

**BEFORE WAIKATO REGIONAL COUNCIL
HEARINGS PANEL**

UNDER the Resource Management Act 1991 (**RMA**)

IN THE MATTER OF Proposed Plan Change 1 to the Waikato Regional
Plan and Variation 1 to that Proposed Plan Change:
Waikato and Waipā River Catchments

Adam Joshua Daniel

**PRIMARY EVIDENCE ON BEHALF OF THE AUCKLAND/WAIKATO &
EASTERN REGION FISH AND GAME COUNCILS (“FISH & GAME”)**

SUBMITTER ID: 74985

Hearing Block 1

Dated: 15 February 2019

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1. QUALIFICATIONS AND EXPERIENCE

- 1.1 My full name is Dr Adam Joshua Daniel.
- 1.2 I am employed as the Fisheries Manager for the Auckland/Waikato Fish and Game Council at the Hamilton office.
- 1.3 I have a BSc degree in Biology from Washington State University (USA) in 1998 and a PhD in freshwater ecology from the University of Waikato in 2009.
- 1.4 I have been a freshwater ecologist since 1999 in the United States and New Zealand. Following my undergraduate degree, I worked as a research biologist studying fish behaviour and survival of fish at large

hydropower facilities at the Columbia River Research Laboratory, USA. In 2006 I began my PhD on behaviour and habitat use of fish in the lower Waikato River. After completing my PhD, I worked as a biologist investigating both water quality and fish passage issues on the Columbia River for the U.S. Army Corps of Engineers. In 2011 I returned to New Zealand to become the principal investigator for the pest fish section of the University of Waikato's 'Lake Biodiversity Restoration Outcome Based Investment' under Professor David Hamilton. I have been employed as the Fisheries Manager for the Auckland/Waikato Fish and Game Council since 2013 (Fish & Game).

- 1.7 I am a member of the New Zealand Freshwater Sciences Society and a former member of the American Fisheries Society.
- 1.8 I am very familiar with the Waikato and Waipā River catchments My work as Auckland/Waikato Fish & Game's Fisheries Manager has included extensive electrofishing of tributaries, and annual drift dives, within these catchments. I also have substantial knowledge of water quality data within the Waikato and Waipā catchments from previous RMA processes that I have assisted Fish & Game with, and my work at the University of Waikato.
- 1.9 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have noted (above) that I am employed by the Auckland/Waikato Fish & Game Council.
- 1.10 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions, I have made in forming my opinions.
- 1.11 My opinions rely in part on the Evidence in Chief presented by expert witness Adam Canning appearing for Fish & Game.

2. SCOPE OF EVIDENCE

2.1 My evidence will cover the importance of the Waikato and Waipā River sports fisheries and their decline due to diminishing ecosystem health. My evidence will deal with the following issues:

2.1.1 Significance of the Waikato and Waipā fisheries for sports fish (trout).

2.1.2 Declining angler use within the Waikato and Waipā fisheries.

2.1.3 The importance trout migrations in the Waikato and Waipā fisheries.

2.1.4 Declining water quality and ecosystem health in the Waikato and Waipā fisheries.

2.1.5 Water clarity and fisheries.

2.2 Ecosystem health and the impacts of the key contaminants on trout will be covered in Adam Douglas Canning's evidence. The implementation of a framework to reduce the impact on the trout fishery will be covered by Helen Marr.

3 SUMMARY STATEMENT

3.1 Fish and Game Councils are statutory entities. There are 12 Fish & Game Council Regions across New Zealand, with elected Councillors. PC 1 affects the interests of the Auckland/Waikato and Eastern Regions. Fish & Game Management Plans are required to be had regard to under Section 66(2)(c)(ii) RMA. The two Management Plans that are relevant align well with the Vision and Strategy – a healthy Waikato river which sustains abundant life.

3.2 Section 7(h) of the RMA recognises the protection of the habitat of trout and salmon. There is good correlation between the habitat requirements of salmonids and suitability for other species, such as indigenous fish populations.

3.3 Waterways are one of New Zealand's most valuable cultural assets and many new Zealanders have a strong cultural connection with rivers and streams through sport and recreation.

3.4 The Waikato and Waipā River sports fisheries are highly recreationally and culturally significant. Trout fishing represents the largest food gathering activity on the Waipā and Waikato Rivers with a combined total of 17,230 angler days¹.

3.5 The migratory nature of trout requires water quality suitable for trout, trout forage species and trout habitat throughout the Waipā and Waikato catchments. Trout require both access to forage fish in the mainstems of the Waikato and Waipā Rivers and access to cool clean streams at higher elevation to avoid lethal summer temperatures. Water quantity is critical during summer as fish are limited to only 17% of their potential habitat making the population less resilient and increasing the impact of additional stressors. The large decline in Waikato River whitebait runs and the lack of an estuary migration by brown trout are clear signs of very poor ecosystem health that has directly impacted the gathering of food in the lower Waikato River. Declining water quality has resulted in reduced trout numbers in the Waipā and reduced fish health in mainstem Waikato River sites. Degraded

¹ The time spent fishing by one person for any part of a day

water quality has greatly diminished the recreational and cultural value of the Waipā and Waikato Rivers by negatively impacting fishing.

