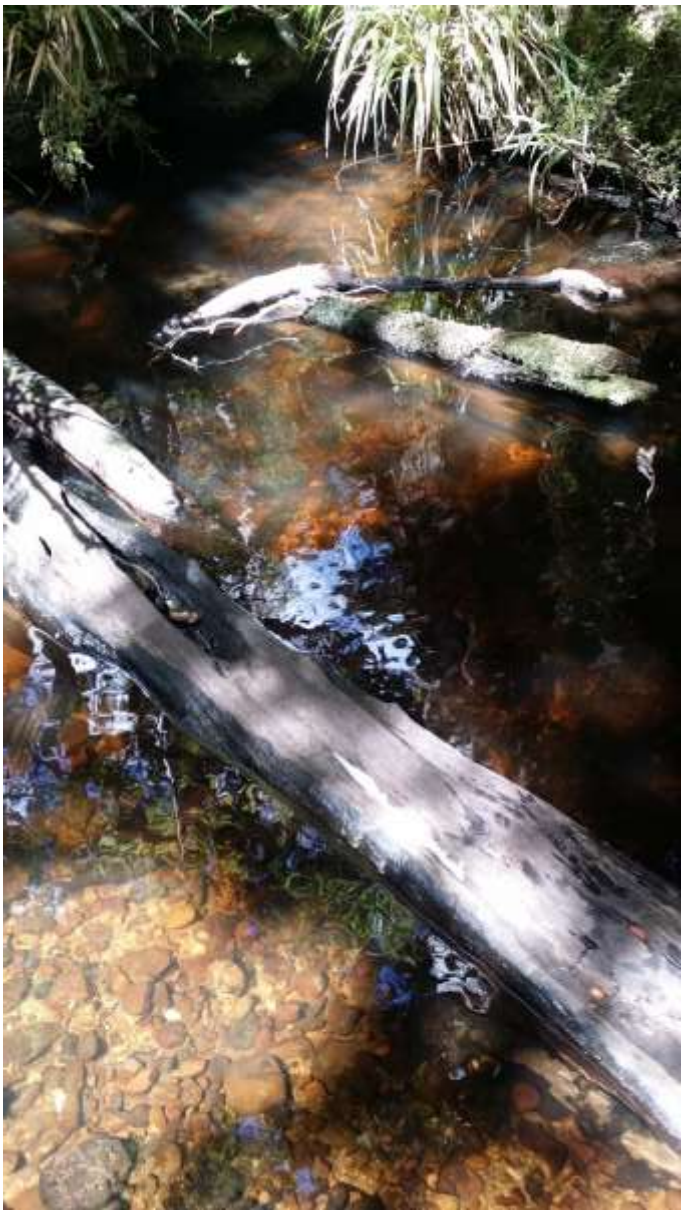
Fleming and Tautuku Rivers 2017 Survey



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Introduction

To date there has been little fish survey work done in the Tautuku and Fleming catchments. A fish survey of the Fleming River was undertaken centered on the Forest and Bird's Lenz Reserve, effort was extended to include the adjacent Tautuku River. A review of prior work in the catchment is provided.

The primary purpose of the survey was to understand the fish community in the river. A prime consideration was to obtain a better understanding of the presence and distribution of invasive salmonids. An aim of Forest and Bird has been reintroduction of Blue Duck or Whio. Whio feed on rocks in shallow fast flowing water and there has been concern at whether adequate food resources are present. It has been suggested that brown trout, if present, aggressive and voracious feeders, may reduce habitat value for Whio as they feed on the same aquatic insects; caddisfly, stonefly and mayfly (G Loh pers. comm.). Work on whio diet has found that they consume large proportions of cased caddisfly larvae largely driven by prey availability and positioning on rock surfaces (Collier 1991).[1] This diet overlaps with that of trout which would mean there may be competition for available food. Establishing whether they are present, would remove this concern, if indeed they are not.

Both the Fleming and Tautuku Rivers feed into the upper Tautuku Estuary and similar species could be expected in each, dependant on habitat. Given the proximity of these catchment extents to the sea, migratory species will maintain a considerable presence. As a rule of thumb, more species can be expected with increasing proximity to the sea.[2]

A significant feature of the geology of the region is the presence of waterfalls. Large waterfalls pose a near insurmountable barrier to most species. Some of our native species are able climbers (longfin eel, koaro, redfin bully, southern pouched lamprey) but the height and vertical dimension of a waterfall will determine whether any species can scale the height. In addition, the number of falls present in a catchment will also reduce inland distribution and species diversity.

Until now most ecological work has focussed on the botanical and avian ecological associations of the Lenz Reserve. The podocarp forest in the Tautuku and Fleming catchments form part of the largest remaining podocarp assemblage in the eastern South Island. The tremendous importance of this forest has been long recognised due to its scale, composition and scenic value. The habitat value and scale provide for rich native birdlife, with many of these under threat such large tracts of old growth forest are of national importance. These same values can be expected to provide relatively intact instream biota on a catchment scale unimpacted by pasture conversion. Again, this is otherwise unknown on the east coast of the

[1] Collier, K J. 1991. Invertebrate food supplies and diet of blue duck on rivers in two regions of the North Island, New Zealand. New Zealand Journal of Ecology, 15(2), 131–138.

[2] Jowett, IG. and Richardson, J. 1996. Distribution and abundance of freshwater fish in New Zealand rivers. New Zealand Journal of Marine and Freshwater Research 30: 239–255. Marine and Freshwater Research 29: 13-23.

South Island where very few catchments of any size are free of grazing and agriculture. The fish composition of these catchments will inform our understanding of the fish community composition pre-forestry elsewhere in the Catlins region, where pasture is now largely present.

Methods

Both the Tautuku River and Fleming River were surveyed. The upper reaches of these rivers are not easily accessible and since access to the upper Fleming River was via the Tautuku River the survey effort was extended to include the Tautuku River. An area of focus was the Forest and Bird, Lenz Reserve (Figure 1), but also the catchment extent above the number of falls in the mid-section which had not been previously surveyed for freshwater values. The larger area is Crown land under management by the Department of Conservation, much of which is designated Catlins Conservation Park.

Waterfalls are significant barriers to migratory native fish but trout in particular. These were mapped from the unpublished report; Waterfalls of the Catlins State Forest Park. Rhys Buckingham. Eastern District Southland Conservancy 1982. New Zealand Forest Service. While there may be others that may be enough to prevent trout, those in the report are the major barriers present in each catchment.

Catchment areas were mapped as defined by Freshwater Environments of New Zealand (FWENZ).[3] Modelled catchment data were derived using the NZFFD expanded stream networks program.[4]

New Zealand Freshwater Fish Database records

The New Zealand Freshwater Fish Database (NIWA)[5] was accessed 27/12/2017 and downloaded for all tributary catchments of the Tautuku River, in which the Fleming River is included as a tributary. The Fleming River confluence with the Tautuku River in the upper Tautuku estuary.

