BEFORE THE PROPOSED NATURAL RESOURCES PLAN HEARINGS PANEL

IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of Schedule I: Important trout fishery rivers and spawning waters
AND	
IN THE MATTER	of the submissions and further submissions set out in the S42a Officer Report

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STATEMENT OF PRIMARY EVIDENCE OF ADAM DOUGLAS CANNING ON BEHALF OF WELLINGTON REGIONAL COUNCIL

TECHNICAL- IMPORTANT TROUT FISHERY RIVERS AND SPAWNING WATERS

28th of February 2018

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1. INTRODUCTION

1.1 My name is Adam Douglas Canning. I have a Bachelor of Science with Honours – First class (Biological Sciences and Environmental Science) and hold a PhD in Ecology from Massey University. I am a member of the International Association for Ecology (INTECOL), the New Zealand Freshwater Sciences Society, the International Society for Ecological Modelling, the Australasian Society for Fish Biology, and the Society for Ecological Restoration. I am employed by Wellington Fish and Game Council as a Research Scientist/Technical where I work in the resource management and research of trout fisheries within the Wellington region.

1.2 This evidence documents the criteria and their application to identify important trout fishery and trout spawning rivers throughout the Greater Wellington region.

I have been engaged by Fish and Game to present evidence in support of its submissions on the proposed Plan. I have also provided assistance to the Council with the preparation of Schedule I. The extent of my involvement with the Council in Schedule I is:

- Reporting to the Council the results of all trout spawning surveys by the Wellington Fish and Game Council.
- Establishing the criteria that a stream/river must meet for its inclusion in Schedule I as having Important Trout Fishery or Spawning values.
- Assessing the streams in Schedule I of the PNRP against the criteria I suggest for their conclusion.

I understand that this statement of evidence is to be relied on by the Council.

2. CODE OF CONDUCT

2.1 I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note and that I agree to

comply with the code. My evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter to detract from the opinions which I express.

3. BACKGROUND

When exercising functions and powers to prepare regional plans, the regional council is required under section 7(h) of the RMA to have particular regard to the protection of the habitat of trout and salmon. The PNRP includes Objective O30 which is to maintain and improve the habitat of trout identified in Schedule I (trout habitat), along with a number of supporting policies and methods.

Schedule I lists rivers that are important for fishery recreation value and rivers important for trout spawning. The background 'Section 32 report: Aquatic ecosystems', that explains and justifies the PNRP provisions states that recreational value is based on Wellington Fish & Game Council surveys of places where people fish. Trout spawning reaches are particularly important habitat because they are sources of recruitment for the trout fishery [1]. There is no further detail provided regarding the specific criteria used to identify the rivers included in Schedule I.

A large number of submissions, mainly from the farming community, have requested clarification of the criteria used to identify the rivers listed in PNRP Schedule I, along with a reassessment of Schedule I rivers against these criteria. This report addresses these requests.

4. IMPORTANT TROUT FISHERY RIVERS

4.1 Criteria for defining important trout fishery rivers

A river is considered to be an "important" trout fishery where it contains a trout population and meets at least two of the following criteria (these criteria are defined/explained in Table 1). The river:

- is close to home
- provides a wilderness experience

- has a high frequency of use
- has a high catch rate
- has a high chance of catching a trophy fish.

These are common used criteria to determine the significance of fish and game habitats across New Zealand.

Table 1. Values held by important trout fishery rivers in the Wellington region: definitions and justification

Value	**Definition/Explanation**	**Justification**
Contains a trout population	A river reach is considered to have a trout population if trout have been surveyed as present in monitoring in the last 15 years or (if not surveyed in last 15 years) has a predicted probability of trout occurrence greater than 0.5 as modelled in the Freshwater Environments of New Zealand GIS database.	In any situation an important trout fishery river must be able to support a sustained population. Field surveys confirm the presence or absence of trout. Where field surveys have not occurred, a probability of occurrence threshold of 0.5 for trout is similar to those recommended by Joy [2] as a minimum needed for trout to be considered present.
Provides a pristine/wilderness experience	Rivers that provide a wilderness experience (1) have accessible and fishable reaches that flow through a forest park or have greater than 85% native vegetation cover and less than 15% pastoral cover upstream (sites are considered pristine); and (2) have been identified as having wilderness values by the	Peaceful and scenic surroundings were ranked as of high importance by anglers and is well correlated with indigenous forest cover [4, 5] Forest parks have well-defined boundaries and their natural character is protected. Furthermore, not all areas that provide wilderness experiences are within forest park boundaries, as such I