3.6 Angler use in the Auckland/Waikato Region has declined 42% since the 1994/1995 fishing season with 90% of the overall decline occurring in the Waikato and Waipā catchments likely due to declining ecosystem health. In contrast, rivers within the Region with improving water quality like the Whakapapa and upper Whanganui Rivers have had considerable increases in angler use, despite being much further from urban centres.

3.7 Significant improvements in water clarity will be required to achieve the goals of the Vision and Strategy for the Waikato River. Significant declines in visual clarity within the Waikato and Waipā tributaries threaten the recreational and cultural value of trout fisheries. Table 1 of my evidence recommends water clarity limits (short term and 80 year) for nationally and regionally significant sites and at significant spawning sites.

4 KEY FACTS AND OPINIONS

4.1 Fish & Game, Management Plans and trout management in the Waikato.

4.1.1 There are 12 Fish & Game Council Regions across New Zealand (excluding the Taupō sports fishery, which is managed by DOC). Fish and Game Councils were created in 1990 by the Conservation Act 1987, broadly from the former Acclimatisation Societies. Specific functions, responsibilities and powers to manage sports fish, and game birds, are set out in sections 26Q, 26R, and 26S of the Conservation Act 1987.

4.1.2 The Fish and Game Councils are solely funded through income that is generated through licences purchased by game bird hunters and freshwater anglers. There are two Fish and Game regions impacted by PC 1: the Auckland/Waikato and Eastern Regions.

- 4.1.3 The management of sports fish is governed by Sports Fish and Game Management Plans (Fish and Game Plans). Fish and Game Plans specify the objectives and policies of a Fish and Game region in realising its goals in managing, maintaining and enhancing the sports fish resource, and maximising angling opportunities.
- 4.1.4 Fish and Game Plans are statutory planning documents, required under the Conservation Act 1987 for Fish & Game to fulfil its statutory mandate to *manage, maintain and enhance the sports fish and game bird resource in the recreational interests of hunters and anglers* (Section 26Q(1) Conservation Act). A regional council must “*have regard to*” these management plans, when preparing or changing a regional plan.²
- 4.1.5 Maintenance of trout populations in the Waikato Region relies on the natural spawning of fish (rather than the liberation of hatchery-reared stock), and therefore natural dynamics of self-sustaining populations must be maintained. As such, the management of the Waikato trout fishery requires sustaining suitable habitat for fish to complete their lifecycles, including water quality, to provide for the sustainability of these fisheries.
- 4.1.6 The outcomes of regional council plans are of critical importance in managing a self-sustaining fishery such as the Waikato catchment, as these are the key instruments impacting the management of sports fish habitats. In other words, ensuring sufficient habitat of appropriate quality is available to maintain and enhance self-sustaining populations of sports fish and angling opportunities is an important aspect of managing the sports fish resource.
- 4.1.7 The objectives of the relevant Fish and Game Plans include: to *protect and increase habitat for sports fish and game birds³; advocacy of sports fish and game habitat values, angling and hunting values using statutory and non-statutory processes.*⁴

² Because they are statutory plans: Section 66(2)(c)(ii) Resource Management Act 1991.

³ Auckland/Waikato Sports Fish and Game Bird Management Plan 2010, Part 2, p 12; Eastern Region Sports Fish and Game Bird Management Plan 2010, Goal 2, p 30.

⁴ Eastern Region Sports Fish and Game Bird Management Plan 2010, Objective 2.1.2, p 34.

4.1.8 The Fish and Game Plans set methods and policies for achieving objectives and specify the Issues. Methods and policies include:⁵

- *Assessing and monitoring the condition and trend of sports fish and game bird habitat in the region;*
- *To seek through the RMA, provisions in plans for rules on land and water use that maintain or enhance aquatic ecosystems;⁶*
- *To seek through the RMA, provisions in plans for maintenance and enhancement of riparian margins;*
- *To seek through the RMA, provisions in plans for catchment protection;*
- *To seek through the RMA, other provisions that will benefit sports fish habitats or recreational values.*

4.1.9 The Fish and Game Plans also identify sites of national (Waikato River and Lake Arapuni) and regional (Waipā River, Waipapa River and Mangatutu Stream) significance for recreational fishing.

4.1.10 As such Fish and Game Plans align well with the Vision of a healthy Waikato River that sustains abundant life, and the following objectives of the Vision and Strategy:

- (i) the protection and enhancement of significant sites, fisheries, flora and fauna.
- (e) the integrated, holistic and coordinated approach for management of the natural, physical cultural and historic resources of the Waikato River.
- (k) the restoration of water quality so that it is safe to swim in and take food from over its entire length.

