Towards evidence-informed policy evaluation

Exploring National Monitoring System data to determine effectiveness of the National Policy Statement for Highly Productive Land

Ministry for the
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Executive summary

There is a growing need and expectation to progress evidence-informed effectiveness monitoring, whether it be policy or other forms of intervention. Attention and resourcing on this matter have arguably been absent or neglected to date. Although this type of monitoring is complex, it can give decision-makers and affected communities confidence that laws and policies are founded on good science and evidence.

The National Policy Statement for Highly Productive Land (NPS-HPL) came into legal effect in 2022. It recognises highly productive land (HPL) as a national asset and aims to protect HPL for land-based primary production for future generations.

The National Monitoring System (NMS), which is run by the Ministry for the Environment (the Ministry), captures data on resource consents and plan changes. This report analyses the data to test its ability in evaluating the effectiveness of the NPS-HPL.

Analysis methodology

Using the most recently available NMS data at the time of assessment, this analysis explores the potential use of 2021/22 NMS data to evaluate the effectiveness of the NPS-HPL. Although the data was derived before the NPS-HPL had legal effect, the purpose of this analysis is to explore the potential value of NMS data to inform environmental policy (using the NPS-HPL as a workable example at a national scale).

The analysis required:

1. Geolocating all 2021/22 NMS resource consent data (no geolocation data was available for plan changes – a subset of resource management).
2. Selecting keywords to identify 'subdivision' and 'other land use' consents relevant to the NPS-HPL.
3. Matching keywords and extracting 'subdivision' and 'other land use' consents.
4. Determining the coincidence of 'subdivision' and 'other land use' consents with HPL or non-HPL. (The current transitional definition of HPL is Land Use Capability (LUC) classes 1, 2 and 3 as per the New Zealand Land Resource Inventory (NZLRI), and not the subsequent NPS-HPL definition, which is currently being determined by regional and territorial authorities.)

Results

The results were encouraging, showing it is possible to identify the land area associated with each consent. Specifically, 94 per cent of the 46,838 resource consents reported to the Ministry for 2021/22 were geolocated nationally for the first time. Eighty-five per cent of all consents were matched to areal extent or polygon and were used to determine the coincidence with HPL or non-HPL.

When the area for a consent needs to be constructed from multiple components (whether titles or parcels), it is possible that only a subset of these is found, leading to an underestimation of the area.

Of specific relevance to the NPS-HPL, 3,755 consents for 'subdivision' and 1,445 for 'other land use' coincided with HPL. This equated to 4,933 unique related consents, because 267 overlapped both types. This translated to 48,327 hectares of HPL associated with these consent types.

This area is likely to be the upper bound of the potentially affected HPL area, due to data limitations (discussed in detail in the report). For example, the affected area does not take into account district plan zones with a non-rural production purpose (eg, residential, industrial, future urban), because they are not nationally available. In the current analysis, it was therefore not possible to exclude zones that are specifically excluded from the HPL definition in the NPS-HPL.

Extracting open text data also introduced significant uncertainty. Despite efforts to cope with variation in consent records, there is no reliable way to identify all relevant records for the NPS-HPL topic. Manually checking each record would be too resource-intensive. NMS information requirements must ensure the collection of data relevant to important subjects like NPS-HPL evaluation.

Recommendations

For future policy evaluation, recommendations to progress towards greater data consistency are identified. This can help achieve higher quality as well as more reliable and efficient analysis for improving monitoring and reporting. Most are relevant beyond monitoring NPS-HPL.

1. Explore a consistent GIS sharing mechanism with territorial authorities to capture:

    –   shapefiles with district plan zone polygons (both operative and proposed or in development), where planning zone categories comply with terminology from national planning standards

    –   shapefiles with a polygon per consent, indicating the land area for which the consent applies.

2. Establish common-use vocabulary for resource consent across councils, which could take the form of developing NMS data protocols and standards.

Shifting towards evidence-informed policy evaluation requires interdisciplinary collaboration. As was the case here, this can span expertise in resource management, data science, geospatial and subject matter. This collaboration, including mātauranga and te ao Māori, is required across all phases of the policy cycle, starting at policy design, to consider and explore ways to evaluate the policy or intervention.

Because decision-making is intended to benefit communities and society, there must be accountability for overseeing the effectiveness of policies or interventions. Also, whatever the intervention (policy, innovation, sustainable management practice), a shared responsibility exists across the science system to engage and collaborate with and contribute to this area of applied science, so that interventions make a difference.

Proactively applying the work captured in this analysis now can allow time to make data improvements, before a formal NPS-HPL evidenced-informed evaluation. The uptake of recommendations from this analysis can also inform and create opportunities for a wider range of environmental policies, so it is supported by good data and evidence.

Introduction

To date, environmental monitoring has mainly focused on surveillance, necessary to inform the state of and trends across various environments such as land, air and water. Despite opportunities to complement, it can be ineffective in informing adaptive management monitoring in order to understand if a desired outcome is being achieved (Stoffels et al 2024).

There is a growing need and expectation to progress evidence-informed effectiveness monitoring, whether for policy or other interventions. Attention and resourcing on effectiveness monitoring have arguably been absent or neglected to date. The Parliamentary Commissioner for the Environment has recognised this. They highlighted the importance of assessing the effectiveness of environmental actions, investments and interventions, to determine whether an intervention is making a difference (Parliamentary Commissioner for the Environment, 2022).

Policy-making must be transparent, accountable and evidence-based. Monitoring determines whether the intervention is having the intended effect. This will provide evidence that justifies a policy or indicates that shifts are needed to reach the intended outcomes (Ministry for the Environment, 2023d). Although monitoring the effectiveness of interventions is arguably more complex than surveillance, it can give decision-makers and affected communities confidence that interventions are warranted and founded on good science and evidence.

The irreversible loss of high-class soils and versatile land to urban expansion, lifestyle block development and fragmentation can have an adverse cumulative effect (Andrew and Dymond, 2012; Curran-Cournane et al., 2021; Mackay et al., 2011; Ministry for Primary Industries and Ministry for Environment, 2019). The loss of productive soils is a long-standing issue, dating back to the 1950s in Aotearoa New Zealand (Hunt, 1959). The value of the unique land and soil characteristics (such as their inherently high versatility, resilience and pollution absorption capacity) makes them exceptional for food production (Lynn et al 2009). This was recognised in Aotearoa New Zealand's previous planning legislation, the Town and Country Planning Act 1977. Its First Schedule stated that land of high productive capability should be excluded from future urban development.

This Act gave way to the Resource Management Act in 1991, which is still Aotearoa New Zealand's current planning legislation. The RMA makes no specific mention of 'versatile' or 'high-class' land. Rather, section 5 uses vague phrasing such as 'safeguarding the life-supporting capacity of air, water, soil and ecosystems'. This has been easy to bypass in court hearings about the loss of high-class soils (Mackay et al 2011).

National Policy Statement for Highly Productive Land

The land and soil science community expressed concerns in the 1990s about the ongoing, permanent loss of high-class soils and the inadequacy of the RMA to prevent this (Basher, 1996, 1997; Doak, 1997; Grundy, 1997; Webb et al, 1997). However, it took another 30 years for these soils to be again regarded as having national significance. In 2018, a new National Policy Statement (NPS) for High Class Land and Versatile Soils was announced (Beehive, 2018) following the release of the *Our Land 2018* report, a national state of environment report specifically on land and soil-related matters. It captured and reinforced the growing evidence on issues affecting these soils (Ministry for the Environment and Stats NZ, 2018).

A discussion document on the proposed National Policy Statement for Highly Productive Land (NPS-HPL) was released in 2019 (Ministry for Primary Industries and Ministry for Environment, 2019). However, it was not until 17 October 2022 that the NPS-HPL finally came into legal effect (Ministry for the Environment, 2022). Its main goal is to protect highly productive land for land-based primary production for future generations.

National Monitoring System

This report uses information captured in the National Monitoring System (NMS) to explore its ability in evaluating the effectiveness of the NPS-HPL. Overseen by the Ministry for the Environment (the Ministry), the NMS collects information from local authorities on their implementation of the RMA.

The NMS arose from section 24(f) of the RMA, which allows the Ministry to monitor the effectiveness and implementation of the RMA. The Ministry periodically seeks data from Aotearoa New Zealand's 78 local government bodies (regional, district or city, and unitary councils) on their implementation of the RMA, which reflects their roles in managing the environment with everyday decision-making. The collated data can be used to inform central and local government of patterns in RMA implementation, and the data is publicly released to make it accessible to the wider resource management community.

The NMS was originally a biennial report, known as the RMA Survey of Local Authorities, from 1995 until 2013. Since 2014, it has been released annually.

The NMS is historical rather than 'real-time' reporting, ordered by financial year. It has grown over the years, from requesting data from 137 fields (in 2014/15) to over 235 fields in 2021/22. The increase has enabled data to be collated on plan reviews, plan-making, section 35 and other monitoring, iwi management plans, resource consents, certificates of compliance, and enforcement.

It has also sought information on two pieces of secondary legislation – known as National Direction – relating to contaminated soils and commercial forestry activities. The NMS remains an essential source for the Ministry of annual information on RMA implementation. Although it focuses on process, the ability to better identify the land area affected by each resource consent would open opportunities for greatly diverse analyses. This includes policy evaluation, because NMS data, such as resource consents, could be particularly useful for analysing the effectiveness of, for example, the NPS-HPL.

Beyond the NMS, data that includes a 'land fragmentation' indicator is also relevant to the NPS-HPL. Methodology for a land fragmentation indicator was developed in 2015 (Rutledge *et al.*, 2015). It was then improved in 2020 (Carrick et al 2020), which coincided with national land fragmentation analysis and reporting for the first time for *Our Land 2021* (Ministry for the Environment and Stats NZ, 2021). Land fragmentation data provides national information on changes in land area (HPL and non-HPL) across urban type and parcel size (small, medium and large, with and without a dwelling). These can be broken down by region and compared across time (Curran-Cournane et al 2021). In evaluating the effectiveness of the NPS-HPL, this report focuses on the NMS as an exploratory proof-of-concept at the national level. However, it briefly covers the role of land fragmentation data in relation to the NPS-HPL.

NMS information for 2021/22 was the most recently published and available data at the time of this writing and analysis (Ministry for the Environment, 2023c).[1] Although this period was before the gazettal of the NPS-HPL, it is intended to provide insight into the potential for NMS data to inform the monitoring of the NPS-HPL. The utility of the NMS to evaluate the NPS-HPL was first explored as a case study at a regional scale before the NPS-HPL came into effect (Menzies and Haines, 2020).

Objectives of this report

This report aims to:

- Proactively progress evidence-informed policy evaluation by drawing on NMS data. The data is used to explore its potential to inform the effectiveness of the NPS-HPL (being a workable example at a national scale). The NPS-HPL is currently evolving, and there could be amendments in future (Ministry for the Environment, 2023a), as well as changes to the definition of HPL (National, 2023). However, this work aims to explore a proof-of-concept at the national level that is expected to be relevant however the NPS-HPL evolves.

- Help improve future NMS data collation, with guidance on information requirements (Ministry for the Environment, 2021). This may help with future monitoring and evaluation of wider policy analysis (as well as the NPS-HPL). Proactively doing this work now can allow time to make any suggested data improvements.

- Have relevance and value across the wider policy system, to progress towards more evidence-informed policy evaluation, supported by good data and evidence.

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[1]   The National Monitoring System for 2022/23 has since been published (Ministry for the Environment, 2024).

Methods

Geolocating National Monitoring System data

To explore monitoring possibilities for the NPS-HPL, the incidence of consents being sought for potentially impactful activities on highly productive land was determined. The NMS consents data does not include location details in a format that can be easily tested against the spatial coverage of HPL, so it was determined indirectly. For each consent, a location defined by a set of coordinates outlining the relevant land was required. However, the data only had descriptions of the land location in formats that varied considerably.

Spatial coordinates or street addresses were sometimes provided, but, more often, the location was specified in the form of the land's 'legal description', made up of key-value pairs. In this context:

- keys are names or labels for components of information (eg, 'lot', 'deposited plan', 'survey district')

- values are the details or specifics of each element (eg, '458461', '4873', 'Parish of Manurewa'). These appear as pairs such as 'Lot 458461', 'Deposited Plan 4873', 'Parish of Manurewa Survey District', forming a complete legal description.

