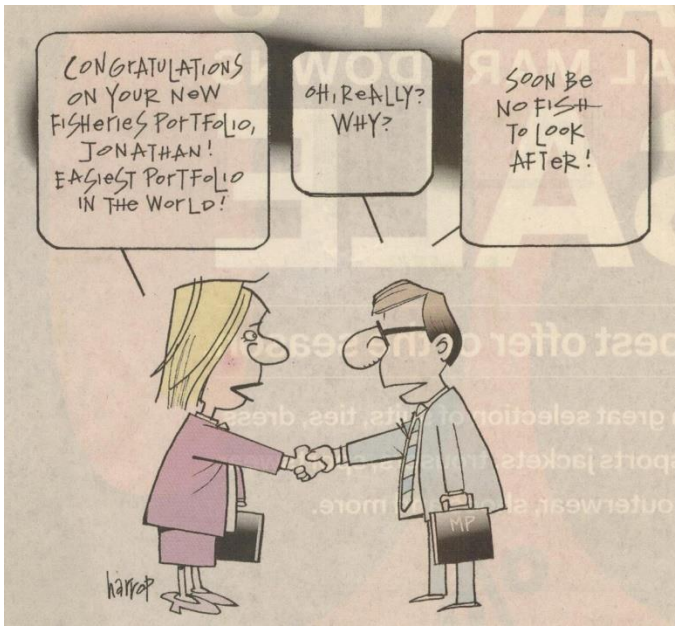
April 2019

To My Salmon Fishing Friends:

Last summer was a difficult year for the salmon.



Jonathan Wilkinson Appointed Minister of Fisheries and Oceans

(Vancouver Sun July 2018)

West Coast Salmon Runs

On November 2, 2018 the Alaska Department of Fish and Game reported that the 2018 total commercial harvest for chinook salmon was 234,614 fish with an estimated value (to the commercial fishermen) of $16.3 million. Total Alaska harvest value for chinook salmon in 2018 was the lowest since 1975. The coho salmon harvest ranked 31st over the 43 year period spanning 1975 to 2018.

In late spring 2018 Fisheries and Oceans Canada (DFO) reduced the daily limit for sports caught chinook salmon from two to one, for the BC coast north of Bella Bella and for the south coast near Vancouver. On August 1, after the early chinook runs had passed, this limit was restored to two chinook. Near Vancouver the daily limit was left at one chinook for the remainder of the summer.

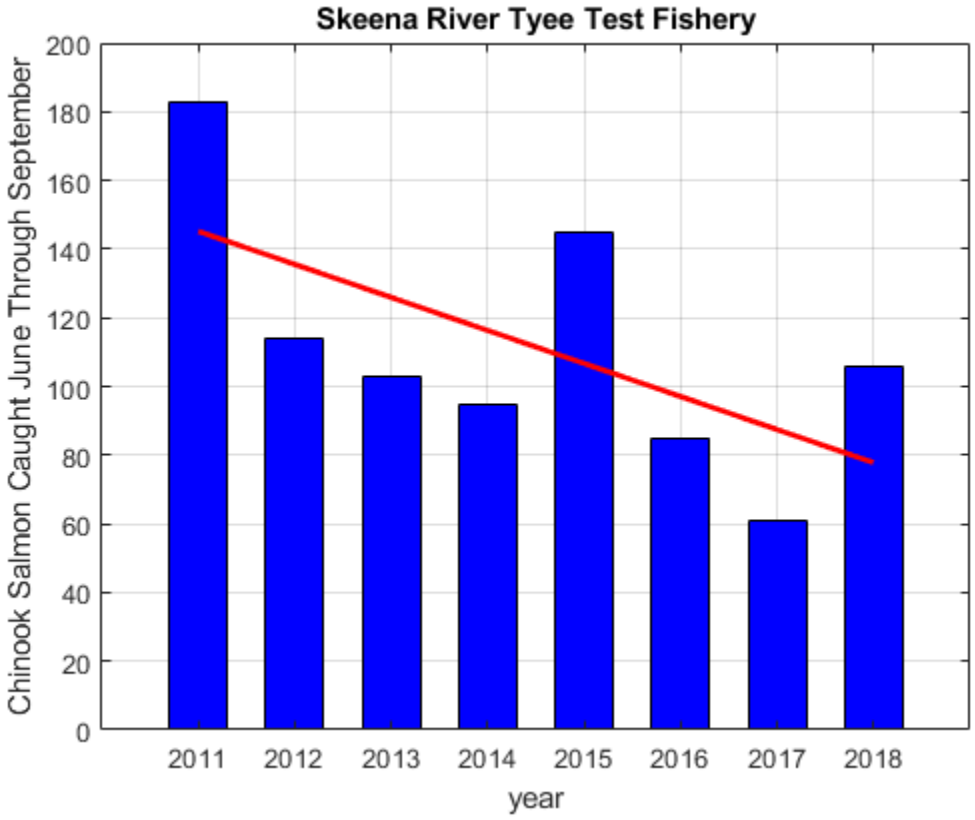
In the northern part of Washington State (which includes Point Roberts, where in past years I have moored my boat) the daily limit for chinook salmon was zero until July 1, one salmon until August 30,

then reduced to zero again. After considering the closures and reduced limits in both Canada and the US, I decided to leave my boat in the garage last season.

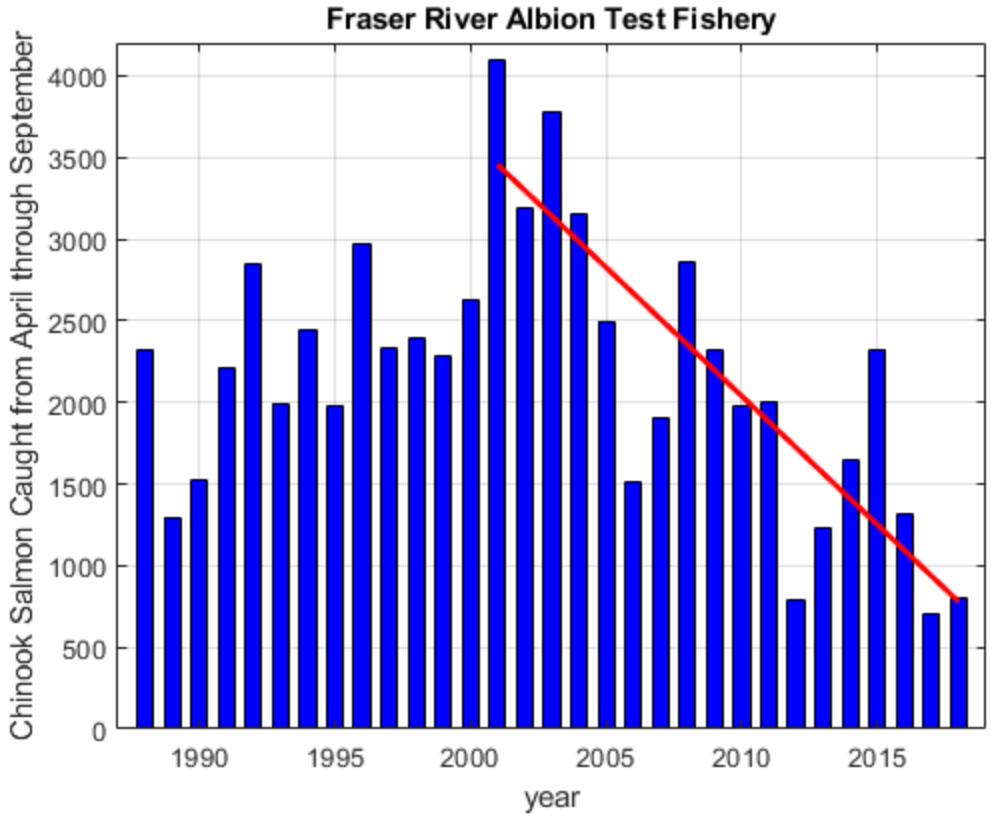
Last year for the second year in a row DFO closed the Fraser and Skeena Rivers (the two largest producers of chinook salmon in British Columbia) to both commercial and recreational salmon fishing (all salmon, not just chinook) until August, when on the Fraser River a major sockeye run arrived and the river was opened again for salmon fishing.

