

# 2021 Whitebait season information capture

Andrew Watson and Dave West



Cover: Whitebaiters at the Tarawera River mouth during DOC Whakatāne Sept 2021 catch sub-sampling. *Photo: Dave West*

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# Executive summary

The Department of Conservation has been the regulatory authority of the Aotearoa New Zealand whitebait fishery since the 1990s. Very little data on the fishery exists, therefore critical knowledge and data gaps complicate the Department's ability to make well-informed fishery management decisions.

As part of the 2021 regulation review announcements, the Department was directed to gather further information about the current state of the whitebait fishery over two seasons (2021/2022). The focus was on what information could be gathered in a relatively short timeframe with existing staff. To gain a national picture of whitebait activity and compliance patrol effort, we asked Operations staff to record: (i) which rivers they went to, (ii) how many fishers they observed, and (iii) what fishing methods were being used. In addition to the field data, we trialled methods for remote data collection in four pilot regions around the country (West Coast, Marlborough, Waikato, and Bay of Plenty) for their potential use and broader application in 2022. Specifically, we trialled aerial flights to test the methods as well as capture the nature and extent of whitebait fishing. A district-led community engagement approach and species catch composition study was done in the Bay of Plenty. Lastly, the Marine Ecology Research Group at the University of Canterbury implemented a social survey of whitebaiters.

Upon completion of the 2021 whitebait season we received: (i) field data from districts in the South Island but none from North Island districts, (ii) remote data on selected whitebaiting rivers in the four pilot regions, (iii) bimonthly catch composition data on three eastern Bay of Plenty rivers, and (iv) a social survey report of Aotearoa New Zealand whitebaiters.

Our field results suggest that limited compliance was carried out during the course of the fishing season. However, it is important to note that 2021 was an unusual fishing season due to COVID-19-related travel restrictions and weather conditions that complicated both DOC's efforts to perform compliance patrols and fishers' ability to go whitebaiting. At least one compliance patrol was undertaken on 27 of the 75 rivers historically identified to be important for whitebaiting in the South Island; although overall the fisher numbers recorded were fewer than those reported in the 1980s, the popular rivers remained the same. Fishing methods and structures used varied by district and river. We were unable to distinguish whether whitebaiters fished for commercial or recreational purposes from the field data collected.

The remote imagery data was used to count fishers, distinguish between fishing methods, and to map whitebait stands or structures. Due to COVID-19 travel restrictions and use of a South Island-based aerial imagery company, flights for the North Island rivers were performed late in the season and do not reflect peak-fishing numbers.

Bimonthly sampling on three eastern Bay of Plenty rivers showed that the proportion of species in the whitebait catch changes through time. For the Tarawera and Whakatāne rivers, the whitebait catch was predominantly comprised of inanga (*Galaxias maculatus*) at the beginning of the season (September) and shifted to greater proportions of smelt (*Retropinna retropinna*) later in the season (October). The Waioeka River catchment has a greater proportion of forest cover and had greater proportions of banded kōkopu (*Galaxias fasciatus*). Results of eDNA analysis indicated that the less common species, giant kōkopu (*Galaxias argenteus*) and shortjaw kōkopu (*Galaxias postvectis*), were present in the whitebait catch in the eastern Bay of Plenty. Both species were detected in the Waioeka River and shortjaw kōkopu were detected in the Whakatāne River.

Most of the respondents to the social survey of whitebaiters placed considerable importance on social reasons, recreational reasons, and food gathering reasons for whitebaiting. Commercial reasons for whitebaiting were not at all important in most regions, but were extremely important for respondents that lived or fished on the South Island's West Coast. Most agreed

that the fishery would be improved by better enforcement of the current regulations and restoration of adult habitats, but disagreed that the introduction of a whitebaiting licence or closure of more rivers to fishing would have the same effect. Respondents had mixed views about the need for changing the current regulations or placing a limit on daily catch to improve the whitebait fishery.

In conclusion, field and remote data collection methods trialled in the 2021 whitebait season gathered important new information on whitebaiting. Compared to field data, remote data were more accurate spatially and for determining fishing method and, in general, recorded more fishers. Aerial images are a good method for quantifying fishers, can be done at large spatial scales, and are less labour intensive. However, collecting data remotely comes with the disadvantage of the Department not being seen by the public in the field, is weather dependent, and requires coordination with the pilot to capture the right tides and fishing days. Both methods show potential to capture national-scale information on whitebait fishing and whitebait fishers, however, we were unable to distinguish between recreational and commercial fishers with the field and remote data collection methods used. Other methods will also be required to understand the types of whitebaiters, their motivations, and the best mechanisms to address equity issues.

# 1. Introduction

## 1.1 Key information requested

The Department of Conservation (DOC) was directed in April 2021 to gather further evidence about the current state of the whitebait fishery, as part of the regulation review (Phase I) announcements. This directive included undertaking further engagement, monitoring, an inventory of whitebait rivers, scientific assessment, and economic analysis (Phase II). The new whitebait regulations announced before the start of the 2021 season can be found [here](#) and will be implemented over three fishing seasons (2021 to 2023). In addition to ensuring awareness of, and compliance with, the new regulations, DOC will be gathering data over the 2021 and 2022 seasons to inform the development of future management options in 2023.

The three-year work programme follows these phases:

- **Phase I (2021):** baseline information gathering and pilot sites. Some basic information will be gathered from across the country to begin building a national picture on whitebaiter numbers, gear, and locations. We will also be trialling more intensive data collection methods in four areas (Waikato, Bay of Plenty, Marlborough, and West Coast) to inform the next phase by testing methods of gathering key information on the nature and extent of whitebait fishing, the success and satisfaction of whitebaiters, and key issues for potential future whitebait management. These trials will include aerial observations (i.e., drones and/or light aircraft), subject to obtaining appropriate approvals.
- **Phase II (2022):** comprehensive information gathering. Findings from the first year will be used to scale-up engagements and the data gathering programme across the country, and other data gaps will be investigated (including estimated harvest, regional variations, and economic impact).
- **Phase III (2023):** analysis and option development. Review of all findings and development of options to ensure sustainable management of the fishery into the long term; includes a publicly accessible policy document.

## 1.2 Data collection approach

We trialled a number of ways to obtain information given that knowledge of the number of fishers, locations they fished (in some cases remote), and types of whitebait fishers was variable or absent. Nationally, we tasked rangers to record the whitebait activity they observed during compliance patrols. Additionally, four South Island and eight North Island whitebaiting rivers were chosen for more detailed assessment and study (see [Section 4, Methods](#)), and the Marine Ecology Research Group at the University of Canterbury was contracted to implement a social survey of whitebaiters. To minimise disruption to programmed operational work, additional resources and new techniques (such as aerial image capture and analysis) were explored to collect required data. Existing data was also canvassed and in the case of the Department's compliance patrols, effort and results were analysed to show common trends.

## 1.3 Objective

The overriding objective of this report is to detail the information gathered, nationally and at pilot sites, during the 2021 whitebait season, to inform a more comprehensive approach for the 2022 season.

## 2. Existing data

### 2.1 An inventory of whitebaiting rivers in the South Island

In 1988, the Ministry of Agriculture and Fisheries (MAF) canvassed the opinions of experienced MAF Fisheries Management Officers to obtain a qualitative assessment of the regional importance of both recreational and commercial whitebaiting on South Island rivers. Specifically, nine MAF Regional Fishery Officers listed and ranked rivers which supported whitebait fisheries of recreational or commercial importance. A total of 75 South Island whitebaiting rivers were listed, of which 73 were identified as supporting recreational whitebait fisheries and 43 as supporting commercial whitebait fisheries (Kelly 1988).

### 2.2 Whitebait stand locations and West Coast back-pegs

Regional councils and iwi have some data on whitebait stand locations and, in some cases, demographics of stand ownership (e.g., Waikato River). The regions identified with whitebait stands already spatially mapped are the West Coast Regional Council, the Waikato Regional Council and Waikato-Tainui. The Department's staff contacted Waikato Regional Council, Waikato-Tainui and West Coast Regional Council to secure spatial files that display the mapped locations of stands (but not the associated demographic information). The location of stands on the rivers are mapped in Figures 2-4. Locations of [back-pegs](#) on West Coast Rivers are shown in Figures 3-4.

### 2.3 2010 West Coast whitebaiters survey

During the 2010 whitebait season a social survey was distributed by the West Coast Whitebaiters Association to gather information on West Coast whitebait fisher types (recreational versus commercial), methods used (net types, net traps, stands, etc.), fishing accommodation, satisfaction with existing regulations, and if licensing should be required. Of the 232 respondents, 82% were recreational fishers, 48% fished from a registered stand, and 75% used nets with traps in them. Respondents used a variety of net types. Half (51%) of the respondents were satisfied with the current whitebaiting regulations and 45% thought that adult whitebaiters should be licensed.

### 2.4 Whitebaiters diaries/record of catch

Staff and researchers were asked to identify where diaries exist and their format. Many rangers that have been involved with whitebait knew of whitebaiters who kept records (diaries) of their whitebaiting. Some of the Department's rangers have initiated diary schemes where they have supplied diaries to whitebaiters in rivers in their districts (e.g. on Waikato River; Figure 1). Whitebaiters have provided some diaries or records to the Department's staff, but they don't have a common format, scale, or time periods. Thus, no regional or national collation has been undertaken and would pose significant analytical challenges to understand or make conclusions (i.e., standardising effort between fishers' diaries). On the West Coast, Dr Mike Hickford (NIWA) was the recipient of diaries when he was based at UC – but, to date, no analysis has been undertaken, nor have these data been provided to the Department.



# WHITEBAIT CATCH RECORDING SHEET FOR \_\_\_\_\_ RIVER

Collected by: \_\_\_\_\_

DATE	OTHER PEOPLE FISHING?			WEATHER CONDITIONS			RIVER CONDITIONS			WATER COLOUR		TOTAL WEIGHT* OF WHITEBAIT CATCH IN GRAMS	ANY COMMENTS
	YES	NO	HOW MANY	FINE	SHOWERS	RAIN	HIGH	NORMAL	LOW	MUDDY	CLEAR		

NOTE: Please TICK appropriate boxes.  
 (1) It is preferred to quote total weight of whitebait catch in grams or kilograms (please specify units used); or  
 (2) As an estimate: eg X 2 litre bucket or, 1 cup full, etc.

Figure 1. Quick whitebait diary supplied to Waikato River whitebaiters (DOC).

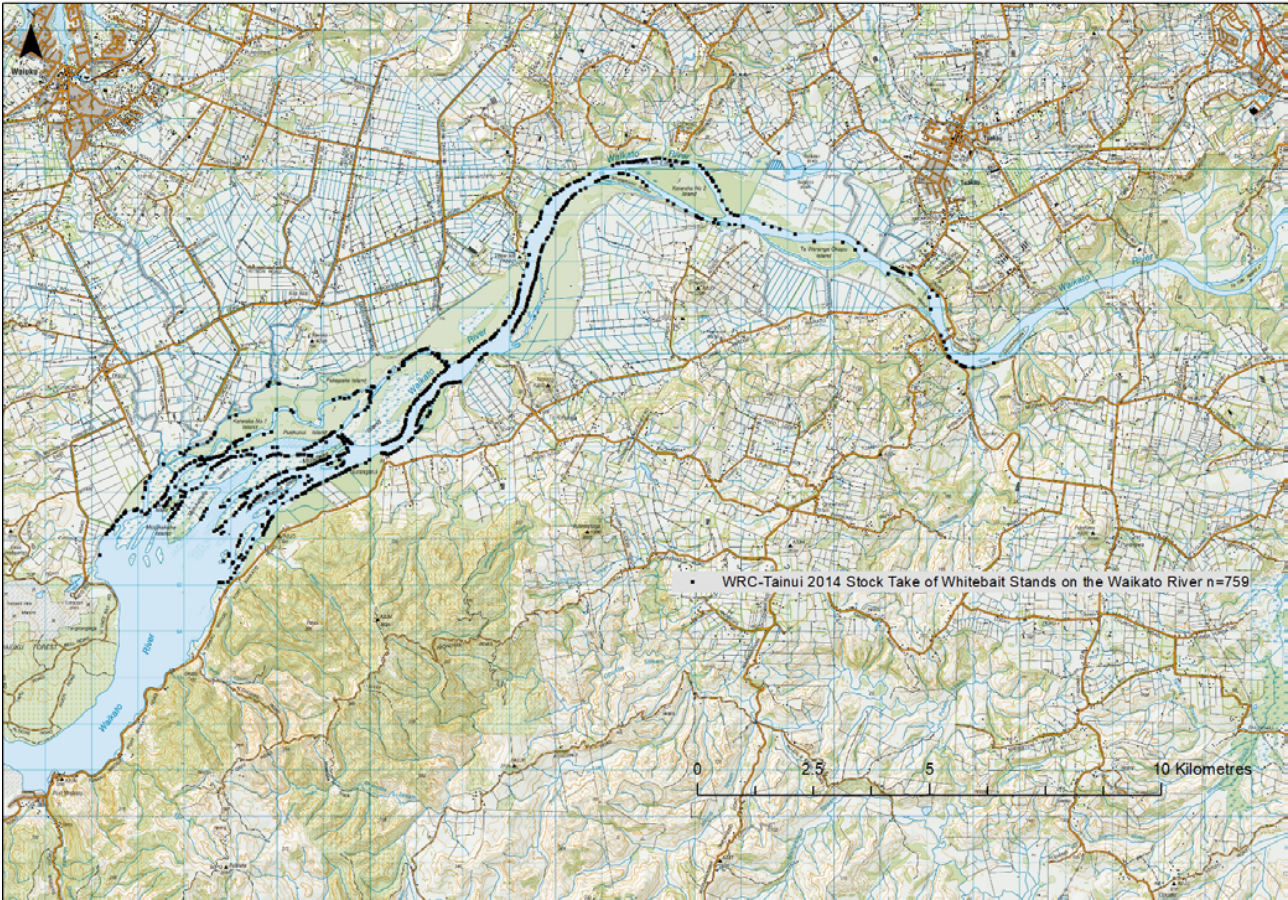


Figure 2. Waikato Regional Council and Waikato Raupatu River Trust 2014 mapping-stocktake of whitebait stands and baches on the Waikato River.



Figure 3. West Coast Regional Council Mōkihinui 2017 whitebait stands ( $n = 69$ ) mapped on 2021 aerial.



Figure 4. West Coast Regional Council Hokitika River 2017 whitebait stands ( $n = 70$ ) mapped on 2021 aerial. It appears the location of braids of the river has changed since 2017. Also shown are DOC whitebait back-pegs denoting upstream limits of whitebaiting (upper left back-peg is for Mahināpua Creek/Tūwharewhare tributary closed area).

### 3. Pre-season advocacy work

The Department's approach to the 2021 season was to first inform fishers of the new regulations and build understanding through advocacy.

Public meetings were held in Geraldine (two meetings) and Whakatāne (one meeting), with strong attendance and engagement. Even though DOC staff had the same information as the public on the new regulations, staff efforts to front the changes were appreciated by the public.

The new [pamphlets](#) received good feedback from DOC staff and the public. They are a practical way to communicate on the riverbank, with straightforward diagrams to reflect real-life scenarios.

A [YouTube video](#) made by a member of the public, Chris Humphreys, also proved a useful tool to inform fishers about the new rules. The video arguably had wider reach being presented by someone other than DOC.