4.1.11 The protection of habitat of trout and salmon is also recognised in Section 7(h) of the Resource Management Act. Trout and salmonids are the most studied fish species in the world. Salmonid habitat requirements are well established and documented in literature, whereas the habitat requirements of most freshwater native fish

⁵ Auckland/Waikato Sports Fish and Game Bird Management Plan 2010, Part 2, p 16 and Eastern Region Sports Fish and Game Bird Management Plan 2010, Policy 2.1.2(c), p 34.

species are less well known. It is generally recognised that provision of salmonid habitat requirements provides protection for the health of most other species in aquatic ecosystems, and for life-supporting capacity generally. That is, there is generally good correlation between the habitat requirements of salmonids and suitability for other species and purposes. Dr Adam Canning's evidence for Fish & Game discusses this further, together with recommended water quality objectives and attributes.

4.2 Recreational significance of the Waikato and Waipā Fisheries

- 4.2.1 The Auckland/Waikato Fish and Game Region stretches from Warkworth to National Park. The Region is home to approximately 43% of New Zealand's residents, making the population base within the Auckland/Waikato Fish and Game Region the largest in New Zealand.
- 4.2.2 The Waikato River below Karapiro dam is the third most popular fishery within the Auckland/Waikato Fish & Game Region due to its proximity to Hamilton and an abundance of brown trout during winter months. Angler use of waterways within both the Waipā and Waikato (below Lake Taupō) catchments represents 53% of the overall angling in the Auckland/Waikato Fish and Game Region (Unwin & Rouse 2016).
- 4.2.3 The upper Waikato River also includes a small portion of the Eastern Fish and Game Region, from the Taupō gates to Lake Maraetai. This is not insignificant from a recreational perspective, as the angler use of the Waikato River within the Eastern Fish & Game Region represents approximately 3,510 angler days annually.
- 4.2.4 There are currently very limited trout angling opportunities north of the Waikato River making the Waikato and Waipā fisheries a critical cultural and recreational asset to a large proportion of New Zealand's residents. The combined use of the Waikato and Waipā rivers by sports fishing anglers is 17,230 angler days annually. A 2014/2015 angling survey (Unwin & Rouse 2016) found that:

- The Waikato River including Lake Arapuni, Lake Karapiro and the mainstem of the Waikato river below Karapiro dam host nearly a third (13,720 angler days) of the Auckland/Waikato Fish & Game Region's freshwater fishing.
- The upper reaches of the Waipā River attract about 9% of total angler use within the Auckland/Waikato Region despite relatively limited access and representing less than 0.01% potential trout fishing water. The combined use of the Waikato and Waipā rivers by sports fishing anglers is 17,230 angler days annually. This is second only to the combined use of swimming and paddling as the highest use activity (Phillips 2014) in the Waikato catchment.

4.2.5 The popularity of these rivers for sport fishing and proximity to urban centres make trout fishing an important asset to the local and regional community.

4.2.6 The social and cultural significance of trout fishing within the Auckland/Waikato Region is also substantial with active freshwater angling clubs in Auckland, Huntly, Hamilton, Morrinsville, Te Awamutu and Tokoroa that depend heavily on the angling opportunities in the Waikato/Waipā catchments. There are three annual fishing competitions held in the Lower Waikato and Waipā Rivers, including the annual Tokoroa 'take a kid fishing' competition that hosts several hundred children annually.

4.2.7 It should be noted that some iwi and hapu also recognise trout as a mahinga kai species in the Waipā and Waikato Rivers. For example the Raukawa fisheries plan lists trout as a freshwater species that Raukawa either have or continue to utilise as a source of food, stating *"[t]he use of the introduced species was likely to be a result of the relative abundance of those species over native species in our waterways."*⁷

⁷ <https://www.raukawa.org.nz/rct/wp-content/uploads/sites/2/2016/11/Raukawa-Fisheries-Plan.pdf> page 12: "All indigenous species are recognised and respected by Raukawa as a significant part of the environment. The following freshwater species have been/are utilised by Raukawa as a source of food: native tuna, kōura, piharau, kōkopu and kōaro, kāeo/kākahi, as well as the introduced catfish, goldfish and trout."

4.2.8 The original introductions of trout were invited by Ngati Maniapoto Chief Rewi shortly after the Maori wars in 1877 (Sullivan 1992). Rewi and Te Puke assisted in dispersing the fish ova into the river and “entertained” the Acclimatisation Society members at the local settlement (Sullivan 1992). Rewi was also the first to protect trout in the catchment by ordering that Maori fishers release the fish until they could become established (Sullivan 1992).

4.3 Declining angler use within the Waikato and Waipā Fisheries

4.3.1 Angler use in the Auckland/Waikato Region has declined 42% since the 1994/1995 fishing season with 90% of the overall decline occurring in the Waikato and Waipā Catchments alone (Appendix 1). The reduction in angler use in the Auckland/Waikato Fish and Game Region appears to be the result of a combination of factors that primarily revolve around water quality. Angler use of the lower Waikato River has plummeted from a high of 7240 angler days during the 1994/1995 season to 3090 angler days in the 2014/2015 census (Unwin & Rouse, 2016; Appendix 1). The angler use of Lake Karapiro has also declined dramatically with 65% less angler use during the 2014/2015 season compared with the 1994/1995 season.