These legal descriptions cannot be directly mapped to determine coincidence with HPL, but they could be matched against land records available from Land Information New Zealand (LINZ). These define locations with coordinates that can then be related to other spatial data, such as coverage of HPL. This match between consent records and land records was made based on the legal descriptions. Occasionally, an exact text match could be made unambiguously to a single LINZ land record. However, usually, the description for the matching land record was not letter-for-letter identical to the legal description, even if it was clear that the key-value pairs matched perfectly. For instance, it is eventually unquestionable that:

> Fee Simple, 1/1, Lot 1 Deposited Plan 458461 and Lot 18-19 Deposited Plan 4873 and Part Lot 14-15 Deposited Plan 4873 and Part Lot 6 Deposited Plan 6115, 3,897 m^2.

is an appropriate match for:

> Lot 1 DP 458461 & Lot 18-19 DP4873, Pt Lot 14,15 Dep Plan 4873 and Part Lot 6 D P 6115.

The values for corresponding keys match exactly and, in this case, are even in the same order, even if 'Deposited Plan' has been variously abbreviated to: DP; D P (space after the D); DP (space after the P); Dep Plan. Such variations were found throughout the NMS consent data and in the LINZ land record tables where matches for the consent legal descriptions were sought.

Geolocating consent records involved finding a matching record in the LINZ dataset for each consent record, based on the text descriptions in both datasets. Projects beyond this study would benefit from the geolocation of consents. Working with a year's complete set of consents helped develop an automated process that could assign locations with a high success rate.

To increase the chances of making a letter-for-letter identical match, the full set of legal descriptions in the consents data, as well as the descriptors of titles, parcels and surveys available from LINZ were pre-processed. This made key terms (eg, DP, Lot, Survey Plan) consistent and stripped out additional text or symbols that would not contribute to match-

making (eg, remove 'pt', remove solidus between 45/b, and convert all to lower case). Multiple components were separated to allow matching. Figure 1 shows this process.

Figure 1: **Making legal description formats consistent**

```
> makeConsistent("Fee Simple, 1/1, Lot 1 Deposited Plan 458461 and Lot 18
-19 Deposited Plan 4873 and Part Lot 14-15 Deposited Plan 4873 and Part L
ot 6 Deposited Plan 6115, 3,897 m2")
[1] "lot 1 dp 458461;lot 18-19 dp 4873;lot 14-15 dp 4873;lot 6 dp 6115"
> makeConsistent("Lot 1 DP 458461 & Lot 18-19 DP4873, Pt Lot 14,15 Dep Pl
an 4873 and Part Lot 6 D P 6115")
[1] "lot 1 dp 458461;lot 18-19 dp 4873;lot 14;15 dp 4873;lot 6 dp 6115"
```

The 'make consistent' function successfully converted two differently formatted legal description strings (orange) to the same output (white), to allow matching.

Pre-processing

Due to the many variations in the legal descriptions, it was unproductive to seek full-text matches without first processing for consistency. For example, the match found for 'LOT 1 DP 558307' was against 'Fee Simple, 1/1, Lot 1 Deposited Plan 558307, 457 m^2'. This would not have been matched without pre-processing for consistency.

Aotearoa New Zealand is divided into multiple survey districts, with land record IDs unique *within* but not necessarily *between* them. To ensure that a resource consent was not matched against a similarly named land record from a remote unrelated part of the country, the land records were pre-processed. They were separated into groups relevant to each council, applying a spatial intersect between the land record geometry and the outline of each council. Matches for a council's resource consent application were only sought amongst land records that had already been identified as falling within the council's boundary.

Other cases needed more flexibility, to allow for rearranging a legal description. So 'Allotment B, sub section 7 in the Parish of Manurewa' is identified as a match for 'Sec vii in allot b, of Manurewa Psh, Auckland', despite the differences in abbreviation, capitalisation, number format and order.

Regex

Matches such as this rely on regular expressions (regex) grammar. Regex is a set of methods for working with text as data, extending from the concept of 'wild cards' like asterisks in file searches. A regex 'string' defines a pattern to be searched for in texts. Each string will either match or not, with flexibility as determined by the design of the string. Regex can allow for optional characters to appear, to allow for:

- British versus American spellings (eg, colour versus color)

- alternatives (eg, Aotearoa and New Zealand being equivalent)

- flexibility in the sequence of elements (eg, to allow both Otago University and University of Otago).

Refining the regex to seek matches was a considerable part of this work. However, there were diminishing returns from ongoing effort. Residual false positive matches and false negative

matches remained in the data. It is acknowledged that the regex matches are less reliable than direct text matches.

Multiple records

The legal description provided with any resource consent could refer to several land records, and, in such cases, the polygon areas of multiple records were assigned to the consent. Such areas could also be non-contiguous.

Coordinates

In cases where councils provided point coordinates when submitting their consent information to the NMS, the title or parcel that they were within, or (less preferably) nearest to, was assigned to that consent. No allowance was made for coordinates in projections other than New Zealand Transverse Mercator' (NZTM). To identify potential coordinate pairs, a regex pattern was generated to identify two seven-digit numbers, neither preceded nor followed by additional digits, the first starting with a 1 or 2, the second starting with a 4, 5 or 6.

Although this may allow some New Zealand Map Grid (NZMG) coordinate pairs to be detected, these were not separately isolated for conversion to NZTM. Subsequent investigation reveals nine such cases.

Identifying NPS-HPL relevant resource consents by keywords

Councils can categorise resource consents in different ways by providing information in a free-text data field. A suite of regex keywords was used to identify the subset of consents relevant to NPS-HPL policies.[2] The focus was to identify consents for rural areas. Any land areas already zoned for urban, future urban or rural lifestyle development are not considered as HPL under the NPS-HPL (Ministry for the Environment, 2023b). However, for this exercise, these zones are not yet nationally available and mapped. Keywords associated with 'urban' consents, which

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[2] National Policy Statement for Highly Productive Land section 2.2:

- Policy 1: Highly productive land is recognised as a resource with finite characteristics and long-term values for land-based primary production.
- Policy 2: The identification and management of highly productive land is undertaken in an integrated way that considers the interactions with freshwater management and urban development.
- Policy 3: Highly productive land is mapped and included in regional policy statements and district plans.
- Policy 4: The use of highly productive land for land-based primary production is prioritised and supported.
- Policy 5: The urban rezoning of highly productive land is avoided, except as provided in this National Policy Statement.
- Policy 6: The rezoning and development of highly productive land as rural lifestyle is avoided, except as provided in this National Policy Statement.
- Policy 7: The subdivision of highly productive land is avoided, except as provided in this National Policy Statement.
- Policy 8: Highly productive land is protected from inappropriate use and development.
- Policy 9: Reverse sensitivity effects are managed so as not to constrain land-based primary production activities on highly productive land.

will not be considered for future analysis of NPS-HPL effectiveness, were less relevant for this keyword selection and analysis.

For consents in rural zones, the following keywords were identified[3] that pertain to three groupings: 'residential subdivision and development (rural)', 'other land use activities' and 'plan changes' (a subset of resource management).

- **Residential subdivision and development (rural)** (relevant to policies 5, 6, 7 and 8)[2] – lifestyle blocks, rural subdivision, boundary adjustments, creation of new or additional lots.

- **Other land use activities** (relevant to policy 8)[2] – greenhouses, indoor piggery, indoor poultry, solar farm, renewable energy, transport/freight depot, storage facility, workers' accommodation, forestry, utilities, infrastructure, flood defence/mitigation, temporary activity, supporting activity, multiple dwellings, designation, outline plan, Māori land, papakāinga, Māori purpose, national importance under s6 of the RMA.

- **Plan changes** (relevant to policies 1, 2, 4 and 9 (for all rezoning) and policy 6 (for rural lifestyle rezoning))[2] – rural residential, rural lifestyle, rural industry.

Matching keywords and extracting NMS resource consent data

Using the selected keywords for resource consents and plan changes, a suite of regular expression (regex) patterns was developed for NMS data matching. These patterns were constructed to account for common character differences, such as spelling mistakes, delimiters such as space and hyphen characters, and plurals. Differences in phrasing of text were also considered with frequently used synonyms and the ordering of words in text being accounted for. For this work, the 'description of activity' column in the resource consents section of the complete NMS dataset was selected. This is where councils most often provide further context to their data beyond the core NMS information requirements.

To refine matches against keyword patterns, more regex patterns were developed to exclude terms from groups of matches. Exclusion patterns were required, to reduce the appearance of false positives (matched consent records that did not align with the intended data gathering). Terms and phrases to be excluded were identified by qualitatively assessing the relevance of terms surrounding matches and commonly used terms in the dataset. Subsets of the text associated with each consent record were extracted by taking the matched term and one word either side of the match. Extracting additional terms surrounding matches gave context to the consent records being matched and allowed for out-of-scope matches to be identified and excluded.

Identification of false positives was supplemented by use of a language model called 'skip-grams'. This identifies commonly used phrases (rather than single words) in the data. Skip-grams split given text information into groups of words ranging in length from a given minimum to a maximum (n) (Guthrie et al, 2006). The number of words to be skipped when identifying phrases in the text can be specified (k). Skipping words in the text allowed the exclusion of 'stop-words' (common and uninformative words such as 'of', 'by', 'with') and other text elements (eg, numeric values or location information) from the output.

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3 The described keywords were identified and explained in section 1.3 (Interpretation) and used in Part 3 of the NPS-HPL. See National Policy Statement For Highly Productive Land 2022.

The result of the skip-gram model was the 'description of activity' column was stripped of all empty terms and filtered to include only three-word phrases. The number of occurrences of unique phrases was then calculated. For this investigation, the 100 most-used phrases were used to supplement prior analysis of terms surrounding matches and to further inform regex patterns, to exclude irrelevant consent records. In cases where boundary terms could not easily be investigated, the 500 most-used skip-gram phrases were analysed.

Consents that could pose a risk to the availability of HPL across the three groupings considered relevant to the NPS-HPL were identified by regex patterns. These were for 'residential subdivision and development (rural)' **(hereafter referred to as 'subdivision')**, 'other land use activities' **(hereafter referred to as 'other land use')** and 'plan changes'. The issue of potential double-counting across categories is considered later in this report (see 'Dual identification of individual consents' section).

'Subdivision' consents were identified by five regex patterns and types.

- Rural – Includes developments like 'rural subdivision' or 'rural residential', excluding reference to irrelevant zonings and minor activities, such as 'shed/barn', or anticipated development in rural towns and villages, such as 'settlement zone'.

- Subdivision – Includes all subdivision consents, excluding terms about residential and other urban zoned areas, such as 'freehold' and 'cross-lease'. Although rural areas may contain many freehold sites, this term was seldom used to refer to rural consents and was more commonly used to refer to urban subdivisions in the 2021/22 NMS data.

- Lifestyle – Includes applications such as any mention of 'lifestyle' or 'lifestyle block'. Rural residential applications were captured under the rural category.

- Boundary adjustment[4] – Includes adjustment of lot boundaries into rural zones, excluding terms relating to urban and residential zones, such as 'fee simple' and 'cross-lease', as with subdivision.

- Creation of new lots – Includes creation of lots, excluding terms relating to residential and urban zones and any minor activities, such as 'freehold', 'cross-lease, 'garage' and 'commonly owned access ways'.

'Other land use' consents were identified by three regex patterns and types.

- Rural activities – Include activities such as 'greenhouse' or 'transport depot', excluding irrelevant terms such as 'residential' and coastal-related terms.

- Infrastructure – Includes developments such as 'solar farm' or 'flood mitigation', excluding irrelevant terms such as 'residential' and 'park infrastructure'.

- Dedicated function – Includes land that is not related to production, such as 'workers accommodation' or 'papakāinga'.

In the same way as rural residential developments were detected (above), activities that were typically rural or infrastructure-related were able to be matched more accurately because consents mentioning 'residential' could be excluded.