#### 3.1 Back-pegs

Back-pegs (Fig. 5) were manufactured and delivered to district officers to place at the upper extent of tidal influence on rivers. The purpose of back-pegs is to make visible the point in a river above which there will be no fishing under the Whitebait Regulations 2021. They have been in place on the West Coast for more than 20 years.

Most Operations teams chose to use the 2021 season to introduce the idea of back-pegs, consult with iwi, hapū, and whānau, and determine appropriate locations, with a view to these being in place for the 2022 season, rather than actually placing pegs during the 2021 season.

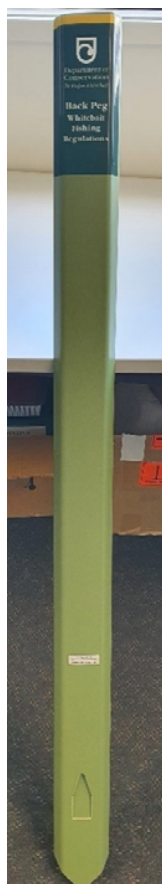


Figure 5. Whitebait back-peg.

## 4. Methods

Our focus during the 2021 season was on information gathering, with current resources, to determine what may be required in the 2022 season to meet key data needs. As part of this process, several pre-season workshops were held with internal and external experts to identify what information could be gathered to undertake effective whitebait fishery management. Included in the appendices are tables outlining the overall whitebait management information gaps ([Goodman 2018](#)) and data needs ([Booth et al. 2013](#)) that were prioritised, as well as research opportunities to pursue within the short timeframe ([Appendix 1](#)), and a summary of the possible approaches to trial for the 2021 fishing season ([Appendix 2](#)).

In addition, a variety of whitebaiting rivers from around Aotearoa New Zealand were identified by DOC staff as pilot rivers for more detailed assessment and study ([Fig. 6](#); see also [Appendix 4](#)). Pilot rivers were selected based on availability of staff at place, as well as being representative of diverse river types geographically interspersed across the North and South Islands.

### 4.1 Field data collection

#### 4.1.1 Regulatory compliance and patrols

To implement the new regulations, the agreed focus for the 2021 season was one of education and advocacy on the riverbank, with enforcement of the regulations focused on either more serious or persistent offending.

The National Compliance Team's regional officers worked with district Operations staff to plan where and what work could be undertaken, including patrols, and to ensure they had the tools for the job. Being a warranted officer is an additional skill- and time-resource on top of the work for which rangers are primarily employed.

#### 4.1.2 Whitebait activity forms

To begin to build a national picture on whitebaiter numbers, gear types, and fishing locations we tasked rangers to make whitebaiting observations using a standard form ([Appendix 3](#); whitebaiter activity form) during their patrols throughout the whitebait fishing season. Scanned copies of the completed forms were asked to be sent to the Whitebait Fishery Team fortnightly throughout the season. It was deemed beyond the scope, comfort, and resource of rangers to engage with fishers to enquire about their catch and time spent fishing. However, the whitebaiter activity form includes the option to record information on catch and effort. These data would be quite useful for fisheries management, so the form provided this option to gauge its potential use.

### 4.2 Remote data collection

#### 4.2.1 Fixed-wing flights

There were a limited number of aerial survey companies capable of providing high resolution 4-band imagery (RGBI – Red, Green, Blue, Infrared) and the required orthomosaics, at a scale and flexibility required for photographing whitebaiting reaches of pilot rivers. We undertook work with local Operations staff to define extents of whitebaiting reaches especially in North Island and multi-channel rivers such as the Wairau. Impacts of travel and Health and

Safety restrictions meant the North Island operator could not be used. The South Island operator captured images of North Island rivers later in the whitebait season.

RGBI images were captured flying at 2,000 feet above ground by Canterbury Aviation (Pilot: Hugh Robinson) yielding a resolution of 3.3 cm Ground Sample Distance (GSD). Images were processed and mosaicked by David Napier from SkyVUW.

a. **Aerial capture timing**

Even large extents on the biggest rivers were captured within the fishing window of one tide, so counts reflect fishing effort per tide very well. Canterbury aviation worked with local DOC rangers or whitebaiters to target right stage of tides and days where whitebaiting was occurring.

b. **Counting**

We had difficulty importing RGBI tif files in ArcMap and ArcPro. This issue was avoided by using QGIS. The resolution of the Enhanced Compression Wavelet (ECW) was suitable for counting and identifying fishing methods and had consistent exposure and contrast compared to tiles in ArcGIS. We counted activity one riverbank at a time from the river mouth to the upstream extent of aerials. Where rivers were small enough, or narrowed further inland, both riverbanks were counted if visible in the same ArcGIS view. Determining licensed stand number from the West Coast Regional Council feature or the Tainui-Waikato Regional Council feature was difficult due to varying spatial accuracy of stand features. In the case of the Waikato River, no stand number was attached to the stand feature, so the feature Object number of the nearest matching point was noted in comments attribute of the counting feature, for example Comment = Floating, =? Tainui-WRC OBJECTID 819, AUTH\_NUM 116971 (Table 1).

Table 1. Attributes captured from aerial survey data.

RIVER	STAND_NUMBER	NORTHING	EASTING	STAND	METHOD	ACTIVITY	SPOTTERBOARDS	COMMENTS
*	*	*	*	Yes, No or Maybe	Set or scoop	Fishing, scooping or Prep	Count	

#### 4.2.2 Drones

The use of drones as a method for data capture (to ascertain number of fishers and methods used) was challenging. On two occasions drone flight operators had their equipment damaged by birds. We contracted a drone operator to trial the use of drones to capture whitebaiting imagery. Drone imagery complemented flight data as it is of higher resolution and provided real-time connection of rangers talking to whitebaiters.

### 4.3 Whakatāne case study

In addition to the remote data collected at the pilot regions, we supported a district-led research project in Whakatāne. During three community hui in Matatā, Whakatāne, and Ōpōtiki, the Whakatāne office staff identified a common thread of concern which was how the whitebait catch changes in species composition throughout the fishing season. To be proactive and responsive to community concerns about whitebait an interim short-term research project to build local capacity and then feed into a longer-term local iwi/hapū-driven kaitiakitanga research project was performed.

Three rivers in the Whakatāne region (Tarawera, Whakatāne, and Waioeka) were sampled each fortnight through September, October, and November. Maramataka Rākaunui (full moon) and Tangaroa (week of the first quarter) days were chosen as fishing/sampling days. Sampling was

conducted on mid-incoming tides and the specific locations on each river were chosen by the key kaitiaki on each awa. Samples were collected with scoop nets until at least 100 whitebait had been caught from more than two shoals. Samples were frozen and then visually identified using available keys (Yungnickel 2017). In addition, DOC staff (science and technical advisors) helped with species identification and participated in community wānanga. To be sure that whitebait species were identified correctly some samples were sent to a lab for genetic analysis. eDNA was collected from a subset of samples.

## 4.4 Social survey

*Taken from the social survey that the Marine Ecology Research Group (University of Canterbury) was contracted to implement.*

In October 2021, the Department of Conservation contracted the Marine Ecology Research Group to undertake a social survey of whitebaiters. Initial plans for this survey had involved pilot face-to-face surveys on riverbanks by DOC compliance officers, but COVID-19 restrictions prevented face-to-face contact with whitebaiters during most of the 2021 season. Given this, it was decided to distribute an electronic version of the survey, via Facebook pages and email, with the support of whitebaiters' associations across Aotearoa New Zealand. It was still planned to augment the survey via distribution of hard copy surveys to whitebaiters on riverbanks. However, delays (until late November) restricted riverbank distribution of the survey to only Canterbury rivers because the West Coast whitebaiting season had closed.

### 4.4.1 Survey questions

The survey consisted of nine questions. When appropriate, questions included an 'Other (please specify)' free-text field and the option 'Prefer not to say'. Respondents could answer as many or as few of the questions as they wanted and still be able to submit the survey.

- Questions 1-4: captured the age, gender, ethnicity and home region of the respondent.
- Question 5: allowed the respondent to describe their reason(s) for whitebaiting.
- Question 6: asked respondents to list their whitebaiting history over the previous five years and captured information about where and how the respondent whitebaited and also gauged fishing effort.
- Question 7: offered respondents some potential changes to whitebait fishery management and asked them to show their level of support for each.
- Question 8: asked respondents to describe how often they sold or traded their whitebait catch.
- Question 9: asked respondents if they were willing to share some contact details with the Department of Conservation for further feedback on the whitebait fishery, but made it clear that these details would not be linked to survey responses.

### 4.4.2 Iwi consultation

Development of the survey included consultation with the Ngāi Tahu Consultation and Engagement Group.

### 4.4.3 Human ethics

The survey was designed in consultation with the University of Canterbury's Human Ethics Committee. It was deemed 'low risk' and approved (HEC 2021/60/LR-PS) after final review.

#### 4.4.4 Distribution

The survey was distributed via the Qualtrics online platform and in a hard-copy form. A brief description of the survey and hyperlink to the Qualtrics survey platform was posted on six Facebook pages: NZ Whitebaiting Community (3,000 members); Whitebaiting NZ (7,500 members), South Island Whitebaiters (5,800 members); Kiwi Whitebaiters (10,500 members); Waimak Whitebaiters (1,400 members) and New Zealand Whitebaiters (4,700 members). We assumed considerable overlap between these memberships. The West Coast Whitebaiters' Association, Southland Recreational Whitebaiters Association, and the Waikanae Estuary Whitebaiters Network emailed a letter of support and links to the survey to their memberships. Hard copies of the survey and links to the online platform were distributed to whitebaiters on the Ashley/Rakahuri, Waimakariri, Avon/Ōtakaro, and Heathcote Rivers in Canterbury in late November. All messaging around the survey invited respondents to pass on the survey to other interested parties.

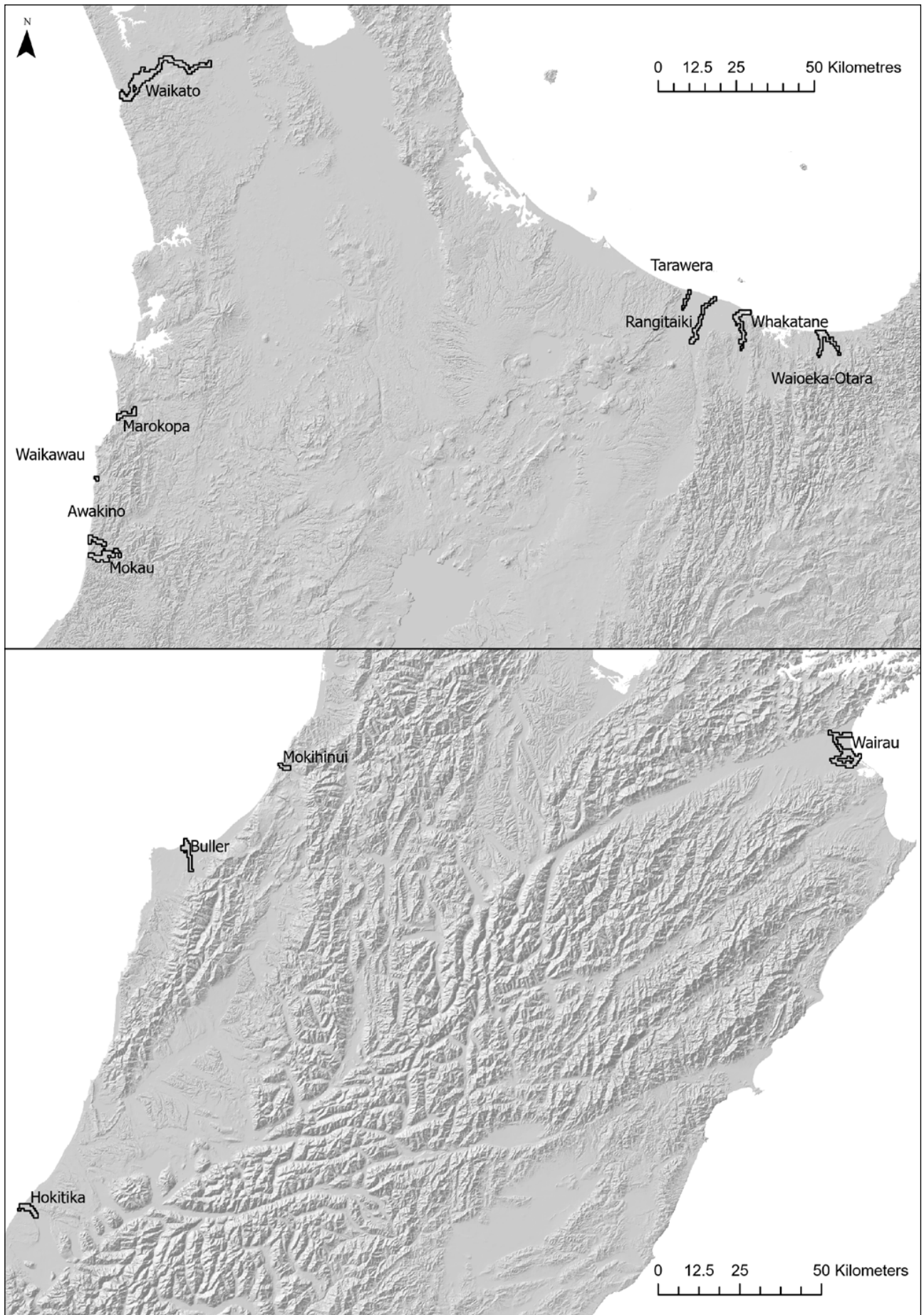


Figure 6. Whitebaiting pilot rivers chosen for more detailed assessment and study on the North (top) and South (bottom) Island Oct–Nov 2021.



## 5. Results and discussion

### 5.1 Field data collection

#### 5.1.1 Regulatory compliance and patrols

COVID-19 Levels 3 and 4 had major impacts on both staff capacity and whitebaiting activity. The Waikato district in particular had planned work that was largely unable to be completed for the whole season due to lockdowns preventing access to the river (only one round of pre-season patrols took place).

Officers advised generally good compliance with the new regulations (Fig. 7), with relatively good self-policing around separation distances, with only a few exceptions. We have had to review consistency between districts in our approach to enforcement (e.g., interpretation of ‘fishing gear’). Fishers generally appreciated seeing the Department’s staff out on the riverbank and reported their relative satisfaction with the new regulations.

Regulatory compliance is a professional role which should be performed by trained staff who have a sound knowledge of the legislation, are trained how to deescalate conflict, manage health and safety risks, understand how to gather evidence, conduct witness interviews, and understand the legal application of powers under various statutes. Sound decision-making ability, often under pressure, is a key attribute.

District Offices deployed staff in numerous ways. There was a varied approach to the deployment of resources and time dedicated to both officer numbers and the frequency of patrolling.

Pre-planned operational deployment requires the environmental conditions to be favourable for patrols to be effective. There is a need for flexibility and the ability to have resource available to respond to complaints made by the public.

#### 5.1.2 Risk Manager and complaints

Risk Manager is the database where health and safety incidents are recorded by DOC staff. There was a total of six incidents reported into Risk Manager for the 2021 whitebait season. This was only slightly down from 2020.

The highest proportion of emails received were from the public reporting the sale of whitebait on social media and frustration that this was a legal activity. The public also provided information on illegal fishing in districts for follow up.

