ASSESSMENT OF RAINBOW TROUT SPAWNING IN THE UPPER MAKARORO RIVER 2011

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Executive Summary

The Tukituki River and tributaries in southern Hawkes Bay attract nearly 12,000 angler days of effort per season (National Angling Survey 2007/08), making it one of the most important river trout fisheries in New Zealand. The fishery comprises both brown and rainbow trout. Brown trout spawn lower in the catchment but not a lot is known about the rainbow fishery. However typically in New Zealand rainbow trout tend to spawn in the river headwaters and smaller tributaries.

A potential dam on the Makaroro River has raised the question that this significant headwater tributary may be an important rainbow trout spawning area for the wider Tukituki fishery. To investigate whether this is the case an assessment of rainbow trout spawning above the proposed dam site was undertaken in August and September 2011.

This study found that the density of adult trout in the upper Makaroro River during this period was very low at only 4.1 trout per kilometre and there appeared to be large areas of ideal spawning habitat that were not utilised. In Dutch Creek, a tributary of the Makaroro, there was a density of 5.6 trout and 3.3 redds per kilometre – in reality representing much higher use because of the smaller nature of this stream and much less available water.

A survey of the Makaretu River which, like the Makaroro, is a headwater tributary flowing out of the Ruahine Ranges observed an even lower density of adult rainbow trout (0.6 trout per kilometre) despite similarly large areas of ideal spawning habitat. Both the Makaroro and Makaretu Rivers are highly unstable and it is suggested that the regular disturbance of the stream bed over winter may impact on redd viability and exert strong selective pressure against spawning in these channels.

The other possibility identified is that there are very large areas of suitable spawning habitat within the Tukituki catchment while the adult trout population may not actually be as large as we might think. Spawning densities may in fact be low across the whole catchment.

Ultimately though, it is apparent that currently the majority of rainbow trout in the Tukituki catchment spawn somewhere other than the Makaroro catchment. However this catchment which is protected by largely being within Ruahine Forest Park could be important in the future if other spawning areas were to become degraded.

Introduction

The Tukituki River and tributaries in southern Hawkes Bay attract nearly 12,000 angler days of effort per season (National Angling Survey 2007/08), making it one of the most important river trout fisheries in New Zealand. The fishery comprises both rainbow (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*).

Brown trout are known to spawn lower in the catchment but not a lot is known about the rainbow fishery. Typically in New Zealand rainbow trout tend to spawn in the river headwaters and smaller tributaries, the juvenile trout dropping downstream to rear in the lower river or associated lakes before migrating back as mature adults to spawn themselves.

A potential dam on the Makaroro River has raised the question that this significant headwater tributary may be an important rainbow trout spawning area for the wider Tukituki fishery. To investigate whether this is the case an assessment of rainbow trout spawning above the proposed dam site was undertaken in August and September 2011.

Study Site

The Makaroro River originates in the Ruahine Ranges flowing south and then east out of the ranges to join the Waipawa River, one of the major tributaries of the Tukituki River. The Tukituki River is one of two large rivers flowing across the Ruataniwha plains in central Hawkes Bay and is approximately 125km in length (Maxwell 2006).

The Makaroro is characterised by an unstable greywacke bed. Below the confluence with Gold Creek (NZTopo50- BK37 767958) the river breaks out of the ranges meandering across an extensive flood plain often a few hundred metres wide. Through this section the river typically flows in a series of highly mobile shallow braids, the dominant feature being the very extensive deposits of unconsolidated greywacke boulders and cobbles.

Above Gold Creek the river is much more constrained by the steep valley sides. The river channel is still highly mobile but tends to be a single channel, often cut several or more metres below the adjacent boulder and cobble deposits. However major bends in the river tend to occur against the valley wall creating more permanent bed rock pools.

Above Barlows Hut (BK36 753990) the gradient steepens significantly rising 70m over 1.5km of river. Again there is a lot of highly mobile rock in this section of river and the channel is characterised by small pools which drop through large rocks and turbulent sections to the next small pool. As the gradient increases further upstream the pools become few and far between.

