# STATUS OF SALMON SPAWNING STOCKS

# OF THE SKEENA RIVER SYSTEM

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This report is part of a review of the status and prospects for Skeena salmon stocks and the fisheries they support.

Each of the species of salmon and steelhead that return to the Skeena system to breed each year is made up of tens or hundreds of more or less isolated and independent spawning stocks. This is the stock structure that provides the diversity of behaviour, physiology and genetic composition that have enabled the salmon species to colonize and adapt to the full array of ecological niches that they occupy throughout the Skeena system (and the rest of their ranges). Stock diversity enables each salmon species to maintain a wide variety of evolutionary strategies that provide a hedge against unpredictable fluctuations in climate and other critical elements of the salmons' world; what works well this year for a species may not work so well next year or next century under changed conditions. A precautionary approach to salmon management should include the concept that all stocks are important—even small or otherwise minor ones. This idea is akin to Aldo Leopold's warning that in tinkering with ecosystems it is wise to keep all the parts.

This report provides a classification of the current status of all known salmon breeding populations in the Skeena system based on escapement estimates collected by Fisheries and Oceans Canada (DFO) since 1950. A preliminary classification was presented in spring 2000 at a series of community workshops in the Skeena region in which community members were asked to provide their knowledge of the status and history of salmon stocks, comments on the preliminary classification, and their assessment of conservation and management problems and solutions. The stock status ratings presented in this report are the result of synthesis of the analysis of DFO data with comments stemming from the workshops.

This stock classification is inspired by a series of projects sponsored by the American Fisheries Society, in which committees of eminent fisheries scientists have evaluated the risk of extinction of individual salmon stocks along the Pacific Coast of North America: BC (Slaney *et al.*, 1996), Alaska (Baker *et al.,* 1996), and California, Oregon and Washington (Nehlsen *et al.*, 1991).

The present study extends the above work in two ways. Due to the large areas and numbers of stocks covered, the above researchers have published only results summarized by species and production area; this study provides a listing of individual stocks and their status classification for the entire Skeena system. Secondly, I have included additional categories in the stock classification in order to provide more detail about the status of stocks considered depressed but not at risk of extinction and about stocks for which data are insufficient to reach a fully reliable conclusion regarding current status.

I have not included Skeena steelhead in the present analysis. Skeena steelhead, especially the summer-run stocks of the upriver tributaries, have long been the focus of management concern because of conflict between the needs of targeted inland sport fisheries and of ocean commercial net fisheries, in which steelhead are taken as bycatch. Because they spawn in spring and in widely distributed small tributaries, steelhead spawning populations are particularly difficult to monitor, and there is no time-series of steelhead escapement estimates comparable to the salmon database. Steelhead stocks will be treated in the later steps of this project, but they are not considered here.

## METHODS

For the purposes of this study, I define a stock of salmon as those fish of a particular species that use the same spawning area at the same time. This definition is intended as an approximation of a biological *population*, which represents an independent breeding unit with a gene pool distinct from other populations.

Operationally, with a few exceptions, I take the reporting units designated in the DFO escapement records as a first approximation of distinct spawning stocks. Rigorous determination of spawning stock definitions would require a specialized analysis of the degree of genetic difference among geographically separated spawning groups. Future work may show that the DFO reporting units separate some neighboring spawning aggregates that should not be considered separate stocks and, conversely, that some units now considered to be homogeneous in fact encompass 2 or more genetically distinct stocks.

In some cases historical records for DFO reporting units make more sense if adjacent units are lumped rather than treated separately. In most of these cases DFO now lumps the reporting units; in the other cases, I decided to lump adjacent units based on conversations with people familiar with the areas and with the escapement enumeration process.

The historical DFO reporting units that I have lumped in my analysis are as follows:

- Johnston Lake and Johnston Creek (Ecstall system);
- Exstew River and Exstew Slough (Lower Skeena mainstem);
- Hadenschild Creek and Anweiler Creek lumped with Cedar River (Kitsumkalum system);
- Upper and Lower Club Creek (Kispiox system);
- Babine River (Sec. 5) lumped with Sec. 4 as Lower Babine River;
- Bear Lake and Bear River;
- Sustut Lake and Sustut River.

My classification of stock status for Skeena salmon stocks is derived from the procedures used by Slaney *et al.* (1996) and Baker *et al.* (1996), who in their turn used modified versions of the classification developed by Nehlsen *et al.* (1991). The results of the four different techniques are comparable but not identical.

My classification is based on a three-step procedure.

First, I applied a set of decision criteria to summary statistics derived from DFO escapement records for individual Skeena salmon stocks (Salmon Escapement Data System—SEDS) for the years 1950 through 1997[1] (Brian Spilsted, DFO/Prince Rupert, unpublished data).

Secondly, I reviewed the series of annual records for each stock and evaluated the classification arising from the first step in light of the particular history of each stock. At this second step I also considered any other information known to me about individual stocks: geography and accessibility to DFO personnel, timing considerations, anecdotal information not reflected in the statistical tables, etc.

Finally, I presented the stock status ratings derived from the first two steps to public community meetings held in February and March 2000 in Houston, Smithers, Hazelton, Terrace and Prince Rupert. At this stage I also met with fisheries staff of the Gitanyow, Gitxsan, Kitsumkalum and Wet'suwet'en First Nations; I also spoke by telephone with Tsimshian Tribal Council and Ned'u'ten contacts. At these meetings and in followup interviews, I solicited comments on the preliminary classification and suggestions for changes. In some cases information provided by the public in this third phase was unpublished quantitative information which supplemented the SEDS data and resulted in

[1] When I began this project the 1997 escapement data were the most recent available. Since then the data for 1998 and 1999 have been compiled, and I have reviewed them. I have continued to exclude the 1998-99 data because of the extraordinary restrictions on Canadian commercial and sport fisheries in those years, which in my opinion may render the escapement data not comparable to earlier years with higher fishery harvest rates. The only exception to this exclusion is in the case of a few stocks for which escapement records in these years are the only records for the 1990s; these stocks earlier were rated *NRR* (see below for details), and that rating was changed to reflect the 1998-99 records confirming their continued existence.

changes in the classification which had been based on SEDS alone. In most cases, public comments were sufficient only to confirm the continued existence of stocks for which SEDS provides no recent records; in such cases I could conclude that the stock was not extinct but had to regard its precise status as unknown.

Revisions at the second and third steps to the status as initially determined by the objective decision criteria of the first step affected from about 10% of the stocks (for chinook and pink salmon) to 30% of the coho stocks. Sockeye (24% of total stocks changed status) and chum (20%) were intermediate in this respect.

**<u>Stock status definitions and decision criteria</u>**

I based the initial status classification for each stock on a combination of the trend of escapement records since 1950 and the average number of spawners observed since 1990.

I calculated the escapement trend as the ratio of the average (arithmetic mean) of all positive records 1990-97 to the average of 1950-89 records— Escapement Trend (*ET*) = Mean Escapement 1990-97 √ Mean Escapement 1950-89. If *ET* is 1.0 or larger, then recent escapement estimates are at least as large as historical records 1950-89. Following Baker *et al.* (1996), I categorize *ET* classes as follows:

| | |
|---|---|
| *ET* > 1.5: | *Population Increasing*; |
| 0.5 ″ *ET* ″ 1.5: | *Population Stable*; |
| *ET* < 0.5: | *Population In Decline*; |
| *ET* < 0.2: | *Population In Precipitous Decline*. |

***Screening of records***

Before classifying stocks based on Escapement Trend, I first screened out stocks for which I considered that there were not enough records to draw a reliable conclusion about status. I divided such stocks into three categories:

***U-P***: *Status unknown*—the record does not establish that this was ever an established, persisting stock. Fewer than 4 annual records of 50 or more spawners (sockeye and pink) or 25 or more spawners (chinook, coho, chum).

