Status of Wild Sockeye Stocks of the Babine Watershed

Prepared for SkeenaWild Conservation Trust
by Michael Price - November, 2011

Summary

• Several wild Babine sockeye stocks have been identified as a growing conservation concern. This report examines the historical trends and current status of wild Babine sockeye returning to the Babine watershed in order to assess the overall health of populations.

• DFO's Salmon Escapement Database System was used to assess escapement trends for all identified wild sockeye stocks that spawned in the Babine watershed between 1950 and 2010.

• Status classification for each stock was based on a combination of the average number of spawners between 1950 and 1999 (historic), and the average escapement between 2000 and 2010 (recent); escapement trends were calculated as the ratio of the arithmetic mean of all records during 2000-2010 to 1950-1999 records.

• A total of 29 wild sockeye populations show spawning records in the Babine watershed.

• Between 1950-2010, only 1 stock has been consistently monitored; 10 have been enumerated more than 50 years, and 7 were enumerated less than 10 years.

• Monitoring effort for Babine sockeye declined during the 1990s, and has yet to rebound to historic levels.

• Combined spawner numbers for all stocks range from a low of 40,750 (1955) to a high of 740,805 (2001), with a historic average annual return of 270,658 spawners (1950-1999).

• Combined escapement has decreased 18% compared with historic data. Specifically, 9 of the previous 11 years were below the historic average, including the 6 most recent years (2005-2010).

• Escapement trends for individual stocks show 17% are decreasing, 17% are stable, 28% are increasing, and 38% are of an unknown status due to insufficient data.

• The classification of individual stocks show 7 of 29 populations are either threatened with extinction or of concern, 10 stocks are unknown, and 12 are considered not threatened.

• Boucher Creek and Nichyeskwa Creek are at *high extinction risk*; Pendleton Creek and Wright Creek are at *moderate extinction risk*.

• The return of wild-origin sockeye to the Babine watershed in 2010 (n = 80,208 spawners) shows a 95-97% decline compared with estimated historic annual returns of 1.7-2.9 million at the height of the commercial fishery.

Introduction

This report was commissioned by SkeenaWild Conservation Trust to examine historical trends and current status of wild sockeye salmon (*Oncorhynchus nerka*) stocks returning to the Babine watershed. Several wild Babine sockeye stocks have been identified recently as a growing conservation concern. The primary objective was to assess the overall health of wild Babine sockeye, and identify any specific populations that are currently in decline. No alternative report exists.

Methods

I assessed escapement trends for all identified wild sockeye stocks that spawned in the Babine watershed between 1950 and 2010 using DFO's Salmon Escapement Database System (NuSEDS; DFO 2011). The accuracy of estimates contained within these databases has been questioned by some (e.g., Irvine and Nelson 1995), and it is important to understand the inherent variability of these records due to inconsistency between observers, inaccessibility to spawning grounds for observers, changes in spawning times relative to the presence and timing of observers, etc. However, no alternative or complimentary data are available. Additionally, many enumeration records within NuSEDS include 'none observed' (i.e., stream inspected, but species was not observed), for a given stock in a given year. Although some of these records could mean that spawners occurred in a given year but were not observed during stream enumeration, these data were considered as 0 spawners. As a test of the influence these particular records may have on spawner abundance averages, I ran subsequent analyses with all 'none observed' data omitted; not surprising, the results for the wild Babine aggregate remained unchanged, with some individual stocks showing both slightly higher historic and recent returns. Thus, with the precautionary principle in mind, all final analyses were performed with the conversion of 'none observed' data to 0. Revisions to the 2010 data are subject to a final review, and changes are possible.

I classified the current status of each sockeye stock using methods similar to Morrell (2000), which was largely based on work by Nehlsen et al. (1991), Slaney et al. (1996), and Baker et al. (1996; Table 1). I based the status classification for each stock on a combination of the average number of spawners between 1950 and 1999 (historic), and the average escapement between 2000 and 2010 (recent). Admittedly, there is vulnerability in this method. As such, the classifications of 2 stocks are singled-out in the Discussion section. I calculated the escapement trend as the ratio of the arithmetic mean of all records during 2000-2010 to 1950-1999 records; thus, Escapement Trend (*ET*) = Mean Escapement 2000-2010 ÷ Mean Escapement 1950-1999. If $ET \geq 1.0$, recent escapement estimates are at least as large as historical records. Similar to Baker et al. (1996), the *ET* classes are as follows:

$ET > 1.5$: ***Population Increasing***
$ET < 1.5$ and ≥ 0.5: ***Population Stable***
$ET < 0.5$: ***Population In Decline***
$ET < 0.2$: ***Population In Precipitous Decline***

Before classifying stocks for Escapement Trend, I first filtered stocks with insufficient records to draw a reliable conclusion about status. The three categories include:

1. ***UnK***: *Unknown* - fewer than 3 annual historical records of spawners (1950-1999).

2. ***NRR***: *No recent records* - more than 3 annual records, but no recorded escapement since 2000. This category may include stocks that have gone extinct since 1950. It may also include healthy stocks that have not been monitored in the 2000s.

3. ***UnK-St***: *Unknown status* - less than 40% enumeration records since 2000.

Stocks classified with *Unknown status* may have been further classified:
S: *Special concern* - insufficient recent information to determine status, but available evidence suggests depletion (i.e., $ET < 0.5$).

Stocks with sufficient data for escapement trends were classified as follows:
Stable and increasing (ET ≥ 0.5)
L: *Low risk of extinction* - Mean escapement 2000-2010 (M_{2000s}) $\geq$ 200.
S-1: *Special concern*, historically small stock now stable - $M_{2000s} < 200$.

Stocks in decline (ET between 0.2 and 0.5)
M: *Moderate risk of extinction* - $M_{2000s} \leq 1{,}000$. [Stocks in this *ET* range with $M_{2000s} < 50$ were classed as ***H***, *High risk of extinction*.]
S-2: *Special concern*, historically large now depleted - $M_{2000s} > 1{,}000$.

Stocks in precipitous decline (ET < 0.2)
H: *High risk of extinction* - Mean escapement $M_{2000s} < 200$.
M: *Moderate risk* - M_{2000s} between 200 and 1,000.
S-2: *Special concern*, historically large now depleted - $M_{2000s} > 1{,}000$.

Table 1. Summary of stock status classifications.

Category	Code	Description
Unthreatened	***L***	Low risk of extinction
Of some concern	***S***	Insufficient data, but available information suggests declining trend
	S-1	Small stock - stable
	S-2	Historically large stock - depleted, but not at immediate risk of extinction
Threatened	***H***	At high risk of extinction
	M	At moderate risk of extinction
Status unknown	***UnK***	Insufficient historical data
	NRR	No recent records - may be extinct
	UnK-St	Insufficient recent data

Results

Twenty-nine wild sockeye populations have spawning records within the Babine watershed. Out of the 61 years of escapement data recorded since 1950, only 1 stock has been consistently monitored and counted for abundance every year (Babine River section 1-3); 10 populations have been enumerated more than 50 years, and 7 populations were enumerated less than 10 years, including Babine Lake and Hazelwood Creek, both enumerated once. Monitoring effort for Babine sockeye declined during the 1990s, and has yet to rebound to historic levels (Table 2).

Table 2. Total enumeration records per decade for wild sockeye stocks spawning in the Babine watershed; 2000s is 2000-2009.

1950s	1960s	1970s	1980s	1990s	2000s
160	171	172	166	154	156

Escapement trends

Combined spawner numbers for all sockeye stocks returning to the Babine watershed range from a low of 40,750 (1955) to a high of 740,730 (2001), with a historic average annual return of 270,658 spawners. The combined escapement of all Babine sockeye stocks has decreased 18% compared with historic records (Figure 1). Specifically, 9 of the previous 11 years were below the historic average, including the 6 most recent years (2005-2010; Figure 2) with an average of 125,933 spawners.

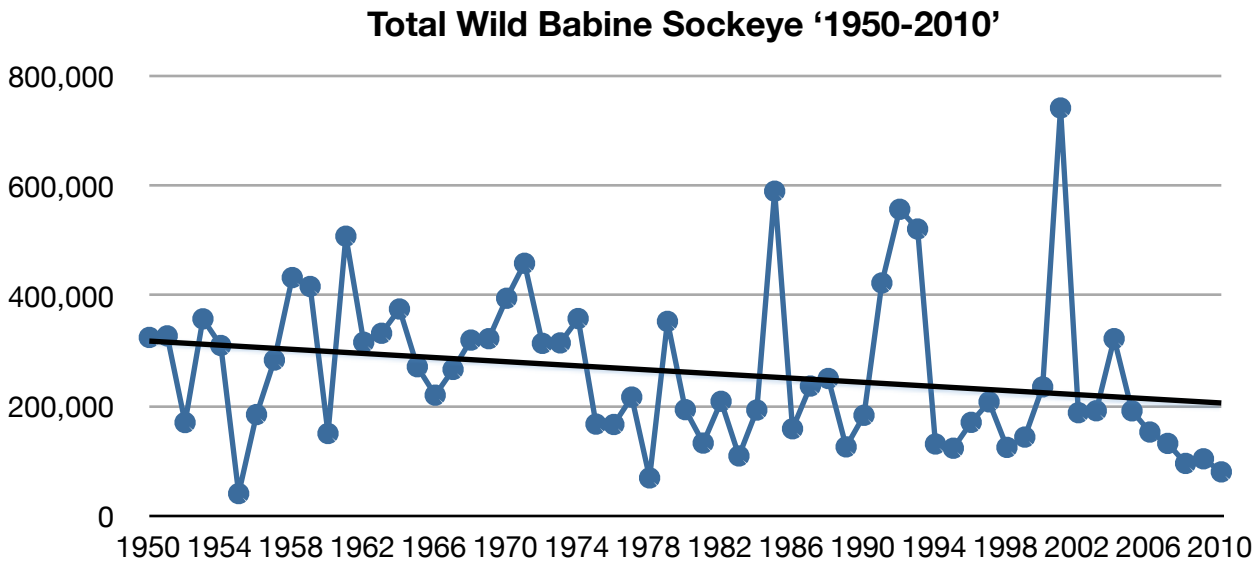


Figure 1. Combined escapement records for all wild sockeye stocks spawning in the Babine watershed between 1950 and 2010.

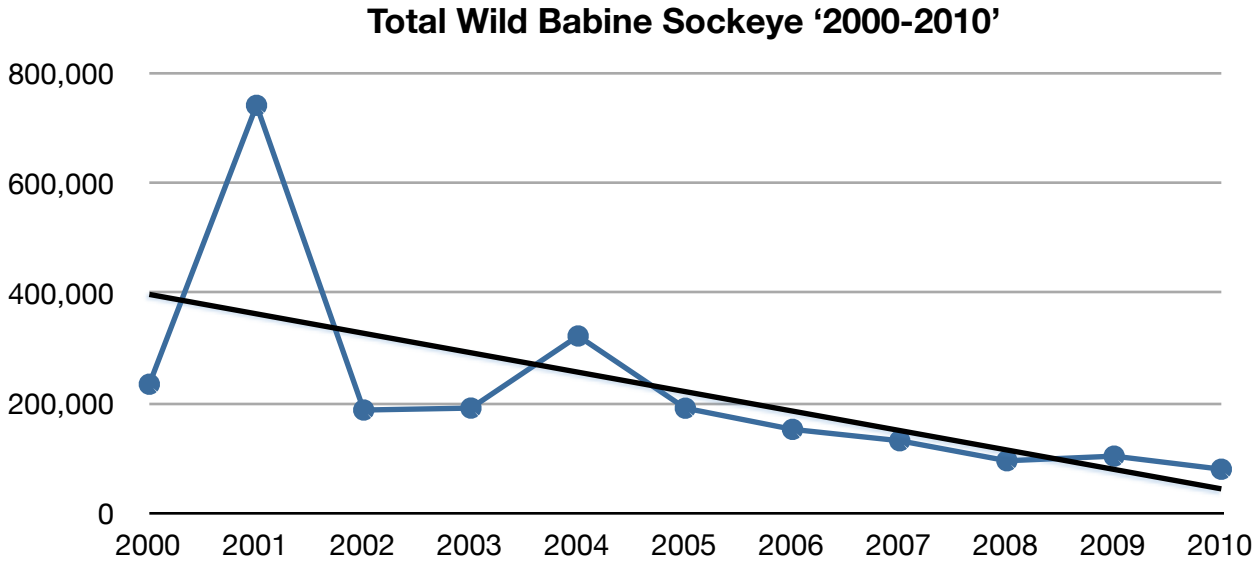


Figure 2. Combined escapement records for all wild sockeye stocks spawning in the Babine watershed between 2000 and 2010.

Stock status and extinction risk

Despite the most recent declines, the escapement trend for the combined returns of sockeye to the Babine over the most recent decade is considered stable. Escapement trends for individual stocks show 17% are in decline, 17% are stable, 28% are increasing, and 38% are of an unknown status due to insufficient data (Figure 3). Using criteria described in the Methods section, the classification of individual stocks show 7 stocks are either threatened with extinction or of concern, 10 stocks are unknown, and 12 of 29 populations are not considered threatened (Figure 4). Four populations are either at high or moderate risk of extinction (Boucher Creek, Nichyeskwa Creek, Pendleton Creek, and Wright Creek; Table 4).

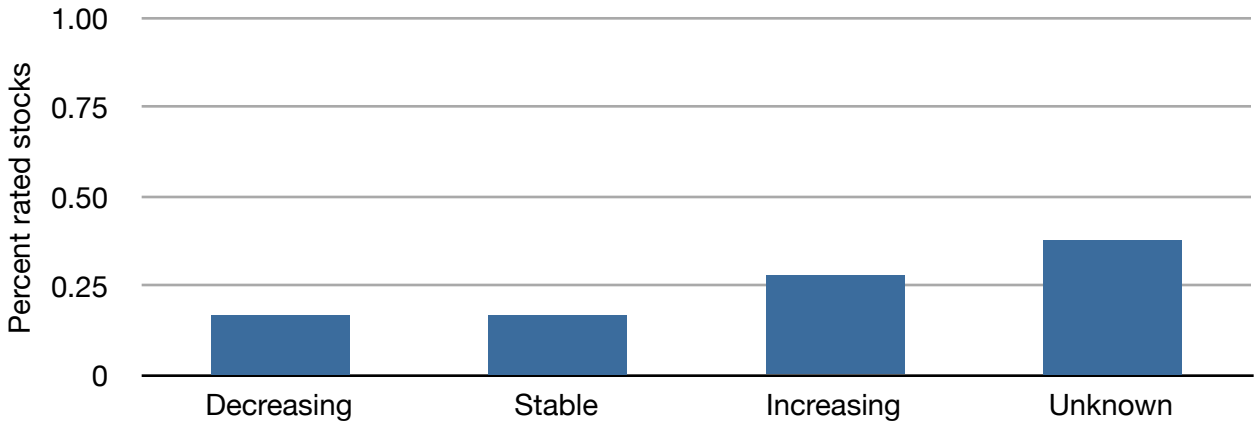


Figure 3. Current status ratings of wild sockeye stocks spawning in the Babine watershed.

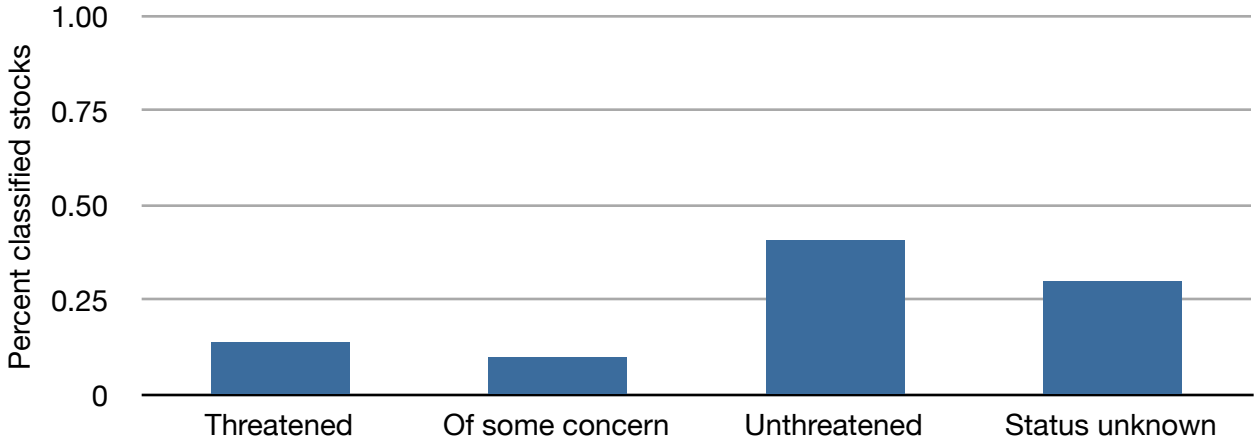


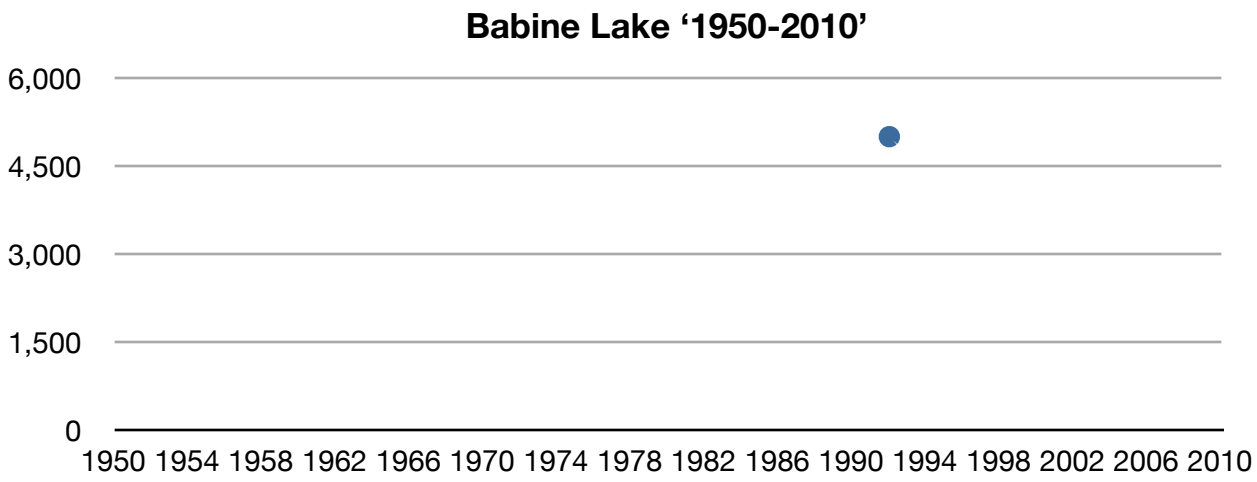
Figure 4. Classifications of wild sockeye stocks spawning in the Babine watershed.