	Local Angler Values Survey [3].	consider pristine sites to also provide a wilderness experience. Clapcott et al [6] considered pristine sites with high ecological health (minimal human disturbance) to occur in areas with >85% native cover and <15% pastoral cover upstream. I use this same criterion to identify reaches with pristine/wilderness values. Likewise, not all wilderness areas are sufficiently accessible or valued for wilderness attributes by anglers, therefore being identified as valued in angler survey is needed.
Frequently used fishery	A frequently used fishery is a river that has recorded at least 100 angler days in at least one of the last three National Angler Surveys (reference these surveys) [7-9].	National Angler Surveys have been conducted by NIWA every seven years since 1995. They provide a small snapshot indication of angler use throughout New Zealand. Actual use is likely to be much higher than surveyed and 100 angler days suggests a high level of use locally. The minimum of 100 days was chosen arbitrarily to exclude sites that were visited sporadically.
Close to home	A fishery close to home is considered as being within 50km (or 30 minutes) travel	Unwin & Deans [10] concluded “that angling is primarily a local activity, often

	from a centre of population (being a town of more than 1500 people).	undertaken within 50 km of where anglers live." This equates to approximately 30 minutes travel. A minimum population size of 1500 as this is the minimum size of a town needed under the Local Government Act 2002 to establish a Community Board.
High catch rate	The fishery has been identified for having a high catch rate in the Local Angler Values Survey [3].	A high catch rate has been identified by Teirney & Richardson [4] and Unwin[5] as highly valued attribute of a fishery by anglers.
Chance of trophy fish capture	The fishery has been identified for having the chance of trophy fish capture in the Local Angler Values Survey [3].	The chance of a trophy fish (10lb+) has been identified by Teirney & Richardson [4] and Unwin[5] as highly valued attribute of a fishery by anglers.

4.2 Assessment of Schedule I rivers against criteria for important trout fishery rivers

I have evaluated the rivers listed in Schedule I Important trout fishery rivers against the criteria set out in section 6.1 and the results are set out in Table 2. As a result of this assessment I consider that all of the rivers listed as important trout fishery rivers in Schedule I meet the criteria for 'importance' and should be retained in Schedule I.

Table 2. Evaluation of the important trout fishery rivers listed in PNRP Schedule I against Table 1 criteria							
River	**Trout population**	**Frequency of use**	**Close to home**	**Wilderness**	**High catch rate**	**Chance of trophy fish capture**	**Deemed Important**
Akatarawa River	Present – DD (2016)	Present [7]	Present	Present	Present	Present	Yes
Te Awa Kairangi/Hutt River	Present – DD (2018)	Present [7]	Present	Present	Present	Present	Yes
Huangaroa River	Present – DD (2016)	Absent	Present	Absent	Present	Absent	Yes
Kopuaranga River	Present – DD (2016)	Present [7]	Present	Present	Present	Absent	Yes
Mangaroa River	Present – P/O (0.85)	Absent	Present	Present	Present	Absent	Yes
Mangatarere Stream	Present – DD (2016)	Present [9]	Present	Present	Present	Absent	Yes
Orongorongo River	Present – P/O (0.88)	Absent	Present	Present	Absent	Absent	Yes
Otaki River	Present – DD (2018)	Present [7]	Present	Present	Present	Present	Yes
Pakuratahi River	Present – DD (2016)	Present [7]	Present	Present	Present	Present	Yes
Ruamahanga River	Present – DD (2018)	Present [7]	Present	Present	Present	Present	Yes
Tauweru River	Present – P/O (0.58)	Present [8]	Present	Absent	Absent	Absent	Yes
Waikanae River	Present – DD (2018)	Present [7]	Present	Present	Present	Present	Yes
Waingawa River	Present – DD (2016)	Present [8]	Present	Present	Present	Present	Yes
Wainuiomata River	Present – DD (2018)	Present [7]	Present	Present	Present	Present	Yes

Waiohine River	Present – DD (2018)	Present[6]	Present	Present	Present	Present	Yes
Waipoua River	Present – DD (2016)	Present[7]	Present	Present	Present	Absent	Yes
Waitohu Stream	Present – P/O (0.84)	Absent	Present	Present	Absent	Absent	Yes
Whakatikei River	Present – DD (1988)	Absent	Present	Present	Present	Absent	Yes
Footnotes	DD (xxxx) – denotes year last present from drift dive monitoring. P/O (XX) – denotes the highest probability of occurrence for Salmo trutta.		Based on Google Maps driving distance.	Based on Canning [3]	Based on Canning [3]	Based on Canning [3]	

