Extend the time-series of catch and escapement estimates for Skeena sockeye, pink, chum and coho salmon stocks.

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(16 October 2012)

The following is a revised summary of the methods used to produce the extended time-series of catch, escapement and exploitation rates for Skeena sockeye, pink, chum and coho salmon CUs. An earlier version of this document was provided in July 2012 with our submission of the file "TRTC_Area4_30July2012.xlsm" containing the results from the preliminary analyses. The preliminary results were reviewed by DFO personnel in September 2012 and no changes were proposed to the analyses conducted for sockeye, pink or coho. Several adjustments were suggested and have been made to the procedures used to produce the exploitation rate estimates for Area 4 chum salmon. The chum salmon section below has been modified to reflect these changes. The file "TRTC_Area4_10Oct2012.xlsm" contains the latest version of the Area 4 extended time-series for each salmon species.

Sockeye Salmon

Steve Cox-Rogers provided a table originally prepared by Les Jantz with 1960-97 escapement, catch, run size and exploitation rate (ER) estimates for the aggregate returns of sockeye to the Skeena watershed. The Jantz estimates for 1982-1997 were compared with those from derived from the Northern Boundary Sockeye Run Reconstruction Model (NBSRRM, English et al. 2004; Alexander et al. 2010). The ERs estimated by Jantz were consistently larger than those derived from the NBSRRM due largely to lower escapement estimates in the Jantz analysis. The escapement estimates used in the NBSRRM were 106-123% larger than the Jantz estimates for these years. This was expected since an expansion factor of 3.6 was has been applied to all non-Babine escapement estimates to derive the total escapement used in the NBSRRM. After replacing the Jantz escapement estimates for 1982-97 with those used in the NBSRRM, the revised Jantz ER estimates were within 3% of those estimated using the NBSRRM. Therefore, we have increased the 1960-1981 escapement estimates by 111%, which is the average of the annual differences between the Jantz and NBSRRM estimates for 1982-97. The above process provides a fairly consistent time-series of ERs for Skeena sockeye from 1960-2009.

The next step was to use the latest estimates of relative run timing for each of the Skeena sockeye CUs (Table 1) and the NBSRRM to derive CU specific ERs for marine fisheries for the 1982-2009 period. These marine ERs for the major component stocks (i.e. Babine middle run timing stocks) were expanded for in-river harvest rates to estimate the total Canadian and total ER for each CU for 1982-2009. The ratio of the CU specific ERs to the ER for the aggregate Skeena sockeye stock for 1982 were used to derive annual ER estimate for each CU from the annual ER estimates for the aggregate stock for 1960-81.

The CU specific ERs were combined with escapement estimates to compute the total run size and catch estimates for each CU. For those CUs where sockeye escapement was estimated using a counting fence (i.e. Babine, Kitwancool 2000-2010, Damshilgwit, and Skeena River High Interior – Jackson Creek) the expansion factor for observer efficiency was set to 1.0. For all other CUs where escapements were estimated from visual surveys, the observer efficiency expansion factor was set to 2.0.

Note: the new NBSRRM now contains an automated procedure for running all years and an Excel file named "Sockeye Exploitation Rate Summary ddmmmyy.xls" contains a macro to extract the annual ER estimates for each CU from all the NBSRRM output files.

Table 1. Summary of the migration timing parameters (offsets and SDs) for each Skeena sockeye CU used in the NBSRRM to estimates marine ERs for sockeye CU, 1982-2009.

							Source: Cox-Rogers (2012)			
#	Stocks (Geographic CUs)	CUs in Group	Offset (days)	Duration (days)	Default SD (days)	2006 SD (days)	Group Name	Peak Week	Offset (days)	SD (weeks)
1	Kluatantan/Kluayaz	2	-10.5	105	17.5	17.5	Bulkley-Morice	72	-10.5	2.5
2	Motase	1	3.5	92	15.4	15.4	Motase	74	3.5	2.2
3	Sustut/Johanson/Spawning	3	-3.5	84	14.0	14.0	Sustut	73	-3.5	2.0
4	Bear/Azuklotz/Asitka	3	-3.5	84	14.0	14.0	Sustut	73	-3.5	2.0
5	Slamgeesh/Damshilgwit	2	-3.5	84	14.0	14.0	Sustut	73	-3.5	2.0
6	Sicintine	1	-3.5	84	14.0	14.0	Sustut	73	-3.5	2.0
7	Babine W Early	1	-10.5	84	14.0	14.0	Babine WE	72	-10.5	2.0
8	Babine W Middle	1	-3.5	84	14.0	14.0	Babine WM	73	-3.5	2.0
9	Babine W Late	1	10.5	84	14.0	14.0	Babine WL	75	10.5	2.0
10	Babine Pinkut	1	-3.5	84	14.0	17.5	Pinkut	73	-3.5	2.0
11	Babine Fulton	1	3.5	84	14.0	17.5	Fulton	73	3.5	2.0
12	Swan/Stephans/Club	3	-10.5	76	12.6	12.6	Swan+	72	-10.5	1.8
13	Bulkley/Maxan	2	-10.5	105	17.5	17.5	Bulkley-Morice	72	-10.5	2.5
14	Morice/Atna	2	-10.5	105	17.5	17.5	Bulkley-Morice	72	-10.5	2.5
15	Kitwanga	1	3.5	118	19.6	19.6	Kitwanga+	74	3.5	2.8
16	Zymoetz	3	-17.5	59	9.8	9.8	Zymoetz	71	-17.5	1.4
17	Kalum	1	-3.5	105	17.5	17.5	Kalum-Bear	73	-3.5	2.5
18	Lakelse	1	-21.0	80	13.3	13.3	Lakelse+	64	-21	1.9
19	Alastair	1	-14.0	109	18.2	18.2	Alastair	71	-14	2.6
20	Johnston	1	-21.0	80	13.3	13.3	Lakelse+	64	-21	1.9