4.3.2 Although all the major fisheries in the Waikato and Waipā catchments show declining angler use, areas where water quality has been maintained have had significant increases in angler use. Despite being a considerable distance from major urban centres the Whakapapa and upper Whanganui Rivers have had considerable increases in angler use (2001/2002-2014/2015) with increases of 119% and 261% respectively. Both rivers have been largely protected from increased contaminants as they run through the Tongariro Forest Park helping to maintain water quality. Anglers strongly prefer good water clarity and healthy riparian margins when fishing upland streams (Beville & Kerr 2008) and are traveling greater distances to fish less degraded streams.

4.4 Migratory nature of trout within the Waikato River catchment

- 4.4.1 Most trout within the free-flowing portions of the Waipā and lower Waikato River (below Karapiro Dam) are migratory. The migratory nature of trout requires suitable water quality in both upland and lowland reaches of the Waikato and Waipā Rivers. Importantly, trout require access to forage fish in the mainstems of the Waikato and Waipā Rivers, and access to cool clean streams to avoid lethal summer temperatures.
- 4.4.2 The existing trout fishery within the mainstem Waikato River downstream of the Karapiro Dam, is almost completely dependent on migratory brown trout primarily from the Waipā catchment. This is because there is little or no brown or rainbow trout spawning habitat within the lower Waikato River, due to the severally degraded water quality within tributary streams.
- 4.4.3 The lower Waikato is a critical feeding ground for brown trout. Brown and some rainbow trout migrate annually from the headwaters of the Waipā River to the lower Waikato River (Wilson and Boubée 1996) to feed primarily on smelt and other fish (Rowe and Boubée 1994), once they reach a size of 200 mm (Gabrielsson and Knight 2014).
- 4.4.4 Much of the Waikato and Waipā rivers, and low elevation tributaries, are too hot and polluted for trout to survive during the summer months, so rainbow trout also migrate upstream in summer, into cool Waipā River tributaries.
- 4.4.5 The contribution of the lower Waikato River, in terms of forage fish, is vital to all the connected waterways including the Waipā River catchment. Trout that are able to feed on fish rather than drifting invertebrates grow much faster making migration worthwhile despite the energetic cost (Gabrielsson & Knight, 2014). Due to their abundance and distribution in the Waikato River, smelt are likely to play a critical role in ecosystem function (Collier et al. 2010). Smelt are estimated to represent up to 50% of the annual adult brown trout diet (Gabrielsson and Knight 2014) significantly improving the size, quality

and fecundity of brown trout that feed annually in the lower Waikato River. Anglers in the Waikato region are highly dependent on fishing for trout that benefit from migrations to the lower Waikato River. Approximately a third of all angling time in the Region is on rivers and streams that benefit from trout migrating from Waipa tributaries to the lower Waikato.

4.4.6 Smelt are a critical food source for trout within the Waikato River, Waikato River hydro lakes and the Waipā catchment. Decreased water clarity is known to have a negative effect on smelt feeding effectiveness (Rowe and Dean 1998). The presence of smelt is used as an indicator of river health, as smelt are known to be sensitive to turbidity (Shearer and Hayes 2010) and their presence is less likely in rivers with higher and more frequent periods of low water clarity (Rowe et al. 2000). The reduction of smelt biomass caused by decreased water clarity in the lower Waikato River and Waikato River hydro lakes has likely impacted adult brown and rainbow trout within the Waipā and Waikato river catchments. Further reducing smelt biomass in the lower Waikato River would have a devastating impact on the brown trout population drastically reducing the availability of food on a catchment level.

4.4.7 Although Waikato and Waipā river brown trout have access to the estuary, they may be the only known population that do not migrate to take advantage of the abundant forage fish normally found in estuaries. Two independent studies (Charteris 2015; Gabriellsson & Knight 2014) have found no evidence that Waikato and Waipā river brown trout access the estuary although there are historic records of brown trout bycatch in the Waikato River whitebait fishery. It is likely that poor water quality is the primary reason trout no longer utilise the Waikato River estuary. The large declines in whitebait runs and the lack of an estuary migration by brown trout are signs of very poor ecosystem health that has directly impacted both the trout and whitebait fisheries.

4.5 Declining water quality and ecosystem health

4.5.1 The migratory nature of trout requires water quality suitable for trout and trout forage species throughout the Waipā and Waikato Rivers including all major tributaries. Due to the complex life history of Waikato

and Waipā River trout, the populations are sensitive to multiple stressors including high water temperatures, decreased water clarity (caused by chlorophyll *a* and suspended solids) and high sediment loads.

