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Barriers to fish passage
in the Waitakere Ranges and
Muriwai Regional Parks :
a comprehensive survey

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Barriers to Fish Passage in the Waitakere Ranges and Muriwai Regional Parks: a comprehensive survey

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Executive Summary

A high proportion of New Zealand's indigenous fish fauna are diadromous, requiring access between riverine habitat and marine or lake environments. In-stream structures such as culverts, fords, dams or weirs can prevent fish migration.

The Waitakere Ecological District contains areas of outstanding wildlife habitat. The large tract of indigenous forest within the Waitakere Ranges and associated high quality freshwater habitats are significant within the District and Auckland Region.

The Brief

A comprehensive survey was undertaken of all in-stream structures located within the Waitakere Ranges and Muriwai regional parks. All roads and tracks accessible by 4WD vehicle bisecting perennial waterways were inspected for culverts, fords, weirs, dams and other instream structures. Structures were assessed for their ability to pass indigenous fish (climbers and eels) according to established assessment protocols.

Key Results

Fifty structures (mostly culverts) were located and evaluated, of which 76% were barriers to fish passage under most flow conditions. In contrast only 12% allowed unrestricted fish passage.

Approximately 26% of the area within the Auckland water supply catchment was affected by fish barriers, with the Upper Nihotupu catchment greatest affected (90%). This equates to nearly 30 kilometres of high quality freshwater fish habitat.

No structures were consented under the Resource Management Act 1991. However, several form part of a comprehensive consent application lodged by Watercare Services to permit the ongoing operation of the water supply reservoirs and associated infrastructure. A hearing of the application was underway during the preparation of this report.

Recommendations

It is recommended that priority be given to restoring fish passage to affected areas of the Huia, Nihotupu and Okiritoto (Muriwai) catchments.

1 Introduction and Rationale

1.1 Background

New Zealand contains approximately 35 species of indigenous freshwater fish of which 18 are diadromous (McDowall 1990). Thirteen of these diadromous fish are found in the Auckland Region (Table 1). Diadromy dictates movement of fish between freshwater and marine or lake environments as a critical component of life history. In Auckland, the Galaxiidae family is an important and in some areas dominant, freshwater fish family. The five species of Galaxiidae native to Auckland (inanga, koaro, banded kokopu, shortjaw kokopu and giant kokopu) are diadromous, with a regular (although not compulsory) juvenile marine phase which return to streams as tiny “whitebait” in the spring (McDowall 1990). Shortfinned and longfinned eel and common, giant and redfin bullies are also diadromous.

Table 1: Critical habitat requirements for the life functioning and spawning of freshwater fish species present or possibly present in the study area. (? denotes uncertain life history). (adapted from ARC 2000).

Species	Larvae	Preferred adult habitat	Spawning
Shortfinned eel	at sea	Lowland waterways	at sea
Longfinned eel	at sea	Upper catchments	at sea
Lamprey	silt deposits	at sea	upper catchments
Torrentfish	sea or estuary?	estuary to upper catchments	estuary?
Inanga	at sea	lowland waterways	on spring tide in upper reaches of estuary
Giant kokopu	sea or lake/pond	lake edges and slow flowing waters with good overhead cover	mid to low reaches of flowing waterways
Shortjaw kokopu	sea or lake	small bush clad streams with high water quality	adult habitat
Banded kokopu	sea or lake	small streams with good overhead cover	during freshes in adult habitat
Koaro	sea or lake/pond		during freshes in adult habitat
Common bully	lowland waterways, lake/pond	lowland waterways, lake/pond	adult habitat
Redfinned bully	at sea	streams	streams
Crans bully	streams	streams	streams
Giant bully	at sea	estuaries and lowland waterways	unknown

In-stream structures such as dams, weirs and culverts can potentially isolate optimal habitat, which can ultimately lead to a decline in adult stocks or reduced biodiversity (Baker 2003).

