IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by Meridian Energy Limited for resource consents for the Mokihinui Hydro Project

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STATEMENT OF EVIDENCE OF MARTIN LEE BONNETT ON BEHALF OF MERIDIAN ENERGY LIMITED

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1. QUALIFICATIONS AND EXPERIENCE

1.1 My full name is Martin Lee Bonnett.

1.2 I am a fisheries biologist employed as a scientist and science group manager by the National Institute of Water and Atmospheric Research Limited (NIWA). I have been involved with research on the biology and ecology of freshwater fish in New Zealand waters since 1980, and I have had relevant experience with freshwater fish and fisheries in a variety of waters on the West Coast of the South Island.

1.3 I have the following qualifications:

a. Bachelor of Science (Zoology) and Diploma in Science (Zoology) from Massey University, and Master of Science from University of Canterbury.

b. I am a member of the Royal Society of New Zealand, and the New Zealand Freshwater Sciences Society.

1.4 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

1.5 I have been involved in the following work in relation to Meridian Energy Limited's (Meridian's) Mokihinui Hydro Proposal (MHP):

- Investigation of the native freshwater fish and fisheries of the Mokihinui River.
- Investigation of the movement and passage of trout in the Mokihinui River.
- Investigation of periphyton and invertebrates of the Mokihinui River.
- Investigation of the aquatic biodiversity of the Mokihinui River.

I have been involved in the preparation of the following reports:

a. Bonnett, M.; Jellyman, D.; Graynoth, E.; Kelly, G.; Henderson, R. 2007. Mokihinui River Proposed Hydropower Scheme: Native Freshwater Fish and Fisheries Report. NIWA Client Report 2007-060. 61 p

b. Hayes, J.W.; Hay, J.; Bickel, T.; Closs, G.P.; Bonnett, M.L. 2007. Mokihinui River Proposed Hydropower Scheme: Trout Movement and Passage. Cawthron Report No 1383. 55 p.

c. Norton, N.; Rouse, H.; Bonnett, M.; Kilroy, C.; Suren, A.; Carter, J.; Jellyman, D. 2008. Mokihinui River aquatic biodiversity – an analysis in the context of the Waters of National Importance (WONI) ranking framework. NIWA Client Report 2008-046. 50 p

and I have prepared my statement of evidence in reliance on this work.

1.6 I have also reviewed:

a. The reports and statements of evidence of other experts giving evidence on behalf of Meridian relevant to my area of expertise, including:

i. Jowett, I.G. (2007). Instream habitat and flow regime requirements in the Mokihinui River. NIWA Client Report HAM2007-150. 43 p.

ii. Suren, A., Kilroy, C. (2007). Mokihinui River Proposed Hydropower Scheme: Periphyton and Invertebrates Report. NIWA Client Report: CHC2007-111. 72 p.

iii. Flöder, S.; Spigel, R. (2007). Mokihinui River Proposed Hydropower Scheme: Lake Water Quality and Habitat Report. NIWA Client Report: CHC2007- 122. 87 p.

iv. Hicks, D.M.; Rouse, H.L.; Tunnicliffe, J.; Walsh, J. (2007). Mokihinui River Proposed Hydropower Scheme: Sediment Report. NIWA Client Report CHC2007-117. 142 p.

v. Henderson. R., McKerchar, A. (2007). Mokihinui River proposed hydropower scheme: Hydrology report. NIWA Client Report: CHC2007-134. 72 p.

b. The review for the Department of Conservation of the Mokihinui Hydro Proposal AEE application and Freshwater Ecological

technical reports, including the section on native fish compiled by Dr. Richard Allibone of Golder Associates

c. The Section 42A officers report compiled by Mr David Cameron on behalf of the West Coast Regional Council

d. Relevant submissions of others, namely :

i. Submission of the West Coast Whitebaiters Association (Inc)

ii. Submission from West Coast Greens and Top of the South Greens, of the Green Party of Aotearoa New Zealand

iii. Submission of Mrs Metiria Turei, MP

iv. Summary of submissions on the MHP prepared by Mitchell Partnerships on behalf of Meridian.

2. SCOPE OF EVIDENCE

2.1 I have been asked by Meridian to prepare evidence in relation to the actual and potential effects of the MHP on native fish. This includes:

a. A brief description of the investigations carried out;

b. An overview of the native fish fauna and fisheries of the Mokihinui River;

c. A description of the potential effects of the MHP on native fish habitat and fish passage;

d. Recommendations on measures to avoid, remedy or mitigate adverse effects;

e. Response to relevant issues raised by submitters; and

f. Conclusions.

2.2 Dr Jellyman will present evidence on the effects of the MHP on eels, and will also present further details on the passage of fish over the proposed dam. Therefore my evidence covers native fish other than eels, and in

terms of the Mokihinui River this includes species such as inanga, torrentfish, bullies and lamprey. Trout are not native fish and are dealt with in the evidence of Dr Hayes.

3. EXECUTIVE SUMMARY

3.1 A variety of surveys and other data sources showed that the assemblage of native fish in the Mokihinui River is best described as typical of rivers in the region.

3.2 Twelve species of freshwater fish are known to occur in the catchment. All are migratory (ie they move between fresh water and the sea as part of their normal life cycle), eight are endemic (found only in New Zealand), and four are regarded as having threatened status.

3.3 The Mokihinui River supports an active and significant whitebait fishery, and although it is likely that all five species of whitebait run into the river, the catch is dominated by whitebait of two species, koaro and inanga.

3.4 There is little habitat suitable for inanga spawning near the estuarine reach of the river, and it is unlikely that any successful inanga spawning occurs.

3.5 The proposed scheme (MHP) will have minor or less than minor effects on the whitebait fishery, as the fishery relies on freshwater (especially floods and freshes) attracting whitebait from the sea into the river, and the proposed flow regime of the river will closely mimic the natural regime during the whitebait season.

3.6 The changes to the flow regime in the lower Mokihinui River proposed as part of the MHP will have only minor or less than minor effects on fish populations in the lower river. The frequency and magnitude of floods will not alter, and will continue to be an influential feature of the river.

3.7 The most significant effect of the MHP on native fish will be that the dam will act as a barrier to fish migration. Although a range of methods is available to assist fish over the dam, a trap and transfer system is recommended as the most suitable option. I am of the opinion that this will be an effective method in maintaining the upstream passage of native fish.

3.8 Assistance over the dam will ensure that migratory stocks of native fish will continue to populate the upper catchment. It is uncertain if additional non-migratory (ie "landlocked") stocks of native fish will establish in the reservoir created by the MHP.

3.9 The downstream passage of whitebait larvae should not be affected by the presence of the proposed dam and reservoir, as hatching of larvae in headwater streams occurs during high flow events; consequently their downstream migration will occur mostly when the water is turbid and travel through the lake is rapid. I would expect a high proportion of the larvae to survive passage through the turbines or over the spillway.

4. THE PROPOSAL

4.1 I confirm my evidence is based on the project proposal as described in the Assessment of Environmental Effects, brief details of which are described in Appendix 1.

5. INVESTIGATIONS AND METHODOLOGY

5.1 The following data sources were accessed, and fishery surveys carried out:

a. The New Zealand Freshwater Fish Database (NZFFDB) was accessed for records of fish occurrence entered prior to this investigation. To these were added the summarised results of surveys conducted during this investigation.

b. Electric fishing surveys at 46 sites throughout the catchment (both mainstem and in tributaries) were conducted during March 2006, April 2006, and April 2007.

c. Whitebait samples were collected from the Mokihinui River at intervals during the 2005 and 2006 whitebaiting seasons, and, to gain a regional perspective, from the Grey, Buller and Karamea Rivers in 2005. Laboratory analysis of the samples provided information on the species composition of the whitebait catch, and how the composition varied over each season.

d. Three surveys to identify potential inanga (one of the five whitebait species) spawning habitat, and record any instances of spawning, were carried out during autumn 2006 in the estuarine and lower river reaches of the Mokihinui River. Each survey consisted of an inspection (at low tide) of the vegetation in areas known or thought to be suitable for inanga spawning, in an attempt to locate eggs. These were followed by surveys in the same areas at peak high tide, in an attempt to observe and confirm spawning.

5.2 I am satisfied that the use of the above data sources and fishery surveys is adequate to allow the features of the Mokihinui River native fish and fisheries to be understood, the actual and potential impacts of the MHP to be assessed, and, where appropriate, mitigation measures recommended. In particular, additional and/or alternative sampling methods such as those discussed by Dr Allibone in his review for the Department of Conservation would no doubt provide additional data, but in my opinion that data would be most unlikely to change the description of the existing fish and fisheries in a way which would be of any benefit in understanding this for the purpose of the MHP consent application.

6. KEY FEATURES OF THE NATIVE FRESHWATER FISH FAUNA AND FISHERY OF THE MOKIHINUI RIVER

6.1 The Mokihinui River contains twelve species of native freshwater fish, and the scientific names, common names, migratory status and threat classification of each species are summarised in Table 1.

6.2 The composition of the fauna compared to two similar sized rivers in the region is presented in Table 2, and it can be seen that the assemblage of fish in the Mokihinui River can best be described as typical for the region.

6.3 I am a co-author of the NIWA Report titled "Mokihinui River aquatic biodiversity – an analysis in the context of the Waters of National Importance (WONI) ranking framework". This report was prepared in response to suggestions based on a report by Chadderton et al. (2004) that the Mokihinui River is ranked 7th nationally. The evidence of Mr Norton summarises NIWA's overall findings on the biodiversity of the Mokihinui River and the effect of the MHP on meeting DoC's objectives for the WONI framework.

6.4 In the report, we made comparisons between the Mokihinui River and waters in other regions, the West Coast, the South Island and the North Island. For native fish, our analysis identified that the Mokihinui River has a very similar assemblage of native fish species to other rivers in the region, and that the fish species are distributed throughout the catchment in a typical pattern. None of the fish species found in the Mokihinui River are unique to the river, and all of the species that could be expected to occur in the river do so. We conclude that the assemblage of freshwater fish species in the Mokihinui River is not distinctive but is representative of the region.

6.5 Of the 12 species, eight are endemic (found only in New Zealand), and four (giant kokopu, lamprey, longfin eel and shortjawed kokopu), are classified as threatened by the Department of Conservation (Hitchmough 2007). The threat classification of both lamprey and shortjawed kokopu is based on these fish being sparse; the status of giant kokopu is based mainly on its gradual decline around New Zealand; and the status of longfin eel reflects the gradual decline in populations nationally, as well as predicted future recruitment failure because of excessive harvest.

