Surf Breaks of Regional Significance: Southland

Report Prepared for

environment SOUTHLAND
REGIONAL COUNCIL
Te Taiao Tonga

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Executive Summary

Surf breaks and surfing resources are recognised by statutory instruments in Aotearoa New Zealand. The piece of legislation is the Resource Management Act (1991), under which the New Zealand Coastal Policy Statement (NZCPS) is a mandatory. The NZCPS provides guidance on day-to-day management for regional, district, local and municipal authorities. The NZCPS has a number of policies relevant to the sustainable management of surfing resources. At the regional level this is to be addressed in the Regional Coastal Plan (RCP). Environment Southland are currently undertaking a review of their RCP and Surf Breaks of Regional Significance (SBRS) are to be included.

This work is first concerned with identifying surf breaks in Southland and determining whether they can be designated as regionally significant. Identification included is achieved through a process of literature review and knowledge gathering. This information provides baseline data regarding the characteristics of each identified surf break. The criteria for regional significance leveraged the methods of previous works in this field.

The 13 SBRS, from west to east these are Big Bay, Martins Bay, Blue Cliffs, Frenches Reef, Porridge, Beatons, Raratoka, Nicks Point, Colac Bay, Riverton Rocks, Oreti Beach, Haldane Bay and Porpoise Bay. Each SBRS is delineated with a Surf Break Area (SBA). Porridge and Beatons, and Martins Bay and Big Bay, share SBAs named Pahia and Awarua, respectively. It is recommended that these SBRS be included in the coastal plan.

Further investigation and information are required to conclusively determine if Mason Bay, Saber Reef, Avalanches, 2nd Break and 3rd Break can be considered regionally significant. In the interim, it is recommended that they are at least recognised as surfing resources under Surf Breaks of Local Significance, or potential SBRS. The western end of Te Waewae Bay, from Rowallan Burn to Sand Hill Point should be designated as a Known Surfing Coastline.

For each SBA a swell corridor was constructed using a historical wave climate. The swell corridor delineates the region of coastal water through which waves travel to reach a particular surf break. A swell corridor is the offshore extension of a SBA. By providing Geographical Information System files, these spatial datasets readily allow in a first-order assessments of activities in the CMA and how they may impact of SBRS, and therefore aid in the day-to-day management of surfing resources.

Threats to SBRS and surfing amenity in the wider Southland region were also considered within this work. Of the range of threats to the use and enjoyment of surfing resources in Southland, water quality poses the most regular threat. Because a risk assessment is activity specific, this work has provided a sensitivity rating for each surf break type identified within

each SBA. A full range of sensitives are apparent, which is a testament to the variety of surf break types on offer in Southland. The sensitivity rating can be used with the threat and risk assessment framework in the Management Guidelines for Surfing Resources.

A conservative approach has been taken to all aspects of this work. The conservative approach is required as, to date, this process has not included community engagement. A community led process would result in a superior management framework and is considered best practice. Prior to finalising the draft coastal plan, it is recommended that this work goes to a second phase that is focussed on participation. Information on surf breaks in Southland is held by local knowledge holders, including surf breaks not listed in guides, and details of each surf break that help to manage the resource, have not been included. An inclusive approach would allow for a community informed assessment with thresholds for significance determined by stakeholders and local experts, while adding valuable information to a database regarding surfing resources for both Environment Southland and the Southland surfing community, and ultimately providing a management strategy that is acceptable to stakeholders.

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1 Introduction

In Aotearoa New Zealand, surfing resources are recognised within coastal management as having a range of values and as contributing to the natural character and landscape of the coastline. Surf breaks have high recreational, cultural, and amenity values, and provide a distinct subsector of the tourism industry.

Each surf break is unique, formed by a combination of swell, currents, water levels, coastal geomorphology, and wind. Policy 16 of the New Zealand Coastal Policy Statement (NZCPS; Department of Conservation, 2010) explicitly identifies 17 Surf Breaks of National Significance (SBNS). These SBNS cumulatively occupy approximately 4.5 km of coast, 0.0003 % of the Aotearoa New Zealand coastline. While there are very few surf breaks in Aotearoa New Zealand celebrated as being of the highest order, there are many other surfing resources that are not only high quality in terms of performance surfing but contribute to the wellbeing of local and regional communities.

The sustainable management of these resources has become the focus of regional coastal planning throughout Aotearoa New Zealand due to its relevance to the Resource Management Act 1991 (RMA), and consistency with other legislation such as the Local Government Act 2002 (LGA) and its objectives (Orchard 2017a, b; Skellern *et al*. 2013). Second-generation plans developed by local authorities have identified Surf Breaks of Regional Significance (SBRS), including Auckland, Bay of Plenty, Gisborne, Northland, Taranaki, Waikato and Wellington. In Southland (Figure 1.1) it has been agreed by Councillors that Surf Breaks of Regional Significance (SBRS) will be included as part of the Regional Coastal Plan (2013) review[1].

The Southland coast is the longest of all the regions in New Zealand. With a length greater than a 5th of New Zealand's coastline and complete exposure to the Southern Ocean, the potential for quality surf breaks in Southland is high. The view of a Southland local and ex-professional surfer, who is well travelled in terms of international surf destinations, is that in terms of surfing opportunities there is a lot to offer in Southland to surfers willing to search for it, there are world-class waves, and that most people do not know how special the waves in southland are, and that there are high quality locations that you cannot access by road. Similar comments refer to Southland as a frontier of surfing. This is often associated with the attribute values of naturalness and wilderness, which can be diminished if the coastal marine area, and surfing resources, are not managed effectively.

[1] 12 March 2020. Joint ES/TAMI Coastal Plan workshop - Miscellaneous and Marine Aquaculture.

A range of approaches have been used to identify SBRS (Atkin and Mead 2017; Coombes and Scarfe 2010; Northland Regional Council 2016a, b; Orchard 2017b, c; Peryman 2011a, b). The identification, delineation and characterisation of surf breaks is described in Atkin *et al*. (2019) and Orchard *et al*. (2019). These works also describe the requirement to manage surf breaks as coastal resources, and how the concept of regional significance has been developed in Aotearoa New Zealand.

Section 2 of this report provide the legislative context under which surfing resources are considered. Section 3 describes the methods used in this work, including how surfing resources in Southland were identified and assigned regional significance, characterisation and construction of swell corridors. Section 4 identifies surf breaks in Southland. Section 5 characterizes each surf break. Section 6 provides the SBRS of and a rationale behind their designation. Section 7 delineates each SBRS with a Surf Break Area (SBA), Section 8 presents their swell corridors, and Section 9 considers the potential threats to the use and enjoyment of surf breaks in Southland. Section 10 provides conclusions and recommendations.

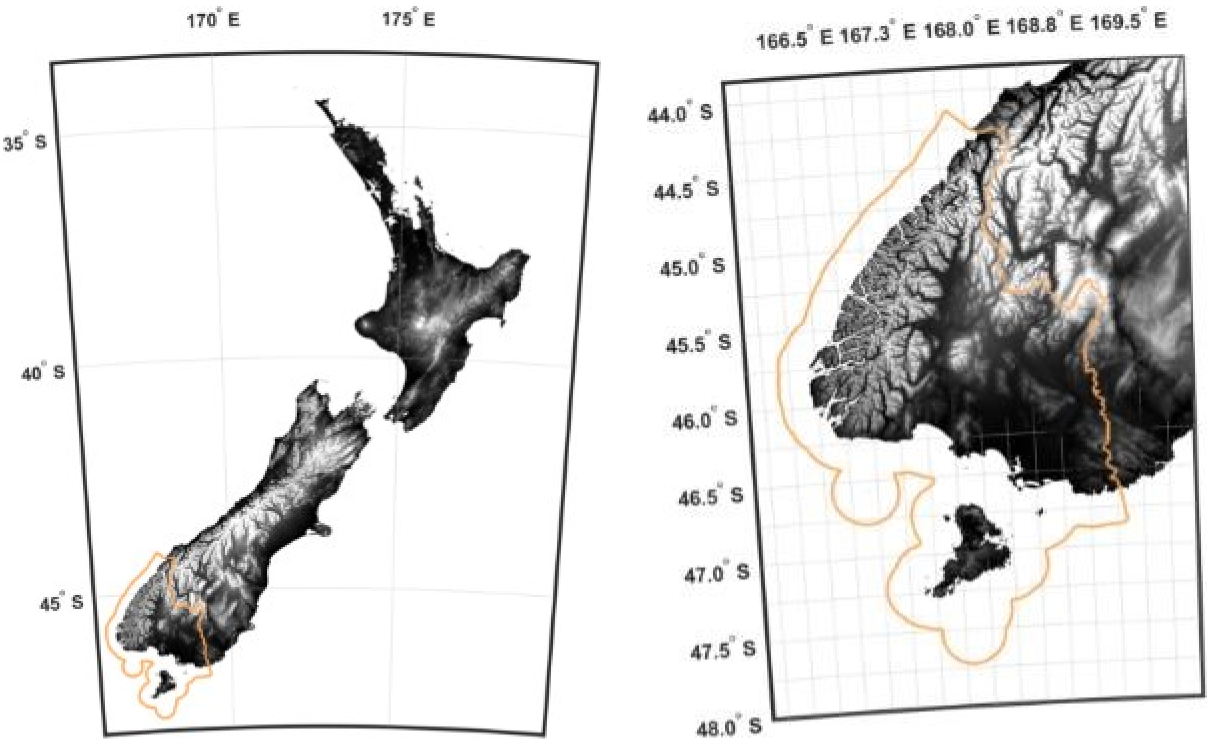


Figure 1.1: Digital elevation model of New Zealand to show study site location and Environment Southland's regional boundary and Territorial Sea jurisdiction (orange line).

2 Legislative Context

2.1 Resource Management Act

The Resource Management Act 1991 (RMA) is the primary legislation for managing surf breaks in New Zealand. Section 6(a) requires the preservation of the natural character of the coastal environment, and section 6(b) requires the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development. Section 30(1)(d) requires the Southland Regional Council (ES) to manage land, resources, and activities in the coastal marine area (CMA).

2.2 New Zealand Coastal Policy Statement (NZCPS)

The NZCPS contains provisions to achieve the purpose of the RMA in relation to the coastal environment. The Objectives of the NZCPS outline a range of matters which must be considered when managing coastal activities. Objective 1 requires safeguarding the integrity, form, functioning and resilience of the coastal environment and sustaining its ecosystems. Objective 2 requires preservation of natural character and protection of natural features and landscape values, in part by identifying areas where various forms of subdivision, use and development would be inappropriate and protecting those areas.

Policy 16 of the NZCPS requires the protection of the Surf Breaks of National Significance, which are listed in Schedule 1 of the NZCPS.

> *Policy 16: Surf Breaks of National Significance:*
>
> *Protect the surf breaks of national significance for surfing listed in Schedule 1, by:*
>
> > *(a) ensuring activities in the coastal environment do not adversely affect the surf breaks; and*
> >
> > *(b) avoiding adverse effects of other activities on access to, and use and enjoyment of the surf breaks.*
>
> Schedule 1 of the NZCPS defines a surf break as:
>
> *A natural feature that is comprised of swell, currents, water levels, seabed morphology, and wind. The hydrodynamic character of the ocean (swell, currents and water levels) combines with the seabed morphology and winds to give rise to a 'surfable wave'. A surf break includes the 'swell corridor' through which the swell travels, and the morphology of the seabed of that wave corridor, through to the point where waves created by the swell dissipate and become non-surfable.*

'Swell corridor' means the region offshore of the surf breaks where ocean swell travels and transforms to a 'surfable wave'. 'Surfable wave' means a wave that can be caught and ridden by a surfer. Surfable waves have a wave breaking point that peels along the unbroken wave crest so that the surfer is propelled laterally along the wave crest.

While there are no SBNS within the Southland region there are a number of other policies with in the NZCPS that transcend Policy 16 in regard to the sustainable management of surfing resources. Policy 13 of the NZCPS requires the preservation of natural character in the coastal environment in accordance the wording in Table 2.1.

Table 2.1: Policy 13 wording.

Type of natural character	Type of adverse effect
Outstanding natural character	Adverse effects of activities on natural character must be avoided
All other natural character	Significant adverse effects on natural character must be avoided. Other adverse effects must be avoided, remedied, or mitigated

Policy 13 also recognises that natural character is not the same as natural features and landscapes or amenity values; natural character includes matters such as natural elements, processes and patterns, the natural darkness of the night sky, and experiential attributes, among others. This policy is relevant to surf breaks as the identification of natural character includes surf breaks. Policy 13(2) lists the matters that may be included in the identification of natural character, and includes those that characterise surf breaks, such as:

- 'Natural elements, processes and patterns';
- 'Natural landforms such as surf breaks';
- 'The natural movement of water and sediment'; and,
- 'Experiential attributes, including the sounds and smell of the sea; and their context or setting'.

2.3 Southland Regional Policy Statement

Regional coastal plans must give effect to any relevant regional policy statement. The Southland Regional Policy Statement 2017 (SRPS) contains a chapter on the Coast which gives effect to the NZCPS. Objective COAST.4 requires the natural character of the coastal environment to be restored, rehabilitated or preserved.

Policy COAST.2 requires adequate measures or methods to be utilised within the coastal environment when making provision for subdivision, use and development to protect indigenous biodiversity, historic heritage, natural character and natural features and landscape values and to maintain or enhance amenity, social, intrinsic, ecological and cultural values, landscapes of cultural significance and coastal dune systems.

Policy COAST.3 requires the protection of the coastal environment by ensuring that subdivision, use and development activities avoid adverse effects on areas of outstanding natural features and landscapes, and/or outstanding natural character, and avoid significant adverse effects, and avoid, remedy or mitigate other adverse effects on other natural features and landscapes and/or natural character in the coastal environment.

2.4 Te Tangi a Tauira – The Cry of the People 2008

Regional coastal plans are required to consider any relevant planning document recognised by an iwi authority. In Southland, the relevant planning document is the Ngāi Tahu ki Murihiku Natural Resources and Environmental Iwi Management Plan 2008 (Te Tangi a Tauira) which notes that a range of activities can affect the cultural health of the coastal environment. Section 3.6.1 Policy 6 requires respect, protection and enhancement of coastal areas of importance where possible. Section 3.6.2 provides direction for Coastal Land Use and Development. The following policies are relevant:

- Policy 2 requires consistency with the NZCPS.
- Policy 8 requires that an Assessment of Environmental Effects includes an assessment of cultural effects and potential cumulative effects on the natural character of the CMA.
- Policy 16 seeks recognition of adverse effects on cultural landscapes.
- Policy 23 requires the avoidance of large scale and imposing development that intrudes on the natural character and visual amenities associated with the coastal environment.

Te Tangi a Tauira provides that current and future generations of Ngāi Tahu Whānui must have the capacity to access, use and protect coastal environment landscapes, wāhi tapu and mahinga kai sites and the history and traditions that are linked to these landscapes.

3 Methodologies

There are three methodology components: identification of the surf break, construction of swell corridors and threat and risk assessment. Where applicable, the methodologies described in the Management Guidelines for Surfing Resources (Atkin *et al*., 2019; and references there in) are used.

3.1 Surf Break Identification

Surf breaks in Southland were identified from a range of surf guides, online resources and a literature review; and, combined with the authors and Environmental Southland's knowledge of surf breaks in the region. The common names for the surf breaks have been used in this report, it should be noted that surf breaks can be referred to under a range of colloquial names, and that this document is not an exhaustive list of these references. While this method is considered the best approach within the scope of works, it is unlikely to identify all utilised surf breaks in Southland as that would require public consultation.