Diadromous fish vary in their ability to negotiate in-stream barriers with locomotory adaptations allowing some species such as koaro, banded kokopu and eels to negotiate the wetted margins of waterfalls, rapids and spillways to bypass obstacles (Boubée et. al.1999). Other species rely on “burst” swimming to get past high velocity areas (Baker 2003). Despite these adaptations many species are unable to negotiate in-stream barriers that are perched, undercut, have sustained high velocity waterflow or lack wetted margins (Boubee et al. 1999).

As with many regions of New Zealand, the majority of low-elevation catchments have been urbanised, developed for intensive agriculture or exotic tree plantations. Associated supporting infrastructure such as roads, dams, ponds and weirs often cross, or are located within, rivers and streams. In the Auckland Region, 21% of streams by length are located within indigenous forest catchments and an additional 13% in scrubland (Terralink International Ltd: New Zealand Landcover Database. <http://www.terralink.co.nz/tech/data/lcdb/lcdb.htm>), of which the majority are within the Hunua and Waitakere Ranges. The remaining streams are within catchments dominated by prime pastoral (58%), urban (8%), or exotic forestry (6%). The majority of streams in the Auckland Region are small and of short reach, with 1st and 2nd order comprising 89% of total length (O’Brien 1999).

1.2 Study scope

This study aims to comprehensively identify and assess all in-stream structures located within the Waitakere Ranges and Muriwai regional parks as potential barriers to the passage of indigenous fish. The survey was conducted above and below the five water supply reservoirs (Upper and Lower Huia, Upper and Lower Nihotupu and Waitakere).

This study follows a limited survey of in-stream structures in both parks undertaken by the Auckland Regional Council (ARC) in 2002 (Waitakere n = 5; Muriwai n = 1) (ARC unpublished data).

2 Study sites

This study compliments an earlier survey of the Hunua Ranges and Muriwai regional parks (Barnes, 2004), and adopts identical rationale. Sites were chosen due to their abundance of high quality fish habitat and proximity to each other. The areas were dominated by hard bottom cobble and gravel streams with high water quality and habitat heterogeneity. Both areas are owned and administered by the ARC as part of the regional park network, although in some circumstances infrastructure is maintained by a third party (i.e. Watercare Services Limited).

The Muriwai study area was extended to include land within the Okiritoto catchment due to the location of a significant structure within the regional park that affects a significant proportion of the upstream catchment.

2.1 Waitakere Ranges Regional Park

The Waitakere Ranges Regional Park lies south-west of metropolitan Auckland within the Waitakere Ecological District (Figure 1). The park is over 16 000 ha in area.

Much of the Waitakere Ranges comprises lava and associated breccias, conglomerates, water-sorted volcanic sands and tuffs resulting from eruptions of andesitic volcanoes (Denyer, et. al. 1993). These rocks overlie an earlier sedimentary bed of sandstone and muddy siltstone formed approximately 16 – 21 million years ago, during the Miocene epoch. Elevation extends to 450 m above sea level in some areas.

The Waitakere River and Huia, Nihotupu, Kakamatura, Kakamatua, Whatipu, Piha, Marawhara, Anawhata Streams are major waterways of the Waitakere Ranges, discharging to the southern or western coasts. Minor catchments on the eastern side include the headwaters of the Oratia and Opanuku Streams. The upper reaches of waterways are typically shallow, fast flowing, with cobble and gravel substrate. Streams within the Regional Park have consistently high water quality (ARC 2003), which progressively degrades downstream with increasing agricultural and urban landuses.

The Waitakere Ranges is one of only two large continuous tracts of indigenous vegetation remaining in the mainland of the Auckland Region (ARC 2003), the other being the Hunua Ranges. The Waitakere Ranges contain a rich diversity of indigneous flora and fauna and lowland coastal ecosystems and are of considerable ecological and wildlife significance.