Fishing Methods

Two fish survey methods were used, electric fishing and observation with handnet. Fishing methods were chosen for ease of implementation and improving probability of capture for target species. Accessibility with the electric fishing machine was extremely difficult in the upper Fleming, whereas access with a handnet most feasible and still yielded results. Habitat measures taken were recorded using the NZFFD forms. NZFFD forms were filled for each of the sites and submitted to DOC for submitting to NIWA. All fish both observed and captured were recorded along with their lengths, either measured or estimated.

Where streams are clear and wadeable a NIWA Kainga EFM300 electric fishing machine (EFM) is a preferred option as it immobilises most species of fish which are flushed into the

[3] Leathwick JR, West D, Chadderton L, Gerbeaux P, Kelly D, Robertson H, Brown D. 2010. Freshwater Ecosystems of New Zealand (FENZ) Geodatabase. VERSION ONE. Department of Conservation, Wellington, New Zealand.
[4] Jowett, IG. 1998. NZFFD Freshwater Fish Database Assistant. Version 6.1.
[5] https://nzffdms.niwa.co.nz/search

pole net or captured with a dip net. This was used on the first trip to the Fleming 11/12 December 2017 and again in the upper Tautuku, 7 February 2018.

Sampled Reaches

For the more inaccessible upper catchment extents of both the Fleming and Tautuku Rivers hand nets were used as a preliminary measure to assess the practicality and necessity of taking in more cumbersome fishing equipment. To access the upper Fleming River, foot access over 10 km of unpathed forested land, limiting the amount of time spent at any one site. Once a good appreciation of the key species and habitat was ascertained we moved to the next site. Key habitat was observed and disturbed with a hand net used to capture dislodged fish. Non-migratory galaxias were expected upstream of the barriers, and timing of fishing meant that larval and juvenile fish were expected, if present in pools and backwaters. Adults were flushed from undercut banks, riffles and cobbles. Fishing with the hand net was limited to several linear meters or ceased when fish were captured.

Representative reaches of wadeable stream where chosen for EFM sampling, in the lower Fleming defined at their upper and lower ends by deep pools and log jams. Due to the Fleming River having a high silt deposition and being heavily tannin stained EFM efficacy was reduced. In the upper Tautuku, non-migratory galaxias were common and several meters of riffle or run habitat were fished and habitat and fish measures recorded before moving to next site.

Non-migratory galaxias and mtDNA identification

Non-migratory fish records from the NZFFD were mapped for the area. Where non-migratory fish were found a fin-clip was taken by removing a small sliver of the caudal fin which was refrigerated until stored in 98% ethanol. Mitochondrial genetic analysis was undertaken by Tania King on cytochrome b (Wallis and Wallis 2011) by Otago University, Zoology Department. Galaxias were measured to the nearest 1 mm. A non-migratory mtDNA database is maintained by the University of Otago, Zoology Department, this was accessed to determine whether mtDNA records existed for these rivers.

Figure 1. Department of Conservation lands in the area surveyed as shown in green, Lenz Reserve, owned and managed by Forest and Bird is the boot shaped area in the lower Fleming River catchment.

Results

New Zealand Freshwater Fish Database NZFFD

A total of 87 fish records exist for the Tautuku and Fleming Rivers across years 1984, 1994, 1996, 1997 and 2016. These were submitted by three organisations, 54% of these DOC (Table 1 and **Figure 2**). All records were for easily accessed locations, generally associated with culverts and bridges within easy reach of the Chaslands Highway. Thirteen of the 87 records (longfin eel n = 7, giant kokopu n = 2, common bully n = 1 and brown trout n = 3) were for the Fleming River. We could expect the species found in one to be present in the other. There were no mtDNA records for either river in the Zoology Department database.

The greater catchment area of the two rivers has some form of protected status. A tributary of the Tautuku River, Duckaday Creek (catchment area = 8.7 km^2) enters directly below McLean Falls. The Tautuku River (catchment area = 15.5 km^2) above the falls is a third order stream before its confluence with Duckaday Creek. In total, the Tautuku, just before its confluence with the Fleming River, has a catchment area of 35.2 km^2 and is a 4th order river. The Fleming River (catchment area = 23.8 km^2) discharges into the estuary adjacent to the Tautuku River on its true left. The Fleming River area sampled above the falls is approximately 12 km^2 with a modelled flow of approximately 0.49 cumecs (MALF 0.052 cumecs) and the Tautuku River 0.76 cumecs (MALF 0.081 cumecs) (Jowett 1998).[6]

Table 1. NZFFD records for the Tautuku River catchment 1984 – 2016, accessed 12/2017.Where angaus = shortfin eel, angdie = longfin eel, galarg = giant kokopu, galbre = koaro, geoaus = southern pouched lamprey, gobcot = common bully, gobhut = redfinned bully, gobiom = bully species unknown, marine = marine species, rhoret = black flounder and saltru = brown trout.

Stream	angaus	angdie	galarg	galbre	geoaus	gobcot	gobhut	gobiom	marine	rhoret	saltru	Total
Duckaday Creek		2									3	5
Fleming River		7	2			1					3	13
Tautuku		1		7	1		4	1	3	3	16	36
Tautuku River	14											14
Tautuku trib		1			5		2				11	19
Grand Total	**14**	**11**	**2**	**7**	**6**	**1**	**6**	**1**	**3**	**3**	**33**	**87**