3.2 Characterisation

A description of each surf break or surf break area is presented using data from surf guides and other online sources (e.g., photographs, news articles, magazines), as well as aerial/satellite photos, previously published works and personal communications. Where possible, the characteristics include, but are not limited to:

- General description of wave type – e.g., breaking to the left or to the right as viewed from the perspective of the surfer;
- Physical composition of the surf break - whether it is a rocky reef, a point break, a beach break, a rock ledge break, a river/estuary bar/delta or mix of these surf break types (Mead, 2000);
- Minimum Wave Height - this is largely required for the construction of swell corridors and is discussed below. The determination of minimum wave heights is discussed in Atkin and Greer (2019);
- Optimum wind direction;
- Optimum tide;
- Wave quality (Shape (Mead and Black, 2001c) and Peel angle (Hutt *et al*., 2001) where possible); and
- Access points.

- Value attributes such as: rarity, frequency, uniqueness, naturalness, wilderness value, amenity value, level of use, economic value, historic, heritage, and cultural associations, and educational value (Orchard *et al*., 2019; Appendix B).

3.3 Significance Criteria

Orchard *et al* (2019) reviewed the approaches taken to establishing SRBS and identified a trifactor of community consultation, technical expert, and local expertise as the best approach to inform the significance assessment. Orchard *et al* (2019) highlights the importance of participatory approach and the use of robust significance thresholds based on the weighted scores of surveys that identify the values associated with each surfing resource. Beyond identifying the right places and determining their significance, community engagement informs technical aspects such as delineating the Surf Break Area (SBA), helps create a list of both perceived and real threats, and allows a picture of coastal processes to be shaped.

Public consultation was beyond the scope of this work, and Environment Southland's requested approach was to identify SBRS for inclusion in the Coastal Plan, with the notification process serving as the community consultation phase, during which time other surf breaks could be potentially identified.

Environment Southland provided a draft report regarding surf breaks in the region and considered nine surf breaks listed in the Wavetrack New Zealand Surf Guide (Morse and Brunskill, 2004) as SBRS. This is consistent with some approaches (e.g., Atkin et al., 2015, GWRC, 2015; TRC, 2004; 2010), and inclusion in the Wavetrack Guide has certainly set a surfing resource management precedent in Aotearoa New Zealand. While regions with a small number of well-known surfing resources in well-defined locations may suit a blanket-type approach, there is the possibility that some surf breaks may not be included.

To advance Environment Southland's initial approach, this work expands the information base by including a review of surf guides, online resources, and published literature, and expert knowledge of surfing resources and surf science, to further inform the identification and characterisation of surf breaks in Southland.

Policy 3 of the NZCPS promotes the use of a precautionary approach when considering effects on the coastal environment that are uncertain, unknown, or little understood, but potentially significantly adverse. Because there is no community consultation in the identification and characterisation phase of this work, and the notification process of the coastal plan is not guaranteed to attract targeted stakeholders nor facilitate the extraction of site-specific details, a conservative approach is required. A surf break is deemed to be regionally significant in Southland if:

- This work confirmed its existence, surfability and usage through inclusion in multiple surf guides (moving away from the singular dependence of the Wavetrack Guide) and/or dedicated surf reports, its existence can be visually confirmed using online sources and/or historical aerial photos, and/or the literature review found additional evidence regarding a surf break' s existence, surfability and usage; and,
- exhibits a dependent population (local, non-local, foreign or a mix), a high frequency of use, and/or, is of outstanding natural character/quality (in terms of surf; Atkin and Mead, 2017); and/or,
- clearly exhibits any of the value attributes detailed in Orchard et al. (2019).

Many surfers like to keep the locations of surf breaks secret, making the management of valued coastal resources challenging. Atkin and Mead (2017) were exposed to the many examples of 'secret spots' in the Waikato and recognised the need to document the existence of these resources yet avoid potential discord within the surfing community by exposing lesser-known surfing locations. To address this, Known Surfing Coastlines (KSCs) were used to bookmark the existence of these exposing lesser-known surfing locations while concealing specific details of their location and wave types, while maintaining their 'secret' status (Atkin, 2017). This gave rise to a separate planning category: Surf Breaks of Local Significance (SBLS), which was later employed in Taranaki (TRC, 2018).

The KSCs identified sections of coast where surfing is known to be undertaken, and leveraged distinct the geographical features on nautical charts, such has the headlands, to delineate the KSCs. The approach maintains the ambiguity of a 'secret spot' and lacks the technical details required to directly access a SBLS, whilst recording the existence of SBLS should management decisions concerning a section of coast be required. Like surf break areas and swell corridors, the KSCs were provided as datasets to be integrated into the council's coastal resource management. Those surf breaks in Southland not positively identified as regionally significant are considered within the category of SBLS and documented here for inclusion in any hearing process.

3.4 Surf Break Delineation

Surf Break Areas (SBA) are designed to encompass the area/locations surfing is undertaken, but where possible also encompass the functional surf break components (Mead and Black, 2001a, b, c), and any local coastal features that influence the waves breaking (e.g., river mouth, jetty, etc.). The cross-shore extents of an SBA align distinct coastal features where possible (headland, stream, etc.). The landward extent of the SBA is delineated using Land Information New Zealand's 1:50,000 coastline polygon, which approximates Mean High Water Spring. The offshore extent of the SBA is a function of depth limited breaking, with a combination of local bathymetry and aerial images used to determine an appropriated depth contour from published hydrographic charts.

At some locations there can be more than one recognised surf break within a small area, therefore a SBA can host a single surf break or multiple surf breaks. The latter is especially true for surf breaks in close proximity which require similar meteorological and oceanographic conditions to become surfable. In addition, the wider area, hosting multiple surf breaks, holds the economic, social and amenity value.

SBAs are estimated using a combination of historical aerial photographs (e.g., Google Earth historical imagery), any apparent wave breaking patterns, existing bathymetric data, published information and knowledge gained from literature reviews and surf guides. This process is best informed and most robust following a process of public consultation.

3.5 Swell Corridors

As the NZCPS is a national policy statement under the Resource Management Act (RMA, 1991), the spatial definition of swell corridors is considered from the Southland coastline out to, and including, the 12 nautical mile Territorial Sea (Figure 1.1) for the identified SBRS.

The swell corridor is an offshore extension of the SBA. Construction of swell corridors combines the learnings from Atkin and Greer (2019) and the methods developed in Atkin *et al*. (2015) and Atkin and Mead (2017). To establish the region offshore of a surf break where ocean swells theoretically travel and transform in to surfable waves, the numerical model SWAN (Simulating WAves Nearshore) was used to simulate wave conditions within the Southland region. SWAN is an industry-standard and globally utilised third generation ocean wave propagation model, incorporating the generation, propagation and transformation of wave fields in both deep water and nearshore regions (Holthuijsen *et al*., 2004).

3.5.1 Model Framework

Computational domains for numerical models were constructed by interpolating depth/elevation data on to a grid or mesh. The depth/elevation data used to construct the domains was compiled from Global Bathymetric Chart of the Oceans (GEBCO; Becker *et al*., 2009) and nautical charts (LINZ). The modelling framework simulates 10 years of hind-casted, 2-dimensional wave spectra from the European Centre for Medium-Range Weather

Forecast's (ECMWF) ERA 5 0.36° resolution database (Hersbach, *et al*., 2020) and 10 m wind data sourced from the National Centre for Environmental Prediction's (NCEP) hourly global reanalysis model (Kalnay *et al*., 1996) with a spatial resolution of 0.312°.

The long-term wave climate conditions were first simulated at a New Zealand scale, on a rectilinear grid with a spatial resolution of 0.05°. Boundary conditions generated from the New Zealand scale grid were then used to simulate the long-term wave climate on a regional to local scale using a flexible triangular mesh with spatial resolutions ranging ~4.5 km to 25 m (Figure 3.2). The resulting model output is a catalogue of wave parameters (e.g., wave height, period and direction) for each model node during each of the original boundary conditions at 3 hourly intervals.

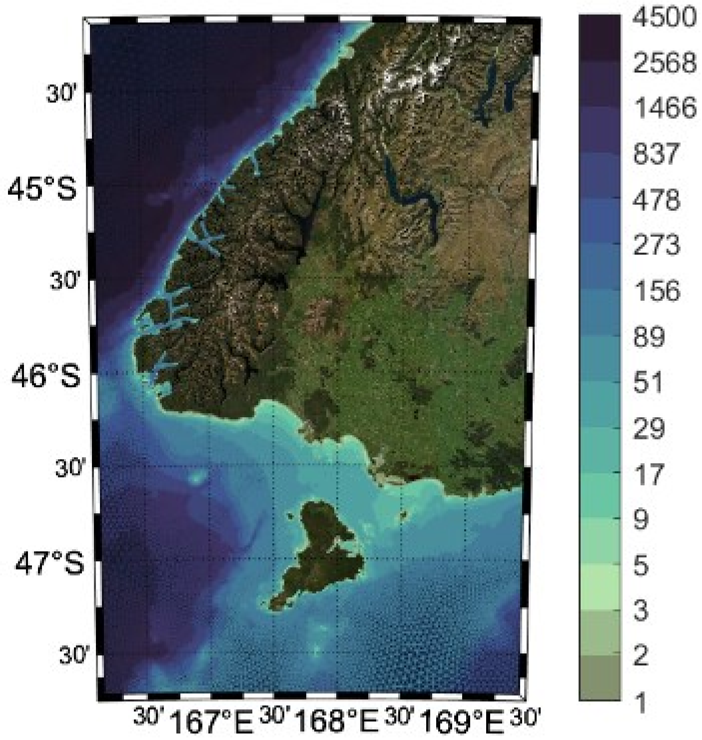
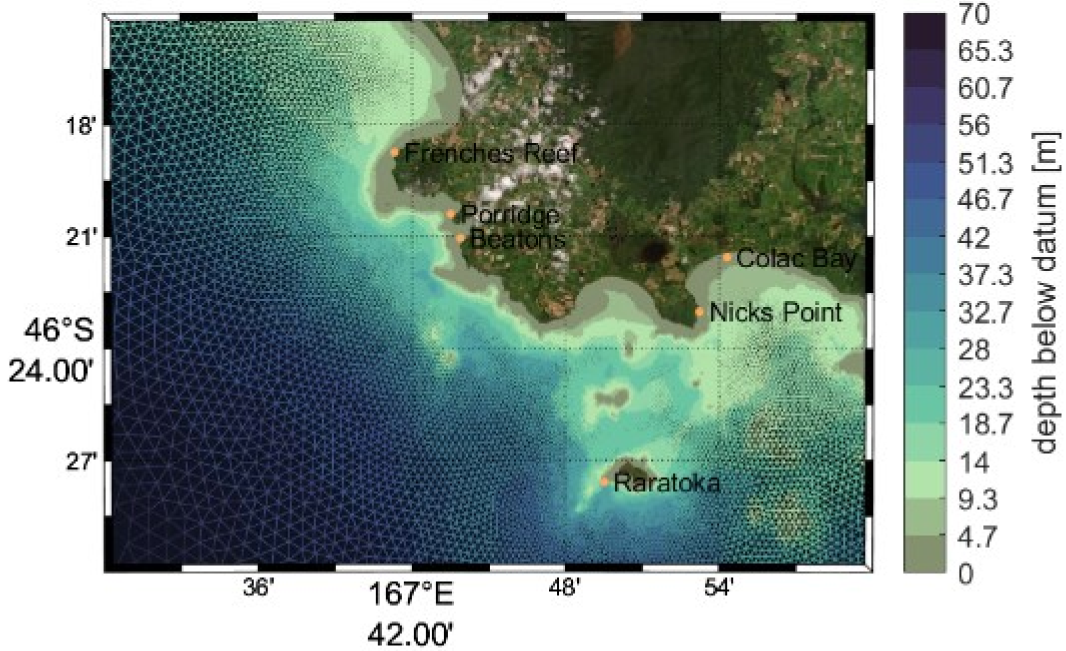


Figure 3.1: Unstructured triangular mesh, coloured with depth (in metres relative to chart datum) for the full model domain (left) using a log space depth scale.



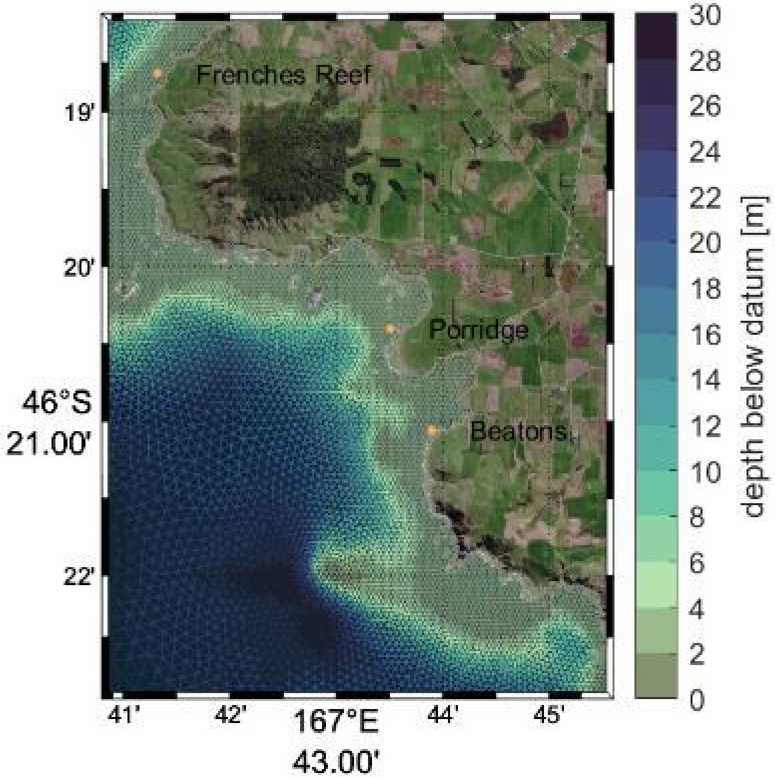


Figure 3.2: Subregional (left) and local (right) examples of unstructured triangular mesh, coloured with depth (in metres relative to chart datum).

3.5.2 Postprocessing

Each SBA was designated a minimum surfable wave height (H_{sf}) to evaluate wave conditions. Atkin and Greer (2019) provide a discussion on surfable wave heights and reviewed published articles and technical reports. Atkin and Greer (2019) and Atkin and Mead (2017), both used 0.75 m as a generic minimum surfable wave height for the purpose of a numerical modelling exercise and the development of swell corridors. A H_{sf} of 0.75 m is deemed appropriate for use in Southland. An exception to this is the big wave surf break at Raratoka (Centre Island). Details relating to a H_{sf} designation of 2.55 m for Raratoka are provided in Section 3.5.

The following procedure is applied to each identified SBA. For each time step of model output the maximum wave height (H_{max}) within the SBA is determined. The value of H_{max} is compared to H_{sf}, if H_{max} is greater than or equal to H_{sf}, and the peak wave period in the SBA is greater than or equal to 7 s, the wave data for that model time step is retained.

For each retained time step, from two points located at either end of the seaward edge of the SBA, an incident wave trace was calculated, as a linear interpolation function of wave direction (wave orthogonal). The trace spatial step was made variable but always less than the size of cell it passed through to ensure relatively high along-trace resolution. Along the length of each trace the statistics of wave height, period, mean direction and peak direction are interpolated.

Checks are performed to determine the suitability of a trace for inclusion. This step addresses the manual editing issues highlighted in Atkin and Greer (2019). If all checks are positive, then the trace is retained. The checks include: the trace extends beyond the Territorial Sea; the range in wave period along the length of the trace is less than 1 s; change in peak direction between consecutive trace points is less than 45°; change in mean direction between consecutive trace points is less than 15°; wave height in the SBA is less than the wave height at the end of the trace; no consecutive downward trends in wave height along the length of the trace; the two traces do not intersect.