Sockeye salmon have a four year cycle and 2010, 2014 and 2018 were peak years. In 2010 the return was 32 million, in 2014 it was 20 million, and in 2018 about 10.5 million salmon. Last summer was a good return but the decline is troubling. My conclusion is that we had very favourable ocean conditions in the two years prior to 2010 but since that time the “warm blob” has done considerable damage.

DFO has a test fishery at Tyee, about twenty-five miles upstream from the mouth of the Skeena River. In the test fishery a gillnet is set for one hour each daylight slack tide during the season. The graph below shows the number of chinook salmon caught from June through September since 2011.



As can be seen from the graph the Skeena River chinook salmon run was better in 2018 than the two previous years but is in decline, and the test fishery catch last summer was low despite the river being closed to commercial and recreational fishing.



The DFO has a similar test fishery at Albion on the Fraser River, and the graph above shows the number of chinook salmon caught from June through September going back thirty years. Last year was better than the previous year, but was the third lowest on record despite the river being closed to commercial and recreational fishing.

For both graphs the red line is fitted to the data using the method of least squares.

This last graph does not show the full story, because the Fraser River has both stream-type and ocean-type chinook salmon and they have fared very differently over the past thirty years.

Fraser River Ocean-Type Chinook

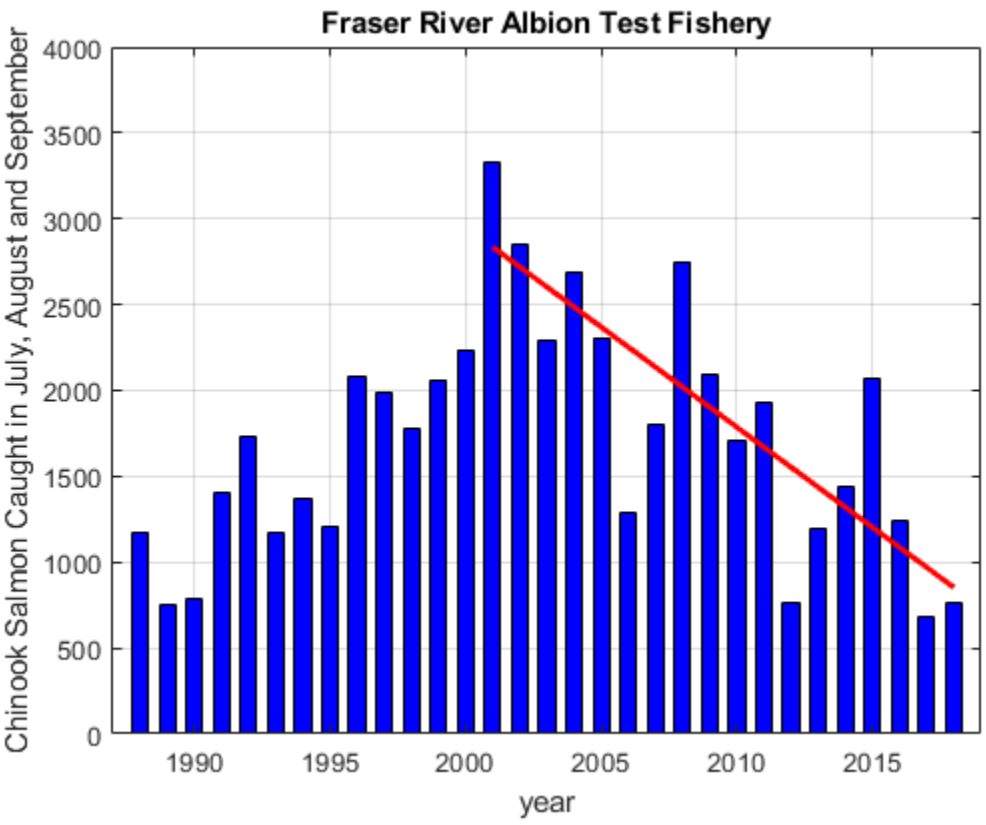
These two behavioural forms are named for where the juvenile salmon spend their first year of life. They are quite distinct and do not interbreed. Where their ranges overlap the stream and ocean-types may spawn in the same rivers although generally in different gravels.

Stream-type chinook generally spawn in rivers which are snow fed, and enter their natal river during the spring freshet when water flow is high, as early as February in the southern rivers (such as the Sacramento River in California) and as late as July in the far northern rivers (such as the Yukon River in Alaska), enabling them to make long upstream migrations before summer low water conditions. Stream-type chinook adults usually spend several months in the river and spawn in the fall, at roughly the same time as ocean-type chinook.

Ocean-type chinook typically spawn in coastal streams and tributaries which are mainly rain fed. They enter their natal river usually between July and December, and take advantage of the additional months in the ocean to feed actively in the inshore areas where baitfish are plentiful. They have a shorter upstream migration and begin spawning within a few days of reaching their home gravel.

In the spring after the eggs hatch and the alevins develop into fry, the ocean-type fry begin a slow downstream migration and spend their first summer in the estuary. For the stream-type fry the migration is much longer (their home gravel is in the upper reaches of the river far from the ocean) and they spend their first summer in the river, and do not begin their migration to the ocean until a year later. Most hatcheries which raise chinook salmon raise ocean-type chinook because they can be released into the river at the fry stage when the salmon are only four or five months old. It is not necessary to raise ocean-type fry at the hatchery through the summer and subsequent winter, and they do not compete with steelhead trout and coho salmon for habitat in the river.

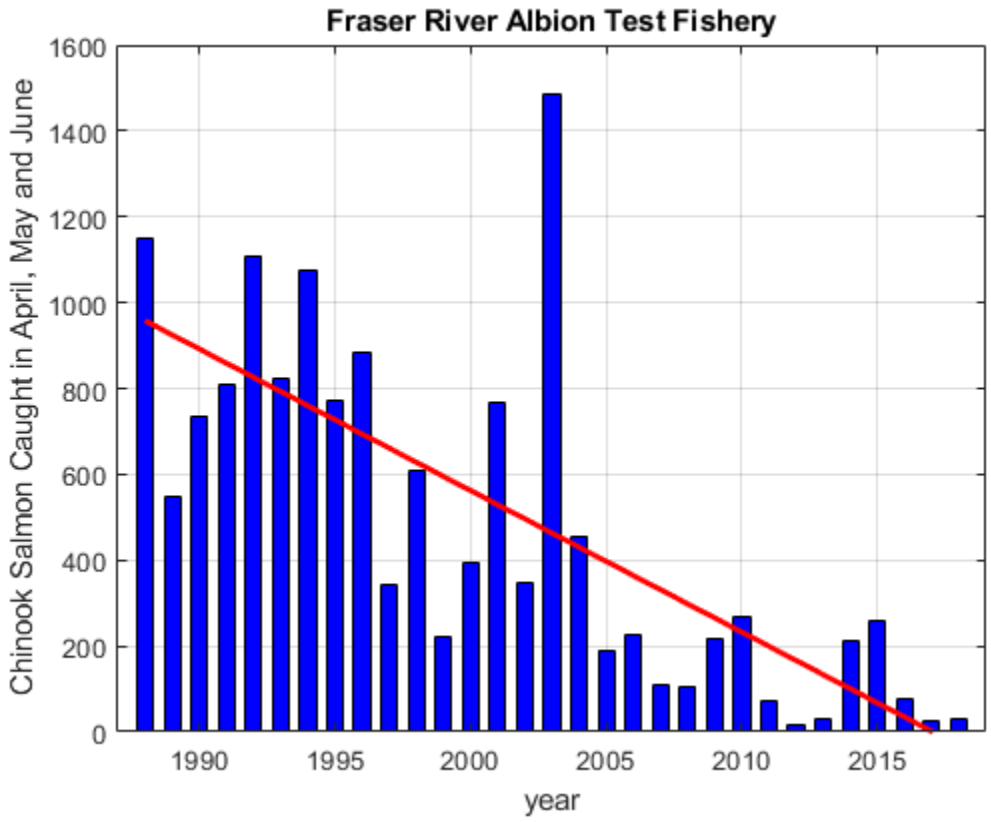
Since stream-type chinook spend their first summer in the river, they are very dependent upon summer water levels. For them low water in the summer means restricted habitat, more competition for food, fewer places to hide and a lower survival rate.