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4   Rearrangement of legal boundaries, through boundary adjustments, is considered as an alternative to losing more HPL to unproductive uses. Because boundary adjustment is a form of subdivision involving the reconfiguration of lot boundaries, rather than creating an additional allotment, it may not be a significant encroachment onto HPL.

Plan changes fell into four regex patterns:

- Rural – Includes any rural plan change.

- Rural residential – Includes identification of plan changes that could allow residential developments in rural zones.

- Rural lifestyle – Includes establishment of lifestyle blocks in rural zones by way of a plan change.

- Rural industrial – Includes industrial plan changes for rural zones or production.

Regex patterns were developed to widely capture the context for each group. These were refined with exclusion patterns, to identify and exclude unrelated consent records, as noted. Appendix 2 shows all patterns used for matching and exclusion.

Dual identification of individual consents

There was potential for a consent on HPL to be double-counted if it matched against both 'subdivision' and 'other land use' keywords. These 'dual-identified' consents were specifically accounted for in this process, to prevent such double-counting.

Consent counts and their corresponding areas of dual-identified consents are provided alongside values for the two distinct categories, to allow for their contributions to be appropriately measured when generating overall totals. Within one of the two categories, a consent might match against more than one of the alternative regex keywords (eg, lifestyle and boundary adjustment). This situation would not lead to double-counting, because each keyword match can only tag consents as subdivision-related. A consent can only be untagged or tagged; double-tagging has no additional effect.

Locating resource consents in HPL or non-HPL zones

Once the resource consents had been geolocated to properties, it was possible to determine whether these properties were on HPL, or what proportion of their area overlapped with HPL. For this analysis, HPL coverage was determined from the New Zealand Land Resource Inventory (NZLRI) Land Use Capability (LUC) database (NZLRI, 2021). LUC classes 1, 2 and 3 make up the transitional definition of HPL in the NPS-HPL, and LUC classes 4 to 8 are non-HPL. This definition will be different from the eventual mapped areas of HPL, which regional councils are currently determining in collaboration with territorial authorities, as per the NPS-HPL (Ministry for the Environment, 2023b).

Where a consent polygon only partially overlapped an HPL polygon, the consent polygon was then split by the HPL boundary to generate fragments. These could then be accounted for separately, as either overlying HPL or not. Any land parcel with multiple consents was not double-counted, because the area of affected HPL (and non-HPL) could not be higher than the total area of HPL in any region.

It is acknowledged that a land parcel identified in the consent data might not *all* be affected by the activity in the consent. The legal description provided with resource consents does not precisely specify the footprint of an activity within a property (land record polygon). This level of resolution is not currently available.

The NZLRI LUC, at the 1:50,000 scale, was not designed for use at the property level, so there will be issues with accuracy at this scale (Lynn et al, 2009).[5] However, it does provide useful regional or national information.

Data analytical software programmes

Data analytical and software programmes used included:

- the software package Excel/R for the keyword search and data filtering/extraction (R Core Team, 2022)

- 'R' and the tidyverse (Wickham et al, 2019) to format and process data, and derive statistics

- the 'unnest_skip_ngrams' function from the tidytext[6] 'R' package to implement the skip-grams language model. An n value (phrase length) of 3 and a k value (max skip length) of 1 were used as parameters alongside NMS open text data.

Geoprocessing in 'R' relied on the 'Simple Features' package (Pebesma, 2018; Pebesma and Bivand, 2023), Geospatial Data Abstraction Library (GDAL)[7] and the Geometry Engine Open Source (GEOS).[8]

Extensive use was made of regular expressions supported by the Perl-Compatible Regular Expressions (PCRE[9] v10.40 2022-04-14) regex library for both geoprocessing and keyword matching.

Graph and map outputs were generated with R base graphics.

Code is available on request.

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[5]   A recent court hearing has determined that the New Zealand Land Resource Inventory maps are the single determinative maps to apply in the transitional NPS-HPL period. Decision No. [2024] NZEnvC 83.

[6]   See CRAN – Package tidytext (r-project.org). Retrieved 6 September 2024.

[7]   GDAL/OGR contributors (2024). GDAL/OGR Geospatial Data Abstraction software Library. Open Source Geospatial Foundation. URL https://gdal.org. From GDAL — GDAL documentation.

[8]   GEOS contributors (2024). GEOS computational geometry library. Open Source Geospatial Foundation. URL https://libgeos.org/. Obtained from GEOS (libgeos.org).

[9]   See PCRE – Perl Compatible Regular Expressions. Retrieved 6 September 2024.

Results

Overview

The resource consents recorded in the 2021/22 NMS totalled 46,838. Of these, 94 per cent were geolocatable at least to a point location if not to the polygon (areal extent) of a specific land record. Of the total consents, 85 per cent were geolocated to a polygon or areal extent (table 1).

Of the remaining 15 per cent, the legal description text of 9 per cent (4,588) only allowed their association to a survey plan, for which LINZ provides only a point location, rather than extent. Another 4 per cent (2,067) failed geolocation due to no text match being found from the current effort in handling or correcting typos, and in handling alternative formats.

Further effort brings diminishing returns in successful matches to land records, signalling the need for tighter specification for consent location information. Appendix 1 details the breakdown of matches between resource consents to titles, parcels or survey plans.

Table 1 shows the breakdown (number and area) of consents associated with 'subdivision' and 'other land use' groupings. Of 46,838 consents recorded in 2021/22, 136 were declined.[10]

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[10] Of the 136 declined resource consents, 22 were for subdivision (114 non-subdivision), 66 were on HPL (70 on non-HPL), and 11 were for subdivision on HPL equating to an estimated 121 hectares. Because this is an exploratory proof-of-concept, this count (n=11) and area (121 hectares) were not excluded from the work. The numbers were calculated post-analysis and would be excluded from future formal evaluations.

Table 1: Summary statistics of geolocatable National Monitoring System data 2021/22

The shaded data informed the remaining analysis.

Statistic	Value	
	Number	**Area (ha)**
Total consents[1]	46,838	
Geolocated consents[2]	44,240 (94%)	
Consents geolocated to polygon or areal extent[3]	39,790 (85%)	
'Subdivision' consents (by keyword match)[4]	13,144	
Geolocatable 'subdivision' consents[5]	12,458	
'Subdivision' consents geolocated to areal extent[6]	10,935	
Area affected by 'subdivision' consents (geolocatable – areal extent)[7]		138,568
'Other land use' consents (by keyword match)[8]	4,530	
'Other land use' geolocatable consents[9]	4,323	
'Other land use' consents geolocated to areal extent[10]	3,949	
Area affected by 'other land use' consents (geolocatable – areal extent)[11]		38,051

Notes:

[1] Total number of resource consents as per 2021/21 NMS.

[2] 'Geolocated' regardless of whether the consents could be attributed to an areal extent or polygon boundary or not.

[3] 'Geolocated to areal extent': the number of consents that could be attributed to an areal extent or polygon boundary to overlay HPL and/or non-HPL.

[4] Total number of NPS-HPL-related 'subdivision' (rural) consents via keyword selection and matching analysis.

[5] Number of 'geolocated' consents regardless of whether the 'subdivision' resource consents could be attributed to an areal extent or polygon boundary or not.

[6] Number of areal extent geolocated resource consents identified as 'subdivision' (rural) of relevance to the NPS-HPL (83 per cent of the 13,144).

[7] Corresponding area of note 6.

[8] Total number of NPS-HPL related consents for 'other land use' (rural) via keyword selection and matching analysis.

[9] Number of 'geolocated' consents regardless of whether the consents for other land use could be attributed to an areal extent or polygon boundary or not.

[10] Number of areal extent geolocated resource consents identified as 'other land use' (rural), of relevance to the NPS-HPL (87% of the 4,530).

[11] Corresponding area of footnote 10.

'Subdivision' and 'other land use' consents that pertain to the NPS-HPL

Subsequent analysis of consent records associated with subdivision and other land use was limited to records that could be assigned a polygon or areal extent, to determine their overlap with HPL and non-HPL (see shaded areas in table 1). Consents that could not be geolocated, whether they were found to be for subdivision or not, could not be (and thus were not) assessed for their effect on HPL.

Table 2 shows the breakdown of consents for 'subdivision' and 'other land use', split across groupings.

Table 2: Number of 'subdivision' and 'other land use' consents by group

'Subdivision' consents by group						
	Rural	Subdivision	Lifestyle	Boundary adjustment	Create new lot	Total unique
Keyword matches	2,884	11,234	173	890	990	13,144
Areal extent geolocated matches	2,257	9,378	114	697	786	10,935
'Other land use' consents by group						
	Rural activities		Infrastructure	Dedicated function	Total unique	
Keyword matches	520		425	3,724	4,530	
Areal extent geolocated matches	407		308	3,338	3,949	

Note: Overlap will occur between the 'subdivision' and 'other land use' consents across the groups, because each consent may relate to more than one group. However, the 'total unique' number counts each resource consent only once. The areal extent geolocated matches are a subset (83 per cent) of the keyword matches.

Areal extent of geolocated 'subdivision' and 'other land use' consents on HPL and non-HPL

Table 3 and figure 2 show the breakdown of the number and area of areal extent geolocated consents for 'subdivision' and 'other land use' by territorial authority and by HPL and non-HPL.

Categories of consent activities ('subdivision', 'other land use') that pose a risk to the availability of HPL were assessed separately. The association of each consent with both categories was made independently, so any one consent could be counted under both. Therefore, the total area of threatened HPL cannot be estimated by deriving the sum of consent areas threatened by subdivision and other land use. This would not account correctly for consents that are identified by keywords for both categories. The degree of overlap between the two was, therefore, quantified, showing that 777 consents with a total area of 14,288 hectares were identified as both 'subdivision' and 'other land use' (table 3).

For consents on HPL, 3,755 consents for 'subdivision' and 1,445 for 'other land use' coincided with HPL. This equated to 4,933 unique related consents, because 267 overlapped. This translated to 48,327 hectares of HPL associated with these collective resource consent types (ie, corrected for double-counting).

Table 3: Number and area (hectares (ha)) of 'subdivision' and 'other land use' consents on highly productive land (HPL) and non-HPL, by territorial authority

Shaded areas are to distinguish between consent types and dual identification analysis.

Territorial authority	Number and area (ha) of consents								
	'Subdivision' consents	'Subdivision' consents covering some HPL	'Subdivision' consents covering some non-HPL	Unique 'land use' consents	'Land use' consents covering some HPL	'Land use' consents covering some non-HPL	Dual-identified consent count (ha)	Dual-identified consents on HPL, count	Dual-identified consents on non-HPL, count
Ashburton District	58 (2679)	52 (2018)	14 (660)	2 (123)	2 (122)	1 (1)	0 (0)	0 (0)	0 (0)
Auckland	3,915 (5,143)	559 (1,765)	3,523 (3,379)	1,688 (2,815)	389 (1,211)	1,396 (1,604)	419 (370)	55 (262)	381 (108)
Bay of Plenty Regional	6 (8)	2 (1)	5 (7)	6 (58)	5 (50)	3 (8)	0 (0)	0 (0)	0 (0)
Buller District	25 (338)	5 (29)	21 (309)	3 (230)	1 (0)	3 (230)	0 (0)	0 (0)	0 (0)
Carterton District	44 (769)	21 (265)	31 (504)	10 (64)	5 (6)	9 (59)	0 (0)	0 (0)	0 (0)
Central Hawke's Bay District	124 (6,885)	95 (2,577)	76 (4,308)	14 (55)	13 (46)	4 (8)	0 (0)	0 (0)	0 (0)
Central Otago District	219 (9,806)	76 (1,033)	191 (8,773)	19 (259)	6 (51)	18 (209)	0 (0)	0 (0)	0 (0)
Chatham Islands	2 (48)	0 (0)	2 (48)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Christchurch City	378 (723)	86 (336)	312 (387)	153 (87)	33 (43)	125 (43)	3 (6)	2 (6)	1 (0)
Clutha District	25 (741)	16 (284)	15 (457)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)
Dunedin City	254 (776)	52 (294)	223 (482)	73 (474)	22 (130)	54 (344)	3 (2)	0 (0)	3 (2)
Environment Canterbury	4 (7)	4 (7)	0 (0)	3 (24)	1 (2)	3 (22)	0 (0)	0 (0)	0 (0)
Environment Southland	0 (0)	0 (0)	0 (0)	32 (3,431)	28 (1,929)	16 (1,503)	0 (0)	0 (0)	0 (0)
Far North District	259 (4,991)	144 (1,605)	179 (3,386)	19 (287)	7 (56)	17 (231)	7 (85)	3 (37)	5 (49)
Gisborne District	110 (525)	55 (156)	74 (370)	37 (361)	18 (33)	25 (329)	12 (20)	8 (17)	6 (3)
Gore District	2 (1)	1 (1)	1 (0)	3 (0)	0 (0)	3 (0)	1 (0)	0 (0)	1 (0)
Greater Wellington Regional	16 (58)	7 (8)	13 (50)	12 (81)	3 (8)	11 (73)	0 (0)	0 (0)	0 (0)
Grey District	48 (984)	1 (0)	47 (983)	4 (8)	0 (0)	4 (8)	3 (4)	0 (0)	3 (4)
Hamilton City	98 (16)	16 (2)	88 (14)	60 (12)	26 (5)	37 (6)	3 (0)	1 (0)	2 (0)