Pink Salmon

The method used to derive annual ERs for Skeena pink salmon CUs was similar to that previously described in English et al. (2012). Annual harvest rate (HR) estimates from the 1982-95 run reconstruction analyses conducted for northern boundary Pink salmon (Gazey and English 2000) were used to derive the relationship between annual HRs and fishing effort for Skeena Pink salmon in Area 3 and 4 fisheries. The effort-HR relationships for 1982-95 were combined with annual fishing effort for 1954-2010 to produce annual estimates of HRs for the 1954-81 and 1996-2010 periods.

Catch, effort and CPUE estimates for the Area 3 and 4 seine and gillnet fisheries were used to derive a time series of annual effort estimates that account for variability in weekly fishing effort for both seine and gillnet gear during the period when Pink salmon were harvested in these fisheries. This process included the following steps for Area 4 Pink salmon stocks:

1) weekly pink salmon catch estimates from sale slips were combined with fishing effort data (boat-days) from hail data to calculate weekly Pink CPUE for Area 4 fisheries;
2) weekly CPUE was used to determine the period when Pink salmon were most abundant in Area 4;
3) pink salmon catch and effort estimates for the above period were used to compute estimates of annual CPUE for gillnet gear for comparison with annual CPUE estimates for seine gear;
4) the annual ratio of gillnet CPUE to seine CPUE (mean 0.052, 95% bounds $\pm$0.01) was used to convert gillnet effort into seine effort; and
5) Adjust annual effort estimates based on weekly timing, such that fishing effort during the peak migration period for pink salmon would receive higher weighting than fishing effort during other periods. The weekly weights were derived from relative weekly CPUE for gillnet and seine gear.

These adjusted annual effort estimates for Area 3 and 4 fisheries were combined with the HR estimates from Gazey and English (2000) for 1982-95 to define the Effort-Harvest Rate (EHR) relationship for Skeena pink salmon stocks (Figure 1).