[6] Ibid. 4

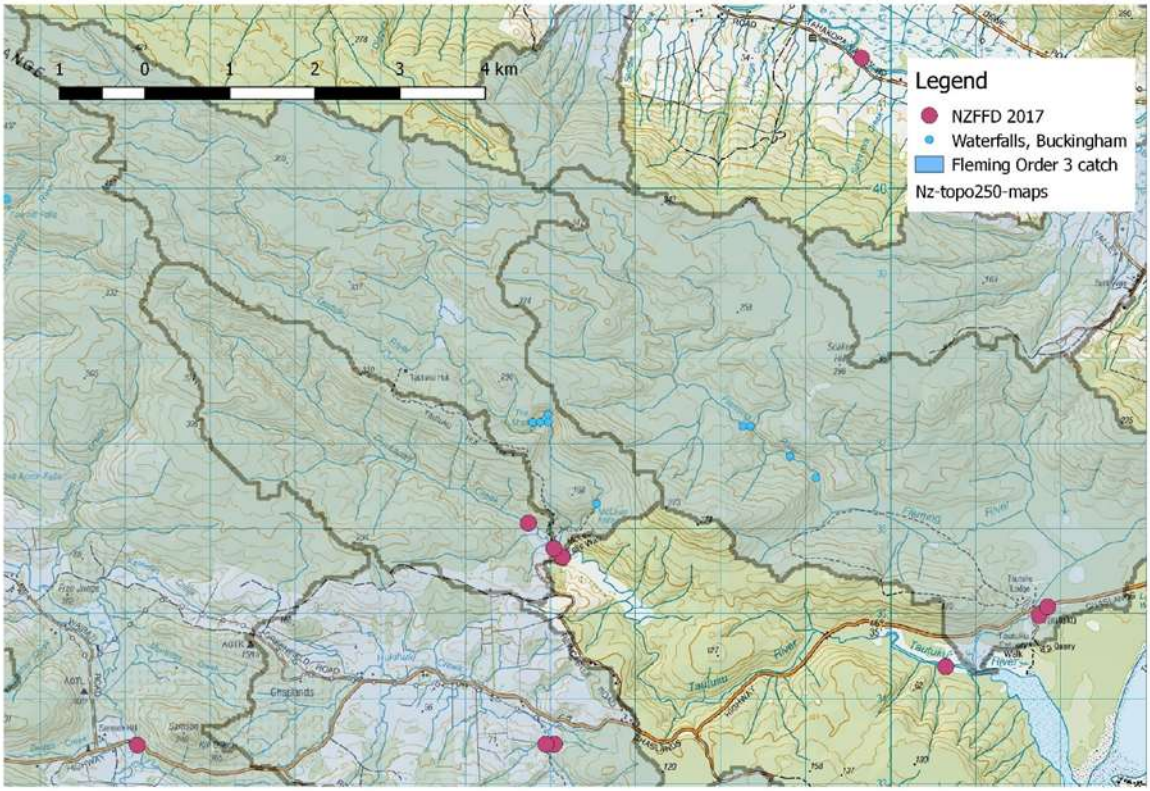

Figure 2. Locations of NZFFD site cards accessed 2017 for records collected 1984, 1994, 1996, 1997 and 2016 (red dots) and waterfall locations as reported by R. Buckingham (blue dots). The blue transparent overlay are the extents of the 3rd Order catchment extents (FWENZ).[7]

Table 2. Waterfalls heights as recorded by R Buckingham 1982.

	Waterfall heights (m)				
Fleming River	6	12	8	8	
Tautuku River	21.6 (McLean Falls)	8	11	6	2.2

Nine waterfalls had been identified by Buckingham (1982) (Figure 2 and Table 2), four in the Fleming River and five in the Tautuku River). The first of the waterfalls of the Tautuku catchment, McLean Falls is the highest at 21.6 m. The highest waterfall of the Fleming River is 12 m. There are a number of other less significant falls in both catchments not meeting the threshold for record in that survey.

[7] Ibid. 3

Sampled Reaches

Nine sites were electric fished in the Fleming River and one site hand netted and larval fish observed (Table 4 and Figure 3). Five sites were hand netted in the Tautuku River and 4 electric fished. The lower reaches of the Fleming were electric fished on the 11th and 12th of December. The mean stream width of the lower Fleming River was 5.7 m, with the most upstream site sampled being the narrowest. Lengths fished in the Fleming River with EFM ranged 2.5 – 50 m but was a median 30 m (area = 195 sqm). Those hand netted in the Tautuku River were substantially smaller 0.25 to 2 m, at a median 1.5 m (area = 4 sqm) as the aim was to determine the presence of non-migratory galaxias. We returned on 7/2/2017 to electric fish the Tautuku to establish trout presence/absence both above and below McClean Falls. One site was fished below the falls (masl approx. 53 m) and three at the DOC hut, approximately 5 km upstream and 234 masl), all sampled sites were 2 -3 m in length.

Table 3. Daily totals of stream reach fished, using both hand net (HN) and electric fishing machine (EFM).

	Summed length of stream sampled (m)					
	11-Dec	12-Dec	22-Dec	28-Dec	7-Feb	Total (m)
Fleming River	72.5(EFM)	210(EFM)	0.75(HN)			283.25
Tautuku River			1.25(HN)	2(HN)	9(EFM)	12.25
Total (m)	72.5	210	2	2	9	295.5

Table 4. Sampling dates and times for Dec 2017 with some site descriptions from NZFFD forms as submitted 2018, for the Tautuku and Fleming Rivers.

Date	River	Time	Site	Stream width (m)	Fished length (m)	Max depth (cm)	Dominant invertebrate	Shrimp	Koura	Comment
11-Dec- 2017	Fleming	16:07	489	5	2.5	130	worms	Y	N	
11-Dec- 2017	Fleming	17:12	490	5.5	20	40	worms	Y	N	
11-Dec- 2017	Fleming	17:52	491	6	50	120	worms	Y	N	
12-Dec- 2017	Fleming	10:26	492	5	40	60	worms	Y	Y	isopod
12-Dec- 2017	Fleming	11:30	493	6	30	70	worms	Y	N	peashells/ triplectides
12-Dec- 2017	Fleming	12:30	494	7	40	45	uncased caddis/ coloburiscus	N	N	peashells/ isopod
12-Dec- 2017	Fleming	15:00	495	6.5	30	55		N	Y	
12-Dec- 2017	Fleming	16:40	496	7	30	120	coloburiscus	N	Y	
12-Dec- 2017	Fleming	18:00	497	3.5	40	130	deleatidium/ coloburiscus	N	Y	
22-Dec- 2017	Tautuku	10:00	499	7	0.25	7	EPT	N	Y	Immediately above McLeans Falls, invertebrate abundance high
22-Dec- 2017	Tautuku	10:30	501	10	1	10		N	Y	High numbers of larval gollums
22-Dec- 2017	Fleming	14:00	512	7	0.5	7	deleatidium	N	Y	Area of waterfalls
22-Dec- 2017	Fleming	14:30	513	10	0.25	8	none	N	Y	Larval gollums obs in rock pool
28-Dec- 2017	Tautuku	2:30	Tau1	2	2	30	cased caddis/deleatidium	N	Y	
7-Feb- 2018	Tautuku	10:30	Tau2	7	3	50	deleatidium	N	Y	
7-Feb- 2018	Tautuku	14:32	Tau3	4.5	2	20	deleatidium	N	Y	
7-Feb- 2018	Tautuku	13:00	Tau4	5.5	2	17	deleatidium	N	Y	
7-Feb- 2018	Tautuku	13:30	Tau5	3.5	2	15	deleatidium	N	Y	