5. IMPORTANT TROUT SPAWNING RIVERS

5.1 Criteria for defining important trout spawning waters

Trout spawn yearly in upland rivers and tributaries between May and September (Austral Winter). During the spawning season trout migrate upstream to find suitable spawning habitat. The females clear a patch of gravel that is typically between 50cm^2 and 150cm^2 (known as a redd – see figure 1) to create a nest where eggs are deposited [11]. Key habitat factors affecting spawning success include the gravel composition, siltation, temperature, flow depth and velocity, and macroinvertebrate composition.

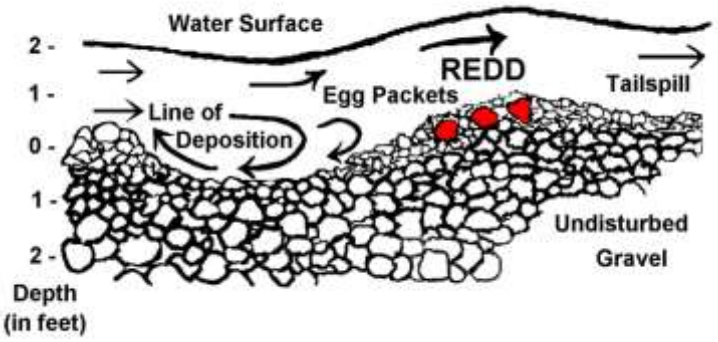


Figure 1. A schematic of a typical spawning redd showing the deposition of eggs. Sourced from: http://wdfw.wa.gov/conservation/habitat/spawningbed_protection/redr.html

5.2 Gravel composition is vital to successful spawning. Gravel must be small enough for female trout to move the particles. If the substrate is too large then females avoid the area for spawning [12]. At the same time, high levels of silt can also degrade spawning conditions by reducing the oxygen flow to developing ova. The suffocation is worsened by high organic matter being trapped within the interstitial spaces as the decomposition depletes large volumes of oxygen. Several studies have shown that *Salmo trutta* spawning successfully occurs in gravels with a geometric mean particle diameter between 15 and 35mm [11-17]. Fine sediment (<1mm) cover also needs to be less than 10% [18].

5.3 The productivity of a trout population will suffer as water temperature approaches and exceeds 19°C. Laboratory studies looking at the impacts of high temperatures on trout, have found that brown trout ceased feeding once temperatures climbed above 19°C and that they would die if temperatures climbed above 25°C for a sustained period [19]. Temperature can also strongly influence spawning success. Low temperatures (below approximately 6˚C) slow egg growth dramatically and may take twice as long to develop, thus increasing their chance of being fatally disturbed [See figure 3, 20]. Maximal egg survival and development has been found to occur between 8-10˚C, with no embryos hatching above 16˚C. An upper limit of 12˚C is recommended for the success of healthy spawning [21, 22]. Ojanguren and Brana [22] showed that embryo size at hatching decreased with increasing temperature. Whilst temperature allows embryos to mature faster, this could result in lower yolk conversion efficiency and consequently smaller body size at hatch [23]. Individuals incubated at low temperatures were larger because they benefited from greater yolk resorption and would consequently be larger at the onset of exogenous feeding [22]. Larger body size is key for survival and competitive ability; therefore, embryos that developed at lower temperatures would have considerable competitive advantage [24-27]. Furthermore, high temperatures not only reduce waters capacity to hold oxygen but also increase the growth and oxygen demand of other taxa which can, in turn, cause the eggs to suffer from hypoxia. High temperatures also increase the rate at which toxins are assimilated and may reach fatal thresholds faster.

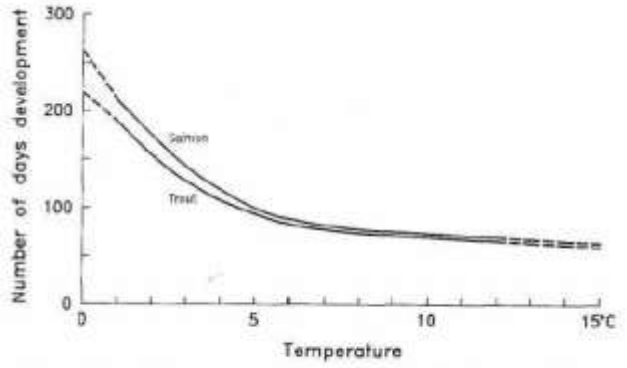


FIG. 2. The number of days required to attain median hatch for trout (*Salmo trutta*) and Atlantic salmon (*Salmo salar*) at different temperatures. The solid lines cover the range of observed values and the broken lines are extrapolations.

