Survey of the Distribution and Abundance of Whio/Blue Ducks in Kahurangi National Park – Interim Report

Photo: Whio pair in the upper Spey River, Aorere Catchment, Tasman Wilderness Area

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Abstract

Starting in July 2020 and ongoing at the time of writing, whio/blue duck (*Hymenolaimus malacorhynchos*) distribution and abundance is being assessed in Kahurangi National Park. This is a repeat of the first national park-wide whio survey conducted in 1998-2000. The aim of this survey is to provide a snapshot of the current whio population across the national park, quantify population changes since the original surveys and relate these to history of predator control and whio management. This report covers the period from July 2020 to April 2023 and summarises methods used, problems with comparing this survey with the original ones, briefly explores the possibility that geology in the national park influences whio abundance and presents the results to date. At the time of writing, 712 kilometres of river have been surveyed, with 377 pairs and 176 single adults counted, giving a total of 930 adult whio. Overall results indicate that rivers that have traps + 1080 have more whio than those which only have 1080 treatment. Repeat surveys on some rivers have revealed a possible decline in the number of pairs, raising a concern that there may have been a die off of whio in some sites since July 2020. This is being investigated further. The potential for climate change induced reduction in whio recruitment is also explored briefly.

1. Introduction

This report covers interim results of the Survey of Distribution and Abundance of Whio/Blue Ducks in Kahurangi National Park. The survey commenced in July 2020 and is ongoing, with field work due for completion by 30 June 2023. It was initially hoped to complete the survey in one or two years, but a number of factors have combined to prolong the field work component of the project.

Whio/blue duck (*Hymenolaimus malacorhynchos*) are an iconic *taonga* species unique to Aotearoa New Zealand. They have patchy distribution over both islands, mostly in headwaters of mountain valleys and are classified as Nationally Vulnerable. Introduced mammalian predators have repeatedly been implicated in the decline or extinction of many NZ endemic bird species and whio population decline has been well studied, with stoats shown to be the major agent of their decline (Whitehead et al. 2007; 2008; Glaser et al. 2010).

A recent study (Steffens et al 2022) showed long term population persistence of whio in a South Island beech dominated site which had *integrated pest control* (valley floor stoat trapping along waterways *and* pulsed aerial 1080).

There is very whio little population data from *un-trapped* sites which only receive pulsed 1080. Within Kahurangi National Park (KNP) there are two whio security sites which are trapped, receive pulsed 1080 and have had intensive management of nesting birds (whiONE and Breed for Release), and several other regions that have traps + 1080 (e.g. Gouland Downs, Takaka/Cobb/Flora catchments). However, a large proportion of KNP (approx. 70%), and much of South Westland and Fiordland (known whio areas) have only pulsed aerial 1080 but no traps. It is important to know if the current National Predator Control Programme (NPCP) 1080 regime in non-trapped areas is benefitting whio.

Whio distribution and abundance was first assessed in KNP with surveys in 1998/99 and 1999/2000. Whio were found to be widespread but in low numbers with just 58 pairs (191 adults total) counted through the park. At the time of these surveys there was no whio management or large-scale predator control occurring in Kahurangi. A repeat survey of the northern part of the park in 2009/10 revealed little change in whio numbers or distribution.

Aerial 1080 operations for possums began in some of the "front country" parts of the national park as early as 2009, and Tiakina Ngā Manu (TNM) 1080 operations over most of the park commenced in 2014. Two whio security sites- Wangapeka-Fyfe and Oparara-Ugly were established in 2009. Two community lead trapping groups- Friends of Flora and Friends of Cobb were established in 2001 and 2006 respectively.

1.1 This Survey

A repeat survey of whio distribution and abundance in KNP was started by the Threats Nelson team in 2020/21 and this interim report covers survey findings to the present. The original aim was to complete the survey in one or two seasons, but a number of factors have delayed completion; in particular covid 19 (lockdowns and personal illness), very wet winters (making rivers too high to survey for long periods), lack of people to help with surveying (due to their own project commitments) and a very small budget (meaning extra help could not be afforded). The field work component of this survey is approximately 70-80% completed and due for completion by 30 June 2023. Following this, a full report and possibly a journal paper will be produced.

1.2 Survey Aims

1. Assess current whio population distribution and abundance in Kahurangi National Park.
2. Quantify population change over the past 25 years.
3. Look for patterns in spatial distribution in response to whio management, landscape scale aerial 1080, and stoat trapping efforts.
4. Document habitat quality and compare with whio density in every waterway surveyed, feeding into spatial distribution analysis.
5. Provide an accurate and repeatable survey method for long term whio population monitoring by selecting a sample of representative rivers which could be surveyed every 5 years.

2. Methods

2.1 Survey Area

At 517,333ha Kahurangi is New Zealand's second largest national park. The park encompasses much of the Northwest corner of the South Island. There are many sizeable rivers draining the park and surveying the approximately >1000km of waterway suitable for whio is a mammoth task. Kahurangi National Park is the most geologically complex and floristically diverse region of NZ. Dissected by many faults and thrusts it is an area shaped by uplift, glaciation and earthquakes. Rivers in the region have been shaped by these processes and their underlying geology. Boulder gardens and jumbles with car to house sized boulders and gorges are common. Many of the bigger rivers have gentle to moderate gradient mid sections leading through steep upper sections into hanging valley heads. Tributary valleys of main rivers tend to be steeper gradient. The varying geology possibly influences whio abundance across the park because rivers flowing through different types of bedrock carry differing levels of dissolved minerals and nutrients (total dissolved solids) which influences the abundance and diversity of macroinvertebrate communities within them. It is likely that food availability is one limiting factor influencing whio abundance.