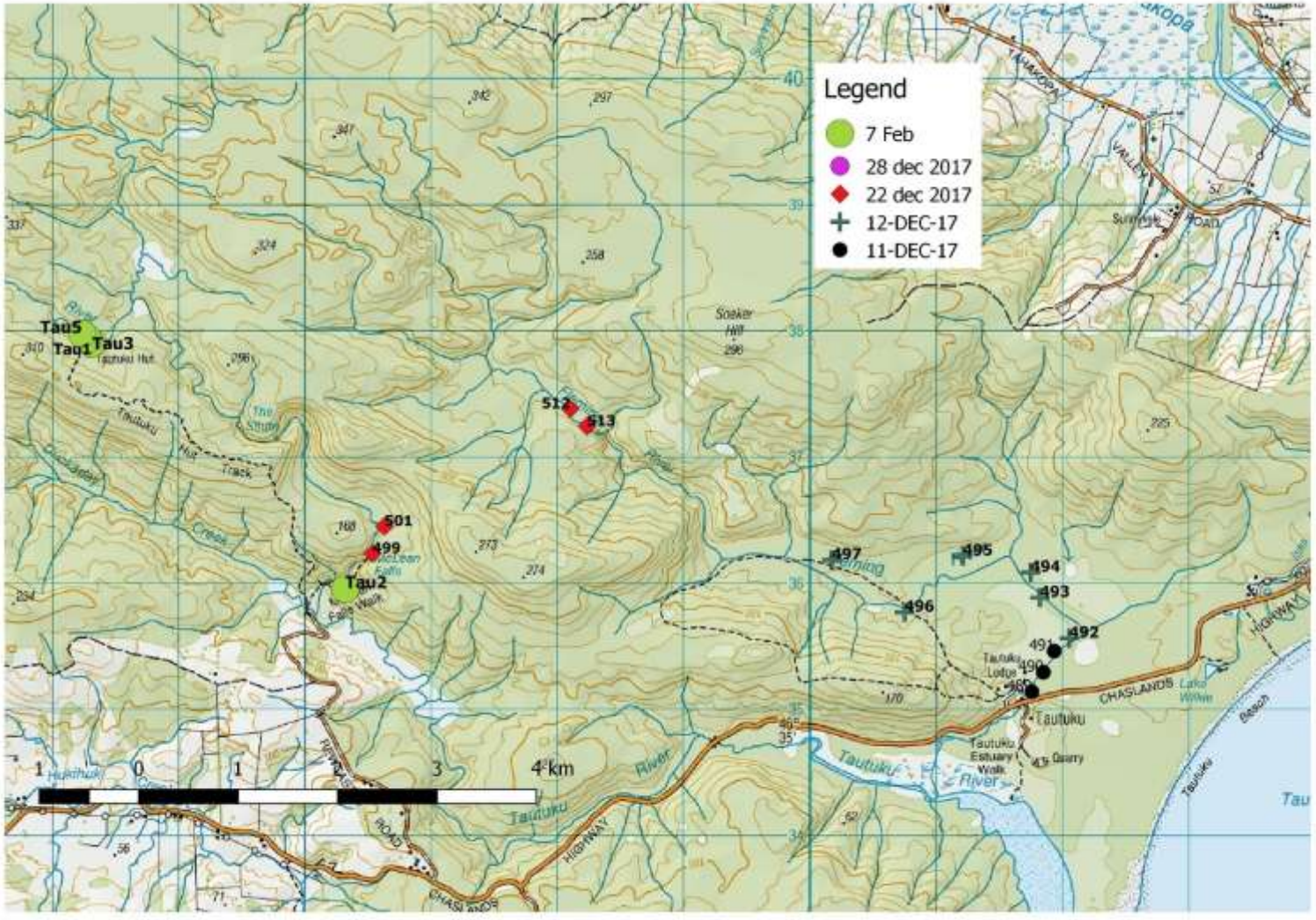

Figure 3. Survey sites across 4 sampling occasions December 2017 and February 2018.

Habitat observations

Fleming River

The lower Fleming River consists of a series of slow meanders with an abundance of instream debris and leaf material (Figure 4). The canopy is low (approximately four meters high on average) and a considerable amount of instream material is from collapsing riparian forest margins (Figure 5), some of which remains suspended between both banks. The average flow is inadequate to flush it out of the river. Log jams are a common feature of the river. Much of the water movement is sluggish and there are many small pools formed by the many log jams.

The substrate consists of a deep layer of fine sediment. The sediment and debris form the primary fish habitat. The dominant substrate in the lower Fleming River is sediment with substantial debris. In the upper two sites sampled of the lower catchment gravels had become common (Figure 6) as gradient increases the water velocity and deposition diminishes. At the observed flow, there was little undercut bank habitat or overhanging vegetation (grasses and ferns) that could be considered to provide habitat and cover. Average bank height is approximately 1.5 meters. The forest canopy heavily shades the stream with limited sunlight filtering to the surface and through the water column (Figure 5).

The upper Fleming River is a striking contrast to the lower as is primarily bedrock with sediment cover and gravels accumulated in depositional areas. There is still considerable woody debris at the edges and deposited instream. The bedrock has moss cover which is the primary substrate for invertebrates on the rock surface.

The morphology of the lower river is slow meanders consisting primarily of long slow runs with some pools but little riffle habitat. There is little oxygenation with riffle habitat minimal, oxygen levels will also be lowered by demands of decaying organic matter. Throughout this river system the water has high coloration and staining. The decaying organic matter (DOM) lends the water it's characteristic tannin colouration (humic acid, tannins, lignins and fluvic acid).[8] Both the low light conditions and tannin stained water reduce the instream photosynthesis that can occur.

Limited photosynthesis characterises the kind of instream fauna present. Instream vegetation, mosses, periphytons or algae were not evident and the instream fauna were largely filter and debris feeders (allochthonous-based community) rather than grazers. In the lower river the only photosynthetic plant material that was observed was some sparse short strand periphyton on large gravels at the upper sites.[9] In the upper river, abundant mosses form the only form of macrophyte observed. Mosses create meso-habitat, reducing velocity and creating habitat for periphytons and invertebrates such as uncased caddis, chironomid species and mayfly.

[8] B. K. Afghan, Alfred S.Y. Chau Analysis of Trace Organics in the Aquatic Environment.

[9] Although low pH does not inhibit the formation of algae is does alter the composition (Collier 1988)

The low elevation of the stream throughout its lower reaches means that tidal amplitude could be considerable. Tidal amplitude is the diurnal rise and fall of the river with the tide. Although instream debris is likely to be reducing the inward progression of the tidal push. The maximal saline intrusion (often called the wedge), varies with flow, and the tidal amplitude, forces the rise and fall of the depth of water beyond the salt water wedge. These factors will determine the upstream distribution of the saline species such as aquatic isopods in the lower reaches of the river.

Figure 4. Typical cross-section of the lower Fleming River with submerged logs and debris common along with leaf litter decomposing on the bottom of the stream, Site 492.

Figure 5. Heavy shading of the water column, slow sluggish flow, brown water and heavy sediment load characterise the lower Fleming River, Site 493.

Figure 6. Change in substrate composition of the Fleming River at the top two stream reaches surveyed, in the Lenz Reserve, at site 497.

Figure 7. Upper reaches of Fleming River near site 513. Series of waterfalls appear to be those identified by Buckingham 1982.

Tautuku River

The Tautuku River was sampled on two occasions. The first occasion was using just handnets, beginning just above the McLean Falls and working to approximately 250 m upstream. Above the falls the substrate was composed of bedrock, bounders, cobbles, gravels and sand with silt settled out into the pools (Figures 8 & 9). Larger substrate features were present providing more fish cover, with mosses plentiful on the bedrock, boulders and cobbles. Here the river is 3rd order and estimated mean 350 litres a second, the observed flow and velocity were relatively low and much of the larger substrate was emergent. Although the river was largely shaded the canopy was high and open.