6.6 All twelve species are migratory, i.e. they migrate between fresh water and marine environments as part of their normal life cycle, and will therefore be present in the river mouth and lower river at least twice during their lives.

6.7 All the migratory fish in the Mokihinui River will attempt to migrate upstream to some extent. Some species are predominately distributed within the lower few kilometres of the river and its tributaries, whereas some others may migrate into the upper reaches of the river and its headwater streams. Overall, the distribution pattern of these migratory species within the Mokihinui River is quite typical of rivers on the West Coast of the South Island.

6.8 Whitebait migrate into the Mokihinui River, and support an active and significant fishery each spring at the mouth, and in the lower reaches of the river. Catches of whitebait in the Mokihinui River are known to comprise at least three species; inanga (*Galaxias maculatus*), koaro, (*G. brevipinnis*), and banded kokopu (*G. fasciatus*). Whitebait of shortjawed kokopu (*G. postvectis*) and giant kokopu (*G. argenteus*) were not identified in the catch samples, but must comprise part of the run at times because adult fish of these two species are found in the catchment.

6.9 The proportions of each species of whitebait in the samples varied over the season, (Appendix 2) but koaro whitebait generally comprised a greater proportion of the catch in the Mokihinui River compared to other rivers in the region, especially in samples collected early in the season.

6.10 Although inanga whitebait comprised a significant proportion of the catch in the Mokihinui River, adult inanga are uncommon in the Mokihinui River. Their abundance may be limited by a lack of suitable habitat, as they favour gently flowing and still waters such as estuaries, lowland rivers, lagoons and backwaters.

6.11 No evidence of inanga spawning, and very little suitable spawning habitat, was found in the lower river or its tributaries. Because there is little suitable spawning habitat, the Mokihinui River inanga that do spawn there will do so in habitats that do not provide suitable conditions for egg development, so that spawning is unlikely to be successful. The lack of suitable spawning habitat may also be exacerbated by the frequency of floods and FIG waves (as discussed in Dr Goring's evidence), in the Mokihinui River, as high water levels may wash out any inanga eggs that have been deposited.

7. ASSESSMENTS OF EFFECTS

7.1 The potential effects of the proposed MHP scheme on native fish other than eels include: 1) effects on native fish in the lower river; 2) effects on native fish migration, 3) effects on fish in the gorge; 4) effects on whitebaiting; and 5) effects on inanga and inanga spawning. These are considered below.

Effects on native fish in the lower river

7.2 The mainstem of the Mokihinui River downstream of the proposed dam site currently supports populations of the native species inanga, longfin eels, torrentfish, bluegill bullies, redfin bullies, common bullies, shortfin eels, and lamprey. Maps of the known distribution of these species from the sources described in paragraph 5.1 of my evidence are attached as Appendix 3. Any changes in the flow regime, water quality, or sediment transport that occur as a result of the MHP, may have the potential to affect these fish populations and their habitat.

7.3 Jowett (2007) assessed instream habitat and flow regime requirements in the Mokihinui River, and considered that the proposed minimum flow of 16 $m^3 s^{-1}$ will maintain near maximum habitat for native fish, many benthic invertebrate species, and food production. He also predicted that daily flow fluctuations below the proposed dam would not have any significant effect on native fish habitat, but may reduce invertebrate

habitat and benthic production. Such a reduction in food production is likely to have a no more than minor effect on native fish.

7.4 The water quality downstream of the dam is predicted to be very similar to that of water flowing into the reservoir, with similar daily mean temperatures. The outflows are predicted to be fully oxygenated (as described in the evidence of Dr Spigel).

7.5 Goring (2007) found that slight changes in the distribution of saline water within the estuarine area may occur under a power-generation flow regime. All the native fish in the Mokihinui River are migratory, and move between fresh water and salt water as part of their normal life cycle; a slight change in salinity in the lower river is likely to have only minor effect.

7.6 Studies of sediment transport in the Mokihinui River (evidence of Dr Hicks) predict that some degradation (i.e., bed scour) would occur for the river channel downstream of the dam as a result of the MHP. The sand patches along the riverbank, and the sand that embeds the cobbly substrate, will be flushed away, so that the surface armour will be coarser, more uniform, and more stable than the existing bed surface. It is my opinion that less sand, and more stable, coarser substrate in the lower river will if anything improve habitat and invertebrate food for native fish, but that overall the effect on native fish habitat from changes in bed sediment is likely to be minor or less than minor.

7.7 The effects predicted in paragraphs 7.3, 7.4, 7.5, and 7.6 show that little or no change in physical habitat and food production for fish will occur, and I consider that adequate quantities of both will be available to support sustainable populations of all the native species present. Therefore the MHP is likely to have minor or less than minor effects on native fish populations and native fish habitat in the mainstem of the lower Mokihinui River. Overall, I expect that the frequency, magnitude, and duration of floods in the lower river will continue to be the influential feature affecting fish populations.

Effects on native fish upstream of the proposed dam.

7.8 The proposed impoundment will inundate approximately 14 km of riverine habitat into a lake. Presently, most of this reach of the river is probably best described as a “gorge”, as it consists principally of a single river channel flowing between steep bedrock banks. The river flows through deep, slow flowing pools interspersed between fast flowing chutes, and there are relatively few riffles. Substrates in the river channel are dominated by bedrock and large boulders, with some smaller substrates, especially in reaches immediately downstream of contributing tributaries such as Rough and Tumble Creek.

7.9 From sampling of fish populations in the mainstem of the river within the gorge, I conclude that its main significance for native fish is as habitat for longfinned eels; and Dr Jellyman will address the potential changes to eel populations in his evidence. Few other native fish were found in the gorge reach, and in my opinion the mainstem of the gorge provides very little habitat that would be suitable for native fish other than eels. Torrentfish, koaro, and redfin bully were found in the lower reaches of Welcome Creek, Maori Creek, Anderson Creek, Johnny Cake Creek, and Rough and Tumble Creek. Some of this riverine habitat in these creeks will be inundated by the proposed impoundment; however I conclude that the effect of inundating the gorge area is minor or less than minor.

Effects on native fish migration

7.10 The most significant potential effect of the MHP on native fish of the Mokihinui River is the potential for the proposed dam to act as a barrier to fish migration. The level of effect will vary with the species as follows. For species that currently migrate upstream of the dam site, the construction of the proposed dam would create a total block to migration if no mitigation was provided. The discussion which follows (paragraph 7.11 – 7.20) describes what the effects would be if there were no mitigation.

7.11 Inanga and giant kokopu are both regarded as lowland species, and have been found only in the lower reaches of the Mokihinui River and its tributaries. These fish would not be expected to penetrate far upstream in the Mokihinui River, and the proposed dam will have little or no effect on their migration.

7.12 Lamprey are uncommon in the Mokihinui River, and it is uncertain if any adult lamprey presently migrate up to or past the proposed dam site to spawn. If any do, the proposed dam will prevent their upstream passage.

7.13 Redfin bullies and torrentfish occur in the lower Mokihinui River and in some tributaries upstream of the proposed dam site. The occurrence and abundance of both species decreases with distance upstream, and I believe that the lack of suitable habitat for these fish in the gorge reach inhibits migration further upstream. The proposed dam will prevent the upstream migration of both species, and may also prevent any downstream migration of adult torrentfish to breed. The proposed dam would therefore have a significant effect on these species.

7.14 Shortjawed kokopu occur in the Mokihinui River catchment, but almost exclusively in the tributary streams that join the Mokihinui River downstream of the proposed dam site. This is consistent with known shortjawed kokopu distribution and habitat preferences throughout New Zealand, as while this species is capable of penetrating well inland, these fish are generally associated with small bouldery streams at low to moderate elevation within podocarp/broadleaf forest. The effect of MHP on the migration of this species would be minor.

7.15 Koaro is regarded as the second most important species (out of five) in the New Zealand whitebait catch, and this species comprises a significant proportion of the whitebait catch in the Mokihinui River. A dam in the lower gorge would have a significant effect on the upstream migration of juvenile koaro, preventing them from moving upstream to their preferred habitats.

7.16 Koaro are relatively common in small, steep headwater tributary streams including those which join the Mokihinui River upstream of the proposed dam site. Although these fish gain access to such streams by migrating up the mainstem and lower elevation tributaries of the river, they are seldom found in such habitats. This may partly be because koaro prefer the habitats provided by small, steep and vegetated tributaries, and partly because such streams are inaccessible to brown trout.

7.17 Furthermore, koaro spawn in these small headwater tributary streams during high flows in the autumn (O'Connor and Koehn, 1998; Allibone and Caskey 2000) and eggs are deposited amongst inundated riparian substrates. Hatching occurs when the eggs are re-inundated and agitated by a subsequent flood, and the newly hatched larvae are carried downstream to sea by the flow.

7.18 In my opinion, filling of the reservoir will have only a minor or less than minor effect on the amount of headwater stream habitat suitable for koaro for living and spawning, and I think it is unlikely that the formation of the reservoir will make any of these streams more accessible to trout.

7.19 The proposed impoundment has the potential to increase the downstream transit time of koaro larvae, which may be detrimental to the survival of the larvae. However, koaro larvae hatch during flood flows in the headwater streams, and during floods their downstream transit times through the reservoir would still be relatively short.

7.20 Koaro larvae passing downstream through the reservoir will encounter the dam; if this is during high flows a substantial proportion of the water will be flowing over the spillway, and downstream transit of the larvae would not be prevented. Some larvae may pass through the turbines, and I would expect these to have a high rate of survival, as they are small enough to avoid mechanical damage, and because they have not developed a swim bladder and are therefore less susceptible to damage from any variations in pressure.

7.21 The spawning biology of torrentfish has not been fully documented, but Scrimgeour and Eldon (1989) suggested that mature torrentfish migrate downstream during floods and spawn in the lower reaches of rivers. If this is the case, then any downstream migration in the Mokihinui River would probably occur when water would be flowing over the spillway, and it is anticipated that some torrentfish will survive such passage. Similarly, due to the size of torrentfish (up to about 150 mm in length) it is anticipated that some will survive passage through the turbines. Overall it is likely that the MHP will allow some mature torrentfish do successfully migrate downstream to spawn. However, there is uncertainty regarding torrentfish populations upstream of the MHP, as well as on how this species may be affected by the scheme, Therefore, I suggest that further research on populations of this fish in the Mokihinui River is required, and could be undertaken as part of the monitoring of freshwater fish suggested in Meridian's proposed aquatic management plan.