- 4.5.2 Fine sediments have severe impacts on fish (Allan 2004; Cavanah et al. 2014) negatively effects salmonid spawning success and reducing invertebrate (i.e. food) production (Hay et al. 2006). Fine sediment also interacts with other stressors, such as high water temperature and elevated nitrogen and phosphorus to further reduce water clarity (Piggott et al. 2012; Jellyman et al. 2003). Combined effects of contaminates are of particular concern in the Waikato Region where high rainfall rates, highly erodible geology and steep hill country areas have combined with large areas of exotic forest harvest and the rapid expansion of intensified land use to generate high sediment yields (Hicks et al. 1996). The evidence of Dr Canning covers the direct impact of sediment on fish and invertebrates.
- 4.5.3 Providing shade is probably the most important way to enhance stream life (Environment Waikato, 2007) and riparian vegetation removal combined with a lack of adequate stream buffers has increased the temperature (Holmes et al., 2016) of the Waikato and Waipā tributaries. Restoring streamside vegetation along perennial waterways, including drains, with an appropriate buffer would reduce sediment loads and stream temperatures (Poole & Berman, 2001).
- 4.5.4 Although habitat may be intact in terms of rivers being accessible to trout, the loss of streamside vegetation and the corresponding increase in water temperatures forces trout to migrate upstream during summer months. For example, adult trout originating in the upper Waipā will occupy approximately 250 km of river including the Lower Waikato (Karapiro to Tuakau) and most of the accessible mainstem Waipā River. However, when water temperatures increase in summer trout are only able to occupy the upper 43km (17% of winter habitat) of the Waipā above Otorohanga. Similarly, the upper reaches of most catchments in the Region are critical thermal refuges for trout. The degradation of this habitat through intensification in hill country farms

has severely degraded many critical summer refuge streams.

4.5.5 The 1994 MFE water clarity values for contact recreation and the ANZECC 2000 guidelines recommend 1.6 m (200 mm diameter black disc) as a minimum water clarity for contact recreation (MFE 1994; Water & Management 2000). The 1.6 m value has also been used to evaluate New Zealand rivers in terms of contact recreation (Davies-Colley & Close 1990). Although 1.6 m guideline is helpful for the limited focus of swimming, the requirements for trout are a minimum of 1.8 m with upland rivers such as the Waipā River tributaries requiring at least 2.0 m to sustain healthy trout populations.⁸

4.5.6 A minimum of 2.0 m is recommended for all trout habitat and trout spawning habitat (Ausseil 2013).⁹ Although it may be aspirational for the entire Waikato River to have water clarity above 2.0 m, it is achievable to have at least 2.0 m of visibility in the Waikato River at the Horotiu Bridge. Additionally, I have listed water clarity bottom lines for nationally significant streams, regionally significant streams and significant spawning streams in Table 1. I compare these to the targets in Table 3.11-1 of PC1.

⁸ 42A [611]

⁹ Hay et al. 2006 recommend water clarity in excess of 5.0 m in all regionally and nationally significant trout fisheries but I am not recommending that here.

Table 1. Water clarity targets in PPC1 and those sought by Fish & Game for nationally significant fisheries, regionally significant fisheries and significant spawning streams.

Location	Significance	Proposed		Fish & Game	
		Short term (m)	80 year (m)	Short term (m)	80 Year (m)
Waikato River (Waipapa Tailrace)	National significance	2.0	3.0	support	support
Waikato River (Narrows Boat Ramp)	National significance	1.7	1.7	1.8	2.0
Waikato River (Horotiu Br)	National significance	1.4	1.6	1.8	2
Waipā River (Mangaokewa Rd)	Regional significance	1.5	1.6	1.6	2.0
Waipā River (Otewa)	Regional significance	2.1	2.1	support	support
Waipā River (SH3)	Regional significance	1.2	1.6	1.8	2
Waipapa Stm (Mokai; Tirohanga Rd Br)	Regional significance	1.2	1.6	1.5	2.2
Little Waipa Stm (Arapuni - Putaruru Rd)	Significant spawning stream	1.5	1.6	1.6	1.8
Pokaiwhenua Stm (Arapuni - Putaruru Rd)	Significant spawning stream	1.3	1.6	1.5	1.8
Puniu River (Bartons Corner Rd Br)	Significant spawning stream	0.9	1.0	1.2	1.8
Kaniwhaniwha Stm (Wright Rd)	Significant spawning stream	0.9	1.0	1.2	1.8
Moakurarua Stm (Ormsby Rd)	Significant spawning stream			1.8	2.0
Mangatawhiri River Lyons Rd Buckingham Br	Significant spawning stream	1.6	1.6	1.8	2.0

4.5.7 Significant spawning streams such as the Little Waipa and Pokaiwhenua Streams not only provide locally significant fisheries but are also the spawning grounds for trout that inhabit Lake Karapiro. Similarly, the Puniu River, Kaniwhaniwha Stream, Moakurarua Stream and Mangatawhiri River are all degraded spawning streams that provide critical spawning habitat and valued fishing opportunities.

