Annual FSC® Monitoring Report 2021

PF Olsen FSC® Group Scheme NC-FM/COC-000190

January 2022

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Author: ....

Sarah Orton 2 February 2022

Environmental Forester

1. Introduction

About PF Olsen

PF Olsen is the leading provider of independent professional forestry services in New Zealand. The company manages significant plantation forest estates and many small to medium-sized woodlots across New Zealand. On behalf of our clients, PF Olsen's annually harvests and markets millions of cubic metres of logs.

We pride ourselves on our reputation for delivering a wide range of professional forestry services to a diverse range of clients including TIMOs, farmers, investors, Māori groups, government agencies and others.

We assist forest owners to minimise and manage investment risks, establish, grow and protect high-quality forests and finally maximise the recovery of value from forest harvest operations, using the latest analytical tools and leading-edge technology.

Forest Stewardship Council (FSC®)

The Forest Stewardship Council (FSC®) is an independent, not-for-profit organisation headquartered in Germany, founded to promote the responsible management of the world's forests. FSC® certification is a means by which our clients can be confident that we are managing their forests in a legal, responsible and sustainable manner.

All forests certified by FSC® must comply with an international set Principles and Criteria. The requirements of FSC® cover the full range of forest management, including complying with the law, environmental requirements (water quality impacts, soils, biodiversity, chemical use etc.), social requirements (worker rights, indigenous people's rights, stakeholder and community benefits etc.), alternative benefits of the forest beyond core forest products, and sound and economically viable forest management practices.

FSC® accredits auditors, who undertake annual audits of FSC® certified forestry operations to confirm compliance with FSC® requirements. The PF Olsen Group Scheme is currently audited by Preferred by Nature.

For further information about FSC® visit https:// fsc.org/en, or https://nz.fsc.org/en-nz.

PF Olsen FSC® Group Scheme

PF Olsen operates New Zealand's first FSC® Group Scheme. The certificate (NC-FM/COC-000190) is held by PF Olsen on behalf of the clients. Should a client choose to leave PF Olsen and/or the Group Scheme, the certificate remains with PF Olsen, the forest is deregistered and decertified.

2. Estate Description

Members

PF Olsen's Group Scheme currently consists of the following members:

Membership Type	Umbrella Client	Number of Forests	Certified Area (ha)	New Members Dec-2021	Deregistered Forests Dec-2021
Resource	China Forests Group (CFGC)	3	3,178.3	0	22
	Nelson City Forests	4	1,837.6	4	0
	PĀMU Farms of New Zealand	7	5,466.1	0	0
	Tasman District Council	6	3,253.2	0	0
	Independents	9	2,265.9	0	3
Group	Independents	3	297.8	1	0
TOTAL		**32**	**16,298.9**	**5**	**25**

Resource members are those for whom full management is undertaken by PF Olsen Ltd under the framework of their FSC® systems. Group members manage their forests, but under the oversight and within the framework of the PF Olsen Ltd FSC® systems.

Area

As of 31 December 2021, the forest and land estate managed under the group scheme certificate contains the following vegetation/land types. On an aggregated basis, the area of indigenous reserves and protected areas is substantial at 24% of the total land area.

Area Type	Area (ha)	Area (%)
Planted	11,770.1	72%
Radiata pine	11,121.6	
Douglas-fir	248.7	
Native Species	145.8	
Acacias	98.4	
Redwoods	135.4	
Other Minor Species	20.2	
Awaiting Planting / Cutover	667.1	4%
Indigenous Reserves	3,861.7	24%
Total Area	**16,298.9**	**100%**

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Productive and replanting areas are accurate. Reserve areas are subject to variation as ongoing programmes of assessment and in some cases, minor retirement from production forest and/or 'setting-back' from streams leads to redefinition and minor area changes.

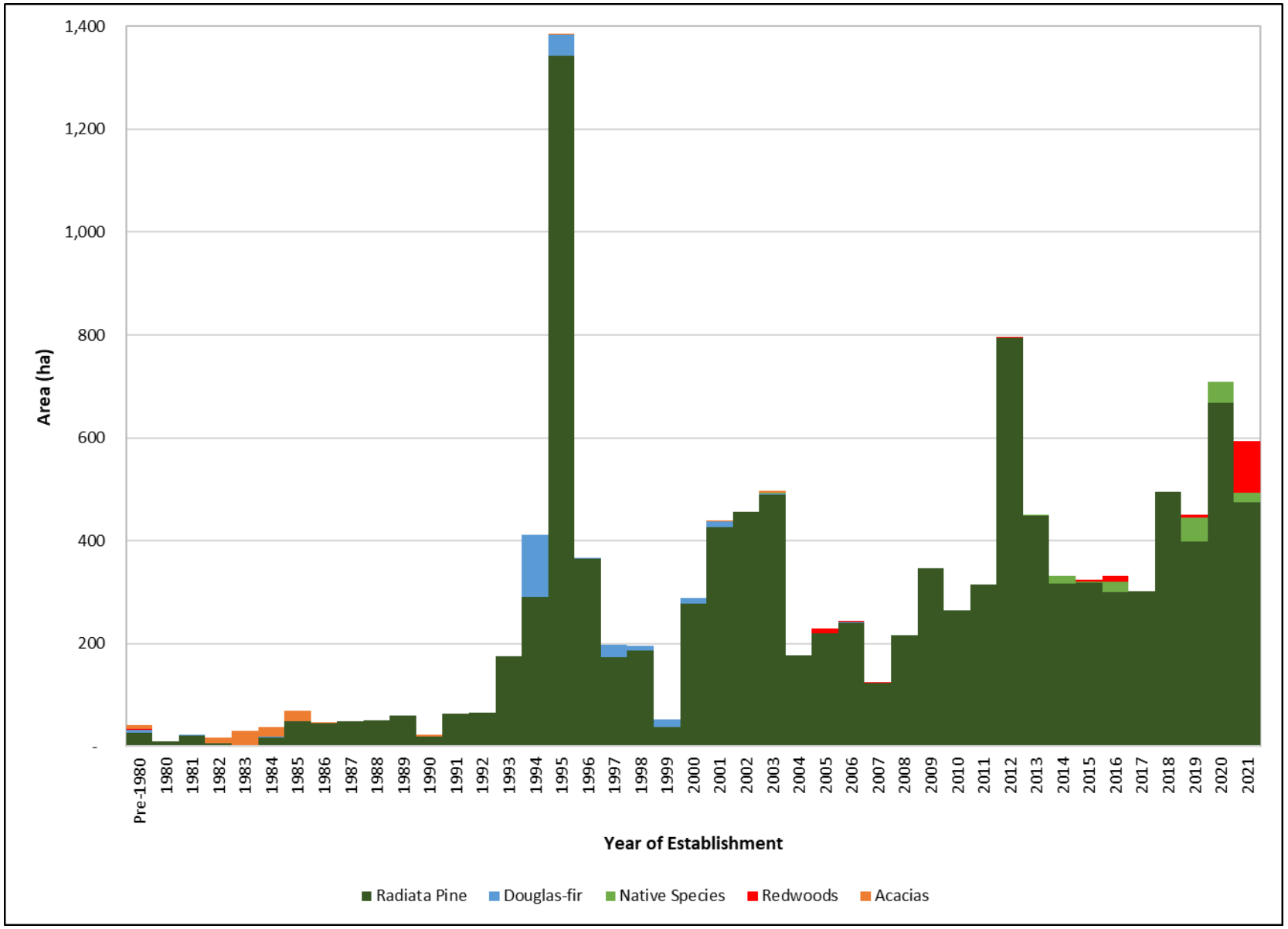
Equally, as some cutting rights are completed and the underlying land is returned to the owners, some of the indigenous reserves may also be "returned" leading to deductions from the totals on a year-to-year basis.

Species mix

The productive plantation forest is made up of a range of species with the predominant species being *Pinus radiata*. This species is present throughout most of New Zealand due to its capability to grow rapidly and predictably on a wide range of sites, paired with well-established markets and processing capability.

Age distribution

The age-class distribution of forests managed under the PF Olsen Ltd Group Scheme ranges from newly planted stands to those ready for harvest. The distribution illustrates a loss in area for stands of harvesting age (as would be expected) but also gains in area from the younger age classes as forests have been added to the certificate register and replanting occurs.


1,400
1,200
1,000
800
600
400
200
-
Area (ha)
Pre-1980
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Year of Establishment
Radiata Pine
Douglas-fir
Native Species
Redwoods
Acacias

Additions / losses to the Group Scheme

During 2021, 25 forests were withdrawn from the scheme. One upon the completion of harvest, two because the owners no longer wished to retain membership of the scheme, and 22 were withdrawn as a result of a change in forest management company. Forests are typically withdrawn due to changes of manager, completion of harvesting and transfer of cutting rights, or landowners indicating that they will not pursue certification maintenance.

Over the same period, ten new forests entered the PF Olsen Group Scheme and PF Olsen expects to certify up to 45 forests in the next twelve-month period.