A survey was also undertaken of Dutch Creek, a tributary of the Makaroro which flows in on the true left 500m below the historic Mill site on the Makaroro River. Dutch Creek is a small, more stable stream of low to moderate gradient that flows out of native beech and pine forest. The bed is characterised by cobbles and gravels, small pools and shallow riffles.

For comparison the survey also looked at the upper Makaretu River above Paget Road (BL36 717667) which is another tributary of the Tukituki flowing out of the Ruahine Ranges to the south of the Makaroro. Like the Makaroro, the Makaretu River carries a very high greywacke bedload but is smaller and the channel appears less mobile, similar to the upper Makaroro with deep permanent bed rock pools on many corners.

A one off comparison was also made with a section of the Tukipo River upstream of the Burnside Road Bridge. The Tukipo River originates in the foothills, is relatively low gradient and meanders over a wide flood plain, the channel a metre or two below the alluvial deposits comprising the plain. As such, the Tukipo River is very different from the Makaroro or Makaretu rivers, and is likely to be representative of smaller lowland tributaries of the Tukituki River. The survey reach consisted of rocks and cobbles and a lot of fine gravel, but not a great deal of intermediate sized material. A fine film of sediment was obvious on the substrate in many locations. The river comprised long reaches with occasional deeper pools particularly associated with willow trees, and extensive shallow riffle areas.

Methodology

Two surveys of the Makaroro River were undertaken on foot on the 9th August 2011 and again on the 4th September 2011 covering from the historic Mill Site (BK37 795956) approximately 5km above the proposed dam site to Barlow's Hut 8.8km upstream (on the second survey this extended another 2.35km upstream to BK36 755003). Surveys were also undertaken on Dutch Creek extending from the confluence with the Makaroro River to 1.3km upstream (BK37 802962) on the 9th August and 2.7km upstream (BK37 800961) on the 4th September. Note that the distances given are calculated by following the river channel and are not necessarily the most direct route up the valley.

In addition, surveys were undertaken on the Makaretu on the 10th August and 5th September extending from Paget Road to just downstream of Happy Daze Hut (BL36 684680), and on the Tukipo on the 4th September.

I walked carefully along looking for any adult rainbow trout or obvious trout redds using polaroid sunglasses. Ideally the whole channel was observed thoroughly. The location of any fish or redds were recorded by GPS along with any observations made.

The first survey followed a heavy snowfall and higher flows which had scoured the periphyton making redd identification difficult given the naturally unstable nature of the bottom. However in the second survey stable flows in the preceding weeks had allowed an obvious periphyton film to develop and freshly cut redds which disturbed the bed were readily apparent.

Where the river was braided the observer followed one braid. Different braid morphologies were selected at different locations to check that any trout were not concentrated in one specific type of habitat.

Results

The survey in early August was preceded two days prior by heavy snow falls in the Hawkes Bay ranges which were sufficient to close the Napier-Taupo highway early on Monday morning (8th August). This affected river flows and clarity and as a consequence Monday was spent walking into Barlow's Hut on the Makaroro River in the hope flows would drop overnight. This meant it was not possible to count the stretch upstream of the hut. Overnight the flows did drop and clear and conditions the next day were good to very good with a sunny day and light winds to count downstream to the old Mill site (where Makaroro Road crosses the river).

However the following day in the Makaretu, ongoing snow melt gave the water a greenish tinge in the deepest pools that made visibility in several pools difficult. Once again though, weather conditions were ideal with a light frost followed by clear skies and no wind.

The September survey followed an extended period of settled conditions. As a consequence flows were very low and clear with conspicuous periphyton growths on the substrate. On the survey days conditions were sunny and calm other than a short period of gusty winds on the Makaretu. However

these did not significantly impact on the ability to see any trout present due to the relatively small nature of this stream.

The reaches surveyed and trout locations recorded for the September survey of the upper Makaroro River and Dutch Creek are shown in figure 1. All of the spots marked with a fish symbol represent the location of either 1 or 2 adult trout, except where indicated on the map.