4.5.8 A recent review of water quality trends in the Waikato Region has shown reductions in both Chlorophyll *a* and total phosphorus (Vant 2018). However, visual clarity in the Waikato is only improving at two sites with reductions in visual clarity at five other sites. Total nitrogen is increasing at an alarming rate with two-thirds of sites across the Region increasing, likely from pastoral farming. Although the mainstem Waikato is important trout habitat water quality in tributary streams is critical to maintain fisheries. Unfortunately, declining water quality parameters were “*twice as common (35 sites) as improvements (16 sites)*” in tributary streams. Similarly, visual clarity is declining at 17 sites with improvements at only 4 sites in tributary streams in the Waikato (below Taupō) and Waipā catchments. The decline of water quality in tributary streams is consistent with field observations of increased intensification of hill country farms in the Waipā and Waikato catchments with corresponding decreases in water clarity.

Case Study 1: Mangatutu River

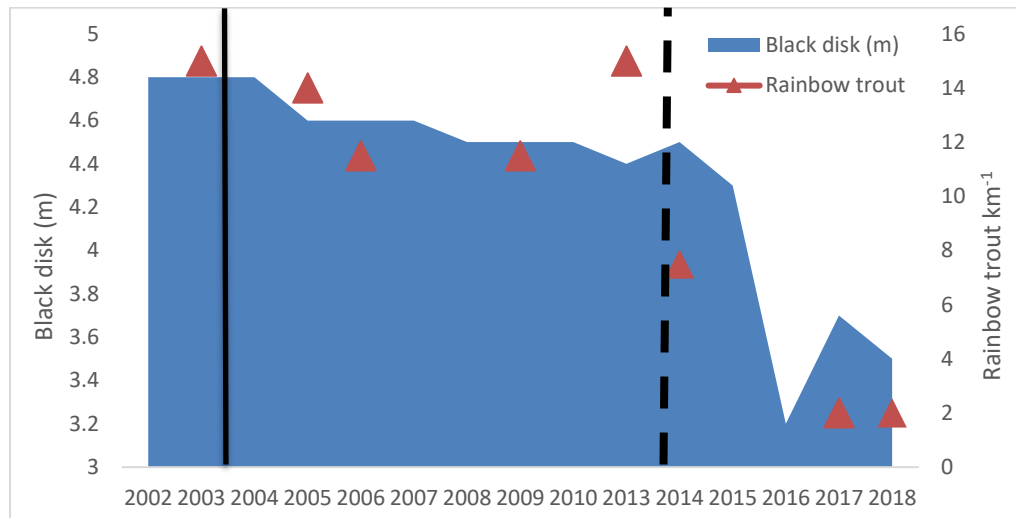
4.5.9 The Mangatutu River (upper Waipā catchment) is a good example of the impact of intensification including clearing vegetation on slopes for and converting dry stock farm to dairy. Hill country slopes along the Mangatutu were cleared in approximately 2003 (Figure 1) for intensification of an existing farm followed by the conversion of a dry stock farm to dairy in 2014 on the opposing bank of the river. The dry stock to dairy conversion included races adjacent to the river and stream crossings that have had an obvious contribution of sediment to the Mangatutu River (Figure 2). Both sites are just downstream of the Pureora Forest Park and no other changes have occurred upstream. Loss of water clarity after the 2003 vegetation removal on steep slopes (Figure 3, black solid line) and the neighbouring dry stock to dairy conversion in 2013 (Figure 3, black dashed line) are apparent in the annual water clarity monitoring (Figure 3, blue). The corresponding reduction in rainbow trout (Figure 3, red triangles) is apparent after the 2014 dairy conversion.



4.5.10 **Figure 1.** Native and scrub vegetation for dairy intensification in 08/06/2001 (left) and the same location after vegetation removal in 03/11/2013. Fish counts were conducted in this section of the river and water clarity was taken about 0.5 km downstream.



4.5.11 **Figure 2.** Unfenced marginal strip converted to a dairy race with no sediment trap on Mangatutu Stream bank, first used in approximately 2013.



4.5.12 **Figure 3.** Rainbow trout over 40 cm per km (red triangle) of drift dive surveys on the Mangatutu River plotted with annual water clarity (blue; black disk) taken at each drift dive. The black line indicates the approximate time when scrub and native brush were removed from the hill country adjacent to the Mangatutu River. The black dashed line indicates when the dairy conversion along the banks of the river occurred.

Case Study 2: Waikato River hydro lakes

4.5.13 The Waikato River hydro lakes are a second example of how declining water quality has had a dramatic impact on fish populations. Water quality in the Waikato River hydro lakes has been steadily declining with a dramatic increase in nitrogen (Figure 4A; Data provided by Waikato Regional Council) and a gradual decrease in water clarity (Figure 4B), at Waipapa Dam since 1998. The dramatic increase in nitrogen and reduction in water clarity have been closely matched by a reduction in trout condition (K) within Lake Arapuni below Waipapa Dam (Figure 5).¹⁰ Fish condition data was collected at the annual Lake Arapuni fishing competition. The long-term reduction in water clarity, increase in nitrogen with a corresponding decline in fish health are direct measures of declining ecosystem health in the Waikato River.