***NRR***: *No recent records*—more than 4 annual records above the criterion level above, but no recorded escapement since 1990. This category may include stocks that have gone extinct since 1950. It may also include healthy stocks that have not been monitored in the 1990s due to geographical isolation, DFO budget constraints or other reasons.

***U-N***: *Status unknown*—4 or more annual records higher than the minimum criteria above. Probably is an established stock, but records are insufficient to establish current status. In many cases, gaps in the record obscure trends in abundance. Available data do not indicate depletion.

***S-2***: *Special concern*—insufficient information to determine status, but available evidence suggests depletion. Criteria as for *U-N* above, but available data show a declining trend ($ET < 0.5$).

Having identified stocks lacking sufficient information for a clear status classification, I then moved to designation of status based on escapement trend and 1990s escapement records.

***Stocks in precipitous decline (*ET *less than 0.2)***

- ***H***: *High risk of extinction*—Mean escapement 1990-97 ($M_{90s}$) less than 200.
- ***M***: *Moderate risk*—$M_{90s}$ between 200 and 1,000.
- ***S-3***: *Special concern*, historically large stock, now depleted—$M_{90s}$ more than 1,000.

***Stocks in decline (*ET *between 0.2 and 0.5)***

- ***M***: *Moderate risk of extinction*—$M_{90s}$ less than or equal to 1,000. [Stocks in this *ET* range with $M_{90s}$ below 50 (sockeye and pink) or 25 (chinook, coho, chum) were classed as *H*, High risk of extinction.]
- ***S-3***: *Special concern*, historically large stock, now depleted—$M_{90s}$ more than 1,000.

***Stable and increasing stocks (*ET *0.5 or higher)***

- ***L***: *Low risk of extinction*— $M_{90s}$ 200 or more.
- ***S-1***: *Special concern*, historically small stock, now apparently stable— $M_{90s}$ less than 200.
- ***S-4*:** *Special concern*, apparently stable, maintained by enhancement.

***Other classifications***

I created two other status classes for stocks that did not fit well into the other categories.

- ***V***: *Variable*—year-to-year variation in the escapement record is so great that trends are not evident and comparison of multi-year averages is meaningless. Status is not clear.
- ***U-T***: *Status unknown*—records may represent transient fish rather than fish that spawn where they were reported. This category was assigned to three sets of sockeye records from the lower reaches of systems with known spawning stocks in the upper reaches.

Summary definitions of stock status classes can be found in Table 1, below.

**Table 1. Summary of Stock Status Classes**

| Category | Code | Description |
|---|---|---|
| **Unthreatened** | | |
| | ***L*** | Low risk of extinction. |
| **Of some concern** | | |
| *Strong evidence* | ***S-1*** | Small stock—apparently stable. |
| | ***S-3*** | Historically large population—now depleted. Not at immediate risk of extinction. |
| | ***S-4*** | Apparently stable. Maintained by enhancement activity. |
| | ***V*** | Historic record variable—no apparent trend. |
| *Incomplete evidence* | ***S-2*** | Insufficient data. Available information suggests declining trend. |
| **Threatened** | | |
| | ***H*** | At high risk of extinction. |
| | ***M*** | At moderate risk of extinction. |
| **Status unknown** | | |
| *Probably is a stock* | ***U-N*** | Insufficient data to determine status. No evidence of depletion. |
| | ***NRR*** | No recent records—may be extinct. |
| *May not be a stock* | ***U-T*** | Records may be of transients *en route* to a different spawning area. |
| | ***U-P*** | Few records. May never have existed as self-perpetuating stock. |

# RESULTS

Appendix 1 provides details of the stock status classifications that resulted from the exercise described above. Results are presented for each stream or lake, by species, grouped by watershed subarea. Results for all species but pink salmon are presented in map form in Appendix 2.

Tables 2 through 7 summarize the stock status classifications by species for the Skeena system as a whole and for four major subregions. I present these summaries to illustrate the broad outlines of the study results, but the real value of this work lies in the stock by stock classification found in the Appendix 1 and the GIS maps in Appendix 2. I strongly urge readers to spend time on the Appendices.

The subregions are as follows:

| | |
|---|---|
| **Coastal**: | coastal parts of DFO Statistical Area 4 and the Skeena system downstream of McLean Point, including all of the Ecstall and Khyex drainages; |
| **Lower Skeena**: | Skeena mainstem and tributaries from McLean Pt. to just upstream of Terrace, including the Lakelse and Kitsumkalum drainages; |
| **Middle Skeena**: | Skeena mainstem and tributaries from the mouth of the Zymoetz (Copper) River (included) upstream to the Hazelton/Kispiox area, including the Kispiox and Bulkley/Morice drainages; |
| **Upper Skeena**: | Skeena mainstem and tributaries from the mouth of the Babine River to the headwaters, including the Babine and Bear Lake drainages. |

I have classified individual stocks into the 12 status categories defined in Table 1 above. The detailed classifications for each stock are presented in Appendix 1. For clarity in this overview of results, I have summarized stock status categories in the text tables below as follows:

| | |
|---|---|
| **Unthreatened**: | Category *L*—low risk of extinction. |
| **Of some concern**: | Categories *S-1*, *S-2*, *S-3* and *S-4*; and *V*—a variety of concerns; see Table 1 for details. |
| **At risk of extinction**: | Categories *H* and *M*—at high and moderate risk of extinction; |
| **No recent records:** | Category *NRR*—stocks known to have persisted for decades in the past but for which there are no 1990s records; |
| **Unknown**: | Category *U-N*—probably a stock; insufficient data to determine status. |

**Questionable stocks:** Categories *U-P* and *U-T*—records which may not correspond to distinct spawning stocks.

**<u>Sockeye</u>**

My analysis of the DFO escapement database identifies records for 88 possible spawning stocks of sockeye in the Skeena system, although 18 of these may not represent actual stocks (my categories *U-P* and *U-T*). Stocks are not distributed evenly through the system: about half of the total are reported from the Upper Skeena subregion, and only 5 are located in the Coastal area.

**Table 2. Status of Skeena sockeye salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|
| **Unthreatened** | **34** | 4 | 5 | 6 | 19 |
| **Of Some Concern** | **12** | 0 | 4 | 0 | 8 |
| **At Risk of Extinction** | **7** | 0 | 3 | 2 | 2 |
| **No Recent Records** | **8** | 0 | 3 | 3 | 2 |
| **Unknown** | **9** | 1 | 1 | 5 | 2 |
| **Total** | **70** | **5** | **16** | **16** | **33** |
| **Questionable stocks** | **18** | 0 | 4 | 6 | 8 |

I was unable to determine the status of 35 presumptive stocks: 8 in the category *No Recent Records*, 9 *Unknown*, plus the 18 listed as *Questionable Stocks* (*U-T* and *U-P*) that may never have existed as self-sustaining entities. Of the remaining 53, nearly two-thirds are in the *Unthreatened* class; all 4 of the classified Coastal stocks are in this category, while the proportion in Lower Skeena subregion is relatively low (i.e. a higher proportion of Lower Skeena stocks are in the *At Risk* and *Of Concern* classes than the average for all areas).

