The Te-Waihora/Lake Ellesmere Brown Trout Fishery "Collapse and the Short Term Recovery"

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March 2016

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The Purpose of This Document

I have lived in Christchurch all my life other than a few years living in the UK on my OE. My profession is an Engineer but my passion is as a fisherman. I value the great New Zealand outdoors, our environment and our wild places.

My family have owned a Bach at the Lower Selwyn Huts since the 1940s and I have grown up spending a lot of time on the Selwyn River and Lake Ellesmere. I was lucky enough to begin my trout fishing days in the 1970s on the Lower Selwyn River and have fond memories of waiting with my father and 30-40 other fishermen for 12.01 am to start the new season at the Selwyn Mouth (new cut as we called it). As I recollect, plenty of fish were caught.

The Te-Waihora/Lake Ellesmere and Selwyn River fishery were prolific for trout numbers and size, being close to a main centre ensuring many angler days were spent fishing. In the 1940-1950 era, the Selwyn River was described as the finest trout river in the nation and probably the world.[1]

Sadly this is no longer the case and the trout fishery has collapsed, it is the best example in the worst way of long term environmental mismanagement in New Zealand and a Fishery collapse of a magnitude rarely seen.

In 1964 The North Canterbury Acclimatisation Society, now Fish and Game, trapped 14,000 trout at Coes Ford who were moving up the river to spawn. In 1984, with the trap located in the same position and at the same time of year, only approximately 40 trout were trapped! This equates to a loss of 99.997% of spawning trout.

My family remember, almost to the day, the trout fishery collapsed. In 1981 we spent the fishing season building an extension to our Bach at the Lower Selwyn Huts (No. 6), which took priority over fishing, as my father said *"the fishing will be there next year"*. How wrong he was because 1981 was the last good *'run'* of trout to enter the river. I vividly remember a local, Cyril Cain, walking past our Bach with his fly rod as we worked on the roof mid-morning. He yelled up at us to stop work as there was a "run of fish at the south west point".[2] We did not stop work but Cyril and several others caught their 'limit bags' that day. Another local, Bill Couch, called us over later to show us 7 lovely trout lying on his lawn.

In 2007, the then Minister for the Environment described the lake as *'dead'*. This initiated many agencies to commission scientific reports and many different groups working on what was required to be done to improve the situation.

The damage appears to have been the result of long and sustained environmental abuse of the lake environment. Some of the issues are environmental and weather related, however, some are man-made and have simply been conveniently ignored.

I have spent many hours reading the documents submitted by the various experts, including the latest state of the lake report.

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1 Game Keepers for the Nation – 2001.
2 South West Point is directly opposite the Lower Selwyn boat ramp.

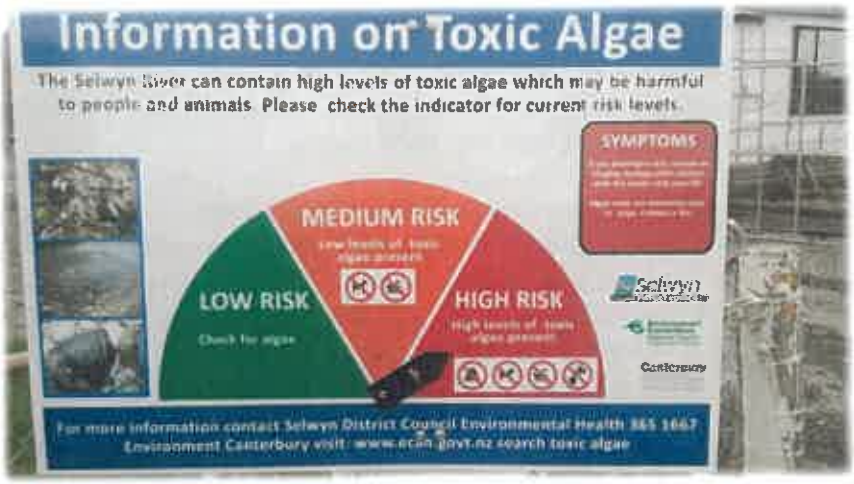

Fig 1: Environment Canterbury Sign - Armstrong Ave, Lower Selwyn Huts, Christmas 2016

It has become obvious that many experts refer to the dramatic collapse of the *'brown trout fishery'* and the lack of recovery. They have acknowledged the trout population has suffered the most from the degradation of the lake and its tributaries. It appears very little has been proposed to be undertaken specifically about the trout fishery. The experts seem to have taken the view that over time (20-40 years), and with enhancement projects (although these are still only in the inception phase), the lake can recover somewhat and they assume so will the trout fishery.

I would like to help or be a part of starting the restoration required to enhance the trout fishery specifically in the Selwyn River. The great work done, and the positive changes at Harts and Boggy Creek, suggests there is hope. If given a chance the environment and the trout population can recover!

My goal has been to assess the many documents written by people, with far more knowledge in this field than myself, and from this information determine 5 practical projects that can be begin immediately to kick start the "The Ellesmere/Selwyn Trout Fishery Recovery".

I am not a fisheries scientist but I do have a rudimentary understanding of the issues and many years of local knowledge. As an engineer I am used to solving complex problems and by using these skills I will endeavour to identify a short term action plan.

These actions must be able to be implemented quickly, have a short term measurable benefit and provide the *'biggest bang for the buck'*. I hope by identifying these projects it may finally get the ball rolling.

Fish and Game New Zealand, the statutory managers of fresh water fish and game, are extremely resource limited. The only funding they have available is from Fishing and Game Bird Hunting licence fees. They have also become one of the few organisations who advocate for the natural fresh water environment and have become by default the *'guardians of fresh water'*.

Unfortunately it has become very clear during my research that the organisations charged with the task of protecting the environment, even though armed with substantial scientific

knowledge, have over a long period of time failed dismally! Possibly due to management decisions, being driven by political aims rather than environmental aims.

Like most recent successful restoration projects (*Harts* and *Boggy Creek*), the actual field work will most likely have to be carried out by volunteers. Unfortunately fishermen and hunters have a propensity to spend any spare time fishing and hunting. Therefore, we will have to attempt to change this culture and get people actively involved in the restoration and enhancement of the environment to support their pass-times. There is potentially a large labour pool available, if people with an interest can be motivated to get out and help.

I feel that it is time to stop talking and start doing something positive!

Fig 2: John Batten with a 6lb Brown Trout from the Lower Selwyn, October 2016

The Good Old Days!

Lake Ellesmere is a large shallow brackish lake located south of banks peninsula. The lake bed was formed many years ago when it was the estuary of the Rakaia and Waimakariri Rivers. Spring fed creeks rise in the low lands surrounding the lake, before draining into the lake. The Selwyn River flows from the Canterbury foot hills and discharges into the lake at the Lower Selwyn Huts.

Many of these rivers are famous trout fishery's. Names like the Selwyn, Halswell, Hart Creek, Irwell and L2 are steeped in Canterbury angling folk law. The Selwyn fly fisherman, David Hope, (Hut owner at the Selwyn Huts) had several of his patterns named after him, the '*Hopes silvery and Hopes dark*', when fished together this set up was termed the '*Selwyn cast*'.

Fig 3: Hopes Silvery

Brown trout were introduced to the Lake Ellesmere system in 1868 by the then North Canterbury acclimatisation society.[3]

3 Game Keepers for the Nation – 2001.

During the 1920s–1930s this fishery became a prolific Brown Trout fishery, the lake also supported good populations of native fish, eels (*Short and long fin*), flat fish and whitebait.

The lake was dominated by weed and considered mesotrophic (*moderate levels of nutrient's*) and had large beds of macrophytes (*aquatic weed - mainly ruppia and potamogeton pectinatus*) which provided food and cover for the various fish species. The weed banks also provided a wave barrier thereby reducing lake edge erosion and sediment re-suspension. Often on still days the water between the weed and lake edge would go clear. Another less obvious benefit of the weed was to provide shade reducing radiant heat, providing protection from the sun and a cool water refuge.

Fig 4: Weed Beds off Timber Yard Point, pre-Wahine Storm

Anecdotally my grandfather and father used to sight fish to cruising brown trout in this clear water area, something which is unimaginable in today's lake conditions. I remember as a young boy sitting in a moored boat in the lake, (Rennies Bay[4]), while my father and his mates walked slowly in line fishing for disturbed trout.

Fig 5: John & Kath Strong, Lower Selwyn Huts

It is calculated[5] that the lake supported a population of between 100,000 to 200,000 brown trout. Percival (1932) said "*The Lake forms a magnificent reserve where fish may be safe from the angler and where they may grow.*" During summer these fish would enter the rivers feeding the lake, following and feeding on the bullies and silveries (*smelt*). This would make the trout available to anglers. In the autumn they would enter the rivers and streams to access spawning areas. This formed what was called a '*run*' of fish which would then move up the river as a group or school.

