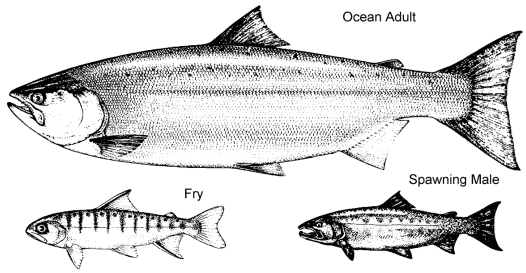


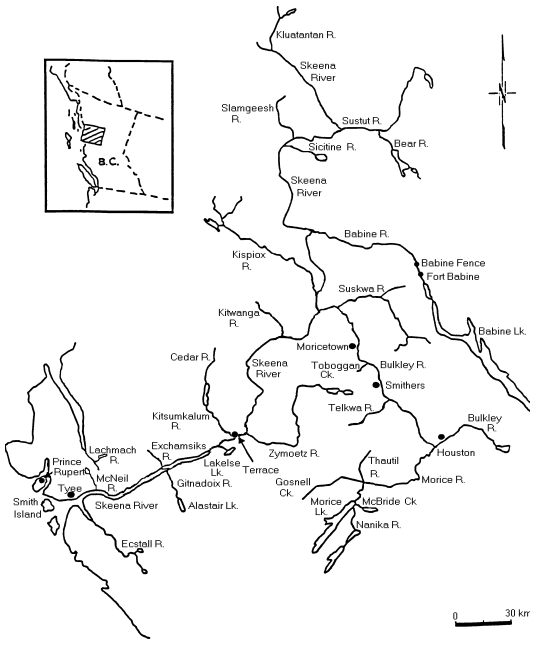
Stock status of Skeena River coho salmon

Background

The coho salmon (Oncorhynchus kisutch) is one of six species of anadromous Pacific salmon found in the Skeena and its tributaries, and occurs throughout the drainage. There are approximately 25 major populations of coho, and numerous smaller ones, in the Skeena. Juvenile coho prefer low-gradient habitats with low water velocities and an abundance of cover, and are abundant in streams, lakes, and beaver ponds. Juvenile coho also occur in the marginal sloughs along large rivers. In lakes, coho inhabit the near-shore or littoral zone and are seldom encountered in the open water or pelagic zone.

Juveniles are aggressive, territorial and are often vibrantly colored with a large orange anal fin edged in black and white. Juvenile coho are often difficult to distinguish from chinook, with which they co-occur. In freshwater, they feed on aquatic insects, plankton, and occasionally small fish. After spending between one and three years in freshwater, coho smolts migrate to the ocean in May and early June. Coho are not distributed as extensively in the ocean as the other Pacific salmon, tending to remain in coastal waters.

Although the proportions vary over time, about half of Skeena coho migrate north along the Alaska panhandle, with the balance remaining in the coastal waters of northern British Columbia. There have been occasional recoveries of Skeena coho in the troll fisheries off the west coast of Vancouver Island and in the Strait of Georgia. Skeena coho are caught in the coastal troll and net fisheries of southern Alaska and northern B.C. Female coho and most males spend about 16 months at sea. A small number of male coho return after only four or five months at sea, and are referred to as "jacks." In the ocean, coho feed at first on euphausiids and other plankton. Squid, herring, sand-lance and other small fishes are added to the diet as the fish grow. Maturing coho return to their natal streams from July through November, with interior fish returning first. Spawning occurs from October through December.



The Fishery

Coho salmon remain in surface waters near the coast throughout their lives in the ocean, and are readily caught with hook-and-line gear. Prior to 1900 coho were caught using hand lines from rowboats or dugout canoes. Around 1910 powered boats were introduced and commercial trolling as it is now known began. Coho are now harvested in directed hook-and-line commercial and recreational fisheries throughout their second year in the ocean. The 1920s saw the advent of gillnet and purse seine fisheries directed at intercepting coho. Although there are currently

no directed net fisheries for coho, there is a substantial bycatch in gillnet and seine fisheries for sockeye, pink and chum salmon.

