comparisons are for BC only because the RDU do not have catch estimates for the Yukon River watershed.) Each figure, except Figure 3, uses the same format. The left hand panels of graphs display our revised catch estimates on the horizontal axis and the RDU sale slip-based estimates on the vertical axis. The 1:1 line is shown for reference. Each point represents one year's catch, and when points fall below the line, this indicates the revised estimate exceeded the original estimate. The right hand panels of graphs illustrate if time series biases occurred. Again, each point is a year, but here we plot relative differences between the revised and RDU estimates. The lines plotted on the right hand panel graphs in Figure 2 are linear fits to the data. A positive slope would indicate increasing negative temporal bias of the RDU estimates (assuming revised estimates to be more accurate), flat lines indicates no temporal bias, and negative slopes would indicate increasingly positive temporal bias. Figure 4 presents the data for each of 7 regions (Fraser R., South Coast Inside, West Coast Vancouver Island, Central Coast, North Coast and Taku and Stikine rivers), while Figure 5 presents the same comparisons for estimates for each of four licence types (commercial, FNEO, scientific, and test).

While there are many area and species-specific findings, the primary observations are that i) revised estimates tend to be higher than RDU estimates (43 out of 45 times in Figure 2), and ii) differences between the two sets of estimates are generally modest in the early period but increase through the time series (Table 3, Table 4, Figure 2 - positive slope for right hand graphs). The average changes in annual province wide totals range from 2.4% for pink salmon to 19.6% for coho salmon (though this large value mainly results from large changes in 3 years with very small catches; Table 4, Fig. 2):

RDU estimates are negatively biased for the vast majority of species/area/fishery combinations (Fig. 3, very few data below 0%). There is no clear relationship between the degree of bias (relative difference) and the size of the number of fish caught.

Relative differences in annual, region-specific catch estimates tend to be very small for the NC regions (Queen Charlotte Islands, North Coast, and Central Coast), as expected based on the analytic approach used to revise estimates (Fig. 4D, 4E, 4F). The much larger, mainly positive, differences in the SC and Lower Fraser regions (Fraser R., SC Inside and West Coast Vancouver Island; Figs 3A, 3B, 3C) were expected and resulted from i) the expansion of reported catch for non-reporting vessels in the revised estimates, and ii) relatively large recent

reductions in sale slip compliance for fishing in these areas, which depressed the RDU estimates. Finally, the large, consistently positive relative differences between the two sets of estimates in the Taku-Stikine region (Fig. 4G) were as expected due to incomplete submissions of catch estimates to the RDU.

Relative differences in annual, province-wide, FNEO catch estimates are large and positive (Fig. 5B), as expected if the catch estimates were incompletely reported to the RDU. The total annual catch estimates identified as Scientific License were relatively small (Fig. 5C), while those under Test licenses were moderately sized (Fig. 5D). For both Scientific and Test licenses, there were many cases in which the changes were negative. The reasons for this are unclear.

Revised estimates are more accurate than those of the RDU because the latter are often incomplete. Although there are no estimates of the precision of revised estimates, we conclude that the precision is generally quite high because the fraction of participating vessels for which catch data was obtained is generally fairly large. Since the RDU estimates are treated as complete, with all participating vessels reporting, those estimates would have no uncertainty.

Table 1. Summary of catch data sources, their coverage and statistical properties including qualitative estimates of bias and imprecision.

Data Type	Period covered	Areas covered	Fisheries covered	Potential bias and imprecision	Fraction of effort reporting
Fisher Reported					
Sale slip	1996-2004	Entire Pacific Region	All	High	High**
Logbook/ Phone-In	1998-1999*	South Coast and Lower Fraser	Commercial Salmon	High	High
Logbook/ Phone-In	2000-2004	Entire Pacific Region (except YTB)	Commercial Salmon	High	High
On-water interview	1996-2004	Entire Pacific Region	All	High	Medium
Monitored					
On-board	1998-2004	Primarily South Coast fisheries	Commercial Salmon, Scientific, Test	Low	Low
Dockside-FNEO validation	1996-2004	Entire Pacific Region	All FNEO fisheries	Low	High
Dockside-CWT *	1996-2004	Entire Pacific Region	Fisheries with Chinook or coho retention	Low	Medium

* Coded wire tag (CWT) sampling of landings involves counting the pieces of certain species landed, and thus represents on-land observer data type for those species. This data type is listed for completeness but was not used in this revision.

** For First Nations Economic Opportunity (FNEO) fisheries, the fraction of effort reporting is Low-Medium

Table 2. Count of estimates, by year, area, and Licence category, in the Revised estimates database. Counts represent the number of estimates for each of the five Pacific salmon species, so the total number of estimates is actually five times the number shown. "Fraser R." includes catch from marine areas of Area 29.

Calendar Year	Area	Commercial	FNEO	Scientific	Test	Total
1996	Fraser R	1	14	13	759	787
	SC Inside	38			897	935
	WCVI	1459	13		66	1538
	CC	33				33
	NC	133			16	149
	QCI	42				42
	Taku/Stikine	35			17	52
	Yukon R	29				29
	Total	1770	27	13	1755	3565
1997	Fraser R	2	27	27	695	751
	SC Inside	1140			1518	2658
	WCVI	933	32	1	238	1204
	CC	27				27
	NC	115			12	127
	QCI	70				70
	Taku/Stikine	39			11	50
	Yukon R	19				19
	Total	2345	59	28	2474	4906
1998	Fraser R	2	9	3	677	691
	SC Inside	72	1		2445	2518
	WCVI	902	16	98	258	1274
	CC	27				27
	NC	74			15	89
	QCI	39				39
	Taku/Stikine	35			17	52
	Yukon R	4			1	5
	Total	1155	26	101	3413	4695
1999	Fraser R	3	2	56	678	739
	SC Inside	4	1		1656	1661
	WCVI	955	18		380	1353
	CC	31				31
	NC	69			15	84
	QCI	27				27
	Taku/Stikine	29			47	76
	Yukon R	21				21
	Total	1139	21	56	2776	3992
2000	Fraser R	25	7	7	609	648
	SC Inside	45		1	1122	1168
	WCVI	751	8	174	370	1303
	CC	17				17
	NC	69			12	81
	QCI	34				34
	Taku/Stikine	28			67	95
	Yukon R	1			5	6
	Total	970	15	182	2185	3352

Table 2. Count of estimates, by year, area, and Licence category, in the Revised estimates database. Counts represent the number of estimates for each of the five Pacific salmon species, so the total number of estimates is actually five times the number shown. "Fraser R." includes fishing in marine areas of Area 29.

Calendar Year	Area	Commercial	FNEO	Scientific	Test	Total
Cont'd						
2001	SC Inside	65	1		1329	1395
	WCVI	2159	8		263	2430
	CC	28				28
	NC	100			10	110
	QCI	42				42
	Taku/Stikine	24			64	88
	Yukon R	8			3	11
	Total	2439	28	7	2274	4748
2002	Fraser R	22	23		632	677
	SC Inside	347	7		1411	1765
	WCVI	521	18	13	325	877
	CC	22				22
	NC	124			12	136
	QCI	92				92
	Taku/Stikine	23			60	83
	Yukon R	8			4	12
	Total	1159	48	13	2444	3664
2003	Fraser R	41	5		771	817
	SC Inside	231		2	1430	1663
	WCVI	3471	11	6	334	3822
	CC	22				22
	NC	102			14	116
	QCI	79				79
	Taku/Stikine	27			60	87
	Yukon R	24			3	27
	Total	3997	16	8	2612	6633
2004	Fraser R	11	32		706	749
	SC Inside	227		2	1370	1599
	WCVI	3407	21	2	441	3871
	CC	29				29
	NC	94			12	106
	QCI	70				70
	Taku/Stikine	26			38	64
	Yukon R	25			1	26
	Total	3889	53	4	2568	6514
Grand Total		18863	293	412	22501	42069