3.6 Construction of Swell Corridors

Each pair of traces was used to construct a polygon from the SBA to the edge of the numerical model domain. The polygons are combined to define the footprint of the swell corridor, and then combined with the SBA. Unlike in the Waikato (Atkin and Mead, 2017) and Wellington (Atkin et al., 2015), the approach used here has used actual hindcast conditions for the trace rather than idealised conditions (Atkin and Greer, 2019). This approach does not rely on a percentage occurrence threshold for defining the swell corridor and buffer zone interface (e.g., Atkin and Mead, 2017). Instead, the swell corridor reflects the footprint of all postprocessed, filtered and remaining traces.

A 1 km buffer zone around each SBA and swell corridor was created for the following reasons, in no specific order:

- It gives effect to the precautionary approach set out within Policy 3 of the NZCPS: A precautionary approach (Department of Conservation, 2010).
- While numerical modelling is an appropriate tool for studies such as this, the model used here has not been calibrated to site specific data and numerical modelling is always limited by some form of spatial resolution.
- Any developments proximal to an established SBA have the potential to affect wave conditions within that SBA (e.g., a seawall adjacent to, but not inside an SBA may cause wave reflections and alterations to wave breaking properties within the SBA).
- Supports the NZCPS's objective of "avoiding adverse effects of other activities on access to, and use and enjoyment of the surf breaks".
- Gives effect to Policies 13 and 15 of the NZCPS that require the preservation of natural character and protection of natural features.

The width of the buffer zone is larger than that used in previous work (Atkin and Mead, 2017), but is in line the more recent measures being applied in the Bay of Plenty (BOPRC, 2019). The buffer zone also aims to cover access to surf breaks, but also features such as dynamic dune fields, and the lower reaches of tidal inlets, rivers and streams, on which many breaks are reliant.

3.7 Threat and Risk Assessment

The Management Guidelines for Surfing Resources (Atkin *et al*., 2019) provides a comprehensive list of 34 different activities, threats and/or sources that were identified through literature reviews, extensive public consultation, and input from technical experts. These activities, threats and/or sources fall under 4 subcategories:

- Hinterland, Catchment and Waterways;
- In and around a Surf Break Area (SBA);
- Nearshore, Offshore and Swell Corridor; and,
- Social and Technological.

For each activity/threat/source, the potential risk of an effect on surfing resources are provided with examples and/or references from New Zealand and overseas where surf breaks have been affected and/or been assessed, and potential mitigation options.

Activities, threats and sources range in spatial scale (e.g., local, regional and global). Each of these can have different time frames. The effects of an activity/threat/source can be temporary, or permanent; similarly, although some effects can be mitigated, many cannot. They can have negative or positive effects on wave quality and the surf break environment. Some threats are more common at specific geomorphic types of surf breaks (e.g., channel dredging, issues with boat traffic, and water quality are more common to river/estuary bar breaks).

The guidelines provide a threat and risk assessment framework that was developed with the aim to be universally applicable across Aotearoa and beyond. The framework leverages the sensitivity of the surf break in terms of its geomorphological character and environmental setting. Consequence categories draw on examples of known surf break degradation. While the qualitative risk assessment methodology provides a relatively simple method. The framework requires knowledge of coastal processes, surf science and surf break dynamics and leverage detailed characterisation of the SBA.

The SBRS identified in Southland will be evaluated in terms of sensitivity, so that the threat of proposed activities in the future can be more readily evaluated. A surf breaks sensitivity is largely a function of its geomorphology which fits into one, or in some cases a combination of, the following types: coral reefs, rocky reefs, point breaks, rock ledges, river and estuarine deltas, and beaches (Mead, 2000; Mead and Black, 2001b).

The 34 threats and/or activities in the Management Guidelines for Surfing Resources (Atkin *et al.*, 2019) will be considered within the context of the SBRS identified in Southland.

4 Surf Break Identification

From the review of a range of surf guides, online resources and a literature review; combined with the authors and Environmental Southland's knowledge, 19 acknowledge surf breaks have been in southland. The approximate locations of these surf breaks are shown in Figure 4.1.

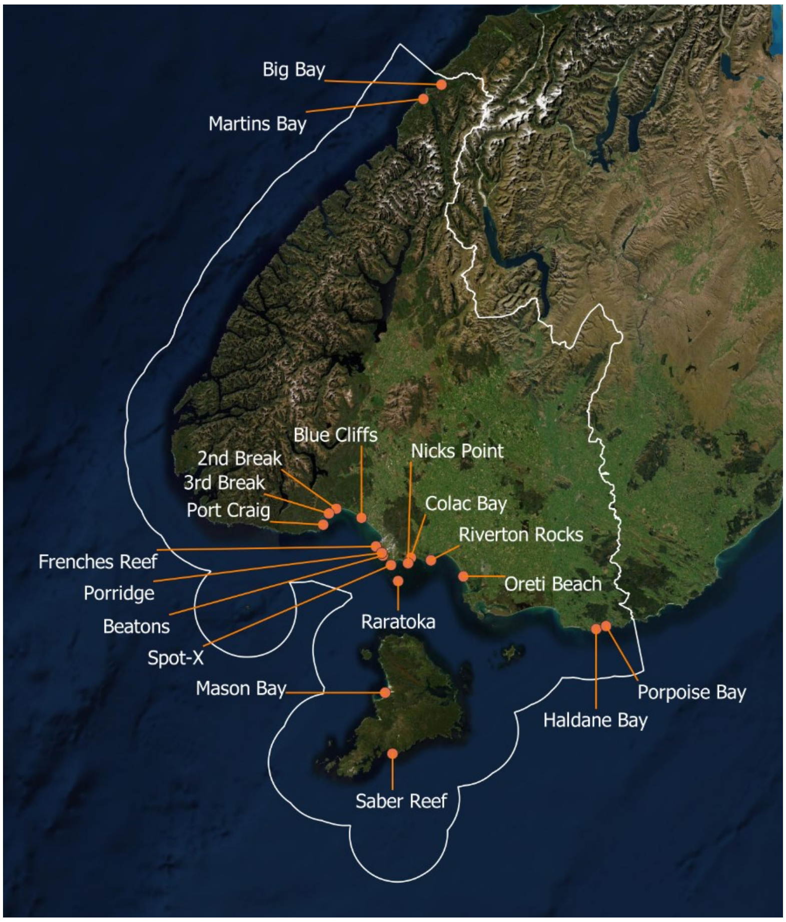


Figure 4.1: Map to show the approximate locations of identified surf breaks.

Morse and Brunskill's (2004) New Zealand Surfing Guide (aka the Wavetrack Guide) list 9 surf breaks in Southland. These are, from west to east: Blue Cliffs, Frenches Reef, Porridge, Beatons, Nicks Point, Colac Bay, Riverton Rocks, Oreti Beach and Porpoise Bay.

Previous scientific investigations (Atkin, Mead and Phillips, 2019; Ivamy and Mead, 2001; Mead, 2002; Mead *et al*., 2003) and magazine articles (Rust and Kirkham, 2009) have highlighted the big wave surfing location of Raratoka (Centre Island). Surf breaks in and around Haldane Bay are known to the author, have been discussed with South Island surfers and are indirectly referenced on surf guides.

Sabre Reef on Rakiura; 2nd Break and 3rd Break located at the western end of Te Waewae Bay and a "Spot X" is noted in between Beatons and Nicks Point were identified from an online, community driven surf guide[2]. Surfing at Mason Bay on Rakiura is acknowledged on surf forecasts websites[3] and an online article[4] The Spot-X Surfing Guidebook notes a big wave surfing location called Avalanches south of Port Craig also at the western end of Te Waewae Bay. Big Bay and Martins Bay were not included in any guidebook, but online surf forecasts are available for both sites[5, 6]. Opportunities to access these sites are offered as adventure type surf tours and articles and online videos have featured the surf at these locations.

[2] Wannasurf
[3] Magicseaweed
[4] Stuff
[5] Magicseaweed- Martins Bay
[6] Marineweather

5 Characterisation

In this section, the objective is to compile relevant information for each of the surf breaks identified in Section 4. This information will aid in determining significance and provide baseline characterisation. Information includes breaking characteristics, functionality, access and value attributes (Orchard *et al*., 2019). Table 5.1 summarises the characteristics of surf breaks in Southland included by Morse and Brunskill (2004). These surf breaks and additional surf breaks identified during the characterisation process, are presented in this Section and are introduced geographically from west to east.

Table 5.1: Summary of surf break characteristics derived from Morse and Brunskill (2004).

Name	Wave Type(s)	Optimum Swell Dir.	Optimum Wind Dir.	Optimum Tide	Stoke Rating	Descriptive Terminology
Blue Cliffs	Right hand river bar break	South	North	Mid to High	7	Fickle
Frenches/ Frentzes Reef	Left reef break	South	East	Mid	6	Heavy
Porridge	Left hand point break	South	Northeast	Mid	9	Mechanical, grinding, ledgy, long walls, hollow barrels
Beatons	Left hand point break	South	Northeast	Mid	7	-
Nicks Point	Right point break	South	West	Mid to Low	7	-
Colac Bay	Beach	South	Northwest	All	4	-
Riverton Rocks	Right hand point break	South	West	Low	6	Fickle, long
Oreti Beach	Beach break	South	East	Low to Mid	2	Soft, close out
Porpoise/ Curio Bay	Beach break	South	West	High	8	Powerful, hollow

5.1 Avalanches/Port Craig

Geographical Setting and Access

The material regarding Avalanches names Port Craig as a starting point. Access to Port Craig is limited to boat or unsealed, nondescript tracks. Beyond leaving Port Craig by boat there is no other details regarding location or access.

Wave Type and Functionality

Avalanches is a big wave surfing location and a right hander. The site is a shallow reef surrounded by deep water and reported breaks in 6 m swells or more.

Wave quality

It is not possible to provide details regarding surfing wave quality in terms of peel angles and wave shapes, with the current amount of information.

Value Attributes

Given that this surf break is located offshore in Fiordland National Park, it is likely, that it would be considered to hold naturalness and wilderness value. Little else can be confidently assumed within the context of values attribute.

5.2 2nd Break and 3rd Break

These surf breaks are reportedly located toward the western end of Te Waewae Bay, on the edge of Fiordland National Park. The unsealed Papatotara Coast Road turns landward shortly after Rowallan Burn. Beyond this, land-based access is on foot along the South Coast Track. Aerial photos present a range of surfing potential, but surfing locations cannot be confirmed. Furthermore, this is not a scoping study nor a reference point for surf exploration.

Wave Type and Functionality

Right hand points breaks are likely given the orientation of the coast. Beyond this no further information is available.

Wave Quality

No information available.

Value Attributes

The surf breaks are located relatively close to Fiordland National Park and likely difficult to access. They would likely be valued in terms of naturalness and wilderness.

5.3 Blue Cliffs

Geographical Setting and Access

Blue Cliffs is a very exposed and isolated location. The ~33 km stretch of beach which includes Blue Cliffs is broken by a few sandy river mouths. Sources indicate that surfing opportunities present themselves along the entire length of beach (Surf Seeker[7], Morse and Brunskill 2004), yet vehicular access is limited for much of the embayment.

There are network of tracks indicating vehicle access toward the Waiau River mouth. Where Papatotara Road meets the coast, Blue Cliffs Beach Road branches off to the west and terminates 750 m to the west, where the Waimotu Creek discharges into Te Waewae Bay. Beyond vehicular access, users of the surf break will likely cross the Waiau River to reach the open coast beach.

Wave Type and Functionality

The coastline around the river mouth appears wave dominated with river flow being largely impounded by the barrier spit. Morse and Brunskill (2004) state the surf break type is a right-hand bar break.

Figure 5.1 consists of historical Google Earth images of the coast at Blue Cliffs. There is no consistency in the location where the Waiau River breaches the sand spit. In the historical images, the river mouth is most often found at the western end of the spit; yet breaches may readily occur at the eastern end as well. It is likely that the morphology around the river mouth allows for waves that break in a manner conducive to surfing; these conditions are highly likely to be ephemeral; and could potentially occur anywhere along the coast where the river discharges. Of the 10 images in Figure 5.1, the 2013 image shows the largest discontinuity in morphology and the greatest potential for surfing.

Wave Quality

Most of the aerial images provide a full range of peel angles (0°-90°) indicating a wave breaking setup that is not well defined. The waves associated with the distinct river mouth in the 2013 image provide peel angles of 40° through 70° indicating conditions conducive to surfing. Little is known in terms of wave shape, but waves breaking over a mix of sand and stones (likely a matrix of both), that is coarser material, have the potential to host steeper face waves due to the coarser material have a steeper seabed gradient (e.g., Mead and Black, 2001c). The guides indicate Blue Cliffs is good for all levels of surfing.

[7] http://surfseeker.nz/

Value Attributes

In terms of the primary attributes best associated with Blue Cliffs it would likely score highly for consistency in terms of having waves to surf, although consistency in terms of quality is unknown. This area is largely free of anthropogenic influence, with only a small settlement set back from the beach, indicating a level naturalness, it is on the edge of Fiordland National Park so there is increased amenity value concerning aesthetics. If it is a consistent surf break, which is likely given its exposed location, it could also have a high frequency of use.

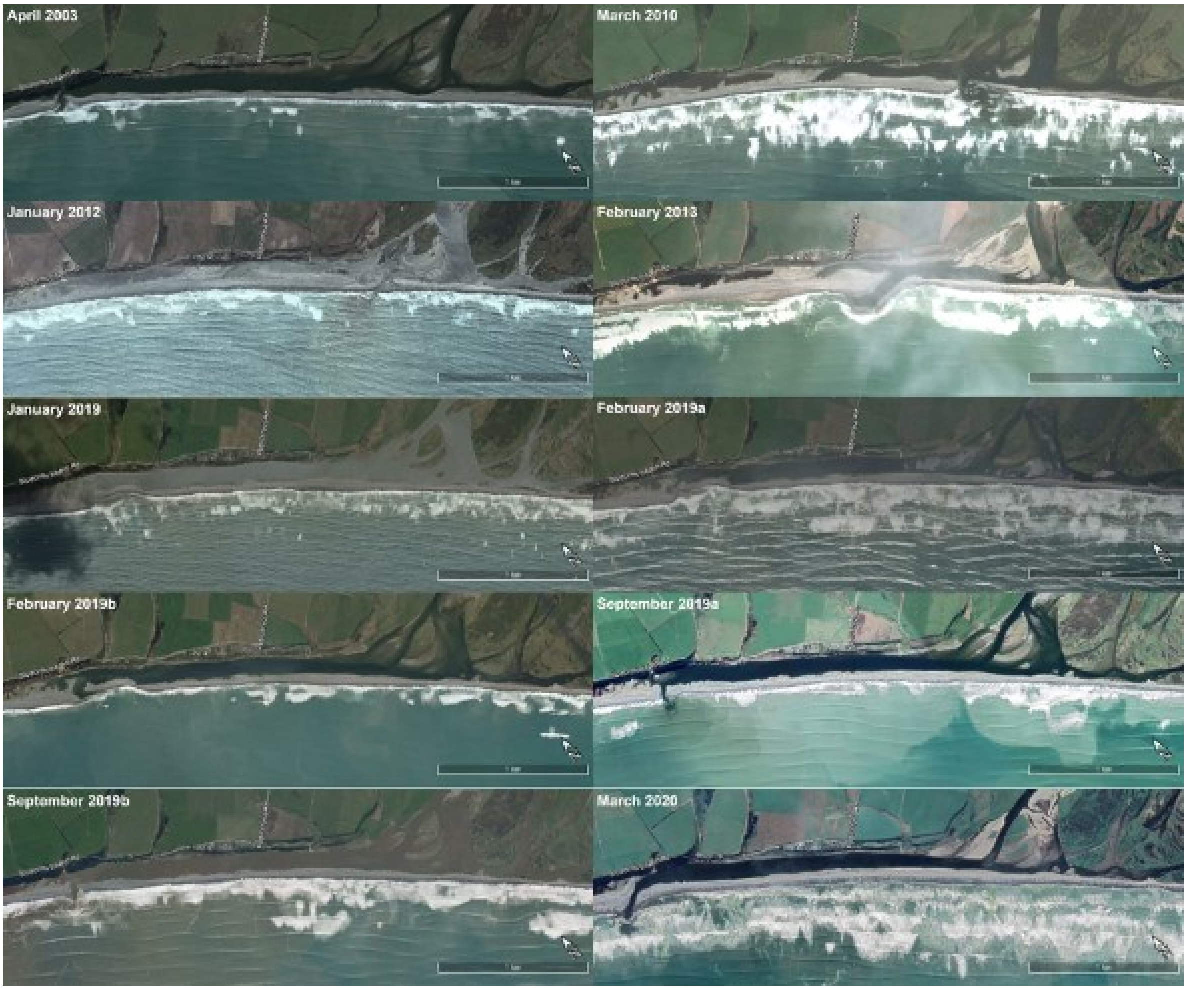


Figure 5.1: Historical aerial imagery from Google Earth of the Blue Cliffs section of Te Waewae Bay and the Waiau River mouth

5.4 Frenches Reef

Geographical Setting and Access

Located at the far eastern end of Te Waewae Bay, on the northern side of the Pahia Point headland, Frenches Reef is one section of the long rocky point. This surf break is also referred to as Frentzes. There is road access along the length of the point but no clear parking or access tracks down to the shoreline. In addition, there are narrow paddocks or sections of bush between the road and shoreline. Walking along the point to access the surf is likely.