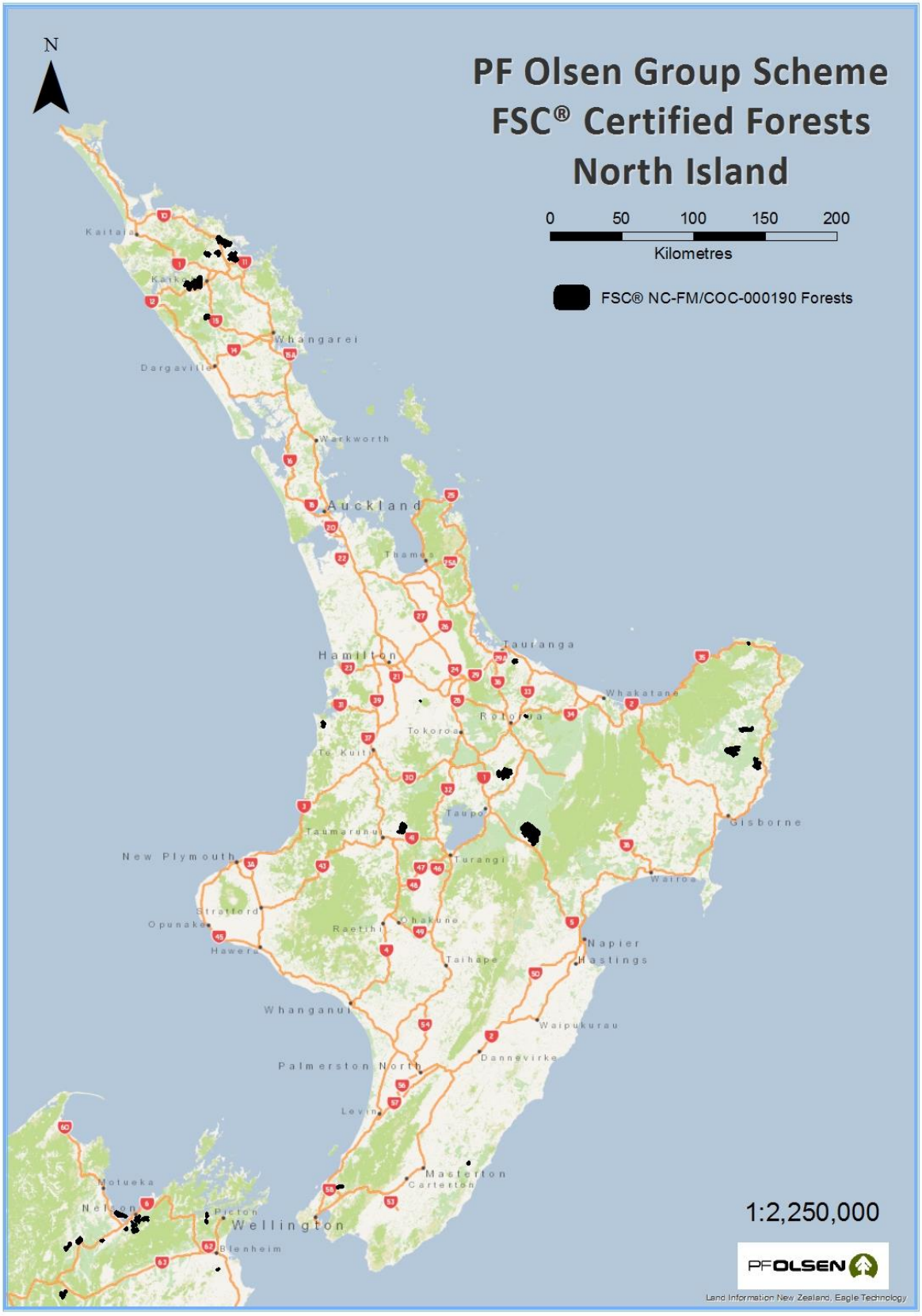
Stakeholders

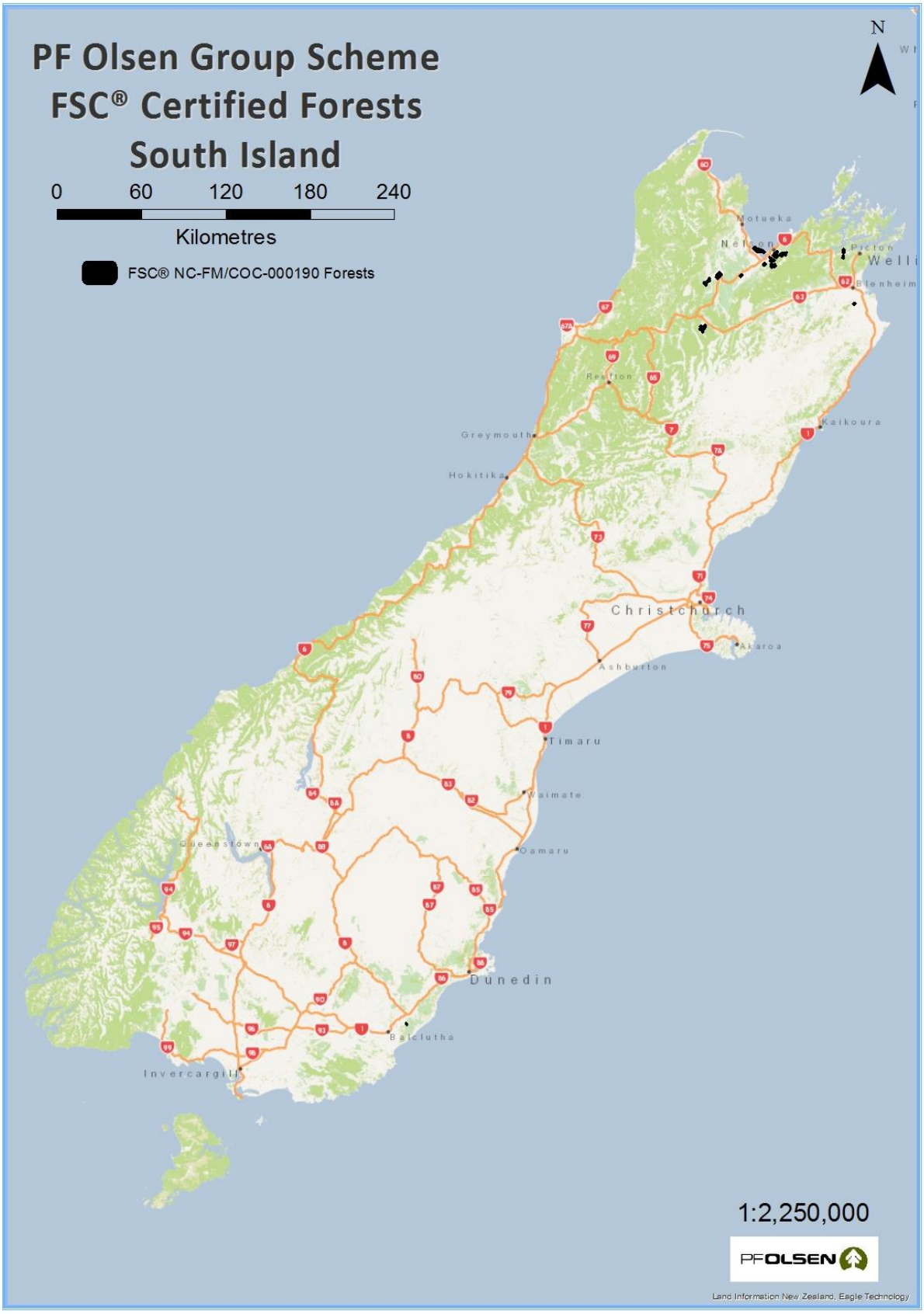
Based on the nature of PF Olsen's FSC® Group Scheme, stakeholders can either be categorised as local or national stakeholders.

Local stakeholders typically consist of forest neighbours, local councils, iwi, and any other groups that may have an interest in the forest (e.g. recreational users, hunters, community conservation groups). National stakeholders are the people and entities that get notified of every certification regardless of the forest's location. They tend to be other forestry companies with FSC® certified forests, government/statutory agencies (e.g. Department of Conservation, Walking Access Commission, Fish and Game Council) and environmental Non-Governmental Organisations (e.g. Forest and Bird, Federated Farmers).

Stakeholders are consulted during the initial stages of a client joining the Group Scheme, to provide feedback on the forest management plan. After certification, stakeholders are consulted if planned forestry operations may impact their land, their interests or their activities (e.g. when harvesting may impact a property boundary or recreational areas).

2.1 Map of 31 December 2021 FSC® forest locations




PF Olsen Group Scheme
FSC® Certified Forests
South Island
0 60 120 180 240
Kilometres
FSC® NC-FM/COC-000190 Forests
N
Motueka
Nelson
Picton
Blenheim
Reefton
Greymouth
Hokitika
Kaikoura
Christchurch
Akaroa
Ashburton
Timaru
Waimate
Queenstown
Oamaru
Dunedin
Balclutha
Invercargill
1:2,250,000
PFOLSEN
Land Information New Zealand, Eagle Technology

3. Health and Safety

Safety Performance

PF Olsen recorded eleven serious injuries (seven Lost Time Injuries and four Medical Treatment Injuries) during 2021. This was a solid reduction from previous years results – 13 in 2020 and 22 in 2019.

Of these injuries, the most serious were two breaking-out (hauler extraction) incidents. In one, a breaker-out was struck by a partially severed stump; in the other, a breaker-out was crushed under stem. Both incidents have been thoroughly investigated with the key finding being 'upset conditions combined with the normalisation of deviation'. These findings have been widely communicated to PF Olsen staff and contractors.

Staff commitment to safety has continued to improve in our areas of focus:

- We reported 400 incidents – a 9.3% increase on 2020 of which 64 reports were proactively identifying sources of risk of harm.
- Driver speed events were 57% less than the national average (as reported by Argus Tracking).

Apart from a solid range of Key Performance Indicator measures for 2022 e.g., training new operational employees, investigation training and system simplification, our 2022 business plan includes two new safety initiatives, summarised as:

- **Boot's n All!** – "Can We Give You a Hand?" a programme to move the Quality, Health and Safety team closer to the action, to help staff with inadequacies and to enable a first-hand knowledge of staff safety issues.
- **Be That One!** – "Looking for Safety Legends" a Quality, Health and Safety rewards and recognition initiative to identify positive examples of the eight sub-themes that counter Normalisation of Deviation.