The main spawning run of trout would occur in autumn, with several thousand fish migrating up the Selwyn River to access the spawning grounds up river. High numbers of fish spawned in the Selwyn main stem, above Coes Ford, and also the sub catchments of

4 Rennies Bay is the bay directly across the river from the Lower Selwyn Huts.
5 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

the Silverstream and Baileys Creek in the low lands. However, most fish travelled further up the river, to spawning areas in the foot hills, including important spawning streams like the Hororata River. Once the spawning was over the adult fish would drop back down the Selwyn River to the lake where they were safe and could recover condition with an abundance of food available. The hatched fingerlings and yearling trout would quickly fill the available space within the river ecosystem, the balance being pushed down the river to the lake. In the lake they could live and grow until they matured and would then repeat the cycle. This movement of fish required adequate River flow for fish passage during these migrations!

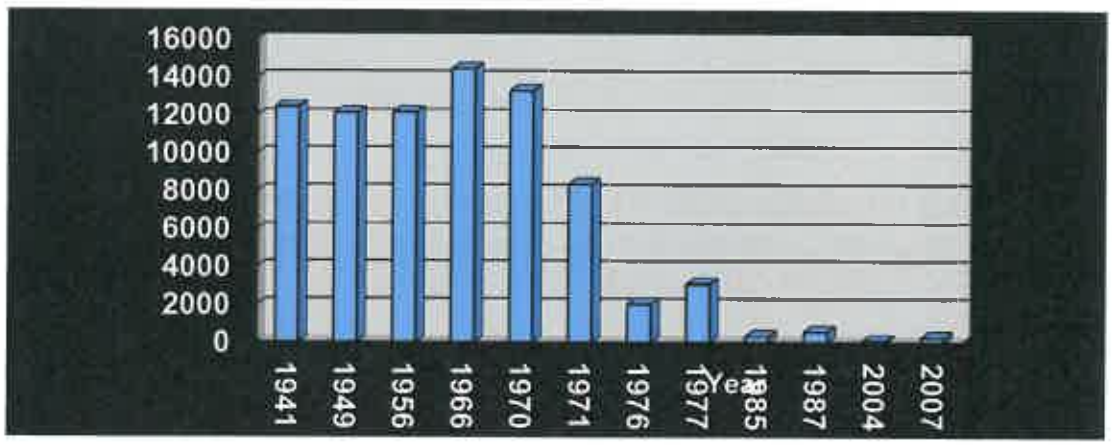

Fig 6: Trout Spawning Numbers Coes Ford 1940-2007

The low land artesian spring fed creeks and small streams of the Ellesmere system all provided good trout habitat but more importantly they provided many kilometres of accessible fine, clean shingle, with clear well-oxygenated water to spawn in. These small streams provided perfect habitat for rearing juvenile fish with good quality water, food in abundance and cover from potential predators. The mouths of streams like the L2, Ewell and Hart Creek were a favoured spot to fish for large lake trout coming into the cooler stream flows at night.

These streams also provided good habitat for native fish, eels, bullies and, at times, silveries.

The lake is mechanically opened to the sea when the lake level reaches a thresh hold height above mean average sea level. This is carried out at Taumutu where the single bar separating the lake from the sea is at its narrowest. The number of openings each year varies depending on the environmental conditions of the season.

The lake level and opening is determined in a Water Conservation Order (WCO) and is discussed by a group of organisations prior to opening. The lake forms the reservoir for much of the drainage system from servicing the area from Halswell to Leeston.

This opening provided the opportunity for trout to access the ocean and generally feed in and around the cut. Trout are known to migrate between river systems and it was not uncommon to re-catch tagged fish from Ellesmere in other systems, such as the Rakaia River. More than likely there was a transfer of genetics between the systems. It is felt that this access to the ocean was unimportant when the lake was extremely productive but now with a degraded lake may be much more important to the trout population.

Fig 7: Lake Opening at Taumutu

Hardy (1989) said that *"Arguably, nowhere in New Zealand has the brown trout thrived better, and been more successful in establishing a large population of large sized fish, than in the Ellesmere catchment - particularly in Ellesmere itself."*

Fig 8: A Beauty with a Fish and Game Booklet for Scale, fish is 650mm long

Fig 9: A Nice Bag of Trout on the Table at the Bach Lower Selwyn Huts

The Collapse

The current state of Lake Ellesmere is well documented and known. In 2007 the Minister for the Environment described the lake as *'dead'*. This has been the catalyst of many studies and reports into the issues. Many agencies have joined forces to understand the issues and plan the restoration of the lake back to its former glory.

As described above, many good people have provided plenty of information about the issues. Studies and trial programs have been implemented. A trail is being run by NIWA to attempt aquatic weed re-establishment, Harts creek and Boggy creek have had sections re-planted and restored. This recovery is expected to be a very long project, some lake water rising from aquifers is said to be up to 100 years old, and pollution created today could take a very long time to work through the system.

My focus is specifically on the Brown Trout fishery and my following comments are specifically related to its virtual extinction and exacerbating issues.

The sad reality is that the brown trout fishery has collapsed and is a shadow of its former glory. The facts are graphically shown below.

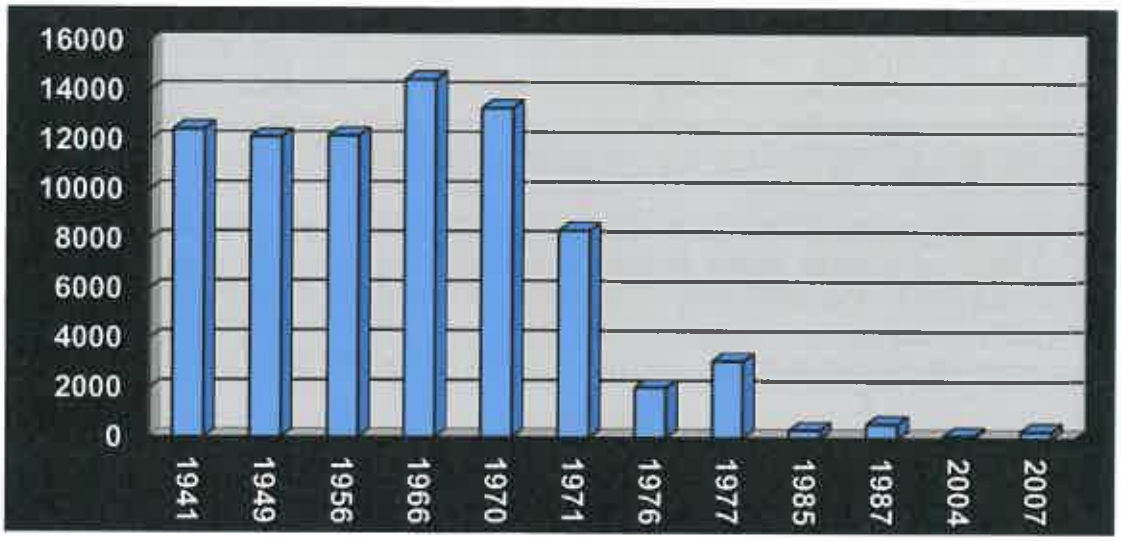

Fig 10: Trout Spawning Numbers, Coes Ford 1940-2007

In 1966, 14,000 Trout where trapped at Coes Ford moving up the Selwyn river to spawn but in 1985 only 40 trout were trapped. This represents a complete population collapse not often seen. For the mathematician's this is a 99.997% reduction in spawning population, effectively the extinction of the Selwyn Trout run!

Millachamp[6] describes the decline as having two distinct phases, *"the post Wahine storm phase 1968-1977 and the latter phase 1977–2007."* He also stated that *"There is still a significant stock of fish in the catchment which a recovery could emanate."*

A realistic short to medium term goal may be to restore the fishery to 1970 levels[7] as a larger recovery back to 1940 levels will be a long term goal or may not be possible at all.

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6 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

7 D J Booker, E Graynoth – Instream Habitat and Flow Regime Requirements in the Selwyn Lower River – 2007, p 38.

Pre-Wahine Storm

The lake and Selwyn River were until the 1968 Wahine storm relatively stable, with the lake being weed dominated and supporting a high number of brown trout. This was the glory days and in 1936 the Selwyn River was considered to be the *"best 3 miles of trout fishing in the dominium and most probable the world."*[8][14].

Post-Wahine Storm

The Wahine storm had southerly winds so sever at Lake Ellesmere that the large beds of aquatic weed (*ruppia*) was literally ripped from the lake bed overnight. The benefit that the lake weed provided the trout was lost and a reduction in trout numbers occurred. The reduction from a peak in 1966 of 14,000 spawning fish at Coes Ford, with estimates of 7300–16,500[9] trout being caught by fishermen to a low of 2,000 fish spawning at Coes Ford in 1976 with no estimate of fish caught. My experience as a young fisherman was that the fishing was still very good and the fishery still attracted a high number of angler days effort.