Wave Type and Functionality

The wave is a left hander and described as being heavy. While the geomorphological type is described as a rocky reef, the shoreline is lined with unconsolidated substrate. It is unknown if wave quality is a function of sediment transport on the reef/point. The December 2020 aerial image (Figure 5.2) indicates a left hander breaking close and adjacent to a protrusion in the shoreline, which is consistent with Morse and Brunskill (2004). However surfing potential is evident to the west and east. At the end of Frentz Rd the reef extents offshore to the north and wave breaking is evident. Further to the west, over a kilometre from the (official) end of Frentz Rd, just outside the area noted by ES, there is a rocky protrusion orientated to the northeast. To the east of the area indicated by Morse and Brunskill (2004), before the scattered rocks and reefs dominate the nearshore, there is a large northward protrusion in the reef which breaks waves in some of the conditions provide in the aerial photos. A bombora[8], located ~500 m from the shoreline causes waves to break as captured in many of the aerial photographs.

Wave Quality

Aerial photos of the area at the end of the point exhibit peeling waves from 45° to 55° and indicate the most potential for high performance surfing along the north coast of this headland. There is no information available regarding wave shape.

Value Attributes

Frenches Reef offers something slightly different in that it is an exposed left have point break offshore in an easterly. At this stage it is not possible to comment on the attribute of wave quality, like Blue Cliffs it would likely score highly for consistency in terms of having waves to surf, thought this does not always translate into quality. While the surf break itself is free of anthropogenic influence the surrounding area is largely farmland and offers little to no natural setting.

[8] Aka 'bombie', refers to an isolated area of breaking wavs often associated with big wave surfing locations.

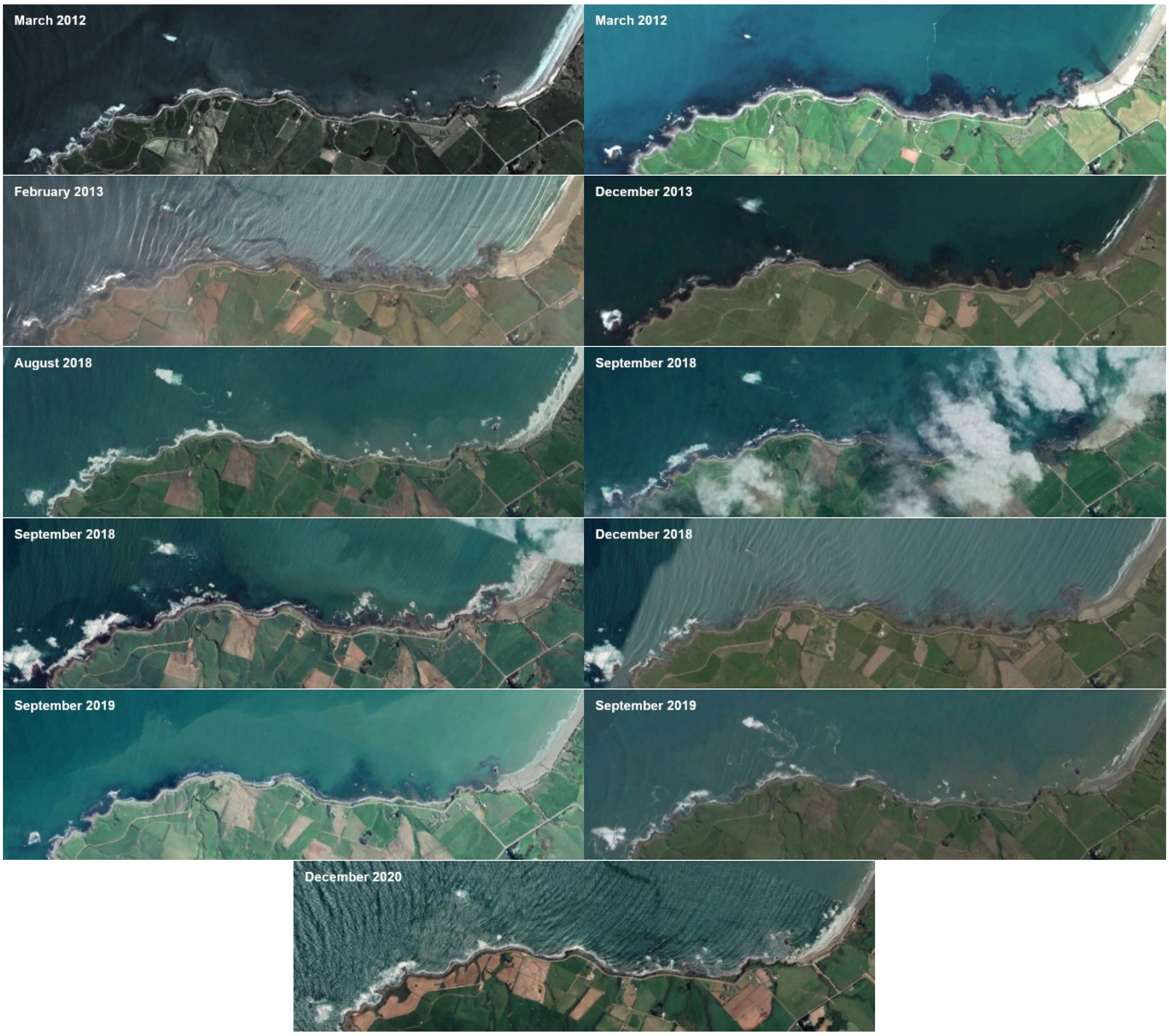


Figure 5.2: Historical aerial imagery from Google Earth of the Frenches Reef headland.

5.5 Porridge

Geographical Setting and Access

Porridge is located south of Pahia Point headland, adjacent to the Pahia settlement. Permission to cross private property from Garden Road is required. Bhana (1999) refers to the embayment to the northeast as a lagoon, with a gap through the reef and rocks which paddle access to the SBA can be made. Aerial images indicate that waves can break across the gap or channel.

Wave Type and Functionality

The geomorphology is described as a rock shelf, exposed reef and point break. From aerial photos (Figure 5.3) and online sources, it appears to be a boulder point break, but with many large, exposed sections of rock. The seafloor is likely to be a mixture of reef and boulder.

Much of the footage and photos available online indicate a take-off area associated with a rock ~100 m from the shoreline, where the orientation of the coast turns from north-south to northeast-southwest. Some footage and aerial photos do show waves breaking and peeling on an outer island/reef some ~250 m from shore (at the most exposed tip of the point). The bathymetry of this surf break (Figure 5.4) shows a large focus (Mead and Black, 2001b), which is a submarine extension of the headland, that is conducive to both waves breaking further offshore around the larger island/reef, and the surf break remaining surfable in larger conditions.

Figure 5.3: Historical aerial imagery from Google Earth of the Porridge and Beatons.

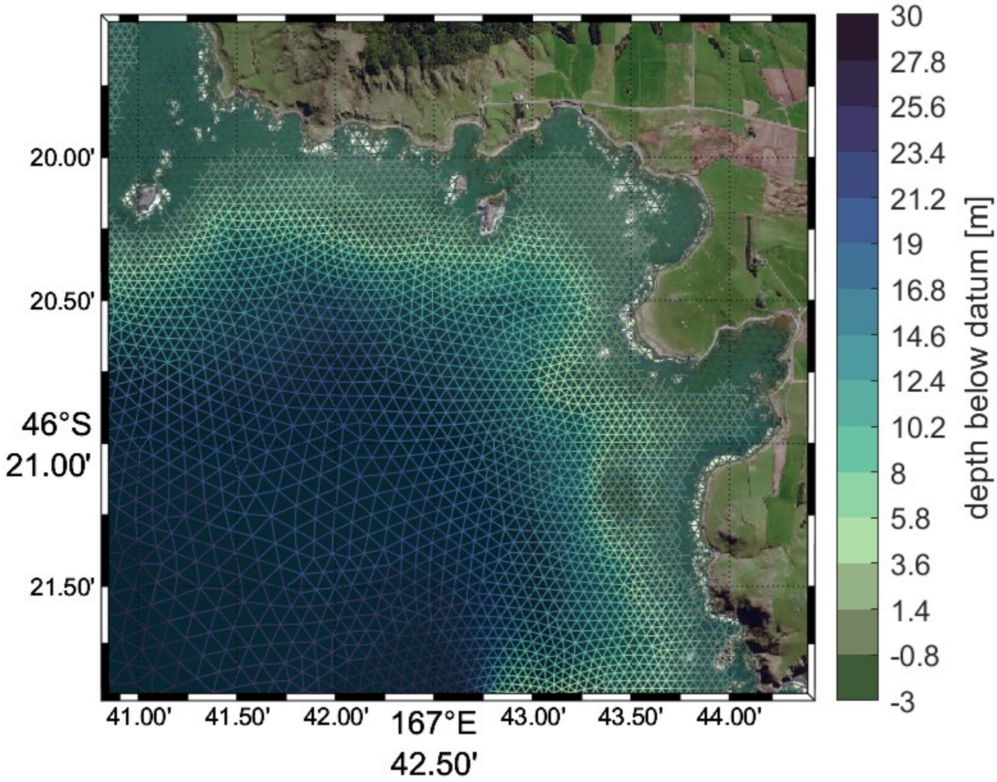


Figure 5.4: Triangular mesh of depth (to Chart Datum) overlain on aerial image of the coast around Porridge and Beatons.

Wave Quality

The left-hand point break is considered by some as the best wave in Southland (Bhana, 1999; Morse and Brunskill, 2004). In terms of wave breaking, the surf break is reported as being powerful ("packs a punch", "grinding"), fast, hollow and ledgy. The term 'mechanical' is also used, a term synonymous with some of the absolute best surfing waves globally. Peel angles in the 40°- 60° range support the case for a high-quality surfing wave. This surf break is reportedly surfable in large conditions, provides long rides, and was host to part of the Ultimate Waterman competition in 2016[9].

Value Attributes

The reported high wave quality and being considered the best wave in the region means that Porridge also algins with the rarity attribute. Given its mechanical nature it is likely to be surfable even in inclement meteorological conditions providing a high level of consistency. Porridge is quite exposed with access challenges, despite this and given its notoriety it is likely to have a relatively high level of use. The surrounding land is used for farming, indicating little

[9] Ultimate Waterman

value in terms of naturalness or wilderness, but the exposed, isolated and challenging nature of the surf break would likely offset this lack of being untouched.

5.6 Beatons

Geographical Setting and Access

Beatons is located south of Pahia Point headland, in the next embayment south of Porridge. As with Porridge, Beatons requires permission from a landowner to cross a paddock to access the surf break. However, the embayment of Ouetota Road has beach access, and there is a boat ramp off Garden Road that would allow a long paddle to the waves.

Wave Type and Functionality

In terms of geomorphological set-up, Beatons is similar to Porridge. It is a left hander breaking over a mixed rock reef and boulder point. Larger boulders and rock structures are more prevalent in the nearshore than at Porridge.

The point break is southwest of the boat ramp and due west of the point, the bathymetric data indicates a large, submerged feature (Figure 5.4). The feature has its major axis north to south, and is highly likely to act as preconditioner, either focussing or disruptive for, both of which enhance surfing conditions (Atkin, Mead and Phillips, 2019). It is not known whether wave quality has a dependence on the movement of the unconsolidated material on this coast.

Wave Quality

Aerial images (Figure 5.3) indicate waves breaking with peel angles ranging between 45° and 70°, making for a wave that provides high performance sections whilst approachable for less skilled participants. The surf guides note that Beatons has good wave shape (‘wally’ i.e., steep) and long rides, but prescribe the surf break for experts.

Value Attributes

Beatons is described as a high-quality wave and would likely score highly in that respect.

5.7 Mason Bay

Geographical Setting and Access

Mason Bay is located on the west coast of Rakiura (Stewart Island). The bay is delimited by Mason Head to the north and the Ernest Islands. There are foot tracks to access the bay, direct boat access to the bay is possible; flights also land on Mason Bay beach.

Wave Type and Functionality

The waves in Mason Bay are very likely beach breaks. A set of rocks in the northern half of the bay likely provide a focal point for discontinuities in beach morphology, similarly there are number of streams and creeks, most notably Duck creek, that drain on to the beach that may also influence beach morphology with respect to surfing. The rocky headlands at either end of the bay also provide some surfing potential.

Wave Quality

Aerial images indicate a full range of peel angles and surfing wave quality would likely be a function of ephemeral beach bars and rips. There is no information regarding surfing wave shape.

Value Attributes

Mason Bay would likely associate with wilderness and naturalness value. It is not possible to consider other value attributes due to the lack of information.

5.8 Spot-X

Geographical Setting and Access

Spot-X is reported to be in the vicinity of Wakaputa Point, in between Beatons and Nicks Point. Unsealed and paper roads extend towards Wakaputa Point, but no definitive access along this stretch of coast is apparent. The land surrounding this area is dedicate to agriculture and permission to access the coast is likely required.

Wave Type and Functionality, Wave Quality and Value Attributes

There is no information regarding the surf break in this area, and no discernible surfing waves.

5.9 Saber Reef

Geographical Setting and Access

Saber Reef, or Sabers, is reportedly located on the south coast of Rakiura (Stewart Island), around the area of The Brothers, a pair of islands to the west of Seal Point. There are no notified access tracks to this section of coast, and it is likely that this is a boat access only surf break.

Wave Type and Functionality

It is described as left hander breaking on a rocky reef. Neither historical aerial images or course bathymetry indicate a distinct surf break in the area. Waves would likely come out of deepwater given the general bathymetry of the area, and the lack of features in the aerial images and bathymetry support the possibility of a slab type wave.

Wave Quality

The terms hollow, fast, heavy and powerful are used to describe the wave indicating a certain level of high performance. The description online indicates that the surf break is more suited to bodyboarding.