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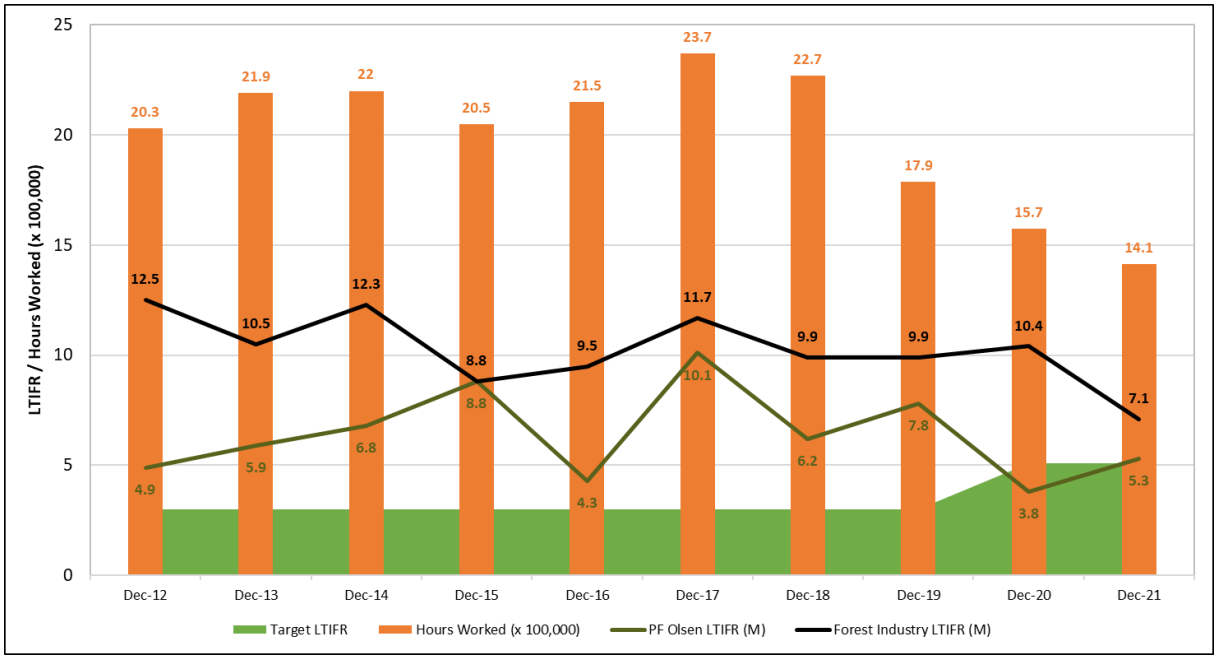

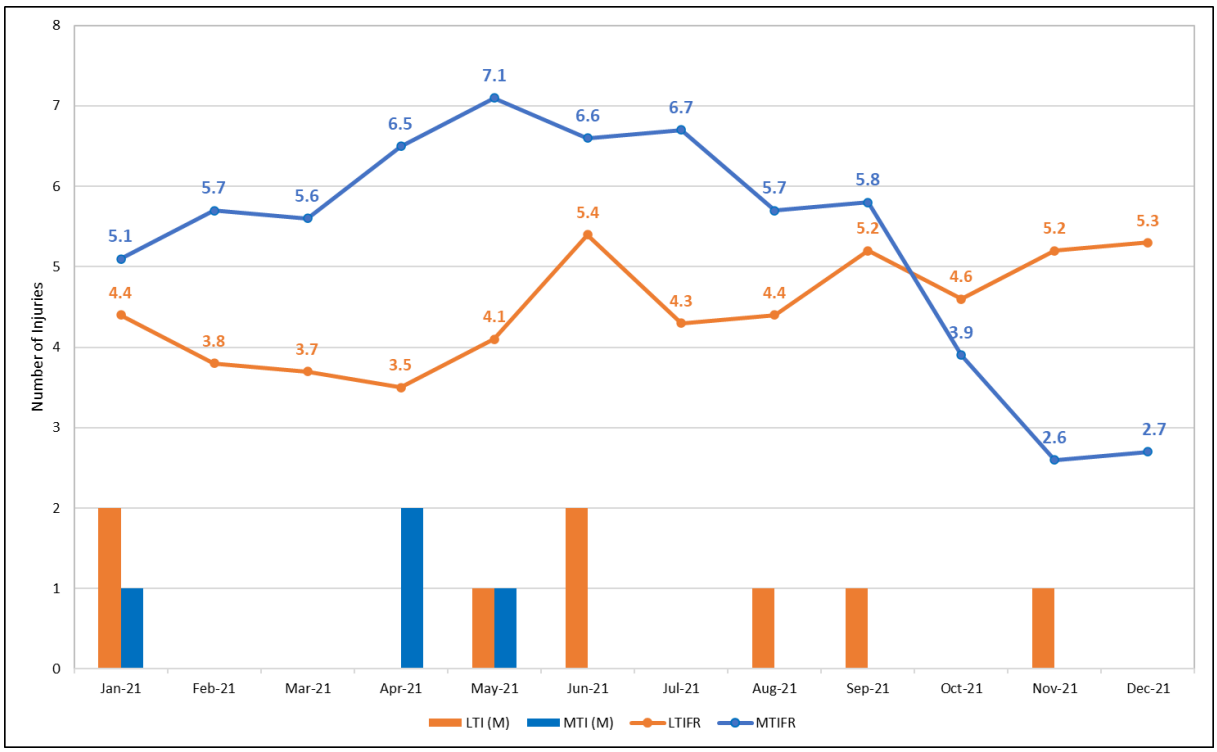

Random drug and alcohol testing

Positive test rates increased during 2021 along with the number of tests undertaken. We had 746 tests and 35 positive results (4.7%). The increase (from 2.4% in 2020) appears to be part of a national trend, which may be related to the added stresses of a second wave of lockdowns and the evolving Covid-19 situation during 2021.

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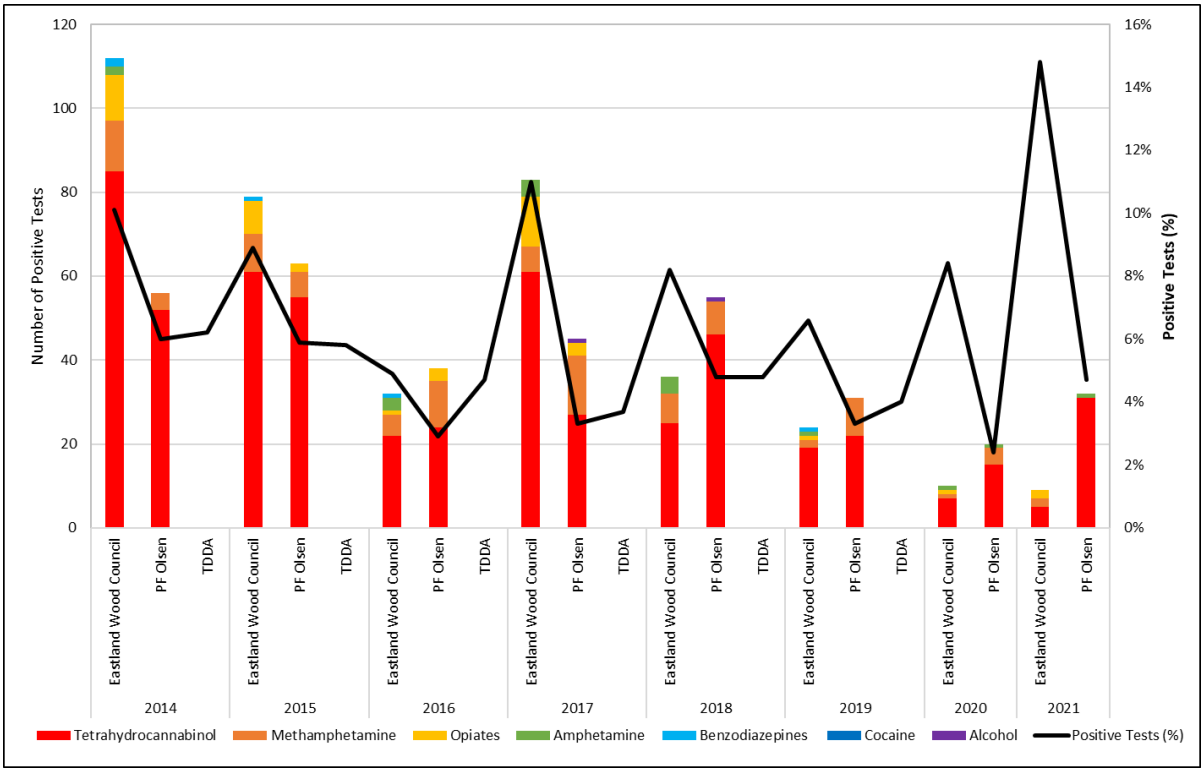
Number of Positive Tests
Positive Tests (%)
120
100
80
60
40
20
0
16%
14%
12%
10%
8%
6%
4%
2%
0%
Eastland Wood Council
PF Olsen
TDDA
2014
2015
2016
2017
2018
2019
2020
2021
Tetrahydrocannabinol
Methamphetamine
Opiates
Amphetamine
Benzodiazepines
Cocaine
Alcohol
Positive Tests (%)

4. Ecological Management

Protected ecosystems

One of the key components of FSC® certification is the protection and management of indigenous flora and fauna. When a client joins the PF Olsen FSC® Group Scheme, every effort is made to locate, assess and describe all of the indigenous ecosystems located within the client's forest/s. The areas are mapped, and once all the data has been collected, the areas are added to the PF Olsen protected ecosystem database.

In addition to determining each area's vegetation composition and type (terrestrial, riparian, wetland or waterbody), care is also taken to determine if each area is protected under other mechanisms (e.g. Significant Natural Areas, Ngā Whenua Rāhui or QEII Trust covenants).