However a recovery occurred in 1977–1981 to approximately 3,000 fish spawning at Coes Ford. It is important to note that this recovery happened without the ecological benefit of the lost lake weed. At this point the river and Lake provided enough food and cover for at least 3,000 fish. I remember the large weed beds within the Selwyn River at the time meaning boat travel was restricted to only the central channel. Importantly this weed was not lost in the Wahine storm due to the sheltering effect of the river banks. The water was also clear on still days and trout could be seen cruising and foraging for food.

I also remember going to the Woolston Working Men's Club Children's Christmas picnic at Coes Ford. There were many firms picnics held here, the river had a good flow and everyone was swimming. The water was waist deep and had good velocity. I now estimate a flow of 3-5 m^3/s in December. We got our car stuck in the Ford because the radiator fan flicked water onto the distributer cap, shorting the HV leads which meant we required a push out.

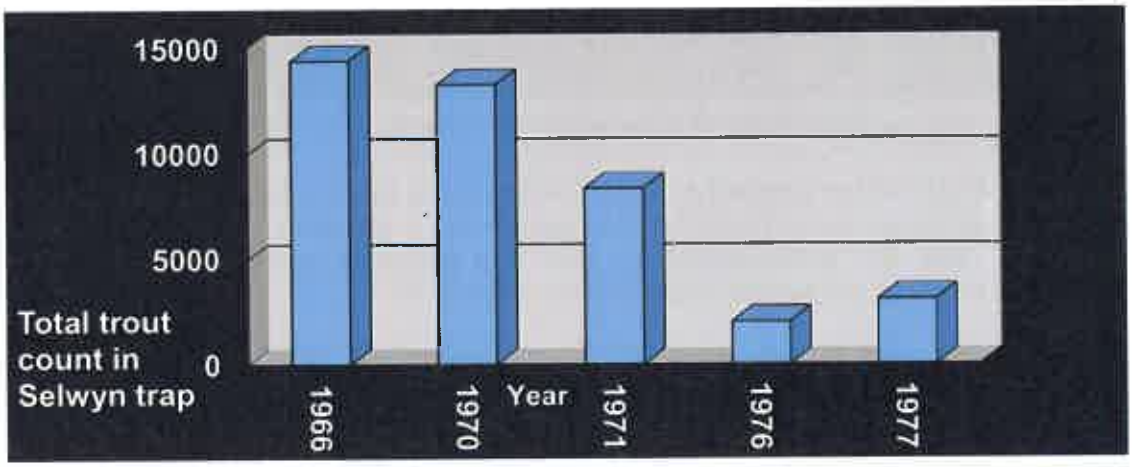


Fig 11: Post-Wahine Decline and Partial Recovery

8 Don Jellyman – Fish Recruitment into Te Waihora/Lake Ellesmere. A Consideration of the Requirements of Key Species – 2012, p 53.

9 D J Booker, E Graynoth – Instream Habitat and Flow Regime Requirements in the Selwyn Lower River – 2007, p 38.

This was a degraded but acceptable Ellesmere system condition and given time the lake weed beds would have recovered and, most likely with it, the spawning trout numbers.

Latter Phase

Another collapse then occurred in 1982 and continues to this day, 34 years later, with no recovery. This collapse was catastrophic in terms of the trout and has seen a major drop in angler day effort.

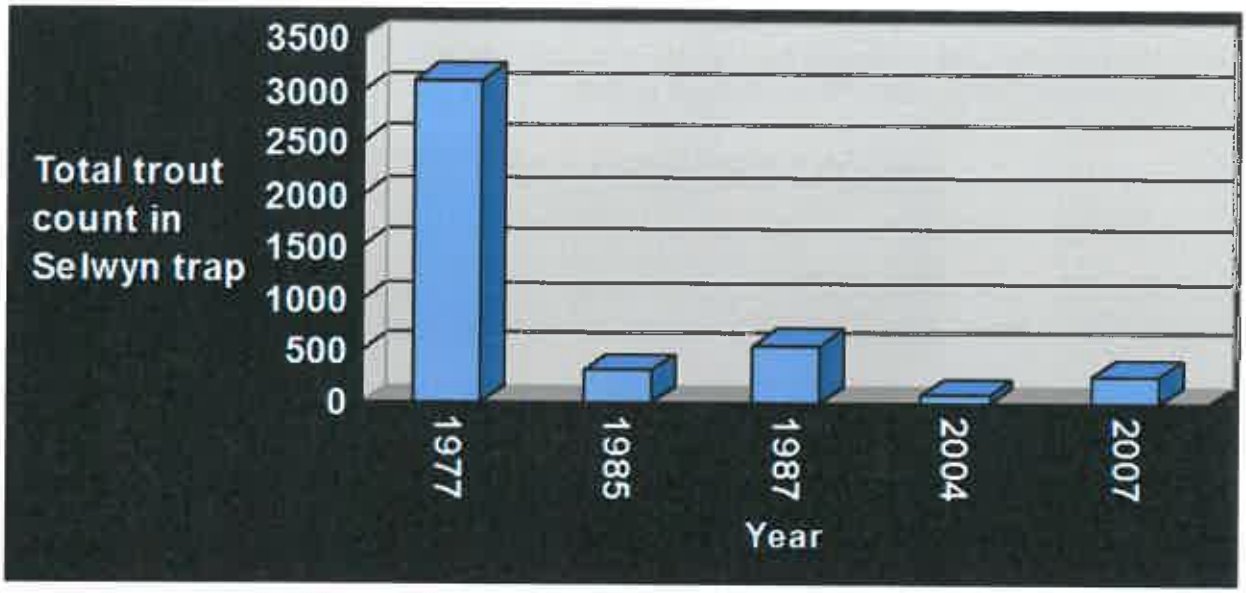


Fig 12: The Latter Phase Collapse and No Recovery 34 Years On

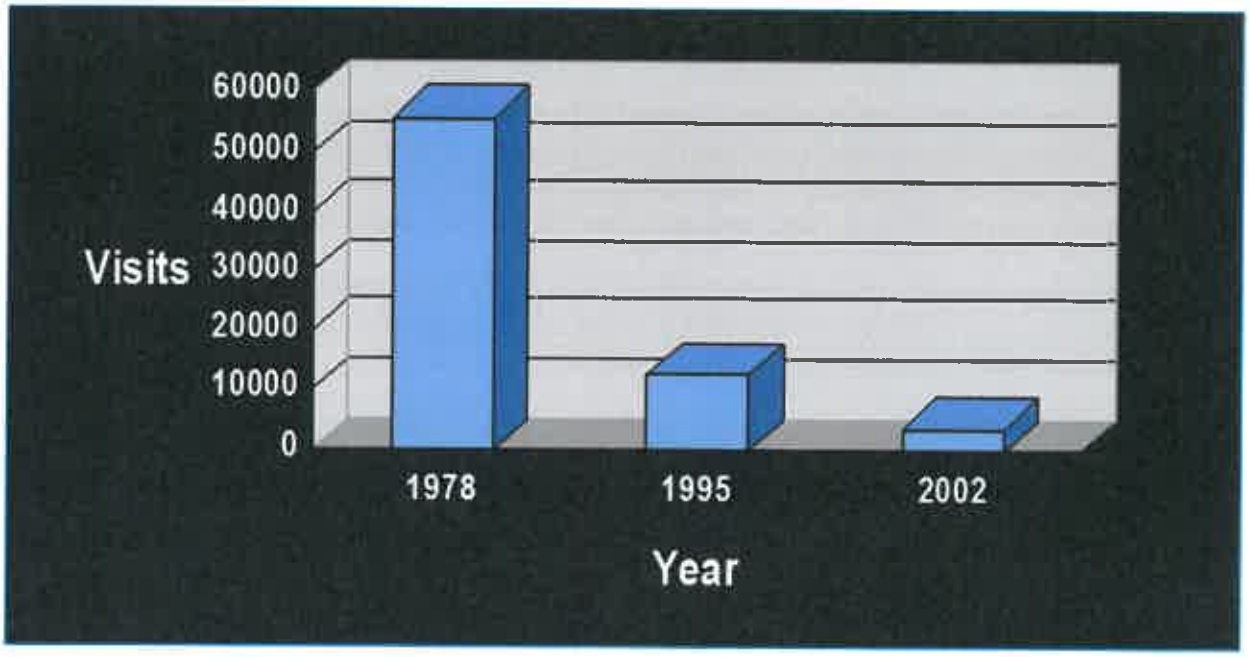


Fig 13: Angler Day Effort 1978-2002

What caused this latter phase collapse? Clearly the loss of Lake weed beds had an effect of the fishery productivity but something else happened about 1982 which triggered the final collapse and virtual extinction of trout from the Selwyn River.