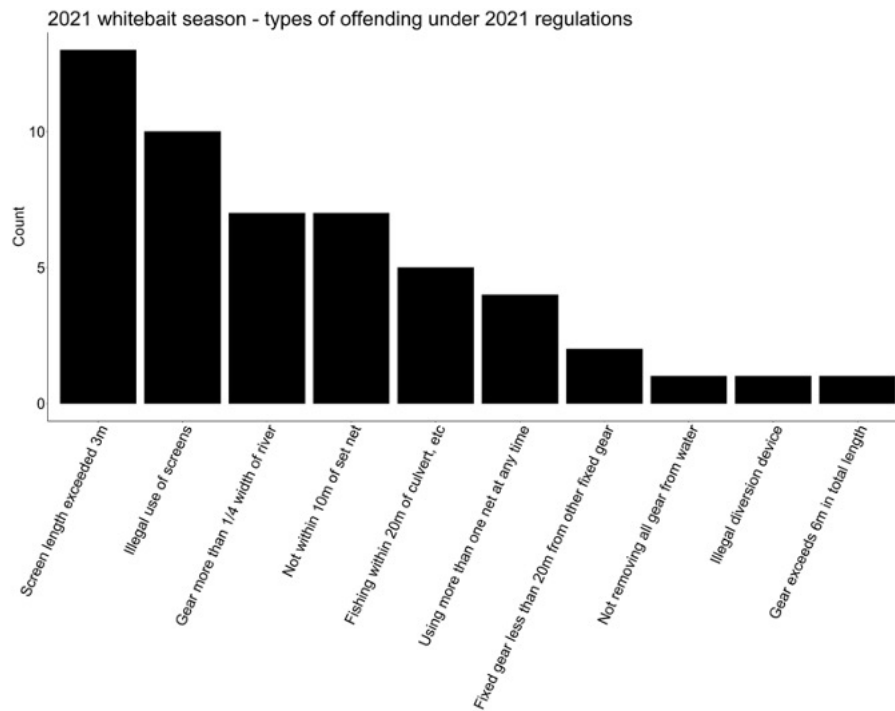


Figure 7. Type and number of whitebait fishing regulation offences reported during the 2021 fishing season.

### 5.1.3 Whitebait activity forms

General feedback received from Operations staff at an end-of-season debrief in March 2022 indicated that the whitebait activity form ([Appendix 3](#)) should be simplified to improve its use.

Here we provide a summary of the whitebait activity forms received for the South Island ([Appendix 4](#)). Fortunately, these results can be compared (somewhat) to a qualitative inventory of whitebaiting rivers in the South Island completed by the New Zealand Ministry of Agriculture and Fisheries in 1988 (Kelly 1988).

Rivers have been grouped by region, starting from Tasman in the north and following a counter-clockwise direction around the South Island to Marlborough. The discussion of each region commences with a brief summary of the region’s fishery as a whole, and where comparisons can be made, describes each individual river and its whitebait fishery with that reported in Kelly (1988).

#### *Tasman*

Kelly (1988) reported that only the larger rivers in the Nelson district support whitebait fisheries of note, with the most popular and productive rivers being the Motueka, Tākaka, Aorere, and Waimea rivers. In the late 1980s, the Nelson (Tasman) fishery was composed mostly of recreational whitebaiters using set nets with screens; some whitebaiters used scoop nets on the lower reaches of the major rivers (Kelly 1988). Our results from the 2021 whitebait season echo the results of Kelly (1988) with the most popular rivers being the Motueka, Tākaka, Aorere, and Waimea rivers (Fig. 8). Other notable fishing locations include the Paturau River and Moturoa/ Rabbit Island, however, only one visit to Moturoa/ Rabbit Island was recorded and may not be representative of fishing effort throughout the season’s entirety (Fig. 8). In the Tasman region whitebaiters do not fish from structures, and in addition to the metal framed set nets, some fishers were observed using sock nets which have become increasingly popular (Fig. 9).

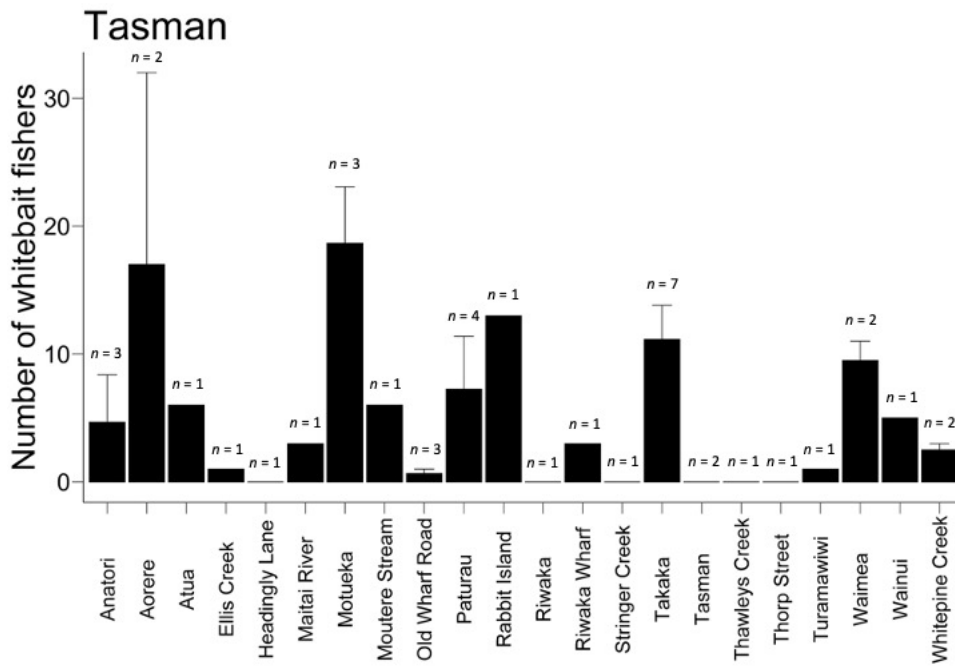


Figure 8. Mean (+SE) number of whitebait fishers recorded during patrols on Tasman rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.

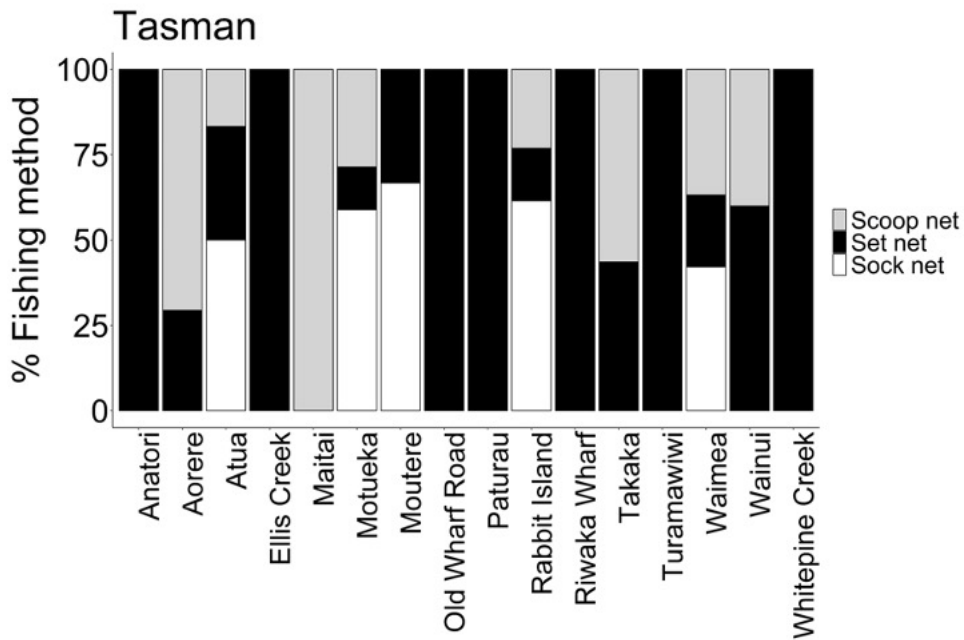


Figure 9. Proportion of fishing methods used by river in Tasman, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

Table 2. Mean ( $\pm$  SD) and maximum number of whitebait fishers observed on Tasman rivers from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO.	2021 MAX NO.	1988	COMMENT FROM KELLY (1988)
Anatori	4.7 (6.4)	12	10–12 commercial fishers; up to 20 regular recreational fishers.	Although isolated, attracts a moderate recreational fishery.
Patarau	7.3 (8.3)	19	Up to 8 commercial and 15 recreational fishers.	6–8 commercial operators. Minor recreational fishery.
Aorere	17.0 (21.2)	32	Up to 8 commercial and between 50–60 recreational fishers.	One of the most important whitebaiting rivers in Tasman.
Tākaka	11.1 (7.1)	18	Up to 10 commercial and between 50–60 recreational fishers.	The most popular whitebaiting river in the region.
Riuwaka	0.0	0	Up to 15 recreational fishers.	Minor fishery.
Motueka	18.7 (7.6)	27	10–12 commercial and 40–50 recreational whitebaiters per day.	One of the most popular and highest commercial ranking in the region.
Moutere	6.0	6	Up to 20 recreational whitebaiters per day at the peak of season.	Minor recreational fishery.
Waimea	9.5 (2.1)	11	2–3 commercial and up to 50 recreational whitebaiters per day.	High recreational value.

### **West Coast**

We did not receive whitebait activity forms from South Westland and therefore we only provide information on the West Coast for North Westland. The rivers of North Westland have better access and are closer to large population centres like Hokitika, Greymouth, and Westport than the southern rivers (Kelly 1988). The Buller River and Grey River/Māwheranui support major recreational whitebait fisheries and do not have registered fishing sites. A large number of recreational fishers come from Canterbury, Otago, and Tasman (Kelly 1988). Due to COVID-19-related travel restrictions, the number of whitebait fishers that travelled to the West Coast may not be representative of a typical year. Furthermore, weather conditions were not favourable for fishing, likely impacting those who were able to go whitebaiting (pers. comm., DOC operations staff in Hokitika, Greymouth, and Westport). The greatest concentrations of commercial whitebaiters are found on the Hokitika, Buller, and Mōkihinui rivers, and fishing methods vary considerably from river to river (Kelly 1988). Our results are consistent with those of Kelly (1988); see Figs. 10–12, however, the numbers recorded for whitebait fishers on the popular rivers (Buller, Grey, and Hokitika) were far fewer than those reported previously (Table 3), and we were unable to distinguish between commercial and recreational fishers.

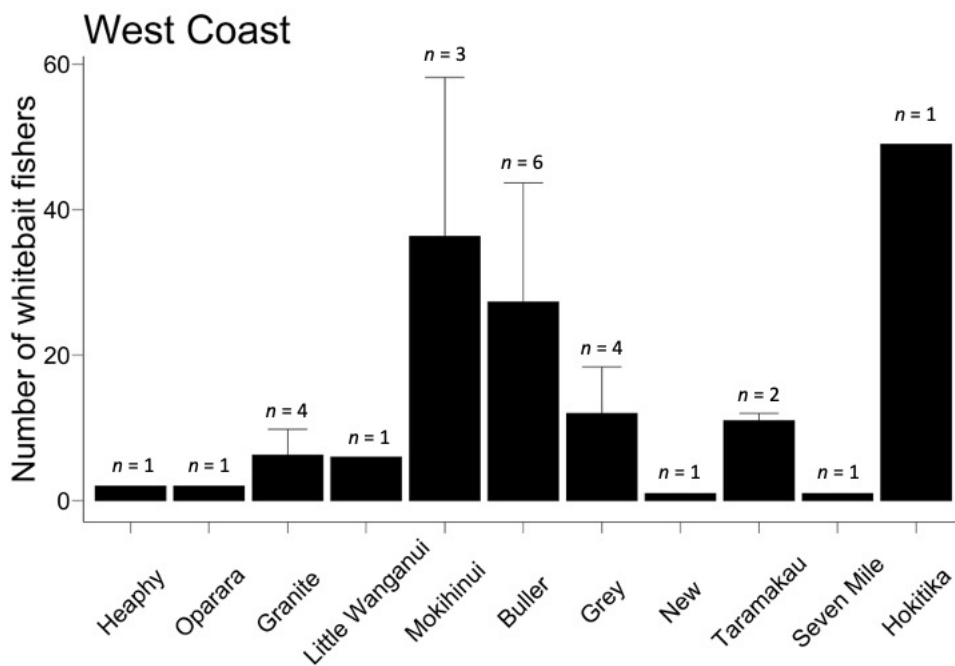


Figure 10. Mean (+SE) number of whitebait fishers recorded during patrols on West Coast rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.

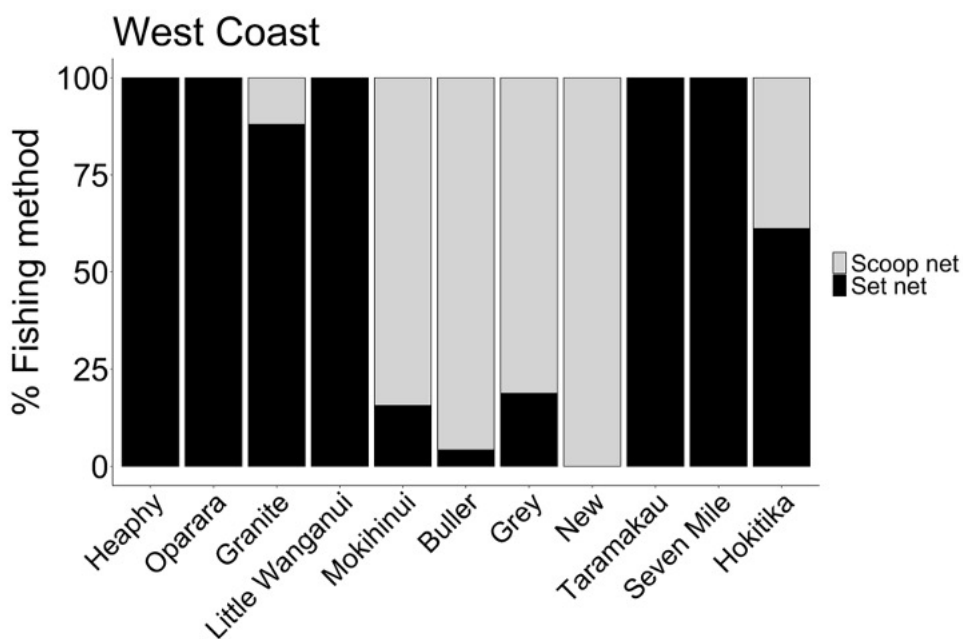


Figure 11. Proportion of fishing methods used by river on the West Coast, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