7.22 Overall, it is my opinion that the potential of the dam to block the migration of some fish is the most significant effect of the MHP on native fish in the Mokihinui River, and considerable mitigation effort is required.

Whitebaiting

7.23 The Mokihinui is rated as being of high recreational and commercial importance as a whitebait fishery, and may attract as many as 180 whitebaiters on a weekday (Kelly 1988). Although there are virtually no catch or effort statistics for the whitebait fishery, it is recognised that the whitebait fishery is an important recreational feature of the lower Mokihinui River, and is significant to local residents and visitors alike (Greenaway 2007).

7.24 Of the five galaxiid whitebait species, at least three contribute to the catch in the Mokihinui River: koaro, inanga and banded kokopu. The abundance of shortjawed kokopu whitebait cannot be determined (as this species is indistinguishable from koaro at the whitebait stage), but it is highly likely that this species is also caught. The remaining species (giant kokopu) did not occur in the samples, but runs of this species are

known to occur later in (and after) the whitebaiting season, and the presence of adult giant kokopu in the catchment confirms their migration as whitebait.

7.25 The fishery is based on “runs” of whitebait that migrate from the sea into the river during spring. The whitebait are attracted into rivers by the flow of fresh water into the sea, and runs mostly coincide with floods or freshes in the river. The different species of whitebait are attracted or repelled by various physical and chemical features of the fresh water, such as water temperature, turbidity, and acidity. Therefore any significant changes that may occur in the flow regime, or water quality in the lower Mokihinui River as a result of the MHP could have effects on the whitebait fishery.

7.26 The proposed flow regime for power generation is based on a minimum flow of 16 $m^3 s^{-1}$ (Jowett 2007). Power will be generated by passing a maximum flow of 120 $m^3 s^{-1}$ through the turbines (or up to approximately 150 m^3/s at times when water would otherwise be passing over the spillway), which will then be discharged in to the lower Mokihinui River. When the inflows to the reservoir are high, power generation will be continuous, and excess water discharged over the spillway. Thus, medium to large-sized floods will continue to affect the lower river. When inflows are low, the 16 $m^3 s^{-1}$ minimum flow will occur during the night, and there will be higher flows timed to coincide with periods of increased electricity demand, particularly in the mornings and evenings, except in periods of very low inflows. During the whitebait season (September to mid-November), it is proposed that the scheme will be operated in a manner more closely aligned to ‘run of river’. Outflow from the dam will follow that of a more normal hydrograph as far as this can practicably be achieved and this is discussed in the flow regime evidence of Mr Watts. This means that there will be up to a 10 week period where the river does not vary significantly more than it would have done naturally. This proposed flow regime should ensure minor or less than minor hydrologically induced effects on the whitebait fishery.

7.27 Some whitebait will migrate upstream before or after the whitebait fishing season, when the flow in the lower river will be subject to the daily

operational regime outlined above. The incidence of medium to large-sized floods should however continue to attract whitebait into the river, and the daily operational flow regime should not prevent the upstream migration of whitebait.

7.28 The proposed dam will intercept some but not all of the suspended sediment load from the upper catchment (evidence of Dr Hicks), but will have little effect on the turbidity of water in the lower river during floods. Suspended sediment will also continue to enter the lower river from tributaries downstream of the dam, so that during floods and freshes, turbid water will flow out of the river mouth. Overall the changes in sediment transport in the lower river should have minor or less than minor effects on "attracting" whitebait into the river.

7.29 In their assessment of the potential effects of creation of the reservoir on water quality below the dam, (discussed in evidence of Dr Spigel) Drs Floeder and Spigel concluded that flows downstream of the dam will have a character that closely mirrors that of inflows – similar daily mean temperatures, and fully oxygenated. Thus, water quality changes should have minor or less than minor effect on the whitebait fishery.

7.30 The flow regime during the whitebaiting season will as closely as practicable mimic natural flows (Jowett 2007), and whitebait will be continue to be attracted into the river, particularly as a result of floods and freshes when turbid water is present. As the dam is predicted to have little or no effect on water quality (Floeder and Spigel 2007), and as the river flows below the dam will be as close as practicable to run of river, it follows that the overall effect on the whitebait fishery should be minor or less than minor.

Inanga and inanga spawning

7.31 Inanga whitebait comprise a significant proportion of the catch on the Mokihinui River, although it seems that few remain in the river to grow into adult inanga. Their abundance may be limited by a lack of suitable adult habitat, as this species favours gently flowing and still waters such

as estuaries, lowland rivers, lagoons and backwaters. From the surveys conducted during the autumn of 2006, no inanga spawning sites were found. The Mokihinui River has some history as a spawning ground, but previous anecdotal records of spawning are thought to be from the area close to the SH67 road bridge. The surveys show that this is unlikely because this area presently has virtually no suitable inanga spawning habitat. The inanga that reside in the lower Mokihinui River have little or no suitable habitat for spawning, therefore any spawning that occurs presumably would have to take place in less suitable habitat, and is unlikely to be successful.

7.32 The lack of suitable spawning habitat may also be exacerbated by the natural frequency of floods in the Mokihinui River and FIG waves, as floods and FIG waves are likely to cause high water levels in the estuarine area outside of times of high spring tides (Goring 2007). High water levels may wash out any inanga eggs that have been deposited.

7.33 As currently no inanga spawning has been observed, and very little suitable habitat for inanga spawning has been identified, I conclude that the effects of the MHP on inanga spawning would be less than minor.

8. MEASURES TO AVOID, REMEDY OR MITIGATE ADVERSE EFFECTS

In the section above I have identified potential unmitigated effects of MHP on migrating native fish. A range of mitigation measures are available as follows:

Assisting migrant fish upstream over the dam

8.1 Juvenile native fish attempting to migrate up the Mokihinui River will congregate below the dam, particularly in spring and summer. The juvenile fish (in addition to eels which are dealt with in Dr Jellyman's evidence) are likely to comprise several species, as described below:

a. Koaro, at the whitebait or post-whitebait stage, and from about 45 to 70 mm in length. Koaro are well known for their climbing ability

(they are sometimes referred to as the climbing whitebait or climbing galaxias), and their climbing ability is assisted by the shape and orientation of their fins.

b. Banded kokopu and shortjawed kokopu, also at the whitebait or post-whitebait stage and from about 45 to 70mm in length. Juveniles of both species are capable of penetrating well inland, and the presence of adult fish above substantial waterfalls in various catchments around New Zealand signifies that they are also “climbers".

c. Torrentfish, redfinned bullies, bluegilled bullies, and common bullies are migratory species, but with lesser climbing abilities than the species mentioned above.

8.2 Several methods to assist the passage of fish over the dam could be used:

a. A “pool and weir” pass, consisting of a bypass channel or channels containing a series of small pools/weirs. Vertical slot and Borda orifice passes work in a similar manner – essentially subdividing a single vertical drop into a series of smaller drops/velocity barriers for fish to overcome, interspersed with areas where fish may rest.

b. Fish “elevators” or “locks”, which raise fish by filling with water a chamber that fish have entered from downstream.

c. “Climbing” passes, which utilise the ability of some native fish such as koaro and eels to climb upstream along the wetted margins at the edges of flowing channels,

d. “Insinuation” passes that utilise pipe partly filled with nylon brushes, with a small flow of water passing through the pipe.

e. “Trap and transfer” passes, where upstream migrant fish are trapped at the downstream side of the obstruction, and transferred upstream.

8.3 Pool and weir passes, fish elevators, and fish locks have traditionally been constructed to assist the passage of large trout and salmon, and the suitability of these methods for assisting the passage of native fish

over a high dam is unknown. Climbing passes are unlikely to be suitable to assist all the species of migrating fish over the proposed dam in the Mokihinui River, as while these types of passes are effective for the passage of native fish past small culverts; their efficiency reduces with the height of the pass. Insinuation passes are not effective for species other than eels, and are in any case selective for the size and species of eel, and may subject the eels to higher water temperatures and predation.

8.4 In my opinion a trap and transfer system is the best means of assisting native fish over the proposed dam in the Mokihinui River. Fish could be attracted to, and climb, a short ramp emptying into a holding box, then later manually transferred upstream. Such systems operate on a number of hydro dams throughout New Zealand (e.g. Karapiro Dam, Patea Dam, Matahina Dam, Mararoa Weir), and are known to be effective for juvenile eels, as collectively 3-4 million elvers are caught and transferred upstream annually. Other native fish (koaro, banded kokopu, shortjawed kokopu, torrentfish, bullies) would also be attracted into the traps, collected, and then transferred above the dam. There is little information on the effectiveness of trap and transfer systems around New Zealand for species other than eels. This is mainly because such systems are presently operated mostly from December through to March, to coincide with peaks in elver migration, whereas migratory whitebait species such as koaro migrate upstream mostly in the spring. Records of native fish "bycatch" including koaro, banded kokopu, inanga, koura, smelt, torrentish, common bully and redfin bully at the elver trap on the Patea Dam (Taranaki) were presented in Martin et al. (2006). Between December 2004 and March 2005, a total of 640 fish other than eels were caught, and between November 2005 and March 2006 a total of 2,513 fish other than eels were caught.

8.5 Trap and transfer systems present several advantages:

a. The most critical requirement of an effective fish pass is the ability to attract fish, which requires the pass "inlet" on the downstream side of the dam to be placed in the best position, and for fish to be attracted by a flow of water. Traps are more

adaptive, and may be positioned or repositioned for optimum performance more simply than other pass systems.

b. The capacity of trap and transfer systems may be increased simply by installing more traps. This would be important if large numbers of fish attempt to migrate above the dam over a short period.

c. Trap and transfer systems are likely to be less selective than climbing or insinuation passes, and a wider range of species, including those of only moderate climbing ability, will be able to be trapped and transferred.

d. Trap and transfer systems are more “fish friendly”, as fish will be required to climb only a small ramp to enter the trap, where they can be held safely until transfer above the dam. In contrast, some fish may take several days to negotiate a climbing or insinuation pass, which exposes them to higher daytime temperatures, and risk of predation.

e. Fish collected in a trap and transfer system will not necessarily be transferred directly into the reservoir, and could be transferred into other parts of the catchment if required.

f. The operation of a trap and transfer system would provide the opportunity to collect robust data on annual migration and recruitment of native fish.