*Table 3. Revised and RDU annual total salmon kept catch estimates, by species. Relative Differences (%) = ((Revised estimate – RDU estimate) / Revised estimate X 100); differences are positive when the revised estimate exceeds the RDU estimate. All other values are thousands of fish. Relative differences exceeding 20% are in **bold**. Averages are based on the absolute differences of the differences.*

	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
Chinook										
Revised	65	234	168	133	86	121	286	351	410	
RDU	57	224	158	113	73	98	246	302	351	
Relative Diff. (%)	12.1	4.3	6.1	15.0	14.6	18.9	14.1	14.0	14.5	12.6
Absolute Diff.	8	10	10	20	12	23	40	49	59	26
Chum										
Revised	1447	1955	4875	1070	597	1358	2948	3151	3480	
RDU	1379	1909	4475	960	565	1191	2458	2836	3075	
Relative Diff. (%)	4.7	2.4	8.2	10.3	5.3	12.3	16.6	10.0	11.6	9.0
Absolute Diff.	67	46	400	111	32	167	490	315	405	226
Coho										
Revised	1316	229	9	15	18	18	136	252	364	
RDU	1415	230	6	9	9	16	120	221	314	
Relative Diff. (%)	-7.5	-0.5	**30.2**	**41.7**	**49.1**	10.2	11.3	12.2	13.7	19.6
Absolute Diff.	-99	-1	3	6	9	2	15	31	50	24
Pink										
Revised	5716	6568	2422	6074	4494	6826	5335	10716	2350	
RDU	5905	6506	2409	6078	4427	6127	5311	10321	2338	
Relative Diff. (%)	-3.3	0.9	0.5	-0.1	1.5	10.2	0.4	3.7	0.5	2.4
Absolute Diff.	-189	62	13	-4	67	700	24	395	12	163
Sockeye										
Revised	6437	11720	1959	775	3562	3034	4211	2789	2439	
RDU	6318	11236	1855	736	3497	2634	3690	2404	1754	
Relative Diff. (%)	1.9	4.1	5.3	4.9	1.8	13.2	12.4	13.8	**28.1**	9.5
Absolute Diff.	119	485	104	38	65	399	521	386	685	311

Table 4. Differences between RDU and revised estimates (annual and region wide) of commercial catch by species (see Table 3 for more details).

Species	Average Relative Diff.	General observations (see also Fig. 2)
Chinook	12.6%	Revised estimates exceeded RDU estimates each year. Negative bias of RDU estimates increase with time (not statistically significant), increases in fish caught range from 12,000 - 59,000.
Chum	9.0%	Revised estimates exceeded RDU estimates each year. Negative bias of RDU estimates increases with time (statistically significant), with increases in fish numbers ranging from 32,000 - 490,000.
Coho	19.6%	Revised estimates exceeded RDU estimates since 1998. Negative bias of RDU estimates increases with time (not statistically significant), with differences in fish numbers ranging from 2,000 - 50,000.
Pink	2.4%	Revised estimates exceeded RDU estimates each year except 1996 and 1999. Negative bias of RDU estimates increases with time (not statistically significant). The revised estimate for 2002 exceeded the RDU estimate by 700,000 fish.
Sockeye	9.5%	Revised estimates exceeded RDU estimates each year but relative differences are small to moderate (<15%) in all years but 2004, for which the difference is 28%. Negative bias of RDU estimates increase with time (statistically significant), with increases in fish numbers ranging from 38,000 - 685,000.

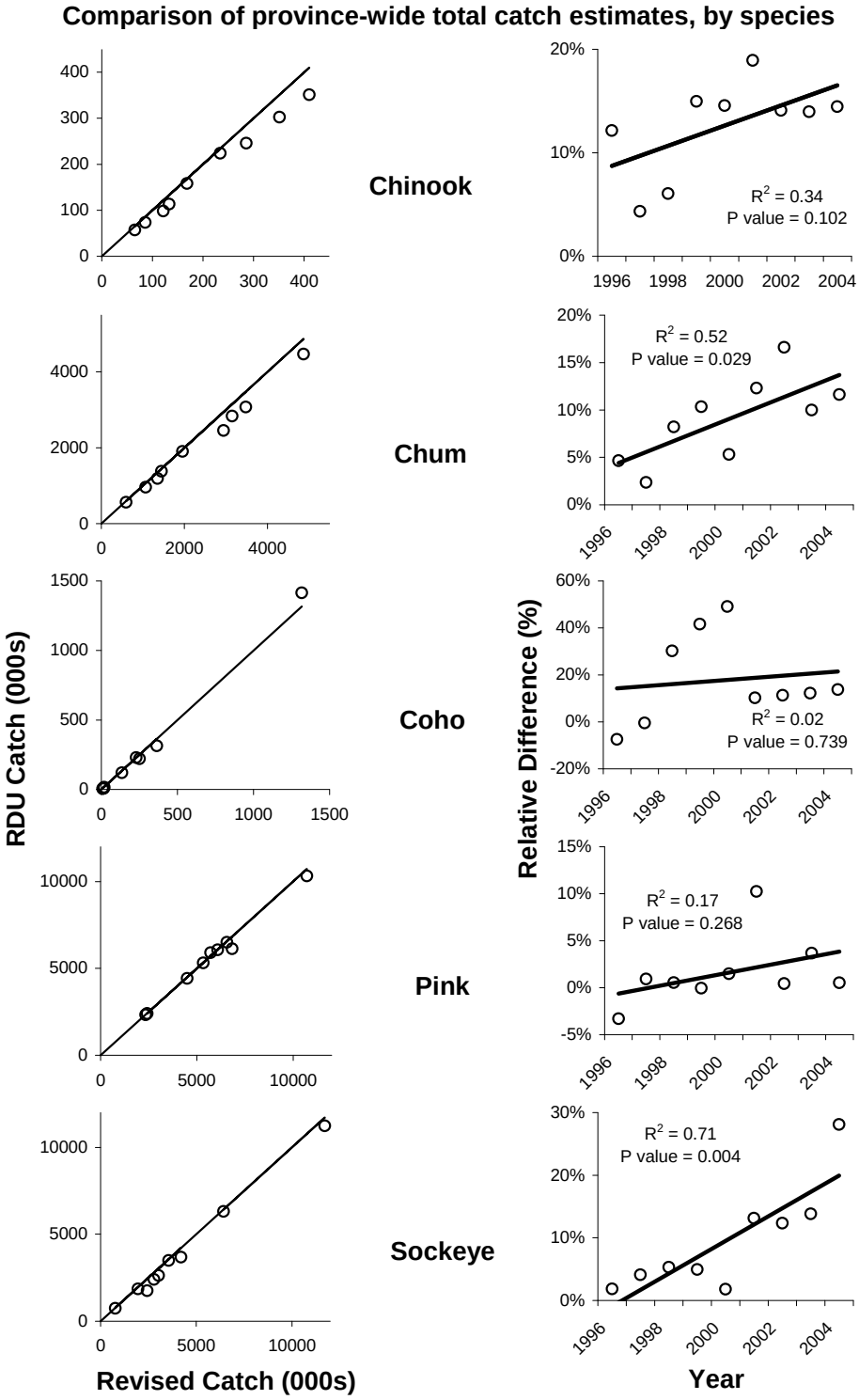

Figure 2. Comparison of RDU- and revised- province-wide, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 line for reference; graphs on the right show the Relative Difference vs year, with a linear regression line. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs. Reported P values are for the slope of the linear regression, for □ = 0.05.

