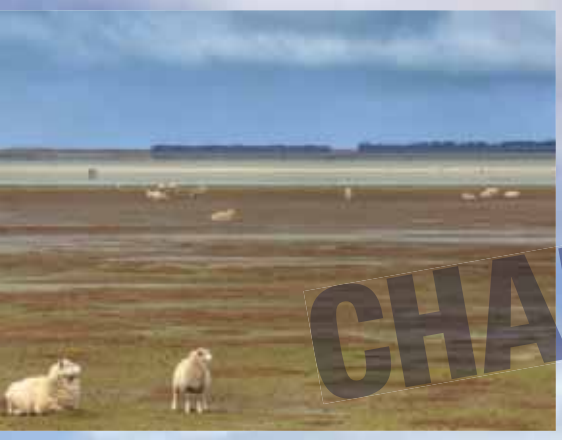
TE WAIHORA/LAKE ELLESMERE
State of the Lake and Future Management

Edited by **KENNETH F.D. HUGHEY** and **KENNETH J.W. TAYLOR**



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Edited by **KENNETH F.D. HUGHEY** and **KENNETH J.W. TAYLOR**
Lincoln University Environment Canterbury

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CONTENTS

SHELLEY McMURTRIE

SHUTTERSTOCK

01 INTRODUCTION

KENNETH F.D. HUGHEY Lincoln University **KENNETH J.W. TAYLOR** Environment Canterbury

Te Waihora/Lake Ellesmere[1] is a large coastal lake, intermittently open to the sea. It is highly regarded for its conservation and related values, some of which are of international significance. Its function as a sink for nutrients from its large predominantly agriculturally based catchment, currently undergoing accelerated intensification, is also recognised, at least implicitly. It is the resulting conflict from these value sets which is mainly responsible for the ongoing debate about the future of the lake, a debate long fuelled by rhetoric and informed by a body of science which highlights the lake's complexity as a biophysical system, but has many gaps. It is a debate that now has substantial statutory implications, arising from factors which include:

- the requirements of conservation, and indigenous needs and entitlements which are growing in prominence and statutory (including property rights based) legitimacy;
- public interest in legal processes associated with further major intensification of agriculture planned for the catchment;
- a recent Environment Court decision in which serious questions about the overall biological health of the lake were raised; and
- the consequences arising from the need for Environment Canterbury to obtain resource consents for the lake operating regime.

In addition, in recent times the Waihora Ellesmere Trust (WET), a community based group advocating for improved management of the lake, has been established. It is within these diverse contexts that this State of Te Waihora/Lake Ellesmere report has been prepared—it results from the 2007 Waihora/Ellesmere Living Lake Symposium, held from 31 October-3 November 2007 at Lincoln University, Canterbury. The symposium was initiated and organised by the WET (see www.wet.org.nz).

The Living Lake Symposium had several key objectives:

- To determine the overall state of the lake, by first defining the key value sets, and indicators that could be reported against;
- To suggest future management actions that would address key issues affecting the defined values;
- To provide a forum within which lay individuals, scientists and managers could openly debate issues; and
- To provide a launching pad for integrated and focused future management of the lake and its environs.

The programme incorporated three keynote speakers: Dr Larry Hildebrand from Environment Canada, Dr Hamish Rennie from Lincoln University, and Dr Bryan Jenkins from Environment Canterbury—their addresses made a major contribution to the symposium although none are included in this report, because it is focused primarily on the science and the management options associated with the lake.

The format of this report is designed to be readily updateable. Ten of the principal presentations in the main sessions of day two of the symposium are included in this report—two Power Point presentations (both regarding water quantity and related issues) are provided as appendices to improve completeness. Over time, however, topic areas not available as full papers for this report, e.g., surface water quantity, will be written up and included in detail. Similarly, the papers herein will themselves be updated as new and significant data become available. Each subject area will be reconsidered within the same structure and context as has been provided here. One paper, 'Te Waihora/Lake Ellesmere: An integrated view of the current state and possible futures', was presented on the final formal day of the symposium and it is included as the concluding chapter of this report.

Finally, the Waihora Ellesmere Trust and many of the others attending the symposium saw merit in reconvening the event around two years after the initial symposium, to report on progress with management, indicator monitoring, scientific understanding and other matters. We support that suggestion.

In terms of report format it is important that readers note the following:

- All authors were provided with 'briefs of work' and were requested to contextualise their work with that contained within the Taylor (1996) report on the lake—this was more easily achievable for some than others. Given some lack of consistency between symposium presentations and final papers it is our intention that a revised set of agreed indicators will be considered and included in any follow-up symposium and associated reports—some considerable work will be required in some areas to achieve this objective;
- Only the wildlife and integration papers included in this report have been formally peer reviewed; and
- All other papers have been standardised and style edited-some changes have been suggested by the report editors and made by the paper authors.