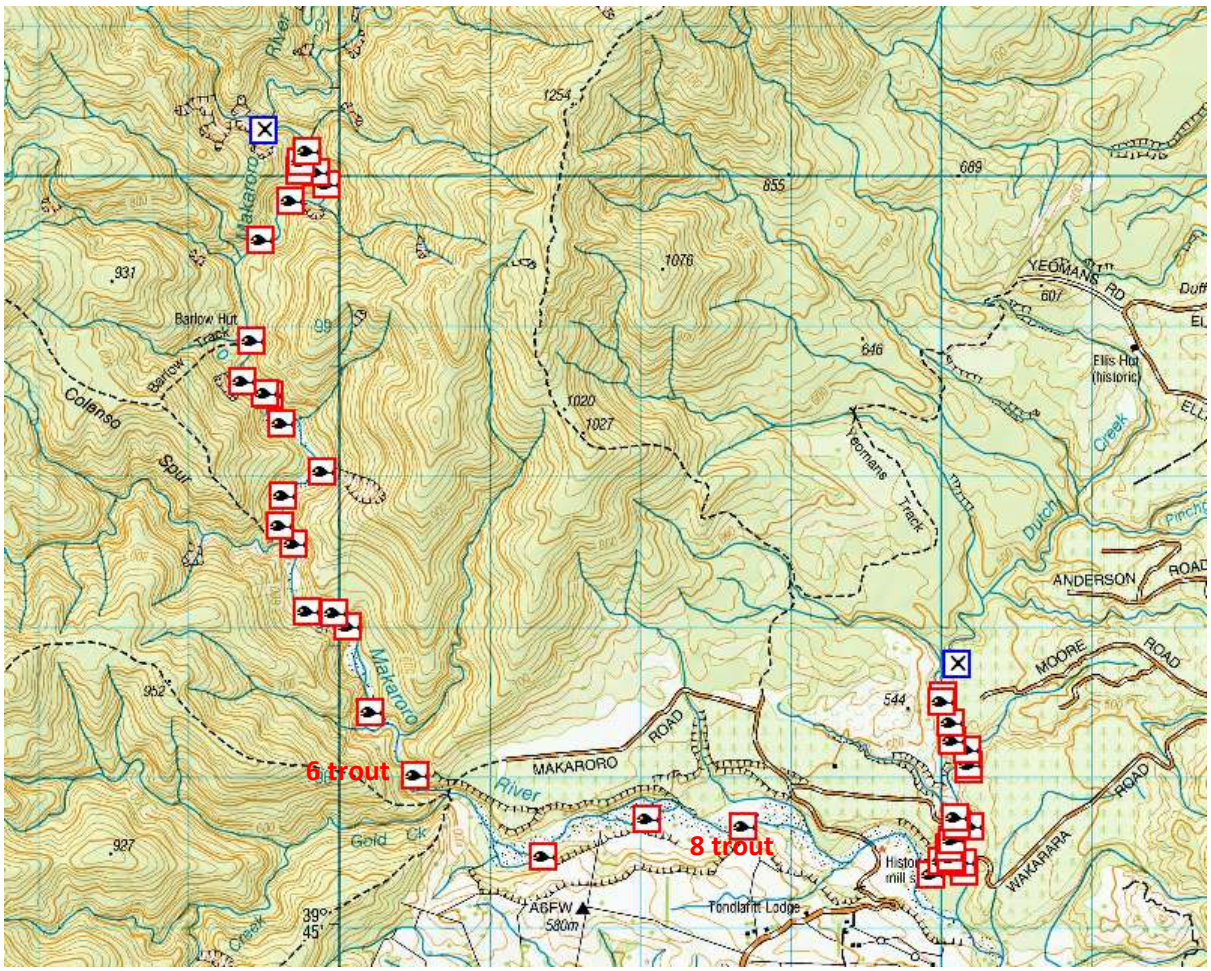

Figure 1 Survey reaches on the Makaroro River and Dutch Creek (upstream limit marked by the black X) and the locations of trout observed in the September survey.

The total number of adult trout counted in each of the survey reaches over both August and September is summarised in table 1.