Territorial authority	Number and area (ha) of consents								
	'Subdivision' consents	'Subdivision' consents covering some HPL	'Subdivision' consents covering some non-HPL	Unique 'land use' consents	'Land use' consents covering some HPL	'Land use' consents covering some non-HPL	Dual-identified consent count (ha)	Dual-identified consents on HPL, count	Dual-identified consents on non-HPL, count
Hastings District	224 (8,551)	92 (1,180)	188 (7,371)	35 (939)	25 (148)	22 (792)	10 (833)	5 (56)	9 (777)
Hauraki District	92 (1,581)	58 (944)	52 (637)	18 (60)	10 (11)	9 (49)	1 (48)	0 (0)	1 (48)
Hawke's Bay Regional	4 (208)	2 (70)	4 (137)	4 (97)	3 (12)	3 (85)	0 (0)	0 (0)	0 (0)
Horizons Regional	28 (201)	23 (78)	16 (123)	7 (182)	1 (15)	6 (167)	0 (0)	0 (0)	0 (0)
Horowhenua District	154 (711)	53 (491)	113 (220)	18 (220)	8 (113)	14 (108)	0 (0)	0 (0)	0 (0)
Hurunui District	39 (1,371)	35 (605)	15 (766)	39 (842)	33 (369)	12 (472)	0 (0)	0 (0)	0 (0)
Hutt City	169 (277)	8 (15)	167 (262)	35 (138)	2 (11)	35 (127)	1 (129)	1 (9)	1 (121)
Invercargill City	127 (616)	41 (141)	91 (475)	9 (57)	2 (16)	7 (41)	4 (45)	1 (4)	3 (41)
Kaikoura District	16 (444)	6 (65)	16 (380)	6 (8)	3 (6)	4 (2)	0 (0)	0 (0)	0 (0)
Kaipara District	121 (2,367)	47 (413)	108 (1,954)	68 (142)	22 (14)	50 (128)	0 (0)	0 (0)	0 (0)
Kapiti Coast District	23 (37)	5 (27)	20 (10)	1 (2)	1 (2)	1 (0)	0 (0)	0 (0)	0 (0)
Kawerau District	2 (0)	1 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mackenzie District	19 (624)	3 (205)	16 (418)	9 (288)	0 (0)	9 (288)	0 (0)	0 (0)	0 (0)
Manawatu District	156 (1,953)	106 (1,461)	84 (492)	49 (545)	35 (467)	20 (78)	15 (312)	12 (242)	6 (70)
Marlborough District	171 (10,737)	70 (853)	139 (9,884)	108 (4,999)	53 (394)	82 (4,605)	10 (2)	1 (1)	9 (1)
Masterton District	85 (1,557)	33 (335)	72 (1,222)	14 (182)	5 (165)	11 (17)	2 (5)	1 (5)	1 (0)
Matamata-Piako District	77 (2,156)	55 (1,036)	43 (1,121)	29 (1,264)	27 (239)	8 (1,026)	4 (984)	4 (72)	2 (912)
Napier City	126 (60)	22 (22)	110 (39)	22 (12)	5 (5)	17 (7)	6 (1)	3 (1)	3 (0)
Nelson City	33 (168)	22 (14)	20 (154)	19 (15)	9 (10)	14 (5)	2 (3)	2 (3)	2 (0)
New Plymouth District	195 (2378)	82 (847)	163 (1530)	48 (269)	36 (135)	37 (179)	9 (68)	6 (4)	6 (63)
Northland Regional	28 (720)	20 (209)	24 (511)	32 (1,038)	23 (327)	22 (711)	0 (0)	0 (0)	0 (0)
Opotiki District	11 (62)	9 (13)	5 (49)	9 (126)	9 (108)	4 (17)	3 (1)	3 (1)	0 (0)

Territorial authority	Number and area (ha) of consents								
	'Subdivision' consents	'Subdivision' consents covering some HPL	'Subdivision' consents covering some non-HPL	Unique 'land use' consents	'Land use' consents covering some HPL	'Land use' consents covering some non-HPL	Dual-identified consent count (ha)	Dual-identified consents on HPL, count	Dual-identified consents on non-HPL, count
Otago Regional	33 (1,142)	16 (75)	23 (1,067)	2 (288)	2 (279)	2 (9)	0 (0)	0 (0)	0 (0)
Otorohanga District	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Palmerston North City	180 (605)	52 (384)	140 (221)	88 (207)	25 (149)	71 (58)	25 (114)	7 (104)	19 (9)
Porirua City	53 (149)	4 (22)	50 (127)	59 (118)	5 (30)	55 (88)	3 (50)	1 (0)	2 (50)
Queenstown-Lakes District	189 (2,145)	56 (442)	166 (1,703)	44 (736)	23 (192)	30 (544)	1 (0)	1 (0)	0 (0)
Rangitikei District	49 (1,447)	34 (348)	37 (1,099)	6 (7)	4 (4)	5 (3)	3 (7)	3 (4)	3 (2)
Rotorua District	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ruapehu District	25 (1,404)	13 (112)	21 (1,291)	4 (19)	2 (5)	4 (14)	1 (4)	1 (3)	1 (1)
Selwyn District	126 (1,453)	88 (814)	45 (639)	123 (1,676)	93 (1,014)	37 (662)	9 (256)	8 (256)	1 (0)
South Taranaki District	66 (1,091)	41 (649)	43 (442)	7 (6)	4 (6)	3 (0)	0 (0)	0 (0)	0 (0)
South Waikato District	20 (3,182)	5 (23)	18 (3,159)	8 (137)	6 (13)	4 (124)	1 (0)	1 (0)	0 (0)
South Wairarapa District	103 (2,590)	71 (781)	60 (1,809)	39 (681)	26 (191)	22 (490)	17 (601)	14 (129)	7 (473)
Southland District	123 (5,024)	81 (2549)	64 (2,475)	31 (202)	17 (110)	15 (92)	2 (8)	1 (0)	1 (8)
Stratford District	54 (1,002)	46 (386)	21 (616)	3 (7)	3 (7)	0 (0)	0 (0)	0 (0)	0 (0)
Taranaki Regional	6 (978)	6 (173)	6 (805)	1 (2)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Tararua District	98 (2,979)	65 (727)	67 (2,252)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)
Tasman District	304 (4,243)	185 (927)	183 (3,316)	87 (1,875)	52 (311)	53 (1,564)	55 (1,638)	33 (227)	34 (1,411)
Taupo District	93 (1,746)	19 (66)	84 (1,680)	46 (414)	3 (0)	44 (413)	1 (24)	0 (0)	1 (24)
Tauranga City	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Thames-Coromandel District	81 (1,118)	38 (311)	58 (807)	28 (91)	12 (48)	22 (43)	14 (52)	7 (26)	10 (26)
Timaru District	86 (1,615)	50 (1,199)	51 (416)	13 (112)	6 (49)	9 (63)	2 (1)	1 (1)	1 (0)
Upper Hutt City	76 (74)	3 (33)	75 (40)	36 (103)	0 (0)	36 (103)	9 (5)	0 (0)	9 (5)

Territorial authority	Number and area (ha) of consents								
	'Subdivision' consents	'Subdivision' consents covering some HPL	'Subdivision' consents covering some non-HPL	Unique 'land use' consents	'Land use' consents covering some HPL	'Land use' consents covering some non-HPL	Dual-identified consent count (ha)	Dual-identified consents on HPL, count	Dual-identified consents on non-HPL, count
Waikato District	331 (5,774)	258 (3,340)	172 (2,434)	155 (1,549)	110 (938)	73 (611)	54 (1,237)	43 (736)	25 (501)
Waikato Regional	48 (258)	39 (149)	27 (110)	11 (1,068)	9 (235)	6 (833)	1 (7)	1 (7)	0 (0)
Waimakariri District	159 (3,204)	127 (2,289)	58 (915)	109 (856)	72 (356)	41 (500)	16 (327)	9 (148)	8 (179)
Waimate District	21 (3,449)	15 (185)	8 (3,264)	4 (305)	2 (239)	3 (66)	0 (0)	0 (0)	0 (0)
Waipa District	263 (3,321)	168 (1,619)	165 (1,702)	75 (1,244)	56 (556)	43 (688)	27 (1,032)	22 (450)	17 (582)
Wairoa District	9 (359)	5 (28)	8 (332)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Waitaki District	95 (1,1527)	64 (1,628)	51 (9,899)	6 (5,959)	4 (460)	5 (5,499)	5 (5,958)	3 (459)	5 (5,499)
Waitomo District	5 (144)	1 (5)	4 (139)	2 (3)	1 (1)	2 (2)	0 (0)	0 (0)	0 (0)
Wellington City	129 (106)	0 (0)	129 (106)	97 (87)	0 (0)	97 (87)	2 (11)	0 (0)	2 (11)
West Coast Regional	0 (0)	0 (0)	0 (0)	1 (3)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)
Western Bay of Plenty District	107 (1,106)	62 (232)	74 (875)	63 (134)	28 (55)	42 (78)	5 (35)	3 (3)	3 (32)
Westland District	79 (807)	2 (4)	79 (803)	5 (5)	0 (0)	5 (5)	4 (5)	0 (0)	4 (5)
Whakatane District	36 (477)	10 (230)	31 (248)	16 (248)	7 (176)	11 (71)	0 (0)	0 (0)	0 (0)
Whanganui District	194 (817)	61 (300)	181 (517)	30 (17)	6 (9)	29 (8)	2 (0)	0 (0)	2 (0)
Whangarei District	189 (2,382)	85 (450)	159 (1,932)	12 (50)	6 (24)	11 (26)	0 (0)	0 (0)	0 (0)
Aotearoa New Zealand	**10,917 (138,997)**	**3,755 (39,883)**	**8,640 (99,114)**	**3,930 (38,004)**	**1,445 (11,716)**	**2,898 (26,288)**	**777 (14,288)**	**267 (3,272)**	**600 (11,016)**

Notes: When split across HPL and non-HPL, the combined HPL and non-HPL *number* is higher than the number of unique consents, because some overlie both HPL and non-HPL. However, the areas of HPL and non-HPL covered are equal to the total area of the region's consents.

Dual-identified = the number (and hectares) of consents identified by keyword matching as both 'subdivision' and 'other land use'. This set should not be double-counted when combining the two areas of consents. Data is based on relevant resource consents that were geolocated to areal extent.

The difference in distribution of consent types between territorial authority, regional and unitary council reflects the different responsibilities of the two authority types. Territorial authorities have primary responsibility for 'subdivision' consents, while regional councils have primary responsibility for 'other land use' consents. Consents processed by constituent territorial authorities were not attributed to their regional counterparts, because regional councils did not hold the responsibility of granting these consents.