Finally, an attempt has been made to present the papers in a logical sequence of 11 chapters: chapter 1 sets the scene; chapters 2-7 cover the biophysical science dimensions (groundwater, water quality, native vegetation, native fisheries, trout, wildlife); chapters 8-10 deal with the human dimensions (Ngāi Tahu, recreation, economics); and chapter 11 deals with integration of the findings from the previous chapters and setting the scene for future management.

[1] Note that the Geographic Place Names Board has defined the name as Lake Ellesmere (Te Waihora). It is not our intention to debate the nomenclature, but rather to put the focus where we consider it should lie, within the lake's initial historical and cultural context for indigenous Maori.

06 BROWN TROUT fishery

ROSS NOVIS

ROSS MILLICHAMP Fish & Game North Canterbury

The Te Waihora/Lake Ellesmere brown trout fishery is one of the most degraded in New Zealand. There are fisheries with fewer fish, but Te Waihora/Lake Ellesmere stands alone in terms of the extent to which the fishery has changed. A range of natural and human-induced factors are likely to have contributed to the decline but it is difficult to single out a primary cause. Restoration of the fishery is possible given the will to do so, but the target for restoration needs to be carefully considered. The restoration of the fishery to 1940s levels is unlikely to be achievable but restoration to early 1980s levels is achievable and would deliver considerable benefits to the community

6.1 Introduction

The brown trout (*Salmo trutta*) fishery of Te Waihora/Lake Ellesmere had a reputation as one of the world's best in the 1920s and 1930s. Over the following decades the fishery slowly declined, in fits and starts, and is now highly degraded and of limited local value. In this paper I present the issues, explain the context to these issues and suggest some future management actions which might contribute to restoration of this fishery.

6.2 History of the golden years

Brown trout were introduced to the Te Waihora/Lake Ellesmere system in 1868 and a very productive fishery quickly became established. Hardy (1989) proposed 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."*

The final few words of that statement are particularly important because while other Canterbury lowland fisheries appear to be reliant on ocean production, Te Waihora/Lake Ellesmere seemed to rely heavily on production within the lake.

The success of the Te Waihora/Lake Ellesmere brown trout fishery has been put down to a number of factors:

Access to the ocean

The presence of a large population of trout which spend part of their lives living in the ocean off the Canterbury coast has undoubtedly made some contribution to the fishery. These fish migrate through the cut when the lake is open to the sea. Trout also move from headwater spawning grounds to the lower reaches, estuary and ocean after spawning, seeking out warm water and an abundant food supply to allow them to recover from the rigours of spawning. In most Canterbury rivers it is likely that the available habitat in the typically small estuaries is quickly exhausted and most fish move into the ocean during this phase of their life cycle.

The extent to which sea run brown trout contribute to the productivity of low country fisheries in New Zealand is poorly understood. However a tag/recapture study conducted by the North Canterbury Acclimatisation Society in the 1962 and 1963 seasons showed that 15% of trout tagged at the Selwyn Trap and later recaptured by anglers, were re-captured outside of the Te Waihora/Lake Ellesmere catchment.

Lake habitat

The weed beds of Te Waihora/Lake Ellesmere were thought to provide exceptional shelter, protection and feeding opportunities for young trout. The importance of Te Waihora/Lake Ellesmere to the trout fishery was summed up by Percival (1932) who stated that:

> *"The Lake forms a magnificent reserve where the fish may be safe from the angler and where they may grow".*

The presence of significant lowland freshwater/estuary habitat made Te Waihora/Lake Ellesmere unique and meant that trout that were recovering from spawning may not have needed to move into the ocean. Hardy (1989) found that:

> *"an opening of Lake Ellesmere to the sea at a particular time of year is unlikely to be critical to the maintenance of brown trout populations of the Ellesmere catchment, except insofar as appropriate openings influence the migrations and abundance of the native fish forage species upon which trout feed".*

Tributary feeding and spawning habitat

Te Waihora/Lake Ellesmere tributaries also once provided excellent habitat for trout. Throughout spring and summer large numbers of trout moved from the lake to the lower reaches of tributary streams to feed. It is presumed that they were following populations of native fish species which were entering the rivers to spawn. Trout feeding would be more effective in the tributary streams than in the lake because the prey would have been easier to see due to the improved visibility of the water, and more densely concentrated due to the smaller size of the water bodies.