Of the 7 sockeye stocks I classify as *At Risk*, 3 are in the *High* risk category:

- Clear Creek of the Kitsumkalum system;
- Upper Bulkley River, a small stock in the Bulkley drainage; and
- Upper Tahlo Creek of the Babine system.

In addition, there are 8 stocks for which there has been no recorded escapement in this decade—Status *NRR*. The Lower and Middle Skeena subregions each have 3 of these stocks, and 2 are in the Upper Skeena.

**<u>Chinook</u>**

I interpret the DFO/Prince Rupert chinook escapement records to represent 72 different spawning groups in the Skeena drainage since 1950. Of these locations, 75% are in the Lower and Middle Skeena subregions, and 11% and 14% are located in Coastal and Upper Skeena areas, respectively.

**Table 3. Status of Skeena chinook salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|
| **Unthreatened** | **11** | 0 | 4 | 5 | 2 |
| **Of Some Concern** | **20** | 2 | 7 | 9 | 2 |
| **At Risk of Extinction** | **10** | 3 | 5 | 2 | 0 |
| **No Recent Records** | **6** | 2 | 2 | 1 | 1 |
| **Unknown** | **8** | 0 | 0 | 7 | 1 |
| **Total** | **55** | **7** | **18** | **24** | **6** |
| **Questionable stocks** | **17** | 1 | 7 | 5 | 4 |

I was unable to classify 31 possible stocks due to insufficient data. Eight of these are listed as *Unknown* in Table 3, and 17 I consider of *Questionable* existence as discrete stocks. For 6 chinook stocks with well-established historical records, the DFO SEDS database shows no escapement records in the 1990s.

I only found 27% of the 41 classifiable chinook stocks to be *Unthreatened*, in contrast to sockeye, for which I classed 64% as *Unthreatened*. The proportion of *Unthreatened* chinook stocks in each subregion increases in a smooth gradient upriver: none of the 5 classified Coastal stocks is *Unthreatened*, and the proportion increases through the Lower and Middle Skeena subregions to reach 50% of the 4 classified stocks in the Upper Skeena. The gradient is reversed for the 10 *At Risk* stocks: 60% of the Coastal group, 31% Lower, 12% Middle and none in the Upper Skeena are rated *At Risk*.

I classified 3 chinook stocks as being at *High* risk of extinction:

Johnston Creek, a historically abundant stock spawning in the headwaters of the

Ecstall system in the Coastal subregion;
Deep Creek, a small stock in the Kitsumkalum system; and
Zymacord (or Zymagotitz) River, a historically small stock of the Lower Skeena just below Terrace.

**Coho**

Coho are the most diverse of the Skeena salmon species in terms of total number of reported spawning locations: 153 according to my interpretation of the DFO/Prince Rupert database. Of these, I classified 20 as *U-P*—fragmentary records that may not represent actual stocks that were ever self-sustaining. This leaves 133 which I consider to be documented spawning stocks. Coho stocks are distributed throughout the system; more than two-thirds of the documented stocks are found in the Lower and Middle Skeena subregions combined.

**Table 4. Status of Skeena coho salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|
| **Unthreatened** | **25** | 5 | 10 | 8 | 2 |
| **Of Some Concern** | **38** | 4 | 12 | 21 | 1 |
| **At Risk of Extinction** | **28** | 3 | 12 | 9 | 4 |
| **No Recent Records** | **17** | 4 | 1 | 9 | 3 |
| **Unknown** | **25** | 5 | 9 | 6 | 5 |
| **Total** | **133** | **21** | **44** | **53** | **15** |
| **Questionable stocks** | **20** | 3 | 2 | 6 | 9 |

Of the 91 coho stocks whose status I was able to classify, only 27% fell in the *Unthreatened* category. This is the lowest proportion of relatively healthy stocks that I have found for any of the species treated in this study. The number of classified coho stocks rated as *Unthreatened* is lower in the Upper Skeena than in any other Skeena subregion. In addition, I was unable to classify a further 17 Upper Skeena coho localities due to low numbers of annual observations; no doubt some of these records represent actual stocks that have received little monitoring attention due to their isolation.

I listed 28 coho stocks as *At Risk of Extinction* (31% of classified stocks). This is the highest absolute number of stocks at risk for any of the species considered here, although the *proportion* of stocks at risk is higher for chum. Seven of 12 classifiable coho stocks in the Kitsumkalum drainage are in the *At Risk* category, as are 4 of 12 in the Bulkley.

I classed a total of 7 Skeena coho stocks as at *High Risk* of extinction:

Khyex River, a historically large stock of the Coastal area;
Esker Slough, and 2 Gitnadoix River tributaries (Kadeen and Southend Creeks) in the Lower Skeena area;
Fiddler Creek in the Mid-Skeena between Kitwanga and Terrace; and
Boucher and Pinkut Creek, both small stocks in the Babine system.

In addition, 17 coho stocks are classed *NRR*—no recent records. Twelve of these problematical stocks are in the Middle and Upper Skeena subregions.

## Pink

Pink salmon mature at 2 years of age almost without exception; therefore, even-year and odd-year runs to the same spawning ground represent separate gene pools between which there is no interbreeding. Although population dynamics of runs to the same location in alternate years may be linked in complex ways so as to produce relatively stable two-year cycles of abundance, they are clearly separate breeding populations that can fluctuate independently. For this reason, I follow Baker *et al.* (1996) in treating even-year and odd-year pinks as separate sets of populations.

In the recorded history of pink salmon returns to the Skeena system odd-year dominance, even-year dominance, and no dominance have all been documented in different spawning systems. The dominance pattern within a particular spawning stream can shift over time from one pattern to another. Shifting dominance patterns can introduce long-period cycles into escapement histories that influence the stock classification system I am using. Thus a long-term decline in, say, the even-year line in a particular stream may meet the criteria for designating that stock as *At Risk*; however, if the odd-year line is increasing at the same time, one may question whether the *At Risk* designation is appropriate. Having raised the point, I use the same classification method for even-year and odd-year pinks that I have used for the other species, but the reader should bear in mind that the status designations for pinks may not be precisely equivalent to those for the other species.

### *Even-year Pink Stocks*

My revision of the DFO database shows records of even-year pink escapement to 115 locations in the Skeena system. Records are well-distributed through the Coastal, Lower and Middle Skeena subregions but are relatively scarce in the Upper Skeena. I have designated more than half of the total of possible stocks as unclassifiable, and most of these (40 of 63) are in the *Questionable* category due to sporadic records and/or very low numbers.

**Table 5. Status of Skeena even-year pink salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|
| **Unthreatened** | **31** | 12 | 7 | 10 | 2 |
| **Of Some Concern** | **14** | 2 | 4 | 7 | 1 |
| **At Risk of Extinction** | **7** | 2 | 3 | 2 | 0 |
| **No Recent Records** | **5** | 1 | 1 | 3 | 0 |
| **Unknown** | **18** | 4 | 5 | 8 | 1 |
| **Total** | **75** | **21** | **20** | **30** | **4** |
| **Questionable Stocks** | **40** | 6 | 12 | 14 | 8 |

Of the 52 stocks for which I have designated a status, 60% fall into the *Unthreatened* category. This is similar to the proportion of *Unthreatened* Skeena sockeye stocks and is exceeded in the Skeena only by odd-year pinks. The *Unthreatened* proportion is highest in the Coastal subregion, where 75% of the 16 classified stocks are in this category.