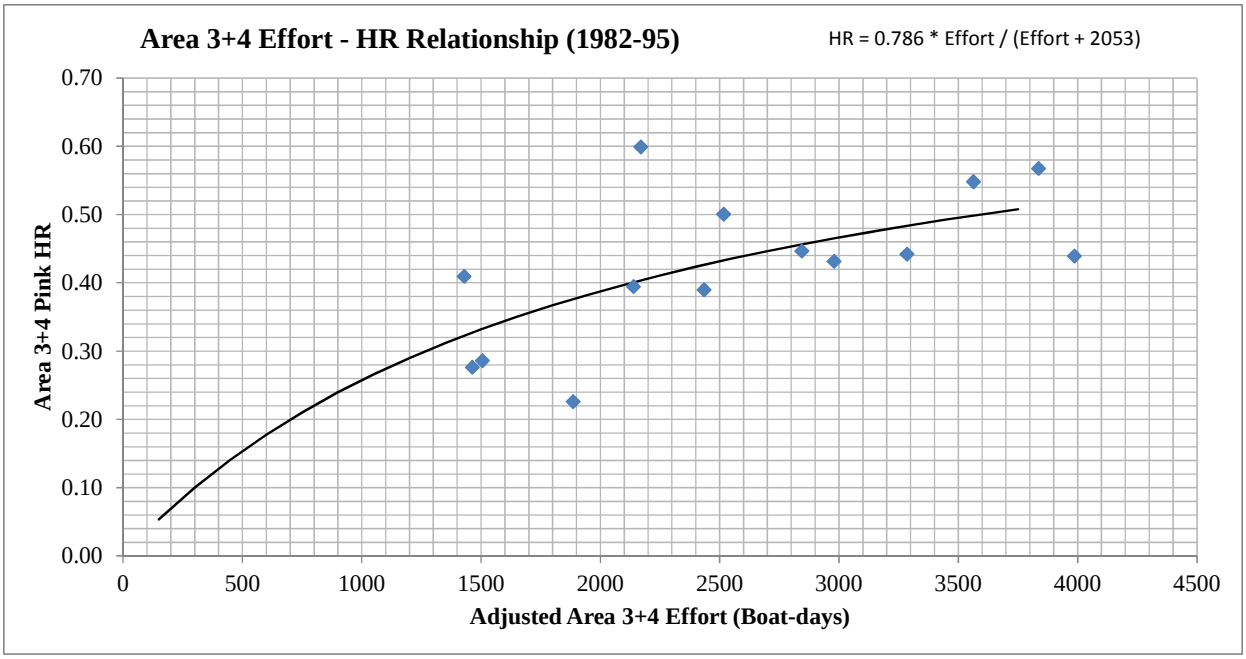

Figure 1. Relationship between the annual Area 3+4 fishing effort and the annual harvest rates estimated for Skeena pink salmon stocks in Area 3+4 fisheries from 1982-95.

The 1982-95 run reconstruction results were used to determine the ratio of annual HRs for other Canadian fisheries to the annual HRs for Area 3 and 4 fisheries. On average, the HRs for other Canadian fisheries were 33% of those for the Area 3 and 4 fisheries and this value was used to estimate the annual HR for other Canadian fisheries for 1954-81. The HR estimates for the other Canadian fisheries from 1996-2010 were assumed to be only 5% of the Area 3 and 4 harvest rates because of the substantial reduction in outside (Area 1 and 5) pink salmon fisheries after 1995.

The ERs for Skeena pink salmon caught in Alaskan fisheries were estimated using the 1982-95 run reconstruction results and effort data of Alaska purse seine fisheries. An Effort-Exploitation Rate (EER) relationship used for Alaskan purse seine fisheries in District 101, 102 and 104 to convert annual fishing effort estimates into ER estimates for Skeena Pink salmon stocks harvested in Alaskan fisheries (English et al. 2012). We did not have access to annual fishing effort for Alaska fisheries data prior to 1982, so we assumed that the Alaska ER for Skeena pink salmon in these years was equal to the average ER for 1982-95 (18%).

Chum Salmon

The procedures used to estimate the annual ERs for Skeena chum salmon were similar to those described above for Skeena pink salmon. This process included the following steps for Skeena chum salmon stocks:

1) Tyee test fishery CPUE data was used to determine the migration period and run timing distribution for Skeena chum salmon in Area 3 and 4 fisheries;
2) Chum salmon catch and effort estimates for the above period were used to compute estimates of annual CPUE for gillnet gear for comparison with annual CPUE estimates for seine gear;
3) the average annual ratio of gillnet CPUE to seine CPUE for 1982-02 (mean 0.15, 95% bounds $\pm$0.02) was used to convert gillnet effort into seine effort for the years after 2002; and
4) weekly run timing proportions derived from Tyee test fishery data were used to weight the weekly effort estimates and compute adjusted annual effort estimates, such that fishing effort during the peak migration period for chum salmon would receive higher weighting than fishing effort during other periods.

These adjusted annual effort estimates for Area 3 and 4 fisheries for 1982-06 were combined with the HR estimates from the Area 4 Chum Model described in English et al. (2012) to define an Effort-Harvest Rate (EHR) relationship for Skeena chum salmon stocks (Figure 2). Three years (1998, 1999 and 2005) were excluded from the data set used to define the relationship because the weekly HRs for Skeena sockeye, used to derive the annual chum HRs, were unusually low in these years. The HR estimates in Figure 2 reflect the average sockeye HRs for the weeks when Skeena chum are present in the Area 3 and 4 fisheries, without any adjustments for non-retention of chum. The resulting EHR relationship was used to derive the annual HR estimates for Area 3 and 4 fisheries using the adjusted annual effort estimates for 1954-1981, 1998, 1999, and 2005. The Area 3 and 4 chum HRs for the other years from 1982-2008 were derived from the Area 4 Chum Model with adjustments for chum non-retention periods for seine and gillnet fisheries from 2000-2008. Preliminary HR estimates for 2009 and 2010 were derived using the chum EHR relationship and reducing the resulting HRs by applying the chum non-retention mortality rate of 60% for gillnet fisheries.

The HRs for Skeena chum in Canadian fisheries outside Area 3 and 4 were set equal to the HRs for Skeena sockeye in those fisheries for 1982-09. The HR estimates for these "Other Canadian" fisheries from 1954-81 was assumed to be 2% based on the average of the HRs estimates for these fisheries from 1982-1990.