Figure 2: Area of highly productive land (HPL), total area of 'subdivision' consents occupying HPL, and total area of 'other land use' consents occupying HPL
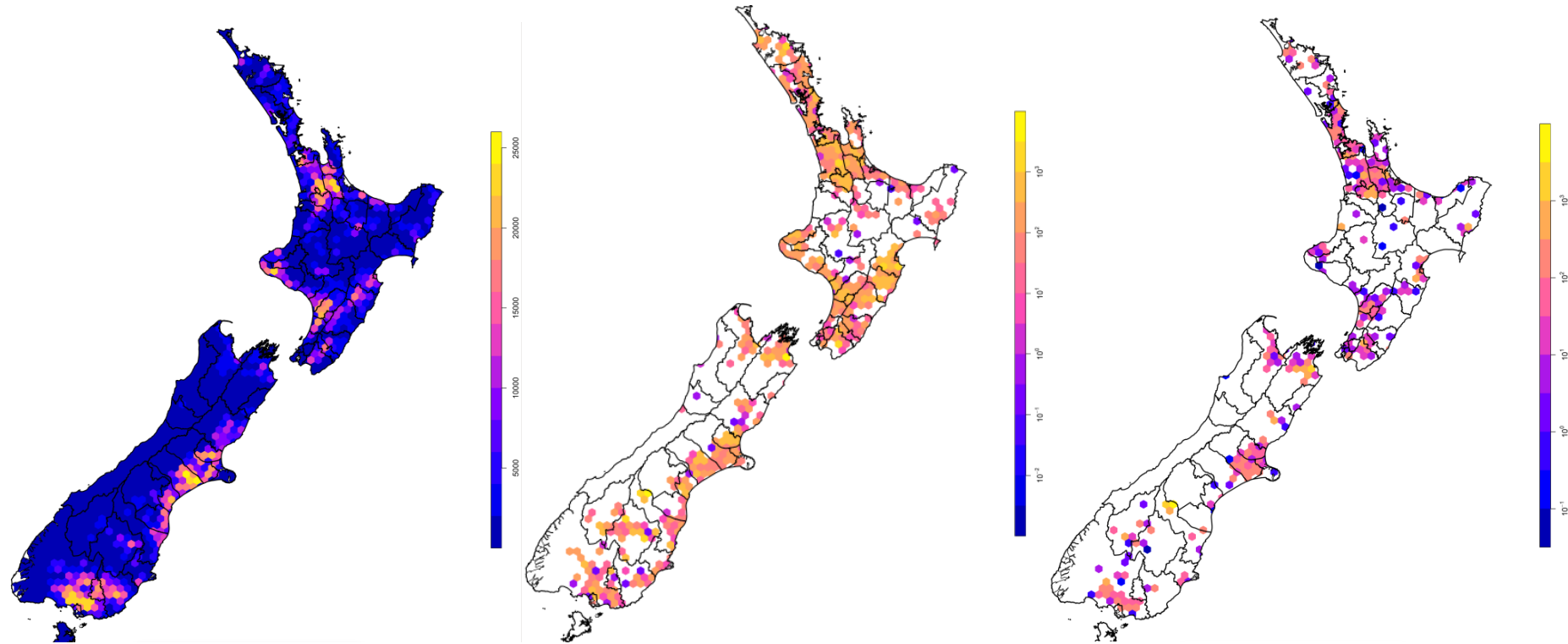
From left: Area of highly productive land, total area of 'subdivision' consents occupying HPL, and total area of 'other land use' consents occupying HPL. The maps use a grid of hexagonal cells, each measuring 250 square kilometres, to aggregate spatial statistics. Cells in the left map are more yellow if they have a higher area of HPL, while cells in the middle and right maps are more yellow if they have more HPL area affected by 'subdivision' and 'other land use' consents. Cells with no colour (white) have no consents identified as for 'subdivision' or 'other land use'. Black lines show territorial authority boundaries.

Areal extent of geolocated consents for subdivision and other land use on LUC class 1, 2 and 3 land

Table 4 shows the breakdown of the unique number and area of areal extent geolocated consents for 'subdivision' and 'other land use' by territorial authority, and LUC class 1, 2 and 3 land split.

As before, categories of resource consent activity ('subdivision' and 'other land use') that pose a risk to the availability of HPL were assessed separately in this analysis so any one consent could be counted under both these categories. The degree of overlap between consents in both categories was also quantified (table 4).

Accounting for the overlap 536, 2,209 and 2,922 unique related resource consents coincided with LUC class 1, 2 and 3 land, respectively. This translated to 2,636 hectares, 16,582 hectares and 29,128 hectares of corresponding LUC class 1, 2 and 3 land, respectively, that was associated with these collective resource consent types (ie, correcting for double-counting) (table 4).

Table 4: Number and area (hectares (ha)) of 'subdivision' and 'other land use' consents on Land Use Capability class (LUC) class 1, 2 and 3 land, by territorial authority

Shaded areas are to distinguish between consent types and dual identification analysis.

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
Ashburton District	52 (2,018)	3 (57)	21 (371)	37 (1,588)	2 (122)	0 (0)	0 (0)	2 (122)	0 (0)	0 (0)	0 (0)	0 (0)
Auckland	559 (1,764)	12 (21)	359 (901)	261 (841)	389 (1210)	8 (53)	205 (782)	213 (376)	55 (262)	2 (0)	39 (203)	25 (58)
Bay of Plenty Regional	2 (0)	0 (0)	0 (0)	2 (0)	5 (50)	0 (0)	2 (3)	4 (46)	0 (0)	0 (0)	0 (0)	0 (0)
Buller District	5 (28)	0 (0)	0 (0)	5 (28)	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Carterton District	21 (264)	1 (1)	5 (45)	19 (217)	5 (5)	1 (2)	1 (1)	4 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Central Hawke's Bay District	95 (2,576)	5 (31)	11 (204)	91 (2,340)	13 (46)	2 (16)	2 (8)	10 (20)	0 (0)	0 (0)	0 (0)	0 (0)
Central Otago District	76 (1,033)	0 (0)	0 (0)	76 (1,033)	6 (50)	0 (0)	0 (0)	6 (50)	0 (0)	0 (0)	0 (0)	0 (0)
Chatham Islands	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Christchurch City	86 (336)	18 (24)	73 (135)	14 (176)	33 (43)	5 (6)	17 (28)	11 (8)	2 (5)	0 (0)	2 (5)	0 (0)
Clutha District	16 (284)	0 (0)	9 (41)	9 (242)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Dunedin City	52 (294)	13 (60)	7 (172)	35 (61)	22 (130)	5 (15)	7 (61)	13 (53)	0 (0)	0 (0)	0 (0)	0 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
Environment Canterbury	4 (6)	1 (5)	1 (0)	3 (1)	1 (2)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Environment Southland	0 (0)	0 (0)	0 (0)	0 (0)	28 (1,928)	0 (0)	14 (886)	18 (1,042)	0 (0)	0 (0)	0 (0)	0 (0)
Far North District	144 (1,604)	0 (0)	78 (702)	84 (901)	7 (56)	0 (0)	2 (4)	5 (51)	3 (36)	0 (0)	2 (4)	1 (32)
Gisborne District	55 (155)	12 (11)	13 (23)	42 (120)	18 (32)	3 (2)	2 (9)	17 (19)	8 (17)	3 (2)	0 (0)	8 (14)
Gore District	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Greater Wellington Regional	7 (7)	0 (0)	0 (0)	7 (7)	3 (7)	0 (0)	0 (0)	3 (7)	0 (0)	0 (0)	0 (0)	0 (0)
Grey District	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hamilton City	16 (2)	4 (0)	13 (1)	0 (0)	26 (5)	4 (0)	22 (5)	1 (0)	1 (0)	1 (0)	0 (0)	0 (0)
Hastings District	92 (1,179)	29 (75)	22 (187)	49 (915)	25 (147)	8 (11)	7 (51)	14 (85)	5 (56)	0 (0)	3 (39)	3 (16)
Hauraki District	58 (943)	0 (0)	22 (114)	49 (829)	10 (11)	0 (0)	2 (2)	9 (8)	0 (0)	0 (0)	0 (0)	0 (0)
Hawke's Bay Regional	2 (70)	1 (26)	0 (0)	2 (44)	3 (11)	2 (1)	1 (0)	1 (9)	0 (0)	0 (0)	0 (0)	0 (0)
Horizons Regional	23 (77)	3 (1)	16 (46)	9 (29)	1 (14)	0 (0)	1 (6)	1 (7)	0 (0)	0 (0)	0 (0)	0 (0)
Horowhenua District	53 (490)	10 (5)	21 (233)	42 (251)	8 (112)	3 (48)	3 (62)	4 (1)	0 (0)	0 (0)	0 (0)	0 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
Hurunui District	35 (604)	10 (23)	7 (85)	21 (495)	33 (369)	14 (13)	2 (44)	19 (311)	0 (0)	0 (0)	0 (0)	0 (0)
Hutt City	8 (14)	0 (0)	0 (0)	8 (14)	2 (10)	0 (0)	0 (0)	2 (10)	1 (8)	0 (0)	0 (0)	1 (8)
Invercargill City	41 (140)	0 (0)	23 (98)	20 (42)	2 (16)	0 (0)	1 (4)	1 (12)	1 (4)	0 (0)	1 (4)	0 (0)
Kaikoura District	6 (64)	0 (0)	3 (62)	3 (2)	3 (5)	0 (0)	2 (5)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Kaipara District	47 (413)	0 (0)	8 (94)	42 (318)	22 (13)	0 (0)	0 (0)	22 (13)	0 (0)	0 (0)	0 (0)	0 (0)
Kapiti Coast District	5 (27)	1 (1)	1 (0)	3 (24)	1 (2)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Kawerau District	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mackenzie District	3 (205)	0 (0)	0 (0)	3 (205)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Manawatu District	106 (1,461)	11 (90)	74 (958)	35 (412)	35 (466)	2 (0)	25 (250)	10 (215)	12 (241)	0 (0)	6 (92)	6 (149)
Marlborough District	70 (852)	9 (18)	33 (124)	39 (709)	53 (394)	4 (10)	15 (40)	42 (342)	1 (1)	1 (0)	1 (1)	0 (0)
Masterton District	33 (335)	0 (0)	15 (167)	25 (167)	5 (165)	0 (0)	2 (110)	4 (54)	1 (4)	0 (0)	1 (4)	0 (0)
Matamata-Piako District	55 (1,035)	19 (259)	39 (569)	21 (206)	27 (238)	10 (49)	17 (173)	11 (15)	4 (71)	1 (10)	1 (60)	2 (0)
Napier City	22 (21)	6 (1)	7 (6)	9 (14)	5 (5)	0 (0)	4 (4)	1 (0)	3 (0)	0 (0)	3 (0)	0 (0)
Nelson City	22 (13)	0 (0)	7 (5)	17 (8)	9 (10)	0 (0)	1 (2)	8 (7)	2 (2)	0 (0)	1 (2)	1 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
New Plymouth District	82 (847)	28 (131)	28 (81)	47 (634)	25 (134)	7 (58)	8 (7)	16 (68)	6 (4)	2 (0)	1 (1)	4 (1)
Northland Regional	20 (209)	0 (0)	5 (54)	15 (155)	23 (327)	0 (0)	8 (49)	18 (277)	0 (0)	0 (0)	0 (0)	0 (0)
Opotiki District	9 (12)	0 (0)	9 (12)	1 (0)	9 (108)	0 (0)	7 (102)	2 (5)	3 (0)	0 (0)	3 (0)	0 (0)
Otago Regional	16 (74)	0 (0)	6 (56)	10 (18)	2 (278)	0 (0)	1 (1)	2 (276)	0 (0)	0 (0)	0 (0)	0 (0)
Otorohanga District	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Palmerston North City	52 (384)	1 (0)	35 (150)	25 (233)	25 (148)	4 (14)	10 (97)	14 (36)	7 (104)	1 (0)	3 (85)	4 (18)
Porirua City	4 (22)	0 (0)	1 (2)	3 (20)	5 (29)	0 (0)	0 (0)	5 (29)	1 (0)	0 (0)	0 (0)	1 (0)
Queenstown-Lakes District	56 (441)	0 (0)	23 (88)	34 (353)	23 (191)	0 (0)	4 (35)	19 (156)	1 (0)	0 (0)	0 (0)	1 (0)
Rangitikei District	34 (348)	2 (0)	27 (219)	11 (128)	4 (4)	0 (0)	4 (4)	1 (0)	3 (4)	0 (0)	3 (4)	0 (0)
Rotorua District	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ruapehu District	13 (112)	0 (0)	2 (17)	11 (95)	2 (4)	0 (0)	1 (2)	1 (1)	1 (2)	0 (0)	1 (2)	0 (0)
Selwyn District	88 (814)	15 (77)	29 (256)	56 (480)	93 (1,014)	15 (110)	47 (255)	43 (647)	8 (255)	1 (16)	5 (102)	3 (136)
South Taranaki District	41 (649)	13 (64)	15 (226)	25 (358)	4 (5)	2 (0)	1 (0)	2 (4)	0 (0)	0 (0)	0 (0)	0 (0)
South Waikato District	5 (23)	1 (2)	1 (0)	5 (20)	6 (12)	0 (0)	1 (0)	6 (12)	1 (0)	0 (0)	0 (0)	1 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
South Wairarapa District	71 (780)	17 (33)	13 (116)	47 (630)	26 (190)	4 (21)	5 (10)	18 (158)	14 (128)	3 (20)	2 (8)	9 (99)
Southland District	81 (2,549)	0 (0)	47 (675)	48 (1,873)	17 (110)	0 (0)	11 (98)	9 (12)	1 (0)	0 (0)	0 (0)	1 (0)
Stratford District	46 (385)	0 (0)	0 (0)	46 (385)	3 (7)	0 (0)	0 (0)	3 (7)	0 (0)	0 (0)	0 (0)	0 (0)
Taranaki Regional	6 (172)	2 (145)	1 (4)	4 (22)	1 (2)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Tararua District	65 (726)	0 (0)	33 (217)	39 (509)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tasman District	185 (927)	25 (194)	20 (138)	157 (594)	52 (311)	9 (54)	3 (13)	44 (243)	33 (226)	6 (51)	2 (10)	27 (165)
Taupo District	19 (66)	0 (0)	0 (0)	19 (66)	3 (0)	0 (0)	0 (0)	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Tauranga City	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Thames-Coromandel District	38 (311)	0 (0)	20 (197)	20 (113)	12 (47)	0 (0)	6 (42)	7 (5)	7 (25)	0 (0)	5 (22)	2 (3)
Timaru District	50 (1,198)	2 (27)	19 (440)	40 (730)	6 (48)	0 (0)	3 (3)	3 (45)	1 (0)	0 (0)	0 (0)	1 (0)
Upper Hutt City	3 (33)	0 (0)	0 (0)	3 (33)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Waikato District	258 (3,339)	51 (177)	169 (2,326)	120 (851)	110 (937)	26 (47)	54 (641)	52 (249)	43 (735)	14 (41)	27 (564)	12 (129)
Waikato Regional	39 (148)	5 (28)	32 (76)	8 (44)	9 (234)	1 (0)	6 (44)	6 (189)	1 (6)	0 (0)	1 (6)	0 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
Waimakariri District	127 (2,289)	7 (143)	63 (800)	91 (1,345)	72 (356)	1 (29)	46 (190)	33 (136)	9 (148)	0 (0)	5 (60)	8 (87)
Waimate District	15 (184)	0 (0)	8 (76)	10 (107)	2 (239)	0 (0)	0 (0)	2 (239)	0 (0)	0 (0)	0 (0)	0 (0)
Waipa District	168 (1,619)	57 (220)	98 (762)	58 (636)	56 (555)	12 (45)	34 (276)	19 (234)	22 (450)	1 (0)	17 (232)	9 (217)
Wairoa District	5 (27)	0 (0)	3 (17)	2 (9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Waitaki District	64 (1,627)	0 (0)	36 (623)	36 (1,004)	4 (459)	0 (0)	0 (0)	4 (459)	3 (458)	0 (0)	0 (0)	3 (458)
Waitomo District	1 (4)	0 (0)	0 (0)	1 (4)	1 (1)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Wellington City	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
West Coast Regional	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Western Bay of Plenty District	62 (231)	0 (0)	29 (94)	36 (136)	28 (55)	0 (0)	9 (24)	20 (30)	3 (3)	0 (0)	1 (0)	2 (2)
Westland District	2 (3)	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Whakatane District	10 (229)	3 (20)	5 (172)	5 (36)	7 (176)	1 (41)	6 (123)	1 (11)	0 (0)	0 (0)	0 (0)	0 (0)
Whanganui District	61 (300)	21 (127)	26 (124)	22 (48)	6 (9)	1 (2)	3 (2)	3 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Whangarei District	85 (450)	0 (0)	16 (138)	72 (311)	6 (23)	0 (0)	1 (0)	6 (23)	0 (0)	0 (0)	0 (0)	0 (0)