Of the 7 even-year pink stocks designated *At Risk*, only 1 meets my criteria for *High* risk designation:

Lockerby Creek of the Coastal area.

***Odd-year Pink Stocks***

The summary of status designations for odd-year pinks is similar to that for the even-year stocks, although the stock-specific details are in some cases very different—odd and even-year lines in the same spawning stream frequently have different status.

There are 112 streams in the Skeena system for which the revised database provides records of odd-year pink escapement in at least one year. Of these, I consider nearly half to be unclassifiable, and the majority of these (31 of 55) may never have represented discrete, self-sustaining spawning stocks.

**Table 6. Status of Skeena odd-year pink salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Unthreatened** | **44** | 12 | 12 | 17 | 3 |
| **Of Some Concern** | **8** | 3 | 2 | 3 | 0 |
| **At Risk of Extinction** | **5** | 5 | 0 | 0 | 0 |
| **No Recent Records** | **1** | 0 | 1 | 0 | 0 |
| **Unknown** | **23** | 1 | 9 | 11 | 2 |
| **Total** | **81** | **21** | **24** | **31** | **5** |
| **Questionable Stocks** | **31** | 4 | 7 | 13 | 7 |

*Unthreatened* stocks make up 77% of the ones I was able to classify; this is the highest proportion of *Unthreatened* stocks determined for any of the Skeena salmon species considered here.

In contrast to even-year pinks, for odd-year pinks the *Unthreatened* proportion, while still relatively high at 60% of the classified stocks, is lowest in the Coastal subregion, and all of the 5 stocks *At Risk* are on the Coast.

I designated 3 odd-year pink stocks as being at *High Risk of Extinction*, all in the Coastal subregion:

Big Falls Creek and Madeline Creek, neighboring tributaries of the Ecstall River; and

Denise Creek, draining into Denise Inlet east of Prince Rupert.

## Chum

Chum salmon have the lowest number of stocks of all the Skeena salmon species considered in this report: 50 spawning locations in my revision of the DFO/Prince Rupert database, of which I have designated 16 (32%) as *Questionable*—status unknown, may not represent a self-sustaining stock. Chums are widespread in the Coastal, Lower and parts of the Middle Skeena subregions, but are seen only rarely in the Bulkley system and occur only as a single small stock in the Upper Skeena.

**Table 7. Status of Skeena chum salmon stocks summarized by subregions: number of stocks in each category.**

| Status | Skeena Total | Coastal | Lower Skeena | Middle Skeena | Upper Skeena |
|---|---|---|---|---|---|
| **Unthreatened** | **7** | 1 | 5 | 1 | 0 |
| **Of Some Concern** | **8** | 0 | 4 | 4 | 0 |
| **At Risk of Extinction** | **10** | 5 | 2 | 2 | 1 |
| **No Recent Records** | **2** | 2 | 0 | 0 | 0 |
| **Unknown** | **7** | 0 | 4 | 3 | 0 |
| **Total** | **34** | **8** | **15** | **10** | **1** |
| **Questionable Stocks** | **16** | 7 | 3 | 6 | 0 |

Of the 25 chum stocks I was able to classify as to Status according to my criteria, only 28% qualified as *Unthreatened*—along with coho, the lowest proportion of relatively healthy stocks found in any of the Skeena salmon species reviewed here.

The proportion of classified Skeena chum stocks *At Risk of Extinction* (40%) is higher than for coho, as is the proportion at *High Risk* (20%).

By my criteria 5 Skeena chum stocks are now at *High Risk of Extinction*:

- Denise Creek, Kloiya River, and Silver Creek, all in the Coastal subarea;
- Kleanza Creek, a small stock in the Middle Skeena area; and
- Lower Babine River, another historically small stock, at the extreme upriver extent of known chum migration in the Skeena system.

# DISCUSSION

The DFO escapement database (SEDS) that underlies this study is a priceless legacy. It contains many thousands of records collected over nearly 50 years by a large number of dedicated men and women working under often difficult conditions.

Although the data set is of great value, it is important to realize that it is flawed in many ways from a statistical perspective: it is like a series of historical photographs taken with different cameras by different individuals under widely varying conditions. For some localities, we have a complete sequence of clearly recognizable pictures. In other cases, some of the pictures are blurry, or part of the historical set is missing; some appear to represent a completely different place, and we wonder if they somehow got put in the wrong box. For all the flaws, we know that the data represent the surviving records of serious attempts to document historical reality by knowledgeable individuals who were on the scene at the time. This is the legacy; it is irreplaceable, and it merits our serious attention. The discussion that follows is intended to raise some of the issues that need to be considered as we attempt to draw inferences from this legacy.

## Uncertainty about quality of escapement data

Data quality varies in precision, accuracy and bias in ways that are unknown from year to year and place to place. Annual escapement estimates reflect not only actual spawner abundance but also

- skill and experience of the observer(s),
- estimation method (e.g. fence count, mark and recapture, or visual estimate by observers in aircraft, watercraft, swimming or on foot),
- weather and water conditions for each observation,
- timing of monitoring visit(s) relative to the peak and duration of the spawning period,
- number of monitoring visits contributing to each annual record,
- accessibility of particular spawning grounds and exact area covered,
- priority given to particular stocks (larger stocks are likely to have received more attention than smaller),
- time and effort available for escapement monitoring (this has varied over time with changing DFO budgets and priorities).

All of these factors affect the reliability of the annual escapement estimates. However, the circumstances associated with each estimate have not been documented in a systematic way, and the database has not been thoroughly screened for data quality. The result is that we know the data vary in quality, but we cannot in general determine the reliability of each annual record. In the face of such uncertainty it is wise to rely more on long-term trends and large, obvious changes than on individual records and subtle differences.

**Historical escapement records do not begin at the beginning.**

Salmon probably re-invaded the Skeena system within a short time after the retreat of the valley glaciers about 10,000 years ago. Salmon figure prominently in aboriginal oral histories of the Skeena, and there are references to occasional shortages as well as general abundance. By all accounts all species were abundant when the first European observers made written records in the mid-19th Century. It is difficult to draw quantitative inferences about the state of particular spawning stocks from either aboriginal or early European records.

Pre-Contact aboriginal fisheries may well have harvested Skeena salmon at near-maximal sustainable levels (Morrell 1987: App 2). Non-Indian commercial fisheries began at the mouth of the Skeena in 1877, and within a few decades they became the principal harvesters of Skeena salmon. Documented catches of all salmon species in the Skeena industrial fisheries increased steadily into the early decades of this century. Coastal commercial catches peaked for different species between 1910 and the early 1940s, and catches of all species were depressed by the time the escapement record begins (Morrell 1985: p 140ff.).

Thus the available documentation of escapement does not begin with pristine stocks, and we must resist the impulse to conclude that the highest recorded escapements for a given stock represent the maximum capability of the system.