Flipping

In 1982 we[10] were first told of the term *eutrophication*, and that the lake had flipped from a weed dominated environment to algae dominated one. Around 1980 the river weed beds which appeared post-Christmas each year had reduced to a fraction of the former area.

Effectively a lake was polluted; high levels of nutrients (*Nitrogen and phosphorus among others*) were enabling out of control algae growth.

Fig 14: The Extent of Pollution in Lake Ellesmere as seen from Space, 2012

It is likely that this situation had been building for some time until the lake system reached a tipping point, or flipping, as it is known. This would have been exacerbated by the loss of the weed beds which would have absorbed nutrients, including nitrogen and phosphorous to grow, removing it from the water and limiting algae growth.

The lake is now considered hypertrophic and is highly nutrient enriched. Predictions from scientists suggest this situation will get worse in the short term as nutrients already in the system work their way through and the commencement of the Central Plains Water (CPW) irrigation system, which will effectively increase the lake nutrient loading.

Lake Ellesmere lies on the seaward side of the Canterbury central plains and forms a natural sump. Any soluble nutrient that leaches into the ground water or runs directly into surface water will eventually end up in the Lake.

It is unlikely that this alone has caused the latter phase collapse as other fish species have continued to thrive in the lake conditions. The actual lake fish biomass is still similar to prior the Wahine storm just the composition of the biomass has changed, mostly consisting of common bullies now.

10 Lower Selwyn Huts bach owners.

Fig 15: Dan & Ben Strong with a 15.5lb Trout Caught by Ben at Lower Selwyn Huts 2011

Factors Affecting the Latter Phase Collapse

It is thought that the latter phase collapse in the result of multiple issues effecting the lake and river environment. Below is a list of these issues:

- Loss of Lake Weed beds;
- Eutrophication (*pollution*);
- Lake level control;
- Commercial set netting;
- Reduced river flow due to over-abstraction;
- Lower river siltation;
- Loss of spawning areas;
- Predators and pests;
- Recreational over-fishing.

Loss of Lake Weed beds

There is no doubt that the 1968 loss of the lake weed beds has had a profound effect on the Ellesmere system trout numbers. To restore the trout fishery back to pre-Wahine conditions the lake weed beds will need to be restored and the lake flipped back to a weed dominated system. It is unclear if this is possible, let alone practical, but one thing is clear, it will be a long term project with no quick fix available.

The recovery in trout spawning numbers in the late 1970s, point to the loss of the weed beds not being a trigger for the collapse in the early 1980s. Although the food and shelter provided meant a much larger population of trout existed in the lake, the lake actually still contains approximately the same fish biomass compared to when the lake was weed dominated.[11]. The food source, for example, flounder, has changed in response, from an aquatic snail based diet to a common bully based diet. It is likely that trout have also changed feeding habits.

The condition of brown trout caught from the Selwyn River is considered second to none and double figure fish are reasonably common. But a healthy fishery should have a higher

11 Don Jellyman – Fish Recruitment into Te Waihora/Lake Ellesmere. A Consideration of the Requirements of Key Species - 2012.

proportion of smaller 2-5lb fish with the occasional double figure fish. This was the case in the late 1970s when I was young.

It would be of benefit to the fishery, from a fishermen's point of view, if more medium sized fish were available to catch and hours per fish caught were reduced. In my experience a reasonable catch rate should be approximately 1 fish per hour of effort. The successful catch rate halved from 1977 to 2002.

This suggests that once trout are adult there is plenty of food and habitat available. Perhaps we should be looking at spawning success and juvenile rearing more closely.

Niwa (*National Institute of Water and Atmosphere*) are currently running a project to investigate re-establishing the weed and have sampled the fish biomass before enhancement and will sample again once the weed is established to determine any benefit.

Fig 16: Niwa Before Weed Restoration Trial Survey

The loss of the weed in the Selwyn River which appeared after Christmas could have had a major effect on the latter phase collapse as this would have reduced the available yearling habitat ever further. Each year the weed struggles to make a comeback but ultimately fails, which could be due to gold fish grazing, suggesting they should be removed from the system. The current river channel condition does not provide particularly good trout habitat.

It has been identified that wave barriers and floating wetlands could also be used. I think that floating wetlands could actually do a similar job as aquatic weed while the latter is re-established.

Benefits of using floating wetlands are that they absorb nutrients from the water, provide shade and shelter, provide a wave barrier for bank erosion protection and the root ball would provide safe habitat for native and young fish.

Fig 17: Floating Wetland Acting as a Wave Barrier

Floating wetlands that have sunken sections could also provide spawning habitat for whitebait (*inanga*). It may be possible to use volunteer labour to assemble the islands and moor them in sheltered bays and strategic locations.

These floating wetlands could be used in the Lower Selwyn, L2 and Halswell Rivers to mitigate the nutrients being delivered to the lake and provide juvenile habitat.

Floating wetlands could be used in conjunction with the re-established weed beds and have the benefit of immediate deployment and therefore offer an immediate benefit.

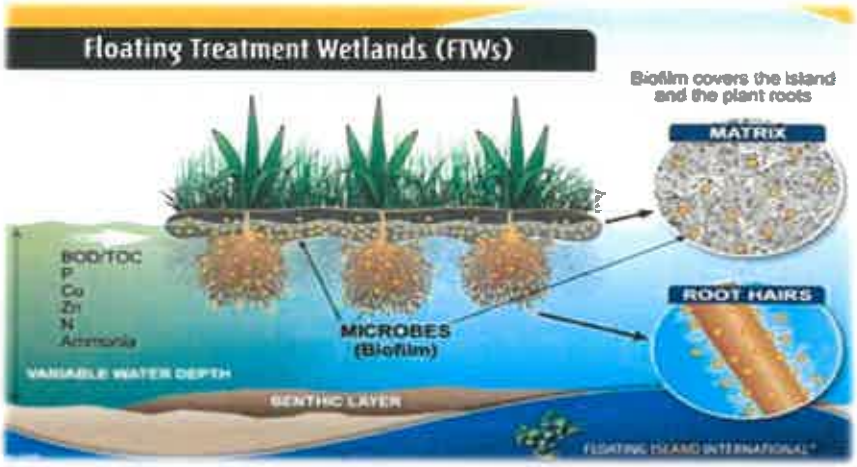


Fig 18: Floating Wetland Root Balls and Biofilm

Who should be responsible for the cost and deployment is a more difficult issue. As the use of floating wetlands is a mitigation effort to remove pollutants then logic suggests the polluters should bear the cost! Restoring the aquatic weed will be a multi-agency long-term project.

Eutrophication (Nutrient Enrichment)

The lake is considered hypertrophic and has a tropic index of 7 on a scale from 1-8. Effectively this means the lake is highly nutrient enriched. The main nutrients (but certainly not limited to) are nitrogen (N) and phosphorus (P) which are a symptom of overuse or poorly applied fertilisers by the agricultural industry.

The nutrients reach the lake via surface water runoff directly into creeks and streams and by leaching into shallow ground water.

However, like the loss of the weed beds, it is unlikely to be a major cause of the latter phase collapse, as trout still live and survive in the lake, even if the carrying capacity is well down. The weed beds and eutrophication are clearly linked and have had a detrimental effect, both are long term projects to improve.

Plans are in place to reduce the nutrient flow into the lake. The Selwyn/Waihora Water Zone Committee has just introduced nutrient budgets for all farms within the lake catchment. Requirements to fence stock out of streams and creeks will go a long way to allowing the water quality to recover. It should be said that a rule or law is only as effective as the enforcement of it!

Stream siltation due to stock and surface runoff is a major problem and has to be dealt with by the local authority via riparian margins and fencing off water access to stock. In the past the authorities have been unprepared to prosecute farmers who break the rules. Pressure needs to be applied to ensure the rules are enforced.

Unfortunately 10% of famers give the other 90% a bad name, but they all have to make a bigger effort.

There are two examples in the Lake Ellesmere system, Harts creek and Boggy creek, where all parties (*land owners, farmers, ECan and fishermen*) working as a group for a common goal have successfully improved the streams environment, reduced in-stream pollution and have shown that when given a chance the trout and other wildlife will come back.

This good work needs to be expanded and will also require substantial buy-in from land owners, fishermen and authority's.

Fig 19: Harts Creek After Restoration

The work to reduce nutrient inputs to the Lake and a reduction in eutrophic state will be a result of many projects:

- Reduction of nutrient leaching and run-off from farm land;
- Fencing off stock from creeks, rivers and lake beds;
- Riparian margins and wetland restoration;
- Restoration of the lake weed beds;
- Floating wetlands; and
- Stream and river restoration.

This work is likely to take decades and is also a multi-agency long-term project.

Lake Level Control

As already described the lake level is controlled to prevent the inundation, of local settlements and farm land. There is a water conservation order which determines at what level the lake is opened to the sea. A committee of interested parties meet and decide when openings should be attempted. This committee includes Fish and Game.