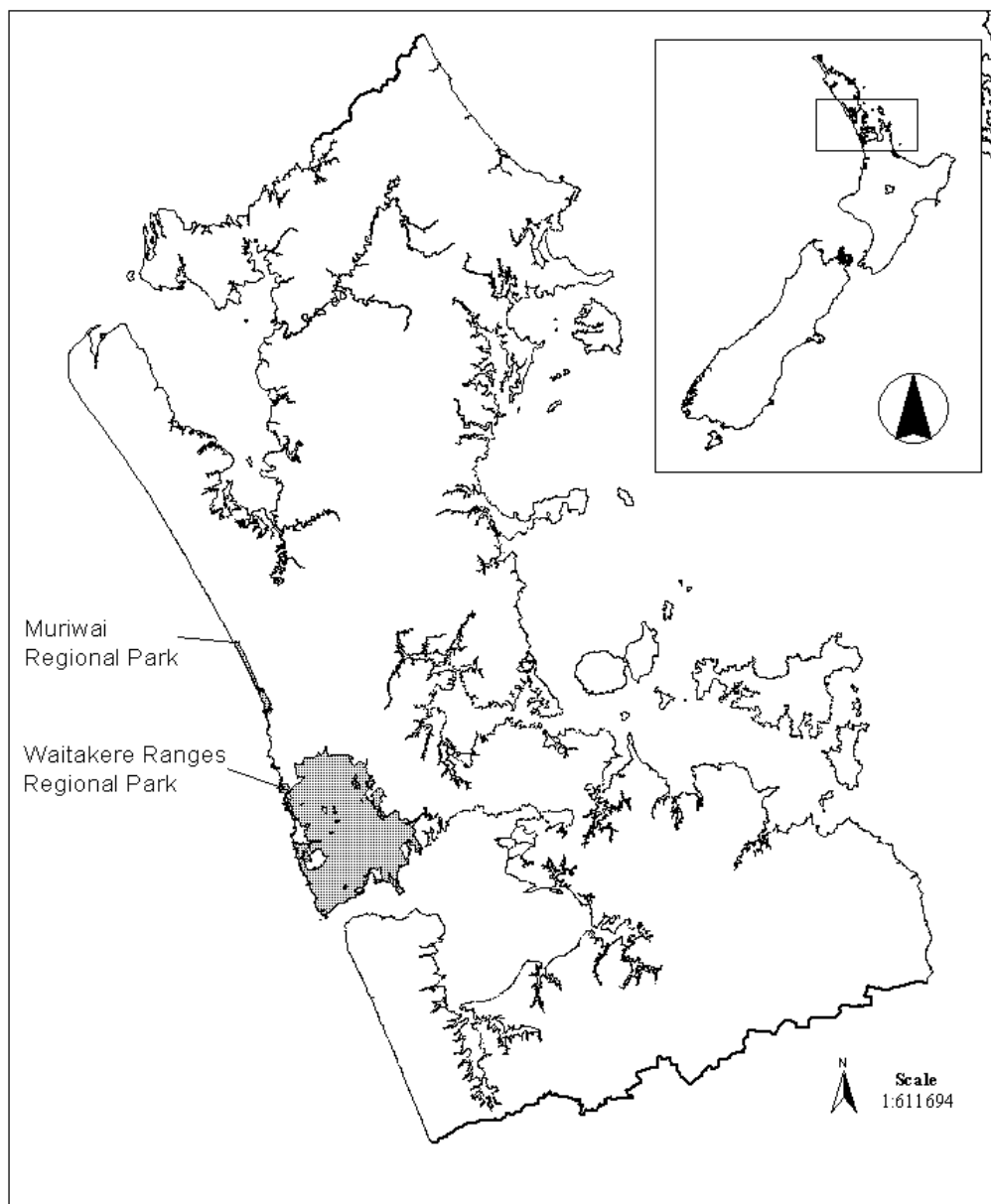


Figure 1: Combined Waitakere Ranges and Muriwai regional parks study area.

A high diversity of fish species have been found the Waitakere Ranges. Galaxiids are represented throughout (primarily banded kokopu and to a lesser extent, koaro). The threatened shortjaw kokopu has been found in the Karamatura and Opanuku streams. Longfinned and shortfinned eels, inanga, Crans bully and common bully are common. The steep nature of the Ranges influences the natural distribution of native fish (Figure 2). Distribution is further restricted above the five water supply reservoirs (Watercare Service Limited 2001), although a number of species, notably banded kokopu and koaro may have established landlocked populations in some reservoirs.