**Other studies of Skeena stock status**

Slaney *et al.* (1996) published a summary of results of their classification of all known BC salmon stocks as to risk of extinction. The methods of my study are modified after Slaney *et al.* and two other parallel American Fishery Society papers covering California, Oregon and Washington (Nehlsen *et al. 1991)* and Alaska (Baker *et al.* 1996), as discussed above in the Methods section of this report.

The detailed results of Slaney *et al.* have not yet been published. Tim Slaney (Aquatic Resources Ltd, Vancouver, pers. comm.) has kindly provided me with a tabulation of the detailed stock classification that underlies the published results. A species-by-species summary of the Slaney *et al.* classification of Skeena stocks, along with comparable figures from my analysis, is shown in Table 8.

**Table 8. Summary of Skeena salmon stock status classifications by Slaney *et al.* (1996)** ['Slaney'] **and in this study** ['Morrell']**: number of stocks in each category.**

| | | | Special | Risk of Extinction | | | Status | |
|---|---|---|---|---|---|---|---|---|
| **Species** | **Source** | **Unthreatened** | **Concern**[a] | **Moderate** | **High** | **Extinct** | **Unknown**[b] | **Total** |
| **Sockeye** | Slaney | 53 | 1 | 0 | 12 | 0 | 41 | **107** |
| | Morrell | 34 | 20 | 4 | 3 | | 27 | **88** |
| **Chinook** | Slaney | 53 | 0 | 0 | 2 | 0 | 71 | **126** |
| | Morrell | 11 | 26 | 7 | 3 | | 25 | **72** |
| **Coho** | Slaney | 103 | 1 | 0 | 21 | 2 | 228 | **355** |
| | Morrell | 25 | 56 | 20 | 7 | | 45 | **153** |
| **Pink**(even) | Slaney | 90 | 0 | 0 | 2 | 0 | 20 | **112**[c] |
| | Morrell | 31 | 19 | 6 | 1 | | 58 | **115** |
| **Pink** (odd) | Slaney | 98 | 0 | 1 | 6 | 0 | 12 | **117**[c] |
| | Morrell | 44 | 9 | 2 | 3 | | 54 | **112** |
| **Chum** | Slaney | 34 | 0 | 0 | 8 | 0 | 30 | **72** |
| | Morrell | 7 | 10 | 5 | 5 | | 23 | **50** |

[a] The *Special Concern* category in this table includes stocks rated *NRR* in previous tables.
[b] The *Unknown* category in this table includes stocks listed as both *Unknown* and *Questionable* in previous tables.
[c] Slaney *et al.* (1996) identified another 49 pink salmon spawning grounds for which they did not separate odd and even-year spawners. They rated stocks at all these localities as *Status Unknown*.

The two classifications in Table 8 are substantially different. I have done a detailed stock-by-stock comparison of my results with those of Slaney *et al.* and have found that the differences arise from differences between the two studies in scope and objectives, base dataset, data analysis and criteria for stock classification.

***Scope and objectives***

Slaney *et al.* undertook to classify all the anadromous salmonid stocks of British Columbia and Yukon as to risk of extinction. They dealt with all BC and Yukon watersheds, seven species and nearly 10,000 stocks. They operated under serious constraints of time and resources. Understandably they restricted themselves to assessment of extinction risk, strictly defined, while noting that their *Unthreatened* category includes many stocks that are depressed (Slaney *et al.* 1996: p 22).

My scope was limited to the Skeena watershed and in this phase of the study only 5 species, excluding steelhead and cutthroat trout—a total of fewer than 600 stocks. Although I have dealt with the question of extinction risk, I have also made a point of classifying stocks of concern in various ways even when they are not in immediate danger of extinction. My more restricted scope allowed me more latitude than Slaney *et al.* for detailed investigation and analysis.

***Basic dataset***

Slaney *et al.* relied primarily on the DFO SEDS database for the spawning years 1953-1992 for quantitative data. They also examined the federal-provincial Stream Information Summary System (SISS) database and solicited comments from fisheries professionals and interest groups provincewide. In the end, for want of alternative quantitative datasets and because of time constraints, their "stock status criteria rely primarily on 'face-value' analysis of escapement observations contained in the SEDS database" (Slaney *et al.* 1996: p 22).

I likewise relied almost entirely on the SEDS database for quantitative data; however, the version of the database I analysed beginning in 1998 was different in important ways from the one used by Slaney *et al*. I used data from the years 1950-1997—a total of eight additional years at both the beginning and the end of the time series. In addition, in using a later edition of the database, I had the benefit of editing of the data carried out by DFO in the mid-1990s. In this editing process many records that previously appeared as zero escapement were revised on the basis of review of the original field reports to "Not Inspected" or "None Observed" (B. Spilsted, DFO/Prince Rupert, pers. comm.); I have taken these revised designations as years of no quantitative record. It appears to me that Slaney *et al.* were working with the earlier dataset and took the years in question at face value as years of nil escapement.

***Data analysis***

Slaney *et al.* and the present study both use comparison of recent and long-term average abundance estimates, combined with the absolute size of recent population estimates to arrive at stock status ratings. We differ in the criteria we use to determine stock status (discussed in the next section), but we also differ in details of the numerical calculation.

For each stock Slaney *et al.* calculated the average escapement during the years 1983-92 as an index of recent abundance of spawners. They compared this recent abundance to long-term average escapement, calculated as the mean of all records in their entire dataset—1953-1992. Thus their long-term abundance estimate includes the records used to calculate recent abundance.

In contrast, I excluded the years used for the calculation of recent abundance from the series used to calculate the long-term average. I compared the average of the years 1990-97 with the average of all records for the previous 40 years, 1950-89.

It seems to me that both of these methods are defensible, but their results are different. My method emphasizes differences between recent escapements and the long-term average, because the 2 time series are completely non-overlapping. The approach of Slaney *et al*, by including recent years in the long-term average, reduces the contrast between the 2 averages—a decline in the recent decade also reduces the long-term average and thereby reduces the difference between the 2 averages in comparison to my calculation.

***Criteria for stock classification***

Slaney *et al. (*1996), Baker *et al. (*1996) both derived their classification criteria, with modifications, from Nehlsen *et al. (*1991). I in my turn reviewed the 3 previous studies and arrived at a synthesis that seemed appropriate to me. The result is that while all 4 of our studies use similar terminology, the specific criteria for different stock status categories differ among the studies—sometimes significantly.

*Data screening* I followed Baker *et al.* in excluding from the main data analysis stocks that did not have a minimum number of observations. As described under *Methods* above, I assigned such stocks to various *Unknown* categories as well as *NRR* for those that lacked records in the 1990s. Slaney *et al.* did not explicitly make this step. More than half the stocks that I classified as *Unknown* were rated *Unthreatened* by Slaney *et al.*; most of the rest were classed *Unknown* in both studies, and Slaney *et al.* ranked 7 as *High Risk*.

*Special Concern* In an effort to provide more detailed status rankings for stocks not in immediate danger of extinction, I created several categories here that were not included in any of the American Fisheries Society (AFS) analyses. My category S-2 (insufficient data but indication of depletion) corresponds to one of the AFS categories, but the others are all different. The details of my category definitions are provided in the *Methods* section.

Slaney *et al.* applied the AFS *Special Concern* classifications sparingly. They classed 1 stock each of sockeye and coho, and 36 steelhead stocks in their category that corresponds to my S-2.

All but 1 of the 44 stocks that I called *S-1* (stable but vulnerable because of low numbers) were ranked *Unthreatened* by Slaney *et al*.