The graph above shows adult chinook salmon which enter the Fraser River during July, August and September. These are mainly ocean-type chinook which spawn in the lower tributaries near the ocean (examples include the Harrison and Chilliwack /Vedder Rivers, which are tributaries in the Fraser Valley near Vancouver). These are also salmon which are heavily supported by hatcheries, such as the hatchery on the Chilliwack/Vedder River.

The increase in the graph from 1988 to 2001 might be explained by an increase in hatchery production. The decline since 2001 is most likely caused by poor ocean conditions (repetitive El Ninos and the “warm blob” a few years ago).

Fraser River Stream-Type Chinook



The ocean-type chinook have done reasonably well compared with the stream-type chinook, shown in the graph above (they enter the river in April, May and June). Stream-type chinook spawn in the headwaters of snow fed tributaries and are very sensitive to winter snow accumulations. In particular a poor snowpack will result in reduced river volume during the spring freshet, making it difficult or impossible for the returning adult salmon to reach their spawning gravel in the upper tributaries. Reduced rainfall in the summer months also means less habitat for the juvenile chinook salmon as they spend their first summer in the river.

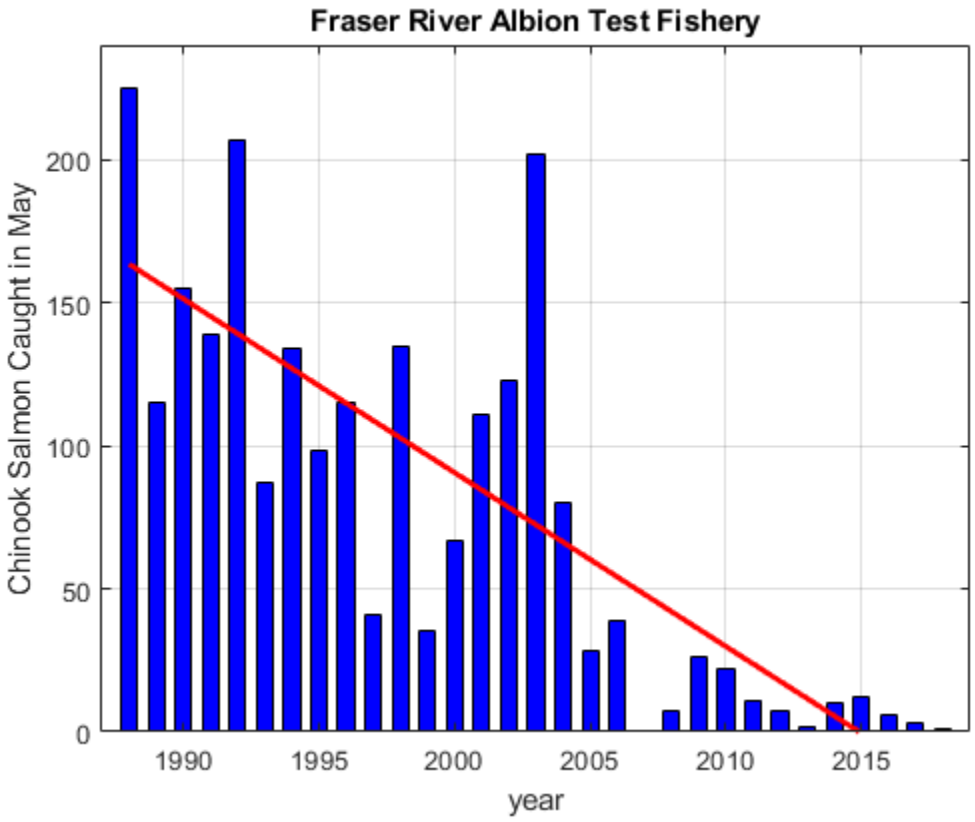
A recent technical paper is very interesting: Menounos, B. (2019) "Heterogeneous changes in western North American glaciers linked to decadal variability in zonal wind strength" published in AGU100 Geophysical Research Letters.

The researchers analyzed the mass budget of Western North American Glaciers over the period 2000 to 2018. They found that glaciers in Alaska and the BC interior lost ice (due to reduced winter snowfall and accelerated summer melt) while during the last ten years of this period there was an increase in glacier ice in the Cascade Mountains of Washington State.

During winter the jet stream normally enters North America over Vancouver Island and carries with it major storms with a lot of rain and snow. This is the reason why coastal BC has traditionally had wet winters.

The change in glacier mass coincided with a southern shift in the jet stream during 2009 to 2018 which resulted in winter storms entering North America south of the US border, bringing rain and snow to Washington State while British Columbia experienced higher air pressure and dryer than normal winter conditions.

There are likely many reasons for the decline in Fraser River stream-type chinook salmon. However after reading this paper I think climate change in the BC Interior might be a big factor (and this is the same climate shift which has resulted in record summer wild fires in BC).



The above graph shows chinook salmon caught at the Albion test fishery during May. As a teenager during the 1960s I used to fish the gravel bar at Brownsville, just south of the Patullo Bridge, and at the time the main chinook runs took place in May and June (the later summer runs were minor in comparison). The decline over the past thirty years has been somewhat precipitous. In 2018 during the entire month of May only one chinook salmon was caught in the Albion test fishery.

Summary: The BC stream-type chinook salmon are getting hammered by climate change. Steelhead trout also spawn in the upper tributaries of snow fed rivers. Both steelhead trout and coho salmon spend the first summer of life in the river and their survival is similarly impacted by summer drought. Climate change is real and it is hitting hard.

DFO Fishery Notice FN0404 Issued May 23, 2018

As I mentioned earlier, last year during the entire month of May only one chinook salmon was caught in the Albion test fishery. You might wonder if this caused any concern at Fisheries and Oceans Canada. Not to worry, they were monitoring the situation. The following excerpt is from DFO Fisheries Notice FN0404 which was issued May 23, 2018. You can read the full notice at https://notices.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?pg=view_notice&DOC_ID=208099&ID=all.

"In 2018, the Albion Chinook test fishery began operating on April 22. The total catch for the period of this update (May 6 to May 19) was one (1) Chinook. Based on this input, the current predicted return to the mouth of the Fraser for the Fraser River Spring 5-2 and Summer 5-2 Chinook aggregates ranges from 21,000 to 54,000 Chinook (median value of 33,850).

The next scheduled update is on May 29 and the final in-season update is planned for June 18."

Summary: The math doesn't work. I'm calling "bullshit" on this one.