2.2 Timing of Survey

Whio feed on aquatic insect larvae which they scrape from rocks and boulders instream. Although they can be seen feeding at any time of day, they are predominantly crepuscular feeders, meaning the likelihood of seeing birds feeding on the river is much higher during the dusk light of early morning and late evening. In between feeding sessions they may spend long periods resting- either visible on riverside boulders and gravel banks, on mid-stream boulders or not visible under boulders/log jams/undercut banks, or up on the riverbank (including in the bush).

Whio can be incredibly secretive and elusive at any time of year but there are some periods when they are especially unlikely to be seen on the river: during breeding season (September-December) when females may be incubating, moult (from early December (non-breeding birds) to early March) when birds may disappear under banks or up side creeks; and during summer most birds will not be seen through much of the day as they shelter from the heat under shady banks/boulders etc. During the winter months (June-August) most birds can generally be seen out on the river right through the day, meaning surveys can run all day. It should be noted that these are general rules- even at the most optimum times for seeing whio it is likely that some birds will be missed. These behavioural traits influence how we conduct our surveys at different times of the year.

2.3 Optimising Timing of Surveys and "Whio Sighting Correction Factor"

Prior to the commencement of this survey our team did four years intensive nest and adult survival monitoring on two colour banded whio populations (Wangapeka and Waingaro Rivers) in Kahurangi National Park. Both rivers were walked fortnightly between August and February to assess breeding status/success of pairs and randomly at other times of years to assess adult survival.

We consequently developed a large data set of home ranges and movements of these birds through much of the year. Because we recorded when we saw or *didn't see* known birds in each home range and the date + time of day for each observation on every day of searching, we have been able to calculate the proportion of known birds on the study rivers that were *actually* seen on any day that we surveyed. This has enabled refinement of survey methodology for this study, including the most optimum times of day and year for potentially seeing the greatest number of birds on the river. The data will also be used to attempt calculating a "sighting correction factor" which will be applied to the results from any given day to give the "true" number of pairs on that survey.
Based on the four years of sighting data we have split the year into two periods when slightly different methods are applied:

Summer (September, December-May)

This is when the birds tend to be particularly crepuscular, so surveys are only conducted around dawn and dusk periods. Morning surveys begin from when it is light enough to see a bird and finish at the latest 3 hours after sunrise. Evening surveys begin no sooner than 3 hours before sunset and finish when it becomes too dark to see a bird. In mid-summer it is preferable to begin evening surveys as near to sunset as practicable because 3hrs before sunset is generally still hot and bright.

Winter (June-August)

In the winter whio are generally on the river all day so surveying can continue right through the day. Very early starts and late finishes are not as crucial during this period.

2.4 Survey Method

For a large-scale survey such as this, the walkthrough survey method is by far the most feasible and efficient. Walkthrough surveying is simply walking along the river and noting sign or birds as they are encountered. Although dog surveys are commonly said to be the most accurate/thorough, there are very few certified whio dogs and handlers nationwide and having ready access to either would have been impossible for the duration of this project. Other negative factors for dog use include the possibility of 1080 baits being on the ground and the long distances to cover, sometimes over multiple days, being too tough for a dog.

In this survey we applied a rule that all surveys had to be run *upstream* for several reasons: whio will commonly slip away downstream unnoticed when disturbed by someone walking downstream, when feeding they are moving (therefore facing) upstream so more likely to see a surveyor coming down towards them, they are generally easier to see when the surveyor is looking up the river (due to elevation and angles), it is also logistically easier doing multi day surveys heading towards the top of a valley which is often the point at which travel becomes very difficult or impossible, it is safer walking upstream into difficult terrain where there is always the option of escaping back down stream.

At the start of each survey the following are recorded: start time, start point, general weather conditions, air and water temperature. The GPS is kept in tracking mode. When whio sign (faeces/feathers) is seen it is marked as a waypoint. When whio are encountered they are marked as waypoints, noting how many birds there are, relationship status, sex, age. Two adults together are marked as a pair unless proven otherwise (e.g. they are both male which has happened very occasionally), 3 adults marked as a pair + 1, single birds marked as male, female or single (when sex unknown) etc. Data is downloaded from the GPS at the end of each trip and subsequently mapped in ArcGIS. Track and bird data is used to calculate length of river surveyed, river gradient, density of pairs/individuals on each waterway. Mapping sign is an important component of surveying as it determines whio presence even when no birds are seen. In the original surveys, sign and birds were also mapped and this will enable us to make comparisons with them.

Rivers on the Western side of KNP are surveyed annually by Buller district DOC staff and they have their own methodology, using a mix of *up* and *downstream* walkthrough and dog surveys. Doc staff from Golden Bay office also conduct annual surveys on the rivers draining the Gouland Downs and they use a mix of up and downstream walkthrough surveying. We are using the data gathered from both areas in the overall results but may not use it in the spatial analysis we do on whio distribution at the completion of the project.