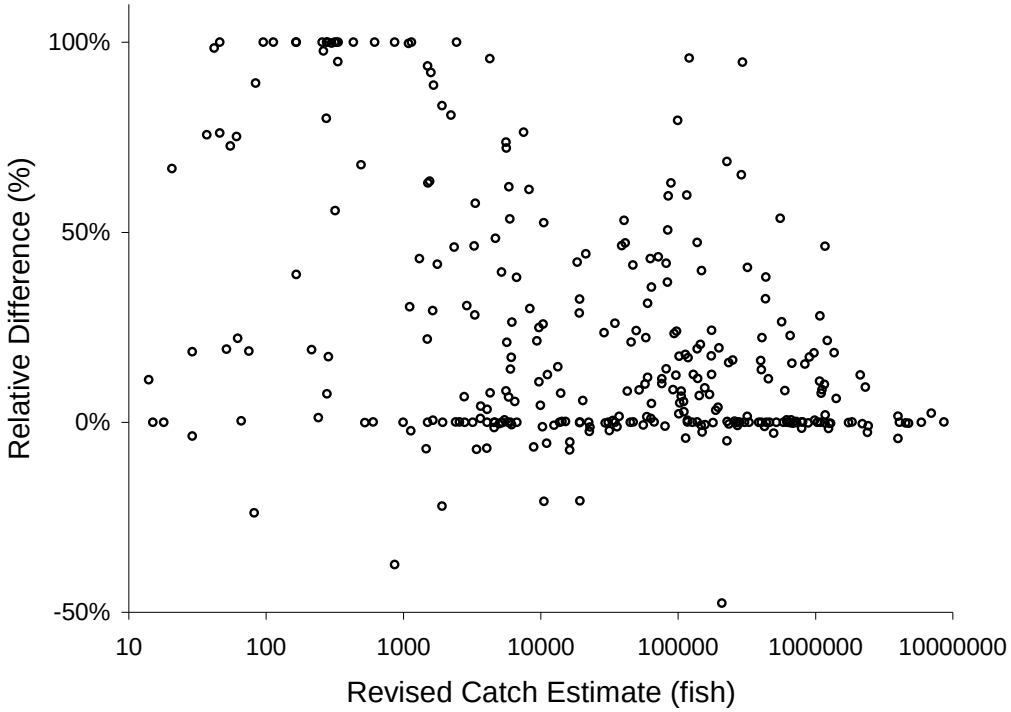

Figure 3. Relative difference (%) versus revised catch (fish) plotted on a logarithmic scale. Points are shown for each annual-, regional-, species-specific comparison. Differences are positive when the revised catch estimate is greater than the RDU estimate. Note: 1 point with very large negative change (-350% relative difference for a revised catch estimate of 136,000 pink salmon in A29 Fraser River in 1998, Fig. 3a) is not shown.

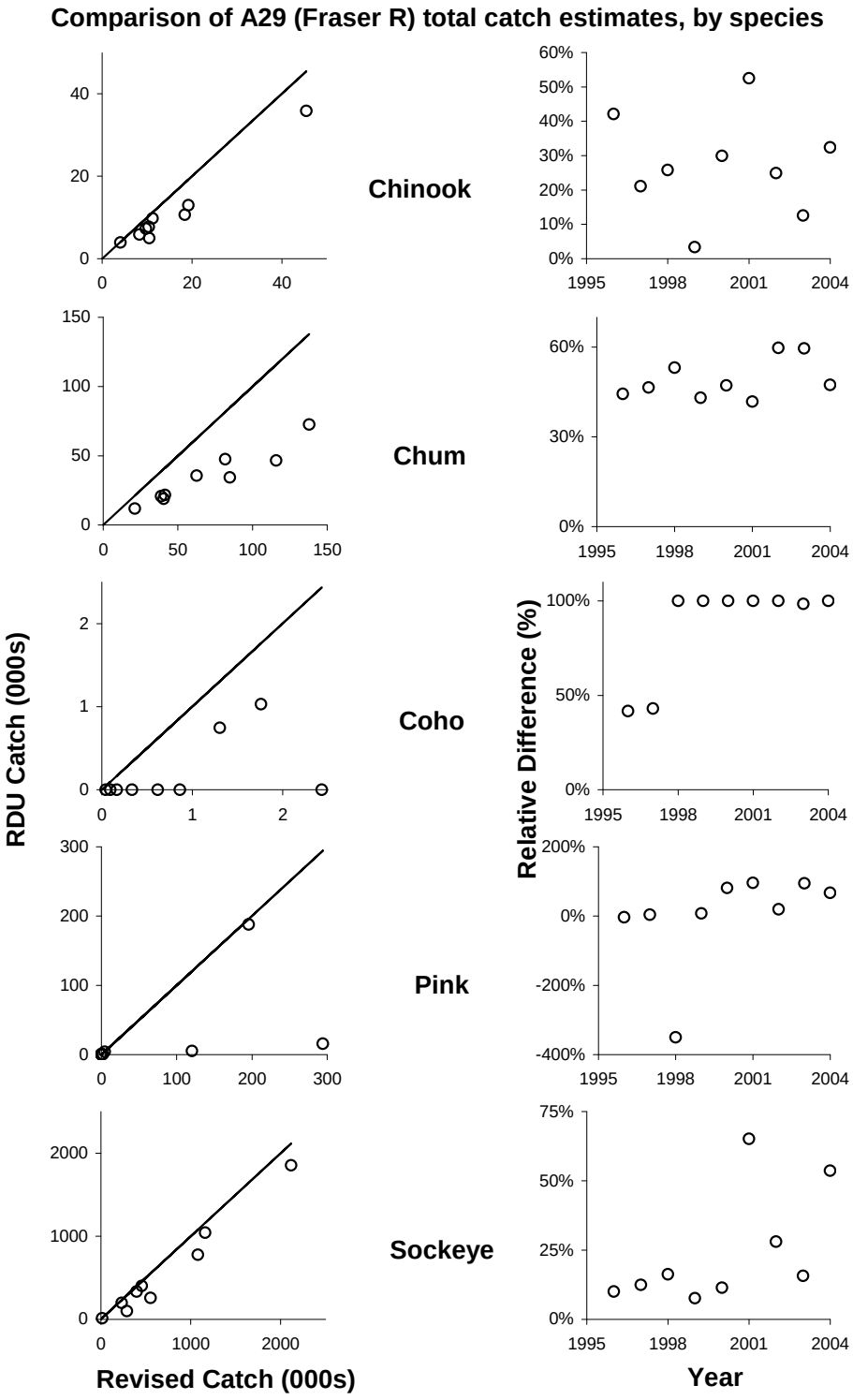

Figure 4A. Comparison of RDU- and revised- Fraser River (Area 29), annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