Table 1 Number of adult rainbow trout and redds counted in the survey reaches on the two survey days

River/ reach	Length of channel (km)	Date	Number of trout	Number of redds	Comments on the count
Makaroro					
Mill site to Gold Creek	3.7	9/08/11	7[a]	n/a	Difficult to see into several deep holes
		4/09/11	11	1	Low and clear, very good visibility
Gold Creek to Barlow's Hut	5.1	9/08/11	11	n/a	Very good coverage
		4/09/11	25	2	Close to 100% coverage
Upstream Barlow's	2.35	4/09/11	10	2	Expect to have seen what was there
Dutch Creek	1.3	4/09/11	12	n/a	Ideal counting conditions
	2.7	5/09/11	15[b]	9	Low and clear
Makaretu	5.3	10/08/11	2	n/a	Some snow melt so deepest pools had green tinge which made visibility marginal
		6/09/11	3	4	2 bedrock pools too deep to count otherwise excellent
Tukipo	2	5/09/11	3	1	Very good coverage except for a couple of deep holes under fallen willows and debris

a – 4 of these were trout spawning in a stable seep off the main river, another 2 were spawning in a very small (1 M wide) side braid

b – 1 medium sized rainbow trout also seen

Using the September counts which were the highest for the two surveys these are converted in to densities per kilometre in table 2. Note that the density in Dutch Creek is actually higher in the August count, however all of the trout seen in August were in the lower 500M of river and it is likely that if the full length had been surveyed that this density would be significantly reduced.

Table 2 Adult rainbow trout and trout redd density per kilometre in the study reaches

River/ reach	Trout/km	Redds/km
Mill site to Gold Creek	3	0.3
Gold Creek to Barlow's Hut	4.9	0.4
Upstream Barlow's	4.3	0.9
Makaroro (overall)	**4.1**	**0.4**
Dutch Creek	**5.6**	**3.3**
Makaretu	**0.6**	**0.8**
Tukipo	**1.5**	**0.5**

All of the rainbows seen with the exception of one immature trout in Dutch Creek were large fish estimated to be 500 to 550mm long or even larger.

Discussion

Rainbow trout spawning biology

The best understood population of wild rainbow trout in New Zealand is that associated with Lake Taupo. In the past mature adult fish migrated from the lake in autumn and early winter, often taking a month or more to reach their spawning grounds. Typically these fish would hold in pools in often large numbers close to their spawning grounds for several months before actually spawning in August and early September. In recent years though, a greater proportion of the trout have run later in the winter, spawning almost as soon as they reach the grounds in September and October. Both these patterns of migration (autumn and spring migrations) are a feature of steelhead populations in North America from which the New Zealand populations are derived.

Radio tracking studies on the Tongariro River indicate that autumn migrations are stimulated by a falling barometer and /or freshes in the river, the fish moving a distance further up the river each time these conditions occur. Conversely during settled conditions these trout may remain in the same pool for weeks on end. On the other hand spring run fish tend to move more steadily and often during the day, perhaps reflecting a biological imperative to reach the spawning grounds quickly.

Generally the males dominate the early part of the run, these fish collecting adjacent to the spawning grounds to await the arrival of the females.

The radio tracking studies also indicate that the trout may select a wide range of spawning areas ranging from the tail of pools in the main river to very small tributary streams. Indeed within the Taupo fishery rainbow trout actively spawn in rivers as diverse as the lower Tongariro River to small spring fed streams only a metre or so wide and 100mm deep. Furthermore the radio tracking also showed that over time the proportion of trout spawning in different parts of the Tongariro River changed, assumed to reflect changes in conditions in the river post the eruption of Mount Ruapehu in 1995 and 1996.

Typical spawning habitat usually occurs at the tail of the pools and in runs in water less than half a metre deep (and often much shallower) amongst coarse gravels and cobbles. However rainbow trout are recognised by fishery managers as being a very plastic species which can adapt to a wide range of habitats. I have witnessed them many times spawning with their backs out of the water, conversely I am aware of one location where redds are dug in water almost two metres deep. This is an extreme situation but nevertheless this site is used every winter. Similarly they may spawn amongst very fine material or cobbles so large they seem too big for the trout to move. However their preferred substrate is a mixture of coarse gravels, stones and small cobbles that allows for significant within gravel water flows and maintenance of high dissolved oxygen concentrations around the developing eggs.

Water temperature is also critical and it is recognised that egg mortality in rainbow trout increases significantly once temperatures exceed 12°C, particularly if they fluctuate. Depending on temperature, egg incubation typically takes about a month, increasing in very cold temperatures.