8.6 Trap and transfer systems around New Zealand are normally operated only during summer months, from about December onwards, to coincide with the time of peak juvenile eel migration. Other species of native fish migrate over a longer season, and if a trap system is to be used to transfer galaxiids and other migrant species in the Mokihinui River, it is recommended that it should operate over a longer season, from August through to April.

8.7 In conclusion, I anticipate that a trap and transfer system will be effective in maintaining the upstream passage of juvenile native fish. I also note that trialling and installing such a system has been adopted by Meridian and is part of the Aquatic Management Plan.

8.8 All but one of the native fish in the Mokihinui River migrate upstream as juveniles, the exception is lamprey, which in late winter or spring migrate upstream into freshwaters around New Zealand as adults of about 450 to 750 mm in length. Lamprey are uncommon in the region, and only one specimen (a juvenile caught downstream of the Chasm Creek confluence) has been recorded from the Mokihinui River. No lamprey were observed upstream of the proposed dam site during the surveys completed in the upper river during 2006 and 2007. In my opinion this species is quite uncommon in the Mokihinui River, and it is unlikely that large numbers of adult lamprey will attempt to migrate upstream past the proposed dam; however if any do attempt to climb over or past the dam, it should be relatively straightforward to collect and transfer them.

Landlocked populations of migratory fish

8.9 Some migratory species of freshwater fish can form land-locked populations above barriers, where a reservoir provides conditions similar to the sea for rearing the early life stages of the fish. In the Mokihinui River, the reservoir formed behind the proposed dam might support landlocked populations of two species, common bully and koaro.

8.10 Populations of common bully occur in most coastal and lowland lakes around New Zealand (McDowall 1990), and become established quite readily. Populations in some inland lakes are probably the result of these fish being introduced into each area in order for the populations to provide a food source for other fish species such as trout. It is uncertain if common bullies would establish naturally in the reservoir created by the proposed dam, as this species has not been recorded upstream of the proposed dam site and thus may not be present in sufficient numbers when the reservoir fills. If some common bullies were present, or were introduced after filling, it is likely that a substantial population would become established.

8.11 Richardson and McKerchar (2006) suggested that water residence time, lake volume and the presence of tributaries in native bush were reasonable predictors of whether or not land-locked populations of koaro would occur. Koaro populations seem unlikely to establish in lakes with

residence time of less than 80 days and volumes less than 10 million cubic metres, unless the tributary streams are well shaded with native bush to provide good spawning habitat. The reservoir formed on the Mokihinui River will have a residence time of about 13 days, and a volume of about 100 million cubic metres (Floeder and Spigel 2007), which indicate a low probability of supporting land-locked koaro populations. However, well-shaded tributaries of the reservoir will still be present and unaffected, and should provide good spawning conditions. Overall, there seems a moderate probability that landlocked koaro populations will form.

8.12 Regardless of whether landlocked populations become established, migratory koaro will be transported over the dam each year, and in my opinion migratory koaro will dominate the populations of this species in the headwaters of the Mokihinui River. .

9. ISSUES RAISED BY SUBMISSIONS

Submission of the West Coast Whitebaiters Association (Inc)

9.1 The submission contends (at page 2) that "the variety of conditions in the river provides suitable environments for all species of whitebait with their differing spawning and habitat needs". This is misleading, as the Mokihinui River provides very little suitable habitat for inanga, very little inanga spawning habitat; little habitat for giant kokopu, and presumably little suitable habitat for adult banded kokopu, as this species never been recorded in the Mokihinui River except as whitebait. The river, or more correctly its smaller tributaries, provides suitable habitat for koaro and shortjawed kokopu, and limited habitat for inanga, giant kokopu, and banded kokopu.

9.2 The submission contends (at paragraph 7 of page 2) that building the dam will lead to the extinction of all species of whitebait that need to travel upstream of the dam. I do not agree, and it is quite clear that there is a need for migratory whitebait species (particularly juvenile koaro) to be assisted over the dam, to allow them access to their preferred habitat,

and that trapping and transfer of these fish is feasible. Overall I conclude that as mitigated this will have no more than a minor effect

9.3 In the same paragraph the submission contends that that the proposed lake will reduce potential spawning area; presumably the submission refers to spawning of koaro. I do not agree; koaro were not found in mainstem habitats of the Mokihinui River, either in the gorge or elsewhere, and they would not be expected to utilise the gorge as anything but a conduit to their preferred habitat; i.e steep, small streams with forest cover, where they live and breed. Substantial areas of existing suitable koaro spawning habitat in the Mokihinui will remain unaffected by the MHP.

9.4 The submission contends that assisting juvenile fish over the dam is not practical, for the four following reasons that are addressed individually:

1. Whitebait will be subject to predators in the lake. Whitebait (and other fish such as juvenile eels) trapped downstream of the dam could be transported to the head of the lake, or to other locations above the dam, if monitoring showed that predation by trout and/or large eels in the lake was a significantly greater issue than is currently the case.

2. Whitebait will have to travel an additional 14km to their preferred spawning areas. This is incorrect; the distance between the dam site and their spawning areas (small forested headwater streams) will not change.

3 .Larvae will have to travel downstream through 14 km of clear still lake. I do not agree; Koaro spawn in small tributary streams during high flows in the autumn, and eggs are deposited amongst inundated riparian substrates. Hatching occurs when the eggs are re-inundated by a subsequent flood, and the newly hatched larvae are carried downstream to sea by the flow. In my opinion it is likely that most larvae will travel downstream to the dam when the river is in flood and the water not clear and still.

4. Larvae will encounter the dam on their downstream passage, and be destroyed by passage through the turbines. I do not agree; koaro larvae will mostly be travelling downstream during flood flows, and encounter the dam when a significant proportion of the water is flowing over the

spillway. I would also expect that any larvae that do pass through the turbines would have a high rate of survival, as they are small enough to avoid mechanical damage, and because they have not developed a swim bladder and are therefore less susceptible to damage from any variations in pressure.

9.5 The submission contends (at page 3) that “Meridian imply that there is no spawning in the Mokihinui River and suggest the whitebait entering the Mokihinui River have come from spawning sites in other rivers.” This is incorrect, there is no such implication. There is virtually no inanga spawning in the Mokihinui River (so that inanga whitebait entering the Mokihinui River have almost certainly been bred in other rivers), but no suggestion or implication that spawning of the other four species of whitebait does not occur in the Mokihinui.

9.6 The submission (at page 3) asks why there are so few inanga caught at the Mokihinui River, despite there being many spawning sites in nearby rivers. In fact, significant numbers of inanga are caught in the Mokihinui River; 14% of the whitebait samples collected from the Mokihinui River in 2005 and 2006 were inanga. Using the submitter's estimate of 8 -10 tonnes of whitebait caught annually in the river, this equates to an annual catch of 1.2 – 1.4 tonnes of inanga per year; or more than 2 million fish.

9.7 The submission concludes that nothing can be done to mitigate or offset the effect of the dam on the spawning sites for koaro, and severely reduced catch of whitebait in the Mokihinui River. I do not agree. Firstly, koaro spawn in small to medium sized tributary streams that are shaded by riparian forest, and these are mostly at higher elevation than the proposed reservoir and will be unaffected. Secondly, in my opinion there will be little or no effect on the production of koaro larvae, or on the migration of koaro larvae downstream to the sea. Consequently, there is nothing to suggest that whitebait catches in the Mokihinui River will change, especially as Meridian will mimic, as much as possible, inflows and outflows during the whitebait season.

Submission of Mrs. Metiria Turei

9.8 The submission contends (at page 2) that the report downplays the impact on native freshwater fish, and that a dam would prevent most freshwater fish species from reaching their preferred habitat in the upper catchment. I do not agree, and it is clear that the potential effects of the dam vary considerably across the species. Many of the species of native fish in the Mokihinui River prefer habitats occurring downstream of the gorge, either in the mainstem, the estuarine tributaries, or in the forested tributary streams at moderate elevation, and a dam would not prevent these species reaching their preferred habitats. The potential effect of the dam blocking the migration of other species is significant, and it has been recognised that assisting fish migration over the dam will be required.

9.9 The submission contends (at page 3) that the greatest threat to the whitebait fishery is the impediment to migration that the dam will create. The dam will create an impediment to some whitebait migration as discussed in my evidence. However, in my opinion this effect can be mitigated by the installation of a suitable trap and transfer system.

9.10 The submission contends (at page 3) that the distribution of several species are inadequate, (by this I presume it implies that our knowledge of fish distribution is inadequate). I do not agree, as our surveys of native fish in the Mokihinui catchment show a clear pattern of distribution that is quite typical to the pattern of fish distribution in rivers throughout the region.

Submission of the West Coast Greens and Top of the South Greens, of the Greens Party of Aotearoa New Zealand.

9.11 The submission contends (at page 19) that the two main methods used by NIWA to assess freshwater fish (fyke netting and electrofishing) produced different numbers of taxa and abundances of native freshwater fish, and underestimate the abundance of native fish. This is misleading, as the two main methods were used explicitly because they are different. Fyke netting was used primarily to collect quantitative information on eels, whereas electrofishing was used to collect information on the

presence and distribution of fish in the catchment. Both methods are widely accepted and robust techniques for assessing fish populations.

9.12 The submission contends (at page 21) that koaro spawn right at the dam site. No substantiation is given to this statement, and I do not believe that is the case at all, as these fish are mostly found in small, steep, forested headwater streams, and are known to spawn in such habitats.

10. SECTION 42A REPORT

10.1 In his review of assessment of effects of aquatic ecology and water quality, Mr. David Cameron concluded that the MHP is likely to have no more than minor effects on native fish populations below the dam, and that because the dam would prevent the migration of fish upstream to their preferred habitats, the upstream passage of all migratory native fish past the dam should be assisted. He commented that there was uncertainty regarding the effect of the reservoir and dam on the establishment of landlocked populations of koaro, and on the successful downstream passage of larval koaro, which I have already addressed in sections 8.9, 8.10, 9.4, and 9.7 of my evidence.