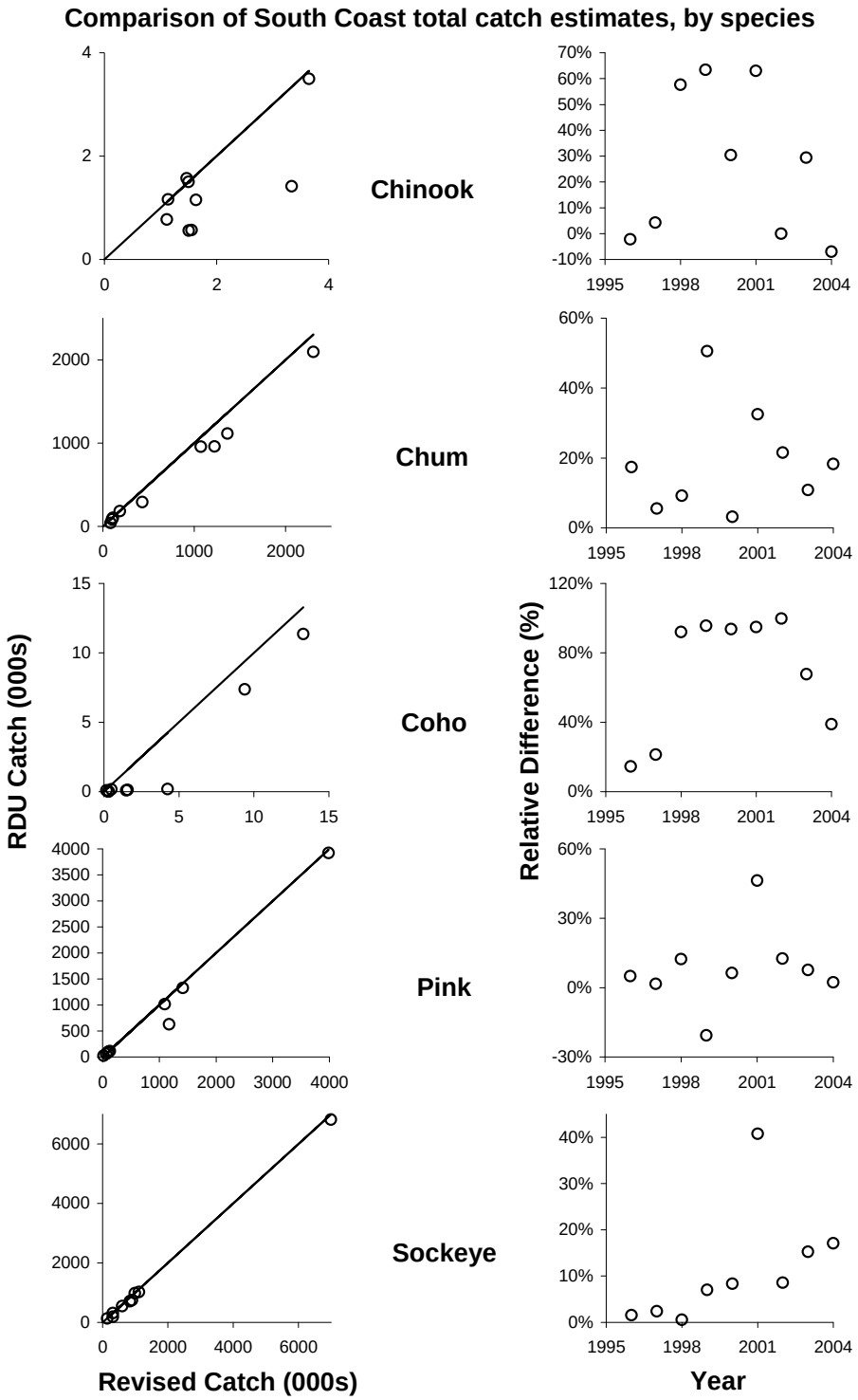

Figure 4B. Comparison of RDU- and revised- South Coast, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

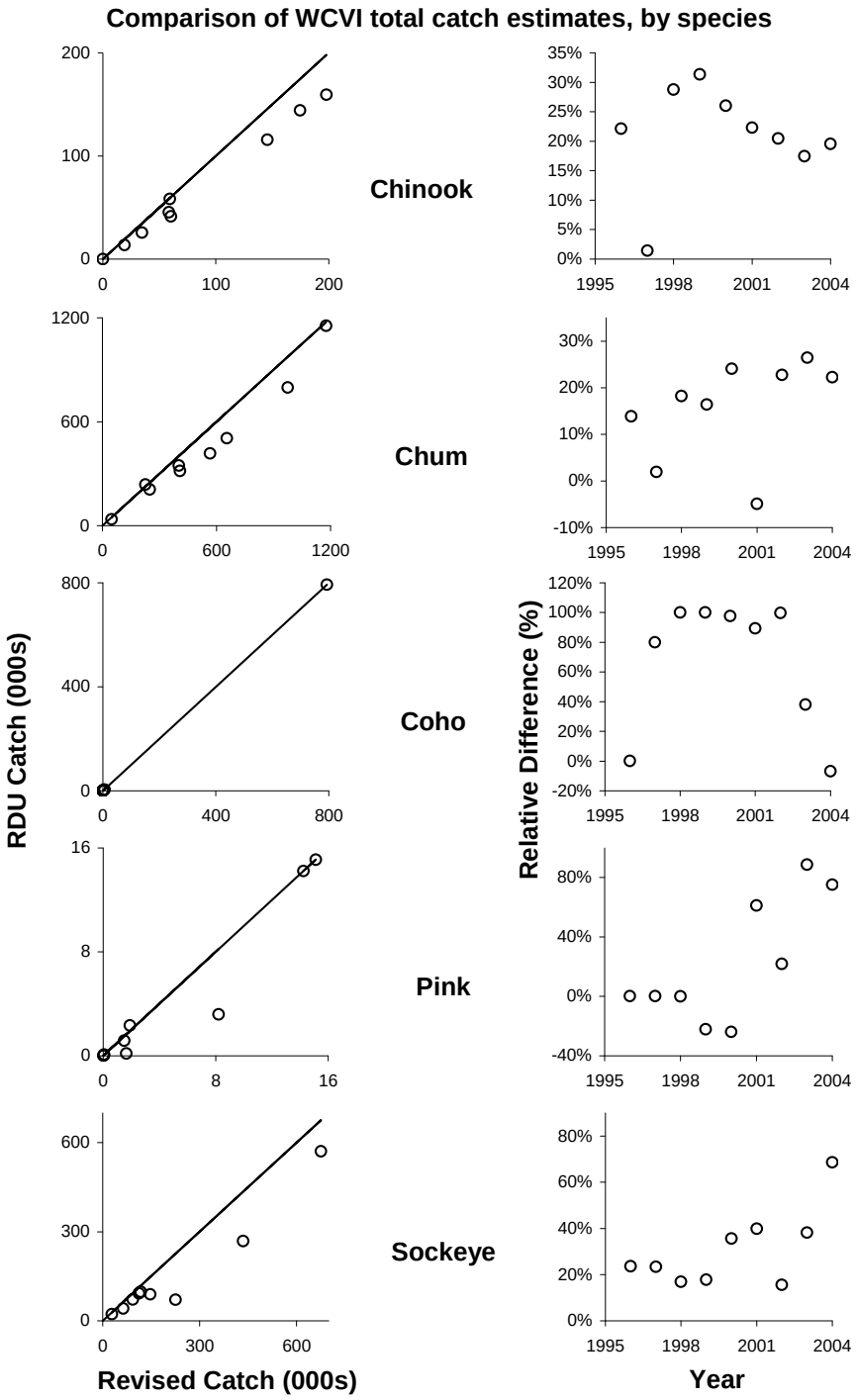

Figure 4C. Comparison of RDU- and revised- WCVI, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