The current levels at which the lake may be mechanically opened are:

- 1.05m above M.S.L. between August and March – Sumer;
- 1.13m above M.S.L. between April – July – Winter;
- Any level between Mid-September – Mid- October – primarily for fish migration.

It is proposed to amend the order by:

- Changing the datum from MSL (*Mean Sea Level*) as at 1998 to the 1937 Lyttelton vertical datum. *(Note this is approximately 100mm lower than the 1998 datum.)*
- Allow mechanical lake openings at any level between 1 April and 15 June.

Fig 20: Developing the Cut to Sea

When required the lake is opened at Taumutu mechanically, with excavators and bulldozers. Opening the lake is very dependent on prevailing weather conditions. If the swell is too large the opening site becomes dangerous, the final breach needs to be done at low tide to provide the largest hydraulic head or height difference between lake level and sea level. This difference is required to ensure lake water flow to sea and scouring of the cut area.

Mechanically opening the lake can be a very difficult process and totally dependent of tide and weather conditions. A successful opening is declared when the lake has been open for at least 4 days.

The best options for sea run trout would be an opening structure which allows free passage between lake and sea. This, however, may not be the best solution for other lake species, such as eels.

Students at Lincoln University are studying the feasibility of building a permanent opening structure. This provides an extra benefit of reducing the sea water input and therefore the salinity to the lake. The re-establishment of the weed beds could be adversely affected by high salinity. However, due to the fine mobile shingle beach a permanent structure may not be economically viable.

Although lake opening frequency has changed slightly over the years, on average it is between 4-6 openings a year. This is not considered to be a contributing factor in the demise of the lake Trout population. However, it is considered to be important in improving feeding opportunities and allowing *'sea run'* trout into and out of the system. The openings also allow prey fish, such as silveries, into the lake which are now a more important food source since the loss of the weed beds.

Evidence from the North Canterbury Acclimatisation Society[12] (*Fish and Game's predecessor*) is that a number of fish that were tagged in the Selwyn River were subsequently re-caught in other systems, such as the Rakaia. Clearly trout will move between systems via the sea.

The best timing for openings for trout fishing is an early October opening for about three weeks. The current lake opening regime is acceptable for trout access to the sea, a permanent structure would be better solution if that can be implemented in the future.

12 Don Jellyman – Fish Recruitment into Te Waihora/Lake Ellesmere. A Consideration of the Requirements of Key Species - 2012.

Commercial Set Netting

Lake Ellesmere maintains a commercial fishing industry, primarily flounder and eels. Eels are caught using fluke nets set in the lake; trout tend not to enter these types of traps and also tend to have a high survival rate when they do. This type of netting does not appear to have a detrimental impact on trout.

Flounder fishing is carried out by gill netting which does catch trout. Trout caught in flounder nets are to be released alive or dead. Many trout are dead. Evidence from the trap at Coes Ford[13] showed up to 6% of fish had net marks from encounters with gill nets. In response to this, an exclusion zone for set netting of ¼ mile from the main river inflows (*mouths*) was created.

As Millachamp[14] pointed out, no data exists on the by catch rates of trout. This should be investigated by the agency responsible for developing and policing the set netting rules, MAF.

The problem has reduced over time in response to the lowering lake trout population but could become an issue again if attempts to re-establish a viable population in the lake are successful.

A commercial fishermen commented to me that trout by catch is rare and he actively avoided areas where this may happen, as large trout rip holes in his nets. He said that by the spit is a patch of shingle bottom and that he does not set nets in this area as trout will be definitely be caught. He also mentioned that getting his boat out the river mouths (*Selwyn and Halswell*) was becoming impossible!

This issue has been raised as being a main contributor to the loss of trout in the lake. While it has undoubtedly had an impact, I do not consider it was a major contributing factor in the latter phase collapse, as the collateral damage from gill netting was tolerated by the population for many years before the 1982 collapse.

Data must be collected from commercial fishermen, which can be used to assess the population of trout in the lake. If the numbers are such, then a change in netting practice may be required.

Reduced River Flow Due to Over Abstraction

Intensive farming practices require intensive irrigation. Since the 1970s the amount of water removed from rivers, and directly from aquifers below ground, has dramatically increased. This has seen a corresponding decrease in lowland river and stream flows.

13 Don Jellyman – Fish Recruitment into Te Waihora/Lake Ellesmere. A Consideration of the Requirements of Key Species – 2012, p 53.

14 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

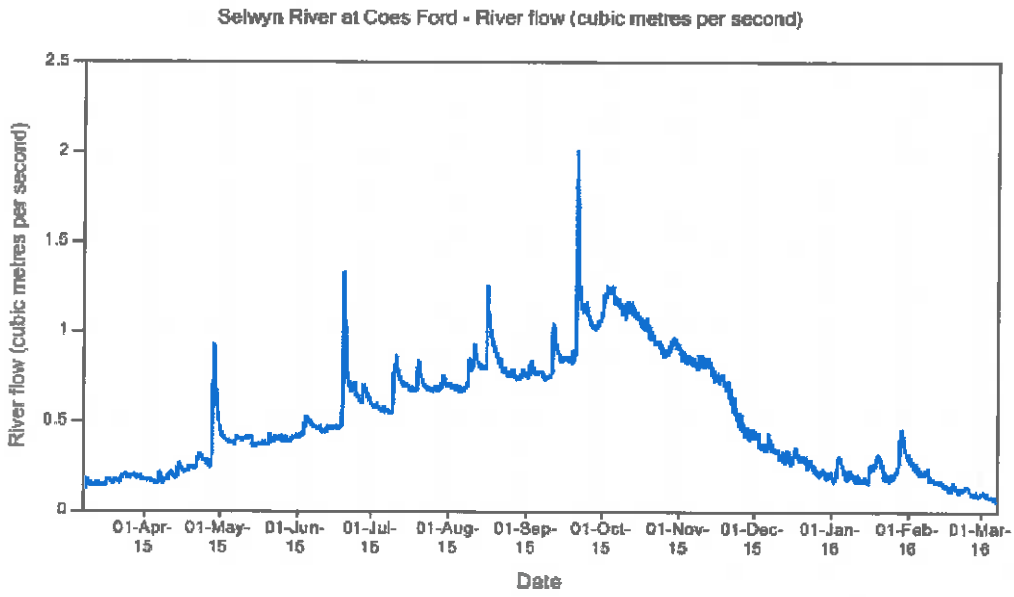


Fig 21: Selwyn River Flow at Coes Ford, 2015-2016

Since 1970, irrigation has increased and now consumes 500 million cubic meters of water, this amounts to a constant flow of **15.85 cubic meters per second**. If we consider this take is mostly abstracted during the '*irrigation season*', which is generally from October to April, then the flow is actually more like **27.5 cubic meters per second**. This equates to a river similar in size to the Hurunui removed from ground water and used for irrigation!

As irrigation flow increases so a corresponding decrease has occurred in river flow. In 1998 the 7 day mean average low flow for the Selwyn River at Coes Ford was 700l/s, in 2006 (8 years) it had dropped to 280l/s.

This is a **60% drop** in river MALF flow when the irrigation take went up by **60%**!

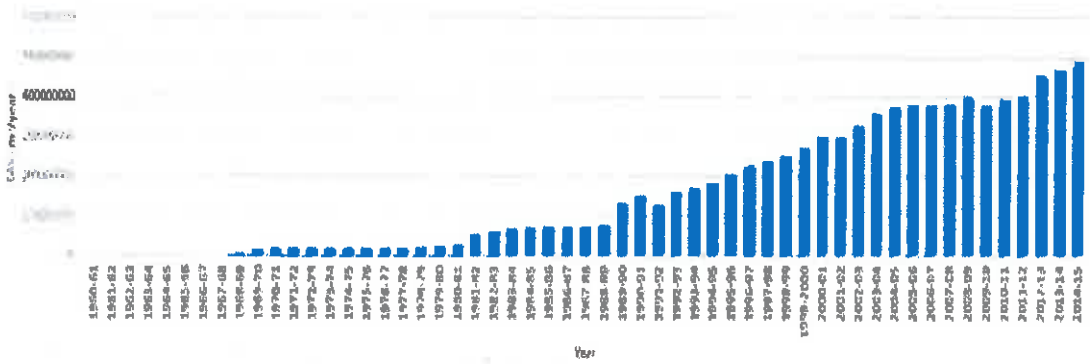
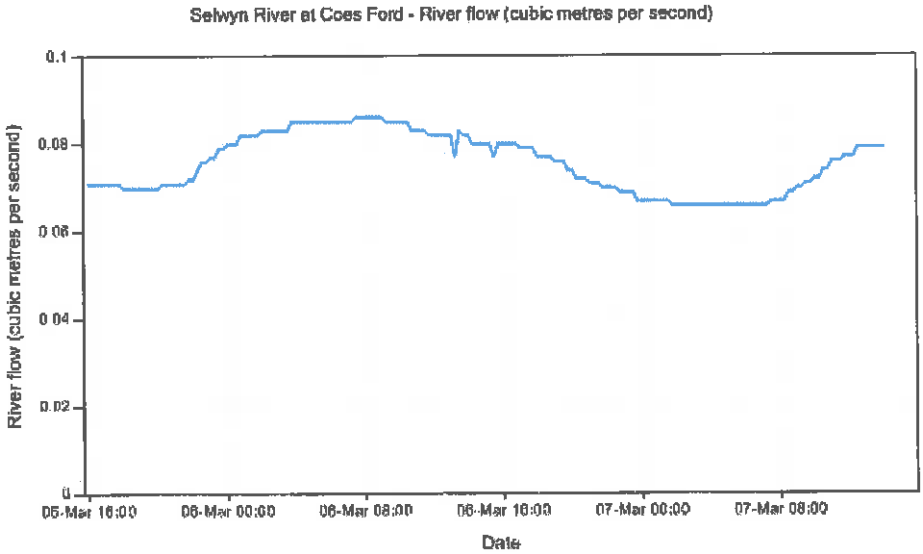