Council	'Subdivision' consents covering some HPL (ha)	'Subdivision' consents covering some LUC class 1 (ha)	'Subdivision' consents covering some LUC class 2 (ha)	'Subdivision' consents covering some LUC class 3 (ha)	'Land use' consents covering some HPL (ha)	'Land use' consents covering some LUC class 1 (ha)	'Land use' consents covering some LUC class 2 (ha)	'Land use' consents covering some LUC class 3 (ha)	Dual-identified consents covering some HPL (ha)	Dual-identified consents covering some LUC class 1 (ha)	Dual-identified consents covering some LUC class 2 (ha)	Dual-identified consents covering some LUC class 3 (ha)
Aotearoa New Zealand	**3,755 (39,883)**	**418 (2,117)**	**1,708 (13,524)**	**2,213 (24,256)**	**1,445 (11,716)**	**154 (663)**	**637 (4,583)**	**824 (6,471)**	**267 (3,271)**	**36 (144)**	**136 (1,525)**	**135 (1,601)**

Notes: When split across each LUC class, the combined *number* is higher than the number of unique consents, because some overlie various LUC 1, 2 and 3 land. However, the *areas* of each LUC class are equal to the total area of the region's consents.

'Dual-identified' indicates the number (and hectare area in parentheses) of consents that were identified by keyword matching as both 'subdivision' and 'other land use activity'. This set should not be double-counted when combining the areas of subdivision and other land use consents.

Data is based on relevant consents that were geolocated to areal extent.

Plan changes

Plan changes could not be assigned a location or areal extent because of the absence of the required geospatial data in NMS. They could therefore not be matched to coincidence with HPL or non-HPL. Plan changes were not refined any further from the initial tranche of regex patterns summarised by type (table 5) and by territorial authority (table 6).

Table 5:   **Summary of total plan change data by type**

An overlap will occur across the plan change types because they are all rural.

	Rural	Rural–residential	Rural–lifestyle	Rural–industrial	Total unique[1]
Number	44	33	1	6	44

[1]   Total unique matches for all groupings. If a consent was flagged by more than one column it was only counted once.

Table 6:   **Number of relevant plan changes by territorial authority**

Territorial authority, regional and unitary council	Number of plan changes[1]
Ashburton District	0
Auckland	7
Bay of Plenty Regional	0
Buller District	1
Carterton District	0
Central Hawke's Bay District	0
Central Otago District	0
Chatham Islands	0
Christchurch City	1
Clutha District	0
Dunedin City	0
Environment Canterbury	0
Environment Southland	0
Far North District	0
Gisborne District	0
Gore District	0
Greater Wellington Regional	0
Grey District	0
Hamilton City	0
Hastings District	0
Hauraki District	0
Hawke's Bay Regional	0
Horizons Regional	0
Horowhenua District	1
Hurunui District	0
Hutt City	1
Invercargill City	0

Territorial authority, regional and unitary council	Number of plan changes [1]
Kaikoura District	0
Kaipara District	0
Kapiti Coast District	0
Kawerau District	0
Mackenzie District	0
Manawatu District	1
Marlborough District	0
Masterton District	0
Matamata-Piako District	1
Napier City	0
Nelson City	1
New Plymouth District	0
Northland Regional	0
Opotiki District	0
Otago Regional	1
Otorohanga District	0
Palmerston North City	1
Porirua City	0
Queenstown-Lakes District	0
Rangitikei District	1
Rotorua District	0
Ruapehu District	0
Selwyn District	21
South Taranaki District	0
South Waikato District	0
South Wairarapa District	0
Southland District	0
Stratford District	0
Taranaki Regional	0
Tararua District	0
Tasman District	0
Taupo District	2
Tauranga City	0
Thames-Coromandel District	0
Timaru District	0
Upper Hutt City	3
Waikato District	0
Waikato Regional	0
Waimakariri District	1
Waimate District	0
Waipa District	0
Wairoa District	0

Territorial authority, regional and unitary council	Number of plan changes [1]
Waitaki District	0
Waitomo District	0
Wellington City	0
West Coast Regional	0
Western Bay of Plenty District	0
Westland District	0
Whakatane District	0
Whanganui District	0
Whangarei District	0
Aotearoa New Zealand	**44**

[1] Total number of unique matches for plan changes across all groupings for each authority or council.

Discussion

Overview

Using 2021/22 NMS data, 94 per cent of resource consent data was geolocated nationally and 85 per cent were matched to areal extent or polygon for the first time. Only the areal extent of geolocated consents was used to determine coincidence with HPL or non-HPL. The presented findings are encouraging because they demonstrate the ability to identify the potential land area associated with affected resource consents. This creates opportunities for more diverse analyses beyond the NPS-HPL in this example.

Results from this analysis indicate that 3,755 (39,883 hectares) and 1,445 (11,716 hectares) resource consents for 'subdivision' and 'other land use', respectively, coincided with HPL. This equated to 4,933 unique resource consents (because 267 (3,272 hectares) overlapped both categories). This translates to a combined total of 48,327 hectares (accounting for dual-identified consents and areas, ie, 51,602 hectares – 3,272 hectares) (table 3) or 1.26 per cent[11] of Aotearoa New Zealand's HPL area in one year (2021/22). This does not consider adverse cumulative effects.

For context, 48,327 hectares of HPL are equivalent to almost 1.3 times the reported area of outdoor vegetable production in 2023 (United Fresh, 2023). It is also almost 1.3 times the area of HPL that was occupied for urban and residential use between 2002 and 2019 (Curran-Cournane *et al.*, 2021).

However, several caveats apply when interpreting this 48,327 hectare HPL figure. For example, the affected area does not account for district plan zones with non-rural production uses (eg, residential, lifestyle, industrial, future urban), because they are not nationally available.[12] Therefore, it is not possible to exclude areas such as 'future urban use' from the current analysis. The total HPL area presented is therefore likely to be the upper boundary of the affected area. Also, although boundary adjustments are a form of subdivision, they may not be a significant encroachment onto HPL and the category can lead to an overestimation of the actual loss. Future analysis can explore the footprint of this category. For more discussion, see Limitations and refinements below.

Although implementing some consents would constitute a loss or an impact on a natural non-renewable asset, some of the LUC class 1–3 land areas will not qualify for HPL protection (based on the definition of HPL in the NPS-HPL being linked to only certain rural zones).

The results have been presented for individual HPL classes for 'subdivision' and 'other land use' consents, to determine related impacts for each LUC 1, 2 and 3 land class. Presenting as combined HPL figure can otherwise dilute the impacts on LUC 1 and 2 class land, given the

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[11] Based on baseline LUC 1, 2 and 3 land figures (ie, does not take into account what has previously been lost to urban encroachment, as well as fragmentation and development of HPL).

[12] Some district planning zones are available for some regions, but they are not available for the whole country, or it is not immediately obvious how to acquire them from each council. See Local and regional government – Groups – data.govt.nz – discover and use data, for more information.

greater area of LUC class 3[13] (table 4). This is also relevant given the potential for LUC class 3 land to be removed from the definition of HPL (National, 2023). Results from this analysis can provide recent evidence of 'subdivision' and 'other land use' pressures for each separate LUC 1, 2 and 3 class.

The results indicate that (once corrected for double-counting (dual-identified)), 536, 2,209 and 2,922 unique related resource consents coincided with LUC class 1, 2 and 3 land, respectively. This translates to 2,636, 16,582 and 29,128 hectares of corresponding LUC class 1, 2 and 3 land, respectively (table 4). As per baseline figures, this equates to 1.41, 1.38 and 1.19 per cent of Aotearoa New Zealand's LUC class 1, 2 and 3 land, respectively.[12] The same caveats apply to those already noted when interpreting these areas. These caveats are expanded on below.