Figure 8. Habitat heterogeneity at site 501 in the Tautuku River, mosses, overhanging vegetation, instream debris and cobbles providing fish cover. This shallow area was adjacent to a large deep pool. Juvenile non-migratory galaxias of varying ages were abundant on the edges.

Figure 9. Riffle and run habitat in the Tautuku River site 499, immediately above McLean Falls. Adult non-migratory galaxias was captured in the riffle at the far right.

On the second occasion we fished a single site not far from below the McLean Falls and above the confluence with Duckaday Creek. A smaller falls (3 m with multiple flumes and large plunge pool) was approximately 300 m below the sample site. There had been rain for several days leading up to sampling and the river was only wadeable at certain locations, in the lower reaches of the river the water was not clear. Boulders, bedrock and larger cobbles were more prevalent which with the flow further reduced accessibility. Three other sites were fished in the upper Tautuku River near the DOC hut (Figures 10 & 11). A 2nd order stream at this point, with a mean flow of approximately 160 litres a second, it is a combination of runs and riffles with occasional pools. There the river is a flowing stream with sand, gravels and cobbles forming the chief substrate. Sand deposition was high in the depositional areas and sediments not common except in backwaters. Logjams were occasional and created the deeper pools. The canopy is lower than further down the river consisting of shrubby trees, including *Olearia spp, Kanuka, Manuka* Tree Fushia, Coastal totara and *Hebe spp.* Surrounding the banks and sheltering the water were lower growing ferns, and monocots such as *Phormium spp.* and *Cortadaria richardii*. Although the canopy overhangs the stream in places (Figure 11) the stream was relatively open to light. A brownwater stream, the water is cool and well oxygenated and the main macrophyte type present are the aquatic mosses.

Figure 10. The upper looking Tautuku River looking upstream of Site 3. A small area of riffle in the midground.

Figure 11. The upper Tautuku River looking upstream of Site 3. There was abundant vegetation overhanging the stream and undercut banks for fish cover.

Macroinvertebrates

Fleming River

Instream invertebrate abundance was low in the Fleming River. In the lower section, the majority of net hauls returned few macroinvertebrates. The largest macroinvertebrate, koura or *Paranephrops zealandicus*, were common, with the larger specimens being found in the lower river. The aquatic woodlice, the southern South Island isopod *Austridotea lacustris* was found under instream leaf litter (Figure 12). The cased caddis Triplectides that builds its cases out of woody debris was present and well adapted to take advantage of the available material for constructing its shelter. Paratya shrimp *Paratya curvirostris* are another common feature of the instream fauna in the lower reaches.

Of the mayflies, several coloburiscus *Coloburiscus humeralis* were seen in the lower section. A single Deleatidium sp. was not picked up till the substrate became hard bottomed. The abundance of macroinvertebrates in the upper reaches of the river appears low.

Figure 12. The southern South Island isopod Austridotea lacustris found to at least 2.5 km upstream in freshwater.

Tautuku River

The Tautuku River has an invertebrate assemblage in keeping with hard-bottomed streams. In the reach above the main falls, a quick disturbance of the cobbles revealed an abundance of instream invertebrates, stonefly (*Stenoperla sp*), Deleatidium sp. and cased caddis. Apparently free of trout above the McLean Falls, it is likely that the Tautuku River has high diversity of mayfly and stonefly species. Koura were common throughout. In the upper reaches, invertebrate abundance appeared lower. The swimming detritivore mayfly Onescigaster spp. was sampled in both the lower and upper reaches of the river. A species common to bush clad streams with high water quality.

Freshwater fish diversity

Fleming River

Redfins (*Gobiomorphus huttoni*), inaka (*Galaxias maculatus*) and ammoceotes (*Geotris australis*) were common throughout the lower section of the Fleming River (Figure 13 and Table 5). Redfin are more common than their capture rate suggests as the slow flow impeded capture. Instead of washing into the net they tended to drift down into the sediment and were difficult to retrieve from the mud. The same was true for juvenile inanga or white bait, which were disturbed out of the shallow silted margins. Whitebait were so prevalent that only a representative sample were captured. Capturing such small fish risks damaging them and it

was evident that they are a common species in the lower Fleming River. A few second year old inaka were captured as adults but most were seen as whitebait. These are recorded as Galspp, meaning galaxias species unidentified, however, by their shape and characteristics most appeared to be inaka. It is possible there were some koaro among them but I did not observe any banded kokopu, which show their banding from a very early stage and are easy to identify.

The filter feeding ammocoetes, the freshwater juvenile of the southern pouched lamprey was common during sampling, found primarily in the silting stream margins, where there was some flow but velocity was reduced.

Figure 13. Redfin bully, lamprey ammoceote and whitebait, were commonly sampled species in the survey reaches, lower Fleming River.

Eel were not commonly encountered while electric fishing and those that were seen were difficult to capture under the conditions. Estimates of length are provided (Table 6). Without capture, it is often difficult to determine which eel species were observed so most eel were not designated to species (Angspp). Both eel that were identified were both longfin.

Table 5. **Numbers of fish captured or observed at each of the Fleming River sites fished. Where; Angdie = longfin eel, Angspp = unidentified eel, Galmac = inaka, Galspp = unidentified galaxias, Geoaus = southern pouched lamprey, Gobhut = redfinned bully, Salmo = unidentified salmonid and Saltru = brown trout.**

Site Labels	Angdie	Angspp	Galmac	Galspp	Geoaus	Gobhut	Salmo	Saltru	Galgol	Total
489		2				1	3			6
490				20						20
491		2	5	10	2	4	2			25
492	1		4	17			1			23
493					1	2	1			4
494	1	2			1	3				7
495		2		2	6					10
496								2		2
497				1		2				3
499									1	1
501									102	102
512									2	2
513									8	8
Tau1									1	1
Tau2	1							3		4
Tau3									11	11
Tau4									11	11
Tau5									6	6
Grand total	3	8	9	50	10	12	7	5	142	246

Table 6. **Mean lengths of fish captured (measured) or observed (estimated) at each of the sites fished. Where; angdie = longfin eel, angspp = unidentified eel, galmac = inaka, galspp = unidentified galaxias, geoaus = southern pouched lamprey, gobhut = redfinned bully, Salmo = unidentified salmonid and saltru = brown trout**.

			Mean Length mm						
Site labels	Angdie	Angspp	Galmac	Galspp	Geoaus	Gobhut	Salmo	Saltru	Galgol
489		275				61	150		
490				45					
491		250	42	42	80	74	275		
492	111		71	50			250		
493					105	61	350		
494	200	325			90	66			
495		350		47	86				
496								37	
497				40		48			
499									55
501									23
512									56
513									22
Tau1									
Tau2	400							89	62

Tau3									57
Tau4									64
Tau5									56
Total	**237**	**300**	**55**	**46**	**87**	**64**	**229**	**68**	**31**

Non-migratory galaxias (Figure 14) were sampled from the upper Fleming River by handnet and juvenile fish were observed in sheltered still rock pool (Figure 15). It is most likely that trout are not present above the larger falls in the river, above the Lenz Reserve.