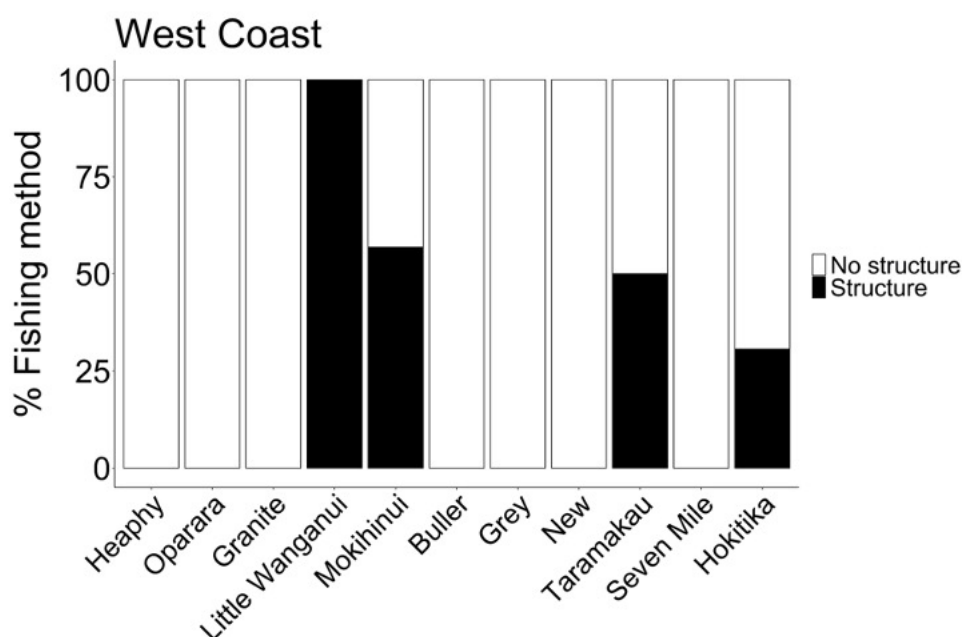


Figure 12. Proportion of whitebait fishing from structures by river on the West Coast, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

Table 3. Mean ( $\pm$ SD) and maximum number of whitebait fishers observed on West Coast rivers from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO.	2021 MAX NO.	KELLY (1988)	COMMENT FROM KELLY (1988)
Granite Creek	6.3 (7.2)	17	Up to 50 recreational fishers.	Popular recreational fishery.
Little Wanganui	6.0	6	Up to 30 whitebaiters.	Small recreational fishery with commercial component.
Mōkihinui	36.3 (37.8)	79	Up to 80 whitebaiters.	Large and competitive recreational and commercial fishery.
Buller	27.3 (40.0)	108	Up to 360 whitebaiters.	Largest commercial, and recreational fishery.
Grey/Māwheranui	12.0 (12.8)	30	Up to 300 whitebaiters.	Small commercial fishery. Very popular recreational fishery.
Taramakau	11.0 (1.4)	12	20 regular whitebaiters of the 38 registered stands.	Most whitebaiters are retired people; a small number could be classed as commercial fishers.
Hokitika	49.0	49	Up to 140 whitebaiters, 78 registered stands.	Large commercial and recreational fishery.

### Southland

All tidal streams and rivers in Southland support a whitebait fishery to some degree (Kelly 1988). Although Kelly (1988) included the Clutha River/Mata-Au in Coastal Otago, we have included it as part of Southland because Operations staff from Murihiku patrolled the Clutha during the fishing season. The region extends around the southern coast to Yates Point at the entrance to Milford Sound/Piopiota. The 2021 whitebait fishing regulations extend the whitebait fishing closed areas from Yates Point in the north, to and including the Waitutu River in the south (previously from Yates Point in the north to Puysegur Point in the south). The rivers in Southland support major recreational and significant commercial whitebait fisheries (Kelly 1988). The majority of rivers have stands or structures which, like the West Coast, are a notable feature of the fishery (Fig. 13). Another interesting result from the 2021 season was that only set nets were observed to be used by whitebaiters actively fishing.

Kelly (1988) reported whitebaiters fishing beaches, river mouths, and bars with scoop nets just after low tide and continuing until high tide. Similar to Kelly (1988) the Mataura River was observed to be the most important whitebait fishery during the 2021 season with the greatest number of fishers observed compared to the other rivers in the region (Fig. 14).

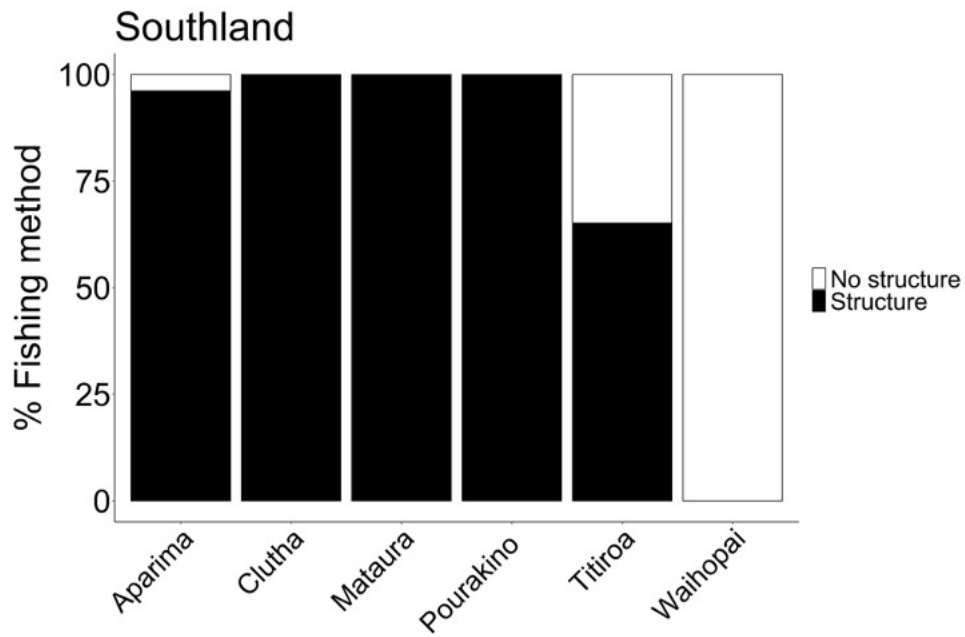


Figure 13. Proportion of whitebait fishing from structures by river in Southland, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

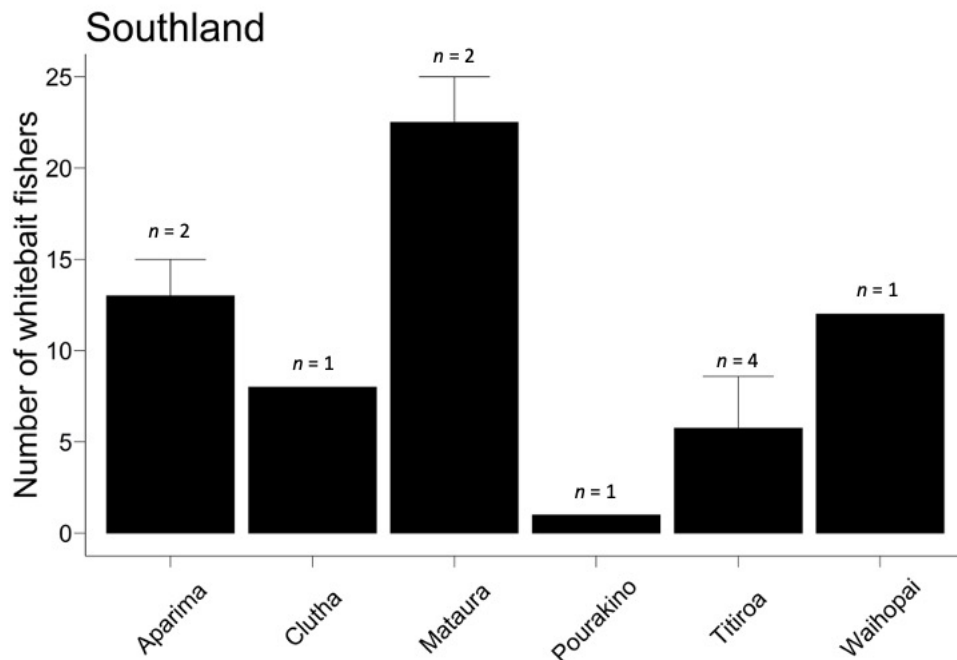


Figure 14. Mean (+SE) number of whitebait fishers recorded during patrols on Southland rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.

Table 4. Mean ( $\pm$ SD) and maximum number of whitebait fishers observed on Southland rivers from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO.	2021 MAX NO.	KELLY (1988)	COMMENT FROM KELLY (1988)
Clutha/Mata-Au	8.0	8	Can attract up to 200 whitebaiters on a good day.	Major whitebait fishery of regional importance. Catch rates consistently higher than on other rivers in the region. Minor commercial component.
Titiroa Stream	5.8 (5.7)	14	65 registered stands.	Important fishery. Large commercial component. Heavy fishing pressure during weekends.
Mataura	22.5 (3.5)	25	222 registered stands.	Most important whitebait fishery in Southland. Large commercial component. Major recreational fishery.
Aparima	13.0 (2.8)	15	125 registered stands.	Very popular, good access. Small commercial component.
Pourakino	1.0	1	11 registered stands during 1986 season.	Small local fishery. Mostly recreational.

### Coastal Otago

Otago’s whitebait fishery is largely recreational (Kelly 1988). Fishing methods vary greatly from river to river (Figs 15–16). The Kakanui and Taiari (Taieri) Rivers were the most popular in 2021 with a minor fishery on the Waikouaiti (Fig. 15), consistent with the results from Kelly (1988).

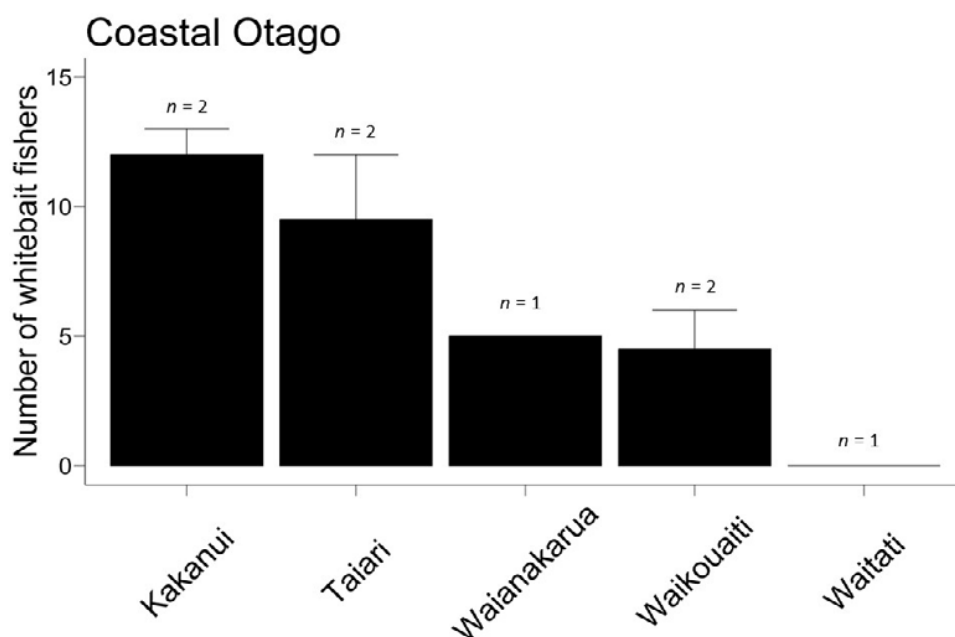


Figure 15. Mean ( $\pm$ SE) number of whitebait fishers recorded during patrols on Coastal Otago rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.



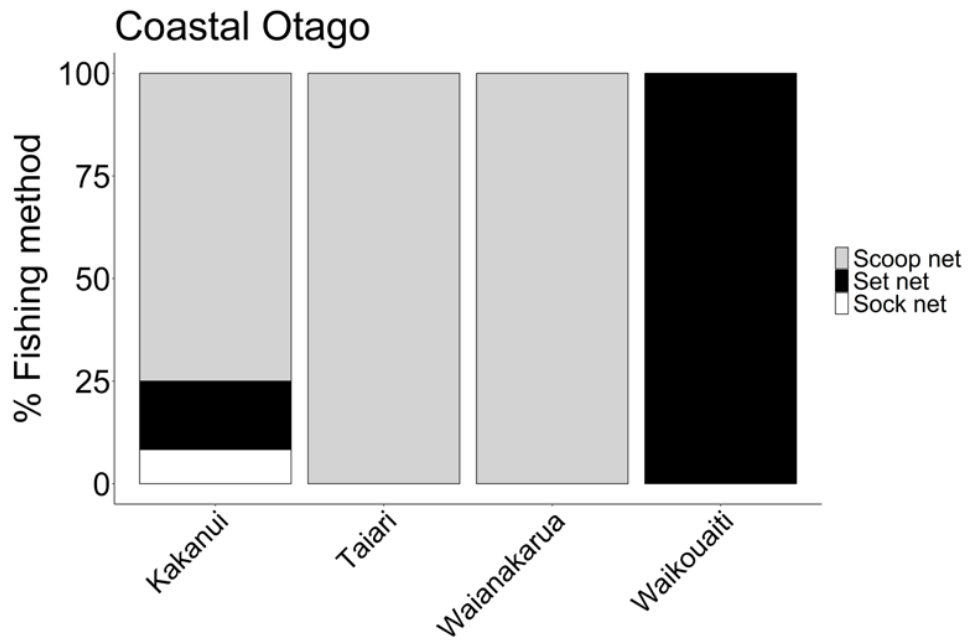


Figure 16. Proportion of fishing methods used by river in Coastal Otago, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

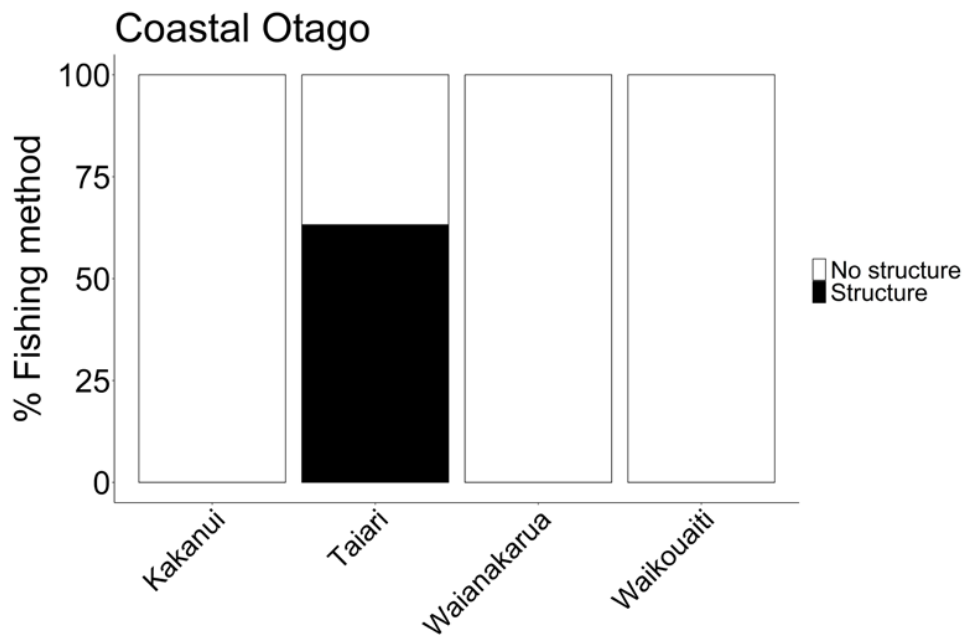


Figure 17. Proportion of whitebait fishing from structures by river in Coastal Otago, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

Table 5. Mean ( $\pm$ SD) and maximum number of whitebait fishers observed on Coastal Otago rivers from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO.	2021 MAX NO.	KELLY (1988)	COMMENT FROM KELLY (1988)
Kakanui	12.0 (1.4)	13	Up to 50 people on a good day. A maximum count of 67 recorded (Pierce 1987).	Although small, can attract up to 50 whitebaiters. Catches generally small.
Waikouaiti	4.5 (2.1)	6	Average of about 25 people with up to 100 on a holiday weekend.	Reasonably popular. Fished mainly by locals and some from Dunedin. Up to 50 whitebaiters on a good day.
Taiari	9.5 (3.5)	12	Up to 150 whitebaiters on a good weekend when the whitebait are running.	Good access and 25–30km of slow tidal reach to fish attracts whitebaiters from a wide area.