Value Attributes

Saber Reef would likely associate with wilderness and naturalness value, and by the description possibly have some extreme surfing value similar to big wave surfing sites. It is not possible to consider other value attributes due to the lack of information.

5.10 Raratoka (Centre Island)

Geographical Setting and Access

While located some 7 km from the mainland coast of the South Island and not included in any of the surf guides, Raratoka is a big wave surfing venue. Access is by boat or similar, and according to Maritime New Zealand[10] the island is privately owned.

Wave Type and Functionality

Mead *et al*. (2003; Figure 5.5; Figure 5.6) showed that a submerged offshore ridge runs ~2 km offshore west by south west; the ridge is 650 m wide at the offshore end widening to 900 m inshore; the offshore end is approximately 14 m deep (CD), 16 m above the ambient bathymetry; the feature shoals to 10 m at the inshore plateau, 5 m above the ambient bathymetry (Atkin, Mead and Phillips, 2019). Mead *et al*. (2003) annotated the wave breaking zone of Raratoka straddling an area between the 0 m and 10 m contours, with the bulk of it around the 2 m mark. The surfing wave is a left-hand reef break.

The approach of Atkin and Mead (2017) to determine a minimum surfable wave height (H_{sf}) for Aotea Reef, a big wave surfing location in the Waikato, was to use breaker depth index (e.g., McCowan, 1894; Camenen and Larson, 2005)) which provides wave height at breaking by:

$$\gamma_b = H_b/h_b$$

Where γ_b is the breaker depth index; H_b is wave height at the point of incipient breaking and h_b is the water depth at the point of incipient breaking. The value of γ_b, is reported between 0.5 to

[10] Maritime New Zealand

1.2 (Iribarren and Nogales, 1949: cited in Battjes, 1974; Shand *et al*., 2007). The range of these values are a function of the different incident wave conditions and bed slopes. As slope increases, γ_b decreases. Raratoka is a relatively large, complex feature, with a range of slopes especially around the breaking zone. Taking an approximate average depth of 3 m in the breaking zone of Mead *et al*. (2003), and using an average γ_b value of 0.85, a H_b of 2.55 m is yield. This value is not dissimilar to the wave heights for surfing conditions described by Rust and Kirkham (2009; "*swell of six feet or more"*).

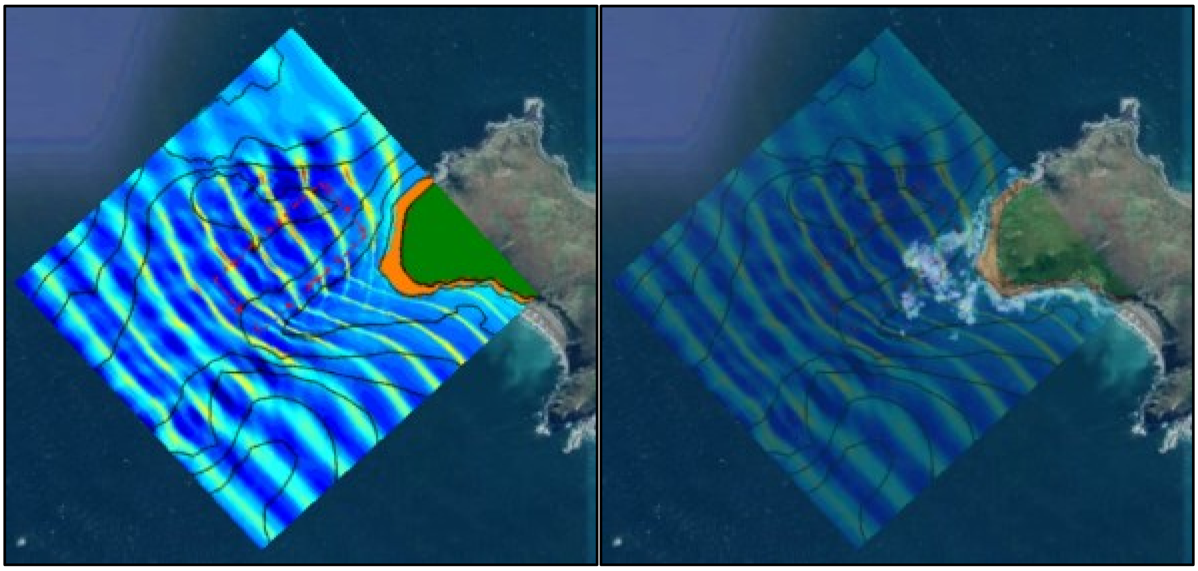


Figure 5.5: Numerical model output with high (left) and low opacity (right) of wave heights from Mead *et al*. (2003) overlain on Google Earth aerial image of the western end of Raratoka.

Wave Quality

As with many big wave surfing locations, there are often large periods of time when the site is not conducive to surfing. Of the 7 aerial images of Raratoka (Figure 5.7) only the 2013 image shows wave peel, at around 60°. Being a big wave surfing location Raratoka possess high quality attributes by default. Rust and Kirkham (2009) describe a powerful wave, which is to be expected from a big wave surfing location, but also as Raratoka is exposed, surrounded by deepwater there is relatively nothing in the pathway between the reef and the Southern Ocean. The bathymetric configuration lends itself to long ride lengths (Figure 5.5), and an image[11] taken during a competition help at Raratoka indicates this is so. Relevant articles also include test regarding barrels or tubes, so it can be assumed that the wave falls into the plunging category of surfing (Mead and Black, 2001c).

[11] Raratoka

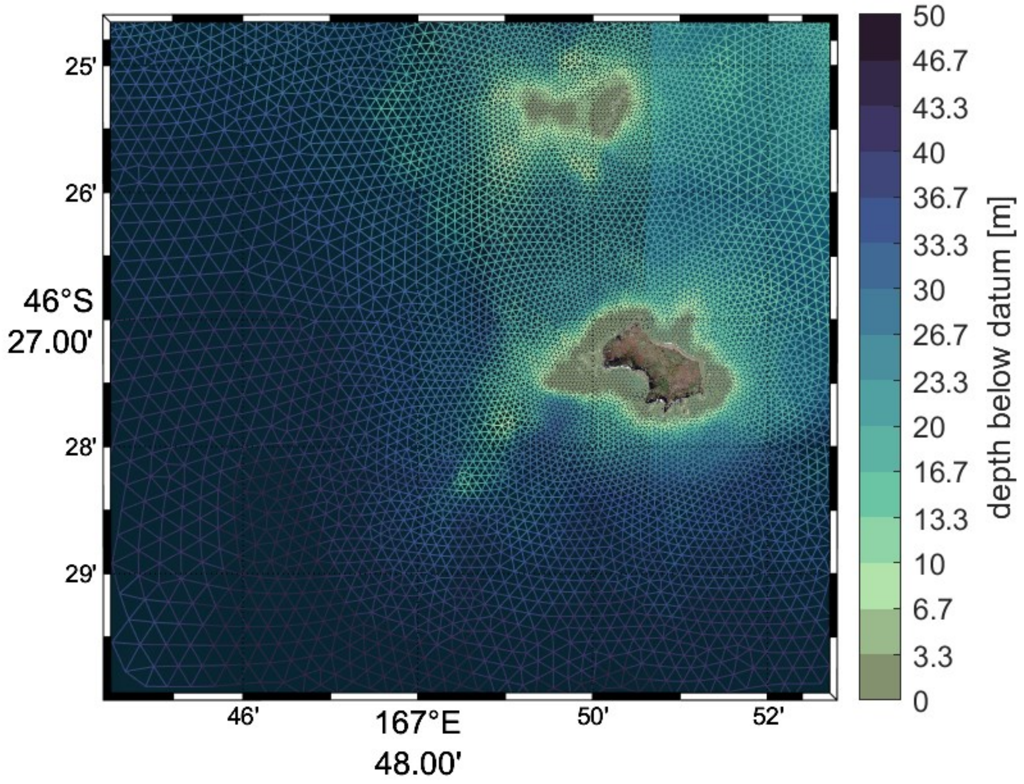


Figure 5.6: Triangular mesh of depth (to Chart Datum) overlain on aerial image of Raratoka.

Value Attributes

There are a limited number of established big wave surfing locations in New Zealand. This site was first surfed in the late 1970's by then lighthouse keeper and South Island surfing aficionado Rod Rust. In 1999, and for several years after, the waves at Raratoka hosted New Zealand's first official big wave event (the Rex von Huben), that included international participation. To provide further significance, it has been between Raratoka and Papatowai that the big wave events in New Zealand were held. Papatowai is one of the 17 Surf Breaks of National Significance. There are no reports of people surfing Papatowai on 'smaller' days, however, Rust and Kirkham (2009) and NZS (2014) certainly indicate that it is surfable when not in the big wave category, with "*swell of six feet or more" resulting in "powerful left-breaking waves" (*Rust and Kirkham, 2009). Raratoka is rich in the attributes of rarity, wave quality, uniqueness, naturalness, wilderness value, and, historic, heritage, and cultural associations.

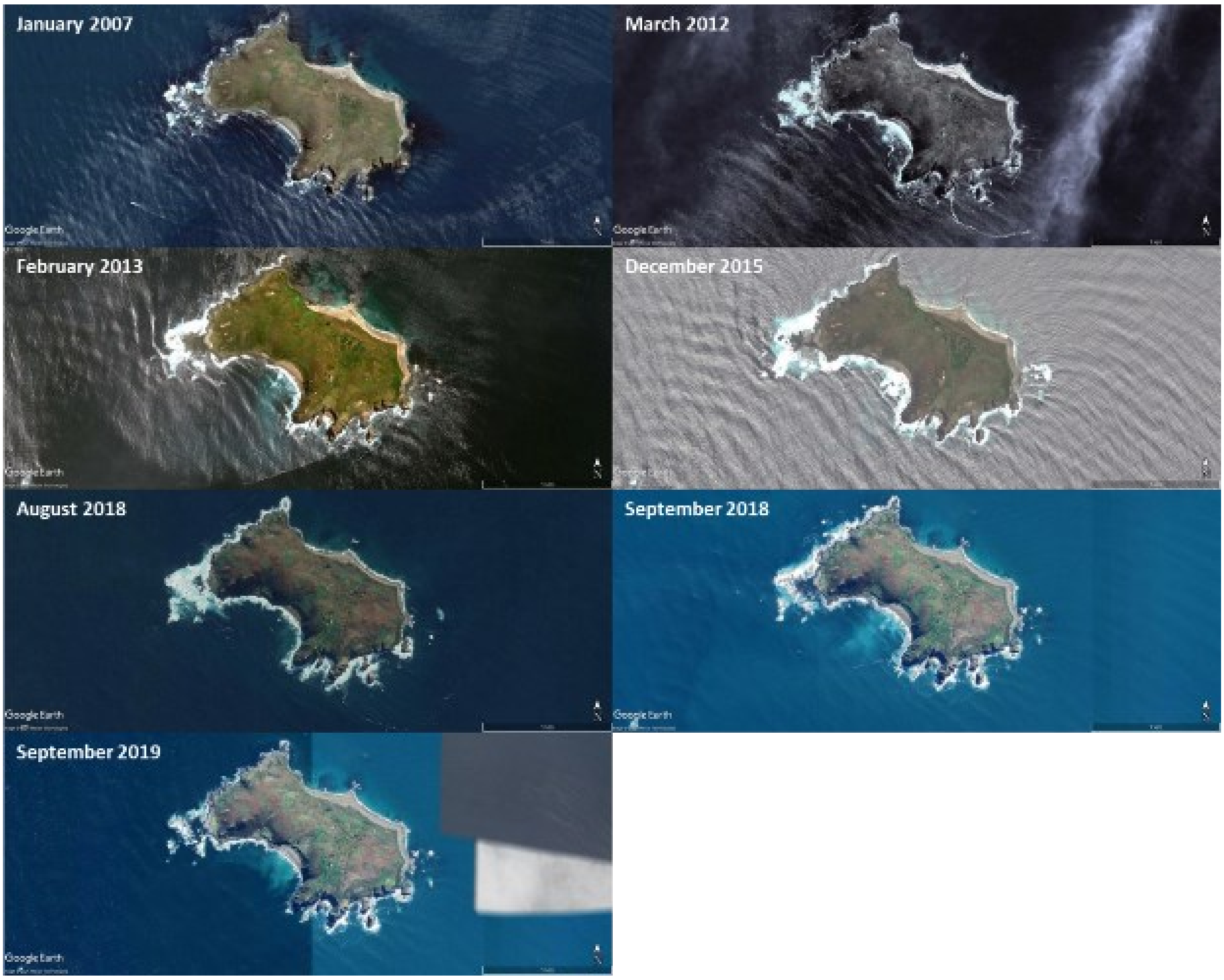


Figure 5.7: Historical aerial imagery from Google Earth of Raratoka.

5.11 Nick's Point

Geographical Setting and Access

Nick's Point is located at the western end of Ōraka (Colac Bay), north of Ōraka Point but south of a boat ramp. Colac Foreshore Road runs along the coast, at the road end there is a carpark, toilet and changing shed, beyond which the point is readily accessible on foot.

Wave Type and Functionality

Nicks Point, or simply Nicks, is a right-hand point break; one source refers to a reef/point combination. Video footage indicates a take-off ~1600 m south of a boat ramp, and surfers participating adjacent and close to large exposed/surging rocks. Figure 5.8 is reported to be 'inside' at Nick Points – inside referring to a section of the wave that breaks further along the point, toward Ōraka township. The photo shows a mix of both boulders and sand, with the boulders varying greatly in size. At the very end of the headland, Ōraka Point, there is surfing potential, although this is separated from the rest of the point by a smaller rocky headland.

One surf guide states the rocks on the point can be covered in kelp. It should be noted that kelp, and other flora, can be both aid and hindrance in terms of surfing wave quality. Kelp beds are well known to dampen low period (high frequency) chop associated with local winds. This makes for 'cleaner' wave faces and generally a better surfing experience. Conversely, excessive kelp can make it difficult to navigate through the water and pose a significant danger to surfers.

Figure 5.8: 'Inside' Nicks Point[12].

Wave Quality

Aerial photos (Figure 5.9) show breaking waves with surfing potential further south along the point, but do not provide the opportunity to evaluate wave quality (peel angle). In terms of wave shape, video/footage show a wave with hollow sections, and surf guides use term such as wally, barrelling, and powerful. Surf guides also state this is a wave for more advanced surfers, indicating a more high-performance surf break.

Value Attributes

Nicks Point is likely to provide surfing opportunities for a large number and range of users; combined with its proximity to Ōraka township, and Riverton, potential for high quality surfing waves, Nicks Point would likely score highly in terms of level of use.

Nicks Point is also one of only two positively identified right hand point breaks. The other is Riverton which requires large swells to be surfable, where Nicks Point is more exposed, giving

[12] https://www.surf-forecast.com/breaks/Nicks-Point/photos/2654

Nicks Point value in terms of rarity. There is an indication the Nicks provides a wave quality that could be associated with high performance surfing. Consistency of quality are unknown, but of the two right hand points breaks, Nicks will likely be the more consistent in terms of surfable days per year.

Figure 5.9: Historical aerial imagery from Google Earth of Nicks Point.

Nicks and Riverton Rocks are unique in the group of point breaks identified in this report in that they will be offshore to cross-offshore in predominant south-westerly winds. The settlement of Ōraka is somewhat disconnected from the surfing area and beyond the derelict wharf boat ramp there is only one dwelling which his setback from the coast. This indicates a modicum of naturalness, but the land use around Nicks Point is largely dedicated to agriculture with low naturalness and wilderness value.