Figure 14. Non-migratory galaxias, Galaxias gollumoides from the Fleming River, site 512.

Figure 15. Small shallow bedrock pool in the Fleming River with larval galaxias, Galaxias gollumoides, site 513.

A number of wooden posts had been erected in the lower Fleming River (Figure 16), in the Lenz Reserve, across the bed just upstream of Site 491. Cloth was still attached to the post on the far true left. This is a fishing structure, to attach either a fyke or whitebait net. Both eeling and whitebaiting regulations were likely broken with the structure by the fishermen blocking the entire stream width and funnelling fish into the net. The structure was semi-permanent and likely to have been revisited.

Figure 16. Upstream of Site 491 with wooden structure erected across the bed used for either whitebait or eeling, possibly both.

Tautuku River

The survey effort in the Tautuku River occurred in the mid to upper reaches. Only one reach was sampled below the McLean Falls, where three brown trout were captured and a single longfin. the first sample site was above a 21.6 m waterfall and migratory species are unlikely, at least in any abundance. It is perhaps possible that elver and koaro could scale this waterfall, it can't be ruled out. A non-migratory galaxias was captured in the first riffle sampled and a fin clip was taken for sequencing (Figure 9). The second location consisted primarily of the shallow margins of a pool and shallow pools within bedrock (Figure 8), at this site larval galaxias were abundant and again a sample was taken.

Non-migratory galaxias and mtDNA identification

Current records for non-migratory galaxias were accessed from the NZFFD and mapped for the Catlins area (Figure 19). *Galaxias gollumoides* and Southern Flatheads have a wide distribution across Southland, while Clutha Flatheads, as the name suggests are restricted to northern southland but have populations across the Catlins as far south as Longbeach Creek to the south of the Tautuku River. These are the first records for a non-migratory species in these two catchments. The overlap in distribution between *Galaxias gollumoides* and Clutha Flatheads means genetic analysis was required to determine which species was in each of the rivers. Threat rankings for each species is presented in Table 7.

Table 7. Non-migratory galaxias, conservation threat rankings from; Goodman JM, Dunn NR, Ravenscroft PJ, Allibone RM, Boubee JAT, David BO, Griffiths M, Ling N, Hitchmough RA and Jeremy R. Rolfe JR. 2014. Conservation status of New Zealand freshwater fish, 2013. DOC.

***Galaxias* "lower Clutha"**, Lower Clutha galaxias (Clutha River) Galaxiidae, Range Restricted, Taxonomically indeterminate, Data Deficient (1).
***Galaxias* "southern",** Southern flathead galaxias (Southland, Otago), Galaxiidae A(1/) Data Poor, Range Restricted, At Risk (3), Declining.
Galaxias gollumoides, McDowall & Chadderton 1999 Gollum galaxias Galaxiidae, **Data Poor, Nationally Vulnerable** B—moderate, stable population (unnatural) B(2/1) ≤15 subpopulations, ≤500 mature individuals in the largest subpopulation, stable population

The non-migratory fish captured in the upper Tautuku River were predominately fished out of the bank undercuts. There were no other fish species sampled in the upper reaches of either river. The mtDNA sequences confirmed the non-migratory galaxias in both rivers as *Galaxias gollumoides* (Table 8). Four of five of the finclips returned a sequence result. There is approximately 15 km[10] of stream upstream of the McLean Falls and 9 km of stream upstream of the lowest falls in the Fleming River.

[10] Estimated using the extended stream network in NZFFD Assistant 6.1.

Figure 17. Non-migratory galaxias from the Tautuku River, site 499.

Figure 18. Larval non-migratory galaxias from the Tautuku River, site 501.

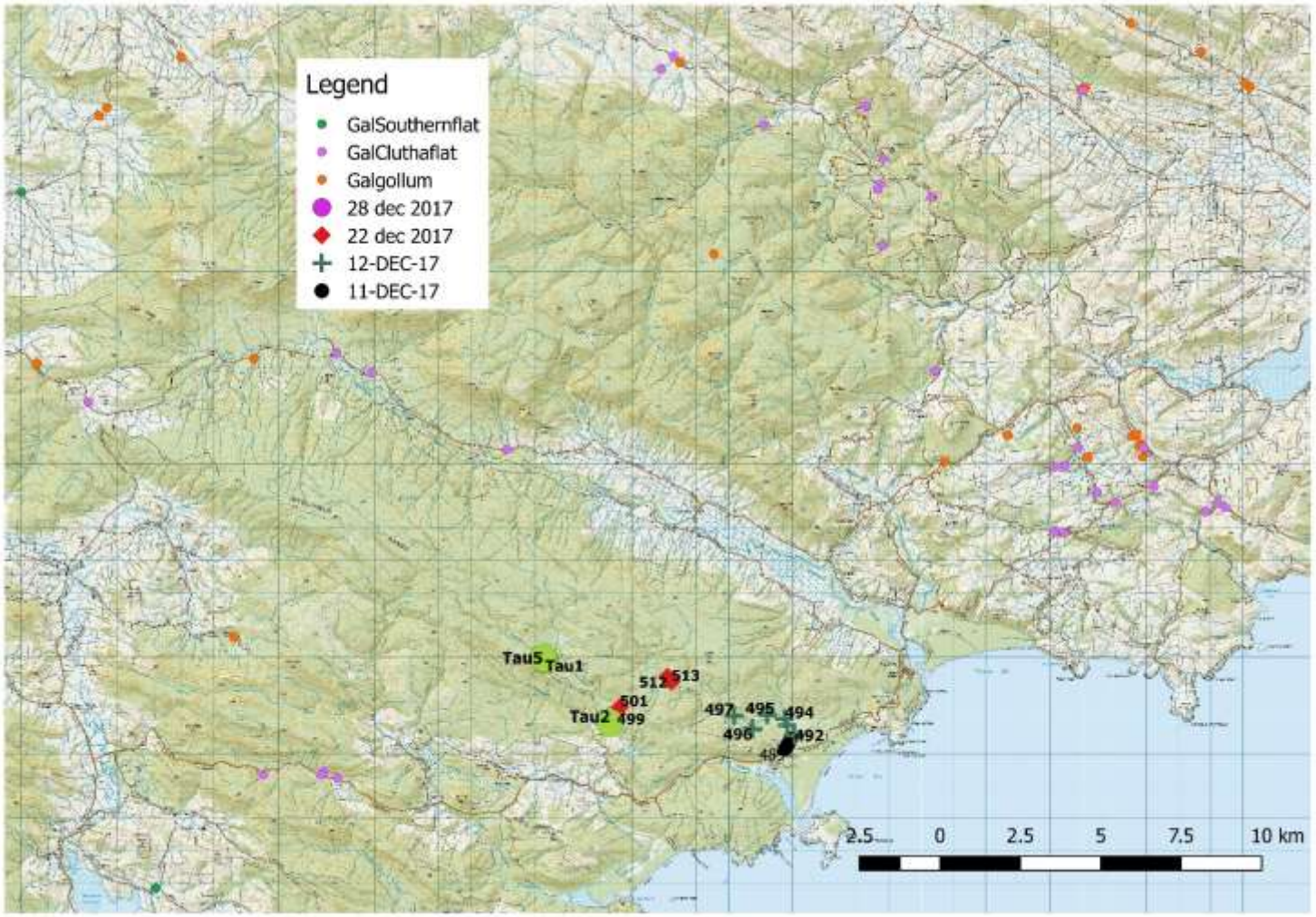

Figure 19. Distribution of known populations of Galaxias gollumoides (Galgolum), Clutha Flathead (GalCluthaflat), and Southern Flathead (GalSouthernFlat), in the Catlins area, Southland (from the NZFFD, assessed February 2018).