Figure 2: The steep nature of the Waitakere Ranges influences fish distribution. Only longfinned eel, koaro and banded kokopu are likely to move above this waterfall.

2.2 Muriwai Regional Park

The Muriwai Regional Park is located on the west coast of Auckland. The park is approximately 430 ha in area.

Muriwai is situated on a coastal interface between harder older rocks and soft unconsolidated Holocene sand dune (ARC 2003).

Muriwai comprises mainly dunes dominated by introduced marram grass, spinifex and lupin, with radiata pine planted further inland. The floodplain of the Okiritoto Stream is vegetated with native toetoe and *Muehlenbeckia*. The upper catchment comprises exotic plantation forest and pasture.

The lower reach of the Okiritoto Stream bisects the southern end of the Park, discharging to the Tasman Sea. The Okiritoto is generally shallow in its upper reaches, with a cobble gravel substrate and pool, run, riffle habitat type. Two waterfalls, the Okiritoto and Toroanui, located above the Regional Park, form the boundary of the lower reaches, dominated by slow flowing pool run habitat with a sandy substrate. Several surveys of the freshwater fauna have revealed a diverse fishery consisting of banded kokopu, inanga, redfinned bully, common smelt, grey mullet, giant bully and longfinned and shortfinned eel. The introduced pest koi carp may also be present.

3 Methods

The survey was conducted over a five day period during January 2005. Water levels during the survey period were normal. The study was limited to roads and tracks accessible by 4WD vehicle. Structures on walking or mountain bike tracks, or located outside the park boundaries were not included. Structures on ephemeral streams were not assessed.

Probable structure locations were pre-determined by bisecting streams and roads within the study sites using the NZMS 260 topographic map series on ARCVIEW 3.2a (Environmental Systems Research Institute Inc (ESRI) 2000). In addition, the Auckland Regional Council consents database was searched for activities consented or permitted under section 13 of the Resource Management Act (RMA) 1991. Records of freshwater fish surveyed from the Waitakere Ranges and Muriwai regional parks were obtained from the NIWA administered New Zealand Freshwater Fish Database (the Fish Database).

3.1 Structure Evaluation

The evaluation of each structure followed a protocol adapted from previous studies of fish passage in New Zealand and overseas (Boubee et al. 1999; Speirs & Kelly, 2001). For each structure an evaluation sheet was completed (Appendix 1).

Field equipment consisted of a measuring tape, gauge board, hand-held Global Positioning System (GPS) unit, digital camera and pocket portable computer (Appendix). Photographs were taken of the inlet and outlet of all structures. Locations were recorded according to New Zealand Map Grid (Geodetic Datum 1949). The gauge board and measuring tape enabled various attributes of each structure to be recorded.

Structures were assigned to one of four categories following Speirs and Kelly (2001):

- **None or minimal**, where the structure poses no significant barrier to the upstream or downstream passage of fish likely to be found in the stream under normal flow conditions.
- **Low flow**, where the structure is a significant barrier to fish passage, but only during periods of low flow.
- **High flow**, where the structure is a significant barrier to fish passage, but only during periods of high flow.
- **Most flow**, where the structure is a significant barrier to fish passage during most flow conditions.

3.2 Electronic Data Capture

A Hewlett Packard H2210 was used to capture field data electronically. The field sheet was converted to ARC Pad 6 (ESRI 2002) format using associated ESRI form building software. Data was downloaded to the Auckland Regional Council geographic information system at the completion of each field day.

The pocket PC provided a quick and accurate method of recording field data in a format that allowed immediate access for data analysis, while providing uniformity of descriptors.

3.3 Data Analysis

Initial data analysis was undertaken in ARCVIEW 3.2a (ESRI 2000). Upstream catchment area and stream length were calculated for each structure using the watershed layer developed by NIWA within the River Environment Classification REC system (Snelder et al. 2002), and the New Zealand Map Series 260 streams layer. Distance to sea was calculated for each structure using 'Tracer Tool' supplied with REC. Additional calculations were made in Microsoft Excel 2000 (Microsoft Corporation, 9.0.6926 SP-3).