Unlike sockeye, pink and chum salmon but like chinook salmon, most coho are harvested in rearing areas and not during their spawning migrations. As a result, coho fisheries catch individuals from potentially hundreds of populations. Coho are also harvested in "gauntlet" and "terminal" fisheries directed at other salmon species, such as sockeye, as they return from the high seas to their natal streams. A typical coho fishery is thus a mixed-stock fishery, which poses many problems for the assessment and management of the species.

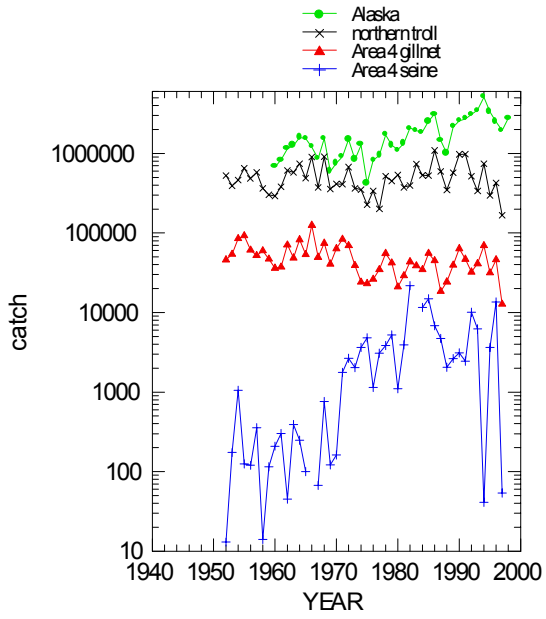


Figure 1. Catches in the four major fisheries exploiting Skeena coho. Note that the catch has been logarithmically scaled. Canadian catches of coho in 1998 were zero. Area 4 comprises the approaches to the Skeena River.

Trends in catch for the four major fisheries that exploit Skeena coho are shown in Figure 1. Increased catches of coho in the Area 4 seine fishery began in the early 1970s coincident with increased fishing on the enhanced Babine Lake sockeye. However, the catch in the seine fishery remains small. Before 1980, trends in the northern troll catch and the Area 4 gillnet catch of coho were similar and probably reflected the abundance of coho in the Skeena and other producing systems on the north and central coasts. The Area 4 gillnet catch of coho has shown no trend over the last 20 years while the catch in the northern troll has been declining since the peak catches of the mid 1980s.

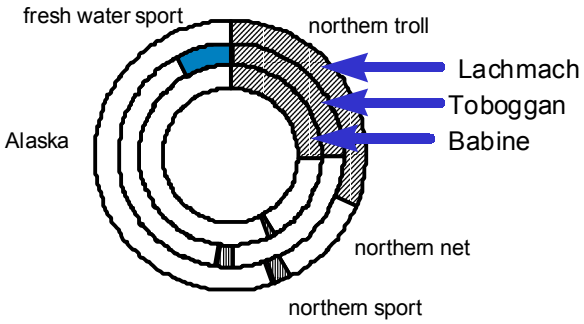


Figure 2. Distribution of catch for two release sites in the Skeena (Toboggan & Babine) and the Lachmach River, averaged over 1990 to 1996. There were small catches in southern Canadian areas that are not visible in this plot.

Because coho are harvested in mixed-stock fisheries, it is not routinely possible to determine the catch for individual populations or groups of populations, even for large aggregates such as the Skeena River stock. Individual populations can be tracked in fisheries if the smolts have been given a coded-wire tag and an external mark. Coded-wire tags are small pieces of magnetized steel inserted in the nasal cartilage, with a binary code inscribed on the tags. A coast-wide mark-recovery program allows the systematic recovery of tags in nearly all ocean commercial and recreational fisheries. The information allows researchers to estimate the catch and its distribution for tagged populations. The catch distributions of three populations that have been consistently tagged over the last five to seven years are shown in Figure 2. The coho of the Lachmach River, which is located at the head of Work Channel, is a wild (not enhanced) population used as an indicator for coastal populations on the north coast including the Skeena. The Toboggan Creek and Babine populations have been enhanced through the

Community Development Projects of the Salmonid Enhancement Program. Toboggan Creek is a lower tributary of the Bulkley River. The Babine population is reared in net pens on Nilkitkwa Lake near Fort Babine.