¹⁰ Fish condition (K) is the relationship between length and weight with a score of 1.6 indicating excellent fish condition, 1.2 fair condition and scores of 1.0 and below indicating poor fish condition (Fulton 1902).

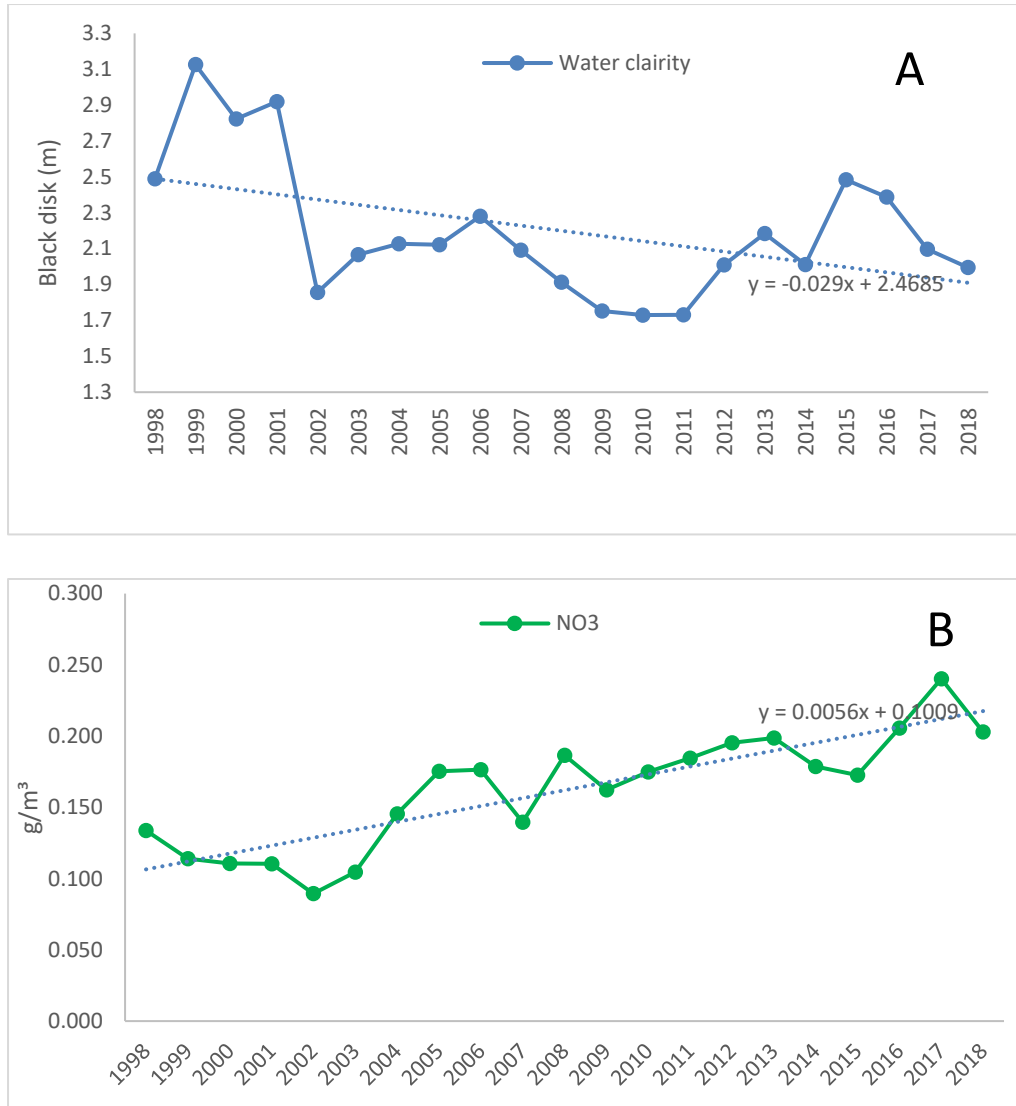


Figure 4. (A) mean annual Water Clarity measured by black disk at Waipapa Dam 1998-2018 (B) Mean annual Nitrate nitrogen NO3-N as measured at Waipapa Dam 1998-2018.