As summer came to an end the trout moved upstream out of the lake and from lower reaches of tributary streams to seek reaches with clean gravels and clear water in which to spawn. In smaller streams such as the Doyleston Drain and Boggy Creek, spawning took place within 10-20 km of the lake. However, in the Selwyn River, trout migrated up as far as the foothills to spawn. Access to permanent water in the foothills is the major point of difference between the Selwyn and other Te Waihora/Lake Ellesmere spawning streams, and may be the reason it is the most important.

Most estimates of the size of the Te Waihora/Lake Ellesmere trout fishery have been obtained by counting spawning trout in the lower Selwyn River. The fishery was probably at its peak during the 1940s when the North Canterbury Acclimatisation Society (the predecessor of Fish & Game New Zealand) estimated the spawning population of the Selwyn River at 65,000 trout. Although the Selwyn is undoubtedly the most important tributary for brown trout spawning, that estimate only relates to a portion of the total Te Waihora/Lake Ellesmere fishery, and comes at a stage of the life cycle when the portion of the run which is caught by anglers and commercial fishermen (as bycatch) has already been removed. The entire Te Waihora/Lake Ellesmere brown trout fishery could conceivably have constituted 100,000-200,000 adult fish at this time.

Such was the productivity of the Te Waihora/Lake Ellesmere brown trout fishery that it was used as a hatchery for stocking other fisheries. Professor Percival was quoted in Lamb (1964) as saying "enough fish could be salvaged from the Selwyn in a season to stock all rivers in the South Island".

A fishery of this scale attracts considerable angler interest and provides significant amenity values. Hardy (1989) suggested that the Te Waihora/Lake Ellesmere trout fishery ranked second in popularity and usage (to the Waimakariri) in the North Canterbury Acclimatisation Society district. In order to put this into context, robust assessments of angler usage conducted in 1995 and 2001 (Fish & Game NZ National Angler Survey) found that the Waimakariri was the most heavily fished river in New Zealand. Teirney et al. (1987) estimated that anglers made

55,800 visits to Te Waihora/Lake Ellesmere and its tributaries during the 1975/76 and 1978/79 seasons, at a time when the fishery had already started to degrade.

National Angling Survey data indicates an ongoing downward trend in angler use of the catchment:

- 1994-95: 12,920 +/- 2,080 angler-days (Unwin and Brown 1998)
- 2001-02: 3,780 +/- 660 angler-days (Unwin and Image 2003)
- 2007-08: 2,770 +/- 530 angler-days (M. Unwin, NIWA, pers. comm. October 2008).

Recreational fishing was largely focused on the lower reaches of tributary streams where the fish were found in dense concentrations. Fishing often took place during the hours of darkness when the trout came out from the shelter of undercut banks or riparian vegetation to feed in the shallow water where the prey species were congregating. The fishery provided excellent angling opportunities throughout the duration of the October to April open season.

6.3 The decline of the Te Waihora/Lake Ellesmere brown trout fishery

The Te Waihora/Lake Ellesmere brown trout fishery has undergone a dramatic decline since the 1940s. The decline can be broken into two distinct phases; the decline which took place immediately after the Wahine Storm, and the more gradual decline which has taken place over the last 20-30 years.

Figure 1 shows the change in the number of trout spawning in the Selwyn River as estimated by a series of census traps operated by the North Canterbury Acclimatisation Society and the North Canterbury Fish & Game Council since 1941. These traps involve a considerable operational effort and were operated at infrequent intervals so there are significant gaps in the data. However, for the purpose of this paper, the period between 1941 and 1977 can be considered the "post-Wahine" phase and the period between 1977 and 2007 the "latter" phase.

The inclusion of pre-1977 data in Figure 1 hides the size of more recent declines, because of the scale on the y-axis. Figure 2 gives a better indication of the change in trout returns in the second phase of the decline.

Angler activity is another useful way to document changes in fish populations. Anglers are highly mobile and make decisions on which water to visit based partly on the number of fish that a particular fishery offers. However, there is likely to be a time lag between a reduction in fish numbers and a reduction in angler use, as anglers who have a lifetime of association with a fishery take time to accept that the changes they are observing are permanent. There are very few estimates of angler use of Te Waihora/Lake Ellesmere available (see Figure 3), especially for the period prior to 1977.

The phase of fishery reduction which took place after 1968 is presumed to relate to the devastating effects of the Wahine storm, in April of that year, which destroyed beds of aquatic macrophytes such as *Ruppia* and *Potamogeton pectinatus*. The loss of permanent weed beds led to increased erosion of the lakeshore due to a loss of the "breakwater" effect, increased erosion of the lake bed by wave action and an increase in the amount of suspended sediment in the water column of near-shore lake waters.