*Moderate Risk of Extinction*
Slaney *et al.* define this category to include those stocks with recent average escapement 20% or less of the long-term average and recent average greater than 300 fish. In contrast, I have followed Baker *et al.* in defining this category as follows: recent average 20% to 50% of long-term average and recent average between 200 and 1,000 fish per year.

My definition is much more inclusive than that of Slaney *et al*, and the difference is readily apparent in Table 8.

***Other differences in methods***
Because the current study focuses on a single large watershed with a manageable number of stocks, I was able to spend more time on detailed evaluation of individual stock histories than were Slaney *et al*. After an initial classification based on average long-term and recent escapements and the criteria as defined, I examined all the annual records to see if the initial classification seemed appropriate. I changed many of the initial classifications at this stage to reflect quirks of the data (e.g. single extremely high records or periodic variation) that made the averages unrepresentative of actual trends in the escapement estimates. Slaney *et al*., working with almost 10,000 stocks covering all of BC, probably were not able to examine annual records in such detail.

I then spent 3 weeks in the Skeena region holding public meetings to display the stock classifications in map form and to discuss the project results to that point. These meetings and followup interviews with more than 50 individuals (listed in Appendix 3) generated more information, which I used to further revise the results.

The stock classifications presented in this report have been revised from the initial classifications based on SEDS and the formal decision criteria for 10% of the stocks (for chinook and pink salmon) to 30% of the coho stocks. Sockeye (24% of total stocks changed status) and chum (20%) were intermediate in this respect.

***Summary of differences shown in Table 8***
*Slaney* et al. *list more total stocks for all species but pink.* In all cases the large majority of the stocks listed by Slaney *et al.* and not listed in the present study are rated *Unknown* by Slaney *et al*. These stocks must all be those for which Slaney *et al.* found information outside the SEDS database. I speculate that that many of these listings originate in observations of adults and records of juveniles in the SISS database that do not provide a quantitative basis for establishing a trend in abundance.

*Slaney* et al. *list many more stocks in the* Unthreatened *category for all species.* These differences arise from differences of objectives, methods, dataset and criteria between the 2 studies. The focus of Slaney *et al.* on risk of extinction leads them to correctly classify as *Unthreatened* many stocks that I class as *Of Special Concern*. In addition, many stocks classified *Unthreatened* by Slaney *et al.* show up as *At Moderate Risk* in my scheme due to the differences in definition of the category *Moderate Risk* already discussed. My data screening process puts many stocks in *Unknown* categories that Slaney *et al.* rank as *Unthreatened*. Differences between the actual datasets used in the 2 studies result in a scattering of the *Unthreatened* of Slaney *et al.* across all my categories, including *No Recent Records*.

*Slaney* et al. *rate more stocks at* High Risk. As a result of my data screening, many of Slaney *et al*'s *High Risk* stocks fall into my *Unknown* and *S-2* categories. Others I classify as *Moderate Risk* due to differences between the datasets and also the different definitions we use for the *Moderate Risk* class.

*I rated many more stocks as* Moderate Risk *and* Special Concern. These differences stem from differences in category definitions and criteria and have been discussed above.

*Slaney* et al. *consider 2 coho stocks extinct*. One of these stocks, Kathlyn Creek, probably is in fact extinct as a wild stock. In the 1990s stocking of juvenile coho of the Toboggan Creek stock has restored coho to the system and there is now some natural spawning (M. O'Neill, Toboggan Creek Enhancement Society, Smithers, pers. comm.). I rated this stock S-4 (maintained by enhancement).

The other coho stock rated *Extinct* by Slaney *et al.* is Owen Creek in the Morice system. Initially I ranked this stock *NRR* based on the SEDS database through 1997, which showed no escapement records since 1980. However, spawners were observed in Owen Creek during an aerial survey in 1999 (B. Finnegan, DFO/Pac.Biol.Stn., Nanaimo, pers. comm.). Accordingly, I revised my ranking to *U-N* (adults present, stock status unknown).

It may well be that other stocks have gone extinct in the Skeena system. Certainly there are anecdotal accounts to that effect—for example, Dahlie and Seymour Creeks in the area now occupied by the town of Smithers formerly supported coho (G. Cobb, Smithers, pers. comm.). Extinction of these stocks is plausible, but they are not represented in the SEDS database, and I know of no quantitative documentation of their history, so I have not included them in my analysis. Currently, the Salmonids in the Classroom program of Fisheries and Oceans Canada releases coho fry into Dahlie Creek, and rearing juveniles have been observed there recently (G. Tamblyn, Nadina Community Futures/Houston, pers. comm.).

Some of the stocks listed in the SEDS database may be extinct now. In my rating system they would be included in the *NRR* category. In the absence of a systematic effort to find spawners in more than one year, it seems to me premature to draw a positive conclusion of extinction.

**Significance of Results**

This paper is the first step in a larger program to assess the status of Skeena salmon resources and to review options for future management. The main objective of the present work is to establish a credible system of stock status ratings as a basis for future work dealing with causal factors and management strategies. I present some preliminary analysis of the current stock classifications as a beginning of the longer-term task.

All of the following analysis is based on the subset of stocks that I call *Rated Stocks*. These are the stocks rated *Unthreatened*, *Threatened* and *Of Concern* in the Results section. For this analysis I have excluded other stocks classed as *Unknown* and *No Recent Records* because of the data gaps in records of the excluded group The *Rated Stocks* group includes many fewer stocks than the full array considered to this point; however, it includes most of the escapement data and probably represents most of the actual escapement of each species.

***Stock stability***

In analyzing the mix of stocks and their escapement trends over time, it is important to be clear about what we consider to be a normal or desirable state of stock stability. The simplest definition of stability is *absence of change*, but it is clear that natural populations are always changing. Another approach to the question is to assume that within an array of populations, in this case stocks within a salmon species, during any given time period some will be increasing, some decreasing and some staying more or less at the same level of abundance. We may hypothesize that a stable situation for a salmon species in a large watershed would involve a majority of spawning stocks fluctuating around an average level of abundance with little change over time, while some are on the increase and others are in decline. If the numbers of stocks increasing and decreasing are similar, and especially if most stocks are in the stable range, we may consider that the stock structure of the species as a whole is stable.

Figure 1 shows the proportions of the Rated Stocks of each species that I have classified as Stable, Decreasing and Increasing according to their escapement trend in the DFO record, as defined earlier.