Under advisement from ecologists, management plans may also be developed for these special areas. Typically, they would include a range of activities – such as restoration (e.g. indigenous planting), protection (e.g. weed control or fencing) or monitoring (e.g. bat monitoring or drone survey).

High Conservation Value Forest (HCVF) areas

Under the FSC® Principles and Criteria, indigenous vegetation within the forest estate that meets the FSC® definition of a High Conservation Value Forest (HCVF) must be identified and management plans developed to maintain or enhance the HCVF's.

HCVF's are defined as areas that possess one or more of the following attributes:

- **HCV1:** Forest areas containing globally, regionally or nationally significant concentrations of biodiversity values (e.g. endemism, endangered species, refugia).
- **HCV2:** Forest areas containing globally, regionally or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.
- **HCV3:** Forest areas that are in, or contain rare, threatened or endangered ecosystems.
- **HCV4:** Forest areas that provide basic services of nature in critical situations (e.g. watershed protection, erosion control).
- **HCV5:** Forest areas fundamental to meeting basic needs of local communities (e.g. subsistence, health).
- **HCV6:** Forest areas critical to local communities' traditional cultural identity (areas of cultural, ecological, economic or religious significance identified in cooperation with such local communities).

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Note: Reference to regionally in this instance refers to a global region, not a region within New Zealand, i.e.: sites must be at least nationally significant to meet HCVF criteria 1 and 2.

There are currently 17 HCVF areas identified within the PF Olsen Group Scheme forests, totalling 239.4 hectares. These areas are currently all either HCV1 or HCV3 types; the exception is an area of retired production land in Maitai Forest, Nelson which is HCV5. In this case, the area is part of the Maitai River catchment which provides drinking water for Nelson City. It was previously planted in Douglas-fir, has been retired, and the trees poisoned so they break down slowly over time, providing a larger protective buffer area for the water source while reducing the risk of contamination from harvesting the trees.

Further information on the PF Olsen Group Scheme HCVF areas is contained in the table below.

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Forest	ID	Site Type	HCV Category	Key Management Plan Actions	Other Information
Kingsland	KING-SECF-01	Terrestrial Ecosystem	HCV 3	• Photopoint	
	KING-SECF-02	Riparian Ecosystem	HCV 3	• Photopoint	
Maitai	MAIT-0009-RS04	Retired Production Land / Terrestrial Ecosystem	HCV 5	• To be confirmed	
	MAIT-BRDI-02	Riparian Ecosystem	HCV 1.3	• To be confirmed	
Mangamingi	MNGM-WETL-09	Wetland Ecosystem	HCV 3	• Photopoint	
	MNGM-WETL-10	Wetland Ecosystem	HCV 3	• Photopoint	
	MNGM-WETL-11	Wetland Ecosystem	HCV 3	• Photopoint	SNA
Rabbit Island	RABB-DEPG-01	Rare Species	HCV 1.3 & HCV 1.4		
	RABB-LEPT-01	Wetland Ecosystem	HCV 3	• Photopoint	
	RABB-WETL-01	Wetland Ecosystem	HCV 3	• Photopoint	SNA
Taharoa	TAHA-WETL-03	Wetland Ecosystem	HCV 1.2 & HCV 3		SNA
Waitangi	WNGI-WETL-04	Rare Species / Wetland Ecosystem	HCV 1.2 & HCV 3	• Animal pest control – ground trapping • Drone survey • Photopoint • Weed control	Conservation Covenant
	WNGI-WETL-05	Rare Species / Wetland Ecosystem	HCV 1.2 & HCV 3	• Animal pest control – ground trapping • Drone survey • Photopoint • Weed control	Conservation Covenant

Forest	ID	Site Type	HCV Category	Key Management Plan Actions	Other Information
	WNGI-WETL-07	Rare Species / Wetland Ecosystem	HCV 1.2 & HCV 3	• Animal pest control – ground trapping • Drone survey • Photopoint • Weed control	Conservation Covenant
	WNGI-WETL-09	Rare Species / Wetland Ecosystem	HCV 1.2 & HCV 3	• Drone survey • Photopoint • Weed control	Conservation Covenant
	WNGI-WETL-18	Wetland Ecosystem	HCV 1.2 & HCV 3	• Animal pest control – ground trapping • Drone survey • Photopoint • Weed control	Conservation Covenant
	WNGI-WETL-21	Rare Species / Wetland Ecosystem	HCV 1.2 & HCV 3	• Animal pest control – ground trapping • Drone survey • Photopoint • Weed control	Conservation Covenant

Rare and Threatened Species

Sightings of New Zealand's rare and threatened species within PF Olsen managed forests are recorded in iNaturalist and linked to the 'Biodiversity in Plantations' project (New Zealand plantation forest industry database) to record information on the rare, threatened and indigenous species that use and/or are present in our plantation forests.

During 2021, PF Olsen staff recorded 2,944 observations of 269 different species as shown in the following table:

Species	Number of Observations	Taxon
Bellbird / Koromiko	2	Bird
Black Beech	1	Plant
Bracken	1	Plant
Cabbage Tree	1	Plant
Fantail / Piwakawaka	2	Bird
Fly Agaric	1	Fungi
Green and Golden Bell Frog	2	Amphibian
Green Blotched Moth	1	Insect
Grey Warbler	1	Bird
Hebe	1	Plant
Hound's Tongue Fern	1	Fern
Karearea / NZ Falcon	7	Bird
Kea	2	Bird
Kereru / Wood Pigeon	1	Bird
Kingfisher	2	Bird
King Fern	1	Fern
Little Fringed Weevil	1	Insect
Longfin Eel	1	Fish
Long Tailed Bat	2	Mammal
Matai	1	Plant
Morepork / Ruru	3	Bird
New Zealand Pipit	2	Bird
North Island Weka	1	Bird
Olearia bullata	1	Plant
Orange Pore Fungus	1	Fungi
Pukio	1	Plant
Rata	1	Plant
Red Admiral	1	Insect

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Species	Number of Observations	Taxon
Robin	6	Bird
Sickle Spleenwort	1	Fern
Silvereye	1	Bird
Silver Fern	2	Fern
Spectacular Rustgill	1	Fungi
Three-lined Hover Fly	1	Insect
Tomtit	3	Bird
Western Weka	1	Bird
Whitehead / Mohoua	1	Bird

Over the same time period, several pest species were also identified using the iNaturalist app. These included banana passionfruit, barberry, formosan lily, pampas, plague skink, old man's beard, rats, rabbits and woolly nightshade.

All data logged in iNaturalist is used to assist in identifying where management requirements and or specialist advice might be needed prior to planned forestry operations.

Archaeological Sites

Under the Heritage New Zealand Pouhere Taonga Act 2014, it is the landowner's responsibility to identify any historic sites on their land prior to undertaking any work which may disturb or destroy such sites. Records of archaeological and historic places are maintained in the New Zealand Archaeological Association (NZAA) archaeological site recording scheme (https://archsite.eaglegis.co.nz/NZAAPublic).

If a site is found or suspected in any forest, PF Olsen's archaeological site management protocols are followed. Additionally, site specific management plans may also be developed in conjunction with Heritage New Zealand (HNZ), archaeologists, Iwi or other stakeholders.

Where there is the potential for disturbance or destruction of a site, an 'Authority to Modify or Destroy' will be sought from Heritage New Zealand. Such authorities are similar to resource consents and, if granted, normally have conditions that must be met. In some cases, permission to modify an archaeological site may also be required from the appropriate District or Regional Council.

Checks for the presence of archaeological sites, and their exact locations and boundaries, are required before any harvesting or related earthworks commence.

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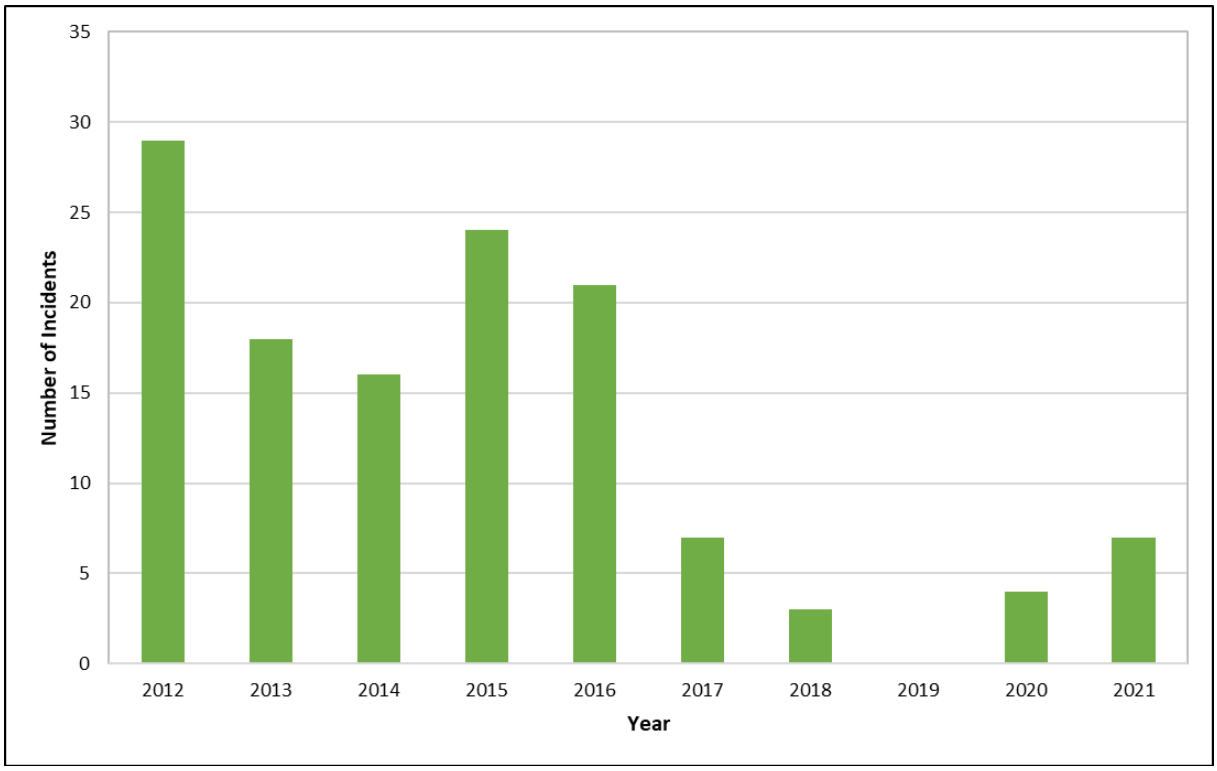
5. Environmental Incidents

PF Olsen requires all staff and contractors to report and respond to environmental incidents. While most environmental incidents are generally weather-related (e.g. heavy rain causing damage), other incidents are a result of human activities (e.g. dogs roaming in known kiwi areas). The graph below shows the number of recorded environmental incidents from 2012 – 2021 in PF Olsen's Group Scheme FSC® managed forests.