Mr Cameron also noted that:

- Construction effects on native fish had not been assessed.
- There is risk of the combined effects of increased periphyton biomass, increased bed armouring, and reduced invertebrate habitat reducing food production for native fish downstream of the dam.
- There is not yet sufficient information on the likely performance of the proposed methods to assist fish passage past the dam.

10.2 Construction of the MHP and disturbance of instream habitat, a potential increase in fine sediments and the diversion could have potential effects on native fish. Provided the construction process is undertaken carefully to minimise potential effects and in accordance with the Environmental Construction Management Plan, potential effects on native fish should

be no more than minor. Therefore it is appropriate that possible construction effects and the other issues raised by Mr Cameron are addressed through the Aquatic Ecology Management Plan prepared by Meridian and submitted to the Consent Authority. The plan includes measures to mitigate any adverse construction effects, to monitor periphyton in the river downstream of the dam site, to monitor macroinvertebrate and native fish communities downstream and upstream of the dam site, and to monitor the catch and transfers of native fish, to refine and maximise the effectiveness of the proposed mitigation measures.

11. CONCLUSIONS

11.1 The assemblage of freshwater fishes in the Mokihinui River can best be described as typical of rivers in the West Coast region. Twelve species are now known from the river; eight of these are endemic (found only in New Zealand), and four (giant kokopu, lamprey, longfin eel and shortjawed kokopu), are classified as threatened by the Department of Conservation. All twelve species are migratory (i.e. they move between the sea and freshwater as part of their normal life cycle).

11.2 The presence of the dam will have little effect on native fishes that presently are found in the lower Mokihinui River (i.e. downstream of the dam site.

11.3 The most likely, and significant, potential effect of the proposed scheme on native fish of the Mokihinui River is a barrier to fish migration for some species. For most species, the location of the dam will have little effect, as they do not normally penetrate much further upstream of the proposed dam site. For other species, i.e. those which may penetrate further inland, the effect is likely to be adverse, as a dam would prevent juvenile fish from moving upstream into their preferred habitat. The two species of most concern are longfin eel and koaro, as these are presently widely distributed throughout the Mokihinui River catchment. A trap and transfer system installed at the dam will be effective in allowing upstream migration of these species, and will also allow for upstream

migration of other migrant species such as shortjawed kokopu, banded kokopu, torrentfish and bullies. Downstream migration of sexually maturing adult eels is an issue addressed in the evidence of Dr Jellyman.

11.4 The downstream passage of whitebait larvae should not be affected by the presence of the proposed dam and reservoir, as hatching of larvae in headwater streams occurs during high flow events; consequently their downstream migration will occur mostly when the water is turbid and passage through the lake is rapid. I would expect a high proportion of the larvae to survive passage through the turbines or over the spillway.

11.5 The flow regime during the whitebaiting season will as closely as practicable mimic natural flows, and therefore, the overall effect on the whitebait fishery during the whitebait season should be less than minor.

11.6 Some whitebait will migrate upstream before or after the whitebait fishing season, when the flow in the lower river will be subject to the daily operational regime. However, the incidence of turbid medium to large-sized floods will continue to attract whitebait into the river, and overall the effects on “attracting” whitebait into the river should be minor or less than minor.

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TABLES

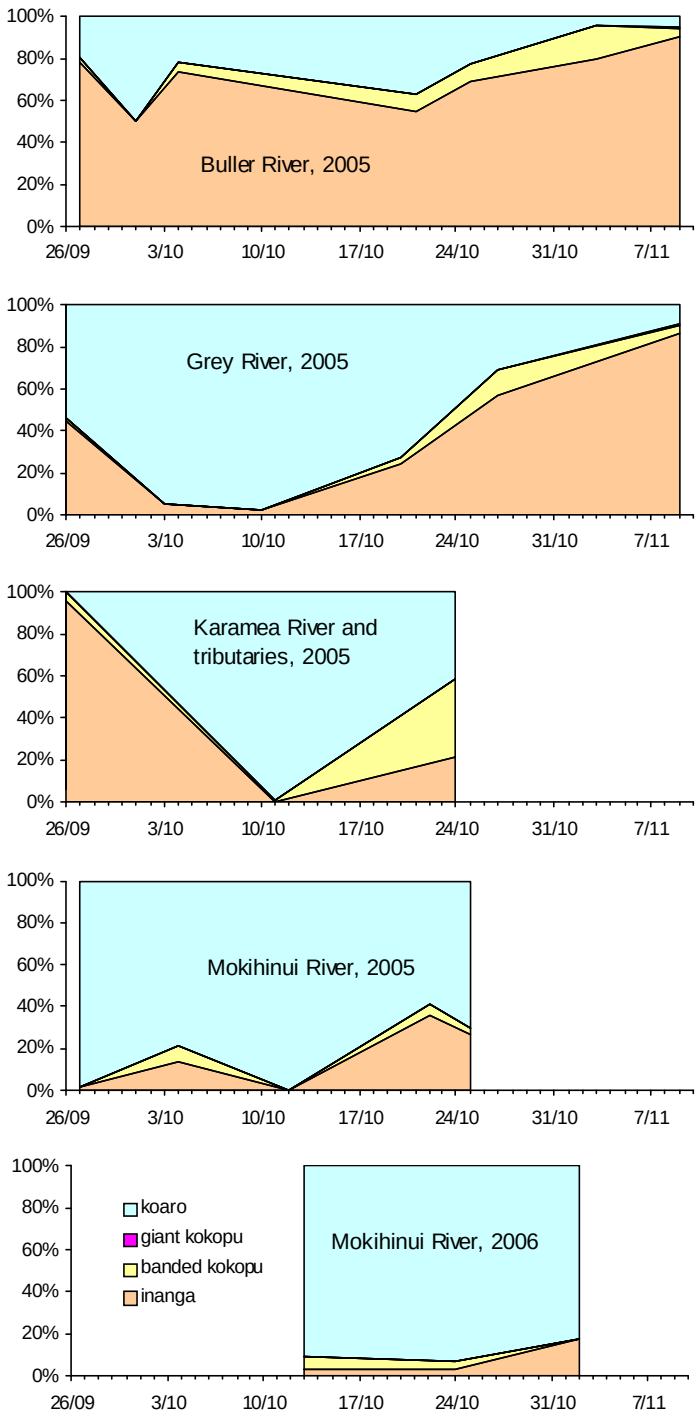
Table 1: Common and scientific names of fish species in the Mokihinui River catchment, and their status (N = native, E = endemic, T = regarded as threatened)

Common name	Scientific name	Status
Banded kokopu	*Galaxias fasciatus*	N,E
Bluegill bully	*Gobiomorphus hubbsi*	N,E
Common bully	*Gobiomorphus cotidianus*	N,E
Giant kokopu	*Galaxias argenteus*	N,E,T
Inanga	*Galaxias maculatus*	N
Koaro	*Galaxias brevipinnis*	N
Lamprey	*Geotria australis*	N,T
Longfin eel	*Anguilla dieffenbachii*	N,E,T
Redfin bully	*Gobiomorphus huttoni*	N,E
Shortfin eel	*Anguilla australis*	N
Shortjaw kokopu	*Galaxias postvectis*	N,E,T
Torrentfish	*Cheimarrichthys fosteri*	N,E

Table 2: Native fish species known to occur in the Mokihinui River, and, for comparison, in the Little Wanganui and Karamea Rivers.

Species	Mokihinui R.	Little Wanganui R.	Karamea R
Banded kokopu	y	y	y
Bluegill bully	y	y	
Brown mudfish		y	
Common bully	y	y	y
Giant kokopu	y	y	y
Inanga	y	y	y
Koaro	y	y	y
Lamprey	y		y
Longfin eel	y	y	y
Redfin bully	y	y	y
Shortfin eel	y		y
Shortjawed kokopu	y		y
Torrentfish	y	y	y
Number of species	12	10	11

Appendix 2. Percentage composition of samples of whitebait from the Grey, Buller, Karamea and Mokihinui Rivers during the 2005 whitebaiting season, and from the Mokihinui River during the 2006 season