The second phase of reduction in the trout fishery was less spectacular in terms of absolute numbers but may be more significant in terms of its impact on anglers. The post Wahine storm phase appears to have been associated with a further substantial reduction in the number of trout available

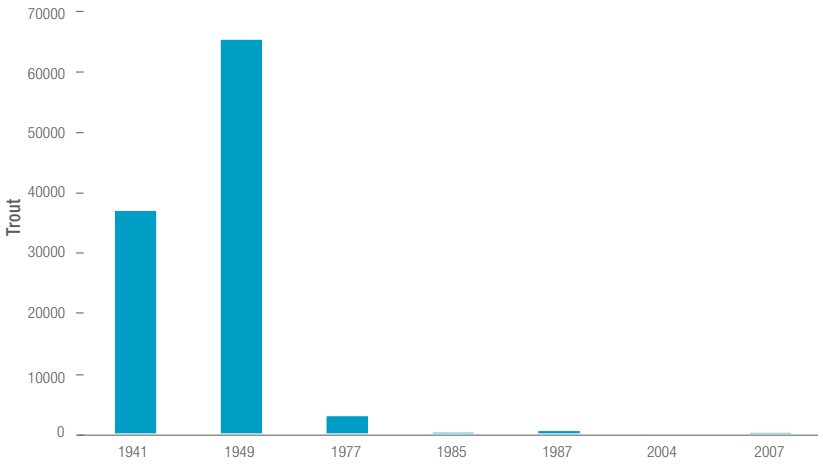

FIGURE 1. Estimates of the Selwyn River brown trout spawning runs from census traps, 1941-2007.

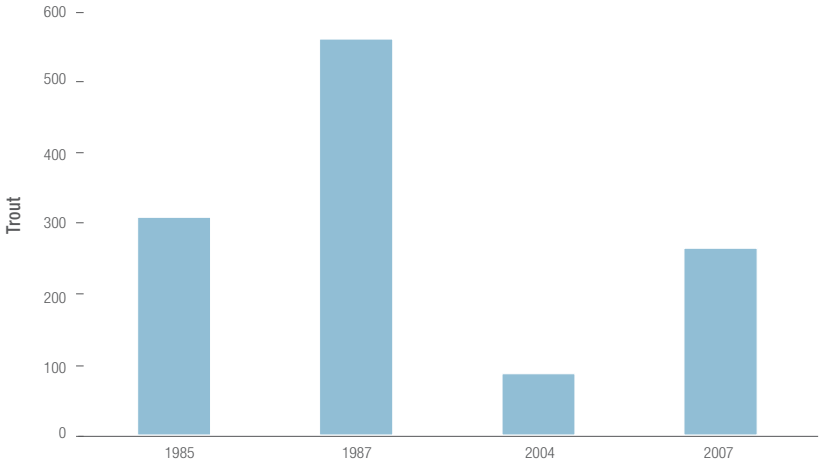

FIGURE 2. Estimates of the Selwyn River brown trout spawning run from census traps, 1977-2007. Please note that the 2007 census was conducted downstream of previous sites and reflects close to total spawning escapement for the Selwyn River.

to anglers. Figure 3 shows the Te Waihora/Lake Ellesmere fishery still attracted very considerable angler effort at this time and was still in fact the most popular trout fishery in the North Canterbury region. Only the salmon fisheries of the Rakaia and Waimakariri rivers attracted more angler interest in the region. The fishery continued to provide significant (albeit reducing) angler opportunity as late as the mid 1990s but has now declined to being of local significance only. The major factors in play during the second phase of fishery reduction were a reduction in tributary flows and increased intensification of land use in the catchment.

In 2003 NIWA conducted a study of anglers' perceptions of changes in the state of lowland river trout fisheries throughout New Zealand over the previous 20 years and concluded that Canterbury's fisheries were amongst the most degraded in the country. The Selwyn River was identified by the authors as being a "river showing a marked decline in angling quality" which the anglers put down to "low flows due to excessive water abstraction for irrigation" (Jellyman et al. 2003). Anglers also indicated that they had observed deterioration in spring-fed Canterbury streams where flows had remained stable but water quality was perceived to have deteriorated.

Possible causes of the decline

Although there do appear to be two phases to the decline of the Te Waihora/Lake Ellesmere trout fishery, it is difficult to single out a predominant cause. Hardy (1989) proposed 10 possible explanations but concluded that were was insufficient scientific information available to narrow them down beyond that. Main and Glennie (1996) took a fresh look at the issue and proposed 11 possible explanations. They concluded that the loss of macrophtye beds and bycatch by commercial fishermen were likely to be the major factors.