Figure 20. Non-migratory galaxias from the upper Tautuku River, sampled on the 7 February 2018, Tau1.

Table 8. Blast sequence results from mtDNA analysis of fin clips, analysed by Tania King, University of Canterbury, Zoology Department.

GAL	Location	date	notes	collector	GPS	Material	BLAST ID
1224	Tautuku River	7/02/2018	collected for F&Bird, likely species *Galaxias gollumoides*	RJC	E1318315 N4837904	fin clip	*Galaxias gollumoides* / 98%
1225	Tautuku River	7/02/2018	collected for F&Bird	RJC	E1318279 N4837942	fin clip	*Galaxias gollumoides* / 98%
1226	Fleming River	22/12/2017	collected for F&Bird; in water for a period of time	RJC	E1322101 N4837385	fin clip	*Galaxias gollumoides* / 98%
1227	Tautuku River	22/12/2017	collected for F&Bird; in water for a period of time	RJC	E1320533 N4836238	fin clip	could not sequence
1228	Tautuku River	22/12/2017	collected for F&Bird; in water for a period of time	RJC	E1320630 N4836453	fin clip	*Galaxias gollumoides* / 98%

Discussion

The sites surveyed in this study indicate that despite being sister catchments and both discharging into the Tautuku estuary, these rivers are dissimilar in a number of ways. The lower elevation section the Tautuku River was not surveyed, so no comparison of the lower reaches can be made with the Fleming River, in the Lenz reserve. The upper reaches of the two rivers, in the reaches observed, differed in substrate, water colour and invertebrate abundance. The Tautuku River above the McLeans Falls and at the Tautuku DOC hut has substrate dominated by gravels and cobbles with occasional boulders. The wetted area of the river is largely bank to bank. This provides a great deal of habitat for both invertebrates and small fish both instream and due to bank cover. In its runs and riffles the velocity of the Tautuku River is greater than the Fleming River, which is slow throughout, but interspersed by cascades.

Although the upper Fleming River has cobbles and gravels the mosses which were abundant in the Tautuku were not so common. Mosses did cloak the bedrock in the Fleming River but periphyton and mosses were largely absent from the cobbles and gravels. The Fleming River is primarily allocanthous, it derives its nutrients from external sources, leaves, branches and invertebrates that drop in. The cobbles of the upper Fleming River Deleatidium sp. and Coloburiscus sp. beneath but they were not abundant. In the lower section of the Fleming River, most electric fished net hauls flushed out very few macro-invertebrates. Invertebrates were characteristic of soft-bottomed streams such as worms. This could be expected as the canopy heavily overhangs the river in the lower reaches and instream primary production is light limited. The macroinvertebrate community consists of shredders and filters. The aquatic woodlice and koura being the larger of these. Even the cased caddis present, Triplectides sp. or stick caddis relies on plant material to build its home and a diet of leaf litter. The most common mayfly found *Coloburiscus humeralis* also filter feeds, using their hairy legs to trap drifting food particles. There were very few grazing species, we saw one *Potamopyrgus antipodarum* snail and one uncased caddis.

At the Tautuku River, above the McLean Falls, invertebrates were diverse and abundant with a range of grazers, filter feeders and predators. Plenty of fish food, or whio food. One of the original questions was whether trout were present due to the impact they could have on the food resources in the rivers for the reintroduction of whio. There was an apparent difference between the Fleming and the Tautuku Rivers with a higher abundance of invertebrates in the Tautuku and higher numbers of mayflies and stoneflies. The swimming stonefly onescigater was seen several times as was stenoperla. Although macroinvertebrate abundance and diversity was not quantified, our cursory look suggested that the invertebrate resources of the Tautuku are greater than that of the Fleming.

Instream conditions can impede the efficacy of fish capture using electric fishing machines and other means of capture must also be employed. In the Fleming River, the slow flow did not appear to be flushing fish out from their daytime refugia reducing capture. Use of the EFM relies on a good flow to flush immobilised fish down into a hand or pole net. Where

water is slow or sluggish, fish are not flushed out but may either remain in place or sink. A hand net may be used then to capture them, but this relies on the conditions being optimal for both observations and capture. Due to the Fleming River having a high silt deposition and being heavily tannin stained EFM efficacy was reduced. In addition, the amount of debris was high and numerous debris jams impeded movement for capture of fish with the hand nets.

A significant habitat type in the Fleming River consists of deep pools > 1.5 meters deep. This is beyond wadeable and must be fished with nets. I would expect that large migratory kokopu, either banded or giant, occupy these pools. This is also good resting eel habitat. In either case fyke nets will be needed to capture fish in these pools.

The water of the Fleming River both in the upper and particularly lower reaches was a dark brown derived from dissolved organic matter (DOM). DOM is derived from the instream decay of plant material directly into the water but also leaching in from the blanket peat soil which comprises the forest floor. The pH of brown water streams on the West Coast of NZ has been found to be as low as 4.0 and benthic invertebrates densities were lower at brownwater sites compared to clearwater (Collier 1988).[11] Collier (1988) wrote that …"affects on fish populations have been detected when pH declines below 6.0-6.5, and most fish species and many groups of benthic invertebrates are often absent from waters that average pH 4.9 or less (Magnuson et al., 1984).[12] In his work on West Coast, in brownwater streams the taxonomic composition of benthic invertebrate assemblages was not affected by low pH but their densities were found to be much lower in acid brown water streams, with poorer quality and quantity of food. In the lower reaches of the Fleming River, habitat consists of largely sediment and debris but even in the upper reaches where cobbles and gravels where present invertebrate abundance remained low. "Main et al. (1985)[13] observed that koaro (*Galaxias brevipinnis*) apparently avoided brownwater tributaries but that banded kokopu (*G. fasciatus*) was common in such waters." It would be useful to ascertain the pH of these waters to understand if the pH is another natural constraint on the fish community.