2.5 Survey Pauses

Surveying for official results is paused through the height of the breeding season, between mid-September to early-mid December, and again from around early to mid-January into February for moult. Using the data shown in *Table 1* and conducting duckling/moult surveys each December in the Wangapeka and Waingaro rivers has been instrumental in deciding when to begin surveying again after the nesting pause. Whio that either failed early season or did not breed will begin moult in late November and will have completed moult by January. If for example a high proportion of birds seen in the December survey are moulting (moulting birds have obvious missing feathers and feathers are commonly seen in the riverbed) or don't have ducklings, we can begin surveying early February with high confidence that we won't be missing birds that are hiding away in moult.

Conversely if a significant proportion of birds are seen with ducklings in December, we know that the main moult won't occur until January/February. In this case, surveying wouldn't resume until late February.

2.6 Habitat Assessment

In this survey the quality of habitat for whio is assessed in every waterway (including side streams) surveyed. Collier et al (1993) identified 4 criteria as the most important predictors of whio presence in a river:

Channel gradient >10m/km
Moderate to good stability
Substrate in riffles >13cm across with high proportion of boulders >26cm across
Predominantly native forest on both banks

Using a combination of parts of the Pfankuch method for measuring river stability as described by Collier (1992) and the Freshwater Stream Habitat Assessment Field Sheet developed by Harding et al (2009) we produced a shorter version habitat assessment that only takes a few minutes to complete. Our assessment has two sections- the first section includes estimates relating to stream characteristics such as width/depth, proportion of river that is pool, rapid, run etc; and substrate characteristics – proportion of river that is bed rock, boulders, cobbles etc. The second section scores riverbank and bottom characteristics which relate to the river's stability. Lower scores equal more stable, better habitat. River gradient will be measured using ArcGIS. Data from these habitat assessments will be used in spatial modelling of the Kahurangi whio population at the conclusion of the survey.

Habitat Assessments are conducted at or near the start of each survey and whenever there is a significant change in the character of the waterway.

2.7 Repeat Surveys

Due to the long period of time that has elapsed since beginning the survey of the national park, a few rivers have been chosen for repeat surveys, aiming to quantify what, if any change has occurred in whio abundance during the period. If any decline in numbers is detected, the rivers need to be visited on multiple occasions to be sure that the decline is real and not just an artefact of the fickle, secretive nature of whio.

2.8 Comparison Surveys

The original 1998-2000 surveys were conducted through summer months only (Table 1). Some of these surveys were conducted when there was still a possibility of a significant proportion of females incubating (see Table 2) and others when a large proportion of birds may have been moulting. Some surveys were also conducted at sub-optimal times of day (i.e. too far out from the dawn/dusk optimums for seeing birds). Therefore, the accuracy of some of the original surveys is a little questionable. We have surveyed rivers through a much larger portion of the year than the original surveys and endeavoured to survey at the most optimal times of day. This means that in many cases it is difficult to make direct comparisons between ours and the original results. To compensate for this, a selection of rivers through the eastern side of KNP were chosen for comparison surveys in addition to the official survey. On each sample river, the exact same reach was surveyed near or on

the same date, in the same direction (i.e. up or downstream) and at the same time of day for a direct comparison in results.

1998 / 1999	1999 / 2000	2020	2021	2022	2023
1 Dec - 6 Feb	15 Nov - 28 Jan	9 Jul - 10 Sept 20/21 Dec	16 Feb - 27 May 16 Sept	15 Feb - 11 May 15 Aug - 8 Sept	10/11 Jan 8 Feb – 8 Mar

Table 1: Periods in the year that surveying was conducted, comparing the original surveys with this one.

3. Results

In the final report which will be produced after the completion of this survey (i.e. after 30 June 2023) the results will be covered in more depth, including looking at individual rivers and their geology, history of predator control etc. Here I have summarised the raw results to date, with no deeper analysis.

3.1 Seasonal Timing of Survey

The graph in *Fig 1* clearly shows that winter is the best time to survey for whio, with a large proportion of birds likely to be visible on the river through the day, whereas in summer only early morning and late evening are reliable times. There are exceptions to these rules at any time of year. We have several records from our nesting study of known birds that were not seen for more than one year despite multiple searches through their territories. This just highlights how secretive whio can be.

Winter is the preferred time to survey and with the appropriate clothing and equipment is very feasible. The key to staying warm whilst winter surveying is to keep dry and there is equipment/clothing which enables this. There are two main issues in winter which can affect the ability to survey- there are often sustained wet periods which cause rivers to run elevated and unworkable for long periods and cold shaded valley floors often result in frost and ice buildup on boulders which can make travel more treacherous. We have tried to do as much winter surveying as possible, but the winters of 2021 and 2022 were consistently wet with elevated river flows making surveying impossible much of the time.