Alaska Halibut

In 2014 the groundfish trawl fishery in the State of Alaska Bering Sea Aleutian Islands (BSAI) region took a bycatch of 4.56 million pounds of halibut. This was seven times the halibut catch landed by the directed (legal, regulated) Alaska halibut fishery, which has had its quota reduced by 70% in the past ten years.

Bottom trawling destroys habitat and takes primarily juvenile halibut (60% to 80% under 71 cm long). More than 70% of the juvenile halibut in the Bering Sea eventually migrate to the Gulf of Alaska and as far south as Northern California.

To put this in perspective, for 2019 the Fisheries and Oceans Canada sport fishing allocation for the entire BC coast is 890,013 lbs of halibut.

BC, Washington, Oregon and California have instituted regulations which have virtually eliminated halibut bycatch in their trawl fisheries. Alaska remains the hold out. Fisheries and Oceans Canada is particularly concerned because halibut migrate, and overfishing in Alaska impacts BC halibut.

Summary: On March 29, 2019 Fisheries and Oceans Canada reduced the sports fishing halibut possession limit to one halibut between 90 cm and 126 cm or two halibut each less than 90 cm in length https://notices.dfo-mpo.gc.ca/fns-sap/index-eng.cfm?pg=view_notice&DOC_ID=220245&ID=all. This

reduction in possession limit is partly due to concerns about deteriorating ocean conditions, but also because of the Alaskan refusal to practice modern conservation methods.

Chuck's Trip to North Island Lodge

My friend Chuck Gould made a trip to the West Coast Fishing Club North Island Lodge at Langara in mid-June. He arrived on a Monday and with his fishing partner in the first afternoon they caught twelve springs, most between six and ten pounds (the largest was 13 lbs).

The next morning Chuck and his partner were on the water early, and to their surprise were surrounded by the commercial troller fleet. He personally counted 63 trollers (many were US boats). Fishing slowed down considerably that day. Wednesday was slower again and by Friday it was practically dead. Chuck changed to flasher and hootchie for the last couple of days and managed to pick up four springs to take home, none of which were over 14 lbs. Compared with other fishermen he did well. The lodge was 80% guided and guests took home an average of just two chinook each for the trip (the possession limit was four chinook).

We learned later that many of the lodges at Langara Island have an informal agreement that guided boats will only fish cut plug herring. Since Chuck and his partner were unguided (and unaware of the agreement) they were able to fish with flasher and hootchie, which saved the last couple of days of the trip for them. Still he was very disappointed with the small size of the chinook salmon.

DFO had allocated a total allowable catch of 131,300 chinook to be shared between sport and commercial troll fishermen in the area (remember that in Alaska the 2018 total commercial harvest for chinook salmon was only 234,614 fish). The initial commercial opening was for 93,900 chinook, or 390 salmon per commercial troller. This works out to a maximum of 240 commercial trollers of which Chuck counted 63 in the immediate area around his boat.

Unfortunately the vast majority of the chinook salmon caught by the commercial fleet were six to ten pounds. Very few would have exceeded 14 pounds and salmon above 20 lbs would have been very rare indeed. These six to ten pound salmon were resident chinook, which would otherwise have provided good fishing the following summer (2019) for salmon in the high teens, and many would have been in the high twenties or low thirties by 2020. Unfortunately the commercial boats killed these salmon last summer, several years before they reached maturity and were ready to begin their spawning migration.

If those salmon had been left one or two years before they were harvested the returns to both the sport fishing industry and to the commercial troll fleet would have been far greater.

Summary: Killing a hundred thousand resident chinook salmon at the six to ten pound size, several years before they reach maturity seems very short sighted. My observation is that Fisheries and Oceans Canada (DFO) is primarily driven by political considerations, rather than science.

Sue Grant, Fisheries and Oceans Canada

Last November I attended the Sports Fishing Institute of BC annual conference, where Sue Grant from DFO provided a preliminary salmon outlook for 2019.

She outlined some of the environmental conditions that salmon returning in 2019 have experienced:

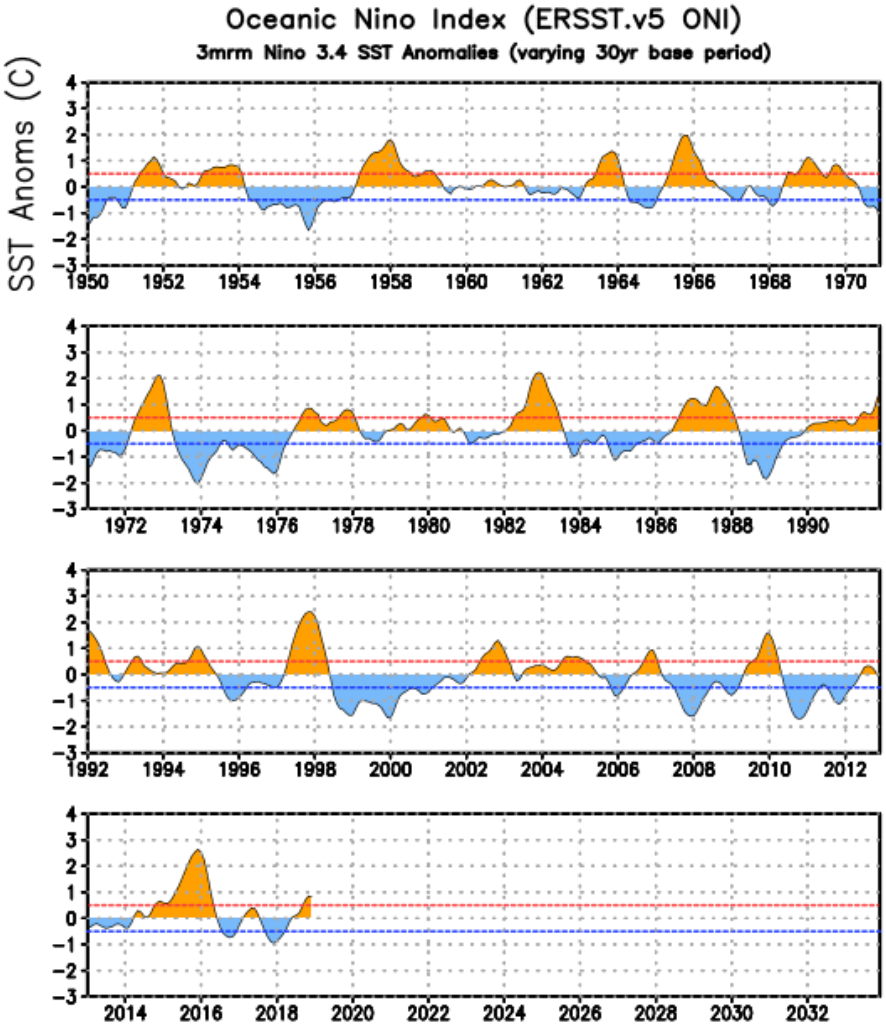
- 0.07^{o}C temperature increase per decade over past 100 years (0.7^{o}C total)
- snow pack has been declining and in recent years there has been virtually no snow pack in the spring months
- warmer air temperatures in summer and warmer river water temperatures during upstream migration (less dissolved oxygen in the water)
- loss of forest canopy due to logging, pine beetle and forest fires. Loss of fresh water habitats.
- drought conditions in the Skeena/Nash in summer months.
- earlier ice-off in lakes, earlier river freshets and earlier smolt migrations (do they arrive in the estuary at the right time?)
- in 2018 the Bering Sea was particularly warm. A second “warm blob” is developing in the North Pacific Ocean.

There has been a coast-wide reduction in chinook stocks. On average chinook are smaller, and also smaller at age (the implication is poor ocean conditions and less feed, resulting in higher mortality and slower growth).