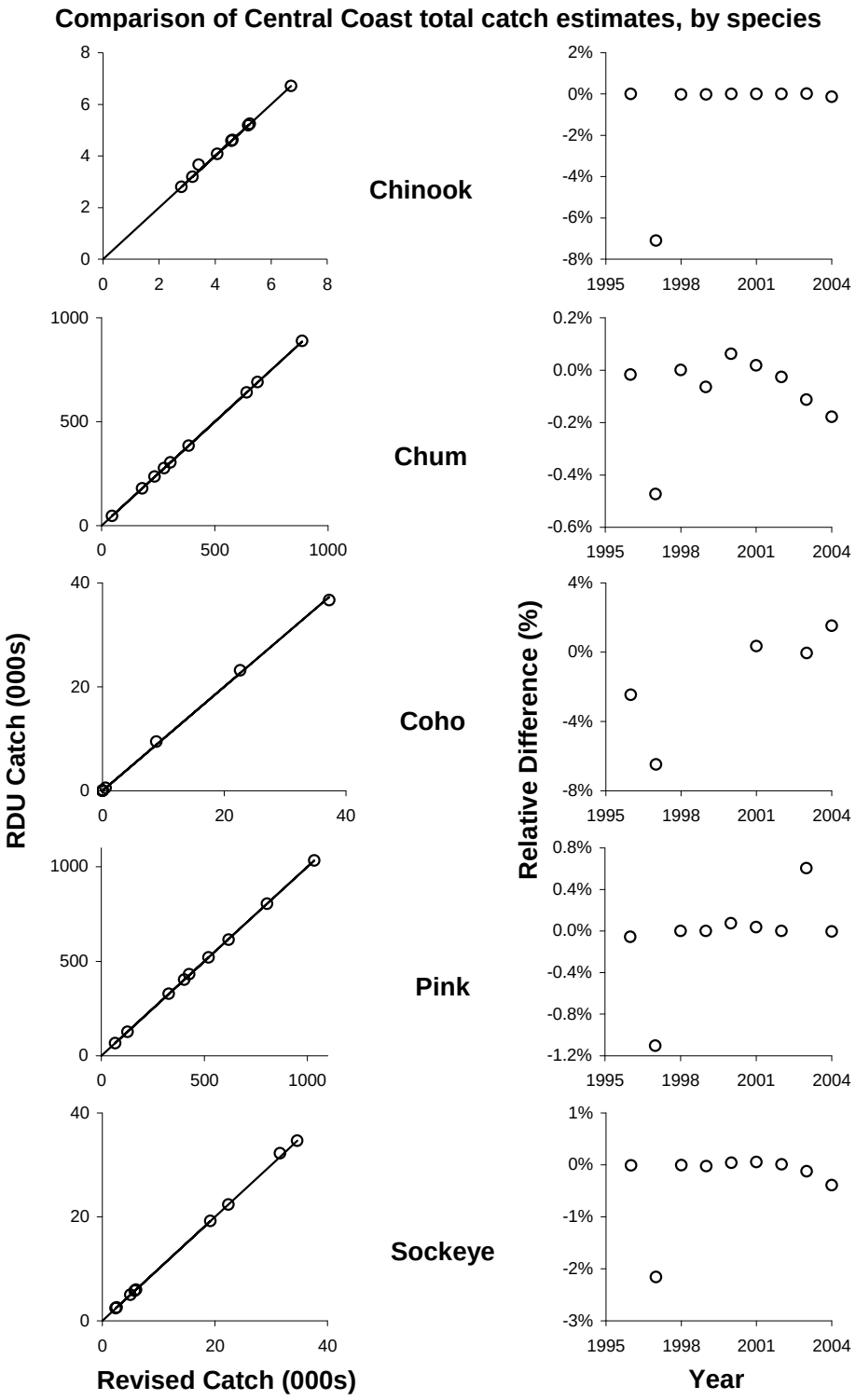

Figure 4D. Comparison of RDU- and revised- Central Coast (Area 8, 9 10), annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

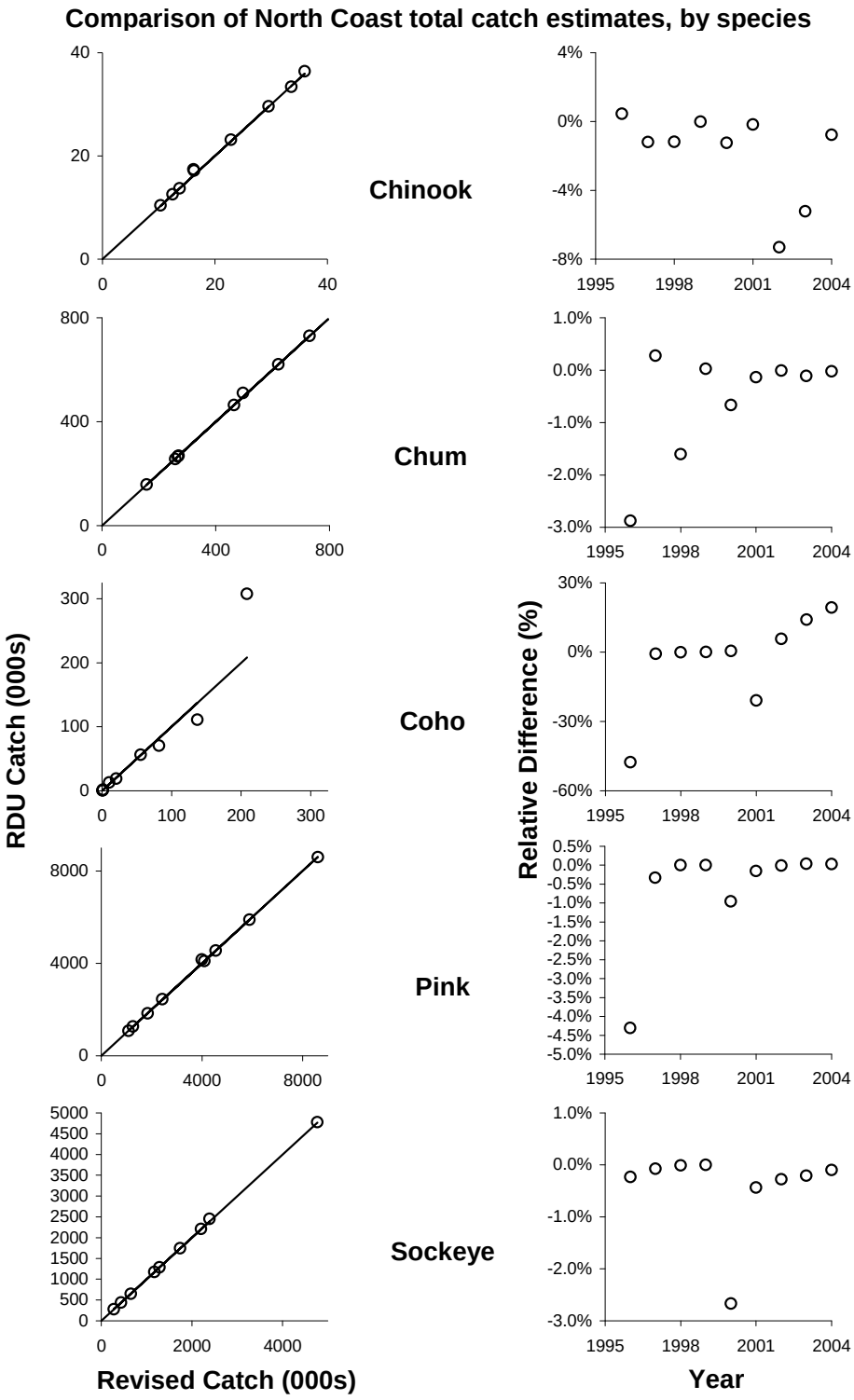

Figure 4E. Comparison of RDU- and revised- North Coast, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