5.12 Colac Bay

Geographical Setting and Access

Colac Bay extends to the east from the inshore end of Nicks Point some 6 km. Morse and Brunskill (2004) indicates the common surfing areas lies from adjacent the local shop, just east of where Colac Bay Road meets Colac Foreshore Road, along the beach to where the western end of Tihaka Beach Road turns away from the coast. Between Tihaka Beach Road and Colac Foreshore Road access to the beach is essentially beach wide. The section of coast just east of the parking area where Colac Foreshore Road meets the coast is reportedly known locally as 'Trees'. There are no reports of surfing between Colac Bay Road and the SBA for Nicks Point.

Wave Type and Functionality

There are surfing opportunities along the entire length of the bay, and the beach is a mix of sand and pebbles, with rock outcroppings.

Wave Quality

The waves are not particularly notable in terms of shape or length and are reportedly 'soft'. A full range of peel angles are evident from historical aerial images (Figure 5.10), with no consistent breaking pattern or take-off area. Wave quality is a function of the ever-changing beach morphology and swells.

Value Attributes

Colac Bay attracts a large number of surfers, including those from Central Otago, with the car park often at capacity on weekends. This indicates that Colac Bay has dependent population. It would be an accessible surf break for many without the challenges of rocky reefs or boulders. It is likely very consistent and is user friendly with the small settlement of Ōraka township close by offering amenities. The beach is backed by a moderate dune system; however, this is almost exclusively colonised by invasive flora, and landward of this is farmland; therefore, not offering clear naturalness and wilderness value.

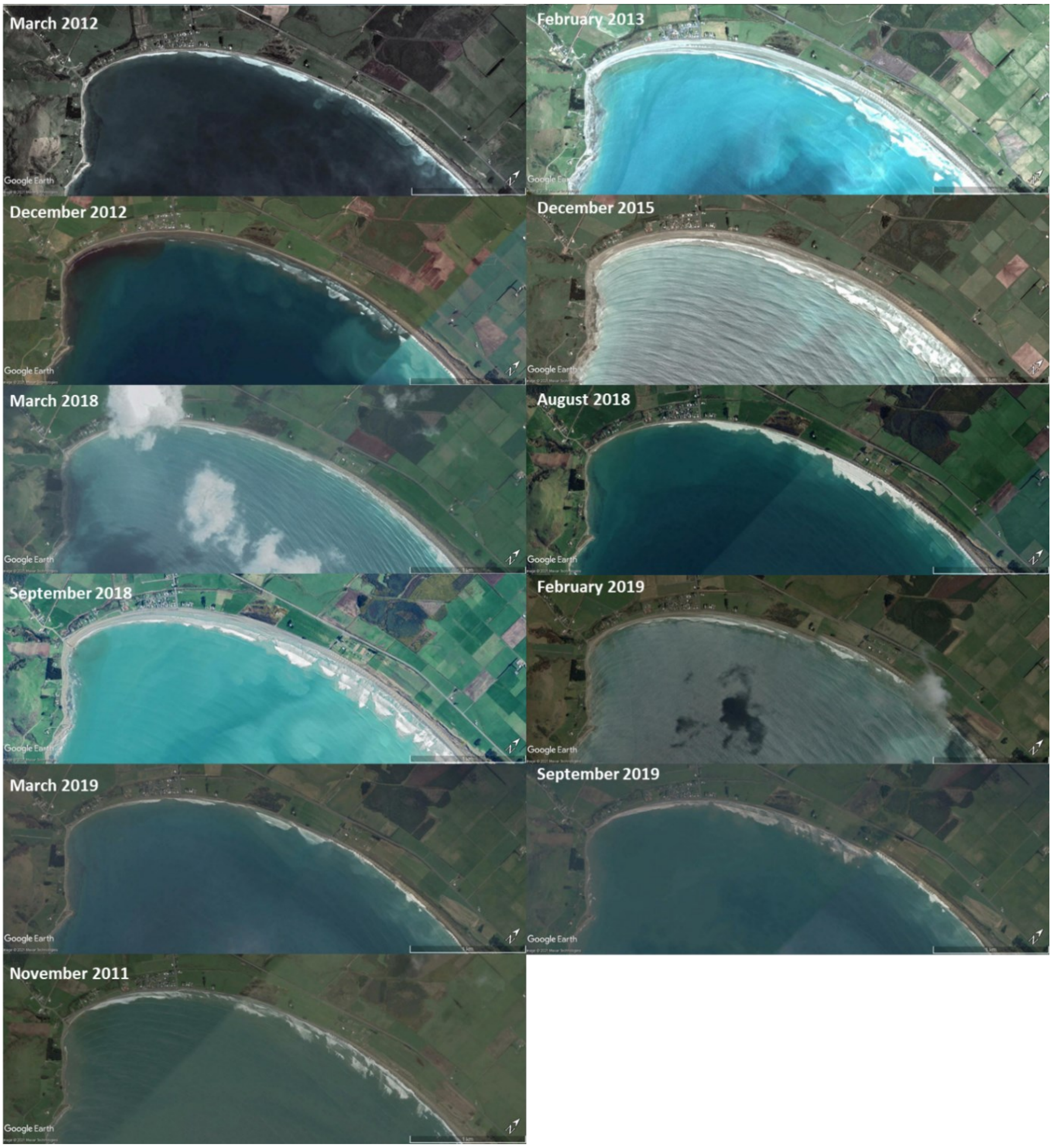


Figure 5.10: Historical aerial imagery from Google Earth of Colac Bay.

5.13 Martins Bay and Big Bay

Geographical Setting and Access

Martins Bay and Big Bay are located on the west coast. They are two separate embayments located adjacent to each other in between May Hill to the south and Awarua Point to the north, the latter of which demarks the jurisdictional boundary of the Southland region. These two surf breaks have been grouped together as they both have similar attributes, but there is only a limited amount of information regarding the technical specification and use.

Martins Bay can be accessed via the Hollyford Track, and Big Bay from Pyke Track (which branches from the Hollyford Track), but this work found no document evidence of surfers undertaking this access route. The only evidence of access found during this work was surfers utilising helicopters directly, and jet skis to search the coast in this area (Rust and Kirkham, 2009). Of note is that Martins Bay is inside Fiordland National Park, while Big Bay is outside the northern boundary.

Wave Type and Functionality

Both bays host barrier spits and tidal inlets. It is likely that surfable waves are found at the tidal inlet mouths. The coastline from May Hill to Awarua Point also hosts numerous point breaks and reef breaks. The shear extent and variation in orientation of Big Bay lends itself to a range of options regarding wind direction. There are reports of big wave surfing locations (Rust and Kirkham, 2009; Dr S. Mead, 2021 pers. comm.). Non technically descript sources also indicate beach breaks, points breaks, river mouths and A-frames[13] (both left and right handers) to suit a range of skill levels[14]. Beyond these observations and examining aerial images, there is no site-specific documentation.

Wave Quality

Images online are limited but do indicate that hollow, high-performance waves can occur. Reports of high-quality waves[15], use of the term mechanical[13] and inclusion of the "*perfect point break*"[13] also support the existence of waves suitable for high performance surfing.

Value Attributes

The geographical location and isolated nature of these sites lends itself to the naturalness and wilderness attribute types. This is frontier surfing, with 2 x world champion Tom Carroll describing surfing in Fiordland as enjoyable because it was a wild and unexplored place[16]. The experience of surfing in Fiordland is certainly unique, as are the access challenges. Reports of big wave surfing locations in the area support the uniqueness attribute as well. Given a helicopter-based adventure tour operation is levering the surfing resources there is likely an economic value associated with the surf breaks.

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[13] The Inertia
[14] Awarua Guides
[15] Matador Network
[16] New Zealand Herald

5.14 Riverton Rocks

Geographical Setting and Access

Riverton Rocks is located at the far western end of a large embayment west of Invercargill, adjacent to the Aparima River inlet. Rocks Highway runs along the length of the point with parking and well used beach access point clearly available in aerial images.

Wave Type and Functionality

Surf guides describe Riverton Rocks as a series of right-hand point breaks that can link up for long rides. The sheltered location of this surf break means it requires exceptionally large swells in the Southern Ocean to become surfable. The headland, the most seaward point of which is Taramea (Howells Point), appears to comprise of rocky reefs interspersed with small sandy beaches, with sand quantities increasing from south to north until rocky outcroppings no longer break the beach (roughly adjacent to Hamlet Street). Surfing at the beach breaks from around Church Street toward the Aparima River is reported. Given the proximity of the surf break to the Aparima River and the abundance of sandy substrate along the point, there may be a surfing wave quality dependence on the sediment transport regime of the river inlet and associated tidal deltas.

Surfing is reported as far along the point as Mitchells Bay. Environment Southland staff indicate that surfing occurs as far along the point as Evelyn Street. Further south along the point from Evelyn Street is Henderson Bay. The January 2018 aerial photo shows wave propagating into Henderson Bay (and further toward Taramea) and breaking, but not in a manner that looks particularly conducive to high performance surfing.

Wave Quality

Video footage and articles online indicate a surf break conducive to learning and progressing. Indeed, the seabed appears very flat, even along the point break, meaning wave breaking will tend toward spilling which is suitable for learners. Of the few aerial photos exhibiting breaking waves, peel angles on the sand bottom part of the point are in the 40°- 50° range, indicating a suitable level of wave breaking for high performance surfing.

Value Attributes

Given this surf break's proximity to Invercargill, a relatively large local population, and the types of waves breaking there, Riverton Rocks is a strong candidate for a nursery break within the region (Board of Inquiry, 2009b), adding both educational value and level of use as attributes. Riverton is a substantial town and the land use adjacent to the breaks is largely housing, and farming beyond that, indicating no notable naturalness or wilderness value. It is one of two relatively well described right point breaks offering offshore conditions in the predominant southwesterlies, while being a sheltered location offering relatively safer surfing conditions where other surf breaks are exhibiting much larger wave heights – indicating both rarity and uniqueness to the regions list of surf breaks.

5.15 Oreti Beach

Geographical Setting and Access

The beach made famous by *The World's Fastest Indian* allows vehicular access, and with Dunns Road from Invercargill terminating on the beach and Ferry Road providing direct access, there is essentially unimpeded access to the surf from the New River Estuary inlet all the way to the Aparima River at Riverton. Where surfing wave quality is marginal, vehicle assistance to search for the best opportunity (sand bank) is highly likely.

Wave Type and Functionality

Oreti Beach is a sand bottom beach break very exposed to swell. There are no defined take off areas, intermittent quality is highly likely a function of ephemeral sand bars, which are reportedly in a constant state of flux. The very gentle beach gradient also indicates a site where waves have a low breaking intensity, also suggesting low surfing wave quality.

Where the Waimatuku Stream discharges on to the beach, some 3 km and 9 km from the end of Ferry Road and Dunns Road, respectively, likely provides some of the best surfing options at any one time - the stream will likely encourage discontinuities in the local bathymetry, potentially allowing waves to break/peel in a different way to the adjacent beach section. The same surfing potential could be apparent where drainage systems (one associated with the Taunamau Creek) discharge on to the beach, as far the west as Otaitai Bush. To the south of the Dunns Road access point, the beach is limited by the New River Estuary mouth.

A set of reefs named Halfway Rocks are located ~4 km southwest of the Dunns Road Access. These reefs could act preconditioners to the surf at Oreti Beach and would likely have some influence on sediment transport in their lee, and therefore on sandy beach morphology for surfing.

Wave Quality

Oreti Beach does not have a reputation for high quality surfing waves and has been referred to as the "Oreti Crumble", which is a testament to spilling waves largely expected from a broad shallow sloping beach. The descriptive terms in surf guides indicate a surf break ideal for learners and progressing surfers.

Value Attributes

Oreti Beach is Invercargill's go to surfing resource and a short distance from the city. Frequency of use, dependent population and educational value are major attributes for Oreti, as well as consistency, not in terms of wave quality but there is likely always a wave for learner surfers.

5.16 Haldane Bay

Geographical Setting and Access

Haldane Bay is located in the east of the Southland Region. It is not included in the surf guide of Morse and Brunskill (2004), and is not mentioned elsewhere, except by the community-driven surf break atlas Wannasurf; even then details are sparse. There is no designated parking for the embayment, and no amenities.

Wave Type and Functionality

The embayment and the adjacent coast are host to a set of high-quality waves[17]. This includes rocky reefs in and around the bay, but also a right hander breaking on the ebb tidal delta of the Haldane Estuary in the embayment. The beach break likely offers surfing options. There is often a reluctance in the surf community to share specific details, including the location, of certain surf breaks. The lack of details surrounding Haldane are a testament to this.

Wave Quality

The rocky reefs in and around Haldane Bay are known to create extremely hollow waves ideal for barrel riding. At times the delta break exhibits peel angles of 35°-50°. A full range of peel angles is found across the beach, but some of the historical aerial imagery indicated complex beach morphology, some of which appears very conducive to surfing.

Value Attributes

Non-local surfers and surfers outside the Southland Region make specifically targeted trips to surf in and around Haldane Bay; the site has hosted wave riding competitions; and the area offers a full range of surfing options, including a high-quality delta, beach breaks and reefs.

While Haldane does not appear to have a high frequency of use, or dependent population, it certainly has outstanding natural character and quality, and attracts others to the region because of this. In terms of attributes, it would likely score highly regarding uniqueness and wilderness.

[17] Author's knowledge and discussions with Dunedin based surfers.

5.17 Porpoise Bay

Geographical Setting and Access

Porpoise Bay is the most easterly of the surfing resources consider in this work and is ~13 km from the regional boundary. In some surf guides Porpoise Bay is referred to as Curio Bay, or some split the embayment as Porpoise Bay being the eastern end and Curio Bay to the western end, adjacent to the settlement of the same name. For this work the embayment is referred to as Porpoise Bay.

Wave Type and Functionality

The main geomorphological type is a beach break. At the eastern end of the bay is the tidal inlet of Waikawa Harbour. The western end of the bay is delimited by a rocky reef complex that extends in towards the middle of the embayment (Figure 5.11). The full extent of this reef complex is unknown, however, surf guides report a bombie on the offshore edge of the embayment, so it is likely to extend far enough from South Head to not be associated with the nearshore bathymetric features.

Wave Quality

Wave quality is reportedly excellent. All surf guide resources refer to powerful hollow waves and multiple peaks and options for users to select waves of their preferred size along the length of the beach, with larger waves at the eastern end of the bay. A-frames are also reported as common occurrences. The historical aerial photos indicate prevalent rip channel features that do not appear particularly conducive to A-frame breaking, so it may be that the offshore reef complex that the bombie is associated with plays an important role in the preconditioning of waves for A-frame formation. During larger swell conditions, waves are reportedly surfable around the tidal inlet. Bhana (1999) refers to this as a right-hand reform[18] breaking in towards the estuary.

Value Attributes

Porpoise Bay provides a range of surfing opportunities, is reportedly of very high quality, and is an isolated location and would likely associate with naturalness value. A surf school operates at the western end of the bay so not only does Porpoise Bay provide educational value it also holds clear economic value, has a high frequency of use and dependent population. Porpoise Bay is unique in that it offers beach breaks that are offshore in the predominant south-westerly winds.

[18] A reform is where a wave sheds the turbulent and aerated white water associated with an initial set of breaking, continues to propagate shoreward and sets up to break a second time.