The catch distributions of all three populations are highly similar. Compared with the Babine coho, a slightly higher proportion of Lachmach coho are caught in the northern troll fishery and a slightly lower proportion in the northern nets but the two populations are otherwise similar. Toboggan coho have a slightly more southerly catch distribution compared with the two other populations and are also caught in significant numbers in a freshwater recreational fishery on the Bulkley River.

Stock Status

Four indices of abundance are used to determine the status of Skeena coho. Three involve measures of escapement which is, the number of adult coho returning to the Skeena to spawn. Estimates of escapement begin between 1946 and 1956 and so allow the description of trends over five decades. As the area covered by these indices ranges from Babine Lake to a major part of the watershed, the indices give a coarse measure of abundance.

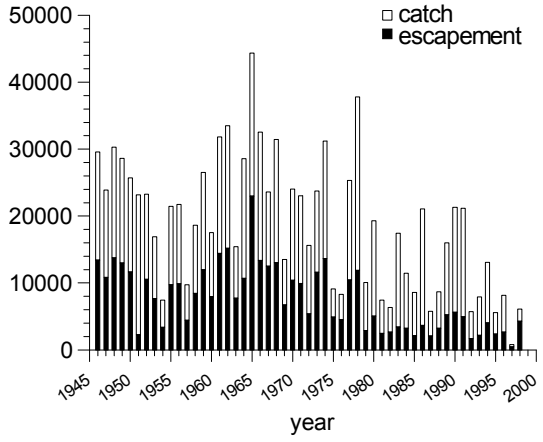


Figure 3. Total number of coho entering Babine Lake and the estimated catch from 1946 to 1998. The total height of the bars is the total stock size.

The first index is a count of coho passing through a fence on the Babine River below Nilkitkwa Lake. The fence has been operated since the fall of 1946 primarily to enumerate sockeye salmon returning to the Babine. Estimates of the total escapement of the Babine Lake coho aggregate (Figure 3) have been between 453 to 22,985, an over 50-fold range. Figure 3 also shows how total stock size (the number of adults alive in each year, or the sum of the catch and escapement) has declined.

Decadal trends in total escapement and total stock size are also summarized in the following Table. The decadal median escapement for the 1990s is 21% of the median for the 1960s. The reduction in total stock size over the same period was only slightly less severe (to 26%).

The temporal patterns of the reductions in stock size and escapement are slightly different. The time series of escapement is noticeably stepped with a marked drop in escapement occurring in 1979 (Figure 3). The time series of total stock size is not stepped and shows a continuous decline since the early 1970s.

Decade	Median Escapement	Median Stock Size
1946-1959	10206	23233
1960-1969	12771	30000
1970-1979	10156	23373
1980-1989	3233	10055
1990-1998	2669	7931

Between 1970 and 1998 the size of the Babine Lake coho stock shrank by an average of 5% each year. This is termed the finite rate of decrease. The average age of a Babine coho at return is 3.3. Consequently, every generation the stock size shrank by an average of 16%. These rates are

modest compared with those seen in the coho of the Thompson River, where generational decreases of 54% to 72% have been observed since 1988. However, the decline of the Babine stock may have been going on for much longer.

The escapement in 1998 to Babine Lake was 4,291, a number comparable to escapement in the early 1990s and 9 times the disastrous escapement in 1997. However, the total stock size in 1998 was the fourth lowest on record. Clearly, the increase in escapement was due to the conservation measures taken in Canadian fisheries and was not due to a recovery of the populations of the Babine.

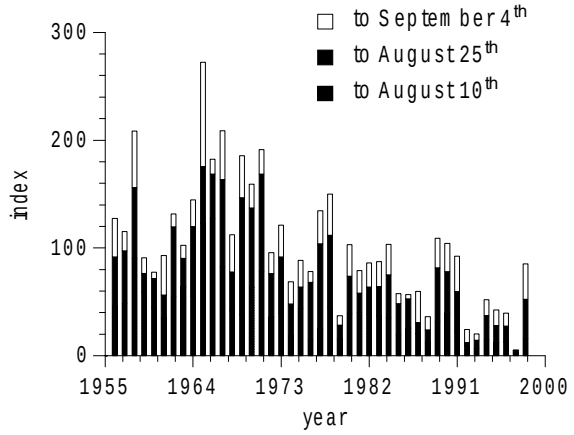


Figure 4. The Skeena test-fishing index for three dates. DFO has used August 25th as the standard index date.