### Canterbury

We did not receive whitebait activity forms for South Canterbury rivers. However, the North Canterbury rivers support valuable recreational whitebait fisheries (Kelly 1988). The most important being the Waimakariri River, which in addition to whitebaiting supports many other forms of recreation. Our results support this with the number of fishers recorded being the greatest on the Waimakariri compared to the other important whitebaiting rivers in North Canterbury (Ashley River/Rakahui and Avon River/Ōtakaro; Fig. 18). Very few fishers were observed on the Ashley River, however. Fishing methods vary from river to river (Fig. 19) and there are no whitebait stands allowed by the regional council. Box netters are typically found fishing the surf at the mouth of the Waimakariri River. Box netters drag a small scoop-like net without a handle through the water.

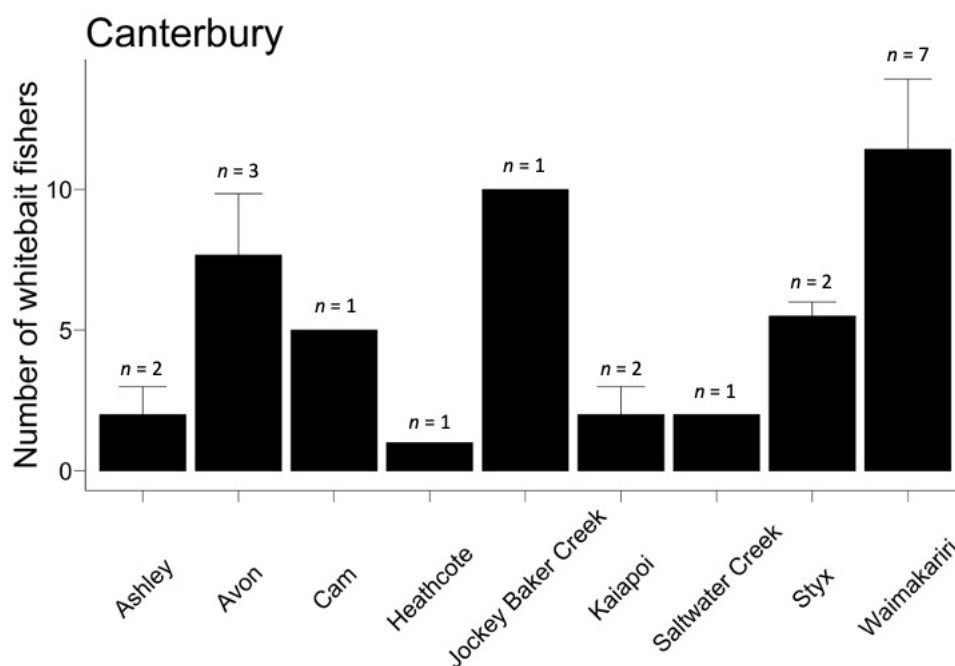


Figure 18. Mean ( $\pm$ SE) number of whitebait fishers recorded during patrols on Canterbury rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.

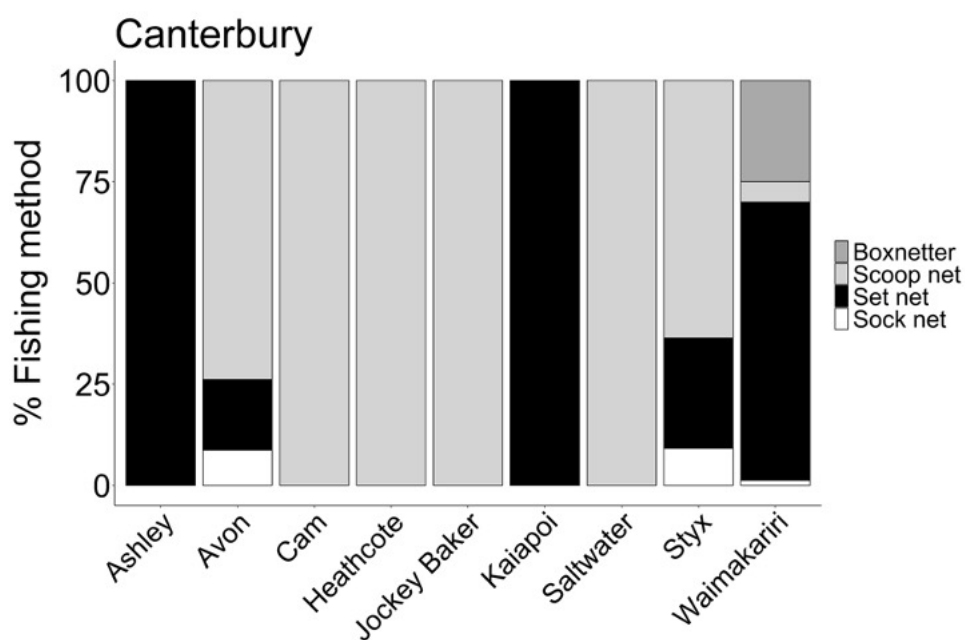


Figure 19. Proportion of fishing methods used by river in Canterbury, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

Table 6. Mean ( $\pm$ SD) and maximum number of whitebait fishers observed on North Canterbury rivers from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO. ( $\pm$ SD)	2021 MAX NO.	KELLY (1988)	COMMENT FROM KELLY (1988)
Ashley/Rakahui	2.0 (1.4)	3	Fished regularly by 40–50 people.	Second most popular whitebaiting river in the region.
Waimakariri	11.4 (6.6)	20	Weekend counts of whitebaiters averaging 169 and weekday counts averaging 124 on good days (North Canterbury Catchment Board and Regional Water Board 1986). An average of 89 persons per survey day (Hardy 1987).	Most popular river in the region. Supports a major recreational fishery of regional importance. Small commercial component.
Avon/Ōtakaro	7.7 (3.8)	12	10–15 whitebaiters during a weekday and up to 100 on a good weekend day.	Popular because of good access and proximity to Christchurch. Used by 16% of Canterbury whitebaiters. Catch rates generally low.

### Marlborough

Only the Wairau and Awatere Rivers in Marlborough were considered important for whitebaiting by Kelly (1988). While the region contains a number of small streams which attract whitebait, most are only fished intermittently and by very few people (Kelly 1988). Of these two important rivers for whitebaiting, compliance and law enforcement patrols were only carried out on the Wairau. The Wairau is the largest river in Marlborough with the majority of fishers traveling from Blenheim and fishing concentrated on the lower 10 km of the Wairau and Ōpaoa (Opawa) Rivers (Kelly 1988).

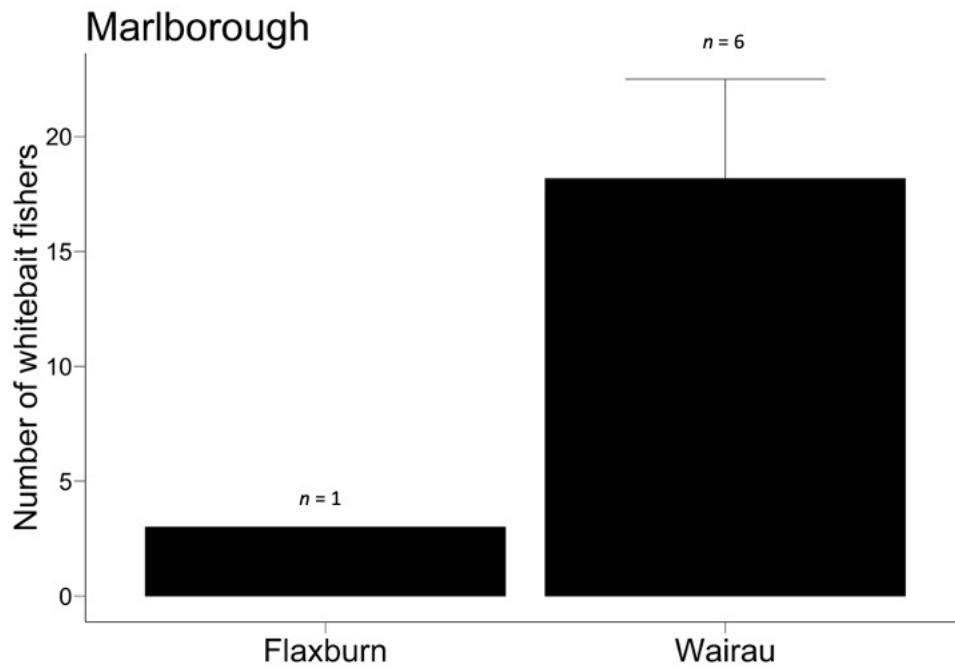


Figure 20. Mean (+SE) number of whitebait fishers recorded during patrols on Marlborough rivers. Sample sizes are shown above bars and correspond to the number of patrols per river.

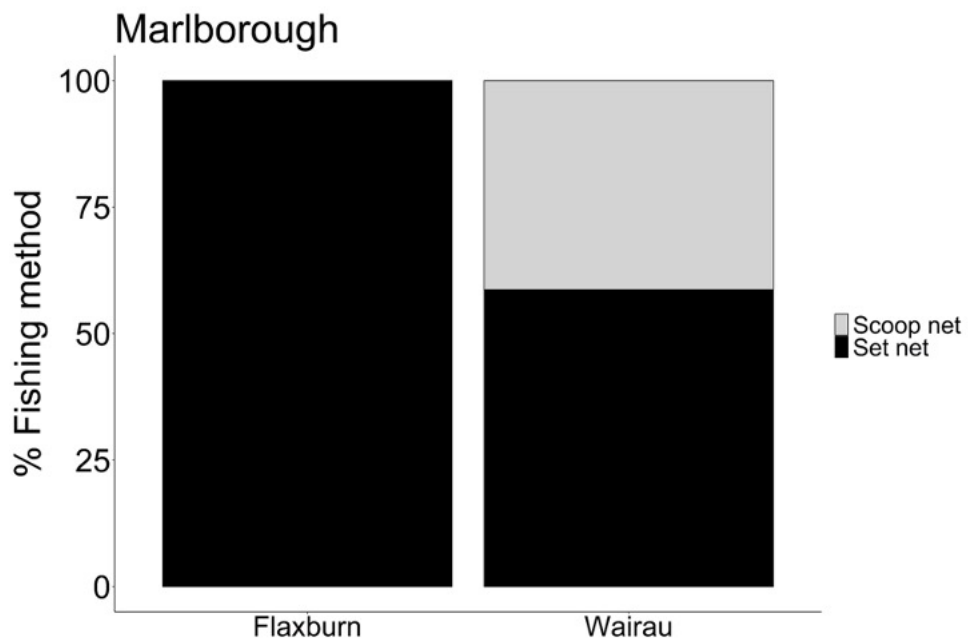


Figure 21. Proportion of fishing methods used by river in Marlborough, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

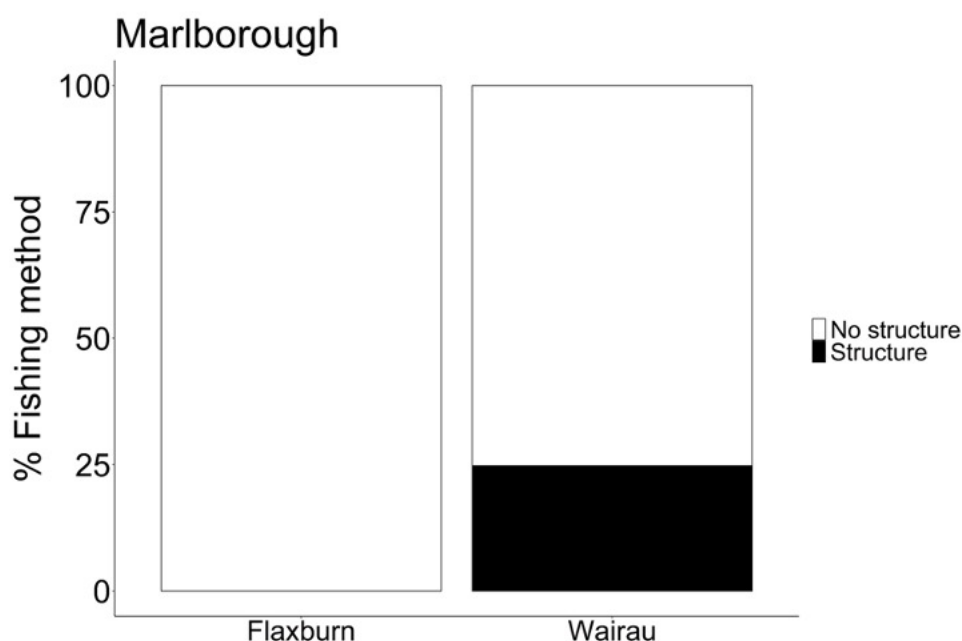


Figure 22. Proportion of whitebait fishing from structures by river on the West Coast, where compliance and law enforcement patrols were completed, during the 2021 fishing season.

Table 7. Mean ( $\pm$ SD) and maximum number of whitebait fishers observed on the Wairau River in Marlborough from 2021 compared to Kelly (1988).

RIVER	2021 MEAN NO.	2021 MAX NO.	KELLY (1988)	COMMENT FROM KELLY (1988)
Wairau	18.2 (10.6)	37	Up to 140 whitebaiters on a good day, the majority coming from Blenheim. Most fishing conducted on the lower 10km of the Wairau and Opawa rivers.	Major recreational fishery. Small commercial component.

## 5.2 Remote data collection

### 5.2.1 Fixed-wing flights

Aerial imagery was captured for whitebaiting rivers in the pilot regions in South Island rivers (Buller, Mōkihinui, Hokitika, and Wairau) on 22 and 30 of October, and for North Island rivers (Waikato, Tarawera, Rangitaiki, Whakatāne, Waioeka, Marokopa, Waikawau, Awakino, and Mokau) from 9–11 November (Table 8). It appears a lot of North Island whitebaiters had stopped or limited their fishing by 11 November, well before close of season on 30 November. Effects of COVID-19-travel restrictions on whitebaiting in Waikato and King Country may also be a factor in very low numbers of whitebaiters counted. Nevertheless, a variety of whitebaiting methods and gear types were observed (Figs 23–24). Not captured or seen in pilot areas were drag nets and larger southern sock nets more commonly used on east coast South Island and southern West Coast South Island rivers, respectively. The high-resolution imagery was also used to count fishers (Figs 25–26) and to map whitebait stands or structures (Figs 27–29). Compared to ground counts, aerial counts were more accurate spatially and for determining fishing method and, in general, recorded more fishers (Figs 30–31).