Summary: Global warming is real.

El Nino and "The Blob"

As I write this (in April 2019) weak El Nino conditions are present in the tropical Pacific but have not yet coupled to the atmosphere off western North America. These conditions are likely to persist through spring 2019. Due to the expected weak strength of this El Nino, NOAA does not anticipate widespread or significant global impacts.

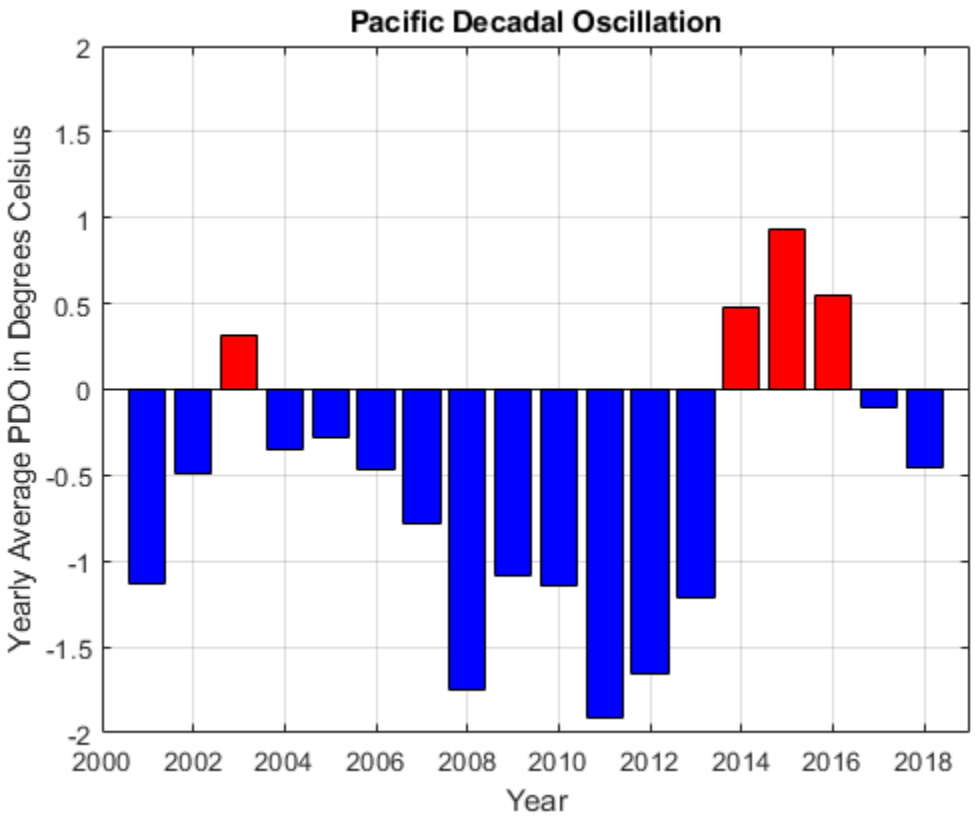


As can be seen from the graph above, in 2016 we experienced one of the strongest El Nino's on record which was preceded by the 2014 "warm blob" in the Gulf of Alaska. This was devastating for the fisheries. The last two years (2017 and 2018) have been relatively normal with cooler water in the Gulf of Alaska, and we are now in another mild El Nino phase. The computer models suggest that this will be a weak El Nino with no widespread or global impacts, but we will only know for certain when it is over (and that huge El Nino in 2016 also started slowly).

Last summer “the blob” of warm water returned briefly to the Gulf of Alaska, then was apparently mixed with colder, nutrient rich water from deeper in the water column during the fall and winter storms (I’ve got my fingers crossed that this is true).

For the latest update on the El Nino / La Nina Southern Oscillation see https://www.climate.gov/enso. The NOAA “expert discussion” is available here: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf.

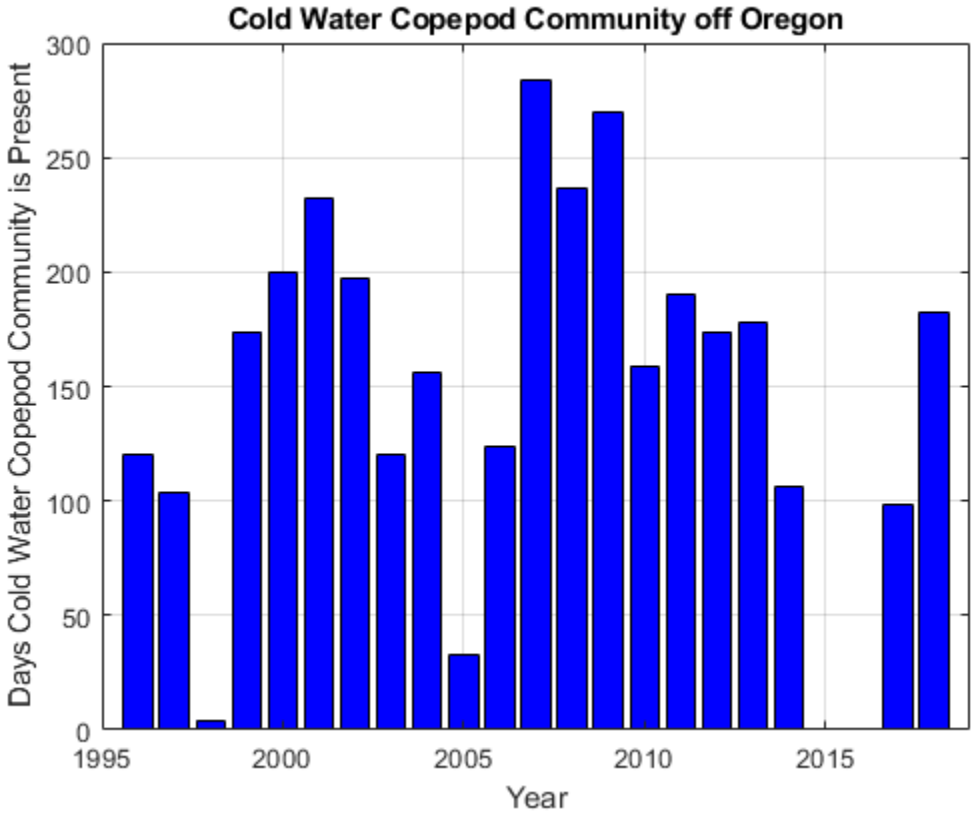
The Pacific Decadal Oscillation (PDO) index (https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm) is a measure of water temperature off the coast of Oregon. This index is positive during El Nino episodes (which are harmful to the salmon) and negative during periods of strong upwelling which are beneficial to the salmon. As can be seen from the diagram below the PDO has been positive during the recent “blob” and El Nino events. It is now negative, indicating that ocean conditions for salmon are improving.



A very useful measure of the health of the oceanic food chain leading directly to salmon is the date of biological spring transition (https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ec-biological-spring-trans.cfm) measured by the Northwest Fisheries Science Center, which is based in Seattle.

During the winter months the current along the California, Oregon and Washington coasts flows north, pushing warm subtropical water and zooplankton with it. This subtropical water has been depleted of nutrients and the accompanying zooplankton species have low food value for salmon. This winter current is called the Davidson Current. Then the onset of sunny spring weather brings winds from the northwest which reverse the direction of the current, now called the California Current. These winds push cooler water from the north and cold water zooplankton species into the area and also cause upwelling along the California and Oregon coasts. The upwelling brings nutrient rich water to the surface which feeds and sustains the summer phytoplankton and zooplankton bloom.