Table 4. Historic and recent average escapement records, current status, and extinction risk for wild sockeye stocks that spawn in the Babine watershed; * indicates an unknown escapement record.

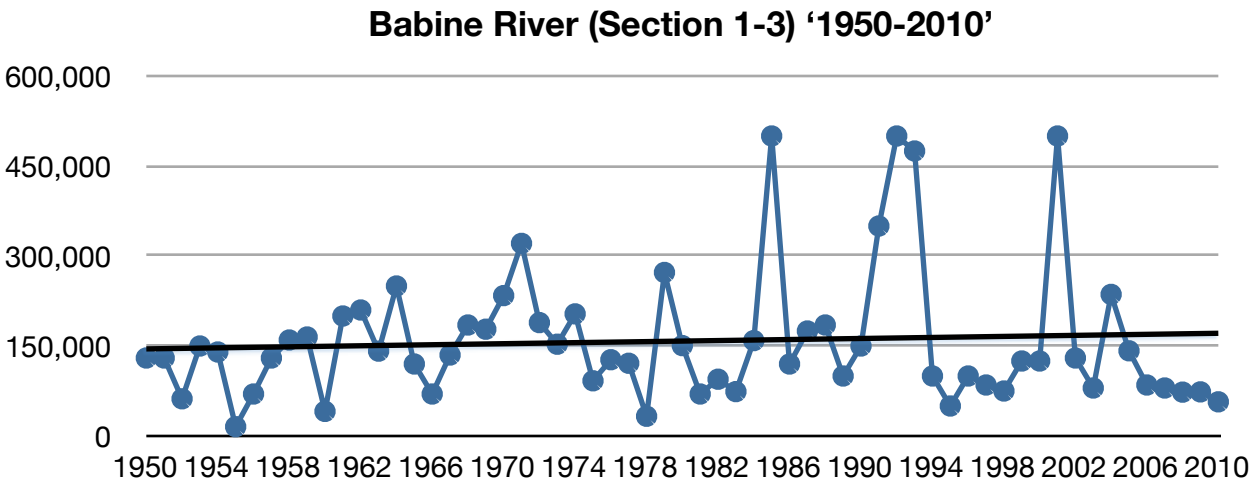
Population	Historic average (1950-1999)	Recent average (2000-2010)	Status	Extinction risk
Babine Lake	5,000	*	Unknown	***UnK***
Babine River - Section 1-3 (upper BR [Rainbow Alley] to Smokehouse island)	161,352	143,780	Stable	***L***
Babine River - Section 4 (Nilkitkwa Lake outlet to counting fence)	49,411	12,943	Decline	***S-2***
Babine River - Section 5 (below counting fence)	1,063	*	Unknown	***NRR***
Bern-Ann Creek	365	541	Unknown	***UnK***
Boucher Creek	298	31	Decline	***H***
Donalds Creek	107	*	Unknown	***UnK-St***
Five Mile Creek	196	624	Increasing	***L***
Forks Creek	86	*	Unknown	***NRR***
Four Mile Creek	4,073	6,398	Increasing	***L***
Hazelwood Creek	50	*	Unknown	***UnK***
Kew Creek	32	*	Unknown	***NRR***
Lower Tahlo Creek	5,727	7,032	Stable	***L***
Morrison Creek	10,214	20,850	Increasing	***L***
Nichyeskwa Creek	582	0	Decline	***H***
Nilkitkwa River	111	106	Stable	***S-1***
Nine Mile Creek	1,109	2,641	Increasing	***L***
Pendleton Creek (Cross Creek)	817	253	Decline	***M***
Pierre Creek	20,583	20,439	Stable	***L***
Shass Creek	6,570	*	Unknown	***NRR***
Six Mile Creek (Gullwing Creek)	1,052	2,339	Increasing	***L***
Sockeye Creek	1,499	4,494	Increasing	***L***
Sutherland River	295	*	Unknown	***NRR***
Tachek Creek	1,669	3,439	Increasing	***L***
Telzato Creek	363	*	Unknown	***UnK-St***
Tsezakwa Creek	134	1,121	Increasing	***L***
Twain Creek	9,593	7,701	Stable	***L***
Upper Tahlo Creek	333	*	Unknown	***S***
Wright Creek	270	75	Decline	***M***
Wild Babine sockeye aggregate	**270,658**	**221,252**	**Stable**	***L***

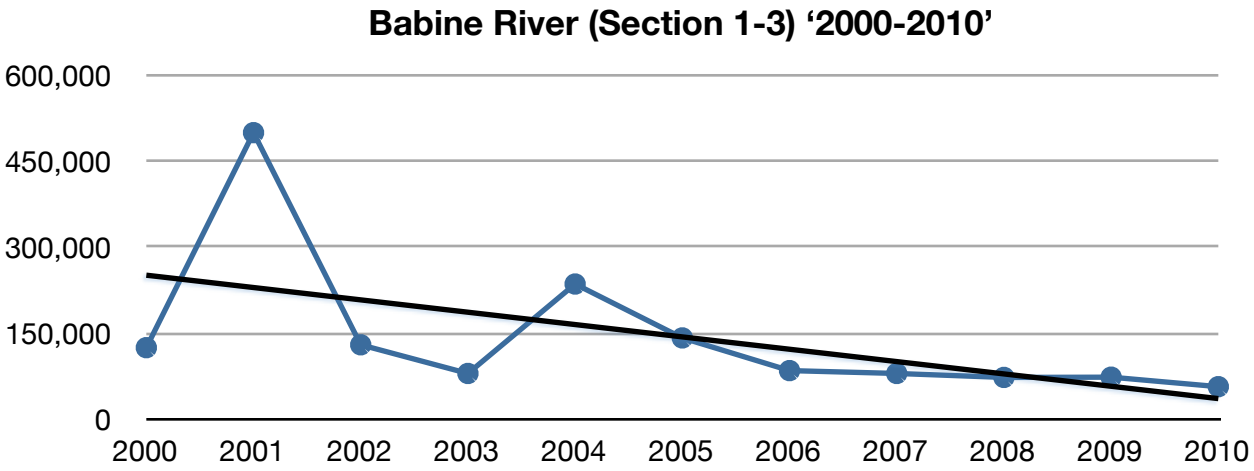
Stock specific trends, status, and classification
The following is a detailed description of escapement trends, current status, and classifications for each sockeye population listed above:

Babine Lake
Enumerated once (1992), with a spawning population of an estimated 5,000. The status of this population is unknown (**too few historic records**).

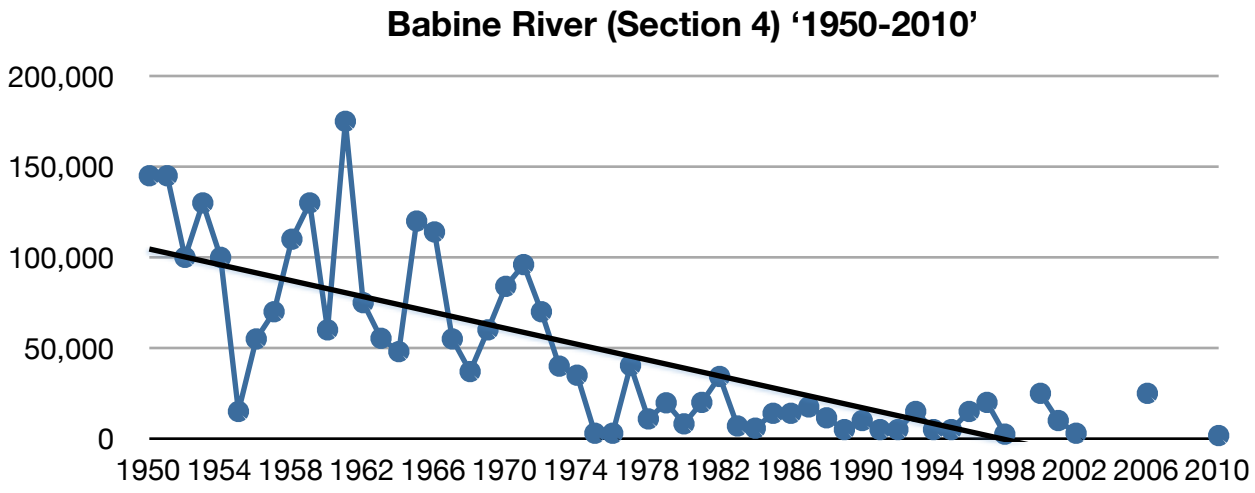


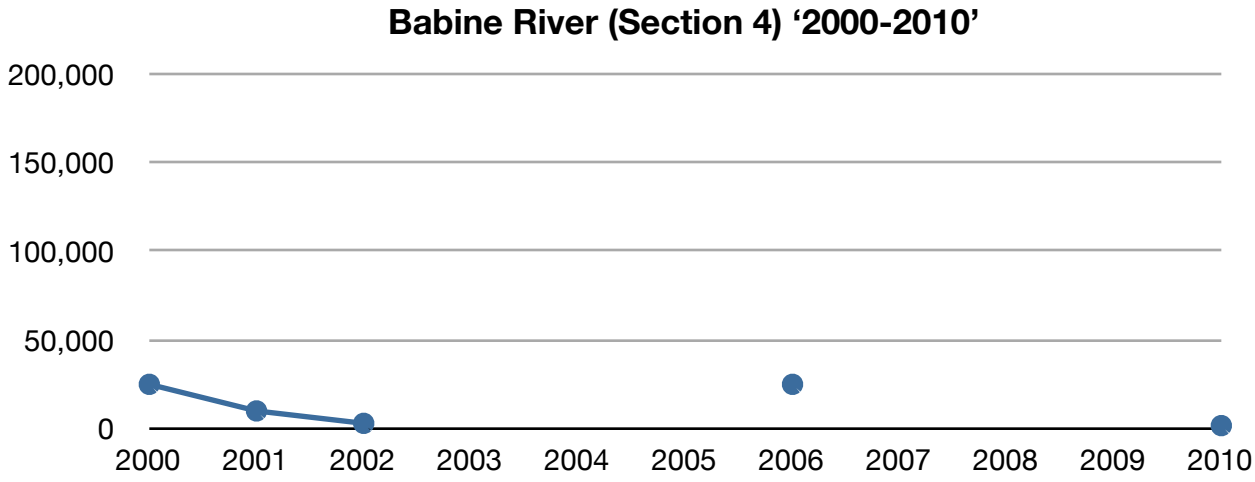
Babine River - Section 1-3 (Upper BR [Rainbow Alley] to Smokehouse Island)
Spawner numbers range from a low of 15,500 (1955) to a high of 500,000 (1985), with a historic average annual return of 161,352 spawners. Nine of the previous 11 years (2000-2010) were below the historic average, including the last 6 years. *ET* = 0.89 (**population stable; *Low extinction risk***).



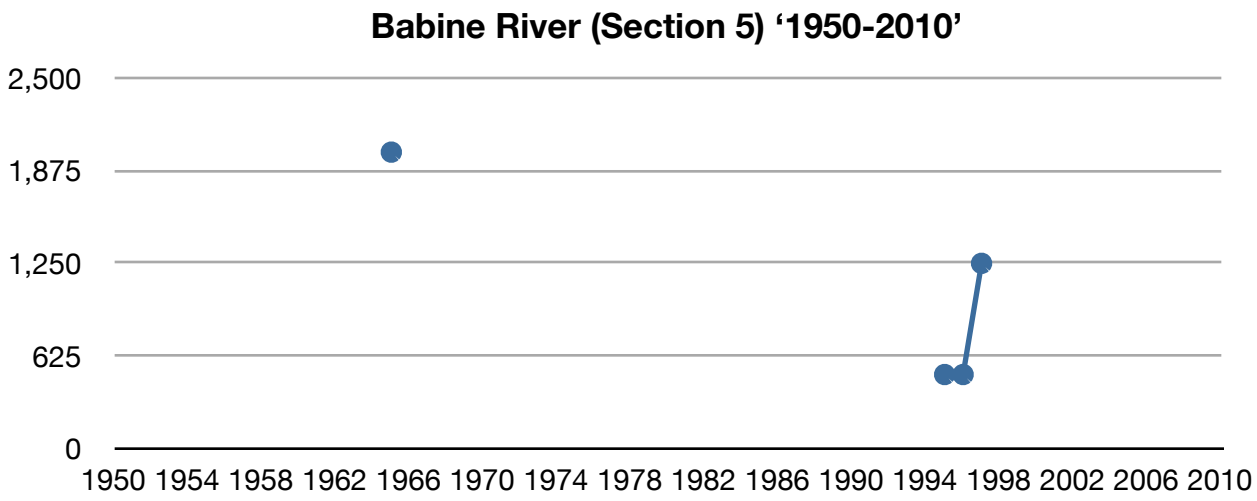


Babine River - Section 4 (Nilkitkwa Lake outlet to counting fence)
Spawner numbers range from a high of 175,000 (1961) to a low of 1,714 (2010), with a historic average annual return of 49,411 spawners. Every spawner count in the recent decade was below the historic average; adults were observed in 2007 and 2008. *ET* = 0.26 (**population in decline; *Special concern***).



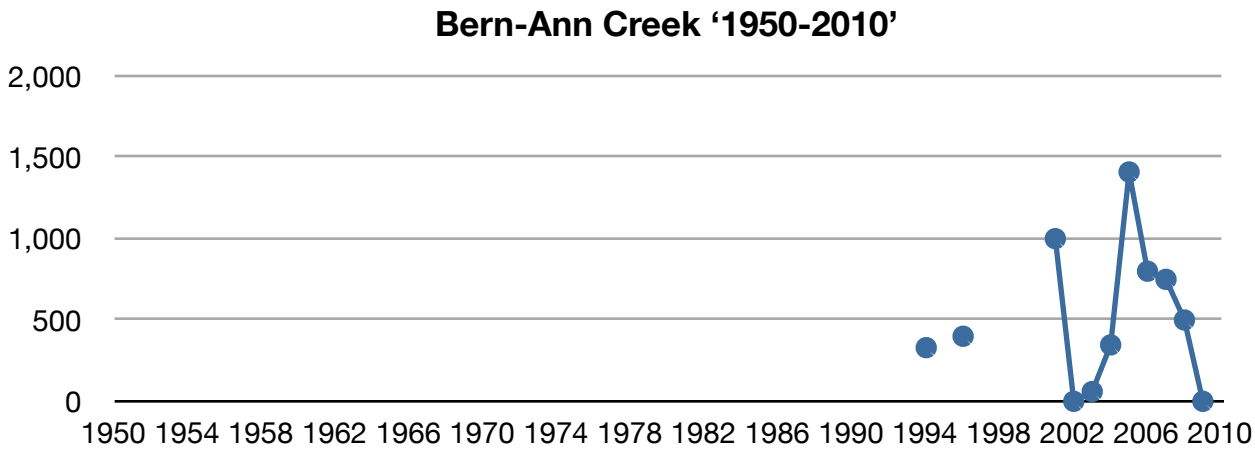


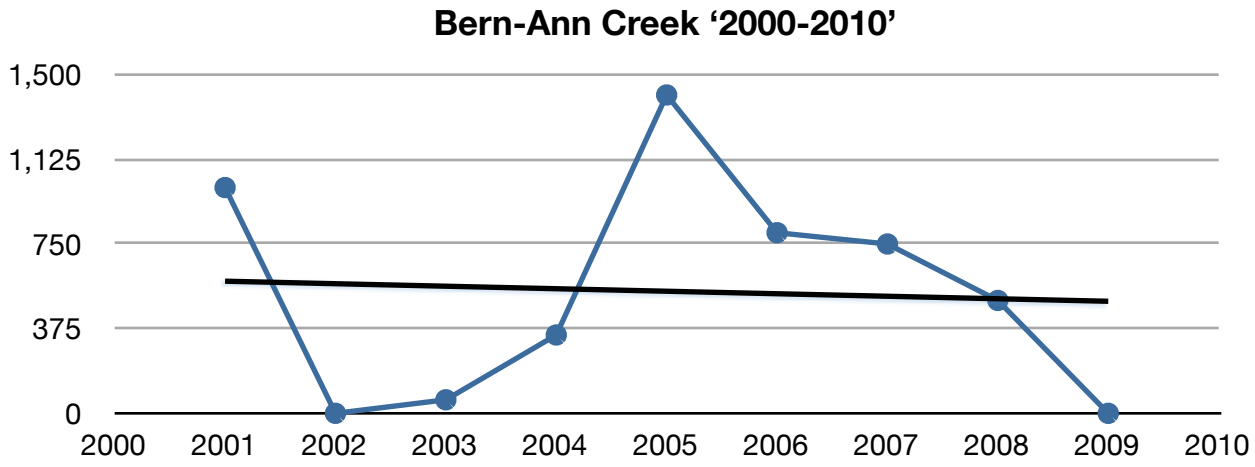
Babine River - Section 5 (below counting fence)
Spawner numbers range from a high of 2,000 (1965) to a low of 500 (1996), with a historic average annual return of 1,063 spawners. This population has been enumerated 4 times in 61 years. Monitoring effort has improved in the 2000s, with the presence of spawners recorded in 9 of the most recent 10 years; however, no estimates have been obtained. The status of this population is unknown (**no recent records**).



Bern-Ann Creek

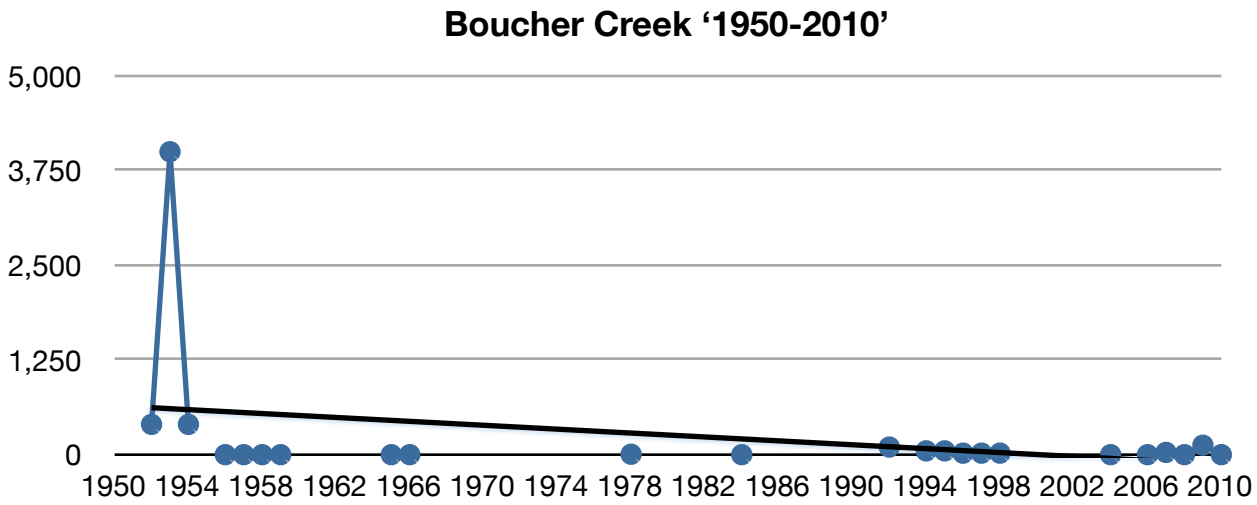
Spawner numbers range from a high of 1,410 (2005) to a low of 0 (2009), with a historic average annual return of 365 spawners based on 2 escapement records. Monitoring effort has improved in the 2000s with a recent spawner average of 541. The status of this population is unknown (**too few historic records**).