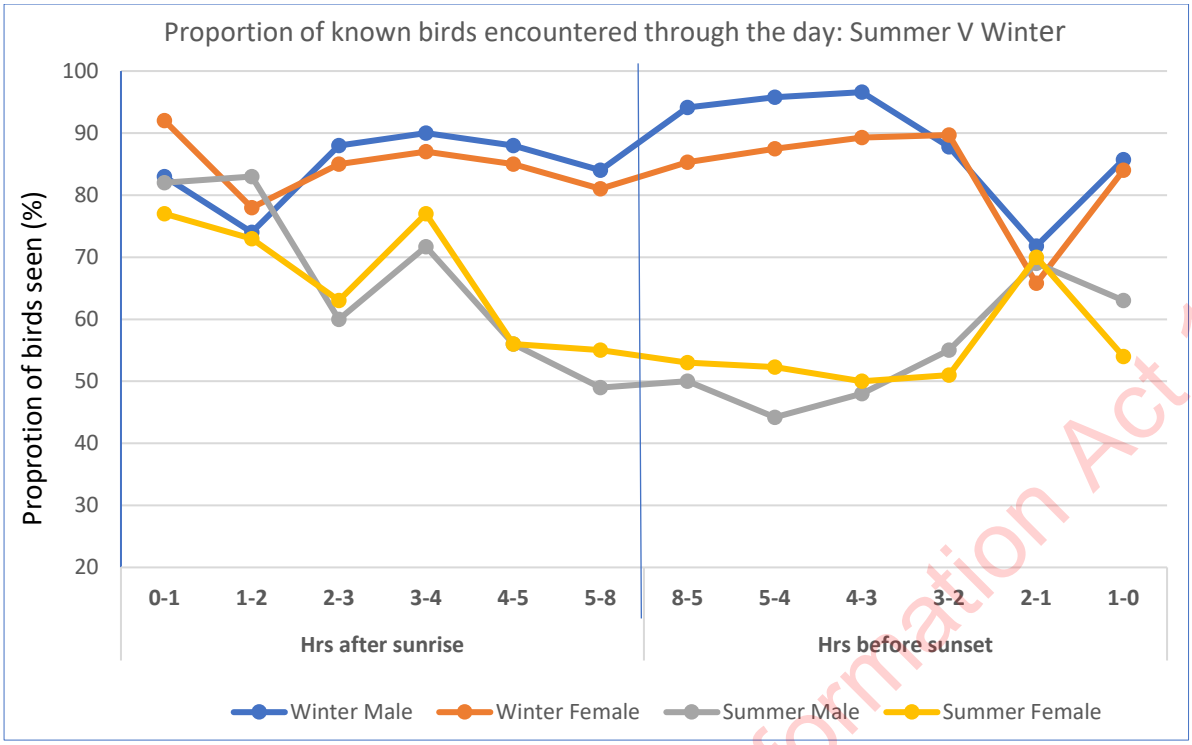

Figure 1: Proportion of known birds seen during 4 years of nesting study, at different stages of the day in winter (June-August) and summer (December-May), showing the large dip in birds observable through much of the day in summer. This was used in deciding what times of year to use summer or winter survey methodology. The cause of the pronounced blips 3-4 hrs after sunrise and 2-1 hrs before sunset is not known. Sighting data between late September and mid-December was not used in this graph because that is when females were most likely incubating, and we haven't surveyed during this period.

Actual/Projected Hatch Dates	**2011**	**2012**	**2013**	**2015**	**2016**	**2017**	**2018**	**2019**
Earliest	31 Oct	27 Nov	6 Nov	30 Oct	13 Oct	23 Oct	29 Sept	23 Sept
Median	23 Nov	14 Dec	9 Nov	28 Nov	20 Nov	23 Nov	11 Nov	25 Oct
Latest	20 Dec	6 Jan	12 Dec	18 Dec	27 Dec	16 Dec	30 Dec	15 Dec
% of nests hatched in **December** (n=total no. nests for season)	28 (7)	71 (7)	40 (5)	40 (5)	25 (4)	20 (5)	21 (19)	19 (26)

Table 2: Nesting data compiled from nest survival studies in the Wangapeka and Waingaro rivers, showing estimated earliest, median and latest hatch dates each season. Projected hatch date = the estimated date that nests which failed in incubation *would have* hatched, based on known incubation period for whio (~35 days). Combined with December duckling/moult surveys, this table helps inform when to start surveying again after the breeding season.

3.2 Daily Timing

Figure 1 indicates that early morning is the best time for seeing birds. In the height of summer, 3 hours before sunset is often very bright and hot. When possible, summer evening surveying should begin nearer sunset than 3 hours. Comparing results of the original surveys and the time of day that some were conducted, with this one highlights the importance of timing surveying to the most optimal part of the day.

3.3 Overall Survey Results

At the time of writing, a total of **712 km** of waterway through Kahurangi National Park has been surveyed with **377 pairs** and **176 single adults** counted, bringing the total number of adult whio counted to **930** birds. In the original 1998-2000 survey **58** pairs and **75** single adults were counted giving a total of **191** birds. Figure 1 shows all pairs counted and rivers surveyed to date.

Comparing whio pair density on rivers which have integrated pest control with rivers which only have aerial 1080 shows a higher density of pairs on the integrated control rivers.

Regime	Length of waterway surveyed (% of total)	Number of pairs (% of total)	Pairs/km	Km/pair
1080 + Traps	270 km (38%)	204 (54%)	0.76	1.32
1080 Only	442 km (62%)	176 (46%)	0.40	2.55

Table 3: All survey data combined indicates that valleys with *integrated pest control* are better than those that only receive *1080*. It is important to note that some rivers regardless of their predator control regime appear to be significantly better for whio than others, e.g. in un-trapped valleys there were three catchments (26% of un-trapped waterway surveyed) which accounted for 57% of all pair sightings in *un-trapped* sites.