4 Results

A total of 50 structures were located and evaluated (Waitakere, n = 49; Muriwai, n = 1), of which the majority 80% were culverts (n=40), followed by weirs (n=5), dams(chute) (n=4) and one ford. Table 2 shows the number of structures assessed within the Waitakere Ranges and Muriwai regional parks in each category of fish passage restriction. Seventy six percent of structures (n=38) were considered significant barriers to the passage of fish during most flow conditions. In contrast, only 12% (n=6) did not present any barrier.

Table 2: Number of structures located within the Waitakere Forest and Muriwai regional parks in each category of fish passage restriction.

Severity of passage restriction	Number of structures	Percentage of total structures surveyed
None or minimal	6	12
Low flow only	4	8
High flow only	2	4
Most flows	38	76
Total	50	100

Seventy two percent of culverts (n=29) were barriers to fish passage during most flow conditions (Table 3), of which the average perched height was 0.75 m. In contrast, only 15% of culverts (n=6) posed no barrier under similar flow conditions. Most culverts assessed as significant fish passage barriers sat above the stream bed (n=32), were narrower than stream width (n=38) and were flatter than stream gradient (n=33).

Table 3: Number and percentage of structures assessed by severity of fish passage restriction within the Waitakere Ranges and Muriwai regional parks.

Severity of passage restriction	Structure							
	Culvert		Ford		Weir		Dam/Chute	
	No	% ^a	No	% ^a	No	% ^a	No	% ^a
None or minimal	6	15	0	0	0	0	0	0
Low flow only	4	10	0	0	0	0	0	0
High flow only	1	2.5	1	100	0	0	0	0
Most flows	29	72.5	0	0	5	100	4	100

a) Percentage values calculated for each structure type

All dams and weirs surveyed restricted fish passage under most flow conditions.

None of the 50 structures assessed had a valid consent under the RMA 1991, although several form part of a comprehensive consent application lodged by Watercare Services Ltd to permit the ongoing operation of the water supply reservoirs and associated infrastructure.

4.1 Waitakere Ranges Water Supply Catchments

Over 30% of the Waitakere Ranges Regional Park is reserved as a water supply catchment for metropolitan Auckland. A network of five dams is operated by Watercare Services Limited, a local authority trading enterprise.

Approximately 1370 ha (26%) of the water reservoir catchment within the Waitakere Ranges Regional Park is above a significant barrier to fish passage¹ (Table 4). This increases to 35% when considering only catchments that include an in-stream structure (i.e. excludes Upper Huia and Upper Waitemata). Figure 3 shows the location and extent of catchments affected by downstream barriers to fish passage.

Table 4: Comparison of catchment area and stream length lost upstream of in-stream structures assessed as barriers to fish passage under most flow conditions within the Waitakere Ranges Regional Park, excluding water supply dam's (ha - hectare; km – kilometre, % - percentage).

Catchment	Total catchment area (ha)	Number of barriers ^a	Catchment area lost (ha)		Stream length lost (km)
			ha	%	
Upper nihotupu	940	3	850	90	20.0
Mid nihotupu	1270	9	345	27	7.4
Nihotupu combined	2210	12	1195	54	27.4
Upper huia	800	0	0.0	0.0	0.0
Mid huia	1400	7	70	5.0	2.4
Huia combined	2200	7	70	3.0	2.4
Upper waitakere	800	0	0.0	0.0	0.0
Study area (reservoir catchments only)	5200	19	1370	26	30

a) Includes structures associated with Watercare services Ltd infrastructure (i.e. culverts on roads used to access the dam's and pipelines). Does not include structures on ARC-Parks only tracks or roads.

The Nihotupu is the most affected of the three water reservoir catchments with in-stream barriers restricting fish access to nearly 1200 ha (54%), affecting approximately 27 kilometres of stream length. This is most pronounced in the Upper Nihotupu with 90% affected. In contrast, fish passage is restricted in only 3% of the Huia catchment.

¹ The effect of the five water supply reservoirs on fish passage was excluded from the catchment area calculations.