6. Resource Consents

Compliance Monitoring

In New Zealand, forestry operations are regulated by the Resource Management Act 1991, including the National Environmental Standards for Plantation Forestry (NES-PF) and Regional and District Council rules. As discussed in the previous section, Archaeological Authorities may also be required under the Heritage New Zealand Pouhere Taonga Act 2014. Under any of these mechanisms, forestry operations can be externally audited to ensure compliance with consent conditions, authority conditions or permitted activity regulations.

PF Olsen records the compliance outcomes of these audits. Regulating authorities report their compliance inspections differently (requiring some interpretation of the compliance outcome to enable standardised reporting across PF Olsen). The data provides an independent assessment of compliance.

The 78 regional, unitary and district councils in New Zealand and Heritage New Zealand undertake compliance monitoring. Most forestry operations compliance monitoring is undertaken by regional and unitary councils. During 2021, 15 councils undertook compliance monitoring inspections of PF Olsen managed operations.

The cumulative results of the compliance monitoring for all PF Olsen managed forests are graphed below for the year, a total of 98 audits. Non-compliance is recognised as an environmental incident. There were only two low and no non-compliant audits in this reporting period.

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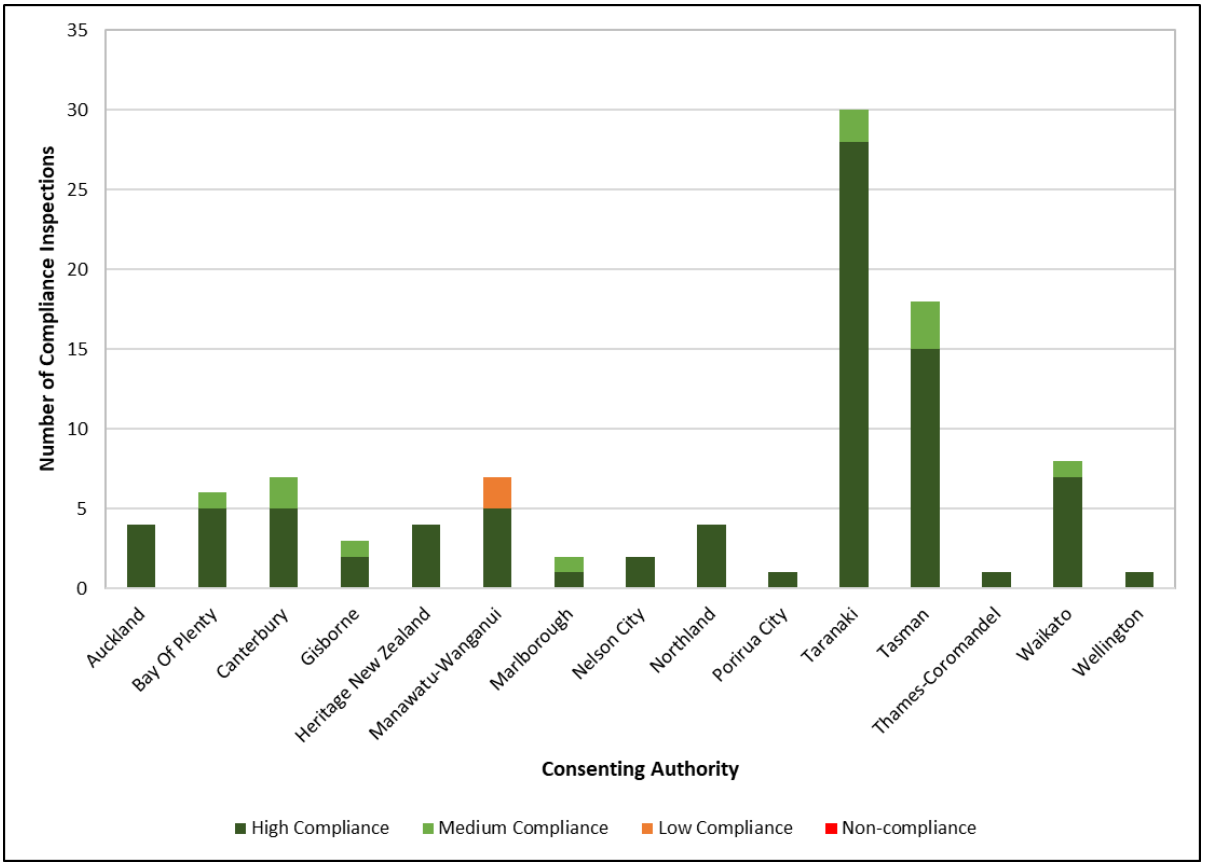

7. Chemicals

FSC® Highly Hazardous Pesticides

FSC® requires certificate holders to identify the best feasible approach to reduce the quantity and use of chemical pesticides in FSC® certified forests and to prevent, minimise and mitigate any related environmental and social impacts.

FSC® has a clear pesticides policy, that is regularly updated to reflect everchanging global circumstances and new technologies. The policy, which considers both global differences and social, environmental and economic needs, outlines FSC®'s commitment to ensuring that:

- the use of highly hazardous pesticides (HHP) in FSC® certified forests is reduced and managed responsibly when there is no alternative
- the use of the most hazardous chemical pesticides is eliminated

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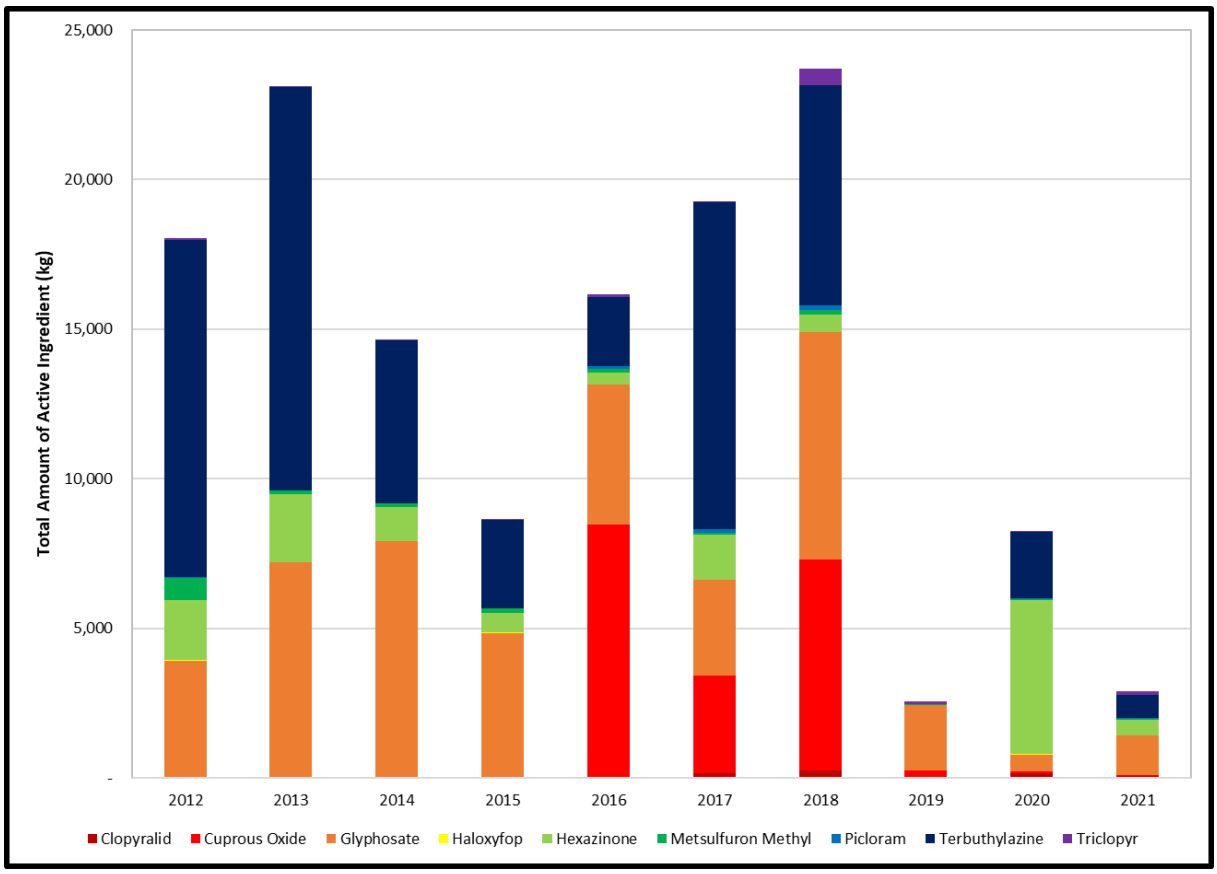
FSC® maintains a list of the pesticides deemed to be highly hazardous; classified as prohibited (e.g. Arsenic, DDT), highly restricted (e.g. brodifacoum) and restricted (e.g. cuprous oxide). Forest owners / managers who wish to use the restricted substances must complete an Environmental and Social Risk Assessment (ESRA) prior to use. The New Zealand forest industry has collectively produced ESRA's for many of the key chemicals used within New Zealand plantation forests.