In 2007 the list of possible causes is strikingly similar to those proposed in the past:

Commercial fishing

The mortality of trout caught as bycatch by commercial fishermen has been identified as a major factor affecting trout abundance in the past. It is thought that trout generally survive capture in fyke nets set for eels, but die when caught in the gill nets set by flounder fishermen. Glova and Todd (1987) claimed that:

> *"over the years the cumulative loss of adult trout in this manner (gillnetting for flounders) is believed to have had a major impact on stocks in the lake, and may well be the single most important factor in the decline of this once abundant sport fishery."*

Despite long-term concerns about the impact of commercial fishing on the Te Waihora/Lake Ellesmere trout fishery, no records exist of how many are actually caught.

It is reasonable to expect that as trout numbers in the lake have declined, the impact of bycatch should have reduced. However, even if bycatch is no longer a significant factor, it could still act as a barrier to fishery restoration in the future. There is little point in undertaking comprehensive programmes targeted at improving the trout fishery only to have them caught as bycatch before becoming available to recreational anglers or to future generations through spawning.

Spawning habitat

Trout require habitat of particularly high quality for spawning. The water needs to be clear and well oxygenated, and the stream bed needs to consist of loose gravel with minimal sediment content. This is often the first sort of habitat to disappear as stream water quality and quantity become degraded. Taylor and Good (2006) conducted a comprehensive survey of trout spawning in the lower reaches of the catchment (east of SH1) and compared the results with those

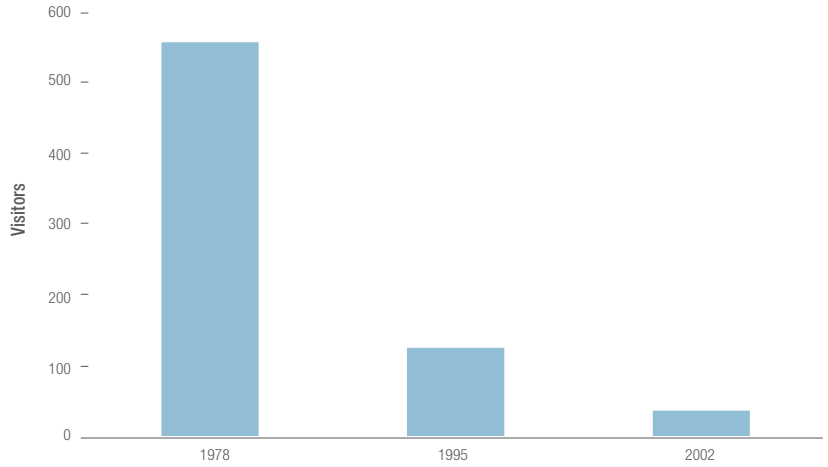

FIGURE 3. Estimates of angler days spent in Te Waihora/Lake Ellesmere and its tributaries in the 1977-78, 1994-95 and 2001-02 seasons (Teirney et al. 1987), (Unwin & Brown 1998) and (Unwin & Image 2003).

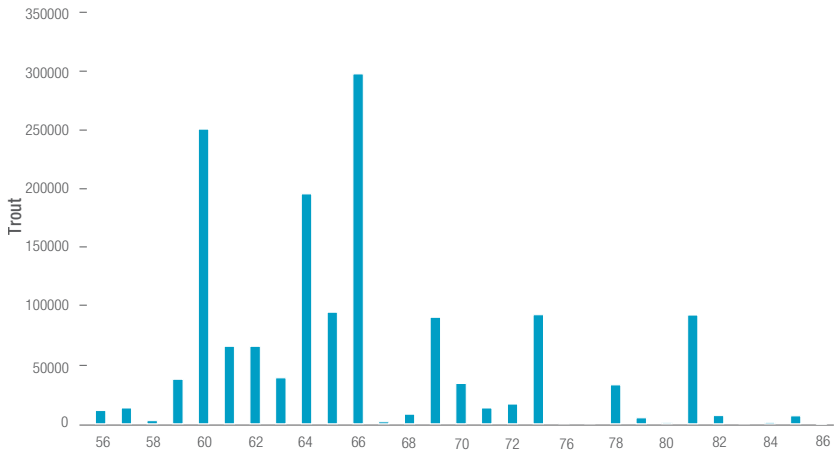

FIGURE 4. North Canterbury Acclimatisation Society trout salvage records, Te Waihora/Lake Ellesmere catchment, 1956-1986.

of similar surveys by the North Canterbury Acclimatisation Society in the 1980s. They found that spawning activity had reduced by 63% in that time, and in some streams had disappeared altogether. Reduction in spawning can reflect either a general decline in the number of fish in the fishery or a reduction in the quality of the spawning habitat. Taylor and Good were of the view that degradation in the quality of the spawning habitat due to stock access, sedimentation and a reduction in surface water flows, were the principal causes of the observed decline.