The second index is generated from the catch of coho in the Tyee test fishery. The test fishery is primarily intended for in-season management of the Skeena sockeye fisheries, but because coho, chinook, steelhead and pink are also caught it has been routinely used as an abundance index for all salmon species returning to the Skeena River. The test fishery has operated from July 1 to August 25 in the same location with the same gear since 1956. The test fishery index is the cumulative catch per 1,000 fathom-minutes over that period. In most years the test fishery has operated into September. Index values in 1998 were considerably higher than in 1997 (Figure 4), with the value of index to August 25 reaching the 29th percentile. The index value has been declining since the mid-1960s, although there is considerable variability. From 1965 to 1996 the finite rate of decrease was 5% and the generational rate of decrease was 15.5%. These are similar rates to those observed for Babine escapement and total stock size, and for the Upper Skeena average escapement.

The origin of the coho caught in the test fishery is uncertain, but until the end of August most are believed to be coho from the Skeena above Terrace. Stock composition in this fishery is currently being examined using DNA techniques.

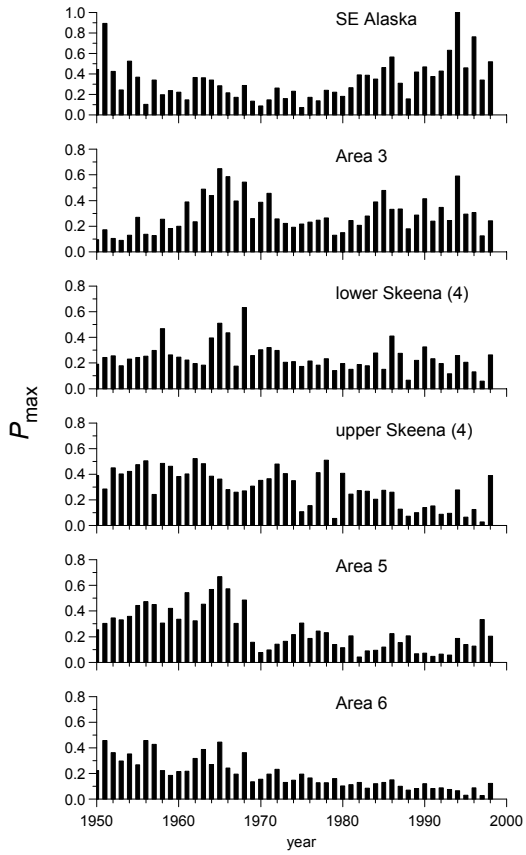


Figure 5. Time series of standardized average escapements to Canadian streams grouped by Statistical Area. For SE Alaska the standardized catch per hook of wild coho in their SE troll is plotted. That index is highly correlated with coho escapement to SE Alaskan indicator streams. The index values are standardized within each area. Differences between the average index values among the areas should not be interpreted as indicating differences in abundance or productivity. Area 3 is the Nass River and Portland Canal. Area 5 is Principe and Grenville Channels. Area 6 is the Kitimat area.

The third index of status is derived from visual counts of spawners made in many streams in the drainage since 1950. Although few systems have been consistently counted, the many counts that are available can be combined into an index of abundance (called "p_{max}" in Figure 5). This relative index of abundance has been generated for systems in the Upper Skeena (upstream of Terrace excluding the Kispiox), and the lower Skeena (all other Skeena streams). For comparative purposes the same index has been calculated for southeast Alaskan streams, and streams in the Nass/Portland, Principe/Grenville and Kitimat areas. Index values from 1950 to 1998 are shown in Figure 5.

One of the interesting aspects of these escapement records is the regional variation in the escapement shortfall in 1997. This event was most severe in the Upper Skeena and in Area 6 and least severe in Area 3 and in southeast Alaska. This event was detectable on the central coast as well. The 1997 event was caused by abnormally poor marine survival of smolts entering the ocean in 1996, which occurred over a broad area.