The Northwest Fisheries Science Center measures the date of transition between the winter (warm water) and summer (cold water) copepod species. Several of the cold water copepod species are particularly high in lipids and Omega 3 acids, and when these copepods are plentiful the juvenile salmon grow rapidly and experience low winter mortality. The date of arrival of the cold water copepod community and the number of days during the summer that they are present are two critical measures of ocean health off the California, Oregon and Washington coasts.



After two disastrous seasons (2015 and 2016) the cold water zooplankton community did arrive in late June 2017. The 2018 season was a return to normal, and hopefully the juvenile salmon will have had good winter survival.

Summary: Ocean conditions off the BC coast have changed for the better. The salmon smolts that migrated down the rivers and entered the ocean in 2017 and 2018 encountered excellent conditions and should have had high survival through this last winter, however it will be another year or two before they return as adults. This summer chinook salmon (at least those that survived the commercial harvest last summer) are likely to be in the high teens and low twenties, while coho runs on the central coast may be quite good. The Fraser River should have a good return of pink salmon this summer.

DFO and the 2017 State of the Ocean Report

The Fisheries and Oceans Canada 2017 State of the Ocean report is now available at http://www.dfo-mpo.gc.ca/oceans/publications/soto-rceo/2017/index-eng.html. This report is one of the best documents produced by DFO each year and is well worth reading.

The 2018 State of the Ocean report should be available later this year.

Caamano Sound

In late July I made a trip to North King Lodge with my fishing partner Scott Colyer. I've been to the lodge many times as guest and as a fishing guide, but this trip in was really special. It was an absolutely clear day and we had the good fortune to fly to the lodge in a Hunter RD4 helicopter. This is a small helicopter with room for the pilot, two skinny passengers and a couple of light bags. The front is a big bubble, similar to the Korean War era helicopters and it provided exceptional visibility. It was a fantastic trip from Bella Bella airport across Laredo Sound and Aristazabal Island to Borrowman Bay.

Unfortunately the rest of the trip was not as good. The moon was full and the weather was clear, with the result that the salmon fed during the night. Fishing was dead slow. We also found that although there were lots of small springs in the area there was practically nothing larger than ten or twelve pounds, and there were very few coho.

The halibut fishing was the best I've ever seen, however with the recent change in regulations (maximum 115 cm last summer) it was hard to find a halibut small enough to keep. The first afternoon Doug and Glenn in the buddy boat released a 130 cm halibut (60 to 65 lbs) which they caught while fishing for salmon with flasher and hootchie. The second day I was able to find a 17 lb halibut that I kept, and on the third day Glenn released a 150 cm (about 105 lbs) halibut. On the final morning Scott caught a 135 cm halibut (about 70 lbs) which was a personal best for Scott and he was very disappointed to release it. That morning Doug and Glenn caught a 115 cm halibut (about 40 lbs) which they were able to keep.

I think most of these big halibut after being released just swam back down to the spot where we caught them. Halibut are territorial and the largest halibut muscle out the smaller halibut for the best resting spots. The really big halibut get caught repeatedly during the season. With the present regulations if you are fishing a good halibut spot it is likely that you will catch a halibut too big to keep, which might be

great if you enjoy catch and release fishing for halibut. Personally I don't, I find halibut to be dead weight and a lot of work to get to the surface.

The guides told us that they were catching about fifteen smaller chinook (six to ten pounds) for every chinook in the mid-teens that they kept. It was steady catch and release, sorting through the small chinook for the occasional larger salmon that a guest would take home. I suspect that many of those smaller chinook that were caught repeatedly through the season would be bleeders and would not survive. Not the type of fishing that I enjoy.

Summary: If possible avoid the full moon. And maybe, if any of those smaller chinook have survived, they will be larger this summer.

Milbanke Sound

On the last day of our North King trip Scott and I flew back in the RD4 to the Bella Bella airport, where I said goodbye and took Don's taxi down to the government dock to meet Dave Algra.

Dave is an interesting fellow. We guided together at West Coast Resorts for several seasons, then last spring he bought a 28 ft Kingfisher welded aluminum boat with the intention of fishing the central coast during the summer. On this trip Dave and I fished with his friend Dion, who is a chef and owns a small restaurant in Abbotsford. Dion hadn't taken a vacation for years and this was a great opportunity for him to see the central coast.

Over the next five days we tried all of our favourite spots in Milbanke Sound (Idol Point, Christensen Point, Cheney Point, Cultus Sound, Spider Island, Cape Mark, McInnes Island, Cape Swain). To our surprise we found that Idol Point was the best spot, and the fishing was much better than it had been a week earlier at North King Lodge. Still lots of small springs but every day we were also catching a few springs in the 20s. The best results were with the T10 flasher and mint green (Joanne) anchovy teaser head. The same flasher with army truck hootchie also produced well.

Summary: Idol Point is a good fishing spot and is close to Shearwater in protected water.

Red Flashers

For years I used the generic red flasher but last summer Dave Algra introduced me to the Gibbs/Delta Highliner Guide Series T-10 flasher. This has the same generic red plastic around the outside but the foil is glow on one side and UV/MoonJelly on the other. In Milbanke Sound last summer this flasher outfished by a wide margin all the other gear on our boat. This flasher is sometimes difficult to find in the stores but is well worth the effort.

Summary: My "go to" red flasher is now the Gibbs/Delta Highliner Guide Series T-10. Don't leave home without it.

The River of My Dreams

Imagine a river of deep pools and long runs, with wide gravel bars to provide easy access and plenty of room for the back cast. Crystal clear water, safe wading and many salmon in each pool, dark shapes clustering near the far bank with occasional splashes on the surface. Thirty or forty salmon in some pools and a few hundred in others. Chinook that have already spawned and are slowly holding station in slow water, waiting to die. Chum that have moved into the lower pools and are preparing to spawn, and bright, strong coho that are slowly working their way up the river to the uppermost pools and the smaller tributaries. And the occasional bright summer run steelhead holding in shallow, faster water near shore.

All this in an old growth forest which has never been logged and which is loaded with wildlife. Huge hemlock and cedar trees on each side and enormous fallen trees in the river itself, roots and trunks providing structure for the salmon to hide during daylight hours.

Bill With a Chrome Bright Coho

Many footprints in the sand and gravel along the bank. Wide bear prints everywhere, deep elk prints and occasional wolf tracks. No human footprints – on a ten kilometer section of the lower river only two fishermen, my partner Dave Algra and myself, and our guide.

Dave by the Big Stump

As a teenager I read the Roderick Haig-Brown books and in my mind imagined a river pretty much identical to this one – it just took me a few years to find it. It was an incredible trip, although in hindsight the fishing was difficult and slow.

It was the first week of October and we were fishing the Tahsish River in Tahsish-Kwois Provincial Park, in Kyuquot Sound on the west coast of Vancouver Island. The fishing was fly only and we released every salmon we caught.

I learned during the trip that the salmon enter the river during heavy rain as the river changes colour and rises, and are relatively easy to catch as the river drops. However the Tahsish is a small river and drops very quickly, usually within 48 hours. In low water conditions the first person fishing a pool at dawn might find self-assured salmon which are a tad aggressive, but anyone fishing behind him would likely find skittish salmon that have been spooked at least once and are now just looking for a place to hide.

It had been a very dry fall, our timing was not the best and we had to work hard for the few salmon we caught. But what a river! I can only imagine what the fishing would be shortly after a rain. And catching a monster coho or chum salmon on the fly is unforgettable.

Dave With a Big Chum Salmon

Summary: Visiting the Tahsish River to fly fish for coho and chum salmon was definitely a bucket list item.

Salmon Farming on the BC Coast

Dr. John Madden was a speaker at the Sports Fishing Institute of BC annual conference last November.