A feature of rainbow trout is their propensity as juveniles to drop downstream as they rear. Rainbow trout are one of the Pacific Salmon family which is characterised by making extensive migrations, often of some hundreds or more kilometres in their natal waters in North America to spawn. However while these headwaters provide optimum spawning conditions they are also commonly very nutrient poor and unproductive. Therefore the salmon have evolved a strategy of migrating downstream as juveniles to take advantage of the rich coastal waters to grow.

It appears that New Zealand populations of wild rainbow trout have generally continued to adopt this pattern. It is hypothesised by some fishery managers that this is why most rainbow trout populations in this country are either associated with lakes (which may act as the sea) or major rivers (e.g. Mohaka, Ngaruroro and Rangitikei Rivers) where the juveniles can move an extensive distances downstream without being lost from the system.

An illustration of this movement was a trial undertaken by Department of Conservation in the upper Whakapapa River in the late 1980s. With the construction of the Whakapapa intake which diverted the river flow into Lake Otamangakau the rainbow fishery in the upper river had progressively declined. It was considered that the juveniles were being lost from this section of river either over the spillway or down the intake.

However in the Ruakituri River in Te Urewera National Park, a rainbow population has remained in the headwaters despite a series of large waterfalls along its length. Managers decided therefore to test whether offspring from Ruakituri parents might remain and establish in the upper Whakapapa system.

The trial involved releasing 600 individually tagged Ruakituri and 600 Taupo strain offspring into the upper Whakapapa, and also the same number directly into Lake Otamangakau. Tag returns from anglers fishing the lake over subsequent years showed almost exactly the same number of Taupo strain fish from both points of release were caught, suggesting that all the Taupo strain juveniles in the Whakapapa had passed down the intake which at that time diverted on average 95 to 98% of the flow. This was also supported by no Taupo strain tagged fish being reported from the Whakapapa system.

On the other hand Ruakituri strain fish released above the intake only occurred in a ratio of 1:3 compared to the same strain fish released direct into the lake, suggesting they had not migrated downstream as readily as the Taupo strain fish. However only 3 tagged fish were reported from the Whakapapa/ Whanganui system (all below the intake) and a drift dive in May 1988 above the intake observed no tagged fish. So it appears that while these particular juveniles had fewer tendencies to migrate downstream, in flood flows they were still swept down and over the spillway. It is hypothesised that the reason these fish still remain in the upper Ruakituri is that the unusual morphology of the river which in places flows through a number of very narrow deep fissures, allows some trout to hold down out of the flood flows passing over the top.

Rainbow trout in the Makaroro

Not a lot is known about how the rainbow population in the Tukituki functions though anecdotally anglers and managers recognise that an upstream spawning migration from the lower river takes place late in the angling season (which ends 30th June). Similarly a number of tributaries are recognised for their angling early in the new season which opens on 1 October each year, before the trout drop back out.

Given this is consistent with the normal rainbow trout life history pattern in New Zealand then it is hypothesised that the Makaroro River as a high quality headwater tributary might be an important spawning tributary for the Tukituki population.

Inspection of the Makaroro indicates it provides extensive areas of potentially excellent spawning habitat. The cobbles and stones are free of sediment despite the bed load, the water is cold and clear and there are extensive shallow areas of coarse uncompact material particularly in the tails of the pools that I would expect to be heavily utilised in the Taupo Fishery for example.

However an overall density of 4.1 large rainbows and 0.4 redds per kilometre of river walked is very low. It is difficult though to compare this density with other rainbow fisheries as most available data relates to spawning densities associated with lake rearing populations such as Taupo, Otamangakau and some of the Rotorua lakes. Certainly in these cases spawning densities are often several orders of magnitude higher.

There are drift dive counts made over summer of the rainbow population in the upper Rangitikei – in 1987 we estimated an average density of 10.7 large rainbows (greater than 40cm length) per kilometre which was consistent with earlier counts. Similarly Errol Cudby estimated a density of 9.1 rainbows (greater than 20cm) per kilometre in the upper Manganuioteao River as part of an intensive study between 1979 and 1981 (Cudby 1986). In both cases though, these are likely to be counts of resident fish rather spawning trout.