Photo: Flanagan Creek (Aorere catchment) showing ideal whio habitat- a boulder studded run

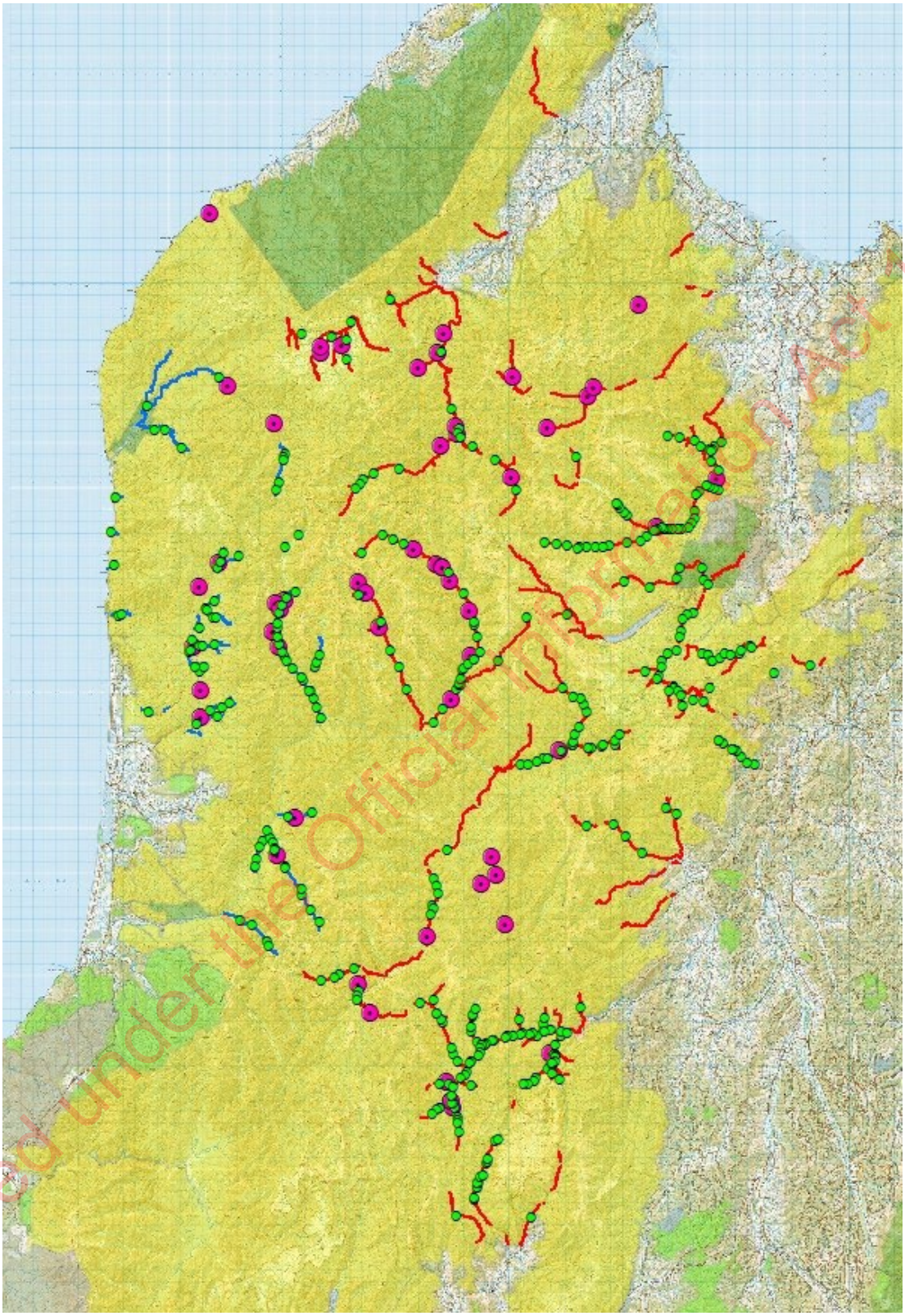

Figure 2: Rivers surveyed (red and blue lines) in Kahurangi National Park at the time of writing (April 2023). Blue lines are surveys conducted by Buller Area DOC staff. Large crimson dots mark whio pairs counted in 1998-2000 survey, smaller green dots mark whio pairs counted in this survey. Some rivers surveyed in 1998-2000 have not yet been done by us. In the final report, the reaches surveyed in 1998-2000 will be mapped.

3.4 Comparison Surveys

Comparison surveys indicated some significant changes in pair abundance in some rivers- notably the Waingaro, but very little change in others.

River	Date	Pairs	Date	Pairs
Leslie	01/12/1998	1	01/12/2020	5
Rolling	08/12/1998	1	04/12/2020	0*
Chummie Creek	08/12/1998	0	04/12/2020	1
Peel Stream	11/01/1999	0	12/01/2023	5
Aorere	15/11/1999	1	13/11/2020	0
Flanagan Creek	16/11/1999	1	13/11/2020	2
Waingaro	29/11/1999	1	18/12/2020	19
Stanley	30/11/1999	0	18/12/2020	2
Wangapeka	23/01/1999	0	24/01/2023	2

Table 2: Comparison surveys conducted on a selection of rivers. * Midday survey of the Rolling River revealed no birds. A repeat survey conducted a couple days later in the evening revealed ***5 pairs*** on the river.

Photo: Leslie River showing another example of premium whio habitat with a long boulder studded run providing stability and ample habitat for nymphs.