The problems with net containment salmon farming in British Columbia are well known. This type of salmon farming has been outlawed in Washington State, and it is likely that many of the net containment farms in British Columbia will be shut down in the near future as their permits come up for renewal.

Dr. Madden also talked about the Atlantic Sapphire closed containment salmon farm in Miami https://www.seafoodsource.com/news/aquaculture/atlantic-sapphire-building-usd-350-million-land-based-salmon-farm-in-miami . I found this particularly interesting. When it reaches full operation Atlantic Sapphire will have a yearly production of 90,000 tonnes of Atlantic salmon, similar to the total BC production today.

Atlantic Sapphire is located on the east coast of the United States and is unique in being close to the end customers (most salmon sold in the US market is flown in from Norway, Chile, or Canada and has high transportation costs).

Summary: If Atlantic Sapphire is successful it could make all existing salmon farms obsolete.

Little Campbell River Salmon Hatchery

A year ago I joined the Semiahmoo Fish and Game Club, which operates the hatchery on the Little Campbell River in South Surrey.

It's been a wonderful experience. My role is to act as a tour guide for elementary school classes. Typical classes are Kindergarten through Grades 2 and 3, and consist of 25 students plus the teacher and six or eight parents. We provide fertilized coho eggs in December, which the classes raise in their classroom through the alevin and fry stages. In April or May they visit the hatchery to release the fry into the river.

Highlights include the children lining up along a gravel bar, each with a small plastic cup containing a coho fry. They name the fry and wish it good luck on its journey, then gently tip the cup into the river and watch the fry swim a few feet away to join its buddies.

Summary: The children love the field trip and their salmon. Huge smiles all around. I'm hoping that we are also raising the next generation of environmentalists.

Salmon Camouflage

As a teenager my father and I mooched with live herring for salmon in the Pender Harbour area, and I can remember watching the herring in our bait tank change the colour of their backs to match the light conditions. The salmon fishermen in the area understood that herring could change their colour to match the surrounding water.

Later as a fishing guide at a lodge I mentioned this to the other guides and they laughed at me. They did not believe that this was possible with herring or salmon. Although I had never actually watched a salmon change its colour, I had read that it is possible and I had seen salmon with green, blue, purple, and coppery brown backs. I had also noticed that the salmon colour becomes much less vivid after it dies.

At the hatchery we remove a small number of coho fry from the big tank (indoor, low light conditions) and place them in a white plastic bucket outdoors prior to release. Over a period of minutes the backs of

the coho fry change from dark brown to light brown. Then when the children release the fry into the river, the fry swim closer to the bottom in a shady area and we can watch as their backs darken to match the colour and shade of the river gravel below.

Summary: Salmon really can change the colour of their backs over a broad range to match the colour of the water or gravel below. The change is neural, controlled by their brains, and can take place in less than a minute. Neural control ends when the salmon dies which is why dead salmon appear more silvery in colour (the white and silver skin cells are not under neural control).

Fish Hatcheries

I recently came across an interesting paper by Hitoshi Araki, Becky Cooper and Michael Blouin "Genetic Effects of Captive Breeding Cause a Rapid, Cumulative Fitness Decline in the Wild", published in Science October 5, 2007, volume 318. (Note that although the paper as published in Science is concise and difficult to read, the supporting online material is easier to follow and provides useful background information).

The authors studied steelhead trout in the Hood River in Oregon. This is one of only a couple of rivers on the west coast (the Little Campbell River is another) where all returning salmon and steelhead can be counted and sampled. Since 1991 every adult steelhead returning to spawn in the Hood River has been catalogued, measured, and had scale and/or fin-snip samples taken for DNA analysis at the Powerdale Dam fish trap by staff of the Oregon Department of Fish and Wildlife (the spawning beds are located above the dam). Between 1991 and 2006, when the study was published, more than 16,000 steelhead trout had been sampled and through the DNA samples their ancestry was determined exactly.

The study began in spring 1993 when only wild-born fish ("first generation") were collected as broodstock and their offspring raised in the hatchery.

The majority of the hatchery raised offspring ("second generation") returned to the river to spawn in spring 1996. Of 232 crosses performed in the hatchery that year, 167 were captive-raised crossed with wild-born steelhead (captive X wild). The remainder were wild-born crossed with wild-born (wild X wild).

These offspring ("third generation") had different genetic backgrounds but were raised together in the same environment in the hatchery and acclimated and released identically. The only difference was the origin of a single parent (captive-raised or wild). The purpose of this paper was to compare the reproductive success of these two groups.

The majority of the third generation offspring returned to the river in spring 1999 and were allowed to spawn naturally in the gravel. Their offspring ("fourth generation") grew up in the wild and returned to the river as adults between fall 2001 and fall 2004. The DNA was analyzed to determine their ancestry, and based on the "fourth generation" returns the relative reproductive success of their parents ("third generation") was calculated and compared with wild steelhead in the river, which were used as the control group.

The researchers found that when a steelhead raised in the hatchery from two wild parents was allowed to spawn in the river gravel with a wild adult, the reproductive success of the union was 60% that of two wild adults spawning in the same gravel (reproductive success is calculated based on the number of offspring from the union which later return as adults to spawn).

They also found that when a steelhead raised in the hatchery from one hatchery parent and one wild parent was allowed to spawn in the river gravel with a wild adult, the reproductive success of the union was 31% that of two wild adults spawning in the same gravel.

Note that this reproductive success could be calculated very accurately because all returning steelhead were caught in the trap below the dam, and the parentage of both hatchery and wild steelhead could be accurately determined through DNA analysis. This study was quite remarkable in its thoroughness.

The authors suggested possible mechanisms for the fitness decline of hatchery raised fish in the wild. These mechanisms included domestication selection, relaxation of natural selection, and heritable epigenetic changes.

The study concluded that steelhead raised in a hatchery environment were less fit than steelhead raised in the river, and that this loss of fitness was genetic and was passed to future generations. The results suggest that even a few generations of domestication may have negative effects on natural reproduction in the wild and that the repeated use of captive-reared parents to supplement wild populations should be carefully considered.

This year DFO is increasing hatchery production of chinook salmon. In British Columbia virtually all of the hatchery raised salmon, as returning adults, are allowed to spawn in the river gravel with wild salmon.

Summary: Hatcheries are beneficial in that they increase the number of steelhead and salmon available to predators such as orcas, eagles, bears and humans. They are also outstanding for introducing children to nature. However interbreeding between hatchery fish and wild fish on the spawning grounds reduces the fitness of the wild population -- steelhead and salmon raised in a hatchery should not be allowed access to the spawning beds in the river.

Southern Resident Killer Whales

There has been a lot of press recently about the Southern Resident Killer Whales (SRKW), most of it poorly informed.

Dr. Andrew Trites works at the Marine Mammal Research Unit, Institute for the Oceans and Fisheries, University of British Columbia. He was a speaker at the Sports Fishing Institute of BC annual conference last November. Please check out this video "The truth about orcas, seals and chinook: a Pacific Science Foundation Presentation" at https://www.youtube.com/watch?v=9Zz8aEAg7dI

The popular press claims that the SRKW population has dropped from 98 individuals in 1995 to 74 today and the whales are in imminent danger of extinction. Some people hear this and conclude that all killer whales are in danger of extinction. The facts are more complex.

There are four major types of killer whales (orcas). The "resident" killer whales eat salmon, travel in large groups and hunt cooperatively using echo location. The "transient" killer whales eat seals, sea lions and sea otters, travel individually or in small groups and do not use echo location when hunting (it would alert the seals). The "offshore" killer whales live in the blue water parts of the oceans well away from coastal regions and hunt basking sharks. Recently a fourth type of killer whale has been discovered in the Southern Ocean and these appear to have similar habits to the "offshore" killer whales.