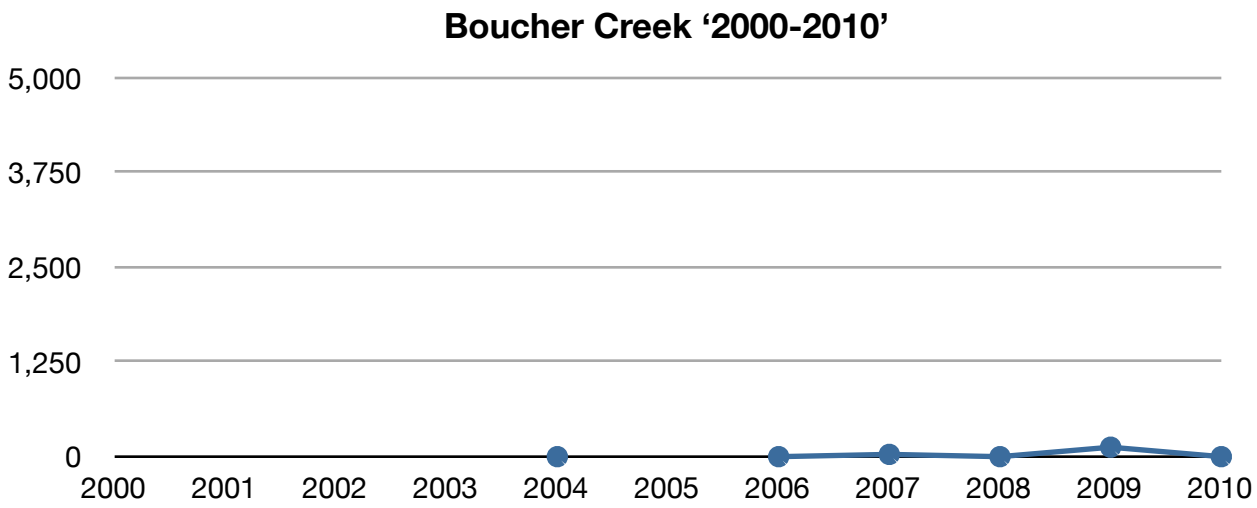




Boucher Creek

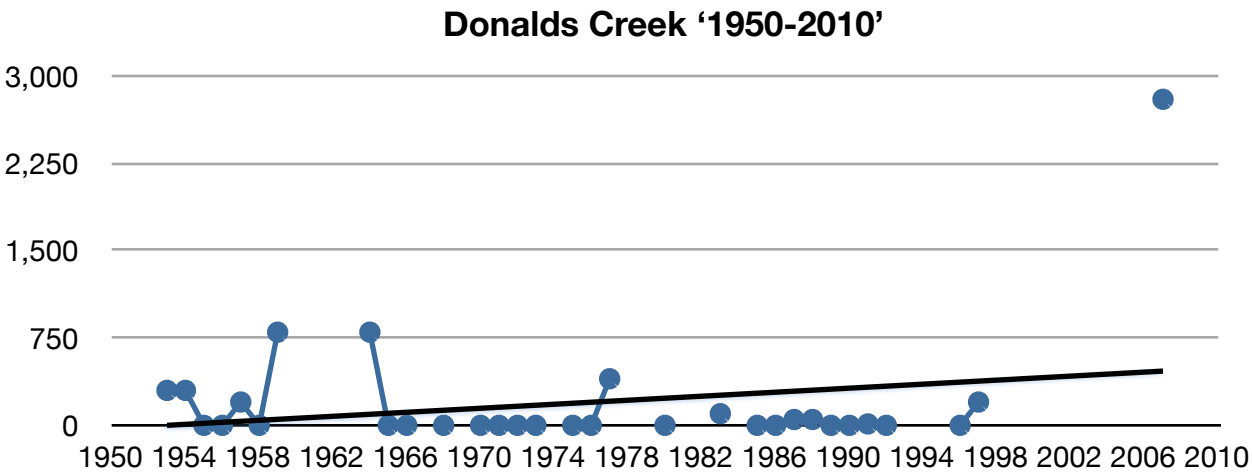
Spawner numbers range from a high of 4,000 (1953) to a low of zero (2010), with a historic average annual return of 298 spawners. Zero spawners were counted in 4 of the most recent 11 years. *ET* = 0.09 (**population in precipitous decline; *High extinction risk***).

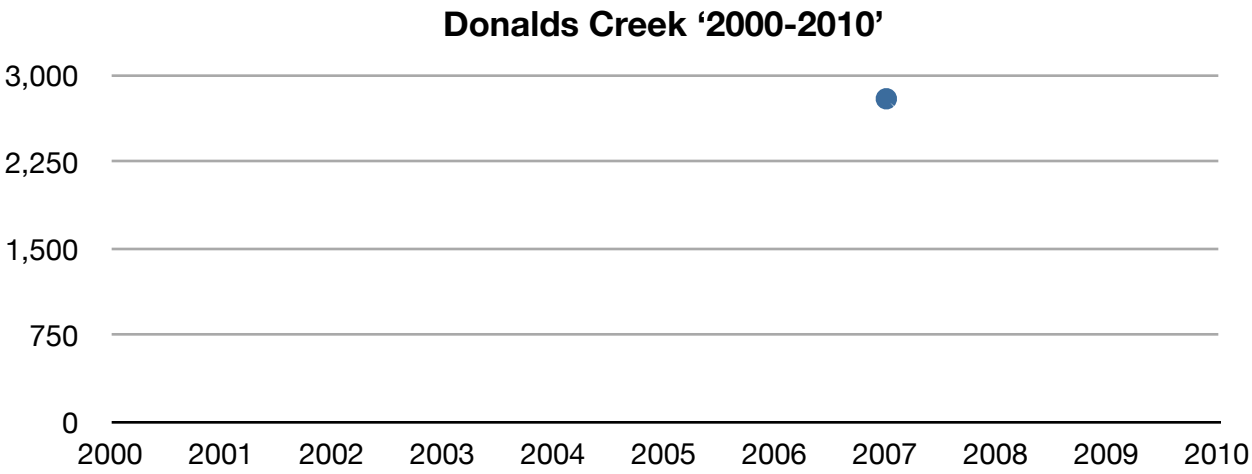




Donalds Creek

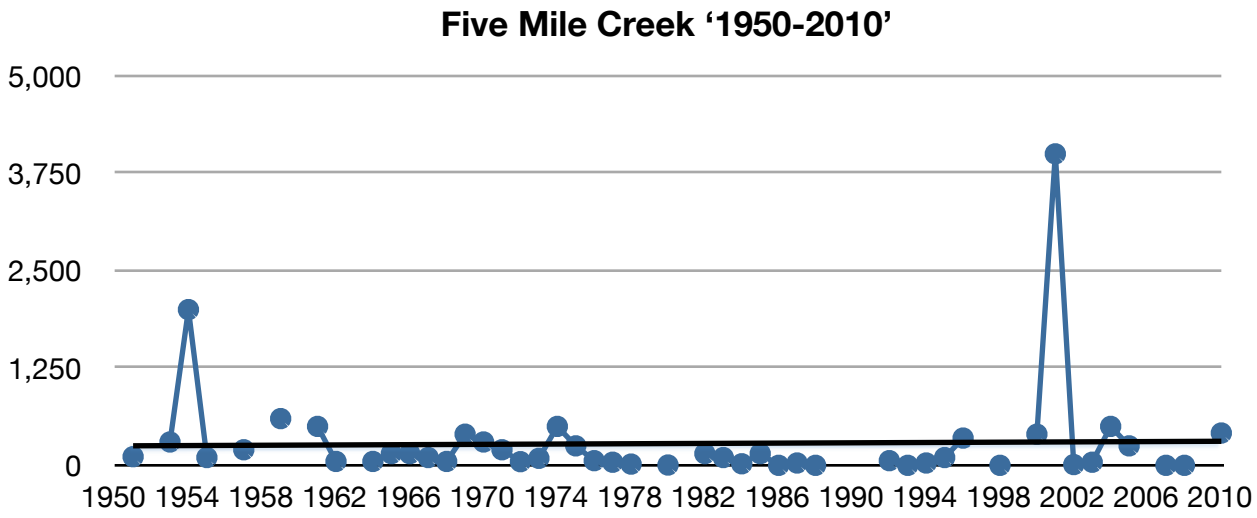
Spawner numbers range from a low of 0 (1996) to a high of 2,800 (2007), with a historic average annual return of 107 spawners. Monitoring effort has been limited to a single enumeration record in the 2000s. The status of this population is unknown (**too few recent records**).

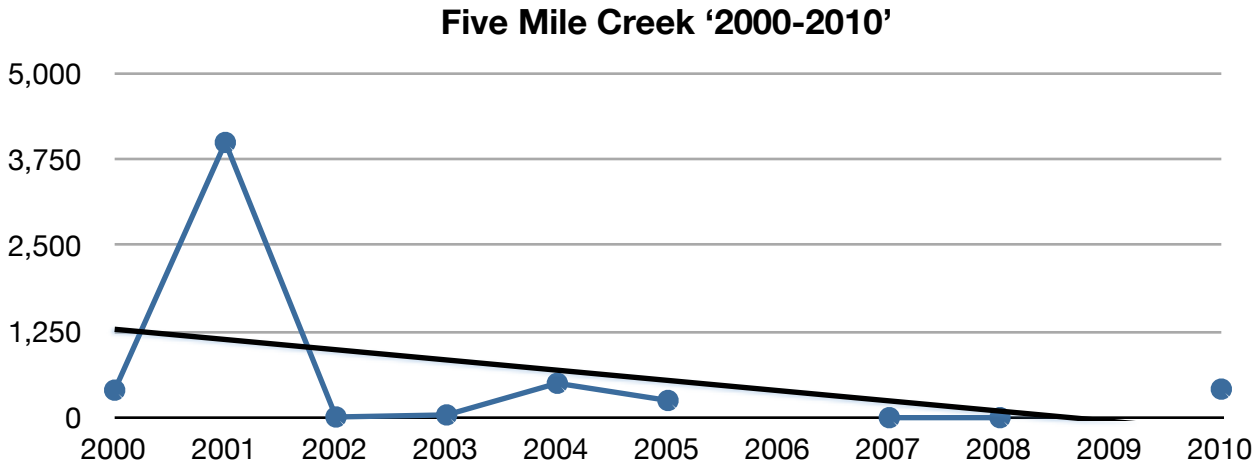




Five Mile Creek

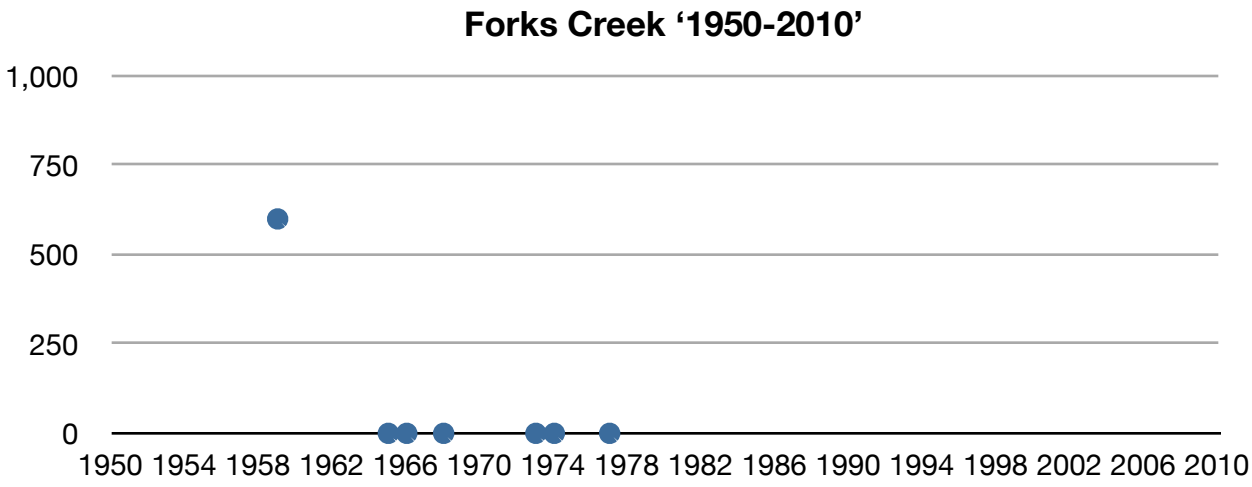
Spawner numbers range from a high of 4,000 (2001) to a low of 0 (2008), with a historic average annual return of 196 spawners. Zero spawners were counted in 2 of 11 most recent years. *ET* = 3.18 (**population increasing; *Low extinction risk***).





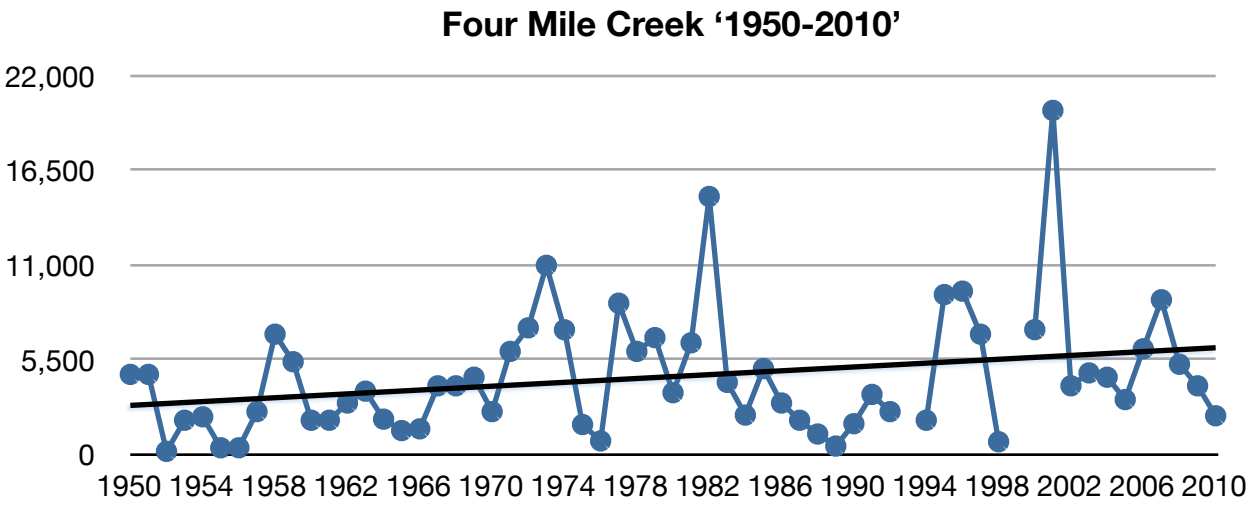
Forks Creek

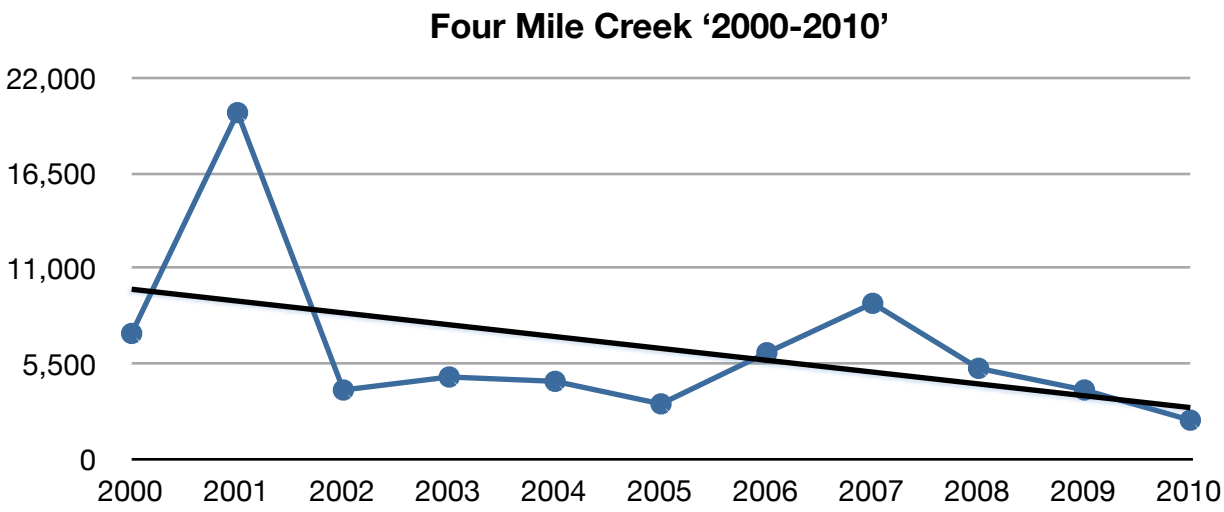
Spawner numbers range from a high of 600 (1959) to a low of 0 (1977), with a historic average annual return of 86 spawners; the 6 most recent records show a count of 0. Monitoring effort has been poor for this population (7 records), with no monitoring effort in the most recent decade. The status of this population is unknown (**no recent records**).