Above the Gold Creek confluence in the Makaroro the trout observed appeared to largely be resident fish. With one exception low down in this reach where there were 6 large rainbows in a small bedrock corner pool, the fish seen were invariably on their own or sharing the pool with only one other. A number of trout were observed holding station and actively feeding including one pair rising to take mayfly duns off the surface. On the first survey most trout were counted high up this section towards Barlow's Hut and these fish appeared to be in exactly the same places on the second survey a month later. However there were more trout in the first several kilometres above Gold Creek on the second survey including the 6 in one pool, and it is possible these were fish moving up on their spawning migration.

By the end of the survey stretch above Barlow's Hut the river had become quite small and very steep, characterised by large boulders and turbulent runs and little suitable spawning water. Nevertheless a Little Black Shag was observed at the most upstream point suggesting that small trout (or other fish) were likely to be present in sufficient numbers to feed on.

There was a strong correlation between the occurrence of trout and the presence of bed rock structure particularly in the pools. Out of 24 trout locations bedrock was a feature of 17 and large boulders of another 6 locations.

The few redds observed were all in the tail of the pools and invariably there was one or two trout in the associated pool. However there were many and extensive areas of similar habitat which appeared ideal for spawning that went unused.

A redd (centre of the picture) in the Makaroro River. Note the proximity to the start of the riffle

In the open braided section in September one trout was observed on a redd in a shallow run. In my opinion there was a lot of 'more ideal' spawning habitat close by suggesting that spawning is not limited by available habitat through this section. However eight of the 11 trout observed were together in a small pool of only several square metres under a major pumice bluff, and were clearly a spawning aggregation. Perhaps co-incidentally these trout were only a couple of hundred metres from where the seven trout were seen in the August survey.

In August two of these fish were observed on an active redd in a side channel only a metre wide which flowed behind a small willow. Another four were seen on and associated with a redd in a permanent seep off the main channel. This seep was clearly not affected by small freshes as it had well established algal growths in comparison to the clean bed of the main channel. However inspection of the seep in September showed it had not been used since.

The redd and actively spawning trout were just at the top of the riffle in this permanent seep

The fact that the only fish seen spawning in August were out of the main flows raises two possibilities. Either the fluctuating flows in the previous days had pushed them off suitable sites in the main channels (however I would have expected them to hold close by) or they were exhibiting a preference for more stable sites. Certainly the one obvious detraction in terms of spawning in the upper Makaroro is the very considerable bed movement, which if it occurs while the eggs are laid in the gravels will cause the death of the eggs. If such movement occurs on a regular basis each winter then there would be a very strong selective pressure to lay the eggs in more stable sites.

The densities observed in the Makaretu were even lower. Like the Makaroro, in low flows the Makaretu provides some excellent spawning conditions - in fact there are several sites that in appearance are identical to parts of the Waimarino or Waiotaka Rivers at Taupo which are used by literally hundreds of spawning trout. However like the Makaroro Riven the bed is highly unstable in comparison to the Taupo rivers.

The highest densities were observed in Dutch Creek (5.6 fish and 3.3 redds per kilometre). One kilometre of water in this small intimate stream represents a great deal less water and available habitat when compared to the Makaroro so in reality these densities reflect a much greater use of this stream. Interestingly when the survey was undertaken in August all of the trout were observed in the lower 500 metres of stream suggesting they might be trout making their way up. However in September they were spread all the way through.

This was the only site where I could regularly predict where I would find a redd. These were invariably at the tail of the pool within a metre of the top of the riffle and in water 100 to 150mm deep. The substrate was normally a mixture of stones and small cobbles up to fist size though several redds had more large gravel. However the key appeared to be that the riffle downstream was only 20 to 50mm deep across the channel, any deeper than this and redds were absent.

A typical site selected by rainbow trout to spawn in Dutch Creek (note the redd just above the shallow riffle in the centre of the picture)

While this characteristic was most apparent in Dutch Creek, in fact several of the redds seen in the Makaroro River were also in similar sites. This suggests that water flow through the gravel may be a key determinant for redd selection in this system.