Tiles, shapefile outlining Tiles extents, and a mosaicked Enhanced Compression Wavelet (ECW) file were supplied for the rivers (Table 8). The total package was c. 323 GB and file sizes ranged from a maximum of 11.5 GB (Waikato ECW) to 48 MB for the ECWs, while the individual tile Tagged Image File (Tifs) ranged in size from 1 GB to 90 MB ([Appendix 4](#)).

Table 8. Date and time ranges that aeriels were captured.

ISLAND	RIVER	DATE	TIME
South	Buller River	22 October 2021	0950 – 1026
South	Möhihinui River	22 October 2021	1039 – 1051
South	Hokitika River	22 October 2021	1137 – 1159
South	Wairau River	30 October 2021	1142 – 1308
North	Waikato River	9 November 2021	1205 – 1358 and 1458 – 1553
North	Marokopa River	11 November 2021	0944 – 1007
North	Waikawau River	11 November 2021	1012 – 1014
North	Awakino River	11 November 2021	1019 – 1035
North	Mokau River	11 November 2021	1040 – 1126
North	Tarawera River	10 November 2021	0834 – 0848
North	Rangitaiki River	10 November 2021	0853 – 0950
North	Whakatāne River	10 November 2021	0955 – 1048
North	Waioeka-Ōtara River	10 November 2021	1054 – 1158



Figure 23. Examples of whitebaiting methods captured by aeriels: Wairau stand scoop netter (A), Wairau box netter (B), Wairau sock netter (C), Möhihinui scoop netters (D), Möhihinui stand scoop netter (E), and Hokitika “stand” set netter (F).



Figure 24. Scoop and set nets on the Hokitika River. Upper left whitebaiter is waiting to scoop over spotter boards and lower right is a set net. Also note scoop net on bank between two active whitebaiters.



Figure 25. Aerial image of the Buller River in Westport with individual fishers identified.





Figure 26. Closeup of Figure 26; aerial image of whitebaiters scoop netting from Shingle Beach to the track loop bridge on the Buller River in Westport. Small red arrows are whitebaiter locations.

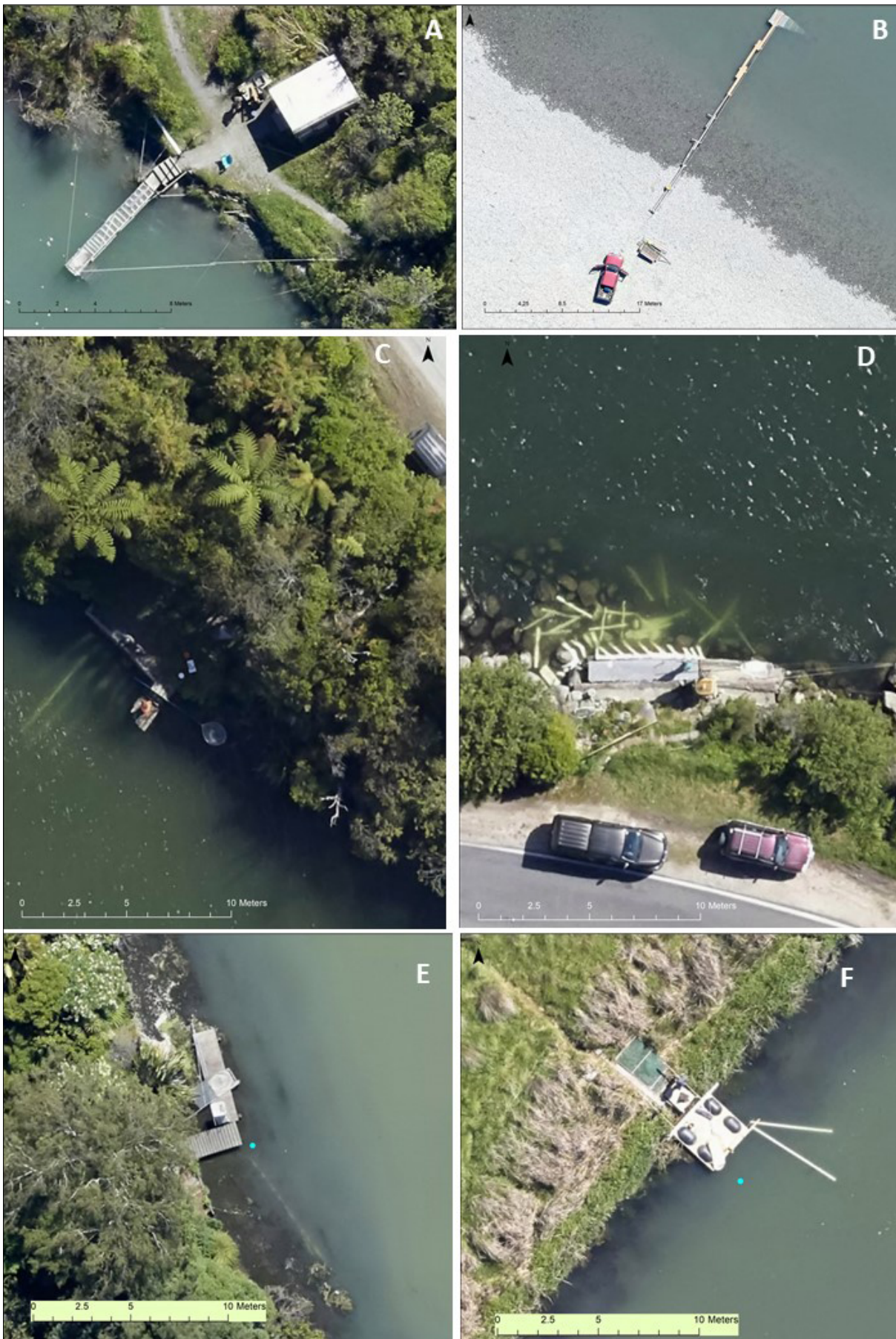


Figure 27. Types of South Island whitebaiting river whitebait structures—stands. (A) Hokitika River set net sock set from a fixed stand TRH, (B) Hokitika River set net set from a long temporary (?) stand TLH, (C) Mōkihinui River fixed stand TRH, (D) Mōkihinui River fixed stand TLH, (E) Wairau River fixed stand TRH, (F) Wairau River floating stand TLH.



Figure 28. Structures being used to whitebait from on true right of the Buller River upstream of the wharf.

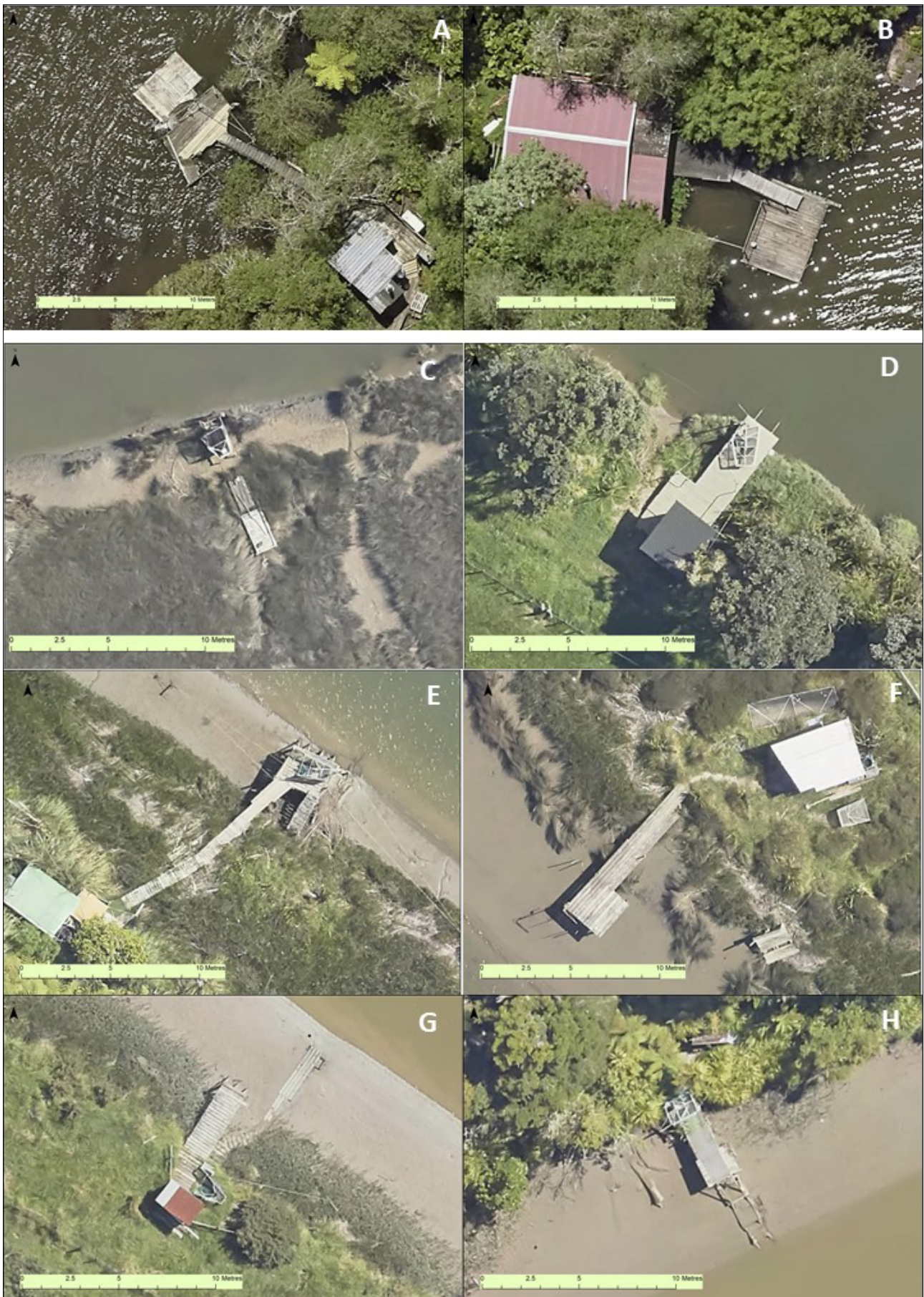


Figure 29. Types of North Island whitebaiting river whitebait structures-stands. (A) Waikato River floating stand TLH, (B) Waikato River floating stand & bach TRH, (C) Marokopa River fixed stand TLH, (D) Marokopa River fixed stand TRH, (E) Awakino River fixed stand TLH, (F) Awakino River fixed stand TRH, (G) Mokau River fixed stand TLH, (H) Mokau River fixed stand TRH.

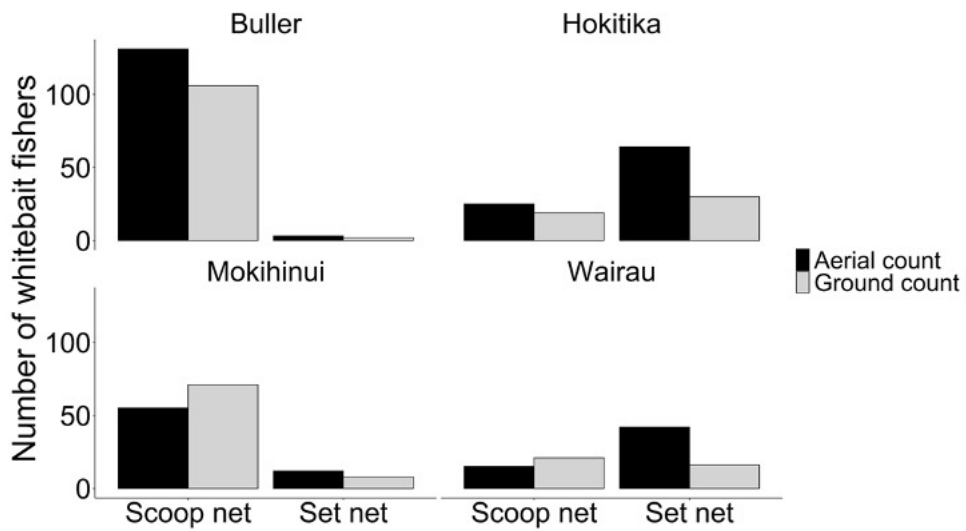


Figure 30. The number of whitebait fishers scoop-netting and set-netting counted from aerial and ground observations on four South Island rivers.

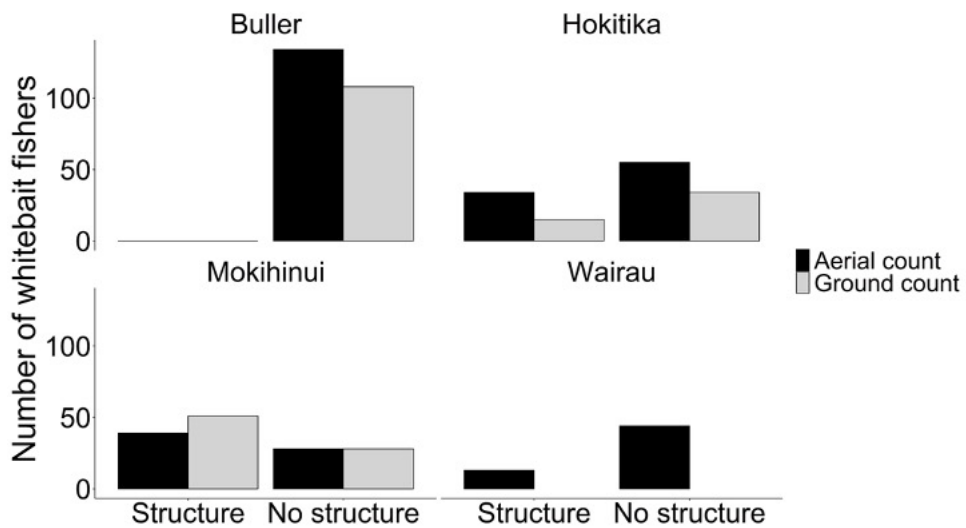


Figure 31. The number of whitebaiters fishing from a structure versus no structure counted from aerial and ground observations on four South Island rivers.

Table 9. Ground and aerial counts of whitebaiters and fishing methods used for the pilot rivers.

RIVER	DATE	SCOOP NET – STAND	SCOOP NET – NO STAND	SET NET – STAND	SET NET – NO STAND	TOTAL
Mōkihinui Ground	22-Oct-21	49	22	2	6	79
Mōkihinui Aerial	22-Oct-21	39	16	0	12	67
Buller Ground	22-Oct-21	0	106	0	2	108
Buller Aerial	22-Oct-21	3	128	0	3	134
Hokitika Ground	22-Oct-21	0	19	15	15	49
Hokitika Aerial	22-Oct-21	0	25	34	30	89
Wairau Ground	30-Oct-21	21	0	16	0	37
Wairau Aerial	30-Oct-21	6	9	7	35	57
Awakino Aerial	11-Nov-21	0	0	13	0	13
Marokopa Aerial	11-Nov-21	0	0	7	0	7
Mokau Aerial	11-Nov-21	0	0	8	1	9
Rangataiki Aerial	10-Nov-21	0	8	0	1	9
Tarawera Aerial	10-Nov-21	0	1	0	2	3
Waikato Aerial	9-Nov-21	0	0	1	0	1
Waikawau Aerial	11-Nov-21	0	0	0	1	1
Waioeka-Otara Aerial	10-Nov-21	0	0	0	2	2
Whakatāne Aerial	10-Nov-21	0	0	0	0	0

### 5.2.2 Drones (flight path and video footage/images captured)

While drones are regularly used by Operations staff, especially on the West Coast for mining site inspections, there are many limitations in their practical use for data collection purposes at a national scale. Most notably, drones are limited in range and must be flown within line-of-sight of the skilled operator. There are also many ethical/privacy considerations. However, drones could be effective for compliance patrols (i.e., capturing illegal fishing activities, providing evidence in court). Despite the challenges we had acquiring drone footage (due to birdstrike) we were able to contract a drone operator to accompany Operations staff on the Wairau River in Marlborough. An example image of scoop netters at mouth of the Wairau is shown in Figure 32 (also see [Appendix 4](#)).