Four Mile Creek

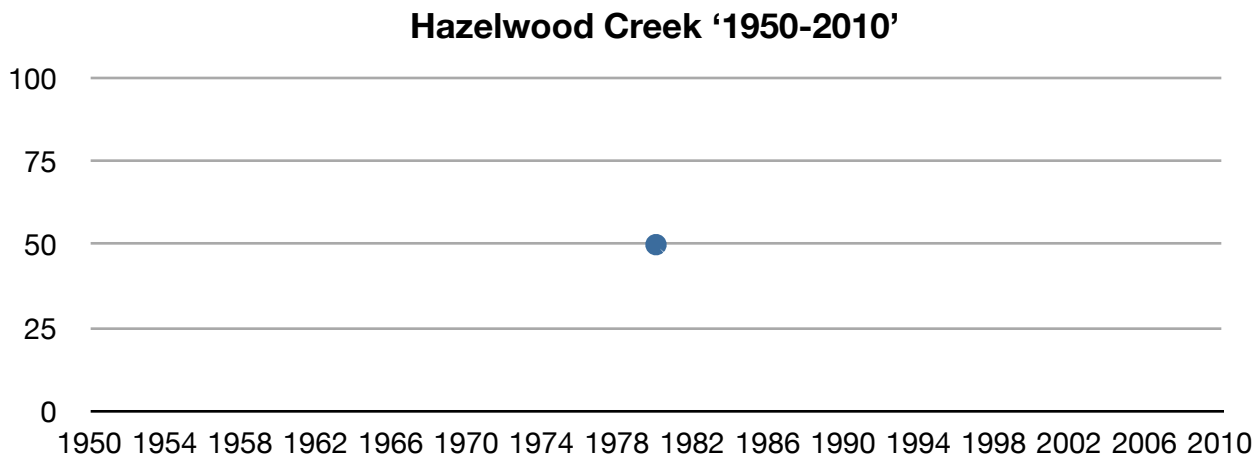
Spawner numbers range from a low of 192 (1952) to a high of 20,000 (2001), with a historic average annual return of 4,073. Eight of 11 most recent spawner records were above the historic average. *ET* = 1.57 (**population increasing; *Low extinction risk***).





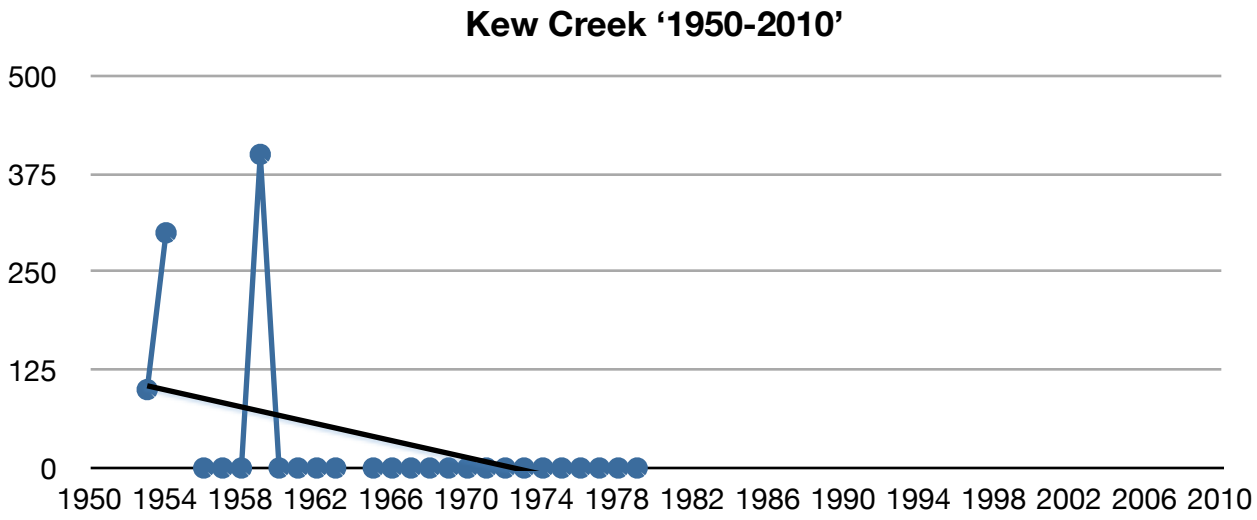
Hazelwood Creek

Enumerated once (1980), with a spawning population of an estimated 50. The status of this population is unknown (**too few historic records, and no recent records**).



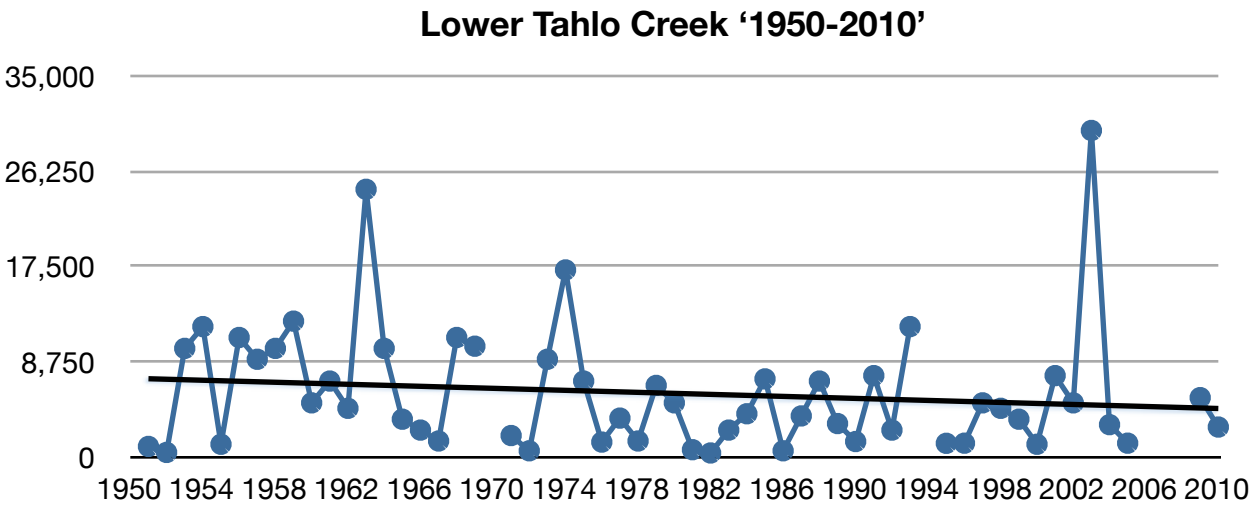
Kew Creek

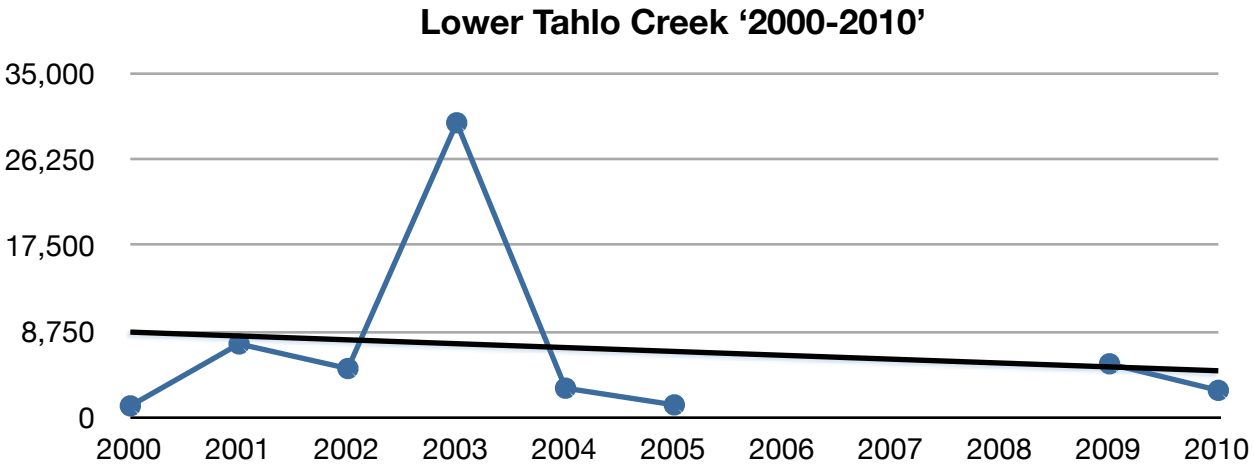
Spawner numbers range from a high of 400 (1959) to a low of 0 (1979), with a historic average annual return of 32. The previous 19 spawner records showed 0. The status of this population is unknown (**no recent records**).



Lower Tahlo Creek

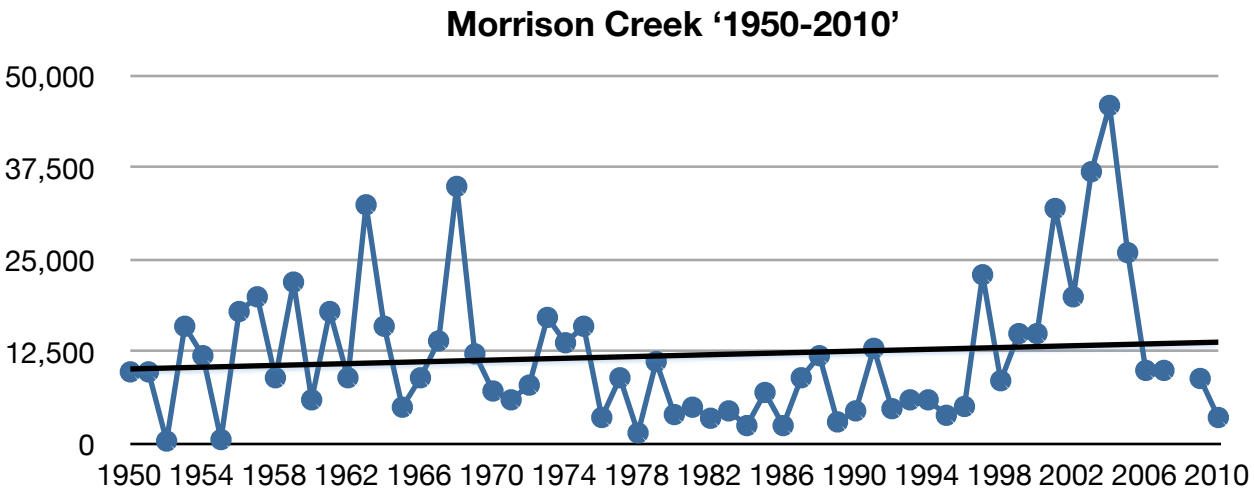
Spawner numbers range from a low of 400 (1982) to a high of 30,000 (2003), with a historic average annual return of 5,727 spawners. Six of the previous 8 spawner counts were below the historic average. *ET* = 1.23 (**population stable; *Low extinction risk***).

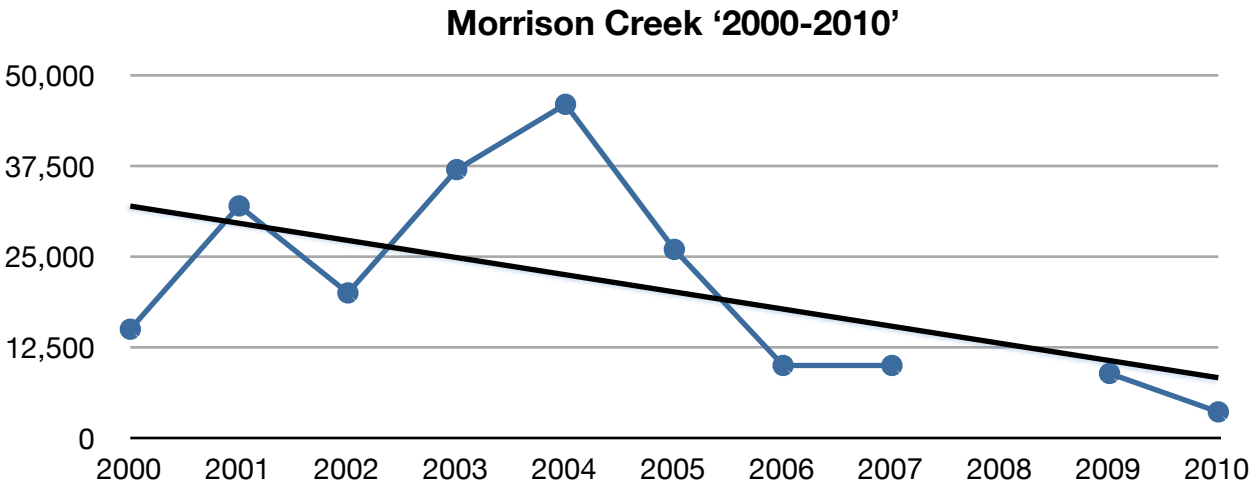




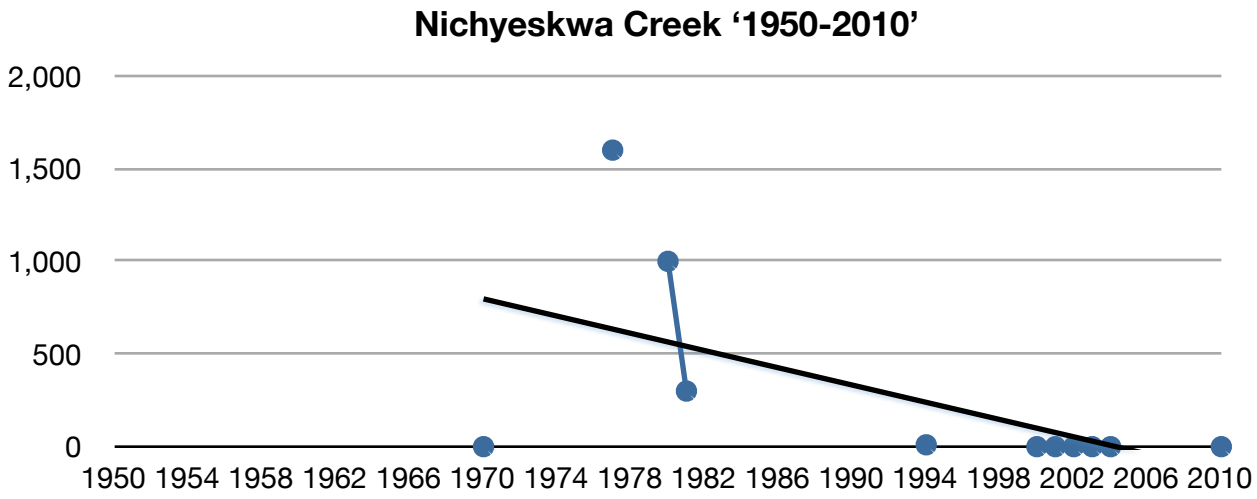
Morrison River

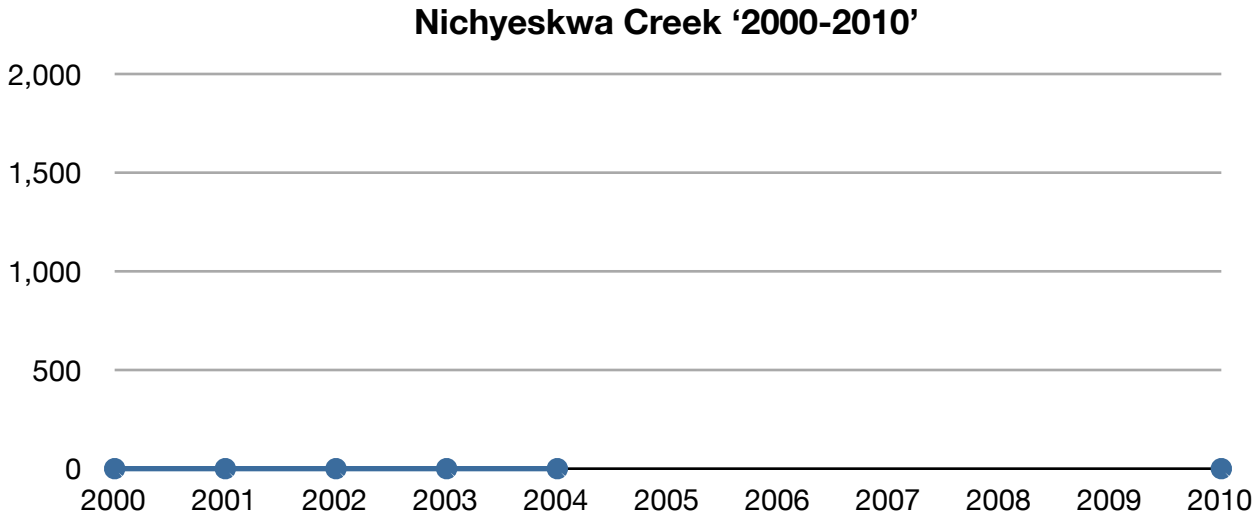
Spawner numbers range from a low of 400 (1952) to a high of 46,000 (2004), with a historic average annual return of 10,214 spawners. Although 6 spawner counts in the 2000s were above the historic average, 4 of the most recent spawner counts were below average (with 2010 spawners exceptionally low - 3,600). *ET* = 2.04 (**population increasing; *Low extinction risk***).





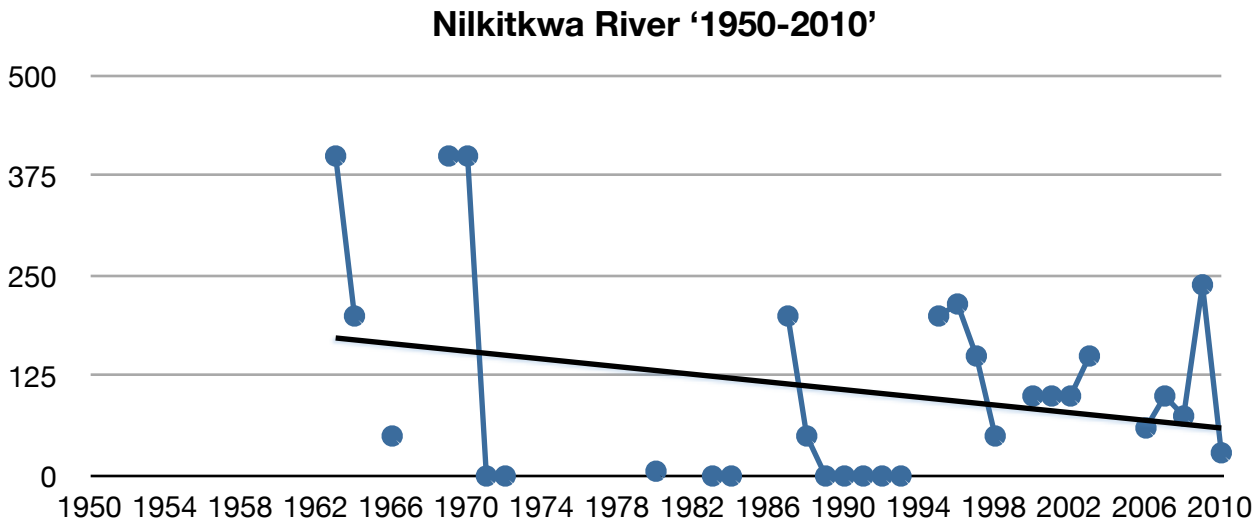
Nichyeskwa Creek
Spawner numbers range from a high of 1,600 (1977) to a low of 0 (2010), with a historic average annual return of 582 spawners. Six of the most recent spawner counts were 0. *ET* = 0 (**population in precipitous decline; *High extinction risk***).