Loss of access to the Selwyn River headwaters

In the past trout migrated up and down the Selwyn River whenever flows allowed. The largest migration took place in early winter as trout attempted to reach permanently flowing headwater spawning reaches. Once spawning was complete adult trout would attempt to migrate back down the river to the lower reaches and lake. Another migration took place as young trout grew and saturated the available habitat in the headwater reaches and surplus fish were pushed out and forced to migrate downstream, eventually reaching the lake.

Trout access to the headwater reaches of the Selwyn River has invariably increased the production of the fishery, particularly for adult spawning and juvenile rearing. The Selwyn River has always been subject to drying in the middle reaches and these migrations were full of risk. North Canterbury Acclimatisation Society and North Canterbury Fish & Game Council records indicate that hundreds of thousands of trout were salvaged by staff and volunteers between 1936 and the present day. Most of the fish which became stranded were fry or yearlings which were moving through the middle reaches during the summer when the river was drying.

Figure 4 shows that trout salvage is highly variable, depending on river flows during critical migration months and staff availability to do the work. It can be assumed that many fish died before they were able to be salvaged and that some of the salvaged fish may not have survived the stressful experience.

Theory relating to standard stock recruitment curves predicts that although trout spawning activity in a catchment can be highly variable, the production of juvenile trout is likely to be relatively constant, because increased spawning activity leads to increased mortality on the spawning grounds and the "output" of young remains constant. If this is the case in the Te Waihora/Lake Ellesmere tributaries, it can be assumed that in the years when salvage was low, 100,000-300,000+ young trout were successfully migrating down the catchment each year over summer. In order for the migratory behaviour to continue, the benefit to the population of having access to the headwaters for spawning must have exceeded the loss incurred in the years when the young fish became stranded on their downstream migration.

The pattern of migration through the Selwyn appears to have now changed. In recent years Fish & Game staff have visited drying reaches of the Selwyn River as it recedes during the summer and found very few fish to salvage. This suggests that trout may have stopped migrating and may no longer be utilising the upper reaches of the catchment. This could be occurring because winter flows are no longer sufficient to allow adult trout to migrate to and from the headwaters to spawn, and/or because summer flows no longer allow young fish to successfully migrate downstream. Interpretation of the data in Figure 4 suggests that the Te Waihora/Lake Ellesmere trout fishery was able to withstand significant mortality amongst young fish in relation to headwater spawning at frequencies of one year out of four, or one year out of five during the 1950s, 60s, 70s and 80s. However, the flows that cause those losses have occurred more

Photo ***Ross Millichamp with a 4.5kg sea run brown trout caught at the Rakaia River mouth. Similar fish do run into Ellesmere but their contribution to the fishery is unclear.*** *Photography* ***Helgie Henderson.***

frequently in recent years and it is possible that headwater spawning is now doing the population more harm than benefit and that the migratory behaviour has stopped.

If the loss of headwater spawning is considered alongside the reduction in low country spawning identified by Taylor and Good (2006), it is highly likely that the Te Waihora/Lake Ellesmere trout fishery is suffering from a lack of juvenile spawning and rearing habitat.

Loss of rearing habitat in Te Waihora/ Lake Ellesmere

Past reviewers have identified that the change in Te Waihora/Lake Ellesmere habitat that followed the Wahine storm is a major factor affecting trout populations. Although the lake has always been turbid, prior to the Waihine storm there were parts of the lake where the water was clear, such as around inflowing streams and between weed beds and the shore due to the "breakwater" effect. Although the areas of clear water were limited in size, they would have collectively added up to a considerable amount of habitat for trout and their prey.

Hardy (1989) analysed North Canterbury Acclimatisation Society records and found that catch per unit effort at census fish traps had remained constant between the 1940s and the 1960s, but plummeted in 1971. A lag of three years between the Wahine storm and a reduction in the trout spawning run can be explained by the fact that most trout first spawn at three years of age. The fact that the storm and collapse happened in sync with each other suggests that lake habitat remains a major contributor to the current state of the trout fishery.

Hardy (1989) proposed that the weed beds were of particular importance to young trout who were reliant on them for food and shelter during the early parts of their lives when they were vulnerable to predation and reliant on insects and very small fish (which tended to live around the weed beds) for food. When the effect of the loss of this habitat of high importance to young trout is considered alongside the loss of young trout habitat in the Selwyn River (see above), it is highly likely that the catchment is suffering from a lack of juvenile rearing habitat.