Figure 2. The influence of water temperature on salmonid ova development. Sourced from: Crisp, D. T. (1993). The environmental requirements of salmon and trout in fresh water. Paper presented at the Freshwater Forum.

5.4 Flow regimes can also impact spawning success. Several studies have shown that *Salmo trutta* tend to select sites for spawning that have a relatively slow flow, between 20-55cm s^{-1}, and a depth between 15-45cm [13, 14, 17].

5.5 Dissolved Oxygen is also important for trout fishery and spawning reaches.

a) If DO drops too low then fish can become stressed or asphyxiated. According to the US EPA, adult salmonids begin to suffer slight production impairment at 6mg/L, with no impairment at concentrations greater than 8mg/L. For spawning and juveniles, concentrations are more stringent because ova require high DO concentrations in gravels. For spawning reaches, the US EPA indicates that a water column DO concentration of 11mg/L is required for an intra-gravel concentration of 8mg/L when no impairment is permitted. Slight impairment occurs when water column DO is 9mg/L (intra-gravel is 6mg/L).

b) If DO saturation gets too high (supersaturated) then fish can suffer from Gas Bubble Disease. This is a condition similar to decompression illness that SCUBA divers get, wherey air embolisms occur in tissue and vessels (Figure 4) [28-31]. When oxygen saturation is high, fish will try swim deeper as the added water pressure compresses air bubbles (Boyles Law), however if water levels are also low and pools are missing then fish can suffer blistering (Figure 3) and struggle maintaining bouyancy [32]. Furthermore, Mesa and Warren [33] found that when juvenile salmonids were exposed to greater than 130% saturation for 3.5h that their predator avoidance ability was significantly reduced and showed extensive gas embolism blocks of the lateral line and gill filaments. Depending on where embolisms have occurred, they can take between 2 hours and 4 days to dissipate [34].

Figure 3. A Rainbow Trout with gas embolism blisters.

5.6 Other factors such as macroinvertebrate composition and nutrient concentrations may also impact on spawning success. Trout preferentially feed on ephemoptera, plecoptera and tricoptera macroinvertebrate taxa as these are typically large so provide greatest energy with less effort. However, these taxa are also sensitive to environmental conditions such as oxygen concentration, nutrient concentration and sedimentation. Given the energetic demands of spawning, dietary energy supply may affect the success or occurrence of spawning [20, 35-39]. Table 3 summarises the characteristics of a healthy spawning reach.

5.7 One of the most effective ways to protect important spawning habitat is by having vegetated riparian buffers. Riparian buffers can reduce bank erosion which can, in turn, prevent the sedimentation of suitable spawning gravels. Buffers can also preserve the natural geomorphology of the stream, thereby maintaining meanders (preserves reach length) and maintaining channel depth. Riparian vegetation provides habitat for adult flies and leaf-litter detritus for fly larvae (shredders) to consume, thereby providing strong energetic support for spawning trout. Buffer shading can also reduce periphyton growth, thus reducing the chances of hypoxic conditions arising and starving egss of oxygen.

Table 3. The habitat characteristics of a trout spawning reach.	
Characteristic	**Measure**
Gravels	The geometric mean particle diameter is between 15-35mm. Fine sediment (<1mm diameter) cover is less than 10% cover.
Temperature	Temperature is below 12˚C during Winter (May-September inclusive) and below 19˚C during Summer (October-April inclusive).
Oxygen	Oxygen saturation between 80-110% and dissolved oxygen concentration greater than 8mg/L.
Flow	Flow velocity between 20-55cm/s and depth between 15-45cm.
Passage	The reach is accessible between May and September (inclusive) by adult trout. This includes being free of barriers, low flows and poor ecosystem health that can prevent adult trout movement.

5.8 I consider a river/stream to be important for trout spawning if it is in the catchment of an important trout fishery river and:

- has either had a confirmed spawning assessment or
- been identified as having suitable spawning habitat (has sites that meet all characteristics in Table 3, or have met them in the past but have since been degraded) since the year 2000.

5.2 Assessment of Schedule I rivers against criteria for important trout spawning waters

I have assessed the trout spawning rivers/streams in the Schedule I against these criteria and concluded whether the stream should be deemed important in Table 4.