The SRKW population has varied from 78 individuals in 1960 to a low of 66 individuals in 1973, a high of 98 individuals in 1995, and to the present population of 74. Increases in the population correlate well with times of high chinook abundance, however genetics suggest that this population has been below 100 individuals for the past hundred years and has probably never exceeded 100 individuals. The SRKWs are "endangered" under Canadian law because they are a small population, but in fact they are likely to never come off the list.

The SRKW population ranges from the Sacramento River delta in California to the northern end of Vancouver Island. The Northern Resident Killer Whale population ranges from the Alaska border to the south end of Vancouver Island. Think of them as two tribes which share adjacent territories and fight when they come in contact. SRKW territory overlaps with the northern residents, and the northern resident population is growing. There is aggressive interaction between the two populations and they do not willingly share habitat – they fight over it and the SRKW population is losing the fight and is being pushed further south.

Some media designated "killer whale experts" have suggested that SRKWs are starving due to lack of food, mainly chinook salmon. Media coverage has focused on individual whales which were thin and appeared emaciated. Dr. Trites believes that this concern is misplaced. Killer whales share food. It is not likely that in a pod of healthy individuals one whale would starve.

Killer whales are an apex predator, similar to humans. He gave the example of a visit to a cancer ward at a hospital. Most of the cancer patients would appear to be emaciated, however they are not starving – they are suffering from a disease. When wildebeest on the African plains are diseased they are quickly

eaten by lions. It is rare to see a diseased wildebeest or zebra in the wild. When apex predators suffer from disease (like cancer) they are more visible and often appear to be starving.

Dr. Trites said that on average Southern Resident Killer Whales are thinner than Northern Resident Killer Whales, and this does indicate a nutrition issue. In 2012 studies showed there were enough salmon for the southern residents. In 2017 studies also indicated enough salmon but the orcas might be having difficulty getting to them because of boats around the whales. DFO responded with a 200 meter exclusion zone. Washington State has proposed a 400 meter exclusion zone for 2019 and a ban on whale watching SRKWs (commercial whale watching in Washington State will be limited to transient killer whales).

The SRKW group overwinters in Oregon and California and returns to our area in the spring in poor condition. Dr. Trites believes that there is a food problem, and it is in Oregon and California. Unfortunately this is related to climate change and there is little we can do about it. The SRKW are being squeezed between declining chinook runs in the south and the expanding population of Northern Resident Killer Whales in the north.

There was a recent paper suggesting that killer whales around the world are in danger due to environmental pollution and in particular PCBs. Dr. Trites does not believe that PCBs are to blame for problems with the SRKWs. Transient killer whales in BC are “off the chart” with respect to PCB levels and they are thriving (they get their PCBs from the seals they eat, which concentrate PCBs to a much greater extent than salmon). Present transient killer whale PCB levels are more than 20 times recommended levels but are dropping over time (PCBs have a relatively short half-life in the body). SRKW PCB levels are near or slightly above the recommended safe levels.

Blaming the Seals

There is a group in BC lobbying for a commercial (not ceremonial) seal kill. Dr. Trites believes that this would be a bad idea.

Until 1970 seals were regularly shot by commercial fishermen. Seals and sea lions are now protected under law, and since 1970 the sea lion population in southern BC has increased considerably. The harbour seal population has increased ten-fold, from 10,000 in 1970 to approximately 100,000 today. The local harbour seal population is now at carrying capacity and has been stable for the past 20 years.

In the fall about 20% of returning adult salmon (chum, pink, sockeye, chinook and coho) are lost to seals. During the 1980s seal diet was primarily hake and herring with about 4% salmon. In 2010 it was similar except with 12% salmon in the spring and 30% salmon in the fall, primarily chum.

Culling the seal population would allow the hake population to increase, and hake are a major predator of juvenile salmon. There are far more hake than seals, and culling seals is likely to harm the salmon.

This increase in the seal and sea lion population in the local area has resulted in more frequent visits by transient killer whales. Twenty years ago they were almost never seen in the Salish Sea, however during 2017 transient killer whales were present for more than 280 days (it was likely longer but few whale watchers are on the water in the winter months). On some days more than 45 individual transient killer whales were observed. There were more than 225 different transient killer whales observed in the Salish Sea during the year. They feed almost exclusively on seals and sea lions, and are controlling the population. Dr. Trites expects that in the next couple of years the local seal population will begin to decline as the transient killer whale population continues to increase.

Culling seals will also harm transient killer whales, as they prefer harbour seals to other mammals and it would reduce their food source. Dr. Trites is adamantly opposed to culling the harbour seal population – he believes this would result in a decline of the transient killer whale population which would otherwise balance the harbour seal population on its own, and that this would be a political and public media disaster.

DFO are considering a seal kill in the Strait of Georgia.

Global Warming and Salmon

Last summer I fished in the Chinook Classic Salmon Derby, which took place at the mouth of the Fraser River during mid-August. For the two days of the derby we had clear (no clouds) sunny weather and poor visibility on the water due to heavy smoke from forest fires in the interior of the province. It seemed that throughout the summer most of BC, Washington, Oregon and California was in flames. And it's not the first time – this has been the situation for several years, each worse than the year before. Each year the dry weather is beginning earlier in the spring and extending later into the fall, and the fires are causing a lot more damage. One of the consequences of the dry summer weather is less water in the rivers and reduced habitat for steelhead trout and chinook and coho salmon. It's not surprising that all three species are in decline.

Last fall at the Little Campbell River fish hatchery the river was very low through September and October until the fall rains finally began in early November. As a result the runs of chinook and coho salmon were trapped in tidal portion of the lower river and suffered severe predation by seals and river otters. Few of these salmon made it up through the counting fence and upstream to the spawning gravel. This spring we had similar unseasonably dry weather during February and March, which resulted in the returning steelhead trout being trapped in the lower river where they suffered predation by river otters. Again few steelhead made it to the counting fence.

In November the World Meteorological Organization announced that the average CO_2 concentration in the atmosphere had reached 405 ppm, a level not seen since the Pliocene, 3 to 5 million years ago. The International Energy Agency reported that despite worldwide concern about global warming energy related CO_2 emissions increased in 2018 to a historic high of 33 billion tons of CO_2. Emissions increased in the US by 3.3% and in China by 2.5%. Emissions declined in Britain, France, Germany and Japan.

Since 1750 the world's average temperature has increased by 1.0^{o}C, of which 0.8^{o}C has taken place since 1948 (the start of the period when accurate government records have been kept). Environment and Climate Change Canada recently reported that since 1948 Canada's average annual temperature over land has increased by 1.7^{o}C, with higher increases seen in the north, the prairies and in northern British Columbia. Temperatures in Canada are increasing more than twice as fast as the global average.

In April 2019 the World Meteorological Organization announced that the last four years have been the hottest on record. Also 2018 saw new records for ocean heat content in the upper 700 meters, and in the upper 2,000 meters. Warmer oceans mean a warmer, more stable surface layer within which the nutrients quickly become exhausted. As the surface layer becomes warmer and thicker there is less mixing with the colder nutrient rich water below. Warmer oceans are less productive oceans. The "warm blob" of 2014/2015 was a surface layer of warm water in the North Pacific which during the winter months did not mix with the layers below, and was devastating for the salmon.

Summary: Climate change is real and affects us personally. The impact on our grandchildren will be profound. The solution is simple: leave all fossil carbon in the ground and end our dependence on coal, oil and natural gas.

My Website

I welcome you to visit my website (www.thescienceofsalmonfishing.com) where you can check out the book and read my fishing notes from previous years.

Have a great summer and I hope to see you on the water.

Bill Haymond