Reduction in frequency of lake openings

Environment Canterbury staff advise that there has been a reduction in the frequency of lake openings in recent years. In the past when the lake was the principal rearing water body in the catchment, access to the ocean was probably unimportant. However, if the lake is no longer providing the quality of trout habitat that it did in the past, access to the ocean is likely to be more important. The timing and duration of lake openings is likely to be more critical to the trout population than the absolute number of openings. If the pattern of trout movement through the mouth of the nearby Rakaia River is taken as a guide, the ideal time for Te Waihora/Lake Ellesmere openings is between mid October and mid January. Many anglers believe that trout enter coastal rivers and lakes to feed on whitebait but in my experience the main runs do not occur until the much bigger runs of Stokells smelt arrive after the main run of whitebait.

Although the modification of the lake opening regime is one of the management actions proposed to address the state of the trout fishery, it is likely that the recent reduction in lake openings has not been a major contributor to the current problem.

Factors unlikely to have caused the decline in the trout fishery

Three factors, often debated in terms of their potential contribution to the demise of the trout fishery, are probably relatively unimportant but do need to be discussed.

Recreational harvest

There is no doubt that anglers once removed a very large number of trout from the Te Waihora/Lake Ellesmere system. At the time when the fishery was at its most productive, catch and release was not commonly practiced by anglers and most of the fish that were caught were killed. However, if over-harvest were an issue, the fishery ought to have recovered by now in response to the significantly reduced angler pressure it now receives (Figure 3).

Lake water quality

Trout do not generally do well in eutrophic conditions, principally because they require highly oxygenated water. Elevated nutrient concentrations generally lead to increased plant photosynthetic activity and reduced oxygen in the water column. Te Waihora/ Lake Ellesmere is one of the most eutrophic lakes in New Zealand but is unusual because the amount of sediment carried in the water is so high that photosynthesis is depressed and oxygen levels remain high. However if weed beds are re-established and water clarity improves, water quality could limit the recovery of the fishery-this hypothesis clearly needs further investigation.

Food supply

Although the lack of weed beds may be restricting the availability of food and cover for young trout, it appears unlikely that food is restricting the growth of large trout. There still appears to be an abundance of native fish which is the principal prey of large trout, and trout that are caught by anglers in Te Waihora/Lake Ellesmere are always in exceptional condition.

Photo ***Fish & Game staff salvaging trout from an isolated (landlocked) pool in the Selwyn River.*** *Photography* ***Brian Ross.***

6.4 Suggested management actions

In order to determine the most appropriate management action to restore the Te Waihora/Lake Ellesmere trout fishery, it is important to be able to identify the predominant cause of the decline. Like past reviewers, I am unable to pinpoint a single factor which has caused the decline in the fishery. In fact it is highly unlikely that the fishery has declined due to a single factor and more likely that it is in response to a combination of factors. Jim Lichatowich sums it up in his book "Salmon Without Rivers" where he writes :

> *"Salmon depletion is nearly always the result of cumulative stresses on the fish's life cycle in the river, estuary and ocean. In healthy, resilient ecosystems, stresses are absorbed with little discernable change in gross measures of production. As stresses accumulate, however, the resiliency of the ecosystem is slowly and invisibly lost. At some point, one more stress causes the catastrophe."*

Restoration of the Te Waihora/Lake Ellesmere brown trout fishery will require action on a broad front. Over time we may come to better understand the importance of the various factors discussed and may even be able to dismiss some altogether. However, at the start we should attempt to address all potential factors and adapt the programme as our knowledge improves.

It is also important to establish a realistic target for fishery restoration. Although restoration of the fishery to 1940s levels may be possible in time, it would be better to start with a target such as restoration back to early 1980 (post-Wahine) levels.

The following management actions are suggested:

Lake opening regime

If the quality of the lake environment can be improved to such an extent that it provides quality trout habitat, then the lake opening regime may be irrelevant. However in the short and medium terms it is a very important management action. The continued productivity of the nearby Rakaia River sea run trout fishery indicates that the local ocean environment does have something to offer the Te Waihora/Lake Ellesmere population. In order to assist the establishment of a truly sea run fishery in Te Waihora/Lake Ellesmere, the lake needs to be open to the sea for as long as possible between mid October and mid January to allow adult fish to enter the lake from the ocean. The number of days the lake is open to the sea is more important than the number of times the lake is opened. A permanent outlet to the sea would be the best action but it is recognised that this may not suit other lake species. However a programme of more frequent openings during spring and summer would be of benefit.

Commercial bycatch

Research needs to be conducted to document the level of bycatch which is taking place and the effect it is having on the trout fishery. Reviewers have been suggesting that this is a likely cause of trout decline for close to twenty years and we are yet to even start gathering data on capture rates. This action would have to be undertaken by the Ministry of Fisheries (MFish) as part of their routine fishery reporting program. Once data on trout capture rates were gathered, NIWA could be commissioned to give advice on the likely impact to the fishery. If a significant impact was determined, MFish could introduce rules governing the way that commercial fishing took place to reduce the bycatch to acceptable levels.