Table 4. Evaluation of Important Trout Spawning Waters identified in PNRP Schedule against Table 2 criteria.

Note – This only includes spawning and habitat surveys since 2000. Where surveys have not been conducted since 2000 then denoted by "?".

River/Stream	In important fishery catchment	Suitable habitat - formally recorded	Confirmed spawning	Deemed important?
Abbotts Creek	Yes	Yes [40]	?	Yes
Pakuratahi River	Yes	?	Yes [41]	Yes

Farm creek	Yes	Yes [40]	Yes [40]	Yes
Rimutaka Stream	Yes	Yes[40]	Yes[42]	Yes
Akatarawa River	Yes	?	Yes[41]	Yes
Akatarawa West River	Yes	?	Yes[42]	Yes
Deadwood Stream	Yes	Yes [40]	No	Yes
Frances Stream	Yes	?	Yes [43]	Yes
Birchville Stream	Yes	?	Yes[44]	Yes
Collins Stream	Yes	Yes [40]	?	Yes
Cooleys Stream	Yes	Yes [40]	?	Yes
Narrow Neck Stream	Yes	?	Yes [43]	Yes
Whakatikei River	Yes	?	Yes [41]	Yes
Wainui Stream	Yes	?	Yes [45]	Yes
Flighty's Stream	Yes	No [45]	No [40]	No
Plateau Stream	Yes	Yes [40]	?	Yes
Moonshine Stream	Yes	?	Yes [45]	Yes
Otaki River	Yes	?	Yes [41]	Yes
Waiotauru River	Yes	?	Yes [45]	Yes
Pukeatua Stream	Yes	?	Yes [45]	Yes
Pukehinau Stream	Yes	No [45]	No [45]	No
Waitatapia Stream	Yes	?	Yes [45]	Yes
Ruamahanga River	Yes	?	Yes [42]	Yes
Kopuaranga River	Yes	?	Yes [46]	Yes
Waipoua River	Yes	Yes [40]	?	Yes
Mikimiki Stream	Yes	?	Yes [46]	Yes
Te Mara Stream	Yes	?	Yes [46]	Yes
Kiriwhakapapa Stream	Yes	?	Yes [46]	Yes
Wakamoekau Creek	Yes	?	Yes [46]	Yes
Waingawa River	Yes	Yes [40]	?	Yes
Blakes Stream	Yes	?	Yes [43]	Yes
Atiwhakatu Stream	Yes	Yes [40]	Yes [46]	Yes
Tauweru River	Yes	No [47]	No [46, 47]	No
Kourarau Stream/Tupurupuru Stream	Yes	Yes [42]	Yes [42]	Yes
Waiohine River	Yes	Yes [40]	Yes [42]	Yes

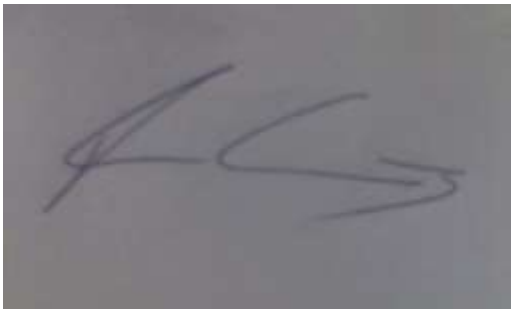
Mangatarere Stream	Yes	?	Yes [42]	Yes
Enaki Stream	Yes	?	Yes [41]	Yes
Kaipatangata Stream	Yes	?	Yes [41]	Yes
Beef Creek	Yes	?	Yes [47]	Yes
Papawai Stream	Yes	?	Yes [47]	Yes
Huangarua River	Yes	Yes	Yes [46]	Yes
Whangaehu Stream	Yes	No [47]	No [47]	No
Ruakokoputuna River	Yes	?	Yes [47]	Yes
Waikanae River	Yes	?	Yes [41]	Yes
Maungakotukutuku Stream	Yes	Yes [40]	?	Yes
Wainuiomata Stream	Yes	?	Yes [41]	Yes
Catchpool Stream	Yes	?	Yes [46]	Yes

As a result of this assessment I consider that Flighty's Stream, Pukehinau Stream, Tauweru River, and Whangaehu Stream do not meet the criteria for an Important Trout Spawning Water and should therefore be removed from Schedule I "Important Trout Spawning Waters".

Adam Douglas Canning

Freshwater Ecologist

28th of February 2018



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