The southern isopod is an important component of the invertebrate fauna in these waters. Fed on by trout, its abundance may be impacted by their predation, greater than in native fish only waters. The isopod is found in association with estuaries and the upper most site it was found was upstream to site 495 (approximately 2.5 km from the estuary). There appears to have been little work done on it. Chadderton et al. (2010) in their assessment of the distribution, conservation and ecology of New Zealand's isopod fauna considered it the most widely distributed of the three species, found in brackish and fresh coastal waters from Lake Ellesmere to Stewart and Campbell islands. They considered "…. the absence of trout from almost all running waters on Stewart Island (Chadderton & Allibone 2000) may be one reason

[11] Collier KJ. 1988. ECOLOGY OF ACID BROWNWATER STREAMS IN WESTLAND, NEW ZEALAND. A thesis submitted for the degree of Doctor of Philosophy 10 Zoology in the University of Canterbury

[12]

[13] Main, M.R., Nicoll, G.J. & Eldon, G.A. 1985: Distribution and biology of freshwater fishes in the Cook River to Piranga River area, South Westland. New Zealand Ministry of Agriculture and Fisheries, Fisheries Environmental Report no. 60. 142 p.

for its abundance there, since it is known to be eaten by trout in the South Island (Marsh 1983) where its distribution is much more patchy …"

The larval freshwater life stage of the native Southern pouched lamprey or kanakana, were also evident during sampling. Migrating downstream from their nests higher in the catchment, the freshwater lifestage may last four years. Kanakana are a species characteristic of Southern South Island waters and a traditional Maori fishery of the nearby Mataura and Waikawa Rivers, when they return to spawn after the marine phase. Although capable climbers the extent of the vertical of the falls in these two catchments is likely to constrain spawning to the lower stream reaches, where boulders become common. Trout are a predator on ammocoetes and will be depredating on them. Ammocoetes are uncommon on the NZFFD as the shallow backwaters and margins they occupy are generally not sampled during electric fishing nor are G-minnows effective in their detection. Two records are in the NZFFD for the Tautuku River DOC 1996, but there is no indication of lifestage. Kanakana are regionally significant and an important customary fishery for Kai Tahu.

Redfins are common throughout the lower reaches. More common than their capture rate suggests, as in the low flow they tended to drift down into the sediment during sampling. This again impeded capture, but they were common, along with inanga. Redfins are good climbers and can scale falls which are barriers to other fish. They will be one of the last migratory fish to be found in the upper catchment. Bluegill and giant bullies are likely present, a bluegill record is present though neither occur in the NZFFD. Giant bullies often tend to occupy brackish water and a targeted approach might result in a capture.

I was surprised not to find any banded kokopu or even giants. The galaxias I was able to identify were all *Galaxias maculatus* or inanga. The whitebait, which were common, appeared mostly to be inanga. Banded kokopu show their bands at very young post larval fish stages, but I saw none amongst the bait we captured. I called all the smaller bait Galspp. as koaro may have been amongst them, though it seems likely most were *G. maculatus*, which are identified with dark pigmentation along their lateral line. One or more species of large migratory galaxias are most likely present, a giant kokopu record for the lower Fleming, occurs in the NZFFD n = 2, captured in a fyke net 1997. Deep pools were common and are likely to be resting habitat for eel, trout and along with the larger migratory galaxias.

Few eel were detected with the EFM. The tannin colour of the stream and darker pools combined with large debris jams prevented detection. Though in the areas fished, even where capture is impeded, I would have expected to have seen an initial cloud of sediment from the impact of the machine on an eel. We captured several very small eel and saw several but the conditions interfered with capture. As did the net we used which was heavy and unwieldy. The next step is to set fyke nets in the stream to fish the non-wadeable pools. It is best to set a baited net, with the leader facing downstream, in the stream where a distinct plume is created to pull fish up into the net. There is paua gut at DOC Dunedin freezer that could be requested. A longfin eel was captured at the uppermost site of the Tautuku fished before McLean falls. Although elvers are good climbers the McLean falls is likely to be an impasse and any eel in the upper Fleming rare.

We captured two small brown trout in the upper reaches of the Fleming sampled. The machine was not holding larger trout. Flow was in part a problem; the sluggish movement of water means fish that sense the machine current at a distance are able to move upstream as the flow does not wash them down. Also, instead of being washed downstream fish drift to the bottom, which in waters that are dark and obstructed with logs impedes visibility and capture.

There is a low probability trout are present above the waterfalls of both catchments. The size of the waterfalls mean that trout could not move up them unaided. There are large plunge pools beneath the falls and these are used by salmonids to get the speed and upward trajectory necessary to propel them over barriers. However, the vertical height of these waterfalls would make this unlikely. As trout push up, sampling in the pools barriers would help to diminish sampling effort, I would expect to find trout in the pool at the upper limit of their distribution. The upper rivers are too difficult for trout fishermen to access and neither do they hold enough water at base flows to carry fish large enough to give a good trout fishery. Some fishermen have made it their mission to spread trout everywhere so introduction is always possible. The number of falls on the Fleming River suggest to me that once flushed down with floods trout could then not naturally re-invade and there are a number of barriers not just one. The importance of these as trout free catchments is magnified by the presence of non-migratory galaxias *Galaxias gollumoides.*

The fish community of the upper reaches of both rivers, consists of the non-migratory *G. gollumoides and* the freshwater cray or koura. These are the first records of *G. gollumoides* obtained from both the Fleming and Tautuku Rivers. The closet relative of these fish, suggested by mtDNA analysis, are *G. gollumoides* in the Tahakopa River.[14] These fish have the threat ranking Nationally Vulnerable with a B (2/1). Where B(2/1) = ≤15 subpopulations, ≤500 mature individuals in the largest subpopulation, stable population.[15] Our finding means we now know these two catchments contain large secure populations. The catchment area above the areas sampled was approximately 15 km of stream upstream of the McLean Falls in the Tautuku River and 9 km of stream upstream of the lowest falls in the Fleming River. This means a total of approximately 24 km of stream extent secure with *G. gollumoides.* The abundance of these non-migratory galaxias in the upper catchments suggests brown trout are not present. It appears that trout are not present for significant reaches of either river. This is really positive as the rivers are not only natural in character, but they also are intact in their fish communities.

[14] Tania King, pers. comm.

[15] Goodman JM, Dunn NR, Ravenscroft PJ, Allibone RM, Boubee JAT, David BO, Griffiths M, Ling N, Hitchmough RA and Jeremy R. Rolfe JR. 2014. Conservation status of New Zealand freshwater fish, 2013. DOC. Wellington. http://doc.org.nz/documents/science-and-technical/nztcs7entire.pdf

Acknowledgements

Thanks to Franny Cunninghame, and Jorge Jimenez Caisabanda for help with planning, carrying gear and help with fishing. Also, to Graeme Loh, for enthusiasm with a net and getting us through the bush into the upper Fleming River. Department of Conservation Southland and Ros Cole for support in permission to undertake field survey work in DOC lands. This work was made possible with the loan of the Te Runanga o Ngai Tahu electric fishing machine from Aukaha, Dunedin, we are extremely grateful for the use of the fishing equipment. Tania King, Zoology Department, Otago University for confirming the non-migratory galaxias species through mtDNA sequencing. Forest and Bird for use of the Forest and Bird Lenz Lodge for accommodation and generally for the opportunity to do this work. Grant Ward and Francis Begg both helped with proofing.