Spawning stream restoration

Taylor and Good (2006) made 12 recommendations to Environment Canterbury about actions that could be taken to address the degradation and loss of spawning habitat that has occurred in recent years. They gave examples of two places where riparian management had improved and spawning numbers were higher than historical levels, which gives some confidence that action will deliver tangible results.

Restoration of Selwyn River flows

Adult trout in the lake and lower reaches need to regain access to the upper Selwyn River catchment for spawning, and juvenile trout need to regain access to the lower reaches and lake for growth. It is unrealistic to expect this to happen every year but it needs to take place three years out of four, or four years out of five. At present trout are being prevented from migrating through the catchment by the impacts of abstraction and climate. Abstraction is the only one of these factors that can be managed and so consent conditions should be reviewed to ensure that the actions of abstractors do not prevent trout from being able to migrate through the system. A number of reviews of groundwater and surface water consents are already underway but may not be targeted at achieving this standard.

Restoration of weed beds

This is clearly a long-term target but a start needs to be made. The theory that weed beds can be reestablished needs to be tested and used as a justification for further work, or the abandonment of the concept.

Juvenile recruitment

Many of the actions listed above are targeted

at improving conditions for the incubation, hatching, rearing and growth of juvenile trout, on the presumption that once they get past a certain critical size, there will be suitable feeding and growth opportunities available to take them through to maturity. This theory should be tested by releasing hatchery reared trout into the lake and monitoring their returns. This was attempted on a small scale by NIWA in the early 1990s and although there was difficultly in tracking returns, Glova (1996) concluded that:

"releasing hatchery reared trout of around 50 g in weight in the Lake Ellesmere system is a viable option for enhancing the fishery".

Research

In 1989 Hardy conducted a comprehensive review of the state of knowledge of the Te Waihora/Lake Ellesmere fishery and concluded that there were large information gaps that needed to be plugged before the true cause of the observed declines could be identified. Main and Glennie (1996) concluded something very similar as little had been done in the intervening period. In 2007 I have again come to the same conclusion. If research is not undertaken to resolve these issues then attempts at restoration are likely to be slow, reactive and unlikely to succeed. Statutory agencies need to co-operatively develop a research strategy for the lake and seek funding from the crown to undertake it.

Photo ***Brian Ross from Fish & Game, loads brown trout salvaged from the Irwell River, into a fish transporter for relocation to permanent water.*** *Photography* ***Ross Millichamp.***

6.5 Conclusions

The restoration of the Te Waihora/Lake Ellesmere brown trout fishery will be a challenging but ultimately rewarding task. The cause of the collapse is likely to be a combination of natural and human-induced factors, but manipulation of the latter, which include commercial fishing, irrigation, land use intensification and riparian management practices, are the only management actions available to us.

Although the fishery is highly degraded compared to its heyday in the first half of the 20th Century, there is still a significant stock of fish in the catchment from which a recovery could emanate. More than 300 trout ran up the Selwyn River to spawn in 2007 which indicates that although the recreational fishery is highly degraded, the population is far from becoming extinct. Taylor and Good (2006) identified around 500 trout redds in other spawning streams and found that spawning was concentrated in waters where restoration programmes were already underway.

Some people may not see the restoration of the Te Waihora/Lake Ellesmere brown trout fishery as a priority, especially if it comes at a cost to agricultural production in the catchment. However, it is important to remember that trout are a vital indicator of lake health, given that they are highly visible and have a strong recreational following. If the trout fishery can be restored, many of the other lake species will likely be restored also.

The real finding of this process is that similar reviews of lake values have taken place in the 1980s and 1990s but no commitment was made to resolving the issues and the lake has continued to degrade. This should not happen again.

6.6 References

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Te Waihora/Lake Ellesmere is a large coastal lake, intermittently open to the sea. It is highly regarded for its conservation and related values, some of which are of international significance. Its function as a sink for nutrients from its large predominantly agriculturally based catchment, currently undergoing accelerated intensification, is also recognised, at least implicitly. It is the resulting conflict from these value sets which is mainly responsible for the ongoing debate about the future of the lake.

This book serves to quantify the nature of this debate by documenting changes to lake values, both over time and spatially. It provides a standardised approach to reporting these changes, set against indicators that are value-specific. Ultimately, it provides a template for thinking about future management scenarios for the lake and its environs. Given this approach the book ultimately serves as a resource for helping understand the ever-changing and current and possible future states of the lake, under a variety of management requirements and implications.