The most fragmented and sparse escapement records are from the Upper Skeena. Escapements in this area fell during the 1980s and 1990s and reached a low point in 1997. The recovery in 1998 to near-average escapement levels reflects in part a real increase in escapement but also an increase in counting effort. Escapement to the lower Skeena has not varied much over time, recovering from a record low in 1997 to a near-average value in 1998. Escapement to the region to the southwest of the Skeena (Area 5) decreased precipitously in 1969 but has remained relatively stable since then, although the quality of data in this area is particularly poor and may not give be reliable. Escapement to streams in the Kitimat area appears to have decreased steadily since the late 1960s and there may be serious conservation problems in this region. In contrast, escapement is robust in the Nass/Portland area and in southeast Alaska.

The last of the four indices of status is the density of juvenile coho in late summer. Pool habitats in small streams throughout the watershed have been sampled since at least 1994 and in some areas since the late 1980s. Densities in excess of 0.75 to 1 juvenile per square metre are considered indicative of full "seeding." Fully seeded streams received enough spawners to populate preferred habitats with juveniles and, under average conditions, should produce near-maximum numbers of smolts.

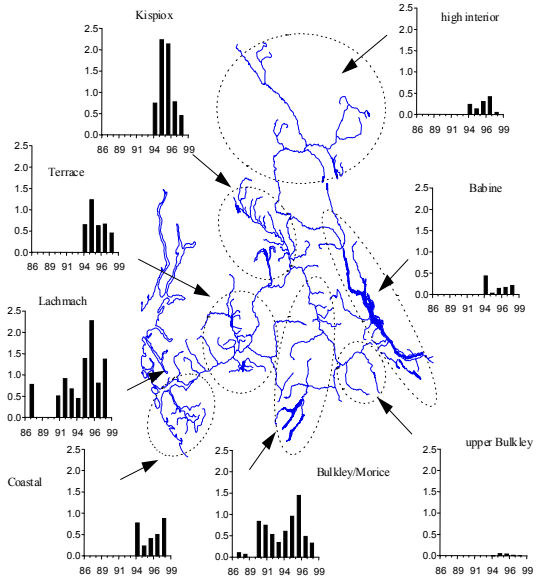


Figure 6. Juvenile coho densities (number per m^2 of pool) in late summer in seven areas of the Skeena watershed and in the Lachmach River on Work channel. The graphs are all to the same scale so the height of the bars allows direct comparison of densities among the areas.

Juvenile densities in most of the Upper Skeena (the high interior, the Babine, and the Upper Bulkley in Figure 6) are low, and in two of the three areas were nearly absent in 1998. Densities in the Morice drainage are considerably higher. Fairly high densities have been consistently recorded in Morice River side-channels. Comparable densities have been observed in the streams around Terrace and in coastal streams. High densities have been observed in Kispiox streams and in the Lachmach River and only these two areas might be considered adequately seeded. The low numbers of juveniles observed in 1998 in the streams of the Upper Skeena is consistent with the poor escapements observed in 1997.

Expected smolt numbers from this large area are also poor, which should lead to poor returns of coho in 2000 and 2001.

The four indicators of coho status indicate that populations in the Upper Skeena are depressed and at levels well below historical abundance. Populations in the lower and middle Skeena appear to be healthy in comparison, although there may be localized exceptions. Coastal populations to the north of the Skeena and especially those in southeast Alaska appear to be robust while those to the south appear to be as depressed as those in the Upper Skeena.

Indicator Streams

Wild smolts leaving the Lachmach River and hatchery smolts produced at the Toboggan Creek CDP hatchery have been coded-wire tagged since 1987. Counts of the number of tagged fish that have returned to each location have been made since 1988. Those counts, combined with estimates of the numbers of tagged fish caught in marine and freshwater fisheries, allow the estimation of the smolt-to-adult survival rate (the proportion of smolts that survive to the fishery and escapement) and the exploitation rate (the proportion of those survivors that are caught).

Total exploitation of the Lachmach population varied from 62 to 76% between 1988 and 1996. Restrictive measures in Canadian fisheries reduced the exploitation rate to 56% in 1997 and complete closure of the commercial fishery reduced the exploitation rate to 46% in 1998, almost all of which was in Alaskan fisheries. Total exploitation of the Toboggan Creek coho ranged from 41 to 73% between 1988 and 1996. With complete closure of the commercial fishery in 1998 total exploitation was 28%.