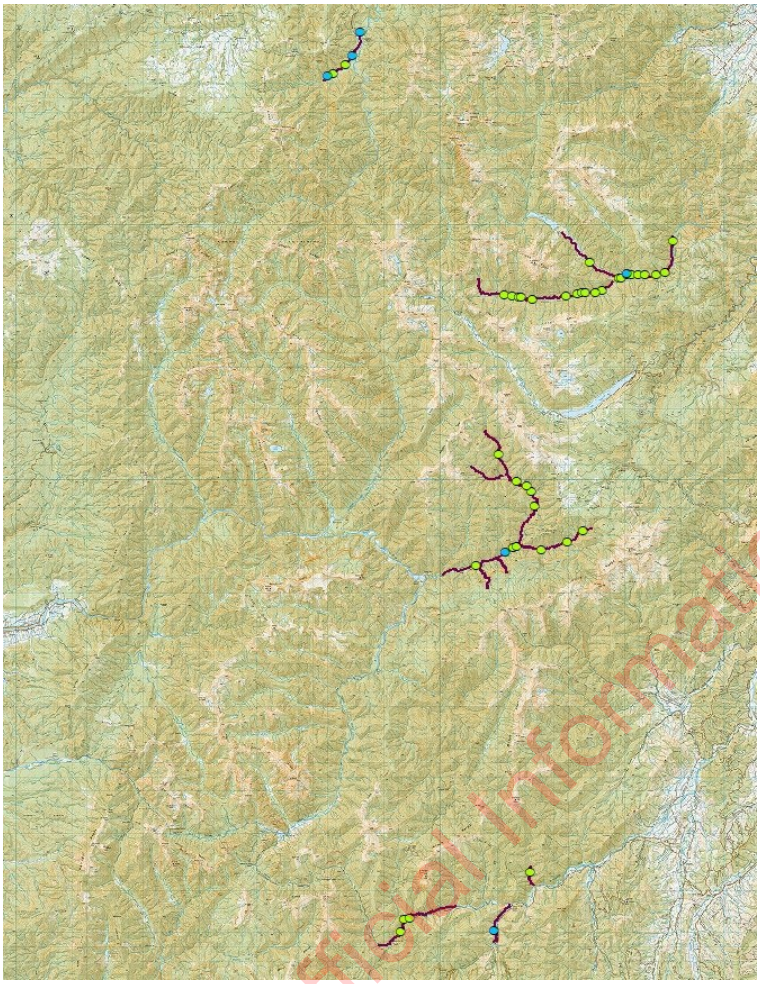

Figure 3: Map shows the reaches and rivers selected for comparison surveys. Blue dots are pairs seen in the original 1998-2000 survey and green dots are pairs seen in this survey.

3.5 Repeat Surveys and Possible Die-Off

Repeat surveys have been conducted on the South Branch Wangapeka river and tributaries, a section of mainstem Wangapeka river, Kiwi Stream, Rolling river, Nuggety and Blue Creeks, Waingaro river, upper Anatoki river and Grecian stream.

There was no major change in numbers of pairs encountered in the South branch Wangapeka, Kiwi Stream, Nuggety and Blue Creeks and the Grecian stream. In May 2022 in the Anatoki river, only 3 males and a single (sex unknown) were seen in the whole valley. A repeat survey was done in the upper valley in February 2023 to confirm whether there were any females or pairs in the valley. The upper section of the valley is the best whio habitat in the whole valley and was where three pairs were seen in 1999. Six males and no females were seen in the February survey.

In the mainstem Wangapeka, Rolling (first surveyed July 2020) and a section of the upper Waingaro rivers (first surveyed Feb 2022) the number of pairs encountered has apparently declined. The Rolling and a section of mainstem Wangapeka rivers have seen a massive apparent decline- from 6 to 1 pair (83%) and 9 to 2 pairs (78%) respectively. The Waingaro has apparently decreased from 7 pairs to 3 (57%).

It is important to note that these are *apparent* declines at this stage- the secretive, fickle nature of whio means that some pairs may still be alive but have not been encountered yet. All three of these

rivers have been repeat surveyed three times so far. I am more confident that the Rolling and mainstem Wangapeka results are real than the Waingaro at this stage. These rivers will be surveyed again at least once before June and again in June or July (when the highest proportion of birds are normally encountered) before the final call is made on whio die off. The overall results in this report do not allow for possible die off.

Repeat surveys will be conducted on a few other rivers including the Leslie, Pearse and hopefully Karamea and Roaring Lion.

4. Discussion

4.1 Survey Timing

In an ideal world the whole Kahurangi whio survey would have been conducted at the most optimal time of year for seeing whio- which is between June and end of August. However due to the problems of elevated river flows brought by winter rains and a lack of resources this has not been possible. It is hoped that the sighting correction factor analysis will enable a reasonable comparison to be made regardless of time of year. It may also be possible to apply the correction factor to the original survey data because we can access the necessary information required to make the calculation (date, reach surveyed, time of day, location of sighting, sunrise/set times).

4.2 Overall Results

Despite issues with making comparisons against the original surveys (time of year and day), I think it is fair to say that whio have increased significantly in many parts of Kahurangi National Park. This is supported in part by data from the comparison surveys.

As expected, the rivers within the whio security sites have abundant birds. Whio numbers in these sites were boosted with the release of juveniles from whiONE and Breed for Release. The raw results show that rivers with integrated pest control have around twice the density of pairs than the 1080 only rivers. This is supported by the findings of the research by Steffens et al (2022) which showed long term persistence of whio in the Wangapeka-Fyfe Security Site (which has integrated pest control). The upper Takaka River, Grecian Stream and Flora Stream catchment also have a good number of whio, and they too have a history of whio releases and integrated pest control.