Fig 22: Irrigation Expansion Since 1970

In the week of 6th March the flow at Coes Ford was 80l/s! This is simply not enough flow to support a viable trout population in the river. Many juvenile trout were seen but no trout larger than 100mm could exist in this stream! Any larger trout would have to drop back to the deeper water of the lower river.



The recommended minimum low flow for adult Brown Trout at Coes Ford is .7-1.0 m^3/s and for spawning purposes, above Coes Ford the same flow is required in winter, May-July .7-1.0 m^3/s.[15] Native fish and eels require a smaller flow rate 0.3m^3/s but this is still well above the current flow at Coes Ford.

Due to extended low flows, the middle reaches of the Selwyn River dry up leaving the upper and lower rivers disconnected. This has always occurred and is a natural phenomenon, but due to climate change and most likely irrigation take, the river bed is almost always dry, only connecting when rain in the foot hills causes a flood flow. This flood flow is high in silt loading and dries up unpredictably. Migration between the lower and upper rivers may be possible but would be extremely hazardous with many fish being caught by the drying river. Millachamp[16] said that the migration of Selwyn trout appears to have stopped.

A lot of material and knowledge is available on the hydrology of the central plains area, but to cut to the chase, irrigation has almost proportionally reduced the flow of downstream rivers and creeks.

The flow of low land streams appears to be ***'inversely proportional to water abstraction'***!

This has had a large effect on the Selwyn trout and is most probably one of the causes of the latter phase decline. Re-establishing river flow will be a long term project. **At least 50% of trout in river habitat has disappeared.**

There is no doubt that the central plains area has allocated aquifer water several times over. ECan data shows a **44% over-allocation.** The commencement of the Central Plains Water Scheme, which uses river run water from the Rakaia and Waimakariri Rivers, will help restore some ground water as consents move from aquifer to alpine water.

15 D J Booker, E Graynoth – Instream Habitat and Flow Regime Requirements in the Selwyn Lower River – 2007, p 38.

16 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

This may be good news for the low land streams, maybe not so good for the large (*soon to be smaller*) Rakaia and Waimakariri alpine rivers.

Loss of Spawning Areas

The loss of a good quality spawning area is I believe the largest factor in the latter phase collapse. Since the 1980s a massive decline in spawning has occurred. The study by Mark Taylor et al. showed **a 63% reduction in available spawning area** in 2006, this situation has continued to get worse, spawning could now be as low as 90%.

In some of the most important spawning areas (*Silver Stream and Bailey's Creek in the Lower Selwyn*) almost **100% of spawning has been lost.**

The Selwyn River disconnection has eliminated most of the headwater spawning areas used by the fish. Once the Hororata River was an extremely important spawning area and loss of access has meant this river is completely lost to the trout population. Millachamp[17] said that *"reliable access was required three out of four or four out of five years to be a spawning run to be viable."*

The loss of river connection, and therefore spawning areas, combined with the major reduction in the low land spawning areas equals a possible 90%+ loss of spawning habitat!

If the upper river spawning has been lost due to intensification of farming, requiring intensive irrigation and over-allocation, then the low land spawning has been lost to direct effects of that intensification.

Factors effecting Low land stream spawning are:

- Low flow reducing spawning area;
- Stock inclusion in water ways;
- Siltation via stock and farm run-off;
- Bank erosion providing a direct path for effluent;
- Barriers to spawning areas (*poorly designed weirs*).

Trout need fine gravels with good and reliable water velocity, high in gravel oxygen levels and cover for hatched fry.

On a positive note when streams are restored like Harts Creek and Boggy Creek then the situation is reversed and all the indicators point to a healthy trout fishery return, including an increase in spawning numbers. In fact an increase, above the traditional base line, has occurred in these restored streams.

In the report by Mark Taylor et al. he provided recommendations to improve trout spawning. These actions are required to be undertaken, as it is now more than 10 years since his recommendations were provided to ECan, with no action taken!

We know from the post-Wahine phase collapse and recovery that a reasonable population of trout can survive in the lake and rivers without the benefits of the lost weed beds in the lake.

17 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

However when a 90% loss of spawning area combines with a 50% loss of habitat, the population will collapse and did!

Fig 23: The Silver Stream Creek Entering the Selwyn River above Coes Ford, March 2016

We can in the short term artificially provide fingerlings or yearlings to mitigate the lack of spawning while this is addressed. If the lack of spawning is a large driver of the collapse then a reasonably quick benefit could be seen.

Niwa ran a trail stocking program and concluded that "stocking trout at 50 grams showed a good percentage of survival and returns", noting that they were returning in good condition between 1-3 years later.

The success of a stocking program is traditionally measured by the simple equation:

Stocking is successful if – ***'the cost to stock is < the benefit derived from stocking'.***

The main problem with this approach is that fishermen will have to bear the cost of stocking but the wider community will benefit from the economic input. However I suggest it would be better to use the measure of success as:

Stocking is successful if – ***'a measurable increase in angler effort is observed'.***

Siltation of Lower Rivers and Loss of Habitat

The lower river sections of the main in-flowing rivers, Halswell, L2, Selwyn and Harts Creek, become slow flowing and wider prior to entering the lake. This part of the river is almost lake like and can act as a sediment trap for sediment transported down river during floods. As the water velocity drops off and the river becomes larger, the sediment can no longer be held in suspension and drops out of the flow to the river bottom.

The siltation is exacerbated by the erosion of the banks and general widening of the river channel. The river channel is now 100% wider than in the 1950s. The river channel is currently from stop bank to stop bank with no flood plain (*area above the normal flow but below the level of flood protection*). When a river channel is eroded like this the result is a wide shallow silted river bed, which is an unattractive habitat for fish and the invertebrates which provide food for the fish. The silt effectively smothers the ecosystem.

My estimates are that a layer of up to 3 meters of silt sits on the bottom of the Selwyn River from the Top Huts down to the lake. I vividly remember watching trout adjacent to the macrocarpas[18] just below the Upper Huts at about 4 meters deep swim along the shingle based bottom with aquatic weed. I can also confirm that the current depth at this same location is 1-1.5m and the water is no longer clear. In the 1970s the river was substantially deeper with regular flood flows flushing it out. As the flood flows are now less regular, siltation has built up on the river bed.

This build up has reduced the available habitat within the rivers for native fish and trout. It stands to reason that with half of the water volume, environmental heating of the water in summer, will be double.

The aquatic weed that was prevalent in the 1970s has disappeared, as water quality has also reduced to the point warning signs are required at the Lower Selwyn Huts due to toxic algae blooms.

The new cut[19] which in the 1980s was on average about 2-3 meters deep, is now not passable by boat due to siltation. In the 1980s the channel ran out several hundred meters from each mouth into the lake, this is now non-existent.