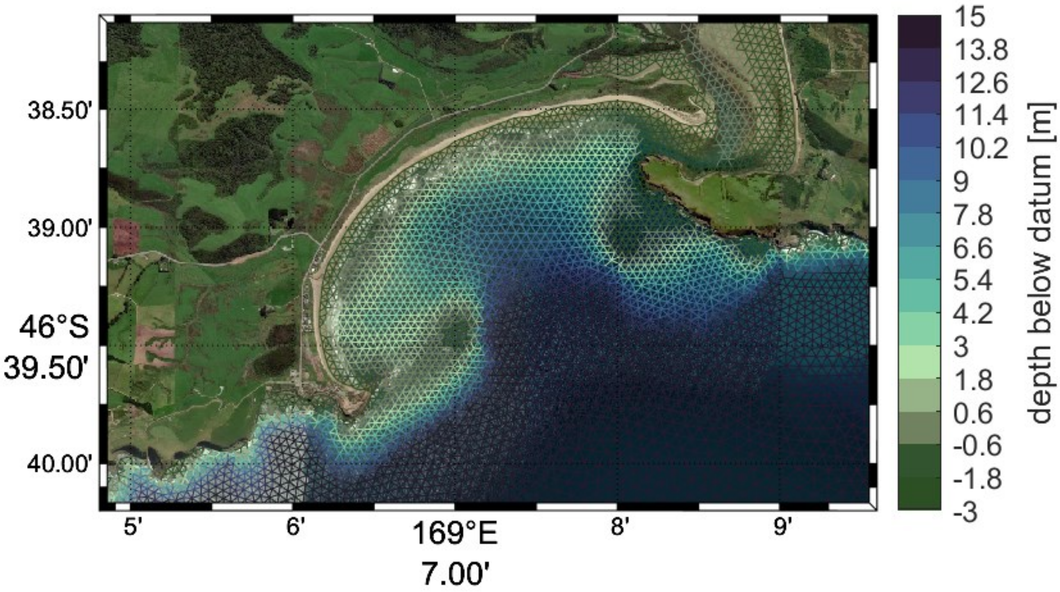

Figure 5.11: Triangular mesh of depth (to Chart Datum) overlain on aerial image of Porpoise Bay.

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6 Surf Breaks of Regional Significance

The most appropriate approach to addressing surfing resource management at a range of scales is to undertake stakeholder engagement as it provides the necessary information to determine what values the community place on coastal resources and facilitate the extraction of technical information to help shape the understanding of the resources in question. Where the subject matter is little understood a precaution is required. There is lack of information, not just for the lesser-known sites, but for all identified surf breaks, and given the lack of public consultation, a conservative approach has been taken toward the designation of regional significance.

Table 6.1 provides a summary of the contributing factors to the designation of significance. The table also indicates which surf breaks identified in Section 4 are designated as SBRS.

Of the 19 locations, 9 are in the Wavetrack Guide of Morse an Brunskill (2004) and appear in other surf guides, have clear evidence of existence and surfable waves, and clearly exhibit the value attributes identified in Orchard *et al*. (2019) and/or align with the criteria with Atkin and Mead (2017). These 9 surf breaks, from west to east, are Blue Cliffs, Frenches Reef, Porridge, Beatons, Nicks Point, Colac Bay, Riverton Rocks, Oreti Beach and Porpoise Bay. These 9 surf breaks are the same as those put forward by Environment Southland as SBRS.

Raratoka is not in any surf guide and this work did not identify a dedicated surf forecast. This is likely because it is not a mainstream surfing location. Raratoka is a big wave surfing venue and unique to not just Southland, but Aotearoa New Zealand. There is clear evidence of its existence, wave quality and value, and therefore significance. Haldane Bay offers a range of surfing options rarely matched by such a small geographic area, has hosted competitions, has high quality waves, and therefore exhibits rarity; wave quality; naturalness; economic value and cultural value. Both Raratoka and Haldane Bay are regionally significant.

Martins Bay and Big Bay lack the technical information to provide detail regarding the location of the surfing waves and the conditions for optimal conditions. They do not appear in any surf guides, yet there are outfits providing helicopter charters to access these surf breaks; sponsored promotional videos have been focussed on these surf breaks; and online footage and images indicate waves of a quality suitable for high performance surfing; they also have dedicated surf forecasts. They are located in (Martins Bay) and directly adjacent to (Big Bay) Fiordland National Park and have specific travel requirements. They clearly exhibit naturalness; wilderness; uniqueness; and economic values. Martins Bay and Big Bay are considered SBRS.

Table 6.1: Summary of significance assessment. Rows coloured in green indicate Surf Breaks of Regional Significance.

Name	Confirmation of Existence	Atkin and Mead (2017)	Value Attributes (Orchard *et al.*, 2019)
Porpoise Bay	Yes	Dependent population; high frequency of use	Wave quality; rarity; consistency; level of use; economic
2nd Break	No	NA	Naturalness; wilderness
3rd Break	No	NA	Naturalness; wilderness
Beatons	Yes	NA	Wave quality
Big Bay	Yes	Outstanding natural character/quality	Naturalness; wilderness; uniqueness; economic
Blue Cliffs	Yes	NA	Consistency; naturalness; level of use
Colac Bay	Yes	Dependent population; high frequency of use	Level of use; consistency; amenity
Frenches Reef	Yes	NA	Uniqueness; consistency
Haldane Bay	Yes	Outstanding natural character/quality	Rarity; wave quality; naturalness; economic value; cultural
Martins Bay	Yes	Outstanding natural character/quality	Naturalness; wilderness; uniqueness; economic
Mason Bay	No	NA	Naturalness; wilderness
Nicks Point	Yes	NA	Level of use; consistency; amenity; uniqueness
Oreti Beach	Yes	Dependent population; high frequency of use	Level of use; amenity; educational; consistency
Porridge	Yes	High frequency of use; outstanding natural character/quality	Wave quality; rarity; consistency; level of use
Avalanches/ Port Craig	No	NA	Naturalness; wilderness;
Raratoka	Yes	Outstanding natural character/quality	Naturalness; wilderness; rarity; uniqueness; wave quality; cultural
Riverton Rocks	Yes	Dependent population	Educational; level of use; rarity; uniqueness
Saber Reef	No	NA	Naturalness; wilderness;
Spot-X	No	NA	NA

Of Mason Bay and Saber Reef on Rakiura; and Avalanches, 2nd Break and 3rd Break located at the western end of Te Waewae Bay, and “Spot-X” around Wakaputa Point, there is no evidence of surfing beyond the brief online refences, neither was any media found to indicate people surfing in these locations. The exception is Avalanches/Port Craig featured in a big wave surfing documentary; however, the location of this wave is unknown. No visual evidence of participation of surfing at Mason Bay was discovered, despite surfable waves indicated from aerial images. Of Saber Reef these is no evidence beyond the community driven surf guide and a generic surf forecast site. The location of 2nd Break and 3rd Break is approximate, no details or evidence of people surfing these surf breaks was found despite evidence of surfability from aerial photographs. Of Spot-X there is no information.

Morse and Brunskill (2004) state that there are many surf breaks around the south coast from Riverton, Te Waewae Bay and further afield, including offshore islands. Bhana (1999) notes that Rakiura (Stewart Island) hosts great waves, despite no mention in Morse and Brunskill (2004). It is almost impossible to draw conclusions about the type of value attributes associated with these surfing locations beyond sharing wilderness and naturalness values. Mason Bay, Saber Reef, Avalanches, 2nd Break, 3rd and “Spot-X cannot be confirmed as SBRS at this stage.

7 Surf Break Areas

This section provides the initial delineation and the Surf Break Area for each of the SBRS. For each SBRS a brief rationale regarding the SBA extents is provided. As per the methodology, the initial delineations are given a 1 km buffer to produce the final SBAs.

Blue Cliffs

The access challenges combined with the ephemeral nature of spit breaches and morphology conducive to surfing means the SBA for Blue Cliffs is relatively extensive. It extends to the west where Cameron Creek meets the coast, and the barrier spit terminates. This is ~1200 m west of the most the western most vehicle access point. The SBA is extended to the east the same distance (1200 m) from the last notable vehicle access point beyond Papatotara Road. This accommodates significant alongshore travel on foot within the SBA. The offshore extent of the SBA is taken as the 5m depth contour which encompasses the wide surf zones shown (see Figure 5.1). Figure 7.1 presents the SBA for Blue Cliffs.

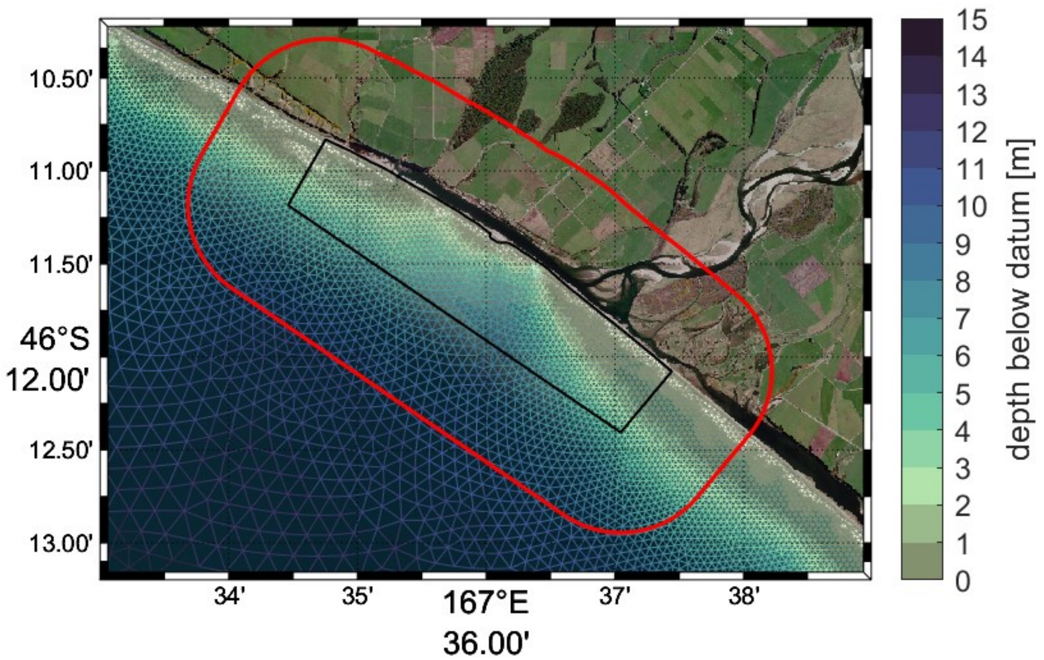

Figure 7.1: Initial delineation (black) and SBA (red) for Blue Cliffs.

Frenches Reef

In terms of delineation a conservative approach is required due to a lack of information. Environment Southland information placed the SBA toward the end of Pahia Point. However, this does not align with unscaled map in Morse and Brunskill (2004). Examination of aerial images reveals little in terms of a definitive SBA. Figure 7.2 presents the SBA, which extends from the scattered rocks in the east, out to the 3 m contour, then to the west around the bombie on the 7 m contour, then to 5 m contour, 1200 m to the southwest of the bombie, then into shore, ~800 m west of the (official) end of Frentz Rd.

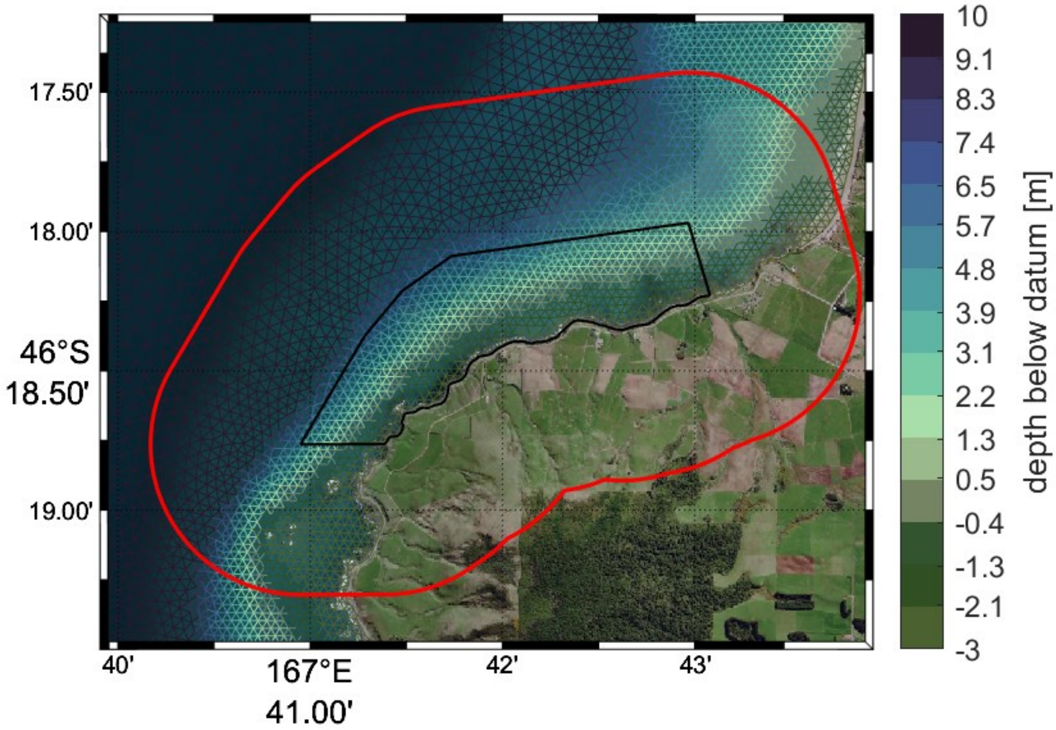

Figure 7.2: Initial delineation (black) and SBA (red) for Frenches (Frentzes) Reef.

Pahia: Porridge and Beatons

The bathymetry offshore of Porridge is complex; and with the potential to host large waves the SBA needs to accommodate, in part, the large submerged focusing feature that extends offshore. Beatons to the south of Porridge is also associated with a large offshore feature. The proximity of the surf breaks and the complex bathymetry both lends themselves to a joint SBA.

The SBA extends offshore for 1 km from the small creek that discharges just northwest of Ruahine Hill to the 15 m contour, bears 340° northward for 1.5 km, intercepting the 15 m contour again before heading shoreward at ~45°N on the northside of the embayment shoreward of Porridge. The SBA encompasses the large focussing features offshore of both Porridge and Beatons. This joint SBA is referred to as Pahia (Figure 7.3).

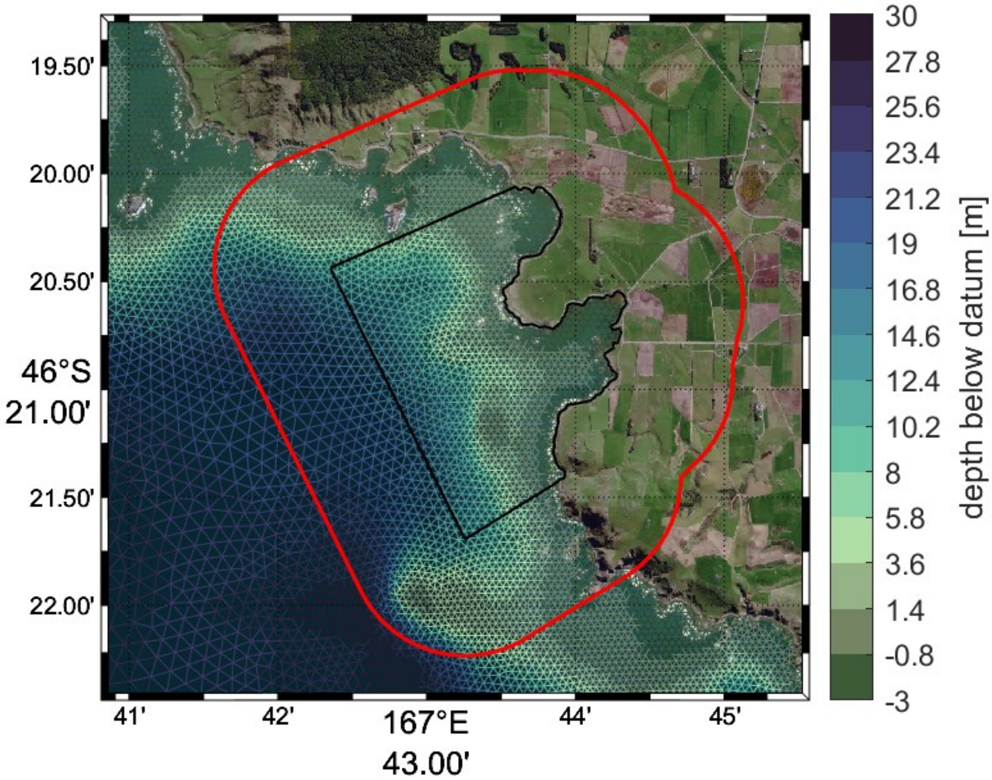

Figure 7.3: Pahia initial delineation (black) and SBA (red) that encompasses both Porridge and Beatons.