Of the non-trapped rivers which we have surveyed, there are three in particular which have a high abundance of whio pairs. They are the Roaring Lion, Leslie and Waingaro. They all share similar characteristics - a gradient of between approximately 10 – 20m/km, numerous long boulder studded runs, relatively flat-bottomed U-shaped valleys, stable substrate and abundant food. They have the right combination of factors that make them the most optimal habitat for whio. The Roaring Lion had the highest density of pairs in rivers surveyed between 1998-2000.

It is interesting that in some rivers there has not been a big change in numbers since the original surveys and in a few the number of pairs encountered has dropped. To be fair, in those where there has been an apparent decline, the change has been minimal, going from one to zero pairs and it may not be significant. It's quite likely that some pairs on these rivers were not seen in the original or this survey. It's also possible that these rivers are not optimal for whio (due to geology) and may have already been at carrying capacity with just one or two pairs.

The poor results of the Anatoki survey seem more likely, however. In 1999 there were 3 pairs found, but surveys in May 2022 and February 2023 have only revealed 6 males. Both recent surveys were thorough and conducted at optimal times of day. It seems unlikely that all pairs (if there were any)

were off the river in the two recent surveys (i.e. at least one pair would have been seen). There is evidence of a possible whio die off in the lower Wangapeka and a section of the Waingaro and its possible it may have been a widespread occurrence through the national park.

4.3 Comparison Surveys

Conducting comparison surveys has been an important component of the Kahurangi survey because of the differences in timing between the original and current surveys. They have highlighted an important issue common to many of the original surveys relating to daily timing of surveying. For example, the raw data suggests that the Rolling River has declined since 1998 when one pair was found, whereas our comparison survey found no birds. However, it was surveyed through the *middle* of the day in summer and because most birds are likely to be off the river during that period, no conclusions can really be made. In fact, we knew from our official survey results that there were actually 6 pairs on the river and an evening survey a few days after the zero-result comparison revealed 5 pairs. It is also possible that there were more birds living in the Rolling in 1998 than the survey showed.

The lower section of Peel Stream was surveyed on 11 January in 1998 and 2023, between 16:00 and 19:00 hours. Sunset that day was around 21:00 hours, making it highly likely that most birds would have been off the river during the survey period. Unsurprisingly, there was sign, but no birds were seen in the lower Peel on either survey.

One section of the Wangapeka was started at 15:45 on 23 January, when sunset was at about 20:55. Again at this stage of the day very few birds are likely to be encountered. In the comparison survey on this section, 2 pairs with fully feathered ducklings were seen and this would have increased the likelihood of them being on the river (i.e. without ducklings they'd have more likely been off the river).

Three comparison surveys did show a major increase in the whio population. The number of pairs found in the Leslie River had increased 400%, Peel Stream 500% and in the Waingaro River *1800%.* In 1998 the main stem Leslie was surveyed right through the day in early December, and its possible birds were missed (in the original survey) because of this timing. It is certain that birds were missed during the Leslie comparison survey. We know this because of sign that was observed in the section where birds weren't. Also, in the official survey which took place in May 2022, following the summer survey methodology (early am and late pm surveying), more than twice as many pairs were found as our comparison survey.

4.4 Possible Whio Die-Off

The potential disappearance of a significant number of pairs on the Wangapeka, Rolling and possibly Waingaro rivers is concerning. It may not be confined to these rivers of course (see note about Anatoki in overall results section) and repeat surveys are required on as many rivers as possible to further our knowledge of this issue. The total count of whio in this report *does not* take potential die off into account.

There is evidence supporting the possibility that a die off could have occurred- in the early winter of 2017, 3 radio tagged adult female whio in the Wangapeka (2 in Rolling River and 1 in Kiwi Stream) were confirmed killed by stoats. This occurred after breeding season and moult which are said to be the most vulnerable times for whio and showed that they can be vulnerable to predation in winter. There are several examples of post rodent crash-prey switching to large prey by stoats: winter 2007 the Murchison Mountains takahe population was reduced by ~45% by a stoat plague following the

post 2006 beech mast rodent crash (Hegg et al 2012); during 2020-2021 there was a peak in stoat and feral cat predation of kea in eastern ecosystems (Nelson Lakes – Arthurs Pass) following a rodent population crash. This reduced adult survival from >90% to less than 60% (Kemp et al 2022). This came after the very big 2019 beech mast which was widespread and also occurred in Kahurangi. A rodent, stoat and possibly cat irruption was associated with the mast and prey switching likely occurred after the rodent population crash. Whio commonly roost under banks, boulders and in riverside forest and when asleep are very easy to approach closely. They would be easy prey for hungry cats, ferrets or stoats.

Given the presence of the riverside trap network along the Rolling and Wangapeka catchments, one could question a possible whio die off in this area. However, the lower Wangapeka and Rolling rivers are near the edge of the treatment block and adjacent to farmland/plantation forests. Ferrets and feral cats have been notable captures in traps near the edge of the block over the past couple of winters. The traps in use are DOC 200's and these are not optimal for ferrets or even suitable for cats. Feral cats seem to have infiltrated some of the remoter parts of the national park. In the past three years we have seen cat sign (faeces) in the South Branch Wangapeka, Granity Pass track and upper Waingaro valley. Friends of Flora community trapping group have seen them in the upper Grecian valley and on a trail camera at a kea nest in the Leslie valley.