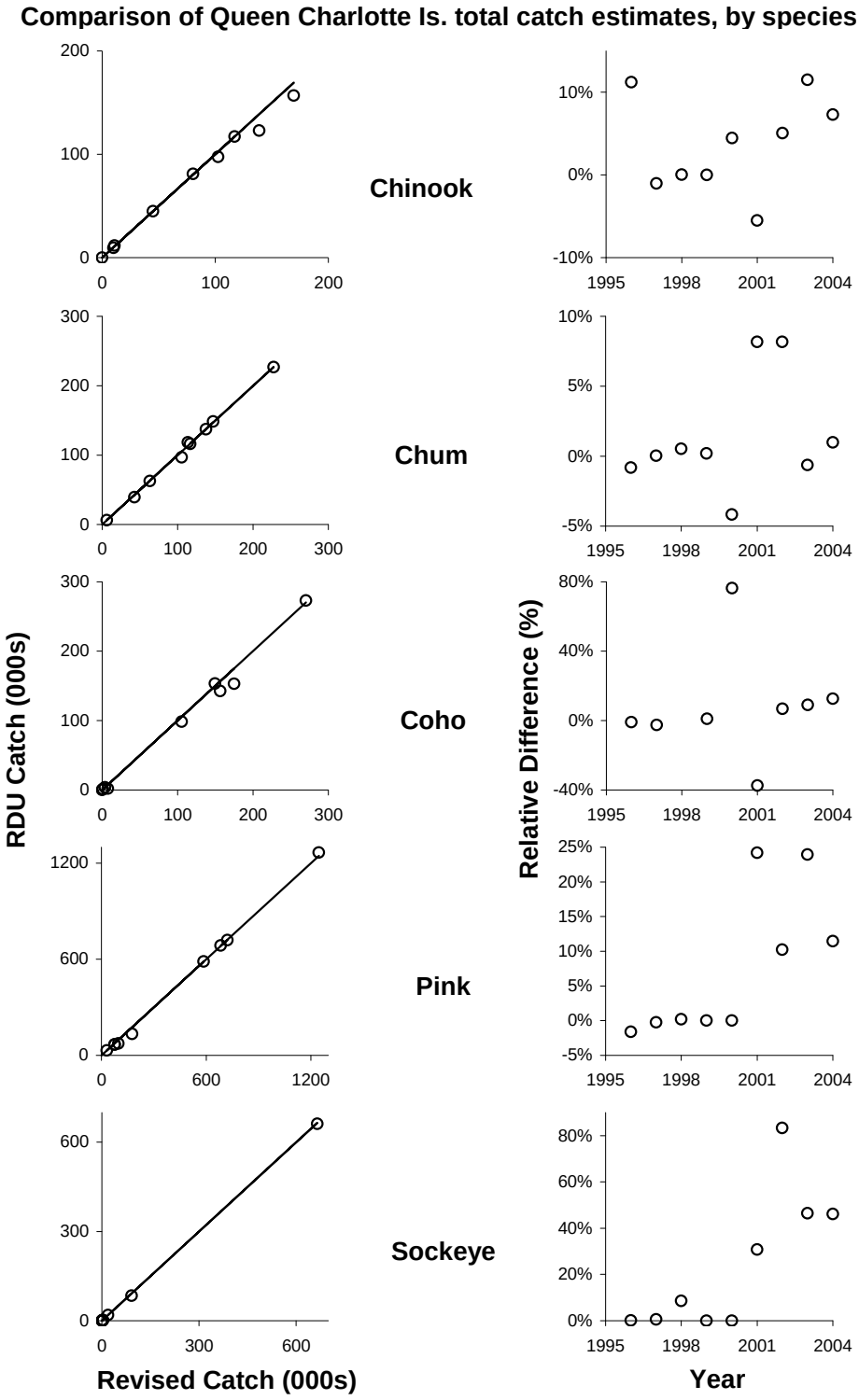

Figure 4F. Comparison of RDU- and revised- Queen Charlotte Islands, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

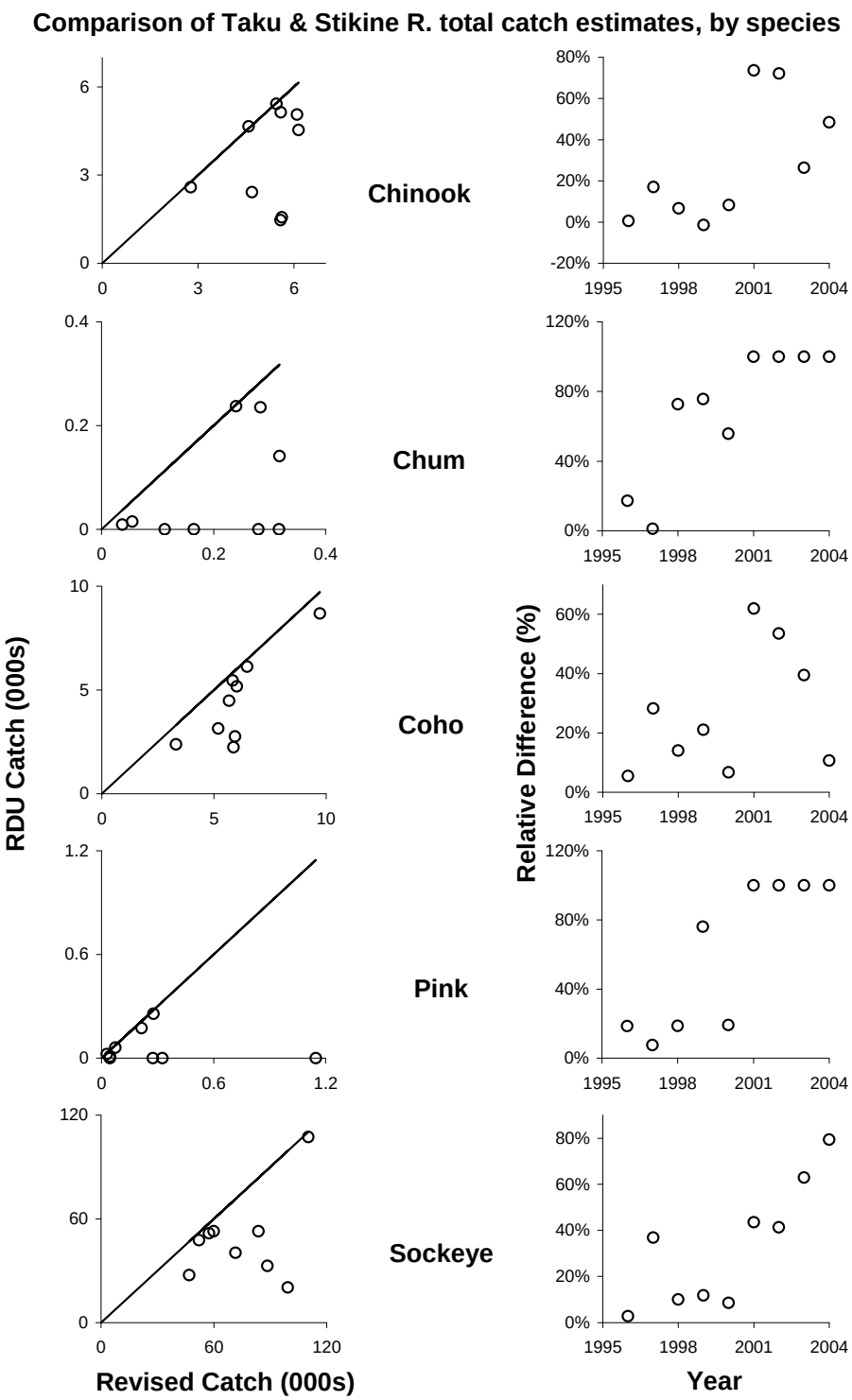

Figure 4G. Comparison of RDU- and revised- Taku and Stikine River, annual, kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