Figure 32. Image captured, via drone, of scoop netters at mouth of the Wairau River on 24 November 2021

### 5.3 Whakatāne case study

Here we discuss the results of the district-led community engagement approach and species catch composition study that was done in three eastern Bay of Plenty whitebaiting rivers. The overall aim of the study was to identify and describe ‘whitebait’ species composition collected in accordance with maramataka (Māori lunar calendar), on three rivers in the Whakatāne district. The specific questions, identified during pre-season wānanga, that the community wanted DOC Whakatāne staff to address were:

- Is there a difference in species composition at different times of the season?
- Is there a time when less of the threatened species are running in our rivers?
- Is the proposed change in season length going to have a knock-on effect of increased fishing pressure in key times of the threatened species run?

Bimonthly sampling on three eastern Bay of Plenty rivers showed that the proportion of species in the whitebait catch changes through time (Fig. 33). This is consistent with the results of research by Yungnickel et al. (2020) and Rowe et al. (1992). For the Tarawera and Whakatāne rivers, the whitebait catch was predominantly comprised of īnanga (*Galaxias maculatus*) at the beginning of the season (September) and shifted to greater proportions of smelt (*Retropinna retropinna*) later in the season (October). The Waioeka River catchment has a greater proportion of forest cover and had greater proportions of banded kōkopu (*G. fasciatus*).

To aid visual identification of whitebait species subsampled from the Bay of Plenty whitebait pilot rivers, eDNA samples were taken on three of the subsampling occasions. The method was easily applied by rangers, results matched whitebait species found in catchments of river samples taken from the NZ Freshwater Fish Database, and were largely consistent with visual identification. Rarer species such as shortjaw and giant kōkopu (*G. postvectis* and *G. argenteus*) were not identified in subsamples, but low numbers of those species in catch and even lower numbers in subsamples meant they may not have been picked up in physical samples. The match between whitebait species detected in eDNA samples and occurrence in river catchments is shown in Figure 34.

Giant kōkopu and shortjaw kōkopu are probably the most threatened species in the whitebait catch, and although they were present, as evidenced by our eDNA results, they contribute much lower proportions to the catch composition compared to īnanga, banded kōkopu, kōaro (*G. brevipinnis*), and smelt (Yungnickel et al. 2020). It is unknown if the proposed change in season length will increase fishing pressure in key times of the threatened species run. Yungnickel et al. (2020) provide evidence that shortjaw kōkopu are most present in the Bay of Plenty whitebait catch during the month of October.

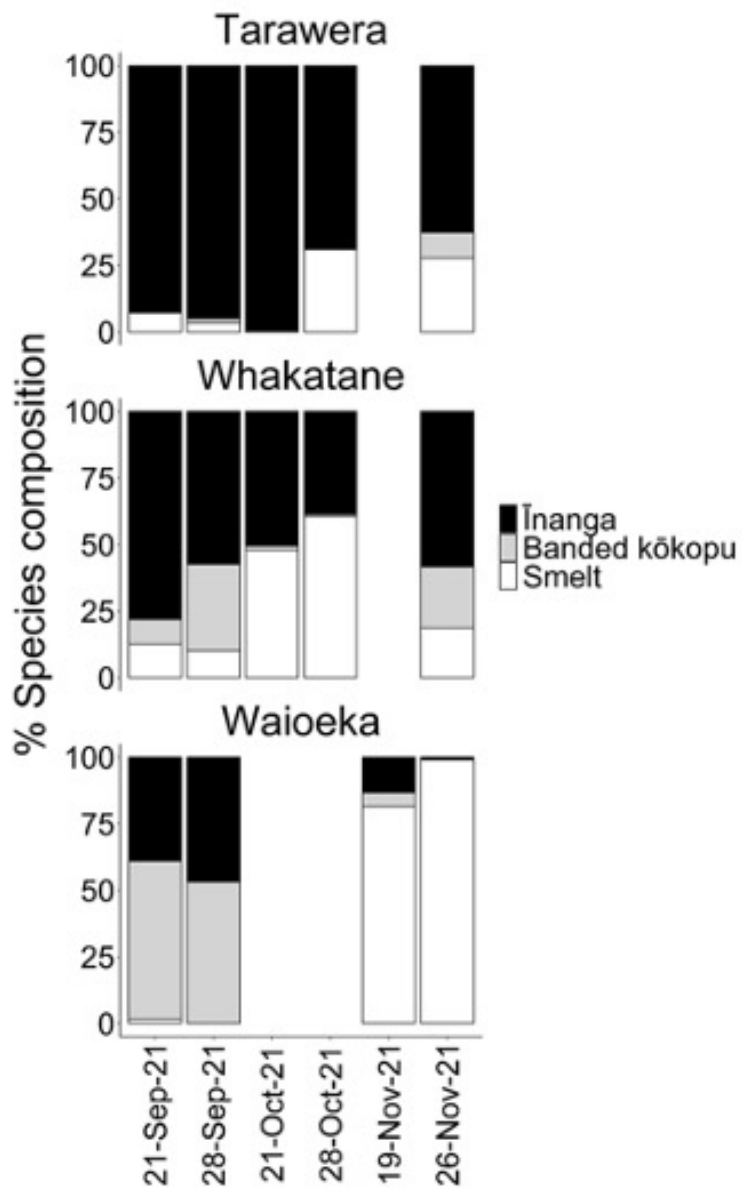


Figure 33. Percent species composition of the whitebait catch at three rivers in the eastern Bay of Plenty throughout the fishing season.



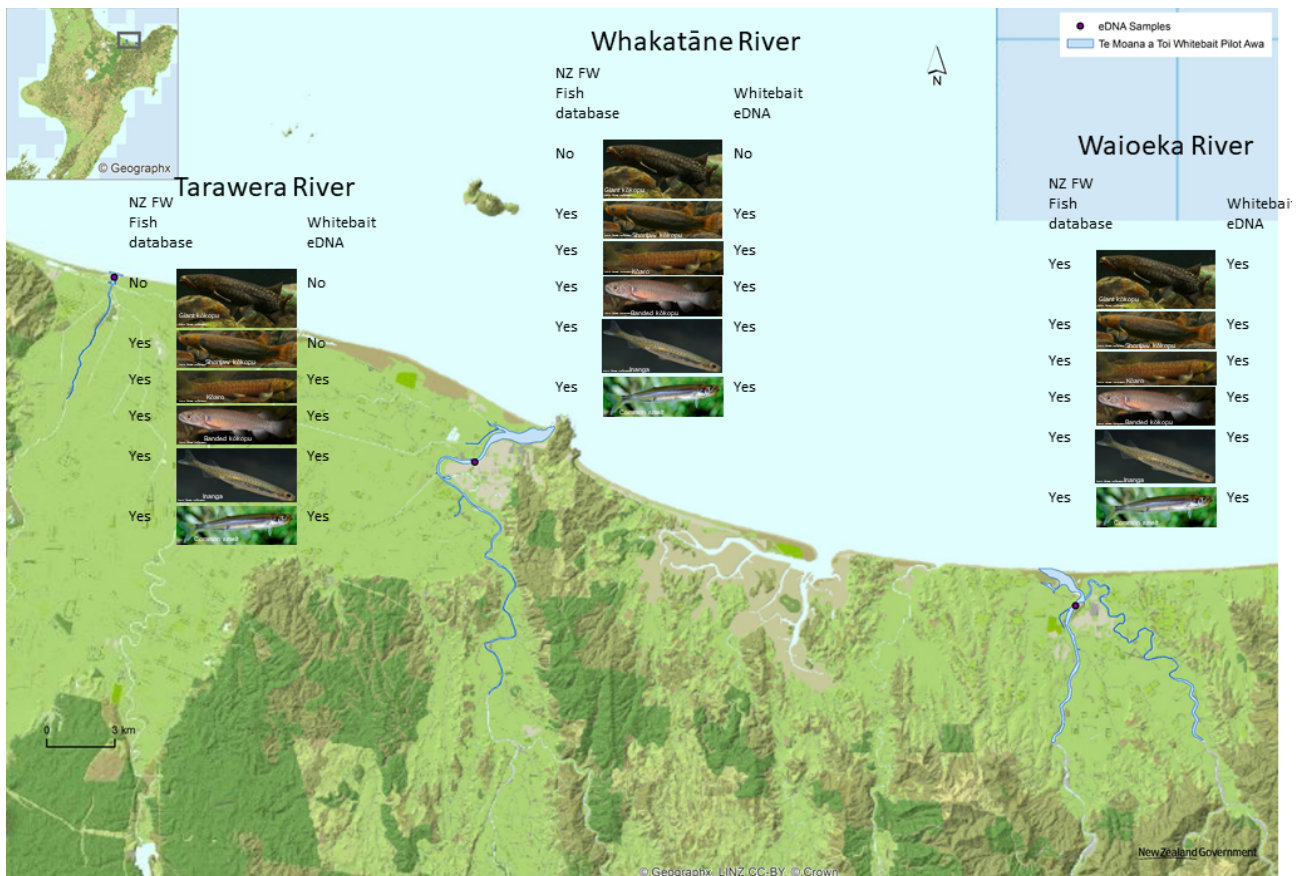


Figure 34. Results of eDNA analysis versus whitebait species found in Bay of Plenty whitebait pilot rivers NZ Freshwater Fish Database Records. Whitebait species pictured (top to bottom): giant kōkopu, shortjaw kōkopu, kōaro, banded kōkopu, īnanga, and common smelt.

## 5.4 Social survey of whitebaiters

*Taken from the Executive Summary of the social survey report from the Marine Ecology Research Group, University of Canterbury:*

The November 2021 electronic social survey of whitebaiters had 589 responses. Most respondents were male, NZ European, and over 45 years old. Most lived in Canterbury ( $n=234$ ), Southland ( $n=83$ ), or on the West Coast ( $n=205$ ), and whitebaited in their home region.

Respondents placed considerable importance on social reasons (especially those that fished on the West Coast), recreational reasons, and food-gathering reasons for whitebaiting. Commercial reasons for whitebaiting were not important in most regions, but were extremely important for respondents that lived or fished on the West Coast.

The majority of respondents had only whitebaited in a single river and region during the previous five years. The median distance travelled by whitebaiters to get to their fishing river was 31.6 km, but this differed significantly between regions. Some regions attracted whitebaiters from a large number of other regions; over 65% of whitebaiters on the West Coast had travelled from another region, particularly Canterbury.

Scoop, set, and sock nets were commonly used. Scoop nets were used more often by younger respondents and in Canterbury. Sock nets were used more often by older respondents and in Southland. Set nets were used more often in Manawatū-Whanganui and Wellington. Most respondents did not whitebait from a registered stand, but those that did commonly used set or sock nets. Respondents fishing from registered stands spent more days per season whitebaiting.

Respondents that were of retirement age spent more days per season whitebaiting than younger respondents. Respondents that spent the most days per season whitebaiting generally fished on the West Coast and in Southland, and more often fished with sock nets. Most respondents whitebaited for  $\leq 6$  hours per day, but those fishing in Tasman tended to fish for longer. Most respondents fishing with a scoop net whitebaited for  $\leq 3$  hours per day, but those fishing with set or sock nets more commonly fished for  $> 6$  hours.

Most respondents had moderate views on whether improvement was needed to the whitebait fishery. Most agreed that the fishery would be improved by better enforcement of the current regulations and restoration of adult habitats, but disagreed that the introduction of a whitebaiting licence or closure of more rivers to fishing would have the same effect. Respondents had mixed views about the need for changing the current regulations or placing a limit on daily catch to improve the whitebait fishery.

Half of the respondents indicated that they never sold their catch, but a higher proportion of those that lived or fished on the West Coast did do so. Respondents that sold their catch tended to fish for a greater number of days per season.

Over 40% of respondents provided their contact details so that they could be contacted for feedback on the whitebait fishery in the future.

## 6. Conclusion

As stated in our introduction, data on the nature and extent of whitebait fishing is largely absent. We listed some existing data on whitebaiting structures held by regional councils and iwi, and examples of local district initiatives to collect data. Basic information such as the number of whitebait fishers, their locations, and fishing methods are critical components to consider when making fisheries management decisions. These data are especially useful to take into account without knowledge of fisheries harvest (i.e., catch/take) or how natural (non-exploited) populations are regulated. Therefore, the identification of whitebaiting rivers, estimated numbers of whitebaiters using those rivers, and their fishing methods, were deemed as the highest value and most achievable baseline information to be gathered in a short timeframe (two seasons) with minimal disruption to programmed operational work. Focus was directed toward fishers because whitebait fishing effort, while inherently variable, is less variable than whitebait fisher catch.

Compared to previous whitebait seasons, the 2021 season was atypical due to COVID-19 travel-related restrictions and further complicated by unfavourable weather conditions that restricted DOC's efforts to perform compliance patrols, and fishers' ability to go whitebaiting. Although limited compliance was carried out throughout the course of the fishing season, at least one compliance patrol was undertaken on 27 of the 75 rivers identified to be important for whitebaiting in the South Island (as reported in Kelly (1988)), and although overall the fisher numbers recorded were fewer than those reported by Kelly (1988), the popular rivers for whitebaiting remained the same.

The finding that fishing methods and structures used varied by district and river was consistent with our expectations. In Tasman and Canterbury, whitebaiters do not fish from structures, whereas in Southland and on the West Coast (South and North Island) most rivers have stands or structures. Another notable feature of the fishery is the diversity of fishing methods and nets used to take whitebait. In addition to the Whitebait Fishing Regulations, net size and type and fishing method are influenced by water depth, bank contour, Kiwi ingenuity, and in some districts, tradition. An interesting result was that only set nets were observed being used by whitebaiters actively fishing in Southland rivers surveyed during the 2021 compliance patrols. However, this result is most likely a consequence/coincidence of when the compliance patrols occurred as whitebaiters are known to change fishing methods depending on the tide state (i.e., alternating between scoop-netting and set-netting according to the tide). We did not receive whitebait activity forms for North Island rivers, which we acknowledge as a significant data collection gap to address in the 2022 season. The trial of aerial imagery on pilot whitebaiting rivers found this method was suitable for counting whitebaiters, methods, and structures especially on South Island rivers. Although we were unable to catalogue whitebaiting methods on North Island rivers, we were successful in trialling aerial approaches to data collection (fixed-wing and drone) at pilot regions nationally. Results from the fixed-wing flights demonstrate the wide variety and extent of whitebait stands, structures, and nets used across the country.