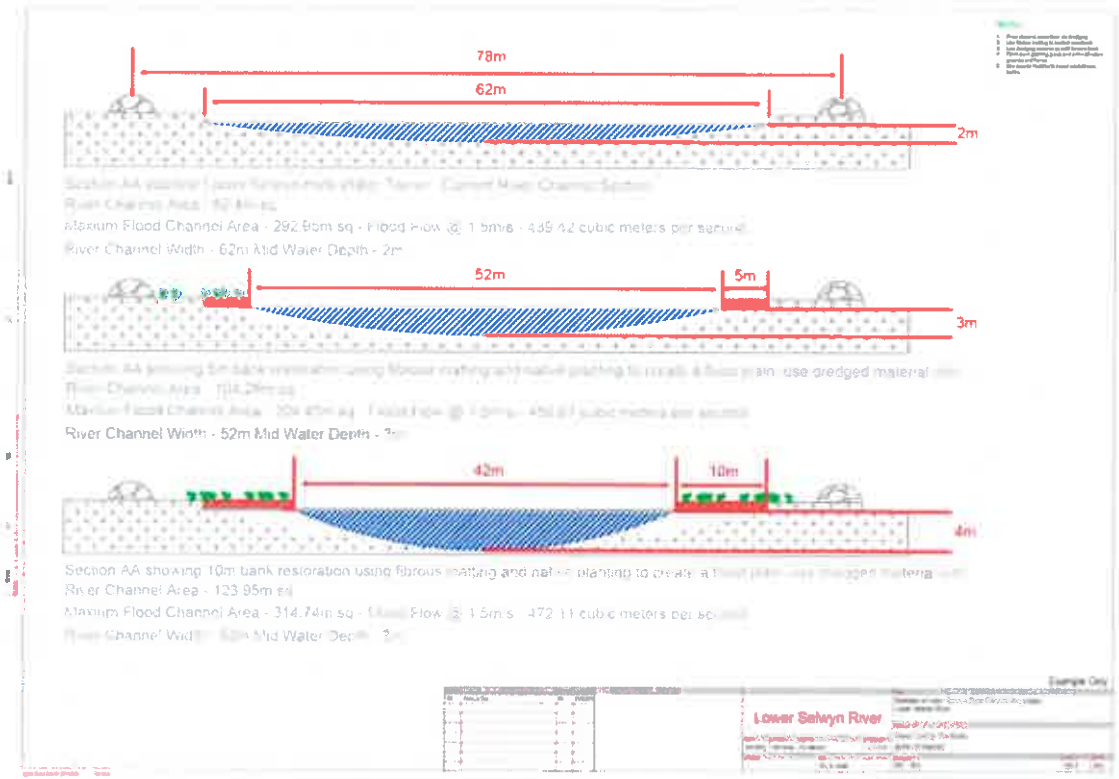


Fig 24: Example of Lower River Restoration and channel improvement

The silt transported to this part of the river is primarily from farm run-off and is high in nutrients. With high summer temperatures, phosphorus will be given off to the water column and add to the growth of algae. The times when the river is clear is very short and

18 The macrocarpa trees that are adjacent the river on the road side below the Top Huts.
19 The artificial channel designed to take flood flows directly to the lake removing the old mouth bend.

mostly when the water temperature is low, due to algae blooms when the temperature increases.

By removing the sediment from these river sections the following benefits will occur:

- Increase (*double*) trout and other aquatic animals habitat;
- Reduce the summer temperature increase, for example a 50% increase in volume will equate to a 25% decrease in environmental heating (*provide a cool water refuge*);
- Prevent re-suspension of phosphorus (P) from the silt;
- Reduce algae blooms by reducing nutrients and cooler water temperatures;
- Provide better water clarity due to lower algae levels and less silt due to wave action re-suspension;
- Aid in weed bank growth and recovery by providing better depth and protection of wave action, higher dissolved oxygen due to lower water temperatures and better photosynthesis due to improved water clarity;
- Aid in flood flow mitigation due to larger area available for flood flows (*see Fig 25*).

Dredging or vacuuming the river channels has been recommended by other reports but as yet nothing has been done. This is a project which will be of immediate benefit by providing improved habitat.

Predators and Pests

An obvious change from the 1980s era is the black shag population, which has grown unchecked over the last twenty years. The population now numbers in perhaps the hundreds.

If each black shag eats a trout a week then 5,200 trout a year will be consumed. There is no point attempting a re-stocking program while the stock is being consumed by shags. The current shag population is a major barrier to trout recovery.

Black shag can consume up to a 3lb trout; this could explain why the fishery is dominated by large fish as all small fish are consumed! The shag population needs to be reduced. This was done when I started game bird shooting in the mid 1980s by putting the shags on the duck shooting licence until the population was under control. Consideration should be given to using this as a way of reducing the predation on trout to sustainable levels.

The lake has a large population of common gold fish, these fish are well known for thriving in low water quality environments, and they stir up the bottom eating weed beds. A reason the weed beds pop up every year or two but disappear in the Selwyn River could be due to gold fish grazing. More work needs to be done, to determine the best course of action.

Ultimately the gold fish should be removed from the lake and river. This has been successfully done in Tasmania with carp. Environment Waikato also has some experience with carp removal! Electric fishing and netting would reduce the population to a lower level. These could be carried out in the warmer months as the gold fish enter the Selwyn River as the lake warms up.

Recreational Over-Fishing

Millachamp[20] said that recreational harvest was unlikely the cause of the latter phase collapse, as angler effort has reduced by about 80%, so the fishery should have recovered and it clearly has not.

In the good old days the limit per person, per day was 10, and fishermen regularly took this number. The estimates of 7,300-16,500 fish being caught with spawning runs of up to 14,000 fish would appear to support the notion that over harvest was not a factor.

The current limit for the Lower Selwyn River has been reduced to two per angler, per day. This limit is one of the only tools available to Fish and Game in response to pressure on trout numbers, which are almost totally determined by other factors outside of Fish and Game control.

If a re-stocking program was commenced, the Coes Ford trap would need to be used for verification of population benefits, year classes could be fin clipped for identification. Once more fish are available, a size limit could be introduced, to ensure more large mature fish make it to spawning.

Estimates have been reported of up to 100% of the spawning population being caught by anglers in some years. A more realistic number is likely to be 50%, which is the approximate angler salmon harvest in Canterbury Rivers. By using this calculation the angler catch can be calculated based on adult spawning fish trapped at Coes Ford. This could be useful information in terms of calculating the success or not of any restoration effort.

Fig 25: Catch and Release was not Practiced in the Old Days, Bag Limit of 10

20 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

Other Organisations with Vested Interests in the Lake

- Environment Canterbury;
- Selwyn District Council/ Christchurch City Council;
- Department of Conservation;
- Ngai Tahu;
- Ministry of Fisheries;
- Fish and Game;
- Waihora Ellesmere Trust/Lincoln University.

Factors Having a Meaningful Effect on the Trout Population and Responsible Agency's

Factor	Rating – contribution to collapse 0-10	Action	Agency
Loss of lake weed beds	7	Trial to re-establish aquatic weed beds, wave barriers and floating weed beds. Consider floating weed beds in the Lower Selwyn River.	NIWA, Environment Canterbury
Eutrophication. (pollution)	6	Farm nutrient budgets, surface run-off and stock exclusion from streams and creeks.	Environment Canterbury, Selwyn District Council, Christchurch City Council
Lake level control	2	Change WCO and investigate a permanent outlet structure.	Lake Committee, Lincoln College
Commercial set netting	5	Gather data on trout by catch, change regulations if required.	MAF
Reduced river flow due to over-abstraction.	8	Change consents from aquifer to alpine water, monitor and reduce ground water take, limit new ground water abstraction.	Environment Canterbury
Lower river siltation	7	Dredge the lower rivers, install floating wet lands.	Environment Canterbury, Selwyn District Council, Christchurch City Council
Loss of spawning areas	9	Enhance and restore spawning streams as per recommendation by Mark Taylor et al, stocking program yearling trout at 50 grams weight, monitor with fish trap at Coes Ford.	Environment Canterbury, Fish and Game, Fishermen and Land Owners

Factor	Rating – contribution to collapse 0-10	Action	Agency
Predators and pests	6	Reduce the black shag population by putting them on the duck shooting licence, investigate gold fish removal.	Fish and Game, Environment Canterbury
Recreational over-fishing.	2	Monitor fish numbers and size to ensure adequate spawning.	Fish and Game

Fishery Economics

Unfortunately for the environment nowadays everything is broken down into monetary terms. It is often very difficult to show the intangible benefits of a healthy environment and particularly a healthy fishery on a balance sheet or a bottom line. As an acclimatised fish, trout cannot be farmed, sold or traded but this does not mean they are worthless. It is well known fishermen spend money, time and commit resources in pursuit of the humble trout.

We hear much from the agricultural community about farm operations adding to the economy and the term *'economic trickle down'* seems to be used as a justification for sustained environmental losses. If we could measure the economic benefit of restoring a viable trout fishery what would it be worth to the local economy?

The US Department of Interior[21] estimated in the Great Lakes, an angler's day of effort had an economic value of $36 US. By extrapolating this to $NZ and at today's rates this would be a value of $95 NZ.

Using this as a basis, the current economic input from the Selwyn River fishery is as follows:

Current

Angler days	3,300	
Economic impact per day	$95	
Current economic input	*3300 x 95*	**$313,500.00**

Historic

Angler days	100,000	
Economic impact per day	$95	
Historic economic impact	*100000 x 95*	**$9,500,000.00**

Restored[22]

Angler days	100 x (180 day season) = 18000	
Economic impact per day	$ 95	
Restored economic impact	*18000 x 95*	**$1,710,000.00**

21 US Department of Interior, et al, (1996).

22 Restored trout fishery back to 1980 levels with a 2,000-3,000 fish spawning run.

It is impossible for me to put a value on restoring the fishery but the above basic calculation shows a real economic benefit to the local community of a 1980s level fishery.