Comparison of province-wide Commercial catch estimates, by species

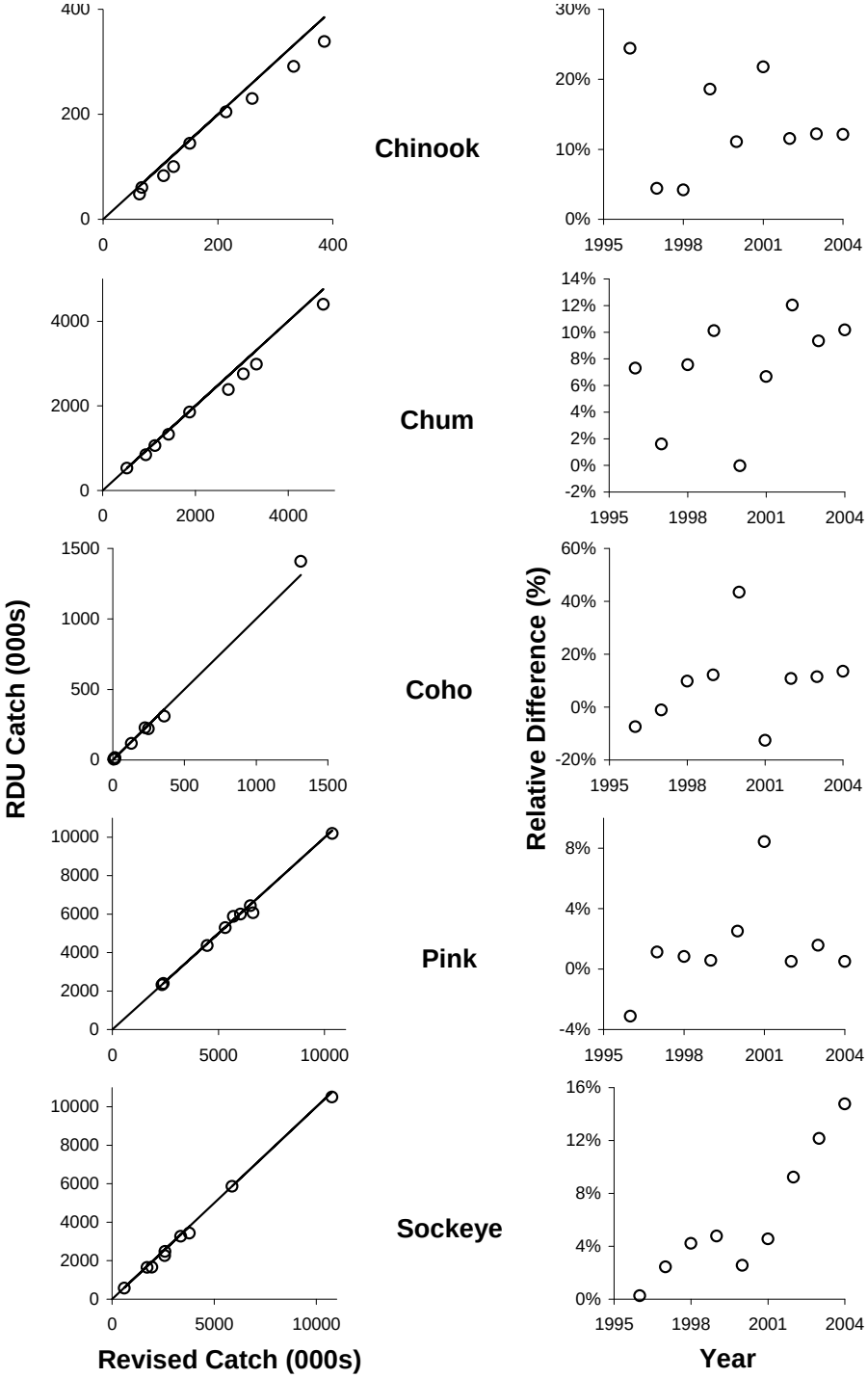

Figure 5A. Comparison of RDU- and revised- province-wide, annual, Commercial kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

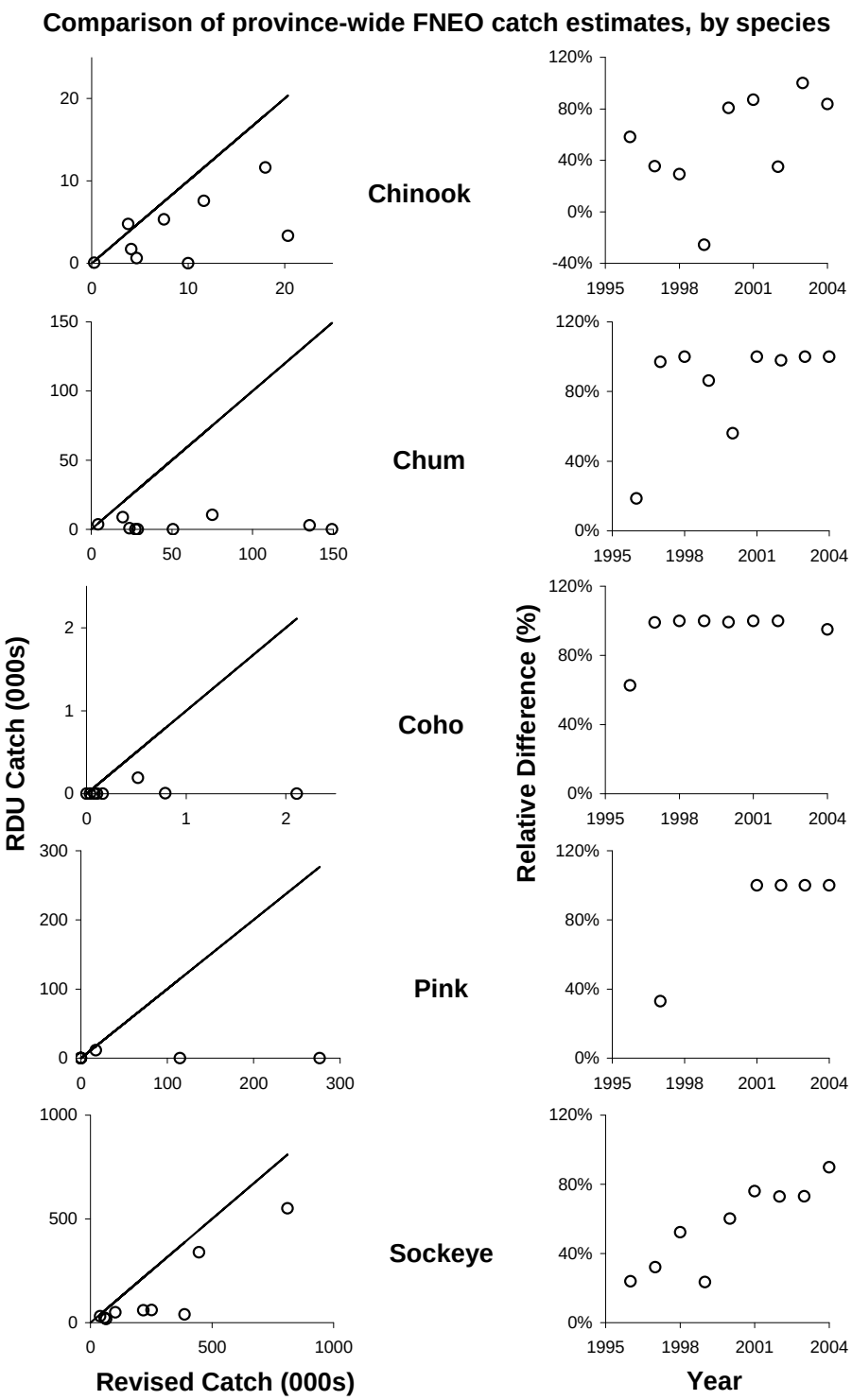

Fig 5B. Comparison of RDU- and revised- province-wide, annual, FNEO kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