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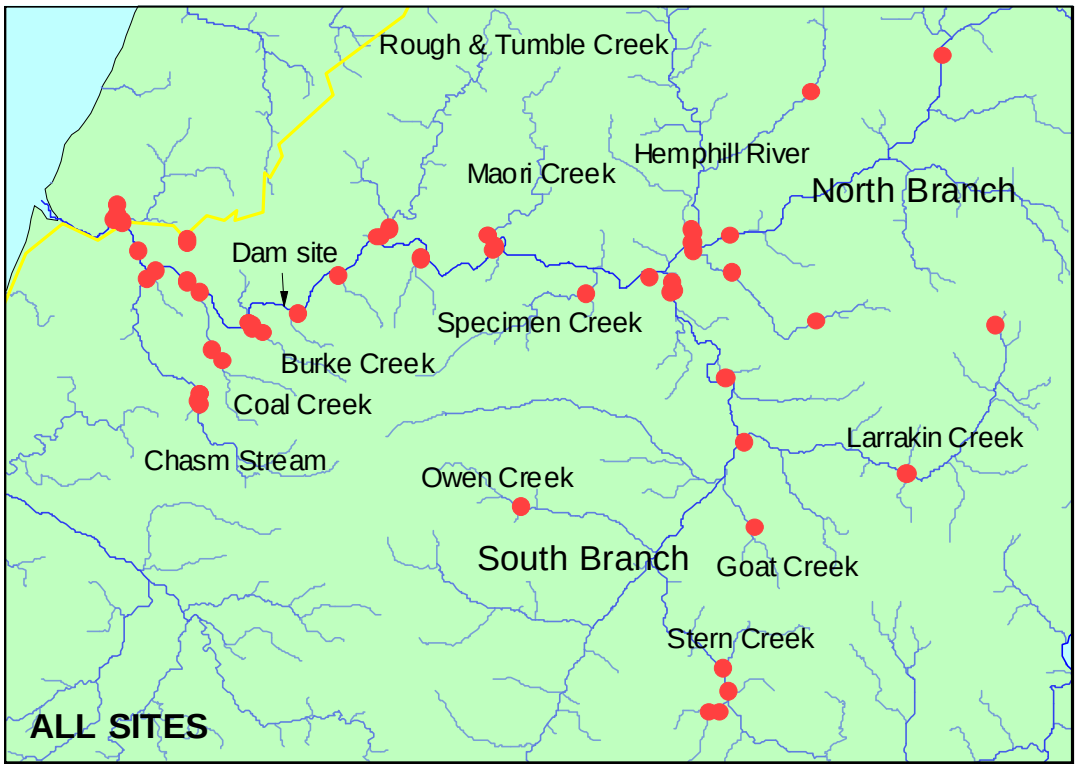
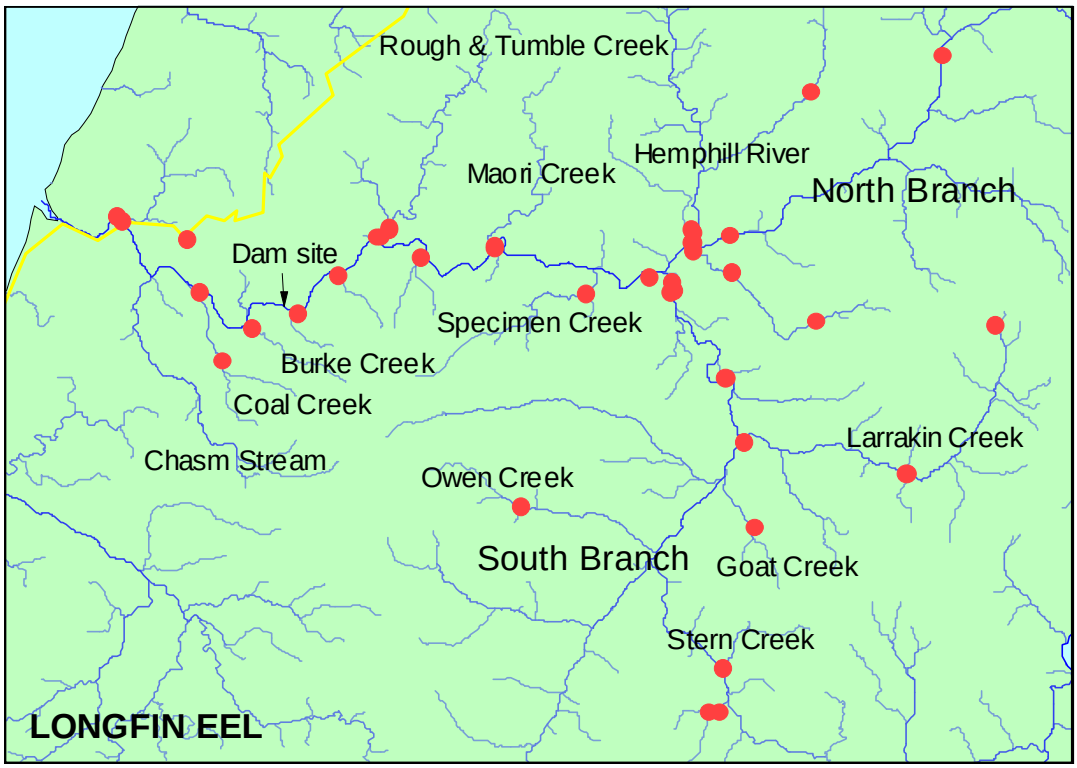
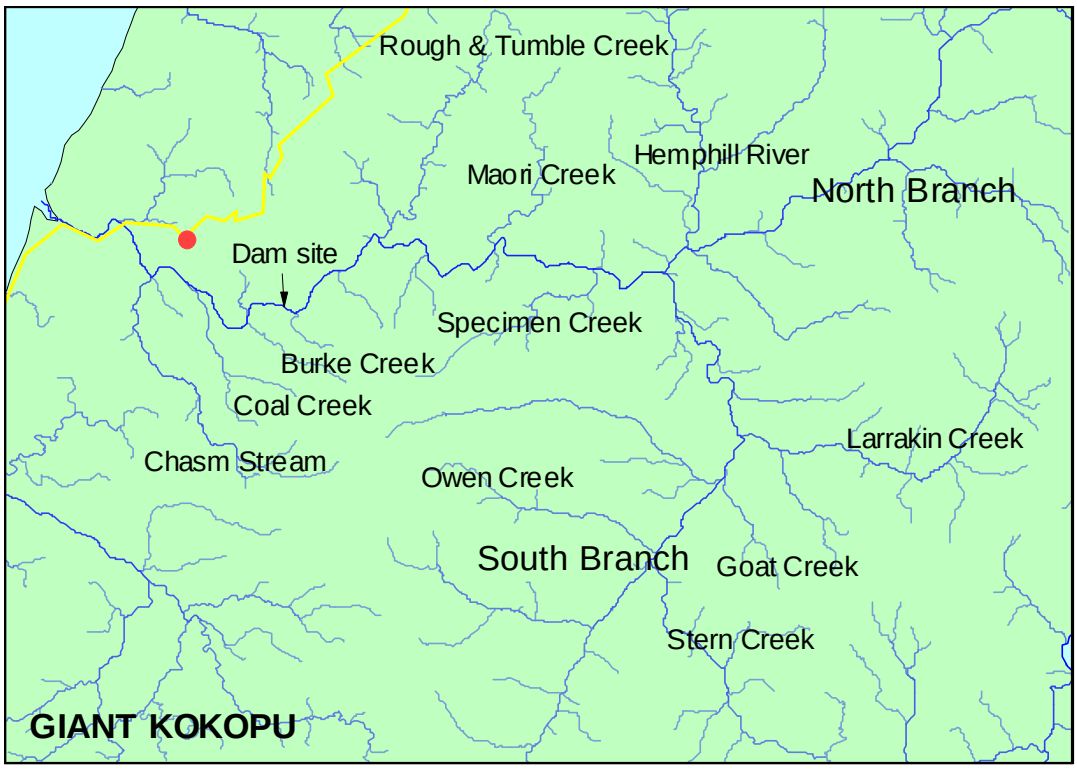
Appendix 3. Maps of native fish distributions in the Mokihinui River