Chemical use in PF Olsen Group Scheme Forests

PF Olsen records chemical usage (total amount, area treated etc) for the Group Scheme forests. The majority of the chemicals are used for weed control. Others are used for crop protection (e.g. cuprous oxide for Dothistroma control). The graph below shows the quantities of key plantation forest chemicals used over time.



Research into Alternatives

PF Olsen has provided financial support to industry co-operative research programmes aiming to advance vegetation weed management efficacy and reduce chemical reliance, including biological control. The aim has been to develop a significant multifaceted strategy for long-term research into chemical use reduction and minimisation.

Key focus of this work was:

- Chemical safety characteristics
- Alternative FSC® compliant formulations and treatment
- 'Best Practice' tools

A number of alternative FSC® compliant active ingredients have been tested against the main plantation forest establishment weeds. This resulted in a shortlist of alternatives, with potential for further investigation, that formed part of the first year's field trial testing as part of an Industry / Sustainable Farming Fund (SFF) three-year programme (project 12/038) which started in 2012. The project tested a range of chemicals in operational field trials determined from the earlier research. Mixes include those free from either terbuthylazine or hexazinone, mixes with some terbuthylazine and a baseline standard practice control of Valzine (a terbuthylazine-hexazinone mix).

The completed project found that the industry standards for terbuthylazine and hexazinone use remained the most effective, although there were some alternative active ingredients offering efficacy under limited conditions, and others that may yet have potential subject to further research. The information has been published and may be accessed from the Sustainable Farming Fund website, Scion Research website and NZ Forest Owners Association website. The published reports can be accessed via the links below:

- Minimising the environmental impact of weed management in New Zealand's planted forests
- Final report on field trials

More recently, research has been restructured and is funded by way of a national levy on all forest growers with research programmes directed through the Forest Growers Levy Trust. Work has subsequently focussed on the environmental fate aspects of herbicide use, with hexazinone and terbuthylazine tested in two of the soil groups most likely prone to leaching, followed in 2015 by similar trials for copper fungicide, recognising the new "highly hazardous" classification attributed to that active ingredient.

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In all cases, the trials reflected standard operational procedure and, while there was an initial detectable spike in presence in water in the hours immediately after application, rates degraded very quickly. The results concluded that human health risks were very low, as were the risk of impacts on aquatic fauna. Specifically, for copper, the report conclusions were:

- Copper was only detected for a few hours on the day of application;
- NZ drinking water standards (2,000 ug L-1) were not exceeded;
- FSC® standard (LC50 18.9 ug L-1 for 48 hours) – concentrations exceeded the level but for less than 2 hours; and
- ANZECC interim sediment quality guideline trigger values were not exceeded.

8. Operational Monitoring

In 2004/05, PF Olsen developed a monitoring system to record the key risks of harvesting, earthworks and mechanical land preparation. PF Olsen staff carry out the monitoring of these key operations on a fortnightly or monthly basis, depending on the risk level of the operation.

Harvesting operations are typically undertaken throughout the year. Engineering and mechanical land preparation activities are mainly undertaken over the summer months, during the window of drier / more stable weather, with monitoring restricted to their operational periods.

Staff also carry out post-storm event checks as required.

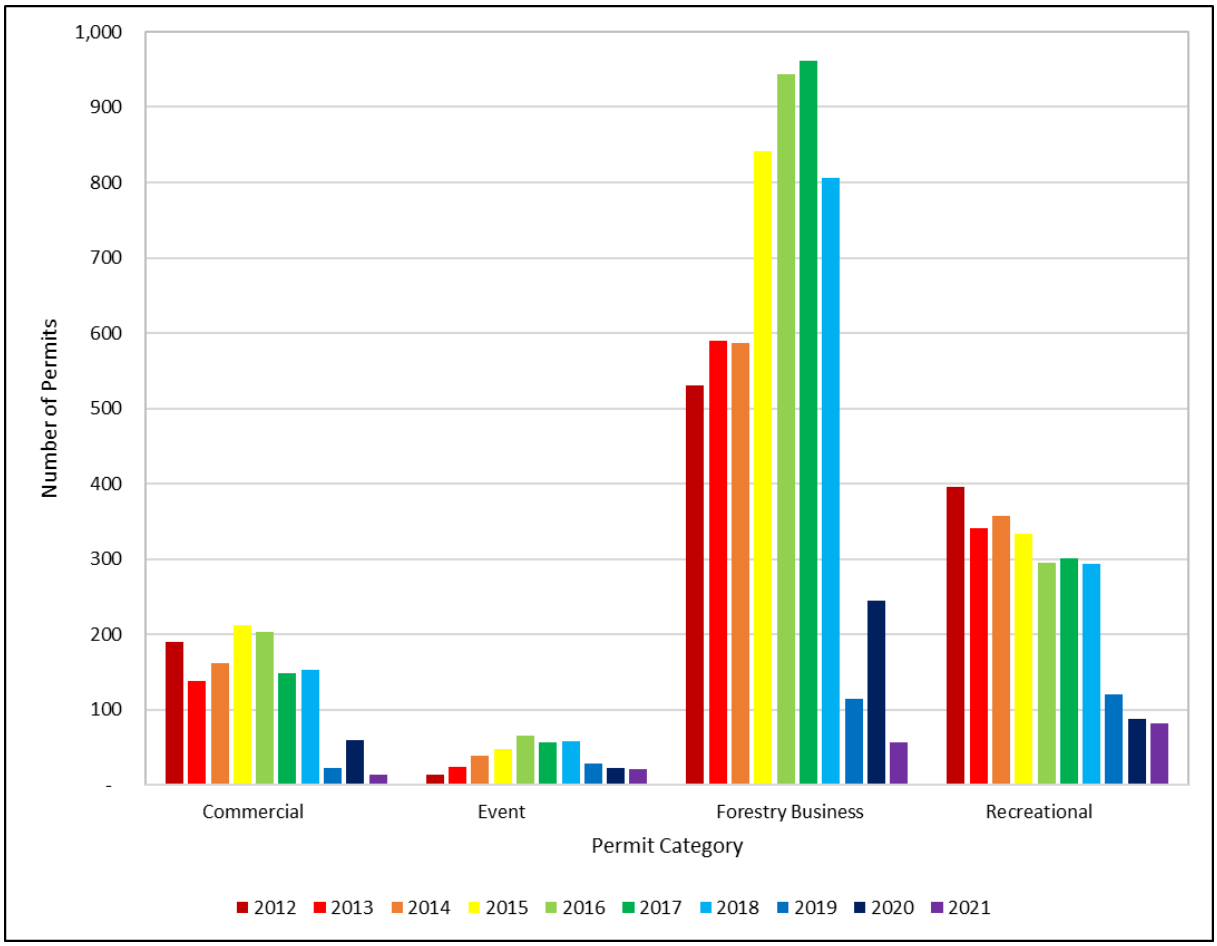
9. Recreational Use

Permits

Recreational usage of the forests is permitted where it does not conflict with operational logistics and safety. Such usage ranges from passive use to active hunting or vehicle-based activities.

Recreational usage is controlled through a permit system. Permits for small group scheme members are either controlled directly by the member or through PF Olsen's branch offices. All permit data is stored in PF Olsen's databases.

The graph below illustrates the relative proportions of permit types issued over the last ten years within the FSC® forests.



Permits issued to contractors and service providers for forestry business are the most common, followed by recreational use. Hunting permits make up the majority of recreational permits issued.

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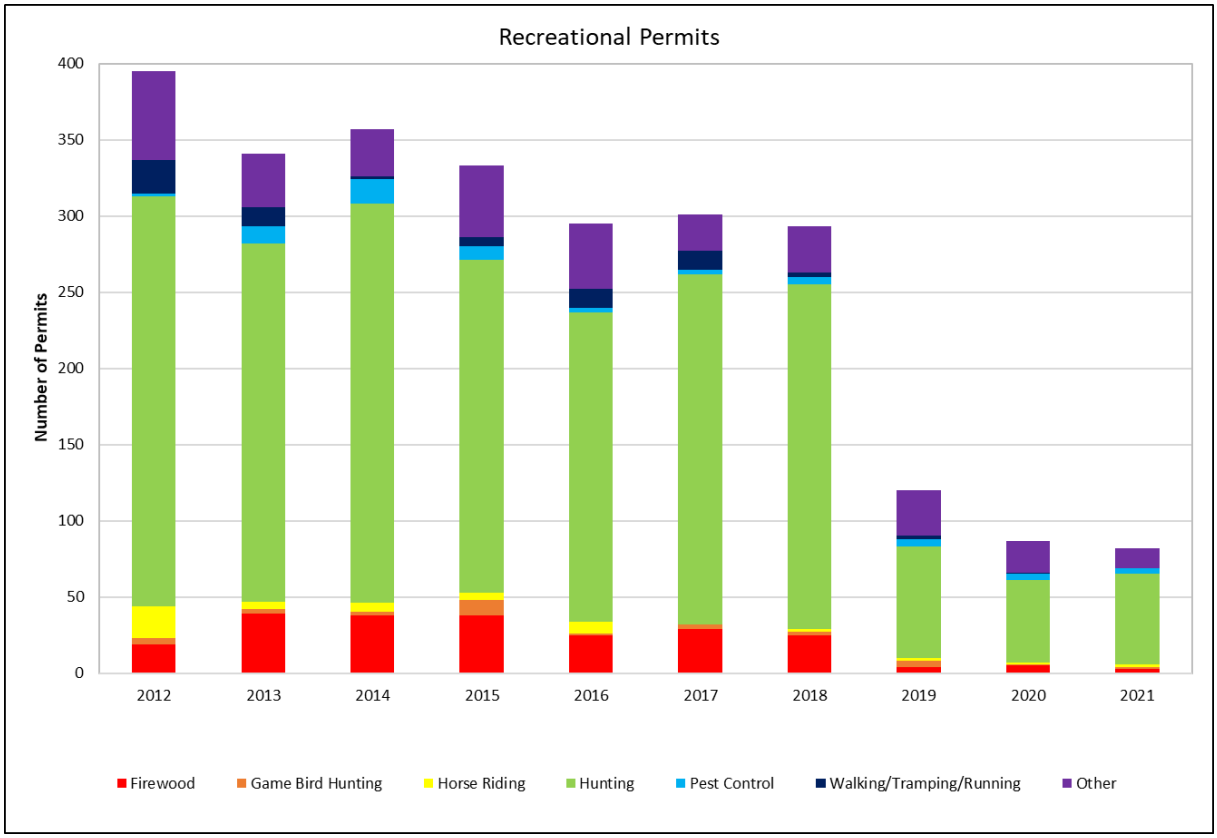


10. Water Quality Monitoring

Introduction

In the last, five to ten years, the importance of understanding and improving water quality has gained traction in both the public and private sectors, most recently with the introduction of the National Policy Statement for Freshwater Management.