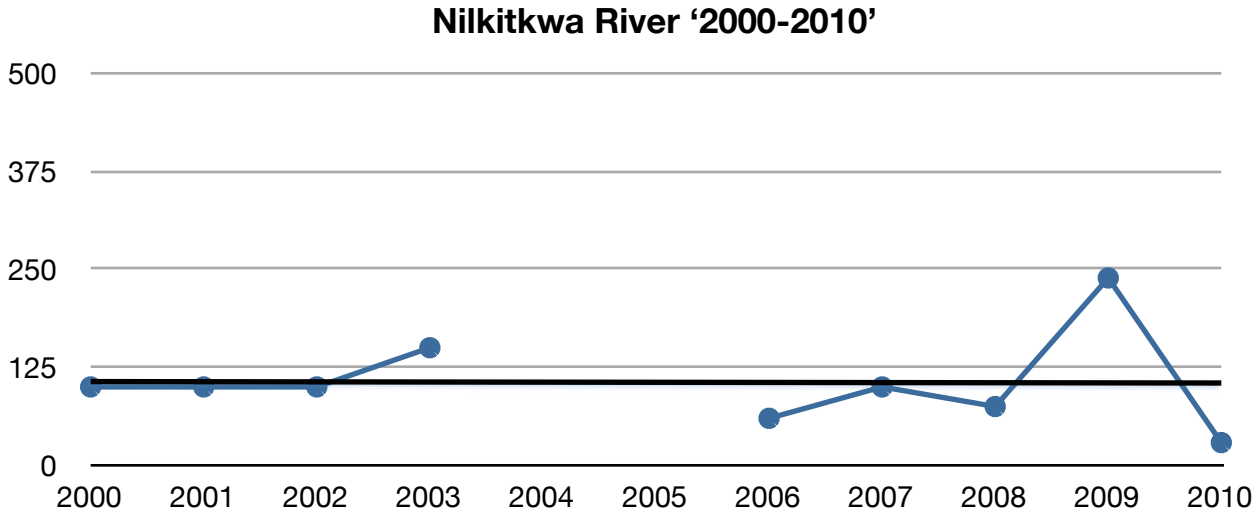




Nilkitkwa River

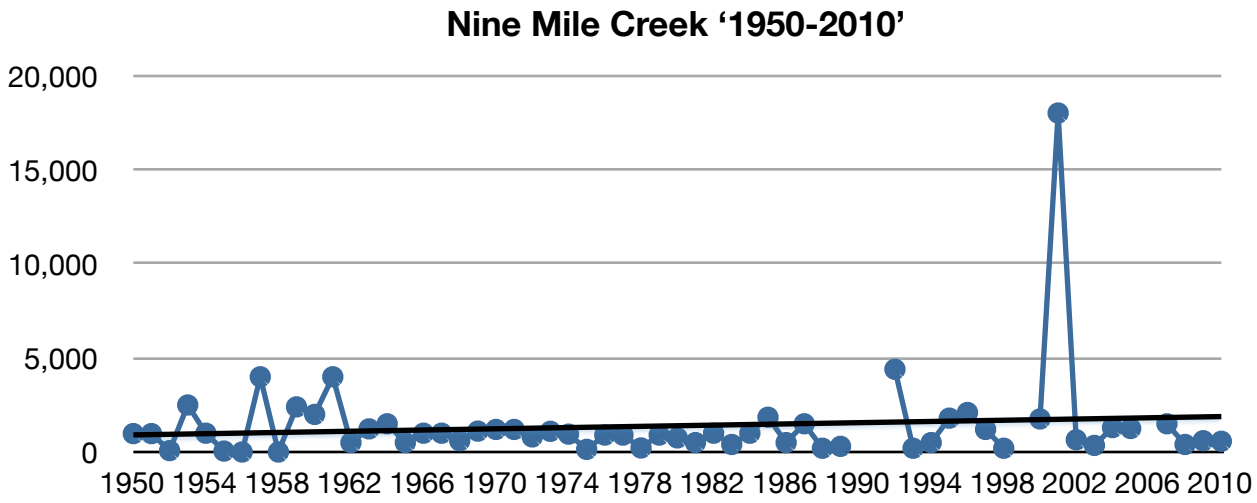
Spawner numbers range from a high of 400 (1970) to a low of 0 (1993), with a historic average annual return of 111 spawners. Seven of 8 spawner records in the most recent decade were below the historic average, including an exceptionally low return of 29 in 2010. *ET* = 0.95 (**population stable; *Special concern***).

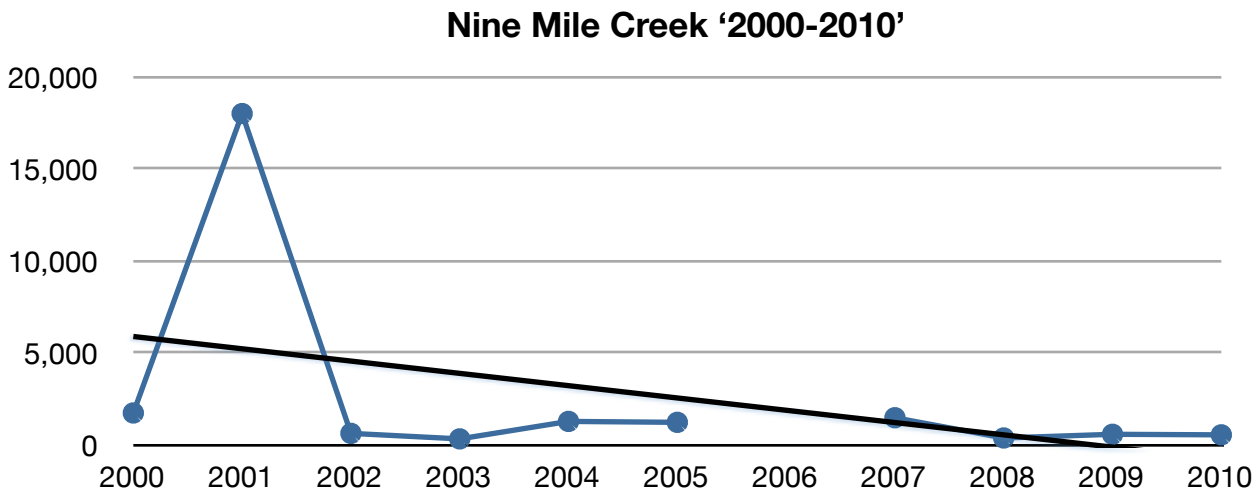




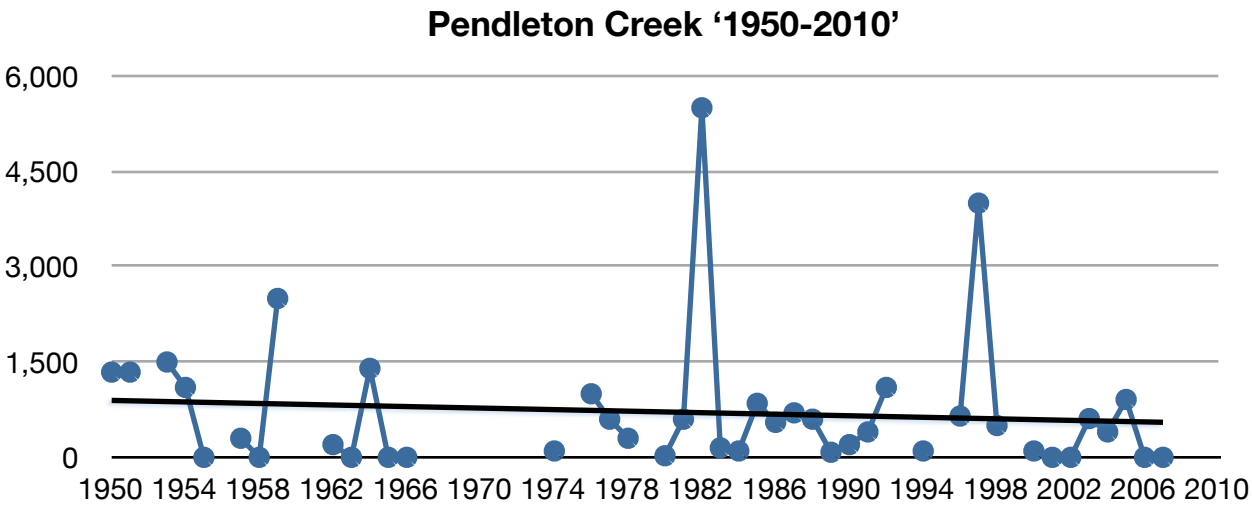
Nine Mile Creek

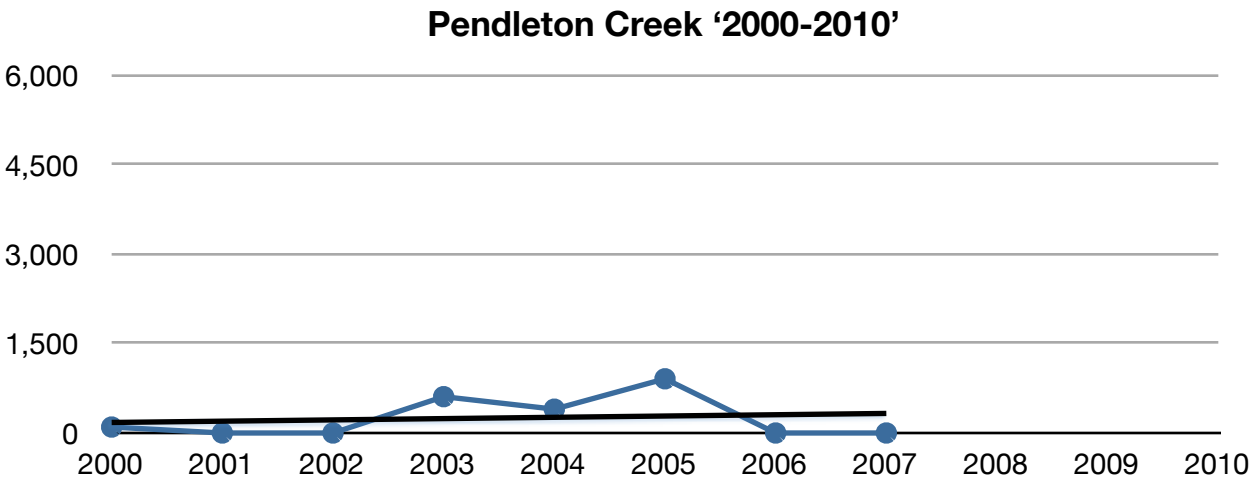
Spawner numbers range from a low of 0 (1958) to a high of 18,030 (2001), with a historic average annual return of 1,109 spawners. Although 5 of the 10 most recent spawner records were above the historic average, the last 3 were below average, including 570 spawners recorded in 2010. *ET* = 2.38 (**population increasing; *Low extinction risk***).





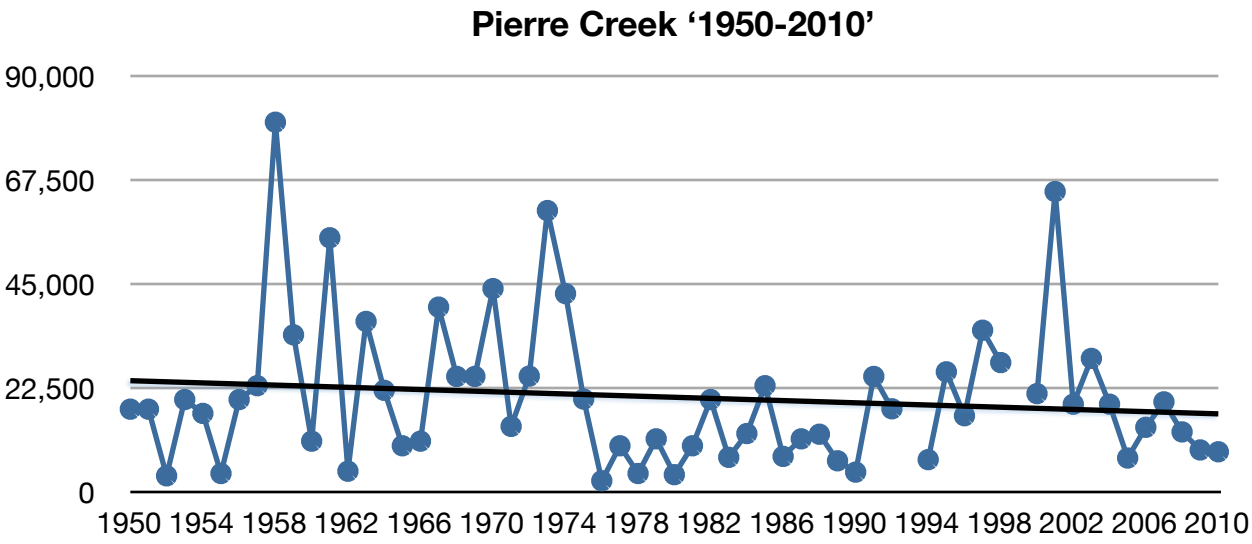
Pendleton Creek (Cross Creek)
Spawner numbers range from a high of 5,500 (1982) to a low of 0 (2007), with a historic average annual return of 817 spawners. Zero spawners were counted in 4 of the 11 most recent years, including the last 2 counts; no known records for 2008, 2009, and 2010. *ET* = 0.31 (**population in decline; *Moderate extinction risk***).

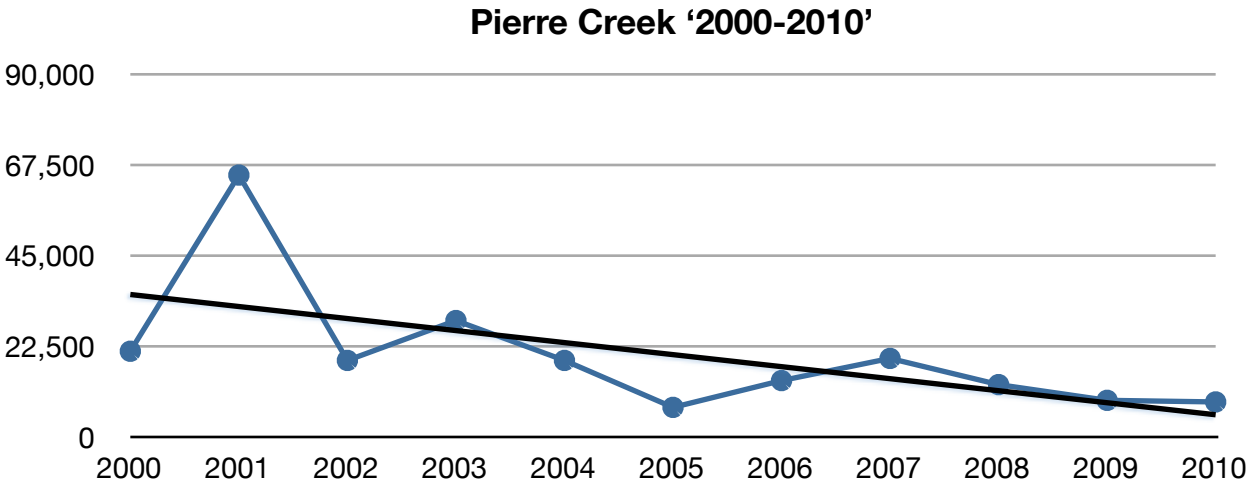




Pierre Creek

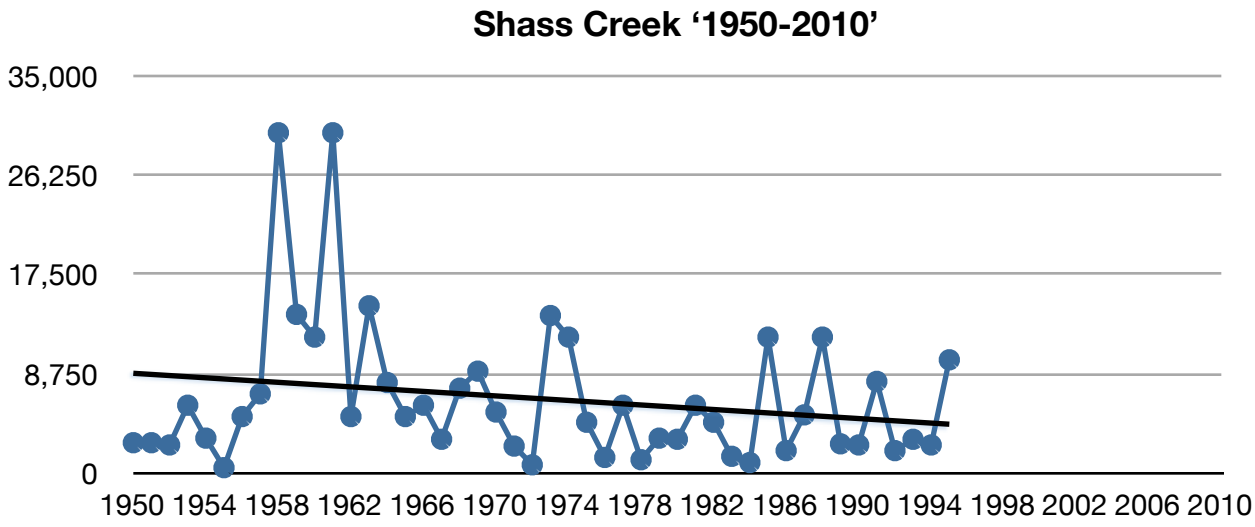
Spawner numbers range from a high of 80,000 (1958) to a low of 2,430 (1976), with a historic average annual return of 20,583 spawners. Eight of the 11 most recent spawner records were below the historic average, including the last 7 years. *ET* = 0.99 (**population stable; *Low extinction risk***).