The ERs for Skeena chum salmon caught in Alaskan fisheries was assumed to be equal to the Alaska ERs for Skeena sockeye from the NBSRRM for 1982-09. In the absence of any other estimates of chum ER for the 1954-81 Alaskan fisheries, we assumed that the Alaska ER for Skeena chum salmon in these years was equal to the average ER for Skeena sockeye in Alaska fisheries for 1982-90 (12%).

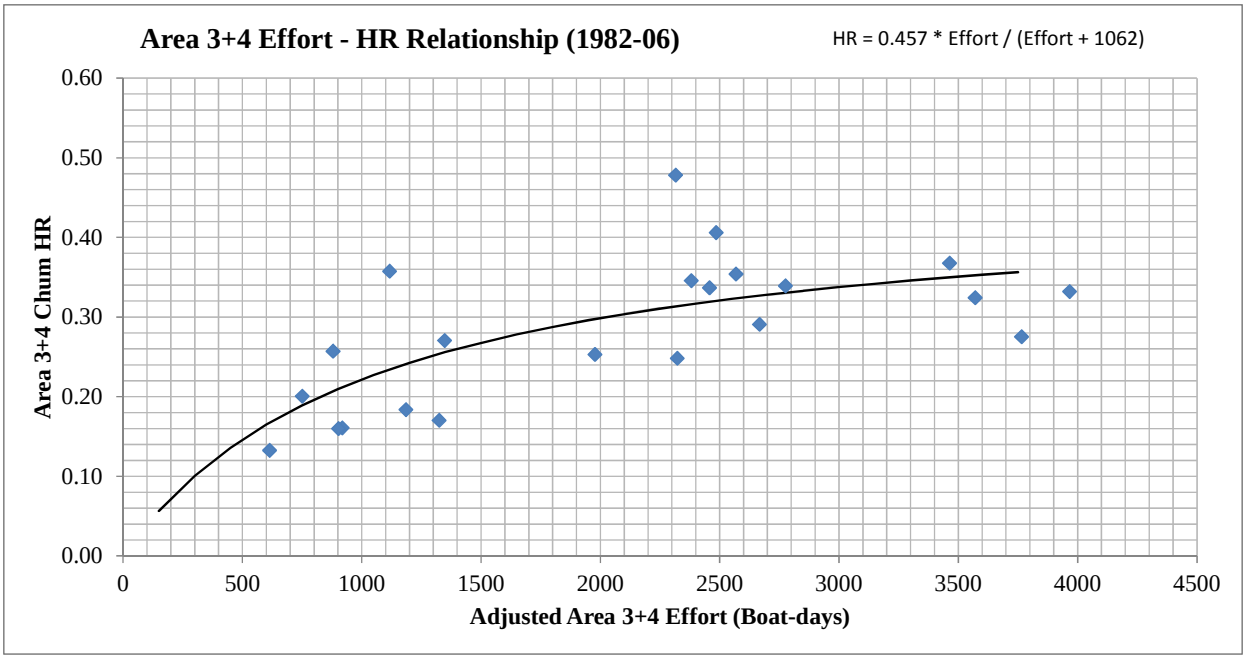

Figure 2. Relationship between the annual Area 3+4 fishing effort and the annual harvest rates estimated for Skeena chum stocks in Area 3+4 fisheries from 1982-06, excluding 1998, 1999 and 2005.

Coho Salmon

The 1954-2010 time-series of ERs for Skeena Coho salmon stocks is comprised of ER estimates for 1954-88 from Holtby (1999) and ER estimates for 1989-2010 derived from CWT data for Toboggan Creek hatchery releases (Dave Peacock, pers. comm.). The CWT data for 1989 and 1990 indicated that Canadian fisheries accounted for 65% of the total ER for Skeena sockeye in these years. This value was used to derive a time series of Canadian ERs from the annual estimates of Total ER reported in Holtby (1999). Holtby (1999) also provided a time-series of escapement estimates for Babine coho for 1946-1998 derived by expanding the Babine fence counts for the portion of the coho run that was not enumerated at the fence. Given the significant uncertainties associated with several of the initial years we used his estimates of the total return from 1954-1998. The 1999-2010 escapement estimates for Babine coho were provided by Dave Peacock and derived from Babine fence counts using methods similar to those reported in Holtby (1999). Babine coho are part of the middle Skeena coho CU, and all of the other estimates of coho escapement to streams in this CU are derived from visual surveys that tend to significantly underestimate the actual escapement of coho. Consequently, our escapement estimate for the the Middle Skeena coho CU is comprised of annual estimates for Babine coho combined with annual estimates for all non-Babine coho streams derived using our standard indicator stream approach with an observer efficiency expansion factor of 3.0 (English et al. 2012). Separate estimates for Babine and non-Babine coho streams within the Middle Skeena coho CU are also provided.

Literature Cited

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