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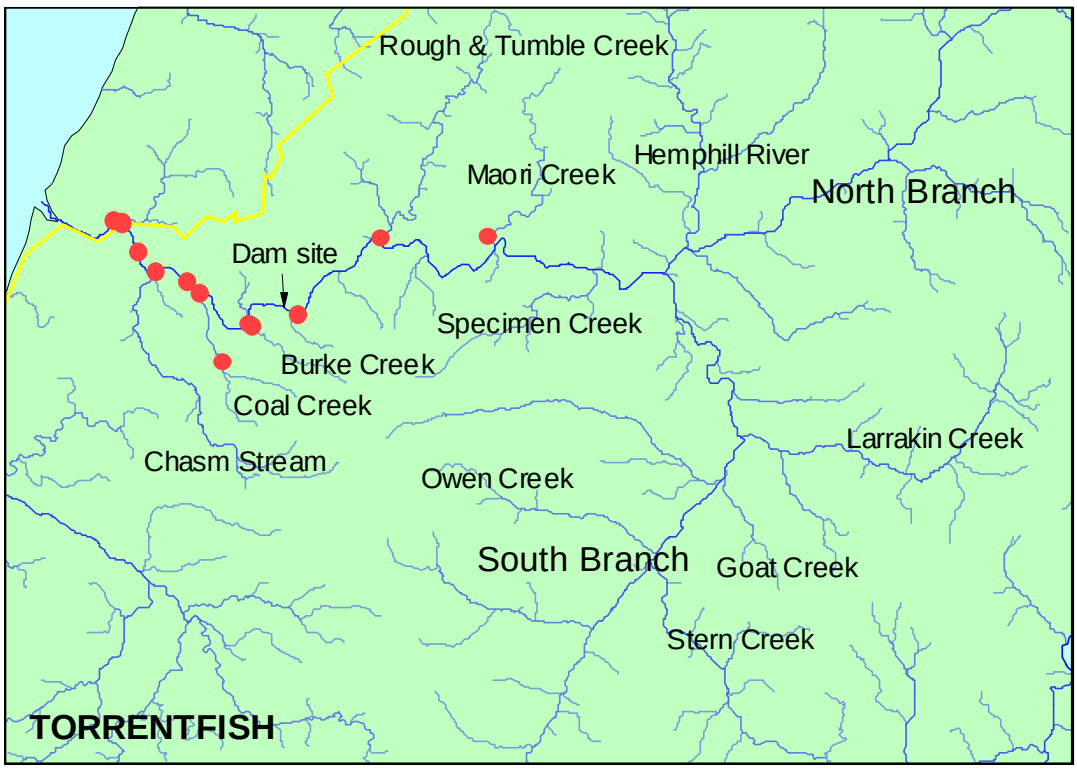
Maori Creek
North Branch
Dam site
Specimen Creek
Burke Creek
Coal Creek
Larrakin Creek
Chasm Stream
Owen Creek
South Branch
Goat Creek
Stern Creek
GIANT KOKOPU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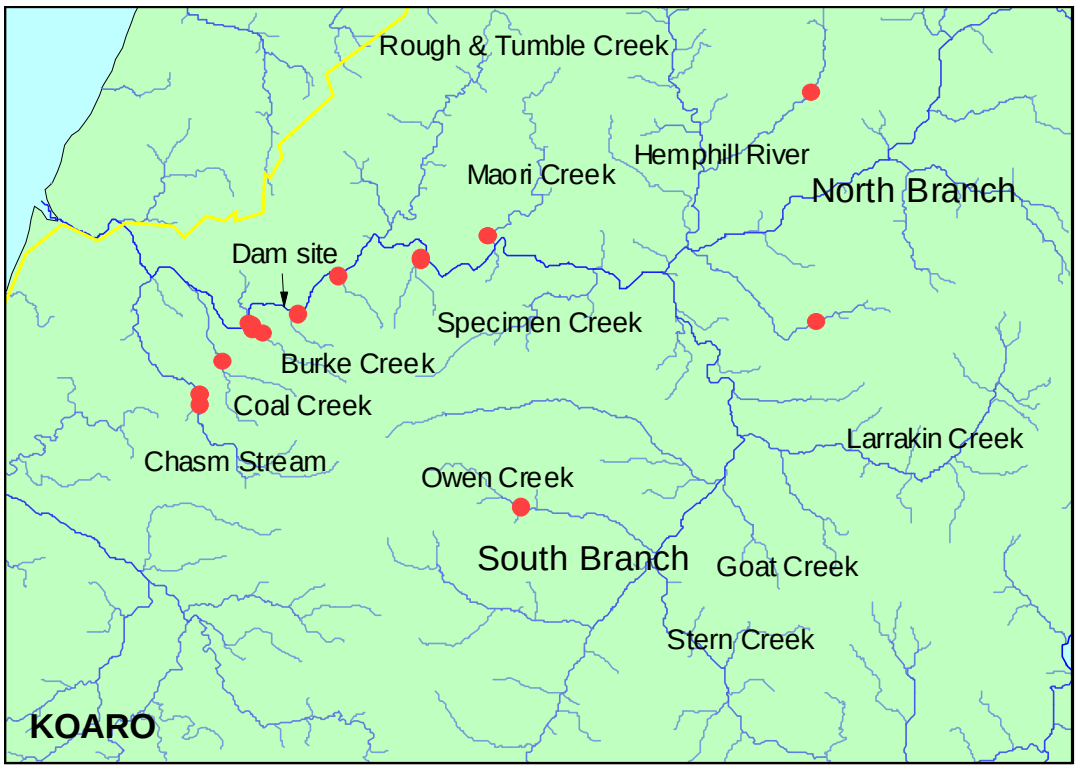
TORRENTFISH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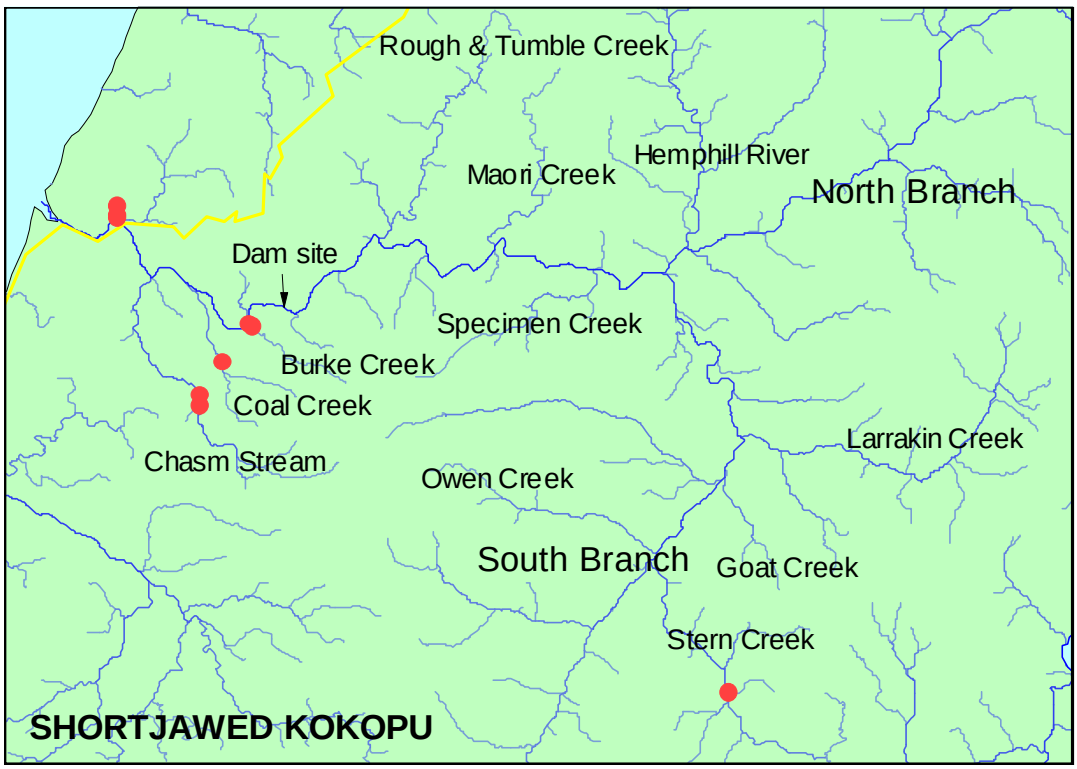
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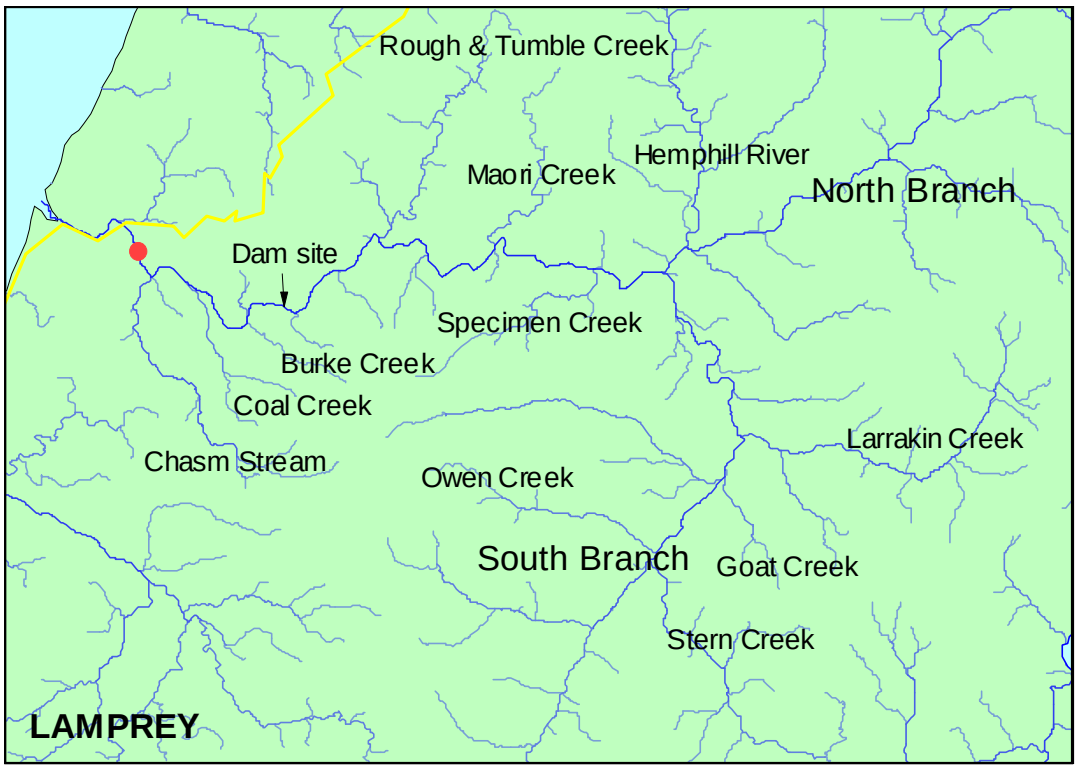
SHORTJAWED KOKOPU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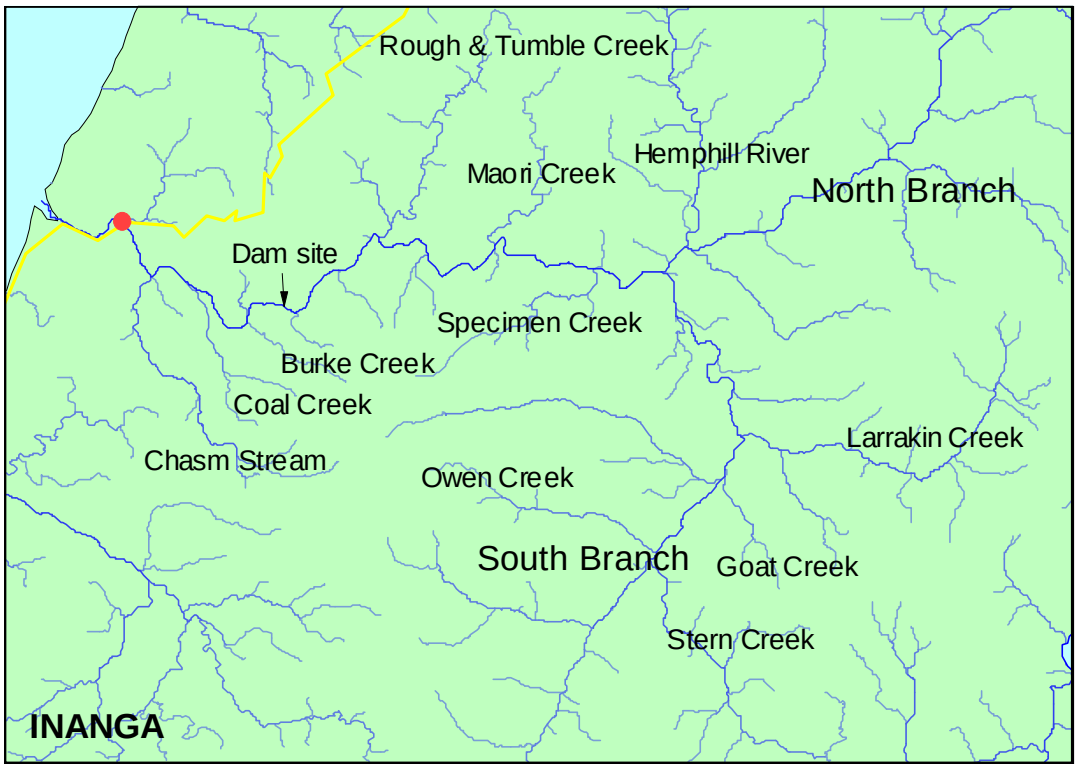
Goat Creek
Stern Creek
LAMPREY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Goat Creek