Differences in the total exploitation rates between the two stocks can be attributed to several factors. Toboggan Creek coho have a more southerly distribution than Lachmach coho. Consequently, measures taken in the Canadian northern troll to reduce impacts on Upper Skeena coho taken throughout the 1990s have had proportionately more effect for Toboggan coho. Larger impacts of freshwater sport and First Nations' fisheries offset that difference to some extent. Tagging information available for Babine Lake coho suggests the ocean distribution of these populations is similar to that of Lachmach coho. That similarity would reduce the benefits of management actions in Canadian fisheries and might explain why the estimated exploitation rate on Babine coho in 1998 was 60%.

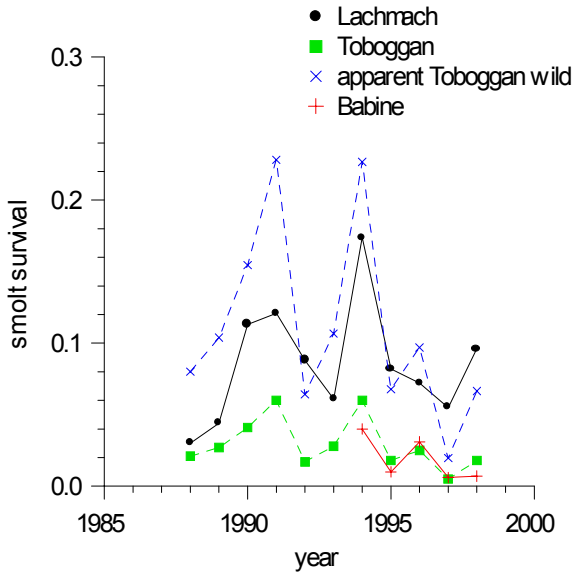


Figure 7. Smolt-to-adult survivals for four coho populations. The year is the return year. Toboggan and Babine are hatchery populations while Lachmach is a wild indicator on Work Channel.

Smolt-to-adult survivals have averaged 8.5% for Lachmach River coho but only 2.9% for Toboggan Creek CDP. Over the past four years it has been possible to estimate the number of wild smolts leaving Toboggan Creek. Using that estimate and counts of wild coho in the escapement fisheries scientists have been able to estimate the survival rates of wild coho, which have averaged 11%. Variations in survival rates are similar for all sites (Figure 7), suggesting that they have common causes. The significantly lower survival value in 1997 (the 1996 smolt year) suggests that marine survival was the likely cause of the escapement shortfall in that year. Survivals rose to near-average levels for the coho returning in 1998.

Toboggan Creek CDP hatchery (interior Skeena)

Return Year	Tags released/ recovered	Total Exploitation rate	smolt-to-adult survival
1988	31794 / 37	0.41	0.02
1989	30354 / 129	0.66	0.03
1990	31300 / 213	0.70	0.04
1991	30954 / 309	0.66	0.06
1992	31290 / 86	0.69	0.02
1993	30926 / 75	0.67	0.03
1994	32600 / 323	0.67	0.06
1995	33533 / 64	0.46	0.02
1996	33609 / 195	0.73	0.03
1997	32368 / 26	0.52	0.005
1998	33255 / 57	0.28	0.02

Lachmach River (coastal Work Channel)

return year	tags released/ recovered	total explotation rate	Smolt-to adult survival
1988	1169 / 5	0.66	0.03
1989	9481 / 68	0.62	0.04
1990	17210 / 418	0.76	0.11
1991	24408 / 635	0.73	0.12
1992	13186 / 268	0.76	0.09
1993	19921 / 255	0.65	0.06
1994	14055 / 502	0.71	0.17
1995	6276 / 102	0.70	0.08
1996	3629 / 91	0.72	0.07
1997	5234 / 41	0.56	0.06
1998	7645 / 108	0.46	0.10

Variations in productivity

The productivity of a fish population determines how many adults can be harvested on a sustained basis. Such characterizations are subject to many uncertainties but we do know enough about the coho populations of the Skeena and surrounding regions to be able to compare their productivities. One approach to characterizing productivities gives estimates of the Maximum Sustained Yield (MSY) and the exploitation rate at which that yield occurs. For any population there is an estimate of the number of spawners required to produce that yield.