The issue of possible die off and its consequences needs more investigation.

4.5 Geology and Influence on Whio Abundance

This will be explored in depth in the final report. But a brief mention is warranted here. It is known that water chemistry in rivers varies depending on the underlying geology (Olsen 2012, Shearer and Young 2011). In this survey there have been apparent anomalies in whio numbers between some adjacent rivers that were difficult to interpret. These are rivers that appeared similar, scored well in the habitat assessment and yet some had lots more pairs than their neighbours. A good example is the Beautiful and Roaring Lion (RL) rivers. The Beautiful is a major tributary of the Roaring Lion and enters the RL just above the Karamea confluence. Both rivers have a similar history of aerial 1080 treatment although they're in different treatment blocks. Keeping in mind that in both rivers its certain that birds were missed in this survey, the Roaring Lion had a pair density of 0.71/km compared to the Beautiful at 0.24/km. Granted also that the Beautiful is generally steeper gradient than the RL, and has some long sections of boulder jumbles consisting of very big (car to house size) boulders, both rivers are bouldery and stable and based on the habitat assessment and knowledge gained from looking at a lot of rivers, the Beautiful should have more pairs (5 pairs versus 21). A major difference between the two lies in their geology- the Beautiful/RL confluence sits on the boundary between the Karamea Suite granites (predominantly potassium feldspar-biotite granite) lying to the west (true right side) of the Beautiful, and the Buller Terrane (predominantly quartz muscovite sandstones, siltstones, shales) lying to the east of the TL Beautiful and including most of the Roaring Lion (the top of the Roaring Lion is in the Karamea Suite granite). Rivers flowing through granite-type geology are known to be lower in dissolved solids and have correspondingly lower invertebrate diversity and abundance than rivers in other geological types (Olsen 2012). Anecdotally, the Beautiful had much lower nymph abundance than the Roaring Lion (based on turning over lots of rocks whilst surveying). My feeling is that whio abundance on rivers such as the Beautiful may never be high as it is limited by a low invertebrate abundance.

4.6 Climate Change Impacts on Whio

This topic will be explored in more depth in the final report. In brief, the issue of weather induced mortality (from severe floods) on population viability of whio was investigated by Simpkins et al (2015). They suggested that an increase in severe flood events predicted by long term climate models would, in addition to the already known pressure of predation by introduced mammals, reduce the likelihood of long-term population persistence of whio in their central north island study site.

One of the findings of our four-year nest study was that lightweight female whio are much less likely to breed than heavier ones, and more frequent flooding in the six months prior to breeding season led to a decrease in breeding attempts. Most long-term climate predictions point towards wetter winters in northern South Island and an increase in frequency of severe weather/flood events.

Over the past 3 years of the Kahurangi whio survey there have been relatively few sightings of ducklings or juveniles (anecdotal), and the 2021 and 2022 winters were very wet. Based on the above findings, after the very wet 2022 winter it looked likely that there would be very little breeding, but in the south eastern corner of the national park 8 families of ducklings/juveniles were observed this season in the Wangapeka, and Motueka DOC and Friends of Flora observed 13 juveniles in the Pearse River and a family of 2 ducklings in the Flora Stream. Conversely in the December 2022 duckling /moult survey of the upper Waingaro, in more than 10km of river surveyed there was no sign of a duckling and many of the adults seen were in moult. During the August 2022 heavy rain event which badly impacted the Nelson region, there was a strong North – South gradient in the amount of rain that fell with northern and north facing slopes receiving the most rain. Over the four-day period, the Anatoki rain gauge (on the mountains Nth of Anatoki river) received 1000mm, compared with the gauge at the head of the Wangapeka River 58km to the south receiving 220mm. The relative lack of rain in this event over the south eastern portion of park may have enabled this higher productivity. Overall though it appears that whio recruitment in the national park has been generally low in the past few years and their productivity may be compromised if in future we tend have very wet winters. This needs further investigation.

4.7 Where to from Here?

As we head into winter, the problems of rain events causing elevated rivers effecting our ability to survey become more prevalent. There are a few sites still to be surveyed to complete our picture of the whio population across the national park.

Must do surveys: Crow River catchment (Karamea tributary), Slate River (Golden Bay).

Ideal to do: TL Karamea tributaries, North Branch Mokihinui. The Mokihinui valley is a recent addition to Kahurangi National Park and the North Branch and tributaries have never been surveyed for whio.

Repeat surveys to complete in Leslie, Grecian, Pearse, upper Waingaro, Wangapeka, Baton, and Rolling to explore potential die off. Would like to repeat the Beautiful and Roaring Lion surveys.

There is also a plan to survey two South Westland rivers- the Moeraki and Paringa rivers are beech dominated, non-glacial sourced and adjacent to each other. Both rivers are known to contain whio, but the Moeraki has a history of 20+ years regular aerial 1080 whereas the Paringa (next river to the north) has no treatment history. If regular aerial 1080 (without traps) is working for whio there will be significantly more pairs in the Moeraki river than the Paringa. The results from this survey would provide weight to the Kahurangi results.

Explore geology and whio distribution in more detail.

Writeup- a final report with more detail than this one. Possibly a science paper if we have enough useable data.

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