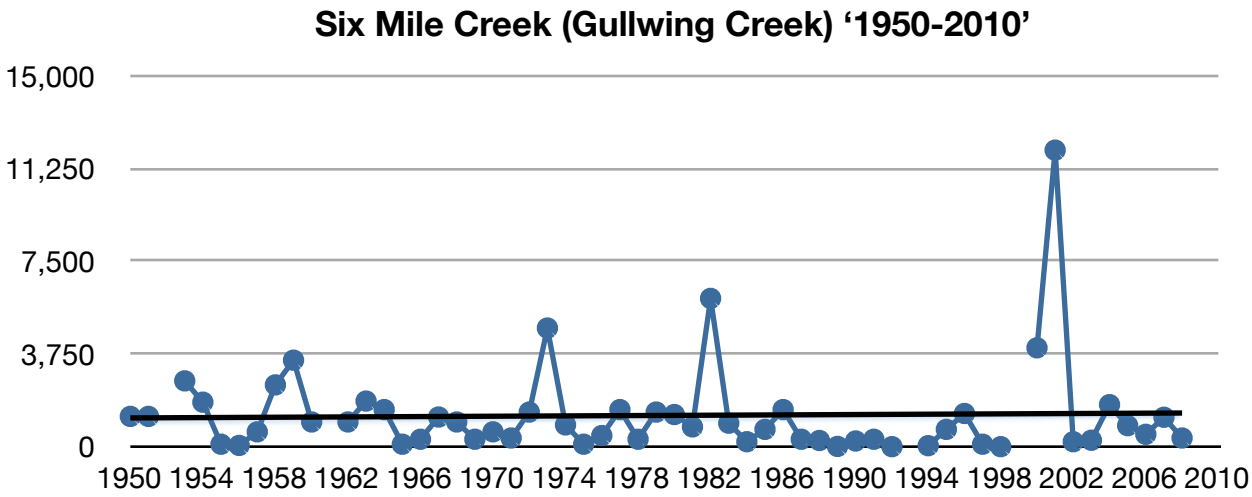
Shass Creek

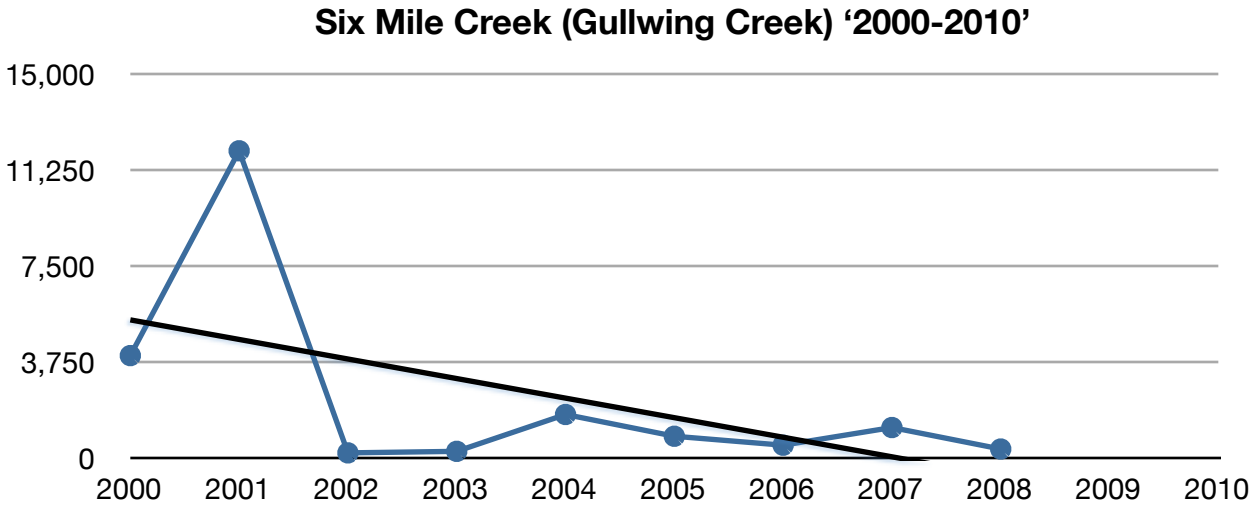
Spawner numbers range from a low of 500 (1955) to a high of 30,000 (1958), with a historic average annual return of 6,570 spawners. Monitoring effort ceased in the 2000s (though adults were observed in 2002, 2007, 2009, and 2010). The status of this population is unknown (**no recent records**).



Six Mile Creek (Gullwing Creek)

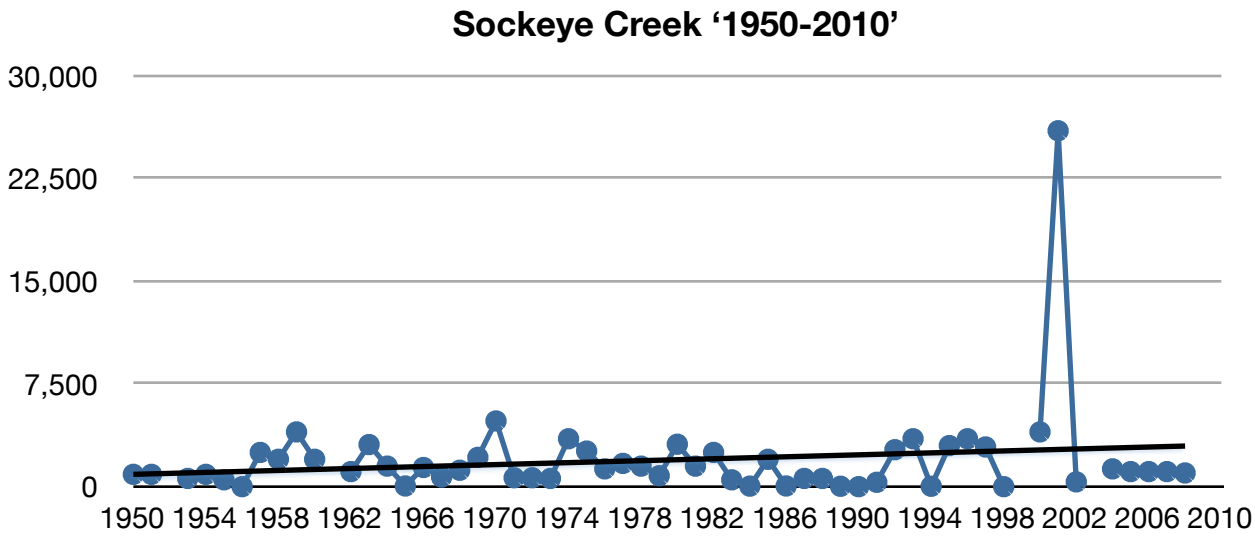
Spawner numbers range from a low of 0 (1998) to a high of 12,000 (2001), with a historic average annual return of 1,052 spawners. Five of the 9 most recent spawner records were below the historic average, with the latest spawner count exceptionally low (n = 350); adults were present in 2009 and 2010. *ET* = 2.22 (**population increasing; *Low extinction risk***).

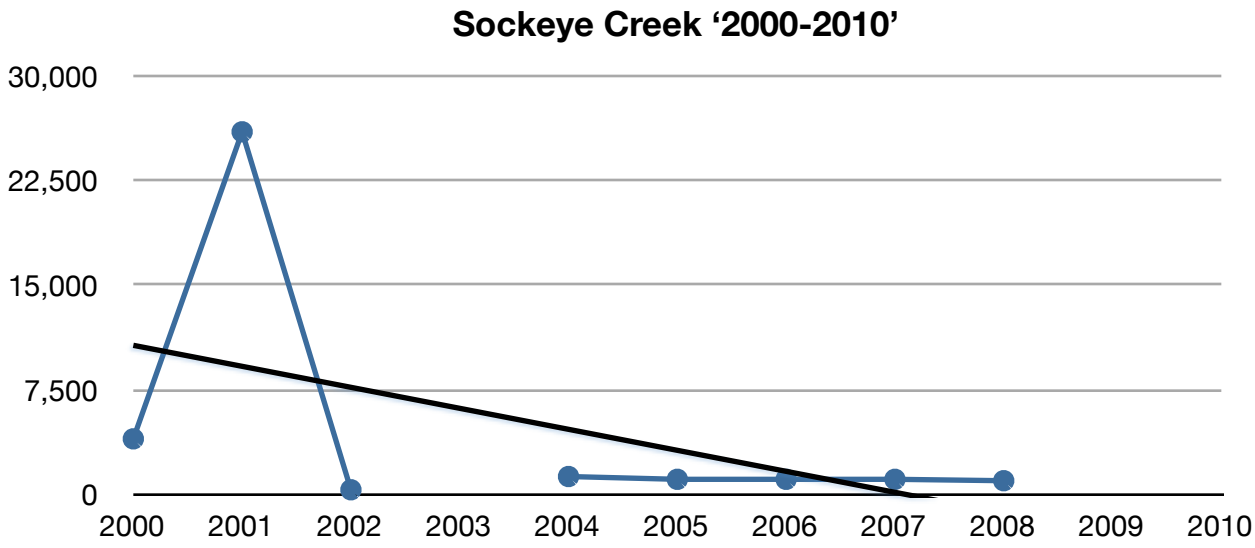




Sockeye Creek

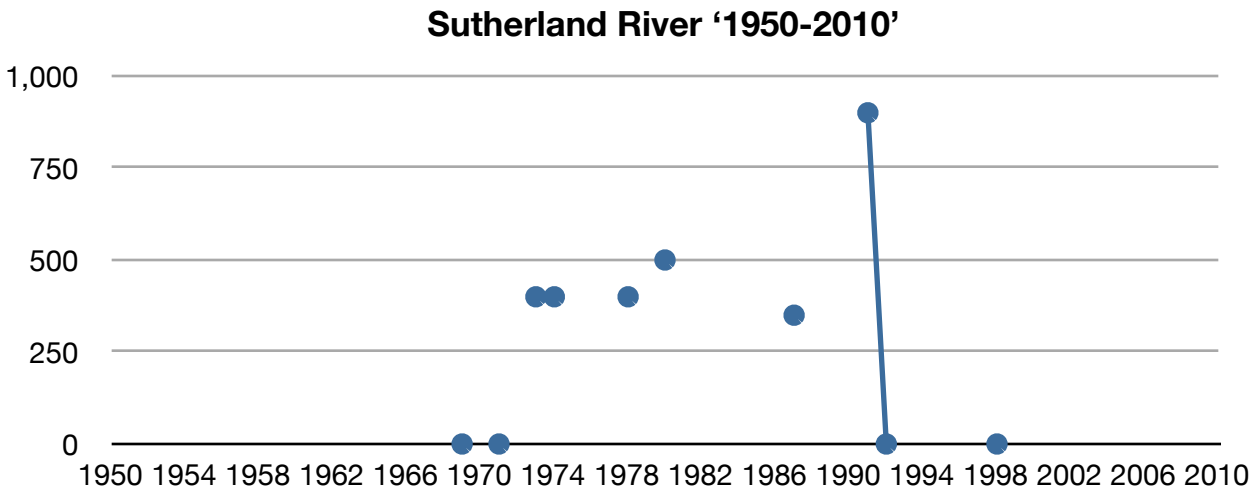
Spawner numbers range from a low of 0 (1998) to a high of 26,000 (2001), with a historic average annual return of 1,499 spawners. Six of the most recent spawner records were below the historic average, with the last spawner count totaling 1,000; adults were present in 2009 and 2010. *ET* = 3.00 (**population increasing; *Low extinction risk***).





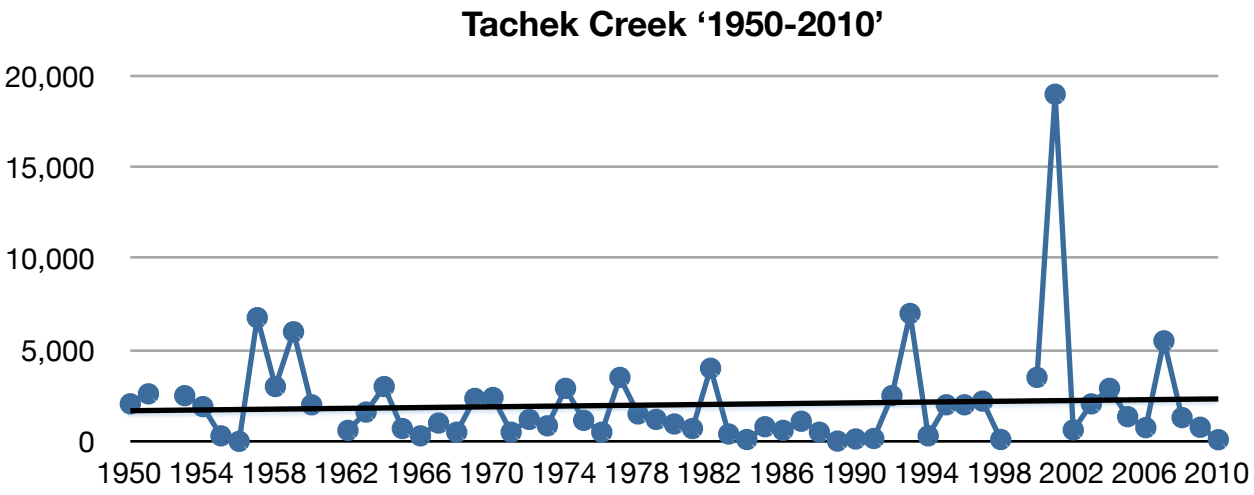
Sutherland River

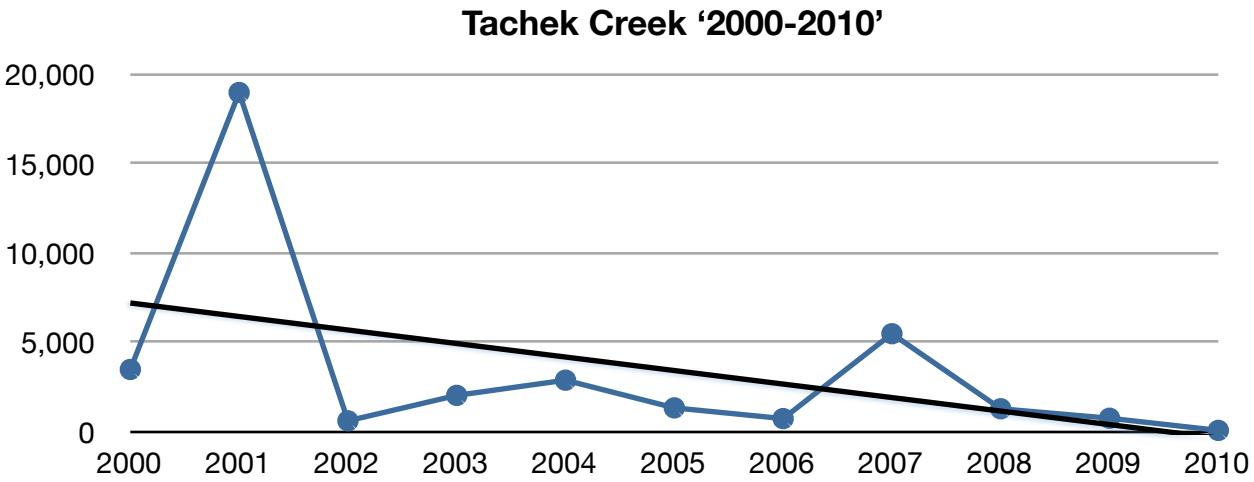
Spawner numbers range from a high of 900 (1991) to a low of 0 (1998), with a historic average annual return of 295 spawners. The last spawner count was 0 (1998), and although enumeration ceased in the most recent decade, adults were present in 2009 and 2010. The status of this population is unknown (**no recent records**).



Tachek Creek

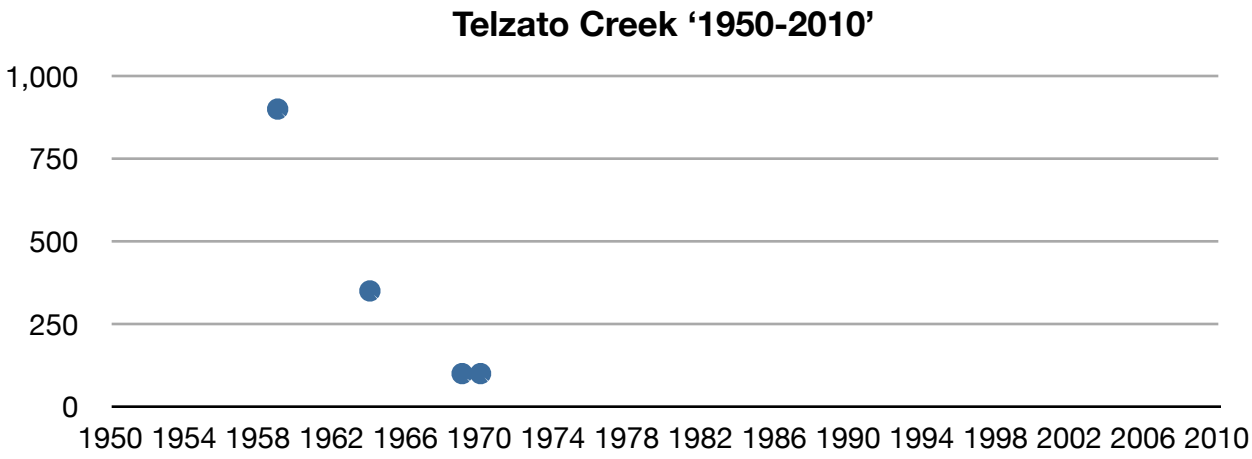
Spawner numbers range from a low of 0 (1956) to a high of 19,000 (2001), with a historic average annual return of 1,669 spawners. Although 5 of the previous 11 spawner records were above the historic average, the last 3 were below average, including 90 spawners recorded in 2010. *ET* = 2.06 (**population increasing; *Low extinction risk***).