For future formal analysis of NPS-HPL evaluation, it will be important to understand how much loss is considered unacceptable within HPL-mapped areas. The threshold (eg, zero hectares or an alternative figure) will need to be determined. This will likely depend on the region, and consideration of the availability and pressure of HPL, which will be region-specific.

Pathways are available to enable non-land-based primary production, including subdivision, onto HPL. Acceptable or non-acceptable thresholds will need to be informed by distinguishing between activities that result in a loss of HPL in regional maps regarded as being appropriate (for example, matters of national significance) or not. Monitoring over time will help to build a picture that planners should be able to consider when determining applications, noting the objective is to ensure HPL is available 'for use in land-based primary production, both now and for future generations' (Ministry for the Environment, 2022).

Limitations and refinements

Resource consent geolocation data

Allowing councils freedom in the input format of location information for each consent for the NMS results in considerable variation in the information. Although many consent locations are specified by a legal description matching an existing land record, text descriptions are often slightly altered and require pre-processing to make them consistent with the format in land records. Many other consents do not match land record legal descriptions, and success is limited in matching consents to properties (allowing them to be geolocated to a polygon area). Councils are not currently required to unambiguously communicate the location of each consent in the NMS data to the Ministry. It is quite possible that a bias exists in consents with unknown locations.

The legal description provided with a consent may feature a list of multiple land references. This can occur when the consent applies to multiple titles, in which case multiple (title) polygons must be aggregated to generate the area for the consent. In other cases, the consent features a list because the single title it applies to is itself made up of many component parcels. In such cases, the consent would be well represented by the single title polygon, if it can be matched (or by the aggregate of its component parcels, if the single matching title cannot be found). When the area for a consent needs to be constructed out of multiple

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13   According to baseline figures, LUC class 1, 2 and 3 land represents 187,114, 1,201,446 and 2,441,866 hectares, representing 0.7, 4.5 and 9.2 per cent, respectively, of Aotearoa New Zealand's land area (Curran-Cournane et al, 2021).

component areas (whether titles or parcels), the potential is for only a subset of those components to be found, leading to an underestimation of the area affected by the consent.

As noted, the consented activity might not affect the entire area of the land record polygon assigned to a resource consent. It is a limitation that the consent's legal description is not precise enough to spatially restrict an activity's effects within a polygon. The area determined for each consent in this analysis is likely higher than the actual affected area. So the current analysis is likely to overestimate the area of HPL affected. Preliminary enquiries about information on the affected footprint area revealed little current availability and no clear pathway to its generation and supply at this time. This will require further consideration.

However, the 'subdivision' and 'other land use' consent types were specifically selected because they were identified as posing a risk to the availability of HPL for land-based primary production for future generations. For example, a sealed footprint of a rural residential development could occupy an area of 200 square metres (or more) within a 4-hectare parcel of HPL land. However, if that parcel of land is identified or characterised as a lifestyle block, that entire 4 hectares can be compromised, because it reduces the potential for commercial primary production. Any production on a lifestyle block will be mainly serving private consumption (Andrew and Dymond, 2012; Hart *et al.*, 2013). Rural residences and lifestyle blocks, which can come in various sizes, are an inefficient use of finite HPL[14] and can reinforce further subdivision, creating an adverse cumulative effect. This is illustrated by the NPS-HPL stipulating that territorial authorities must avoid rezoning HPL for rural lifestyle purposes[15] and avoid subdivision where the productive capacity cannot be retained.[16]

The time required to process, extract and match data to areal extents can be reduced by removing much of the ambiguity and inconsistency in how consents data is recorded in the NMS. The opportunity is available to directly request the polygon definition (or its unique ID) affected by each resource consent in future NMS data collecting. This should prioritise matching consents against a title or parcel, as opposed to a survey plan that does not explicitly match to a polygon, affecting precision. Polygon geolocation data of titles and parcels is readily available in existing land record tables accessible from LINZ. The geolocation data assigned to consents in this project was sourced from these land records, but the process of matching records to consents information in the NMS was arduous and less reliable than it could be, due to the variability in legal description formatting.

Keyword matching

The Methods section highlights challenges with NMS keyword matching and data extraction. The varying descriptions of consent information by territorial authorities in the NMS caused inconsistencies and analysis delays. Extracting open text data introduced significant uncertainty. Despite efforts to cope with variation in consent records, no reliable way is available to identify all relevant records for the NPS-HPL topic. Manually checking each record would be too resource-intensive. It is crucial that NMS information requirements ensure the collection of data relevant to important subjects like NPS-HPL evaluation. Establishing a common vocabulary to better support data exchange, aggregability and analysis would be beneficial. This could take the form of NMS data protocols and standards for assigning resource consent data to polygons, and a common vocabulary when recording consent data. This would

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14   This is specifically relating to small-holdings identified or characterised as lifestyle blocks or rural residences being an inefficient use of HPL, as opposed to small-holdings identified as, for example, *commercial* horticulture or cropping.

15   Clause 3.7(1) National Policy Statement For Highly Productive Land 2022 (environment.govt.nz).

16   Clause 3.8 National Policy Statement For Highly Productive Land 2022 (environment.govt.nz).

ultimately ensure more consistent, reliable, higher quality and quicker analysis for monitoring, reporting and evaluation in the future, which has relevance beyond NPS-HPL evaluation.

Plan changes

Beyond assigning plan changes, including private plans, to their designated territorial authority (table 6), no other data collected by NMS can currently geolocate plan changes to a specific location or determine the areal extent or polygon they cover. Matching plan changes to a location would currently require manual capture of the related information from each territorial authority website.

Some plan changes may not have a specific spatial element, such as a council-initiated change to the text in the district plan. However, other changes (notably to private plans) directly apply to land areas (eg, rezonings). The area affected by plan changes can range from a few hectares to hundreds of hectares and can pose risk to the availability of HPL. The inability to readily geolocate plan change records is a shortcoming of the current NMS dataset. As with the resource consent data, the opportunity is available to directly request the polygon corresponding to each plan change (where relevant[17]) to help with future evaluations.

This exercise used the most recently published 2021/22 NMS data available at the time of analysis. This was prior to the NPS-HPL having legal effect in October 2022. The NMS would not necessarily have featured, required or requested plan change and resource consent data about HPL.

Absence of a national district plan layer

A current caveat when interpreting consent data that could pose a high risk to the availability of HPL is that the area affected does not take into account district plan zones for non-rural production (eg, residential, industrial, future urban). This is because district plan zones are not nationally available, so it is not possible to exclude areas such as 'future urban use' from the current analysis. Resource consents are also not linked to district plan zones.

Therefore, the HPL figure of 48,327 hectares corresponding collectively to consents for 'subdivision' and 'other land use' (table 3) will correspond to some areas that will not qualify for HPL protection as per the NPS-HPL. Non-rural production zones can occupy areas of LUC class 1, 2 and 3 land. This loss is not relevant for NPS-HPL purposes, but it still constitutes a historic loss of a finite resource and reiterates the role of the policy.

As per the NPS-HPL, councils must map land zoned 'general rural' or 'rural production' (or equivalent) that coincides with LUC class 1, 2 and 3 land.[18] This will ultimately be the subject area that future evaluations can match and geolocate against, to determine policy effectiveness (Ministry for the Environment, 2023b). The transitional definition of HPL (LUC classes 1–3 as per the NZLRI) will be in effect until councils produce HPL maps for their respective jurisdictions. This is a current limitation of this analysis because the area used as HPL is unlikely to match the future HPL maps produced by councils.

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[17] The actual development is most often a result of a resource consent not a plan change. The change itself sets up the zone and rules, making it easier to seek a consent.

[18] Acknowledging the potential for LUC class 3 land to be removed from the definition of HPL (National, 2023).

HPL mapping by councils can currently include areas not identified as LUC classes 1, 2 and 3, if they are part of a large, geographically cohesive area of mainly LUC 1–3 class land. Councils also have discretion to include LUC 4–8 class land considered regionally important and highly productive (based on current uses or similar land in the region). Until HPL maps are produced by councils, it would be beneficial to include the district plan zone information for each resource consent and plan change, to help determine if it qualifies for NPS-HPL evaluation.

NPS-HPL purposes aside, it is recommended a national GIS district plan zone layer is created, which all territorial authorities share and contribute to. Although zonings constantly change (eg, due to plan changes), it would help to address an existing gap that could serve several purposes once filled. The National Planning Standards direct councils to all use the same zones in the future, for a degree of consistency across a national GIS district plan zone layer. Although most councils may not yet use the National Planning Standards zones, this would be the intent over the next 5–10 years (as their district plans come up for review).

Comparison with land fragmentation data

The land fragmentation indicator offers multiple benefits, such as providing uniform, consistent and standardised data at a national and regional level (Carrick *et al.*, 2020; Stats NZ, 2021). Table 7 shows a high level comparison using NMS data and land fragmentation data for informing the NPS-HPL.

For the land fragmentation indicator, changes in urban area are informed by drawing on layers (such as 'built up area') from the Land Cover Database (LCDB), which has typically been updated every five years since 1996/97. However, the bulk of additional data is taken from LINZ. This includes the LINZ Primary Parcels cadastral dataset. This records and locates boundaries of land under various tenure systems and is frequently updated (LINZ, 2020).

The land fragmentation data geolocates an electoral address to a parcel polygon. As with the NMS data used in this analysis, it does not account for the footprint of the actual development. The entire parcel of land can be compromised for rural production if, following subdivision or development, it is identified or characterised as a rural residence or a lifestyle block.

Although the NPS-HPL has a transitional definition of HPL, regions are required to produce their own HPL maps, which can also be used with future updates to the land fragmentation indicator. This could overcome the dependence of LCDB for certain layers, so updates can be more regular if required.

Table 7: **Comparison of National Monitoring System (NMS) and land fragmentation data to evaluate the effectiveness of the National Policy Statement for Highly Productive Land (NPS-HPL)**

The assessment assumes that specific HPL maps produced by councils will be used for future evaluations.

		NMS data	Land fragmentation data
Scale	Regional	√	√
	National	√	√
Frequency	Annual	√	√[1]
Informing aspects of NPS-HPL	Rural subdivision	√	√
	Land use	√	
	Plan change[2]	Partial	
Granularity	Assessing against separate HPL land use capability classes	√	√
	Assessing against parcel size categories	Not undertaken but possible	√
Complexity of analysis	Data processing	Currently arduous given the early stage of prototype development[3]	√
	Repeatable/reproducibility	√[4]	√
	Trend analysis	[5]	√

[1]   LINZ Primary Parcels data updated more frequently.

[2]   If a national GIS layer were to be developed and maintained, this could apply more widely to both NMS and land fragmentation data.

[3]   Still requires development but opportunities to improve with future uptake of proposed recommendations.

[4]   Would benefit from the uptake of proposed recommendations to improve data consistency and standardisation, and is somewhat limited by this work still being in a developmental stage.

[5]   Currently assesses new effects on HPL arising in one given year. Trend analysis requires further development of the process and repeating the analysis using time series-consent data. This would benefit from the uptake of proposed recommendations to improve data consistency and standardisation. Repeated analysis would identify areas of ongoing development and could generate typical development sequences, allowing some degree of forecasting once established.

Given the early stage of prototype development, generating code for this proof-of-concept was arduous. However, it could now be applied to other years of NMS data. Analysis is reproducible due to the use of 'R', and can be re-run across various years. Appreciating variation from year to year, a multi-year view (or multi-year average) could be an opportunity to develop and refine the methodology to improve completeness, robustness and accuracy. This could:

- provide more information on the state of contemporary loss of HPL leading up to the NPS-HPL

- set a richer baseline to evaluate the effectiveness of the policy after it was gazetted

- allow for estimating trends.

The NMS and land fragmentation datasets have complementary components for informing the effectiveness of the NPS-HPL. The NMS data provides a greater element of granularity that informs on both 'subdivision' and 'other land use' related to HPL, and it has the potential to inform plan changes. However, given the complexity of current analysis, all NMS components

would benefit from the uptake of the proposed recommendations to help with producing higher quality, more reliable and efficient evaluation analysis in the future.