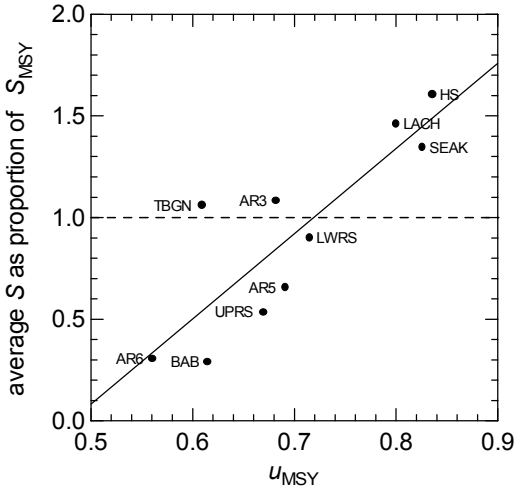


Figure 8. A plot of the recent average escapement to the indicator and index streams as a proportion of the *MSY* escapement vs. their optimal exploitation rate. The identification codes are: 'AR', Statistical Area; 'BAB', Babine Lake aggregate; 'LWRS': lower Skeena (Area 4); 'UPRS': upper Skeena; 'TBGN', Toboggan Creek wild indicator; 'LACH', Lachmach River wild indicator; 'SEAK', SE Alaska index streams; and 'HS', Hugh Smith Lake wild indicator (SE Alaska).

Figure 8 compares the status of coho populations in the northern boundary area with estimates of their productivities. Status is expressed as current escapements as a proportion of the escapement at MSY. The exploitation rate at MSY varies from 56% for Kitimat area streams to 83% for a coastal Alaskan indicator stream. Status varies directly with productivity. The one exception is the

enhanced Toboggan Creek population, which is supplemented by surplus hatchery spawners. Figure 9 shows a similar comparison of population productivities, in which the rate escapement changed between 1970 and 1996 is compared with the exploitation rate at MSY. The less productive populations declined at faster rates over that period.

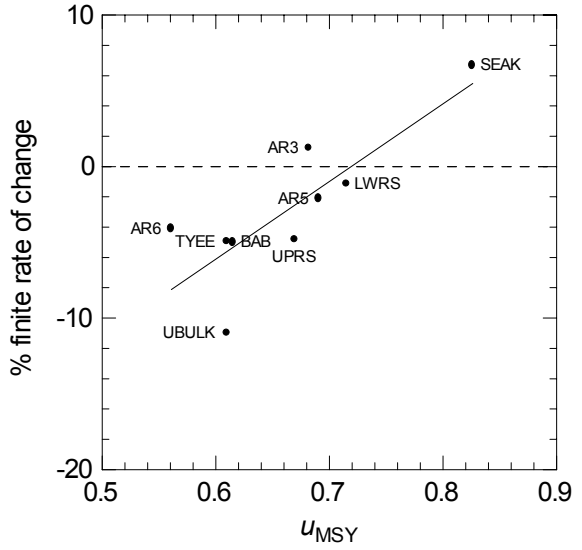


Figure 9. A plot of the finite rate of change to the indicator streams and coho abundance indices as a proportion of their optimal exploitation rate. The identification codes are: 'AR', Statistical Area; 'BAB', Babine Lake aggregate; 'LWRS': lower Skeena (Area 4); 'UPRS': upper Skeena; 'TYEE', test-fishery index to Aug. 25th, 'UBULK' upper Bulkley River, 'LACH', Lachmach River wild indicator; and 'SEAK', SE Alaska coho catch per hook in the troll fishery.

Outlook

The reappearance of detectable numbers of adult coho in most areas of the Upper Skeena in 1998 is a promising indication that the long-term decline in these populations can be reversed through conservation-minded fisheries management. The time for recovery of coho in the Upper Skeena will depend on continued moderation of fishing pressures and continued favorable ocean survival rates. Under those conditions, Upper Skeena coho should recover to healthy levels within two to three cycles, or within nine years.

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