While the spawning density was significantly higher in Dutch Creek there was still a large amount of suitable habitat that was unused. Furthermore only ever one redd was found at each site and there was no indication of redd superimposition. This suggests that Dutch Creek is not fully utilised for spawning.

One possibility if bed instability is an issue is that the rainbow population might instead utilise the more lowland rivers which do not drain from the ranges. To investigate this a 2km section of the Tukipo River was surveyed. However the density of trout and redds (1.5 trout and 0.5 redds per kilometre) was significantly lower than in the Makaroro or Dutch Creek. In some ways this was not a surprise as the Tukipo was very characteristic of a lowland river with a lot of fine gravels and sand and significant sediment visible on the stones, none of which are preferred spawning habitat variables.

Conclusion

The number of trout and redds in the Makaroro River were relatively low and most of the trout that were observed are likely to be resident fish rather than upstream migrants. In contrast Dutch Creek is more intensively utilised. The Makaroro has high water quality and large areas of apparently favourable spawning habitat, although it is highly unstable.

There are three possible explanations for the low of use of this river for spawning.

Firstly, that spawning may occur at a different time of year. Potentially if spawning had occurred earlier then the higher flows preceding the first survey in August could have washed the spent fish back downstream and disturbed the bed sufficiently to mask any redds. However this scenario seems unlikely given the degree of active spawning that occurred through August and early September in the nearby Dutch Creek.

Secondly, the instability of the Makaroro may mean in many winters that most if not all redds laid in the main stem are lost before the eggs can hatch. Or, if they do hatch, that the newly emerged fry are swept away. This would create a strong selective pressure against spawning in the main channel. The relatively higher use of nearby Dutch Creek and the observation of trout spawning in a permanent seep removed from the main channel tend to support this possibility. Similarly the very low use of the Makaretu River which appears to provide ideal spawning habitat but which is also unstable is also consistent with this.

The third option is that there is simply an excess of suitable spawning habitat throughout the Tukituki catchment, such that spawning densities are generally low in most areas. This is consistent with a desk top assessment of spawning opportunities in the catchment by Iain Maxwell in 2006. Iain

concluded "*There are extensive areas in the upper reaches that are within conservation estate and provide exceptional spawning habitat and a number of significant spring fed tributaries that offer exceptional spawning and subsequent rearing habitat*"

The key is that any excess is relative to the number of trout available to utilise it. While the Tukituki is a very important trout fishery there is no information on how big the adult rainbow population is, and it may not be as large as we inherently assume. For want of some figures let's assume most adult rainbows drop down to the lower main stem over the low flows and warm temperatures of summer. That's perhaps 75km of river that might be used. If we then use a density of 32 large rainbows per kilometre which was the highest density recorded in any river not connected to a lake during a survey of 127 different reaches in 88 rivers around New Zealand (Jowett and Tierney 1990) this would equate to just 2,400 large rainbow trout. If these fish are spread over a few hundred kilometres of spawning water then the average density is quite conceivably similar to what we measured in the Makaroro or Dutch Creek.

Almost certainly also there will be some areas that are more attractive than others, and it is possible that there are several high quality spawning areas much closer at hand for trout migrating from the lower river which attract a significant proportion of the run.

There is approximately 20km of suitable spawning water including Dutch Creek above the proposed dam site on the Makaroro River. At a density of 5 trout per kilometre that is 100 trout. Over the spawning period there will be some fish arriving as other have finished and are leaving, nevertheless the total number using the upper Makaroro River to spawn is likely to be significantly less than 200 trout per year. Furthermore a number of these trout are resident fish which will remain in this part of the river all year round. Therefore on this basis it would appear that currently the vast majority of Tukituki rainbow trout spawn somewhere other than in the Makaroro catchment.

However should spawning access to the Makaroro River and Dutch Creek be lost then potentially there is a risk in the future to the Tukituki rainbow fishery should a decline occur in the quality of the remaining spawning sites. As it stands the Makaroro catchment is protected by being within the Ruahine Forest Park.

Finally the Makaroro with its high water quality may potentially be important over summer as a refuge for trout seeking to escape low flows and high water temperatures lower in the catchment. A repeat of the survey in late summer in 2012 is recommended to assess this.

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