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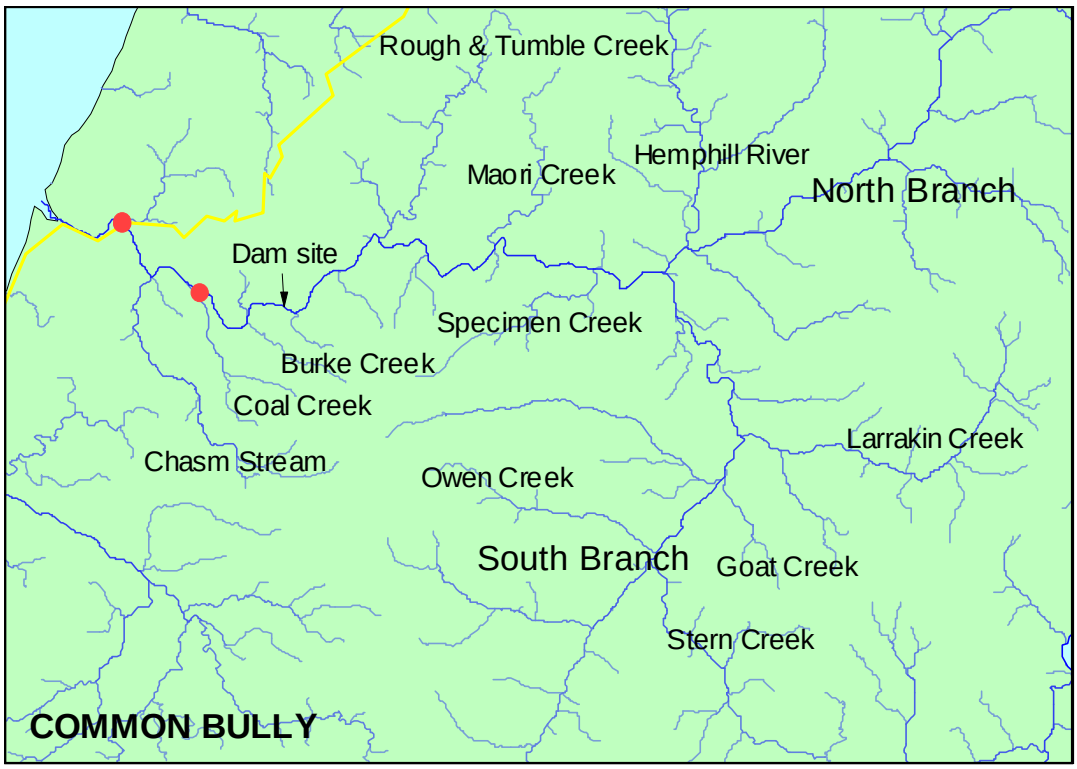
INANGA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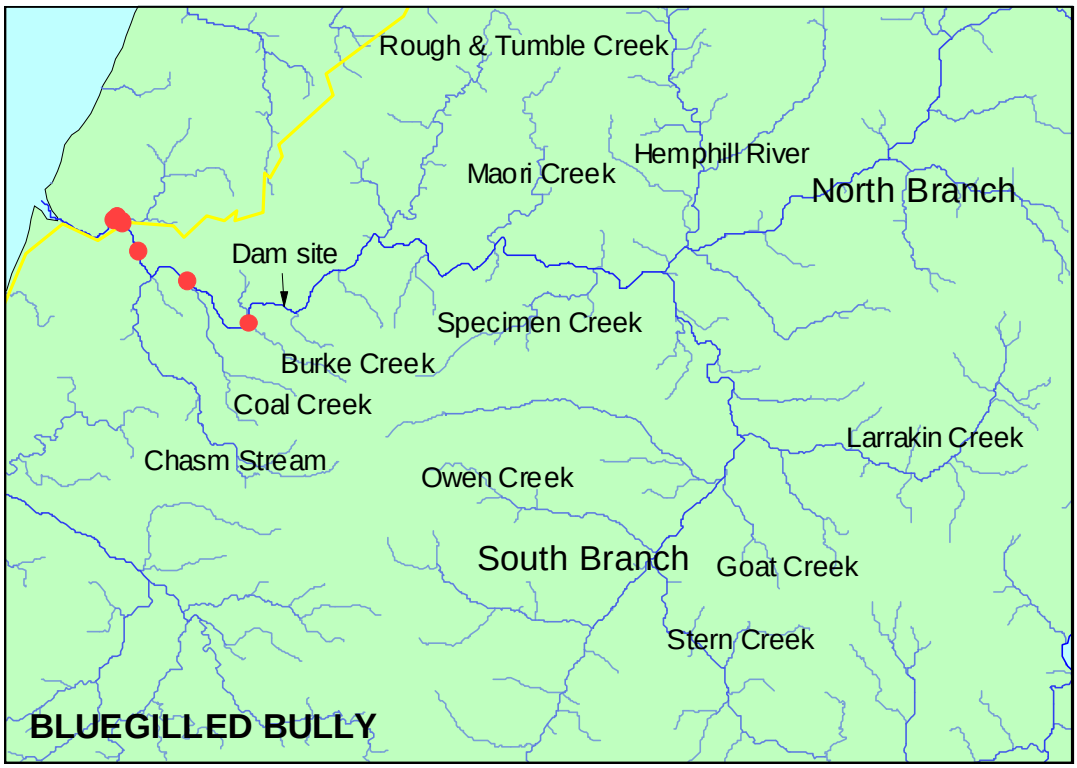
COMMON BULLY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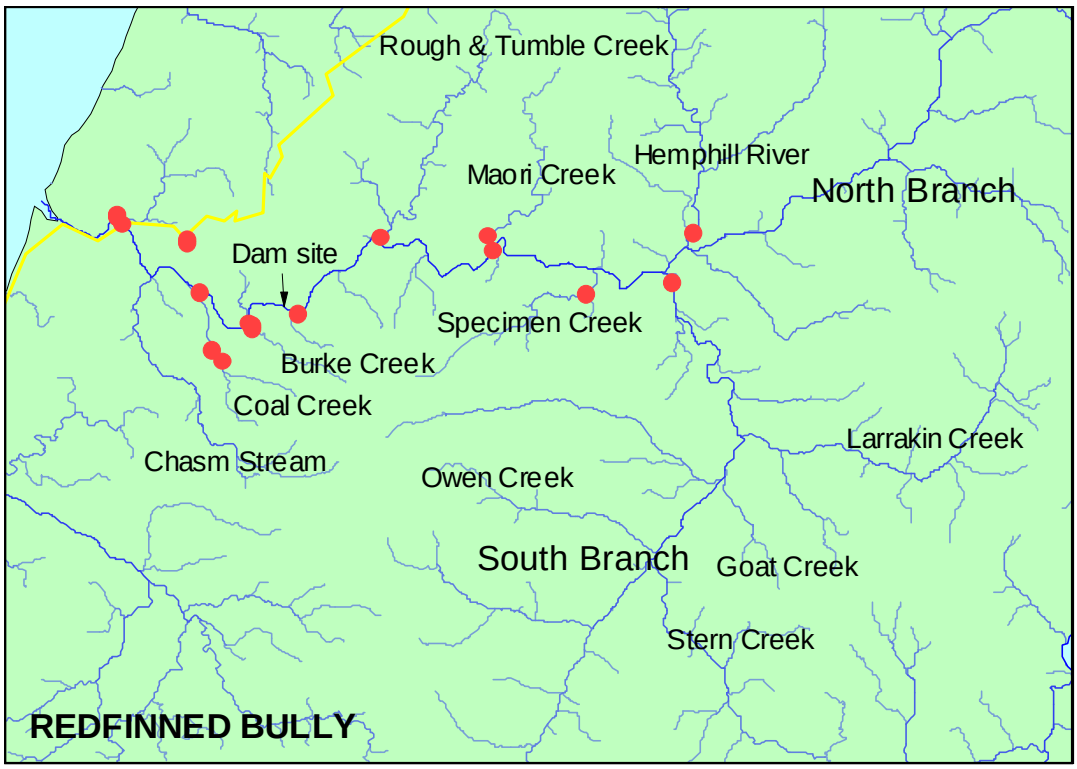
Stern Creek
BLUEGILLED BULLY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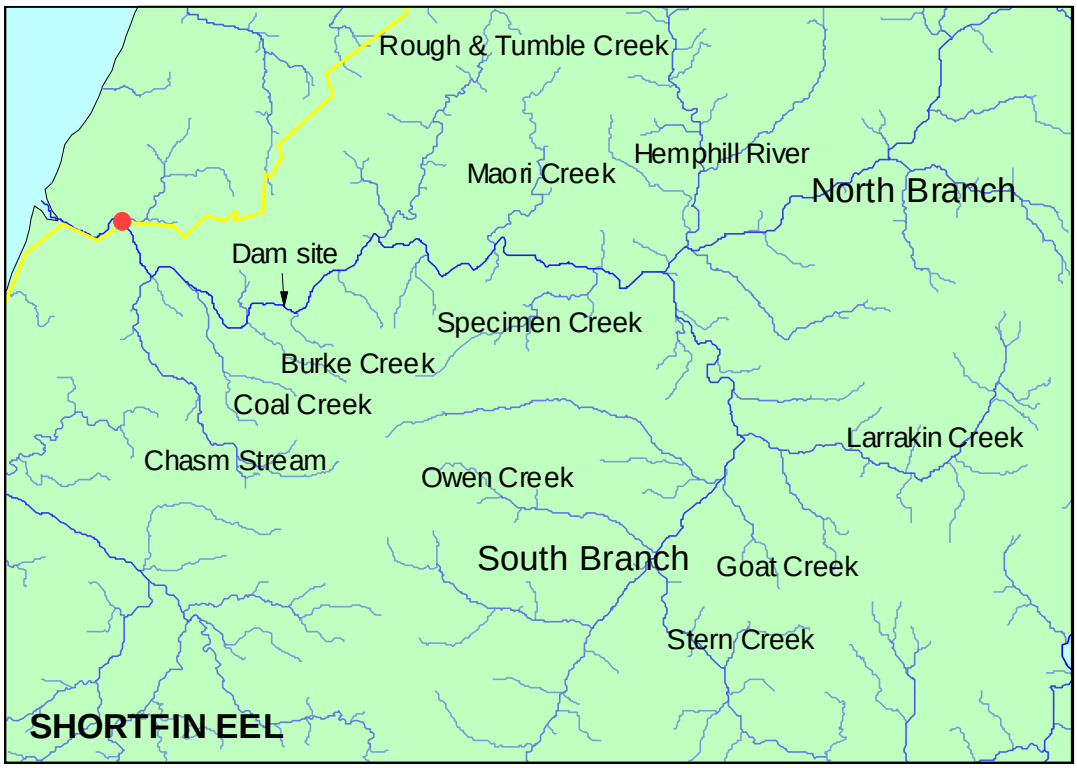
North Branch
Dam site
Specimen Creek
Burke Creek
Coal Creek
Chasm Stream
Larrakin Creek
Owen Creek
South Branch
Goat Creek
Stern Creek
REDFINNED BULLY


Rough & Tumble Creek
Hemphill River
Maori Creek
North Branch
Dam site
Specimen Creek
Burke Creek
Coal Creek
Chasm Stream
Larrakin Creek
Owen Creek
South Branch
Goat Creek
Stern Creek
SHORTFIN EEL