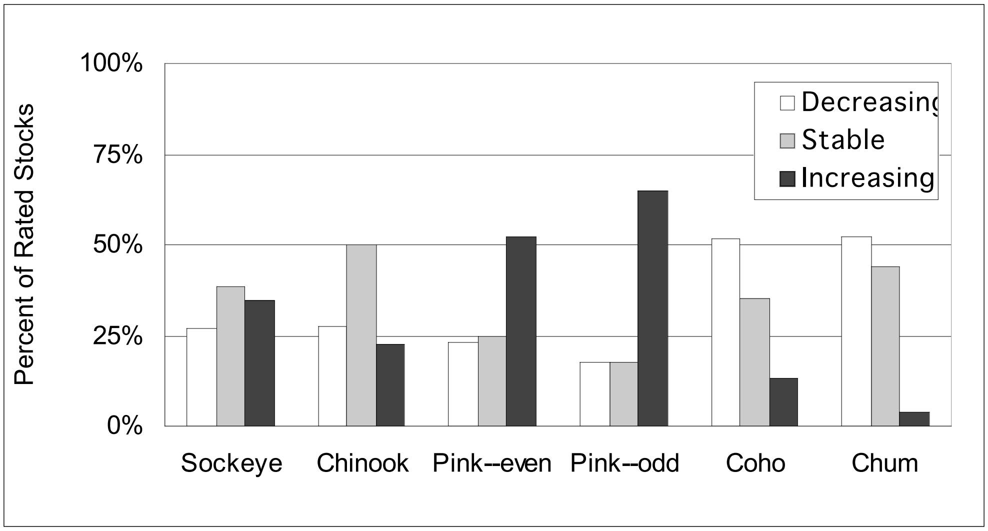


**Figure 1. Percentage of the Rated Stocks of each Skeena salmon species that are stable, increasing and decreasing.** Population trend is assigned according to the ratio of the recent average escapement estimate to the long-term average: a ratio of less than 0.5 indicates decline, 0.5 – 1.5 is defined as stable, and greater than 1.5 is taken as an increasing trend.

Sockeye and chinook display the pattern that I have tentatively characterized as stable at the species level. Both even and odd-year lines of pink salmon show a large excess of increasing over declining stocks. The reverse is true for coho and chums, for which species declining stocks exceed stable ones and few stocks are increasing.

***Status ratings and stock size***

There is a tendency for larger stocks to have healthier status ratings, and for smaller stocks to account for a disproportionate share of the threatened status classes.

Table 9 summarizes this effect for each species. For each species I ranked the Rated Stocks from high to low in order of their average annual escapement over the period of record, 1950-97. I then split the records into upper and lower halves and calculated the percentage that *Unthreatened* stocks made up in each half.

**Table 9. Percentage of Unthreatened stocks in the upper and lower halves of the array of rated stocks of each species, ranked by average escapement 1950-97.**

| Species | Number of Rated Stocks | Percent Unthreatened | |
|---|---|---|---|
| | | Smaller Stocks | Larger Stocks |
| **Sockeye** | 53 | 37% | 92% |
| **Chinook** | 41 | 0% | 55% |
| **Pink--even** | 52 | 38% | 81% |
| **Pink--odd** | 57 | 59% | 96% |
| **Coho** | 91 | 13% | 42% |
| **Chum** | 25 | 8% | 50% |

The disproportion of the *Unthreatened* class among the larger stocks is striking. In part the effect arises directly from the classification methodology, since very small stocks are classed as *Of Concern (S-1)* because of their small average escapement even if they are stable. If I add the small and stable stocks to the *Unthreatened* category for this calculation, the difference in proportion *Unthreatened* between the smaller and larger stocks disappears for chinook, coho and chum salmon, but not for sockeye and pinks.

Thus for sockeye and pink salmon on the Skeena it is correct conclude from our data that the larger stocks appear healthier than the smaller. For the other species the generalization depends on the proposition that small stock size in itself increases the vulnerability of a stock. In either case the data introduce the problem facing managers limited by scarce resources: how much research and management effort is it appropriate to expend on threatened stocks if they are a relatively small component of the run of each species? Another aspect of this dilemma is the situation of fishermen who may be asked to forego harvest of an abundant run of mixed stocks in order to protect threatened stocks that comprise only a small proportion of the available fish.

***Absolute abundance and stock diversity***

Diversity is a critical concept in many aspects of ecology; it is also notoriously difficult to define and measure adequately. A simple measure of diversity is the number of subunits in a larger ecological array: the number of species in an ecological community or the number of subpopulations within a species in a given ecosystem. This is the reason for the focus to this point on simple numbers of stocks within each Skeena salmon species.

A further complexity in understanding diversity is the question of how evenly individuals are distributed among the ecological subunits—among stocks in our case. To the extent that the numbers of an entire species are dominated by members of a few subpopulations or stocks, abundance may be said to be concentrated (as opposed to evenly distributed, which I take as an important aspect of diversity).

As a rough measure of stock diversity as even-ness of distribution of a species' abundance among stocks, I have used a measure that I term $N_{90}$. $N_{90}$ is the minimum number of stocks whose annual escapement average over the period of record comprises 90% of the average escapement of all Rated Stocks combined. If I rank all Rated Stocks of a given species from high to low in order of their average annual escapement, $N_{90}$ is the number of stocks I must list, counting from the top, in order for the sum of their escapements to be as large as 90% of the average of all Rated Stocks. The lower the value of $N_{90}$, the higher is the degree of concentration of escapement and the lower the even-ness component of stock diversity.

Table 10 shows the values of $N_{90}$ for Skeena salmon species.

**Table 10. Degree of concentration of escapement in larger stocks, 1950-97.** $N_{90}$ is the number of the largest stocks necessary to make up 90% of the total average escapement of the species. The smaller the value of $N_{90}$, the greater is the degree of concentration of escapement.

| Species | Number of Rated Stocks | $N_{90}$ | $N_{90}$ as Percent of Number of Rated Stocks |
|---|---|---|---|
| **Sockeye** | 53 | 8 | 15% |
| **Chinook** | 41 | 12 | 29% |
| **Pink--even** | 52 | 8 | 15% |
| **Pink--odd** | 57 | 9 | 16% |
| **Coho** | 91 | 46 | 51% |
| **Chum** | 25 | 11 | 44% |

Table 10 demonstrates that sockeye and pink salmon have their abundance most concentrated in a small number of stocks—15% of the stocks account for 90% of the spawning escapement. The concentration of pink salmon escapement largely reflects the influence of the enormous Lakelse River stock. Sockeye concentration is driven by several strong stocks originating in the Babine Lake system, including the two enhanced stocks at Fulton River and Pinkut Creek, which supported strong stocks even prior to enhancement. Chinook are intermediate in even-ness, and coho and chum abundance is most evenly distributed across stocks.

In our discussion of trends in Skeena salmon stocks it is of interest to map changes in stock structure as well as overall abundance over time. To that end, Table 11 presents a comparison of total escapement and concentration in recent years with the long-term average values for all Rated Stocks.

**Table 11. Species abundance and stock diversity—long-term and recent years.**

| Species | Long-term[a] | | Recent years[b] | |
|---|---|---|---|---|
| | Avg Escapement All Rated Stocks | $N_{90}$ | Avg Escapement All Rated Stocks | $N_{90}$ |
| **Sockeye** | 629,507 | 10 | 1,153,058 | 5 |
| **Chinook** | 39,814 | 12 | 58,318 | 8 |
| **Pink--even** | 908,329 | 7 | 1,513,120 | 7 |
| **Pink--odd** | 1,202,662 | 7 | 2,976,108 | 9 |
| **Coho** | 76,559 | 46 | 42,647 | 36 |
| **Chum** | 20,878 | 11 | 13,848 | 7 |

a. 1950-89 for all species but Pink. 1950/51-1984/85 for Pink.
b. 1990-97 for all species but Pink. 1986/87-1996/97 for Pink.

Table 12 expresses the time trends shown in Table 11 by showing the values for abundance and diversity of the recent period as a percentage of the values for the previous 40 years.