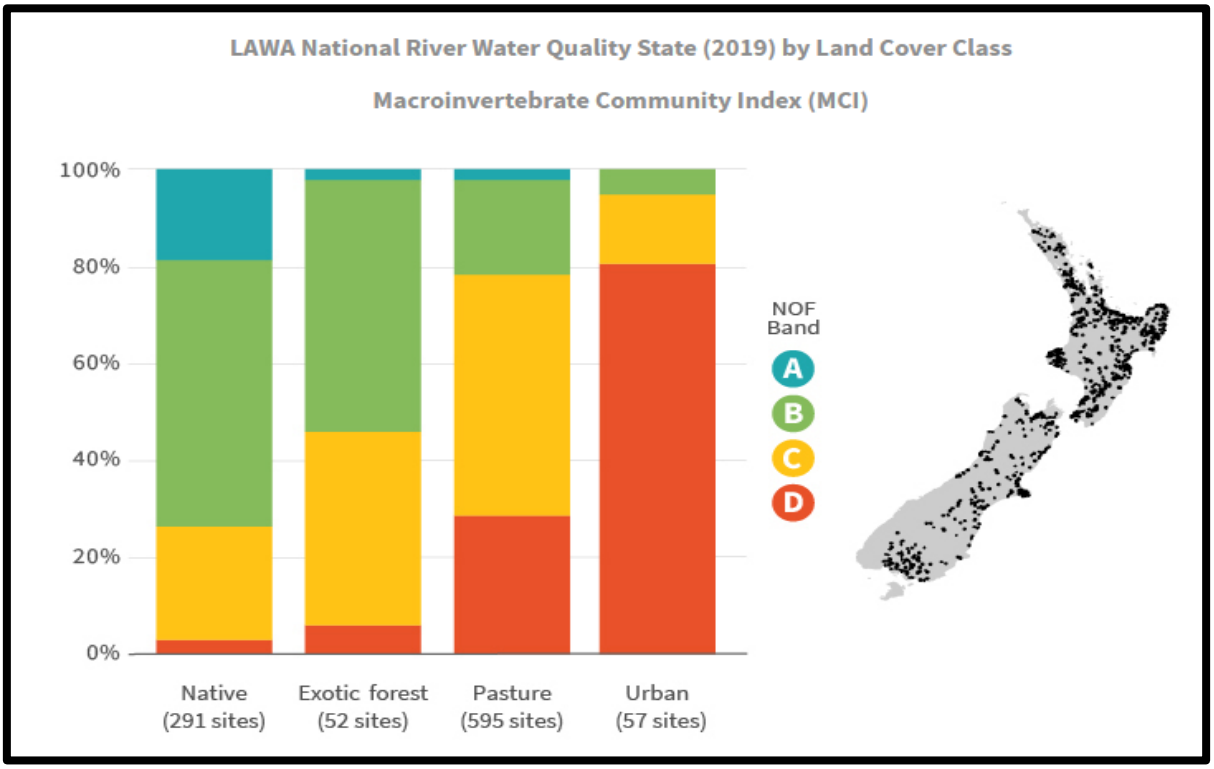
Forestry companies often undertake their water quality monitoring (e.g. eDNA, macroinvertebrate Community Index (MCI), clarity), either to aid their understanding of the impacts of plantation forest operations on receiving waterways or to comply with a resource consent. Monitoring can either be one-off or repeated over time. Where possible, long-term monitoring sites are paired with comparative sites under different land uses (indigenous forest or agricultural land, or harvested with mid-rotation), to understand the impact of different land uses on water quality. One of the best-known New Zealand examples is the Pakuratahi Land Use Study[1].

[1] Eyles, G. O., Fahey, B. D. (2006). *The Pakuratahi land use study: a 12-year paired catchment study of the environmental effects of Pinus Radiata forestry*. Hawkes Bay Regional Council, New Zealand.

LAWA River Water Quality – National Picture Summary 2020

More recently, Regional and District Councils have combined their environmental monitoring into the Land, Air, Water Aotearoa (LAWA) database. On the LAWA website, users can search for data by region, by survey point location, or gain a national perspective. On the River Quality page of the LAWA website there is a national river health summary. Results are shown for macroinvertebrates (995 sites), *E. coli* (757 sites), ammonia (678 sites) and dissolved reactive phosphorus (788 sites), across the four key landscape uses: native, exotic forest, pasture and urban.

In each of the images below, the National Objectives Framework (NOF) bands were calculated for each land class type from median scores across a five-year period (2015 – 2019). The NOF bands are defined in the National Policy Statement for Freshwater Management 2020 and range from Good (A grade) to Poor (D or E grade). The locations of the monitoring sites are shown in each map.



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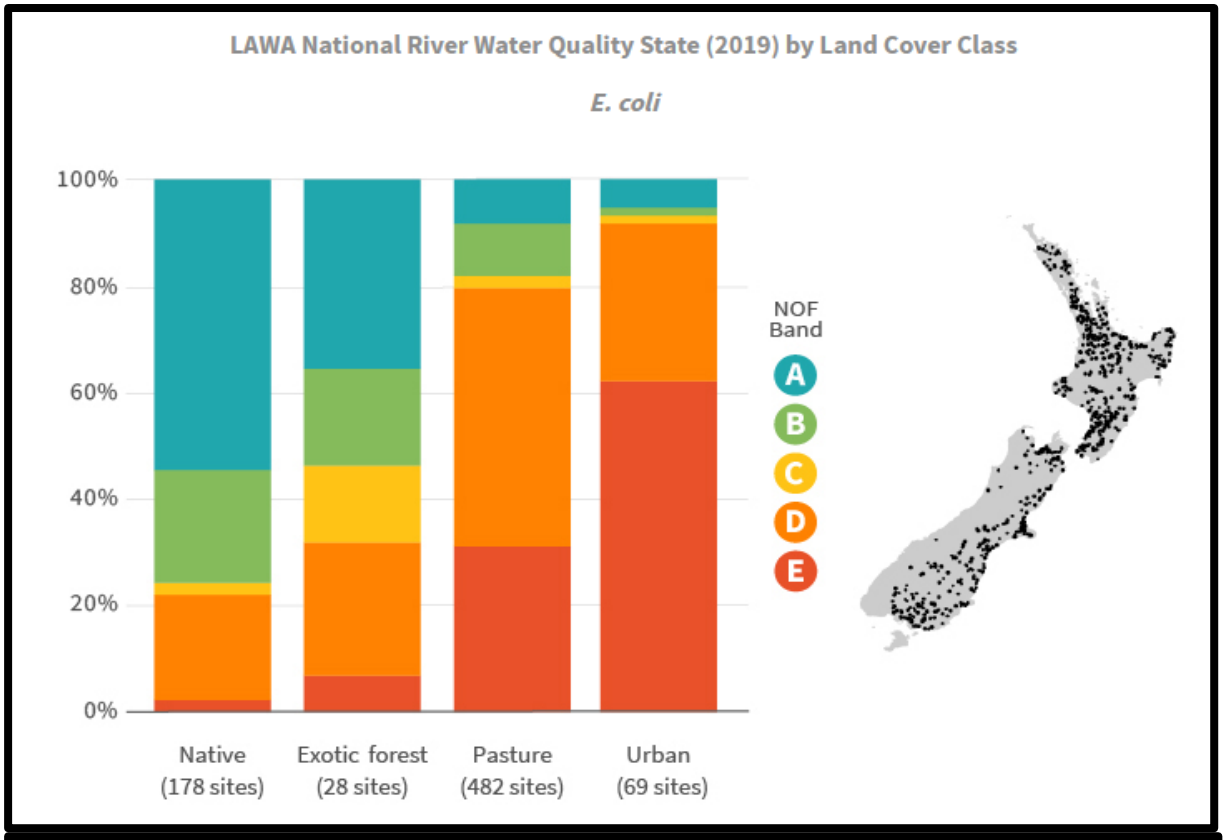