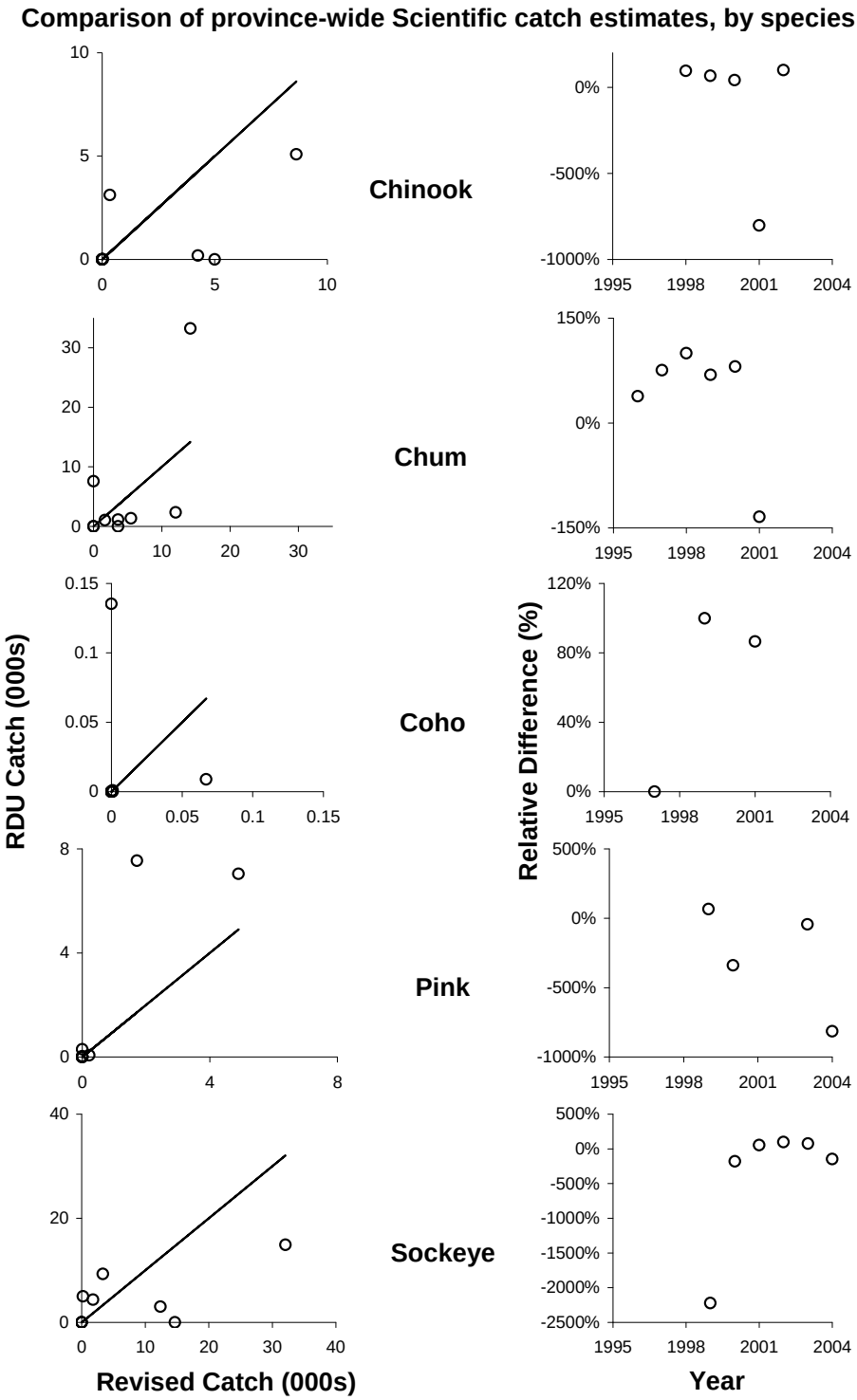

Fig 5C. Comparison of RDU- and revised- province-wide, annual, Scientific kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

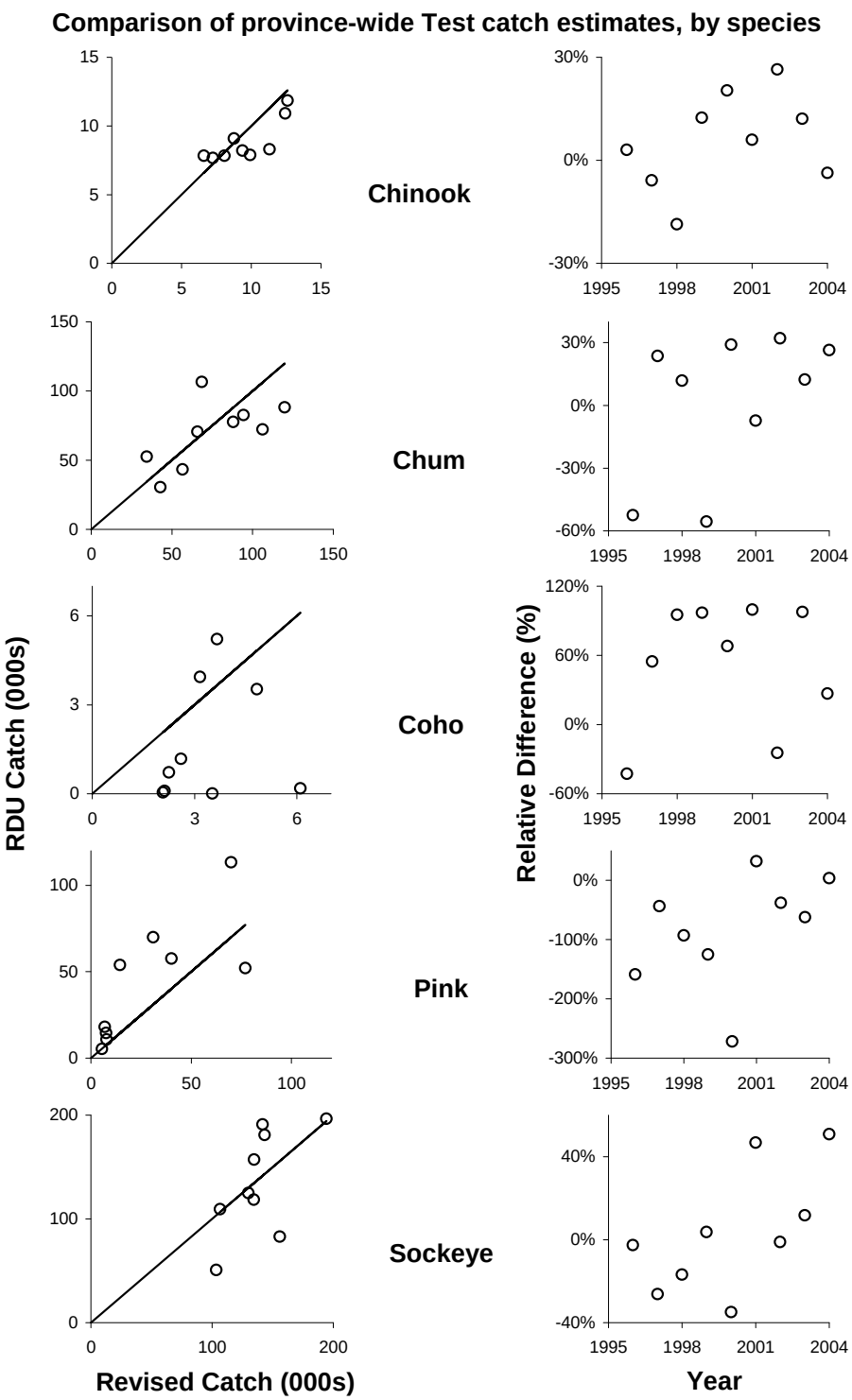

Figure 5D. Comparison of RDU- and revised- province-wide, annual, Test kept catch estimates for five Pacific salmon species. Graphs on the left show RDU catch estimates vs revised catch estimates, with a 1:1 reference line; graphs on the right show the Relative Difference vs year. Catches are in thousands of pieces, and "Relative Difference" = [revised estimate - RDU estimate] / revised estimate X 100. In the graphs on the left, points below the 1:1 line represent cases in which the revised estimate is greater than the RDU estimate, and correspond to positive relative differences on the right hand graphs.

CONCLUSIONS AND ADVICE

- **i)** Commercial fisheries have changed and estimation approaches need to change as well.
- **ii)** RDU sale-slip based estimates underestimate the true catch in virtually all commercial fisheries, and this negative bias generally increased during the study period. There are multiple potential contributors to the time varying bias.
- **iii)** The revised estimates, a summary of which are presented here, have been endorsed by the various areas, and should be adopted as the official catch estimates so that all future internal analyses and external data requests can be based on one agreed single data set.
- **iv)** To facilitate the previous recommendation, these estimates should be stored centrally and made widely available as soon as possible.
- **v)** For each year from 2005 onwards, Area staff should be directed to generate complete sets of finalized commercial kept salmon catch estimates with documentation in a timely fashion, have these verified and "signed off" and then provide estimates to a centralized store.
- **vi)** The development of an approved set of analytic methods (cook book style) to estimate commercial (and other) salmon catches should be considered.
- **vii)** International organisations such as the NPAFC should be provided with these updated commercial catch estimates.

Our findings support those of Bijsterveld et al. (2002) who examined the commercial catch statistics for South Coast commercial fisheries in 2000 and reached similar conclusions.

SOURCES OF INFORMATION

Bijsterveld, L., S. Di Novo, A. Fedorenko, and L. Hop Wo. 2002. Comparison of catch reporting systems for commercial salmon fisheries in British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2626: 44 p.

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ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2009. Revisions to official DFO commercial Pacific Salmon catch estimates for 1996-2004. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/031[1]

[1] Revised November 2009