Compared to ground observations, aerial (fixed-wing) observations were more accurate spatially and for determining fishing method and, in general, recorded more fishers. Added benefits to the high-resolution, georeferenced imagery was the ability to map whitebait stands or structures and the ability to fly multiple rivers in one day. Unfortunately, due to COVID-19-related travel restrictions and use of a South Island-based aerial imagery company, flights for the North Island rivers were performed late in the season and do not reflect peak-fishing numbers. While aerial images are a good method for quantifying fishers, methods used, measuring fishing gear, and mapping stands, there are limitations with using them for data collection purposes. Besides the high cost to capture the images and the large amount of time required to process them, the time of season and tide state also need to be considered and

carefully coordinated with pilots. Depending on the river, time of season, and/or tide state, whitebaiters may be absent or visually missed when processing the images. For example, an incoming high tide may push fishers back into the bush, under overhanging vegetation, making them, and their fishing method, difficult to identify. The use of drones was also trialled and may be useful for capturing and prosecuting illegal fishing behaviour, however, there are more limitations in their practical use for data collection purposes at a national scale compared to fixed-wing flights. Most notably, drones are limited in range and must be flown within line-of-sight of the operator, and ethical/privacy considerations must be made. We recommend that further use of aerial image capture be considered as a core survey and monitoring tool of whitebaiting effort.

The national data/pilot information gathered during the 2021 season illustrates how diverse the whitebait fishery is not only by region, but at the river level. While the diversity we documented relates mostly to fishing methods and gear types, our pilot project in three eastern Bay of Plenty rivers documented how diverse the species composition of the whitebait catch is spatially and temporally.

A limitation to the field/remote data we gathered this year was our inability to distinguish between commercial and recreational fishers. However, the social survey of whitebaiters captured some of this information. One of the main messages conveyed in submissions on the policy reforms was to make the fishery more sustainable and fairer (equity of opportunity to fish).

Dr Nicolas Pirsoul prepared a guidance document on how focus group sessions could be held for future engagement (see [Appendix 4](#)). The purpose of the proposed exercise is to gather information related to the experiences, preferences, and perceptions of people with an interest in the fishery regarding the fairness and efficiency of the current whitebait regulations. It may be a useful information-gathering approach for 2022.

It is also important to mention the potential use of existing information that some recreational and commercial whitebait fishers hold, such as the Cascade Whitebait Company's catch diaries, that would be useful for estimating harvest, examining regional variations, and determining economic impact. Data gathering for 2022 should include, at the very least, a collation/inventory of available catch diaries and analysis of their metadata.

Finally, the social survey completed and analysed by the Marine Ecology Research Group (University of Canterbury) towards the end of the 2021 season produced valuable results, from characterising why people go whitebaiting to the distance they travel to fish during the open season. It may be useful to expand upon these results next year to help inform future management decisions.

In conclusion, despite the difficulties of operating in a COVID-19 environment, we were able to collect important baseline information on the whitebait fishery, especially for the South Island, regarding whitebait rivers, fisher numbers, gear types, and methods used. A number of challenges remain around the Department's ability to comprehensively gather important data (such as numbers of recreational vs. commercial fishers) for the 2022 season. Exploring licensing schemes may be a fruitful area for future work.

## 7. Acknowledgments

This work would not have been possible without the help of Department of Conservation staff, in particular: Terry Greene, Doug Cairns, Ray Bennett, Ray Scrimgeour, Eriora Park, Rebecca Hunter; and former Department of Conservation staff Doug Taucher, Chris Annandale, and others. We thank Jane Goodman, who reviewed the report, and editor Kate Beer.

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# Appendix 1

## Summary of knowledge gaps relating to the whitebait fishery

The following covers the kind of information we need and can collect, and make meaning of, in the next two years.

SCOPE	SOCIAL	ECONOMIC	BIOLOGICAL
Achievable in next two years	<ul style="list-style-type: none"> <li>• <b>How many fishers<sup>a</sup></b> and <b>where</b> (major and possibly medium rivers) – nationwide               <ul style="list-style-type: none"> <li>- If possible, will include <b>method</b> of fishing.</li> </ul> </li> <li>• Understanding level of compliance (both by fishers, and DOC effort)</li> <li>• Fisher effort and harvest – quasi-national level               <ul style="list-style-type: none"> <li>- list of pilot rivers (Waikato, Wairau – Marlborough, Bay of Plenty, West Coast, Southland)</li> <li>- Remote sensing data on pilot rivers</li> </ul> </li> <li>• Perceptions of new regulations on whitebaiters' success and satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>• Whitebait buyers, number</li> </ul>	<ul style="list-style-type: none"> <li>• Effectiveness of changes               <ul style="list-style-type: none"> <li>- Season</li> <li>- Refuges</li> </ul> </li> </ul>
Important, but very hard in two years	<ul style="list-style-type: none"> <li>• Effectiveness of, and response to, regulation changes</li> </ul>	<ul style="list-style-type: none"> <li>• Commercial value vs. recreational value</li> </ul>	
Research opportunities		<ul style="list-style-type: none"> <li>• Value of refuges</li> </ul>	<ul style="list-style-type: none"> <li>• Potential trends: population/scale<sup>b</sup></li> <li>• Larval-sea survival &amp; dynamics</li> <li>• Fishery escapement/ proportion of the run that escapes harvest</li> <li>• Harvest trends</li> <li>• Catch composition</li> </ul>

<sup>a</sup> Number of whitebaiters (survey at sites, number of stands, cars in a car park, boat ramp surveys, social survey, aerial surveys).

<sup>b</sup> Catch diaries which include effort, harvest, utilisation of catch (adding to historical data); survey fishers at site; utilise standardised fishing techniques.

# Appendix 2

## Summary of draft 2021 whitebaiting activity data collection programme – by data

Objective for 2021: Test methods ready for application in 2022.

Principles:

- Testing methods for implementation and utility.
- Ground-truthing of information gathered.
- Remember needs not prioritised in year 1, i.e. financial and other value of fishery/fish.
- Test with other experts/sectors.
- Capture fishery information from whitebaiters who do not complete surveys nor engage with rangers.
- Sustainability of the fishery is the overarching goal (don't lose sight of what info can we collect-use to answer).



Table A2.1. Summary of draft 2021 whitebaiting activity data collection programme – by data.

	TYPE OF INFORMATION (IN PRIORITY ORDER)	DESCRIPTION	OBJECTIVE FOR 2021	APPROACH IN 2021	METHOD (ORDER OF PREFERENCE, * AT PILOT SITES)	NOTES
1	Number of whitebaiters by location (major rivers).	How many whitebaiters are there, where do they fish, and how do they fish?	Develop the method. Collect some data as a by-product of method testing.	Trial approaches including aerial counts, on-site observations, GPS data, other?	<p>1. <b>Aerial counts* (DOC Biodiversity staff lead)</b></p> <p>2. Observational counts by DOC rangers on-river BAU. Operations staff.</p> <p>3. Estimates by key informants (including DOC rangers):</p> <ul style="list-style-type: none"> <li>• Revisiting Kelly 1988 whitebaiting rivers rec-com value 1–3.</li> <li>• RIVAS whitebait river regional workshops (aligned with revisiting Kelly 1988).</li> <li>• This work could be led by anyone.</li> </ul> <p>As top priority information, target this work during the 2021 season.</p>	<p>Ideal metric – total number of whitebaiter days p.a.</p> <p>Also useful to identify where fishing does <u>not</u> take place.</p>
2	Characteristics of whitebaiters, their activity, and their perceptions.	Who goes whitebaiting, what are their expectations, and are they satisfied with key aspects of their whitebaiting experience? Do they comply with the regulations?	Confirm priority data needs. Develop and test questions for those data needs. Collect some data as a by-product of method testing.	Test questions through off-site approaches (e.g. known networks, key informants). Test questions through on-site survey.	<p>1. <b>Develop survey</b>, ideally able to answer multiple information needs. Target whitebait associations and public. Enable other methods of collecting answers too? On-site, phone calls, or in-person interviews. Potential bias if too targeted.</p> <ol style="list-style-type: none"> <li>a. Draft and test questions.</li> <li>b. Test different survey approaches (online, on-site, interviewer administered, etc.).</li> <li>c. Build database.</li> </ol> <p>2. Social media, i.e. Facebook (as a source of data on specific FB groups).</p> <p>3. Mātauranga Māori (could contribute to other info needs too).</p> <p>While we are not yet clear on what is required for mātauranga Māori, the other components do not require on-site data collection during the 2021 season.</p>	<p>Collect usual sort of information about a person and their fishing, e.g. home location, age, number of years whitebaiting, locations fished, methods used.</p> <p>Also questions about perceptions of their experience and self-reporting about their compliance.</p> <p>Will off-site testing need to be done first, and will time run out for on-site testing?</p> <p>Test methods through DOC rangers.</p> <p>Mātauranga Māori: we acknowledge this is an important consideration for research and management decisions, and are working to understand how it will be incorporated into the work. It might be one aspect of survey design, or might be something different altogether – therefore best to keep it separate for now.</p>

Continued on next page

Table A2.1 continued

	TYPE OF INFORMATION (IN PRIORITY ORDER)	DESCRIPTION	OBJECTIVE FOR 2021	APPROACH IN 2021	METHOD (ORDER OF PREFERENCE, * AT PILOT SITES)	NOTES
3	Effect of new regulations (whitebaiters' perceptions and responses), and equity of opportunity to go whitebaiting.	<p>What do whitebaiters know and think about the new regulations (awareness and perceptions)?</p> <p>What has changed for them as a result of the new regulations?</p> <p>Questions about their knowledge and perceptions. Self-reporting on changes they have made or experienced.</p> <p>Is the opportunity to go whitebaiting equitable?</p> <p>What issues impede the opportunity to go fishing, and who is experiencing these issues?</p> <p>Property rights.</p>	Gain indication whether regulations favour particular types of fishers or fishing methods (i.e. some data collected).	<p>Use focus groups to examine whether regulations favour particular types of whitebaiter/method.</p> <p>Because we expect poor awareness of new regulations by whitebaiters, little point in asking them about the regulations through survey.</p> <p>Use data (point 2 above) to develop profiles for different types of whitebaiter.</p> <p>Consider whether any proxies for equity (e.g. stand price as proxy for advantage of fishing with a stand).</p>	<p>1. Key-informant focus groups to (a) segment different types of whitebaiters, and (b) understand likely effects of regulation changes on segments. Run in advance of survey design, as will inform survey question design.</p> <p>2. Test questions for survey of whitebaiters to gather perceptions data and including questions to segment whitebaiters (same survey as for #2; doesn't have to be tested on-river during the season, could be done after the season through known whitebaiters).</p> <p>Plan to run focus groups sooner rather than later, as these events will provide a wealth of info (there is a lot of knowledge, but it needs to be gathered and collated).</p>	<p>No baseline data to objectively measure change. Suggests: (1) collect baseline data now and what are those data? (2) Perceptions data best can do for now.</p> <p>Collate existing equity literature, e.g. LAWf equity research, MfE &amp; MPI help??</p> <p>Revisit RIVAS whitebait method attributes, e.g., access to and along river, social conflict, and crowding</p> <p>Profile types of whitebaiters – e.g. mum-and-dad locals ('local lifestyle'), primarily a business motive ('sellers'), annual family trip to back to fish ('holiday lifestyle').</p> <p>Particular interest in black market commercial fishers, as a key part of the 'problem'.</p> <p>Need to understand who wants to whitebait but cannot (latent demand), or used to and stopped – or is this too sophisticated?</p>
4	Volume of harvest.	How much whitebait is harvested? Ideally recorded by: location (major rivers); change over time; and use category (recreational, commercial, customary).	Develop approach to quantify harvest?	<p>Through key informants (off-site methods).</p> <p>Test willingness of whitebaiters to talk about catch size through survey.</p>	<p>1. Proportion of harvest that is recreational vs. commercial, same river.....* via buyers, river survey, diaries, include scientific sampling (i.e. No. 2).</p> <p>2. Estimate of run (season?) harvest, work out feasibility of quantifying amount of catch entering river and still swimming after whitebaiting section (has been trialed before, more could be done – is it worth the cost/effort?).</p> <p>3. Key informant estimates.</p> <p>4. Whitebaiter surveys.</p> <p>5. Run estimates side-by-side to test validity.</p> <p>Unknown: how would you evaluate efficacy of different methods?</p> <p>This is our lowest-priority data. As someone said in a previous meeting – could gobble up a lot of effort with very little benefit. We are inclined to say: "too hard for now".</p>	<p>Ideally, estimate the total volume of whitebait harvested annually in NZ.</p> <p>Need separate estimate of commercial harvest?</p> <p>Very hard to estimate harvest – could spend a lot of time with little result. Is this a 'nice to have'?</p>

# Appendix 3

## Whitebaiter activity recording form: example

Whitebaiter Activity Recording Form									
Ranger: Rick			Weather Conditions (circle one): Storm (heavy rain) Rain (steady rain) Showers (intermittent) <u>Clear/Sunny</u>						
River: MoKihinvi		District: West Coast		% Cloud Cover: 20%		Tide you are working (circle height, direction and type)		Tide times: High 16:13 Low 09:59	
Date: 14-Sep-2021			Reason for survey: CLE			Low <u>Mid</u> High		Amount of Rain in the last # of hours (circle)	
Start time: 13:00		Finish time: 13:30		Coordinates (NZTM): 1511386 E 5402969 N		Coordinates (NZTM): 1513333 Easting 5401883 Northing		24 hrs ≤ 2 cm <sup>NONE</sup> 2cm < 4cm ≥ 4 cm	
Coordinates (NZTM): 1511386 E 5402969 N		Coordinates (NZTM): 1513333 Easting 5401883 Northing		Incoming <u>Outgoing</u>		Spring / <u>Neap</u>		48 hrs ≤ 2 cm 2cm < 4cm ≥ 4 cm	
River Bank		Fishing Method				Time observed		Catch	
		Scoop net		Set net				Additional info not required, but if available very helpful	
L R		stand	not stand	stand	not stand	Drag net	Other/Notes		
							Approx. amount		
							Time spent fishing		
✓			3				Starting patrol at river mouth on left bank moving upstream		
✓			2				13:00		
			1				13:01		
✓			1				Fishing in middle of River mouth		
							13:03		
✓					2		13:05		
							13:06		
✓					1		13:06 1 Kg 2 hrs 15 min		
✓					1		13:10 1/2 Kg 1.5 hrs		
				3			13:11		
✓		1					Can provide catch diary Whitebaitjoe@gmail.com		
✓				✓			13:25 2 Kg 4 hrs		
							13:25		
✓			✓				13:26		
✓				1			13:27		
✓							Fishing from pontoon using a pole net		
							13:29		
✓					2		13:29		
							13:30		
✓				6					

# Appendix 4

## Internal file references for DOC staff

p 8: "... a variety of whitebaiting rivers from around Aotearoa New Zealand were identified by DOC staff as pilot rivers for more detailed assessment and study" ([docCM link](#))

p 43: "Dr Nicolas Pirsoul prepared a guidance document on how focus group sessions could be held for future engagement" ([docCM link](#)).

### *Whitebait activity forms*

All whitebait activity forms received for the 2021 season are stored in individual region folders in DOC's AWS J Drive under this filepath:

J:\Monitoring&Reporting\National Whitebait Data\Whitebait Activity Forms - 2021 Season.

### *Original aerial image files*

All fixed-wing aircraft images are stored in individual folders in the AWS Q Drive, and individual ArcMap projects with aerials and supporting information added are in the river folders, here:

Q:\GIS\_National\_Groups\Freshwater\Projects\Whitebait\Whitebait\_National

All drone images and video footage are stored in AWS J Drive, here:

J:\Monitoring&Reporting\National Whitebait Data\Wairau Drone Footage