**Table 12. Time trends in species escapement and stock diversity.** Based on Table 11: recent year average escapement of all Rated Stocks and $N_{90}$ as a percentage of long-term values. Time trend values less than 100% indicate a decline in recent years; greater than 100% shows increase.

| Species | **Time Trend** (recent as % long-term) | |
|---|---|---|
| | **Abundance** | **Diversity ($N_{90}$)** |
| **Sockeye** | 183% | 50% |
| **Chinook** | 146% | 67% |
| **Pink--even** | 167% | 100% |
| **Pink--odd** | 247% | 129% |
| **Coho** | 56% | 78% |
| **Chum** | 66% | 64% |

Tables 11 and 12 demonstrate increases in abundance of escapement for sockeye, chinook and both lines of pink salmon. In terms of the even-ness of distribution of escapement, pink salmon are holding their own (even-year) or increasing (odd-year). Sockeye and chinook escapements, on the other hand, are increasingly concentrated; in both species the largest stocks have increased relative to the smaller in recent years.

Our data set shows coho and chum declining both in overall abundance and in diversity. It is noteworthy that these two species of all the Skeena salmon are the least concentrated into a few large stocks. The two species differ importantly, however, in that coho represent the largest number of spawning aggregates (our surrogate for stocks) of any Skeena species, but chum have the fewest.

## CONCLUSIONS

The analysis of stock-by-stock escapement records since 1950 indicates that many stocks of Skeena salmon are substantially less abundant now than in recent history. Limitations of the data set made it impossible to classify all stocks for which records exist. Of those stocks that could be classified under the criteria of this study, I found the following proportions by species to be either at risk of extinction or of some lesser degree of concern:

| | |
|---|---|
| sockeye: | 44%; |
| chinook: | 76%; |
| pink (even-year): | 46%; |
| pink (odd-year): | 24%; |
| coho: | 77%; |
| chum: | 74%. |

Preliminary analysis of the detailed stock classifications supports a number of generalizations:

1. Skeena escapements of pink salmon appear to be increasing in overall abundance, and many more stocks are increasing than are decreasing. Similar trends are apparent for sockeye, but less intensely than for pinks.
2. Chinook escapement is also increasing for the Skeena as a whole, and stock structure appears moderately stable, but rather more spawning stocks are in decline than on the increase.
3. Escapement records of coho and chum salmon show a decreasing trend, and many more stocks are declining than are increasing.
4. The larger spawning stocks of all species appear to be healthier than the smaller ones, and, conversely, extinction threats and other difficulties are concentrated among the smaller stocks. This is especially true of sockeye and pinks.
5. Overall Skeena escapement of each species is concentrated in relatively few spawning aggregates. Sockeye and pink salmon are most concentrated, with about 15% of the stocks accounting for 90% or more of the escapement. Escapement is most evenly distributed among spawning stocks of coho and chum, but escapement of both species is increasingly concentrated in fewer stocks.

With production concentrated in a few relatively large stocks and problems concentrated in smaller ones, there is pressure on fishery managers to focus attention on the larger stocks. While this approach may have merit to a degree and in the short term, there is danger that long-term loss of stock diversity may undermine the entire system. One of the key tasks in salmon management today is to find the balance between management for short-term production on the one hand, and protection and enhancement of stock diversity to ensure long-term viability of the resources and the fisheries on the other.

This paper is one step in a program to assess the current state of Skeena system salmon resources and to explore alternative solutions to existing problems. The next step will be to extend the stock status analysis to include summer steelhead stocks. In the final phase of the project, I will review the history of the fisheries on Skeena salmon stocks, fisheries management and possible habitat impacts. I will seek to relate that history to the current state of the stocks. The ultimate goal will be to provide a set of options for management of the salmon along with projected consequences for salmon and steelhead stocks, their habitats and the fisheries and communities that utilize them.

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# APPENDICES

1. Salmon stock status ratings by locality and species.

2. Maps of distribution of stocks and their status for sockeye, chinook,coho and chum salmon.

3. List of people who contributed stock status information in community meetings and interviews.

# APPENDIX 1

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# APPENDIX 2

## Maps of distribution and status of Skeena sockeye, chinook, coho and chum salmon stocks.

These maps are not included with electronic copies of this report nor with all printed copies.

The maps can be purchased from

Northwest Institute for Bioregional Research,
Box 2781, Smithers, BC, Canada V0J 2NO.
Telephone: 250-847-9693.
E-mail: pmossnwi@bulkley.net

# APPENDIX 3

## People who contributed information used in determining stock status.

| | |
|---|---|
| Dana Atagi | MELP, Fisheries Branch, Smithers |
| Ron Austin | Wet'suwet'en Fish and Wildlife, Moricetown |
| Ian Bergsma | Terrace Salmonid Enhancement Society |
| Bill Blackwater Jr | Kispiox Hatchery |
| Rod Bolton | Kitsumkalum First Nation |
| Dave Bustard | D Bustard and Associates, Smithers |
| Gil Cobb | Smithers |
| Pierce Clegg | Bulkley Valley Guides, Smithers |
| Mark Cleveland | Gitanyow Fisheries Authorities |
| Chris Culp | Terrace Salmonid Enhancement Society |
| Jim Culp | Terrace Salmonid Enhancement Society |
| Rob Dams | Terrace Salmonid Enhancement Society |
| Larry Derrick | Kitsumkalum First Nation |
| Brenda Donas | DFO, Community Advisor, Smithers |
| Barry Drees | Prince Rupert Salmonid Enhancement Society |
| Kolbjorn Eide | Terrace |
| Barry Finnegan | DFO, Pacific Biological Station, Nanaimo |
| Angus Glass | Nadina Community Futures Development Corp, Houston |
| Robert Good | Gitanyow First Nation |
| Allen Gottesfeld | Gitksan Watershed Authorities, Hazelton |
| Noel Gyger | Northwest Fishing Guides, Terrace |
| Rod Harris | Gitksan Watershed Authorities, Hazelton |
| Dave Hooper | Guide, Smithers |
| Les Jantz | DFO, Prince Rupert |
| Walter Joseph | Wet'suwet'en Fish and Wildlife, Moricetown |
| Art Loring Jr | Lax Skiik Landscape Research, Kitwanga |
| Donna Macintyre | Ned'u'ten Fisheries. Burns Lake |
| Scott Mackay | Nadina Community Futures Development Corp, Houston |
| Al McCracken | Nadina Community Futures Development Corp, Houston |
| Brian Michell | Wet'suwet'en Fish and Wildlife, Moricetown |
| Charlie Muldon | Gitksan Watershed Authorities, Hazelton |
| Tod Nelson | Kitsumkalum First Nation |
| Mike O'Neill | Toboggan Creek Salmon and Steelhead Enhancement Society, Smithers |
| Dave Peacock | DFO, Prince Rupert |
| Barry Peters | DFO, Community Advisor, Terrace |
| Bart Proctor | Oona River Community Association |
| Lars Reese-Hansen | Northwest Watershed Contracting and Consulting, Terrace |

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| Dawn Remington | Remington Environmental, Smithers |
| Don Roberts | Kitsumkalum First Nation |
| Jim Roberts | Kitsumkalum Hatchery |
| David Rolston | Oona River Community Association |
| Stefan Schug | Wet'suwet'en Fish and Wildlife, Moricetown |
| David Silver | Hazelton |
| David Taft | Terrace Salmonid Enhancement Society |
| Wolfgang Voelker | Guide, Terrace |
| Gordon Wadley | Nortec Consulting, Smithers |