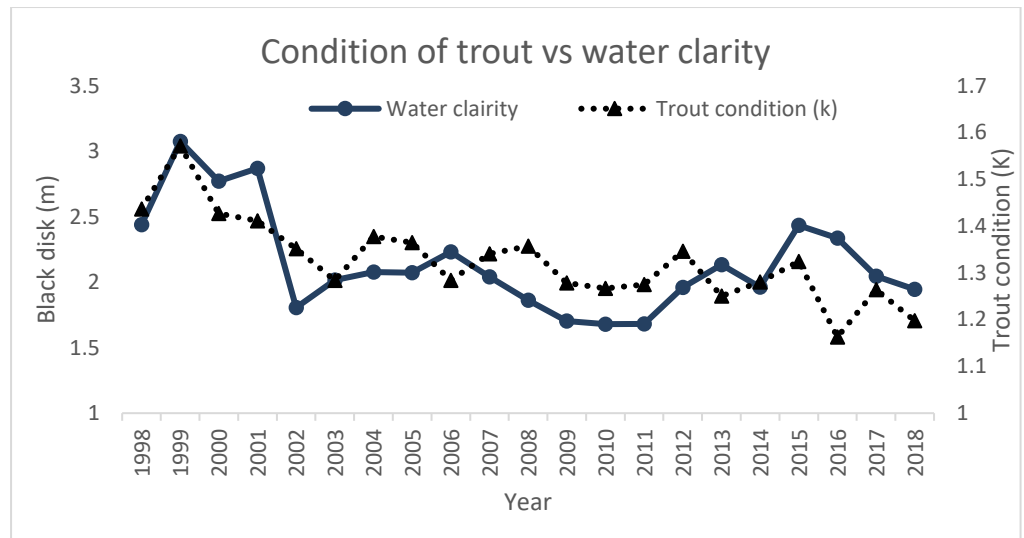


Figure 5. mean annual Water Clarity (blue line) measured by black disk (m) at Waipapa Dam and mean fish condition (K; black triangles & dotted line) from the annual Arapuni fishing competition 1998-2018.

4.6 Fisheries and the Vision for the Waikato River

4.6.1 The Vision for the Waikato River is for a healthy Waikato river which sustains abundant life. In order to realise the Vision, the protection and enhancement of significant sites, fisheries, flora and fauna is required (Objective i), along with the restoration of water quality so that it is safe for people to swim in and take food from the Waikato River over its entire length (Objective k). I am aware that Objective k has been the focus of the CSG in formulating PC 1.

4.6.2 Waterways are one of New Zealand's most valuable cultural assets and many new Zealanders have a strong cultural connection with rivers and streams through recreation. Visual clarity is the primary environmental factor influencing anglers preference (Beville & Kerr 2008) when choosing a fishing location. Water clarity is so critical it ranks higher than fish size or potential catch (Beville & Kerr 2008).

5 Conclusions

5.1 The Waipā and Waikato River sports fisheries have highly recreationally significant with active Fish and Game Clubs in nearly every urban

centre. Trout fishing represents the largest food gathering activity on the Waipā and Waikato Rivers and has been significantly impacted by declining water quality. Angler use in the of the Waikato and Waipā Rivers has declined significantly and at a rate far faster than other rivers. This is likely to be due to severely degraded water quality. At the same time rivers with improving water quality have had considerable increases in angler use.

- 5.2 The migratory nature of trout requires water quality suitable for trout in both upland and lowland reaches of the Waikato and Waipā Rivers.
- 5.3 Declining water quality has resulted in reduced trout numbers in the Waipā and reduced fish health in mainstem Waikato River sites. Degraded water quality has greatly diminished the recreational value of the Waipā and Waikato Rivers.
- 5.4 Although there has been improvement in chlorophyll a within some sites in the Waikato catchment, this has only resulted in improved visual clarity at two sites with reductions in visual clarity at five other sites (Vant 2018). Significant increases in visual clarity are required to meet the basic needs of trout populations in the Waikato and Waipā rivers. To maintain ecosystem health and the recreational value of the rivers to the community requires no further loss of visual clarity¹¹.

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¹¹ Vision and Strategy (objective i, objective k).

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Appendix 1

Appendix 1. Angler use (angler days) of significant fisheries in the Waikato River catchment and the angler use of the Auckland/Waikato Region (Unwin & Rouse, 2016). Angler use is listed for each angler survey and the “**Change**” between the 1994/95 season and the 2014/2015 season. “Significance” of the waterway is designated by the Sports Fish and Game Management Plan for the Auckland/Waikato Region. The “Waikato River catchment” total and Auckland/Waikato “Regional total” are show in bold. “Change” is the difference (angler days) between the 1994/1995 survey and the 2014/2015 survey.

	1994/95	2001/02	2007/08	2014/15	Change	Significance
Lake Arapuni	7 300	9 730	5 990	3 370	- 3 930	National
Lake Karapiro	4 810	2 320	1 160	1 690	- 3 120	Regional
Waikato River	7 240	4 830	6 150	3 090	- 4 150	National
Waipā River	2 600	1 560	1 620	2 340	- 260	Regional
Kaniwhaniwha Stream	860	370	110	310	- 550	Local
Puniu River	1 220	840	440	340	- 880	Local
Mangatutu Stream	1 600	1 070	860	500	- 1 100	Regional
Pokaiwhenua Stream	360	230	120	120	- 240	Local
Little Waipā Stream	730	170	100	390	- 340	Local
Waikato River catchment	30 740	25 860	19 400	13 720	- 17 020	
Regional total	44 940	41 040	30 650	26 040	- 18 900	