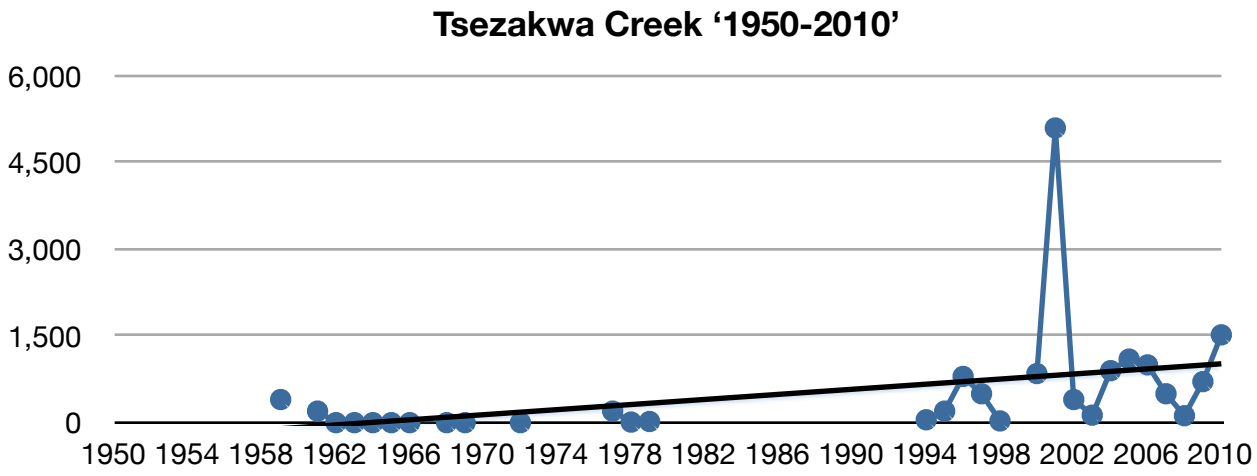
Telzato Creek

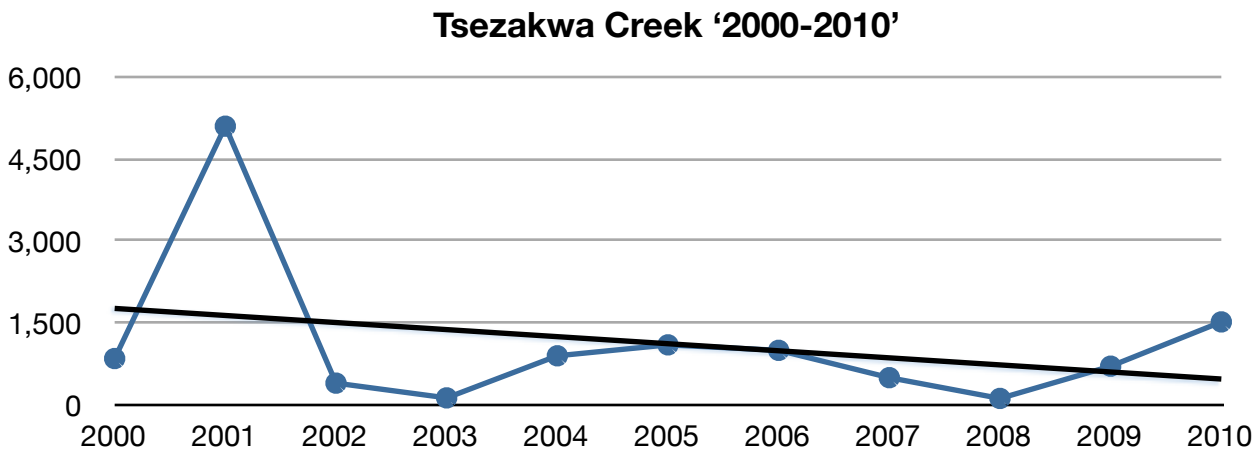
Spawner numbers range from a high of 900 (1959) to a low of 100 (1970), with a historic average annual return of 363 spawners based on 4 escapement records. The status of this population is unknown (**no recent records**).



Tsezakwa Creek

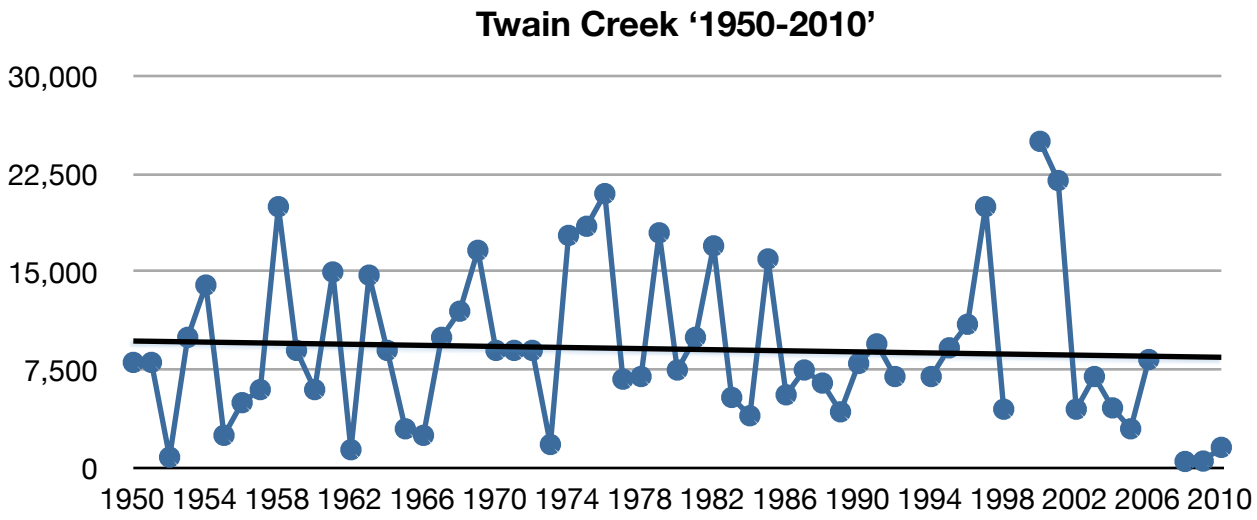
Spawner numbers range from a low of 0 (1972) to a high of 5,100 (2001), with a historic average annual return of 134 spawners. Eight of the previous 11 spawner records were above the historic average, including 2010 with 1,520 spawners. *ET* = 8.37 (**population increasing; *Low extinction risk***).

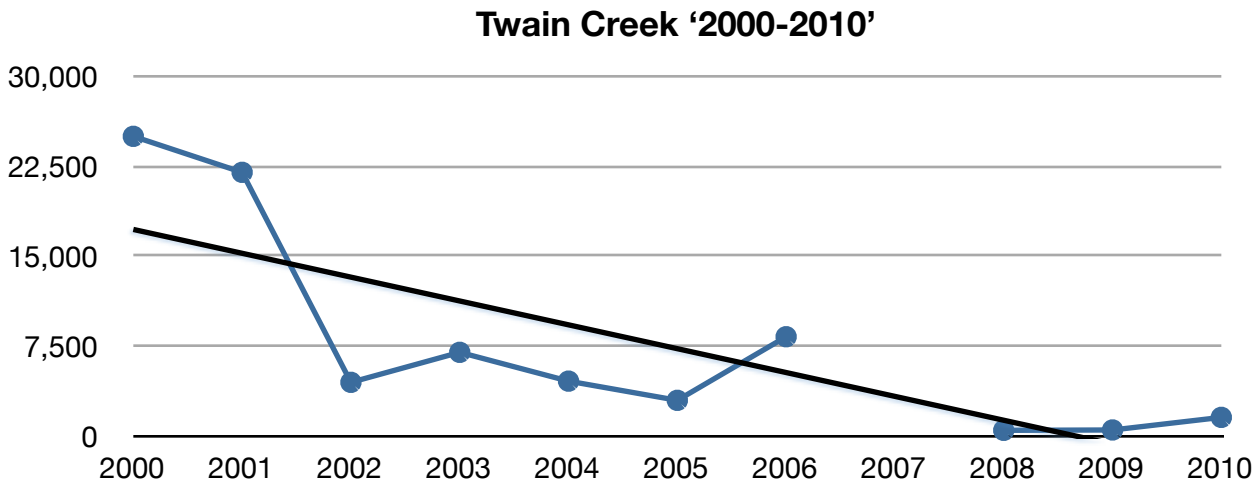




Twain Creek

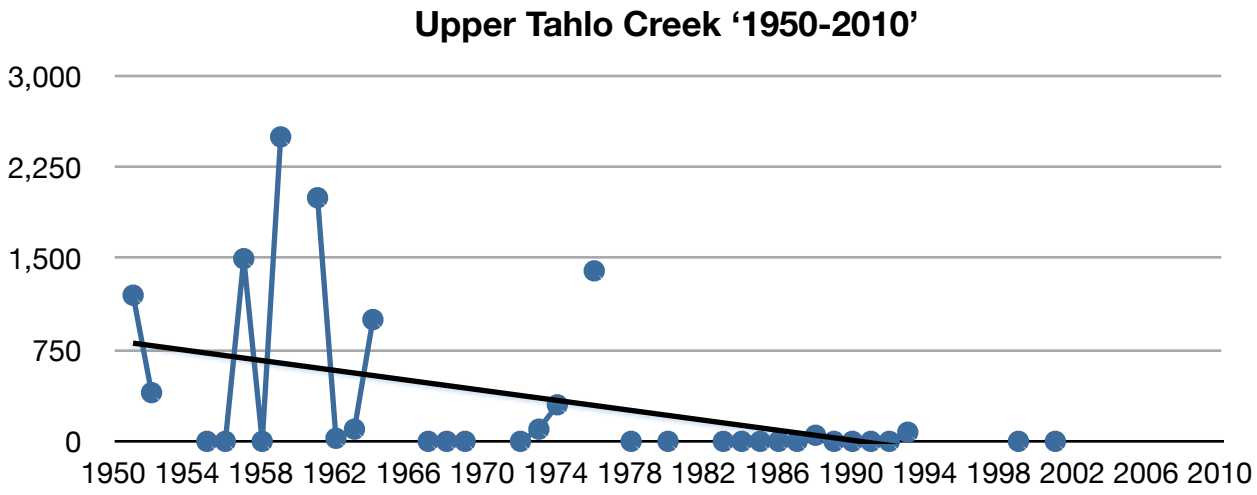
Spawner numbers range from a high of 25,000 (2000) to a low of 500 (2008), with a historic average annual return of 9,593 spawners. Eight of the previous 10 spawner records were below the historic average, including 2 of the lowest returns in the previous 3 years (n = 500 in 2008; n = 530 in 2009). *ET* = 0.80 (**population stable; *Low extinction risk***).

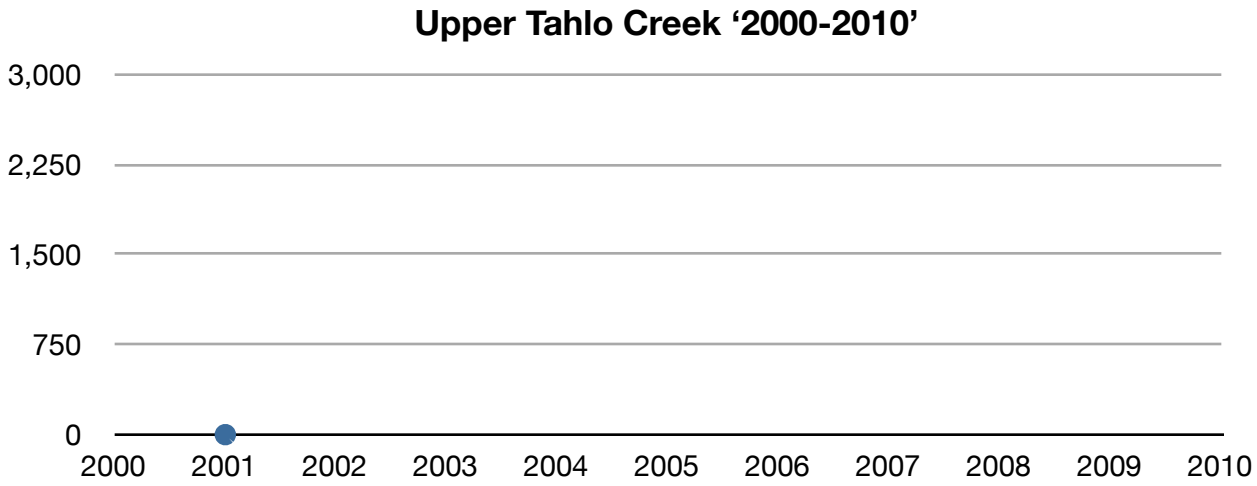




Upper Tahlo Creek

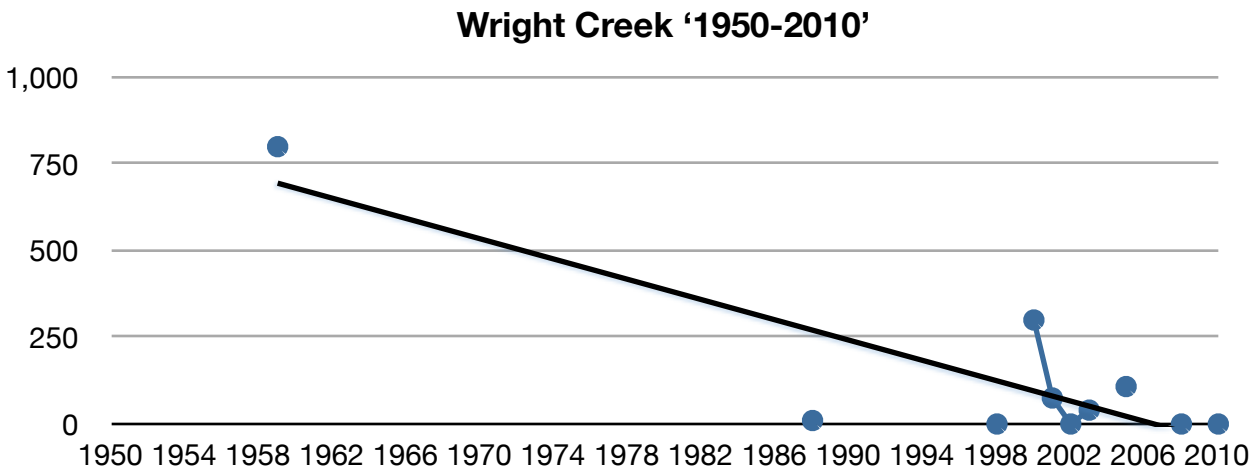
Spawner numbers range from a high of 2,500 (1959) to a low of 0 (2001), with a historic average annual return of 333 spawners. Although only a single enumeration record exists for the most recent decade, adults were observed in 2002-2004, 2007, 2009 and 2010. The status of this population is unknown (***Special concern***).

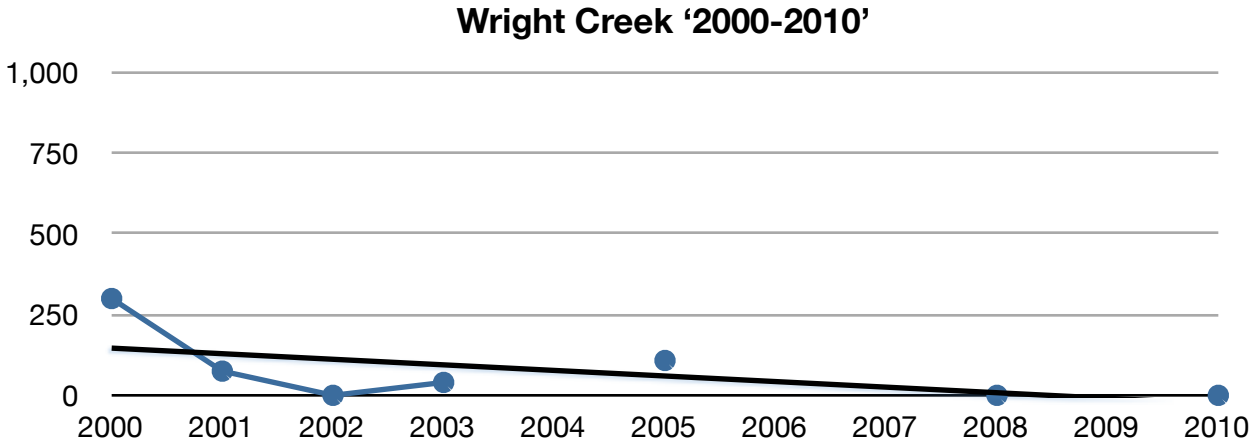




Wright Creek

Spawner numbers range from a high of 800 (1959) to a low of 0 (2010), with a historic average annual return of 270 spawners. Six of the most recent spawner counts were below the historic average, including the last 2 years with 0 spawners. Adults were observed in 2006 and 2007. *ET* = 0.28 (**population in decline; *Moderate extinction risk***).



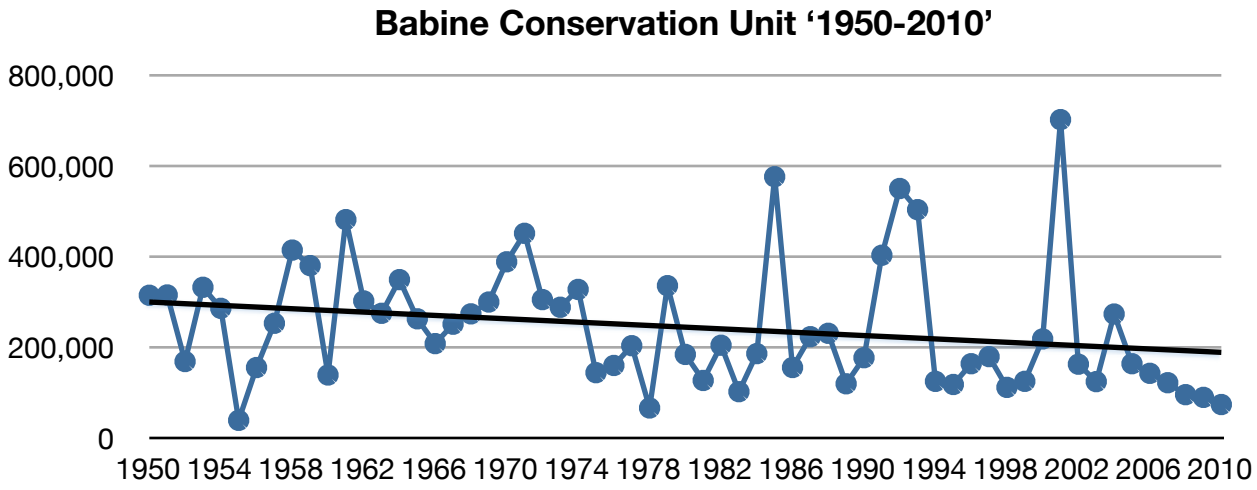


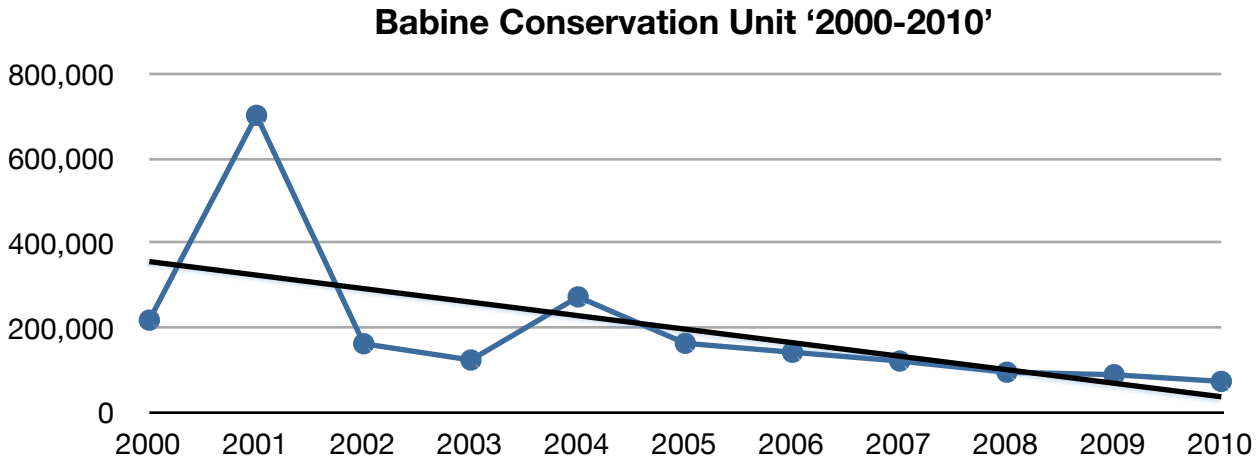
Sockeye Conservation Units

Two sockeye conservation units are classified within the larger Babine watershed: Babine, and Morrison. Approximately 90% of the wild sockeye stocks listed above are included in the Babine Conservation Unit, with the remaining 3 stocks designated within the Morrison Conservation Unit. Details of each are below.