The restoration will come at a cost. My belief is that the environmental cost of low flow, siltation and loss of spawning should be borne by the organisations responsible for this situation.

The organisations responsible for this situation can be broadly described as *'the organisations whom have derived a profit for the increased irrigation and intensification'*.

It could be difficult to bring these organisations to account, as these organisations are also the most politically active and are constantly in the government's and it's agency's ears. This is an example of *'the squeaky wheel getting all the oil'*.

However the above calculation does show that the cost to activate the *'Short term Action Plan'* will provide an economic benefit to the local area! It is most likely that Fish and Game will be required to fund the *'Short Term Action Plan'*. This may not be possible given that Fish and Game's only revenue is derived from fishing and licence sales. This is a chicken and the egg situation and will require some thinking 'outside the box' to solve.

It may be possible to get commercial companies to sponsor releases of yearling trout, use volunteer labour and donated plants, etc. Funding from Government Agencies and other organisations may be possible for specific projects.

The Rakaia River Sea Run Trout Collapse

Several weeks ago I attended a public meeting held by North Canterbury Fish and Game at the Christchurch Horticultural Hall, to discuss the collapse of the "Rakaia Sea Runs" which is pertinent as opposite Harper Ave is the Christchurch Botanical gardens where acclimatisation in Canterbury all began.[23]

A North Rakaia Huts local, Bill Southwood, explained about the work he has carried out and the observations he has made over a long association with this part of the river. He explained the effects of prolonged low flow on single migration to the coast, and its effect on the trout population.

He spoke about fishing for sea runners at the mouth with his father and the fact his father would not let him start fishing until the trout could be seen entering the river mouth! This is hard to imagine in the river today.

He sadly described the 2015-2016 season collapse and the need to protect the fishery during winter. The 100 or so people present voted unanimously to close the winter season and protect the fish. This is now with the Fish and Game for action.

We know that fish tagged in the Selwyn River have been recaptured at the Montrose Hatchery in the Rakaia Gorge and vice versa. Millachamp[24] reported *"in 1962 and 1963 15% of tagged trout from Ellesmere were re-captured outside the catchment"*. It is well documented that trout will travel between waterways and sea run brown trout spend some

23 Game Keepers for the Nation – 2001.
24 Millachamp 2008 - Brown Trout Fishery – Te Waihora State of the Lake and Future Management.

time in the ocean as well as in the lower salinity areas such as estuary's and lagoons. An intermediate area such as a lagoon is required when salmon are transitioning from fresh to salt water, this may also be required with trout.

When a trout scale is observed under a microscope the growth rings indicate when a trout occupied fresh water and when it went to sea. These rings also show the age of the fish. A study in 1945 at Rakaia showed the fish moved to the sea environment at about 2 years of age. A large growth period is then seen, as the sea environment is more productive than the river. Conversely a period of slow growth is seen when the fish re-enters the river for spawning. Interestingly it was noted that growth tended to stop after Christmas!

Very little research has been carried out on the movement between these systems, and very little is known about the movement and life cycle of sea run brown trout in general.

The Te-Waihora/Lake Ellesmere and Rakaia River trout populations do mix, travelling between systems. These systems are interrelated and connected. It is probable similar factors that have driven the collapse at Te-Waihora/Ellesmere are also responsible for the Rakaia River sea run brown trout collapse. Possible issues to be investigated are:

- Reduced main river flows;
- Reduced habitat due to smaller lagoon area. When the river runs direct to sea at the south end for long periods;
- Reduced spawning area due to over-abstraction causing small streams to not flow reliably, siltation due to stock incurrence, toxic shock and high water temperatures due to little or no riparian margins and direct surface run off;
- Reduced food species (Silveries) due to all of the above;
- Higher surface and mixed salinity in the lagoon and sea area due to low river flow changing the fresh/salt mix;
- Loss of juvenile recruitment stock to irrigation schemes, reported losses of thousands of fish lost due to poor/poorly maintained fish screens.[25]. Poor or no policing of correct fish screen operation!;
- Degrading of spawning areas in the Upper Rakaia area;
- Lack of suitably graded shingle material with the correct depth and flow velocity due to reduced flows. Trout prefer water depths of less than 300mm with clean well oxygenated fine inter gravels.[26] Is this combination being reduced due to changes in River flow???

As with the Ellesmere situation by engaging with stakeholders and filling in the information or knowledge gaps, a plan could be developed in collaboration with Te-Waihora/Lake Ellesmere to address the issues that have driven the collapse.

25 North Canterbury Fish and Game – Proposed Issues re Fish Screen for Irrigation.
26 Mark Taylor & Marlynne Good – Brown Trout Spawning in Lake Ellesmere Tributaries, and Surrounding Catchments – 2006.

Fig 26: The Author with a 7lb Rakaia Sea Run Brown Trout, November 2015

Short Term Action Plan

The aim of this document was to provide a 5 step plan which can be implemented quickly, have immediate benefits to the trout fishery.

These initiatives need to be driven by Fish and Game, who are stretched in terms of resources due to the funding model and advocacy role they are force to take. Fish and Game should look to utilise more volunteer labour by getting fishermen, and other interested parties, involved in the restoration.

Ross Millachamp said in his 2008 report said that ***"The real finding of this process is that similar reviews of the lake values have taken place since the 1980s and 1990s but no commitment was made to resolve the issues and the lake has continued to degrade. This should not happen again."***

Action Plan

1. Reduce the black shag population living and nesting in the trees of the Lower Selwyn River. This can be done by putting the black shags on the duck shooting licence until the population is at an acceptable level. There is no point in attempting any other work while the Black shags eat all the improvements.

2. Commence a stocking program to mitigate the lack of spawning recruitment due to low flow and damaged spawning areas. This should be 50 gram fish put into the Selwyn River, above Coes Ford, in September/October to simulate natural recruitment. Niwa carried out a trial stocking program and determined that a high number grew and survived to become accessible to fishermen.

3. Operate the Coes Ford trap to monitor how the re-stocking programme is going and to enable adjustments to stocking numbers and catch limits. This also provides up to date data for ongoing scientific work. As natural spawning takes over, stocking can be reduced, until the population is sustainable.

4. Drive spawning stream restoration and planting, ensure stock exclusion in the Silver Stream and Baileys Creek. Use volunteer labour from fishermen if required, work with DOC and Environment Canterbury. Use the work by Mark Taylor et al, as a template.

5. Investigate the dredging of the lower river channels to provide a better and larger habitat for adult trout. Pressure should be applied to agencies responsible for some commitment and action. May need to do some work around P and re-suspension, including the benefits of slit removal.

If habitat or food availability is a principal limiting factor then it stands to reason that stocking will have little or no effect. However if recruitment is the principal limiting factor then stocking will have a 1-3 year obvious benefit.

Fig 27: Selwyn River above Coes Ford, Feb 2016 – 80l/s

With commitment and some effort from all the stakeholders, including statutory agencies, environment groups, fishermen and farmers, it is possible to restore the Te-Wihora / Lake Ellesmere / Selwyn fishery to 1980 levels. 1980 levels means a spawning run of 3,000 fish at Coes Ford.

Long Term Restoration Projects

These projects have been identified and are expected to take many years to complete. They will have a big benefit in years to come but will not provide a major improvement in the short term.

- **Lake aquatic weed bed re–establishment**
  Niwa are currently running a trial programme to re-establish the weed beds, this could take some time but may have the largest benefit. I suggest floating wet lands are considered as a short term alternative to the weed beds as they provide a similar benefit and will be easier to establish.

- **Nutrient leaching to shallow ground water and surface run off needs to be reduced**
  Environment Canterbury (Zone Committee) has introduced new rules around nutrient budgets; this will take some time to show a benefit to the lake environment.

- **Ensure all stock are excluded from creeks/streams and rivers, this included vehicle access to the Selwyn River bed**
  Environment Canterbury has introduced new rules, they need to be enforced.

- **Improve Flow in low land streams**
  Transfer ground water allocation to alpine water allocation. This will happen over time with the CPW scheme coming on line.

- **Continue important spawning stream restoration**
  Ensure that all of the important creeks and streams are restored to their natural state.

- **Continue lake edge planting to create wetland areas**
  Use interested groups to plant appropriate plants along lake margins.

- **Ensure all major inflowing rivers are dredged and free of siltation**
  The L2 and Halswell Rivers may also need to be cleared. Remove silt from spawning areas.

- **Investigate a permanent lake opening structure**
  Look at options for a workable solution.

- **Collect data on trout by catch from commercial fishermen**
  Audit to the ensure accuracy of reporting.

Fig 28: "Sentiment of the People" - a Sign at the Upper Selwyn Huts with an Irrigator in the Background

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