Finally, the primary purpose of developing the land fragmentation indicator was to inform state and trends analysis for environmental monitoring and reporting (Ministry for the Environment and Stats NZ, 2024), albeit recognising its added benefit of determining the effectiveness of the NPS-HPL, even at a higher narrative level. Although it was developed before the NPS-HPL took effect, future updates to the land fragmentation indicator could consider any other adjustments to support NPS-HPL evaluation. Ultimately, it could serve multiple purposes. NMS data analysis, as is currently reported, will likely still be required for evidenced-informed evaluation of the NPS-HPL.

Progressing evidence-informed policy evaluation

Evaluating the effectiveness of policy requires interdisciplinary collaboration. As in this analysis, this could span expertise in resource management, data science, geospatial, and subject matter. Such collaboration, including te ao Māori and mātauranga Māori, is required across all phases of the policy cycle, starting at policy design to ensure consideration and exploration of how to evaluate the policy or intervention. A challenge can be to span the required expertise across a variety of teams or business groups that can have differing priorities that affect resourcing. Such necessary input and involvement in the policy cycle can also be seen as time-consuming and overly burdensome in a fast-paced environment.

However, despite some upfront resource-heavy requirements, later phases of the policy cycle can be better equipped, benefiting from previous collaborations and systems thinking. Among other benefits, greater efficiencies can arise from previously tested methods and metrics to better set up the policy cycle for future evidence-informed evaluation.

Effectiveness monitoring, when supported by robust data collection and independent monitoring and evaluation of outcomes, can provide an overview of whether different policies are working together, ensuring a holistic systems approach rather than operating as isolated initiatives (Ministry for the Environment, 2023d). Because decision-making is intended to benefit communities and society, it is important there is accountability for the oversight of policy effectiveness.

Whatever the form of intervention (policy, innovation, sustainable management practice), there is a shared responsibility across the science system to engage proactively and collaboratively with, and contribute to, this area of applied science. This will ensure not only that the right interventions have been identified but that they are making a real difference.

Despite the complexities, shifting towards evidence-informed policy, outcomes and effectiveness is necessary to ensure laws, policies and investment are achieving their intended purpose. This is so communities gain confidence that decisions are founded on good science and evidence, which is rigorously tested, inclusive, transparent and accessible (Donnelly *et al.*, 2018).

Recommendations

To improve monitoring and reporting of future policy evaluation which requires greater data consistency (ensuring it is higher quality and more reliable thereby supporting quicker analysis), the following recommendations are made (most of which have relevance beyond NPS-HPL monitoring purposes).

1. Explore a consistent GIS sharing mechanism with territorial authorities to capture:

    − shapefiles with district plan zone polygons (both operative and proposed or in development), where planning zone categories comply with terminology from national planning standards

    − shapefiles with a polygon per consent, indicating the land area for which the consent applied.

2. Establish common-use vocabulary for resource consent across councils, which could take the form of developing NMS data protocols and standards.

Conclusion

The findings from this analysis signal a promising proof-of-concept that can be improved with the uptake of the recommendations. These will help with the consistency and standardisation of data, and produce higher quality, more accurate, reliable and efficient evaluations in the future. A geolocated NMS dataset is useful for a range of environmental policy monitoring. It provides a missing link between policy settings and effectiveness, which needs to be supported by good data and evidence.
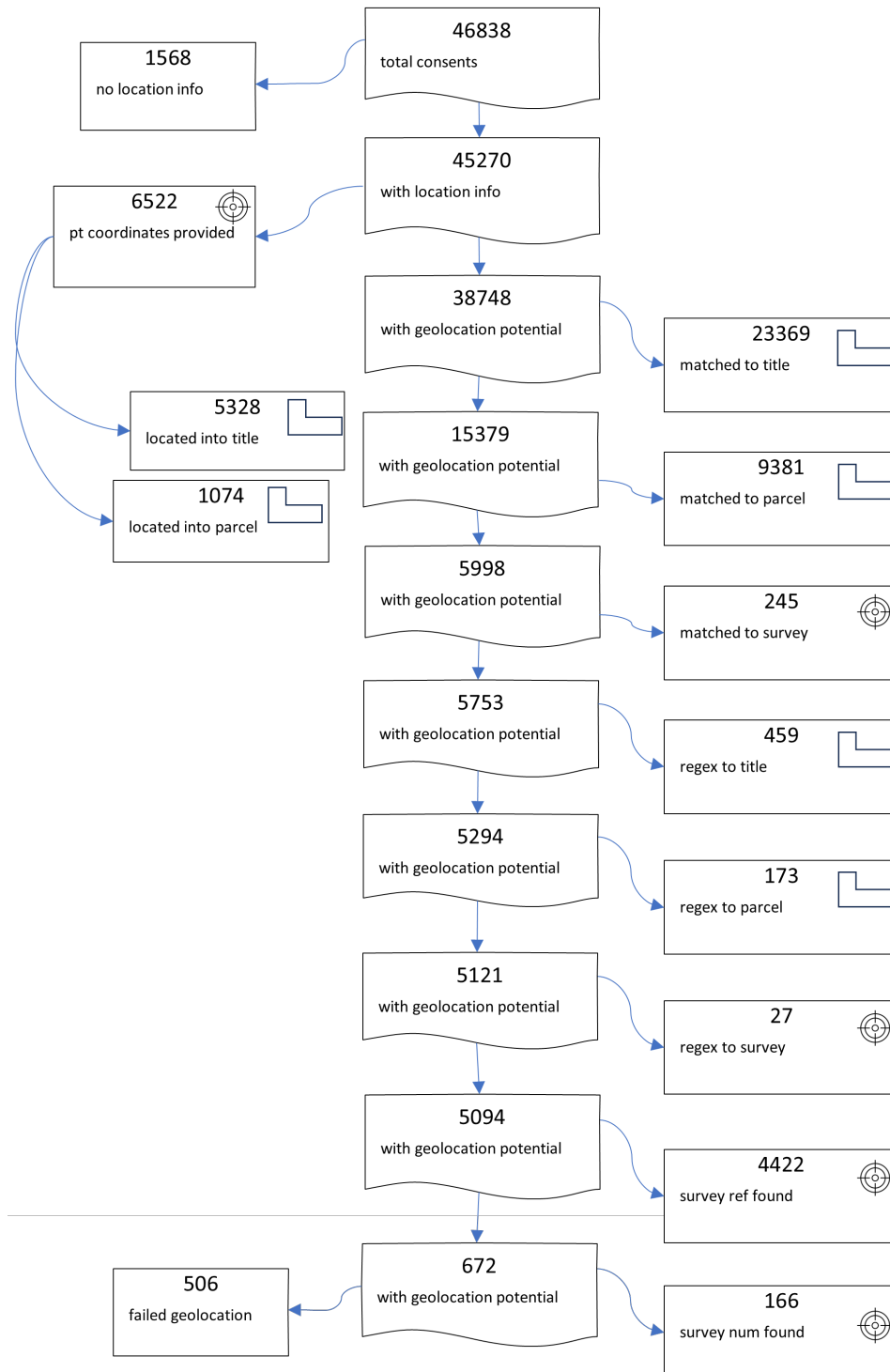
Findings from this discrete-use case on the NPS-HPL will be relevant to wider policy evaluation. This is an area where the Ministry can be more proactive, requiring better and more consistent data and evidence through systems such as the NMS, to help determine if a variety of interventions are making a difference to the environment.

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Appendix 1: Breakdown of all resource consents data that could be geolocated by title, parcel or survey, as well as non-located consents

| 46838 |
| total consents |

| 1568 |
| no location info |

| 45270 |
| with location info |

| 6522 |
| pt coordinates provided |

| 38748 |
| with geolocation potential |

| 23369 |
| matched to title |

| 5328 |
| located into title |

| 15379 |
| with geolocation potential |

| 9381 |
| matched to parcel |

| 1074 |
| located into parcel |

| 5998 |
| with geolocation potential |

| 245 |
| matched to survey |

| 5753 |
| with geolocation potential |

| 459 |
| regex to title |

| 5294 |
| with geolocation potential |

| 173 |
| regex to parcel |

| 5121 |
| with geolocation potential |

| 27 |
| regex to survey |

| 5094 |
| with geolocation potential |

| 4422 |
| survey ref found |

| 506 |
| failed geolocation |

| 672 |
| with geolocation potential |

| 166 |
| survey num found |

Appendix 2: Tables of regular expression patterns for consents relating to subdivision, other land use, and plan changes, and as their groupings

Subdivision	Exclusion pattern	((Settl\w*\sZone)|([rR]ural\s[vV]ill\w*))(?!.*rural\s*prod)|(^(?!.*[dD]welling).*[sS]hed.*[bB]arn)|([rR]ural\s+[aA]meni)|(\broad\b)|([fF]irefig)|(^(?=.*[uU]se).*[sS]ervice)|([rR]ural\s+[wW]ater)|[wW]edding	((free(hold)?(\s+title)?|fee\s*sim[ple]*|cross[-\s]*lease[-\s]*(hold)?|urban|concur[rent]*|duplex|indus[trialyse]*|townhouse)[\s-]*subdivision)|(spe[cial\s-]*hou[sing]*(\s*act)?|\bSHA\b)		(free(hold)?(\s+title)?|fee\s*sim[ple]*|cross[-\s]*lease[-\s]*(hold)?|telecom.*|residential\s+zone)	(dwelling|house|home|garage|vehicle|unit|dentica|system|bridge|biofilter|free(hold)?(\s+title)?|fee\s*sim[ple]*|cross[-\s]*lease[-\s]*(hold)?|residential\s+lot|com[monly]*\s+own|duplex|res[dentical]*\s+re[-\s]?source\s+area|res[dentical]*\s+subdiv|stage\s+res[dentical]*|trans[mission]*\s+line|coastal\s+permit|general\s+res[dentical]*|res[dentical]*\s+zone)
	Match pattern	[rR]ural	(\s|\b)sub[-\s]*division|\bsub[-\s]*divide	life[-\s]*style[s]?(\s*block[s]?)?	(?=.*boundar(y|ies))(?=.*adjust?(ment[s]?|ed)?)	(3)(?<=cre|add|new).*(?=lot).(3)
	Name	Rural	Subdivision	Lifestyle	Boundary adjustment	Create new lot

Other land use	Exclusion pattern	(res[idential]*|transport[\s-]*(infring|stand)|temp.*film|transportable[\s-]*(dwell|house)|supp[orting]*[-\s]*weekend|temporary[-\s]*(noise|visit|porta)|res[idential]*|boat|playgro|shipp|pantry|(seawater|garage)[-\s]*stor|pontoon)	(res[idential]*|storey|(civil|park)[\s-]*infrastructure|free(hold)?(\s+title)?|fee\s*sim[ple]*|cross[-\s]*lease[-\s]*(hold)?|duplex|z[\s-]*energy)	(res[idential]*|(addi|remo|alter|demo).*dwelling|heig.*relat.*bound|garage|dwelling\s*rear(\s*site)?|free(hold)?(\s+title)?|fee\s*sim[ple]*|cross[-\s]*lease[-\s]*(hold)?|duplex|coastal|urban|storm[-\s]*water[-\s]*manag|storey|maximum[-\s]*cover)
	Match pattern	((greenhouse)|(indoor.*(piggery|poultry))|((transport|freight)(.*depot)?)|(storage(.*facility)?)|(forestry)|((temporary|supporting)(\sactivity)?))	((solar(.*farm)?)|((renewable.*)?energy)|(utilities)|(infr?astructure)|(flood(.*(defence|mitigation))?))	((workers?.*acc?omm?odation)|((multiple\s)?dwellings?)|(designation)|(outline\s+plan)|(m(a|`a)ori(\s(land|purpose))?)|(papak(a|`a)inga))
	Name	Rural activities	Infrastructure	Dedicated function

Plan changes	Pattern
Rural	rural
Rural residential	(?=.*rural)(?=.*residential)
Rural lifestyle	(?=.*rural)(?=.*life[-\\s]*style)
Rural industrial	(?=.*rural)(?=.*industr(ial|y|ies))