Babine Conservation Unit

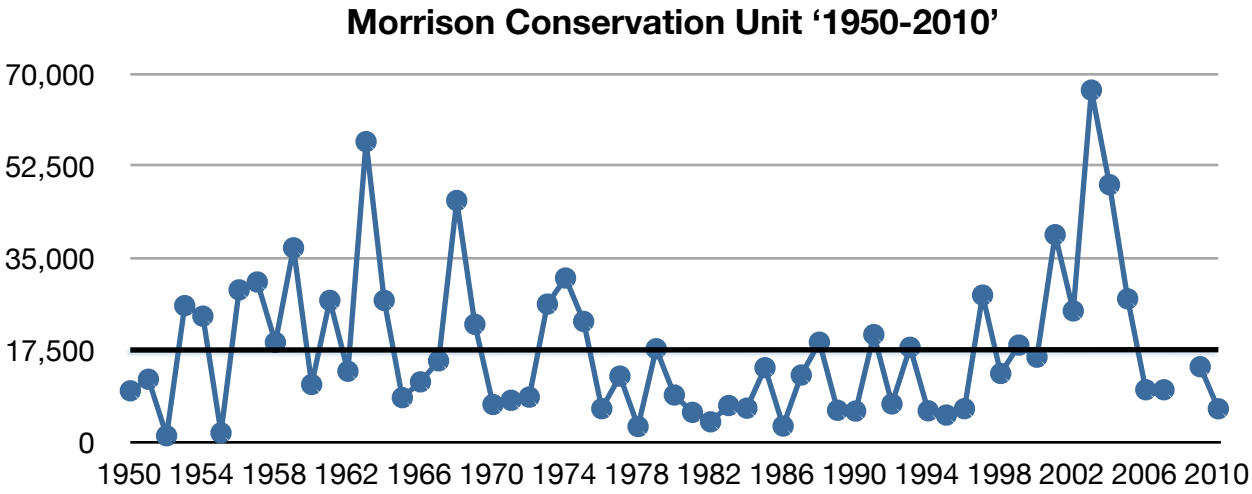
This Conservation Unit (CU) includes all wild sockeye stocks of the Babine watershed except Morrison River, Lower Tahlo Creek, and Upper Tahlo Creek. The recent decade average (197,183) for the aggregate stocks is 27% below the combined historic average of 254,487. After experiencing a record high return of more than 700,000 spawners in 2001, this CU has been experiencing a steady decline, and most notably since 2005, with the most recent spawner count at its lowest level in over 20 years. *ET* = 0.77 (**population stable; *Low extinction risk***).

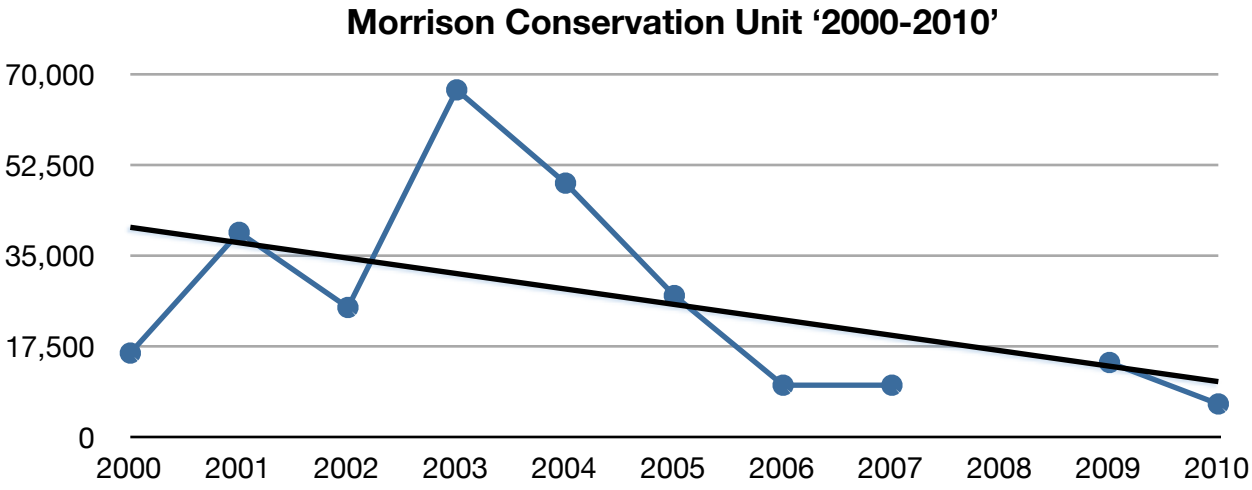




Morrison Conservation Unit

This CU includes Morrison River, Lower Tahlo Creek, and Upper Tahlo Creek, with a combined historic average annual return of 15,811 spawners to the Morrison watershed. Although this CU shows above average returns for the current decade (n = 26,476 spawners per year during 2000-2010) compared to historic records, it has been experiencing a dramatic decline since 2003 to its lowest point in 2010. *ET* = 1.67 (**population increasing; *Low extinction risk***).





Discussion

Historical records dating back to the 1950s are used throughout this report to provide context for changes in abundance over time. However, it is important to note that these data should not be considered a measure for the number of wild-origin sockeye that historically returned to the Babine watershed. Industrial harvesting of sockeye returning to the Skeena River and its tributaries had been employed for more than 50 years before the first year of records used in this report were produced, and historic wild sockeye abundance was arguably much higher. Furthermore, roughly one-third of the original biodiversity is estimated to have disappeared before the 1950s (Walters et al. 2008).

The Skeena River commercial sockeye salmon fishery began in 1877. Sockeye catch rose with the development of the fishery during 1880-1900 to an average of roughly 1.2 million fish annually (Argue and Shepard 2005). Although commercial catch peaked at approximately 2.2 million sockeye in 1910, a steady decline occurred during the period of 1904-1945 with an estimated reduction in the sockeye population of 50% (Pritchard 1948). Total returns of sockeye (catch and escapement) at the height of the aforementioned decline (1944-1948) were estimated at 1.9 million fish per year (Milne 1955); thus, a conservative estimate of the annual number of wild sockeye returning to the Skeena and its tributaries at the height of the commercial fishery is 3.8 million. Considering that the Babine watershed accommodated an estimated 75% of the annual wild sockeye escapement to the Skeena system as a whole during this period (Shepard and Withler 1958), the estimated historic annual return of wild Babine sockeye may have been 2.9 million at the height of the commercial fishery. Alternatively, Wood (2008) estimated the total annual return of Skeena sockeye between 1905-1915 at roughly 2.2 million based on 60% exploitation rates, equating to an estimated annual return of 1.7 million wild Babine sockeye. Although these are loose approximations for historic wild sockeye returns, and a more detailed quantitative analysis may show lower (or higher) estimates, it is an important context to consider when comparing population estimates of the previous 60 years. For example, the combined average escapement of all wild Babine sockeye stocks in the most recent decade has decreased 18% compared with 1950-1999 records (see Figure 1). Importantly, the average annual wild sockeye return to the Babine during 2005-2010 was 125,933, a decline of 47% compared with the historic dataset of 1950-1999. Moreover, the combined number of wild-origin sockeye returning to the Babine watershed in 2010, a year with minimal commercial fishing, was 80,208 - a 70% decline compared with the 1950-1999 dataset, and between a 95% and 97% decline compared with historic wild sockeye estimates.

It is important to note that the above historic wild Babine sockeye estimate included Fulton River and Pinkut Creek, tributaries that supported more than 125,000 annual spawners during 1950-1969. Artificial spawning channels were introduced to these tributaries in the late 1960s, with the first of the enhanced sockeye returning in 1970, and the associated enhanced production has since rebuilt the total Skeena sockeye aggregate to pre-1950 levels. However, this enhanced production has simply replaced wild sockeye production in the Babine watershed (Wood 2001), and is not included in the wild sockeye escapements within this report.

Of the 30 wild sockeye populations listed in NuSEDS within the Babine watershed, 29 host at least one spawning record since 1950. Onerka Lake is the only population to be listed, yet not have any escapement record. Whether this was a stable population before record keeping began is unknown, yet should be considered. Overall monitoring effort for the 29 populations over the last 61 years has been good compared with the rest of British Columbia's north and central coasts (Price et al. 2008). However, while some populations have been extensively monitored, others have been largely ignored. More than one-third of stocks have insufficient data to determine current status, and the poor enumeration effort for stocks with small historic populations is notable. For example, of the 14 populations with historic spawner averages of less than 600/year, only 1 was consistently monitored in the most recent decade (Tsezakwa Creek, a population that is classified as increasing in abundance); 7 were enumerated in 1 or less years during the 2000s (Donalds Creek, Forks Creek, Hazelwood Creek, Kew Creek, Sutherland River, Telzato Creek, and Upper Tahlo Creek). Deficient data for stocks such as these handicap current status assessments, and cannot provide the quality of data needed to conserve populations under heavy fisheries pressure (PFRCC 2004). Monitoring primarily large runs further offers a potentially perverse evaluation of population health for the Babine system as a whole.

Despite the single enumeration record for Babine Lake spawners within the database, a reconstruction of their annual abundance could be derived using 'Unaccounted' spawner data: the total Babine River fence count subtracted by the sum of escapement estimates for all Babine Lake tributary streams, spawning channels, and native harvest at and above the Babine River counting fence. These observed differences suggest that up to 20% of the sockeye entering the Babine watershed may spawn in the lake (McDonald and Hume 1984). However, because annual enumeration of spawning streams is incomplete, and some sockeye destined for the spawning channels are prevented from ascending to avoid over-spawning, 'unaccounted' data is unlikely to accurately reflect annual lake-spawner abundance. Spawning has been observed to occur along the Babine Lake shore (McDonald 1963, 1964), including alluvial fans of tributary streams, although beach-spawning habitat has been considered extremely limited (Wood et al. 1995). Given the paucity of lake spawner data, and the possibility that genetically distinct stocks exist, it seems pertinent that a detailed investigation into the occurrence and abundance of Babine Lake spawners, and suitable spawning habitat, be initiated.

It has been suggested that these 'Unaccounted data' be included either in the annual wild sockeye aggregate counts or applied as a magnification factor to individual wild stocks because these data may reflect either spawner observer underestimates or incomplete enumeration of streams. While it is inappropriate to include a magnification factor to individual stocks because it is unknown where these unaccounted fish originated, it is likely that some proportion of these sockeye are of wild origin. However, it is equally plausible that a large proportion are enhanced fish that were prevented from ascending their natal spawning channels during abundant years as mentioned above. Unfortunately, there are no known records of counting fence closures in the NuSEDS database to at least filter the years when unaccounted fish were predominately of enhanced origin.

Combined spawner numbers for all wild sockeye stocks returning to the Babine watershed are near their lowest level ever recorded, with 9 of the previous 11 years below the historic average, including the 6 most recent years (2005-2010). This decline is driven primarily by the two largest wild sockeye populations in the system (Babine River - Section 1-3, and Babine River - Section 4). The number of spawners returning to Section 1-3 in 2010 was 56,950 (a 65% decline compared to 1950-1999 levels); 1,714 spawners returned to Section 4 in 2010 (a 97% decline). Recovery plans for sockeye within the Babine Conservation Unit should consider these two populations as a top priority.

Of the wild sockeye populations with sufficient data to determine current status, 4 are threatened with extinction (14% of stocks). Two of these populations are at *high extinction risk*: Nichyeskwa Creek, and Boucher Creek. Nichyeskwa Creek has a record of 0 spawners in the previous 6 stream counts as recently as 2010, and Boucher Creek has a record of 0 spawners in 2010. Two populations are at *moderate extinction risk*: Pendleton Creek, and Wright Creek. Pendleton Creek showed 0 spawners in the last two counts (2006-2007), but did not undergo enumeration effort during 2008-2010. Wright Creek has shown a steady decline since 2000, with 0 spawners in the last two counts (2008 and 2010). Also of concern are 3 populations classified as *Special concern*: Babine River - Section 4, Nilkitkwa River, and Upper Tahlo Creek. Babine River - Section 4 is a historically large but depleted stock, with every spawner count in the recent decade below the historic average, including its lowest level ever recorded during 2010. Nilkitkwa River is a historically small stock with 7 of 8 spawner records in the most recent decade below the historic average, including an exceptionally low return of 29 in 2010; a 74% decline compared with the historic average annual return. Upper Tahlo Creek is a historically small stock with insufficient recent records; however, the available information suggests a declining trend, with 0 spawners shown in the most recent record (2001).

One of the weaknesses with the methods used in this report is highlighted in the assessment of 2 populations: Boucher Creek, and Wright Creek. Both Boucher Creek and Wright Creek are classified as stocks in decline with *high* to *moderate* extinction risk, largely based on record high returns in 1953 and 1958, respectively. Given the sparse historical dataset for both populations, these high single-year returns undoubtedly influence the declining trends, and may signify an inflated classification. However, it is important to consider that sockeye returns in 1953 and 1958 were exceptionally high for many stocks, suggesting that these records likely reflect accurate spawner estimates. Additionally, both stocks show very low and declining returns in the recent decade, suggesting that they are populations of concern regardless of historical abundance uncertainties.

Of overarching concern is the general decline in survival rates and productivity of Skeena sockeye since 1992. Brood-year production for Babine sockeye has declined despite stable fry output from the enhanced spawning channels (Figure 5), and much of this reduced survival is thought to have occurred during the early seaward migration of smolts. Similarly large and consistent decreases in sockeye productivity have been observed in many other areas along the west coast of North America since the late 1990s (Peterman and Dorner 2011). With climate

change posing a major threat to the future of wild Babine sockeye, not only through direct effects of temperature, but also through impacts on food webs and habitats, management agencies are urged to take this information into account to successfully conserve threatened populations.

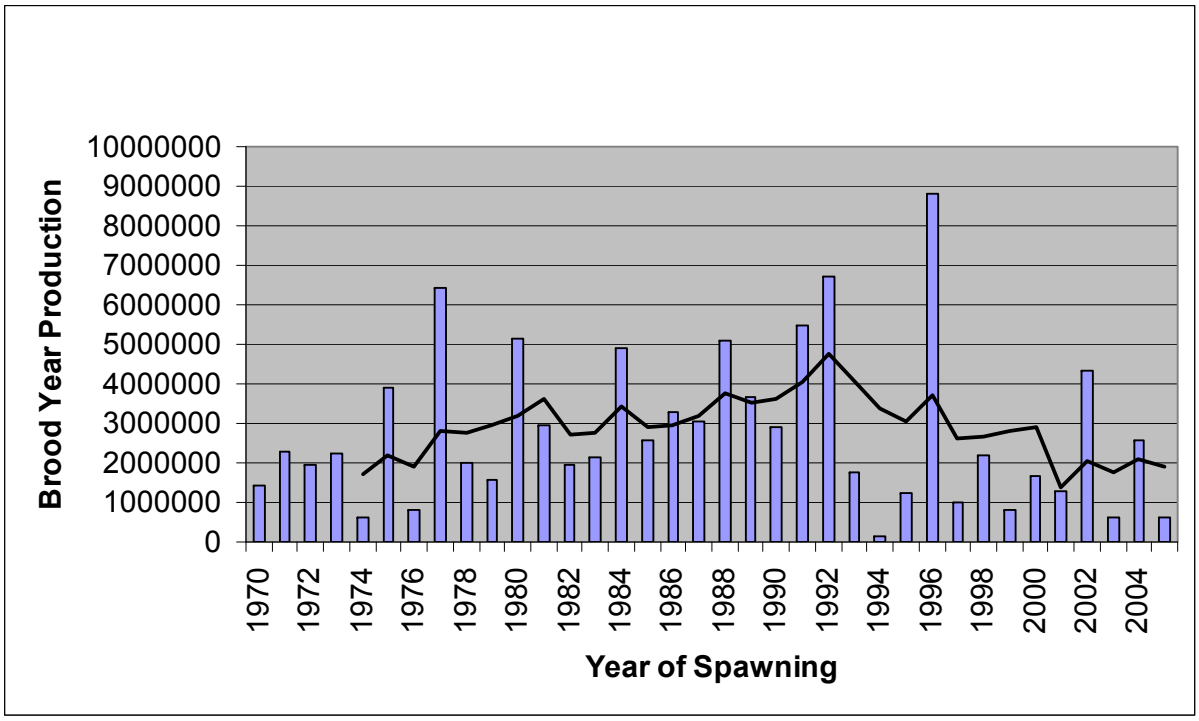


Figure 5. Brood year production of combined Skeena sockeye stocks during 1970-2005, adapted from Steve Cox-Rogers 2010 North/central coasts sockeye overview presentation.

Recommendations

- A quantitative analysis of reported commercial catch data and historical information regarding unreported catches should be performed to estimate the historical abundance of Skeena sockeye; an analysis such as this would provide an essential context for the development of recovery goals.

- Increased monitoring effort for populations with insufficient data to determine current status (1/3 of stocks), with an emphasis on populations with historic spawner averages of less than 600/ year; these are: Donalds Creek, Forks Creek, Hazelwood Creek, Kew Creek, Sutherland River, Telzato Creek, and Upper Tahlo Creek.

- A detailed investigation into the abundance and phenotypic differentiation of Babine Lake spawners (recorded once in 1992), documentation of current spawning locations, and genetic determination of spawners for stock distinctness.

- An examination into the rapid decline of Babine River Section 1-3 and Section 4 populations given the recent absence of fishery pressure on these stocks and probable link to decreased marine survival.

- An investigation of the potential role of the mixed-stock commercial fishery in the overall decline of wild Babine stocks, including genetic analysis of the commercial catch-stock composition.

- A state-of knowledge report on the potential role that enhanced spawning channels have on wild Babine sockeye.

- Creation of recovery plans for threatened stocks: Nichyeskwa Creek, Boucher Creek, Pendleton Creek, and Wright Creek; also Nilkitkwa River, a historically small stock with an exceptionally low return of 29 spawners in 2010.

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