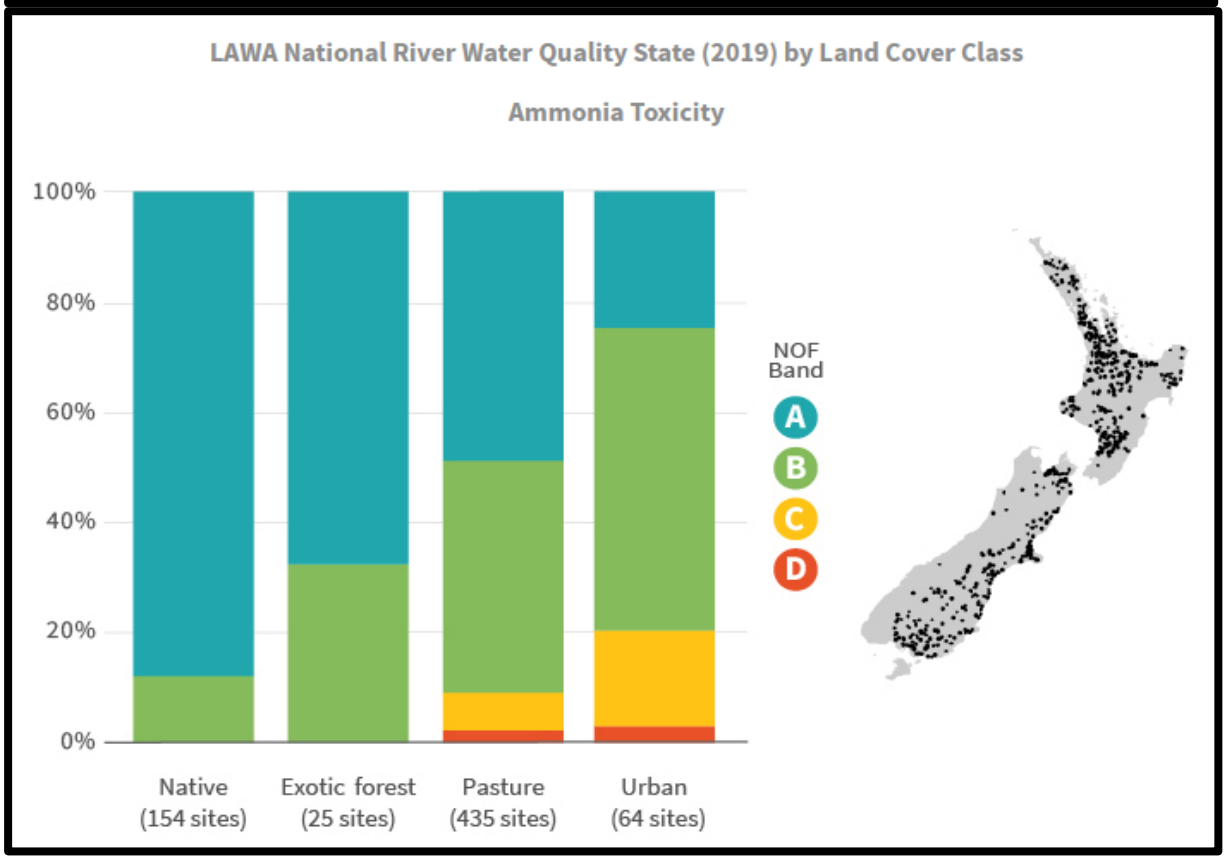

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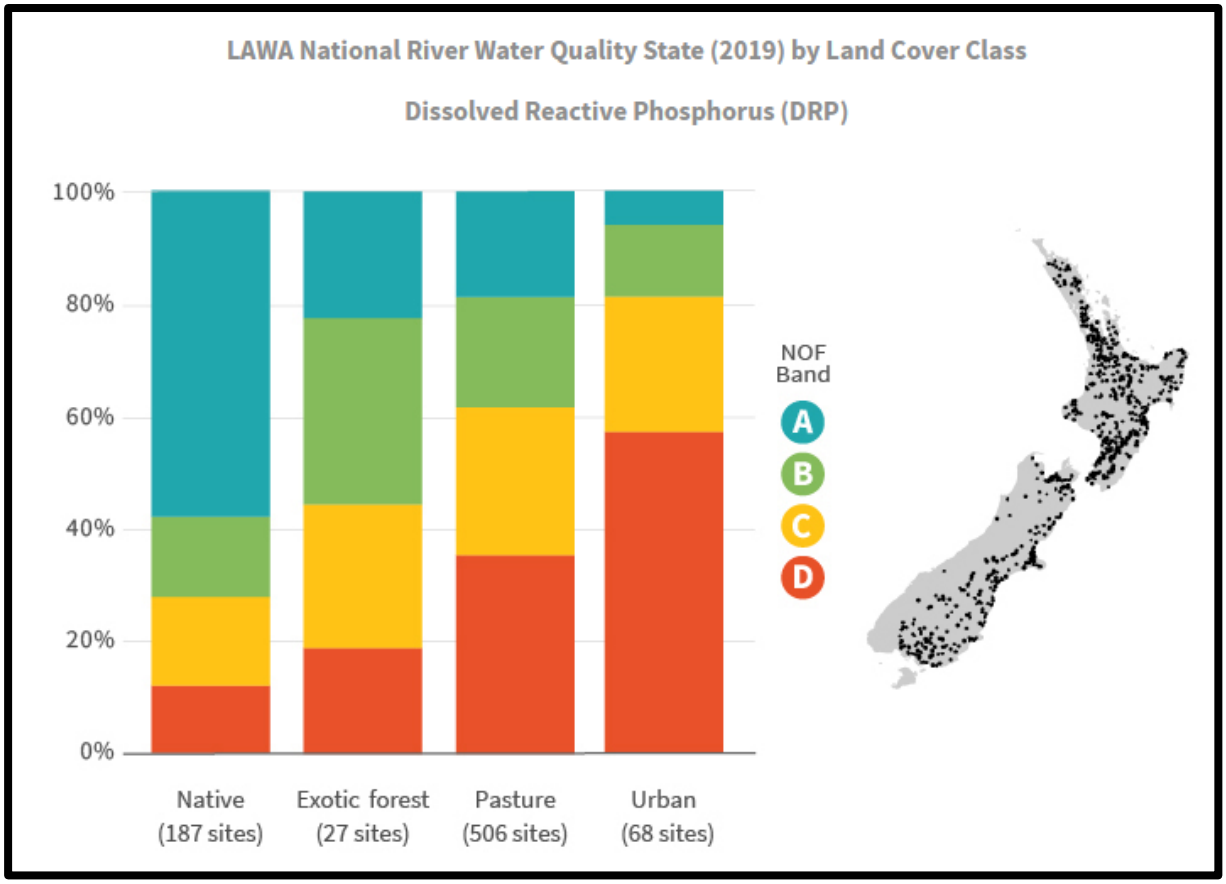

There is a consistent pattern among the land cover categories for all four indicators covered by the national summary – with the highest proportion of better scoring streams located in areas of indigenous vegetation, followed by exotic forest and then pasture. Urban streams generally have the worst water quality of all land covers.

Rivers and streams with catchments classified as being predominantly indigenous vegetation make up 48% of Aotearoa New Zealand's channel length, while pasture is also common making up 45%. Exotic forestry streams (5% of channel length) and urban streams (1%) are less common. While urban streams generally have the worst water quality, they are relatively uncommon throughout New Zealand. Proportionally, across all four indicators, monitoring sites within indigenous forests are under-represented (approximately 20% of the sample size), while pasture and urban sampling sites are over-represented (50 – 65% and 9% of the sample sizes respectively). Exotic forestry water monitoring sites are also under-represented for three of the four national indicators.

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Although catchments in the indigenous vegetation land cover class are the least affected by our activities, they are not fully representative of natural conditions because, their definition allows them to include some urban, pasture, and exotic forest land cover in the upstream catchment, if the catchment is still predominantly in indigenous vegetation. This might explain why some "native vegetation" sites are in the "D" band. Geological differences among streams may also explain high concentrations for some parameters, for example, phosphorus concentrations tend to be naturally high in catchments draining volcanic soils.

Environmental DNA (eDNA)

Another tool that has recently had strong uptake for water monitoring is Environmental DNA (eDNA) testing. eDNA is genetic material that is shed by organisms through the loss of skin, hair, scales, fluids and faeces. The DNA can be isolated and used to monitor the likely presence and distribution of species through time and space. Using this simple method, eDNA tests can identify thousands of species of fish, birds, mammals, reptiles, amphibians, plants, fungi, protists, bacteria, and other organisms, in every water sample submitted.

While the tests can only indicate a species presence or absence within a water sample, their relatively low cost, portability, and ease of use make them a great tool for identifying species that might be present, so that more targeted surveys can then be carried out. Results are uploaded into a national dataset.

The table below shows an example of eDNA results taken from three locations within a PF Olsen managed forest (waterways surrounded by indigenous riparian areas and then plantation forest), and one control site (indigenous forest only). The higher the count for a species, the more likely it is present at the site. Lower counts indicate that a species may be present, or (and more likely) the DNA for that species is present at the site through other means (e.g. insects getting eaten by a bird at another location, and then deposited at the sample site when the bird defecates). Despite the best attempts by all involved to collect and analyse a clean sample, human DNA will inevitably contaminate the samples, hence the high numbers of humans indicated in the results.

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Species	Control	Site 1	Site 2	Site 3
Aquatic Oligochaete Worm		391	42	377
Aquatic Snails				42
Bullies				1,920
Caddisfly		4		
Common Brushtail Possum	25	212	833	41
Common Chaffinch		33	24	
Common or Cran's Bully				2,231
Endemic NZ Caddisfly		21		20
Endemic NZ Dobsonfly		24		37
Goat	61			
Hominids			30	86
Human	3,402	327	899	5,423
Hydra		18		35
Longfin Eel	40	287		163
Marsh Springtail			10	
Mayflies	44			
Micro Caddisfly		18		
Mud Snails		242	175	1,175
Oligochaete worm	21	1,413		350
Red Damselfly		4		
Sheep			26	
Shortfin Eel		721		15
Small Swimming Mayfly		325		
Total	**3,593**	**4,040**	**2,039**	**11,915**