Raratoka

As with many big wave surfing locations, there are often large periods of time when the site is not conducive to surfing. The 7 aerial images of Raratoka (Figure 5.7) do not provide the clearest indication of an SBA. However, unlike the other surf breaks in Southland, Raratoka has been afforded scientific investigations due to its significance as a not only a big wave surfing location, but the distinct geomorphological characteristics and wave breaking processes (Atkin, Mead and Phillips, 2019; Ivamy and Mead, 2001; Mead, 2002; Mead *et al*., 2003).

The Raratoka SBA (Figure 7.4) is delineated to ensure the inner functional surf break components are encompassed – mainly the large wedge (Mead and Black, 2001b) on the northwest side of the island. Further offshore the SBA reaches the 20 m contour, although this is largely a function of the very steep transitions in the complex nearshore bathymetry. The extremely large preconditioning feature at Raratoka is well outside any nominal SBA but will be captured as a component of the surf break through the construction of the swell corridor.

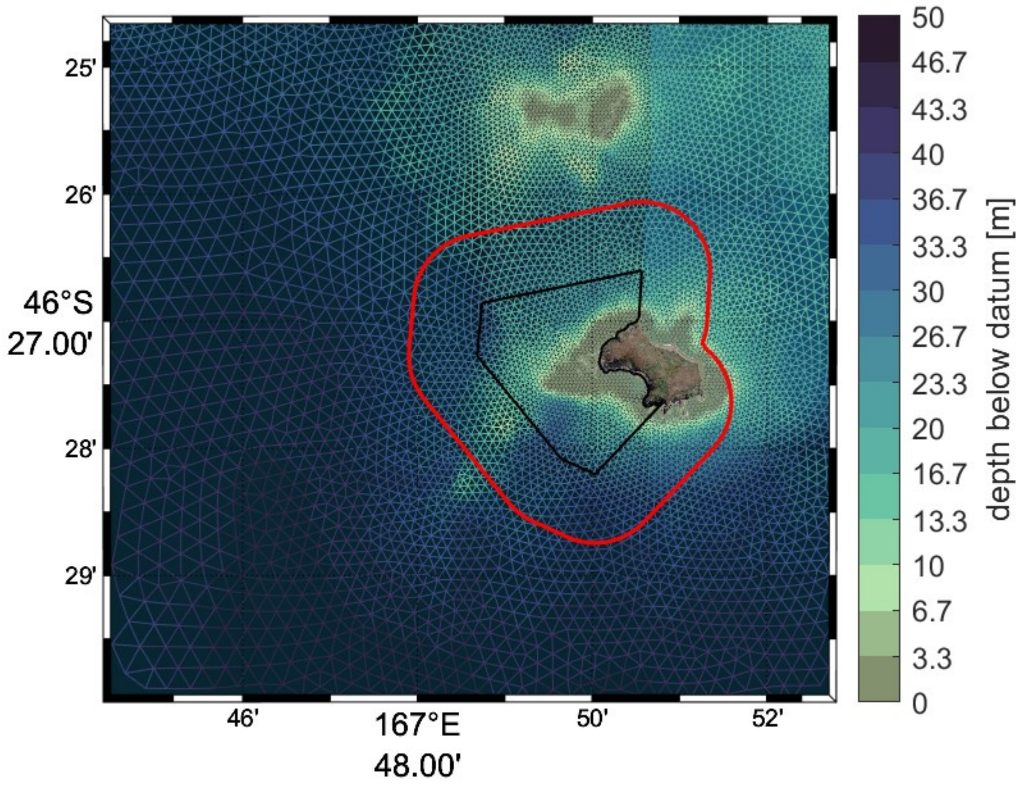

Figure 7.4: Initial delineation (black) and SBA (red) for Raratoka.

Nicks Point

The Nick's Point SBA (Figure 7.5) is extended to Ōraka Point out to the 5 m contour; the SBA approximately follows the 5 m contour into the bay. Before the 5 m contour bears east to follow the shape/profile of Ōraka (Colac Bay) the SBA heads landward running approximately parallel to the coast. The boat ramp is used as a discontinuity in the coast and northern limit of the SBA.

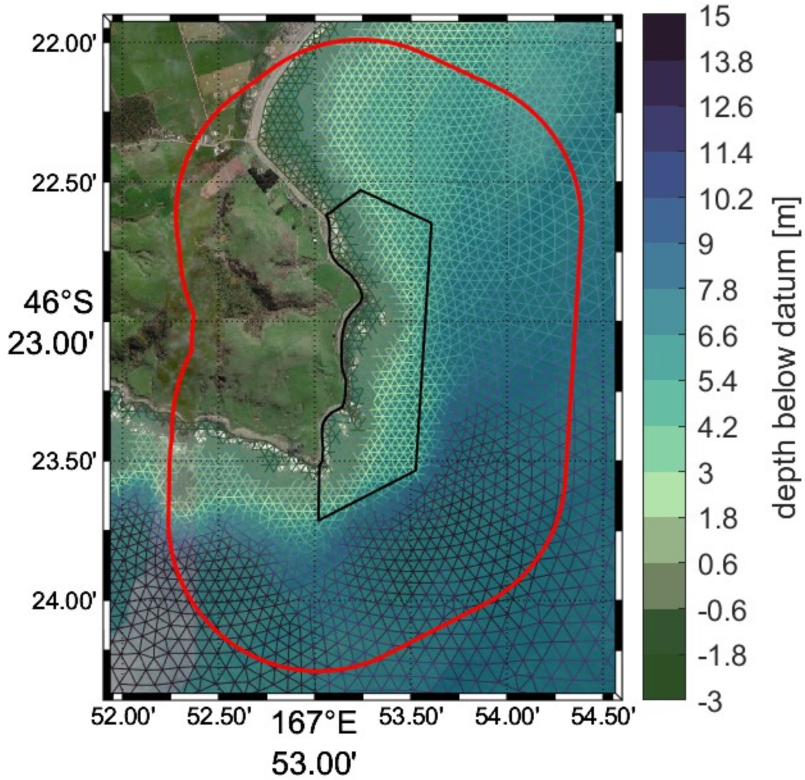

Figure 7.5: Initial delineation (black) and SBA (red) for Nick's Point.

Colac Bay

Considering the descriptions of access to Colac Bay, the SBA (Figure 7.6) extends from Colac Bay Road to the eastern end of the beach. The offshore extent encompasses the surf zone in all historical aerial photos, and largely follows the 3 m isobath.

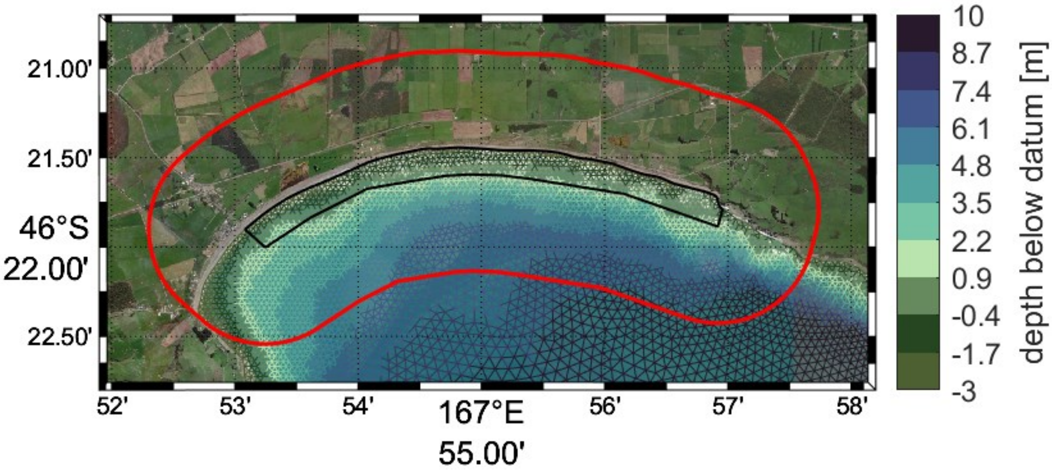

Figure 7.6: Initial delineation (black) and SBA (red) for Colac Bay.

Awarua: Martins Bay and Big Bay

The Awarua SBA (Figure 7.7) encompasses both Martins Bay and Big Bay as: they embayments are directly adjacent to one another; there is a range of surf breaks in this area; individual SBAs would overlap and some surf breaks could straddle these SBAs; the exposure to metocean conditions are assumed to be similar. The SBA encompasses the submarine headland extension of the end of Awarua Point, but only as far north as the regional boundary. Because this submarine feature is so extensive, and the nearshore waters so deep the offshore boundary of the SBA aligns with the 100 m mark offshore of Awarua Point. The offshore boundary extends to the southeast some 18 km to a location adjacent to where the main May Hills reach reaches the coast intersecting 50 m contour south of Martins Bay.

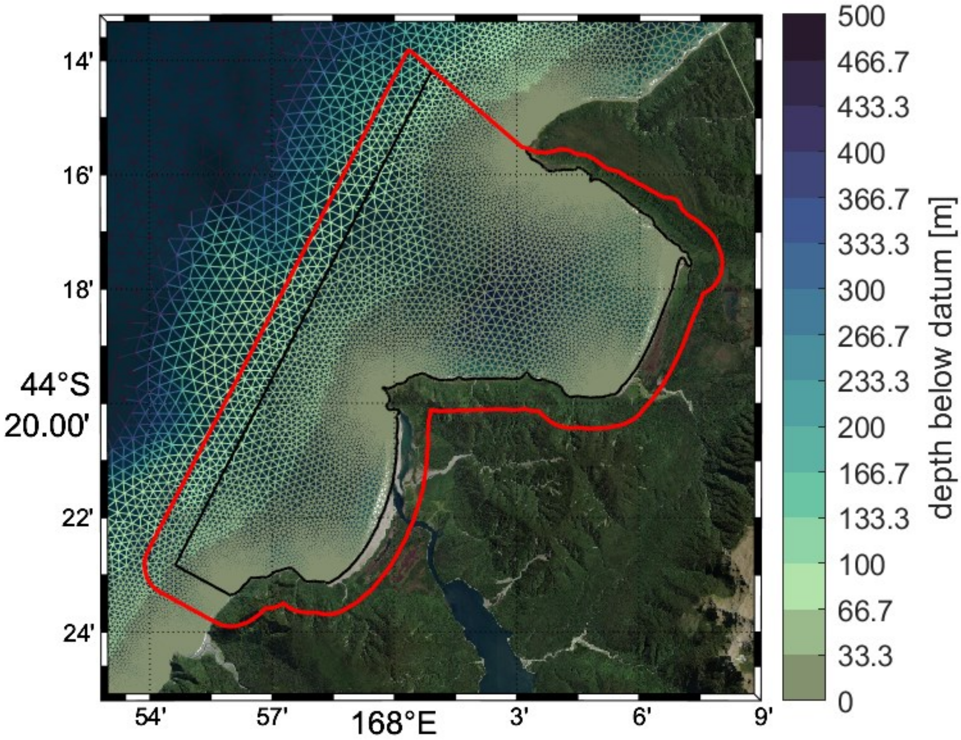

Figure 7.7: Initial delineation (black) and SBA (red) for Awarua which encompasses Martins Bay and Big Bay.

Riverton Rocks

The SBA for Riverton Rocks (Figure 7.8) extends southeast from Taramea (Howells Point) to the 5 m depth contour. The 5 m contour is followed for ~1500 m to the northeast, after which the SBA boundary heads north-northwest toward the Aparima River inlet where the 0 m contour is intersected, and then northwest toward Talls Point. The SBA is inclusive of the beach breaks in Taramea Bay as a prime component of a nursery break (Board of Inquiry, 2009b).

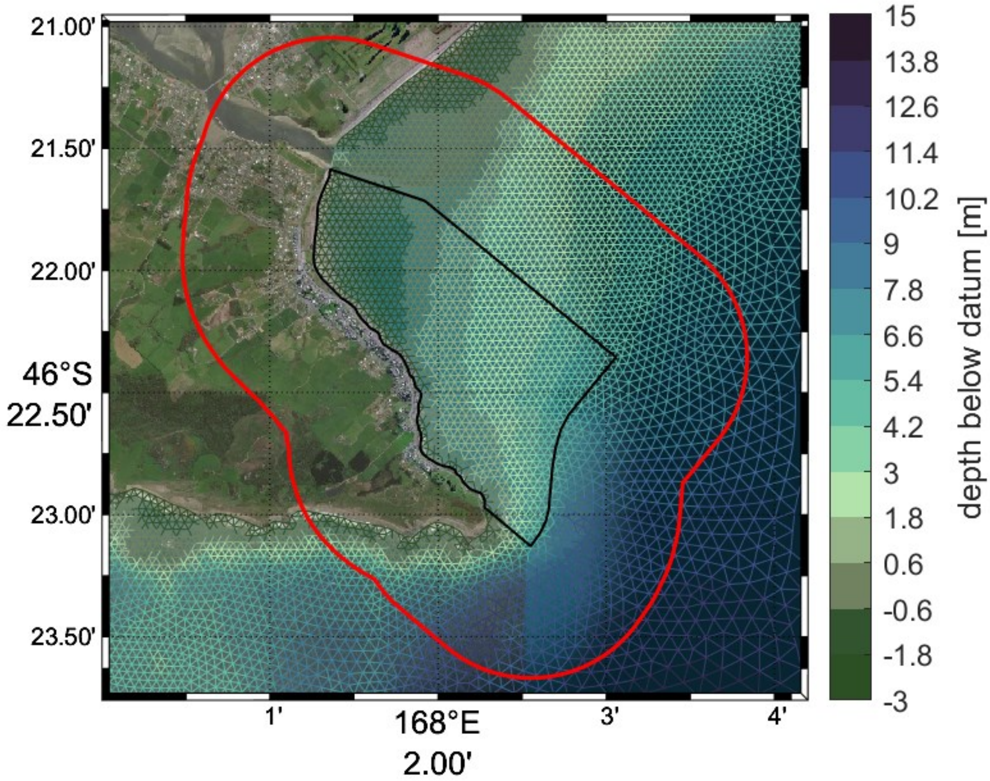

Figure 7.8: Initial delineation (black) and SBA (red) for Riverton Rocks.

Oreti Beach

With vehicular access on to and along the beach allowed, surfers are enabled to drive from the New River Estuary mouth to the Aparima River mouth looking for the best surfing options. The best surfing options on a beach such as Oreti are likely found where streams discharge on to the beach. In line with the conservative approach require due to the lack of public consultation, and the location of the aforementioned streams, the Oreti Beach SBA (Figure 7.9) extends from the New River Estuary mouth to 100 m west of the drain south of Otaitai Bush. The offshore extent roughly follows the 3 m contour, encompassing the surf zone in all available historical aerial image.

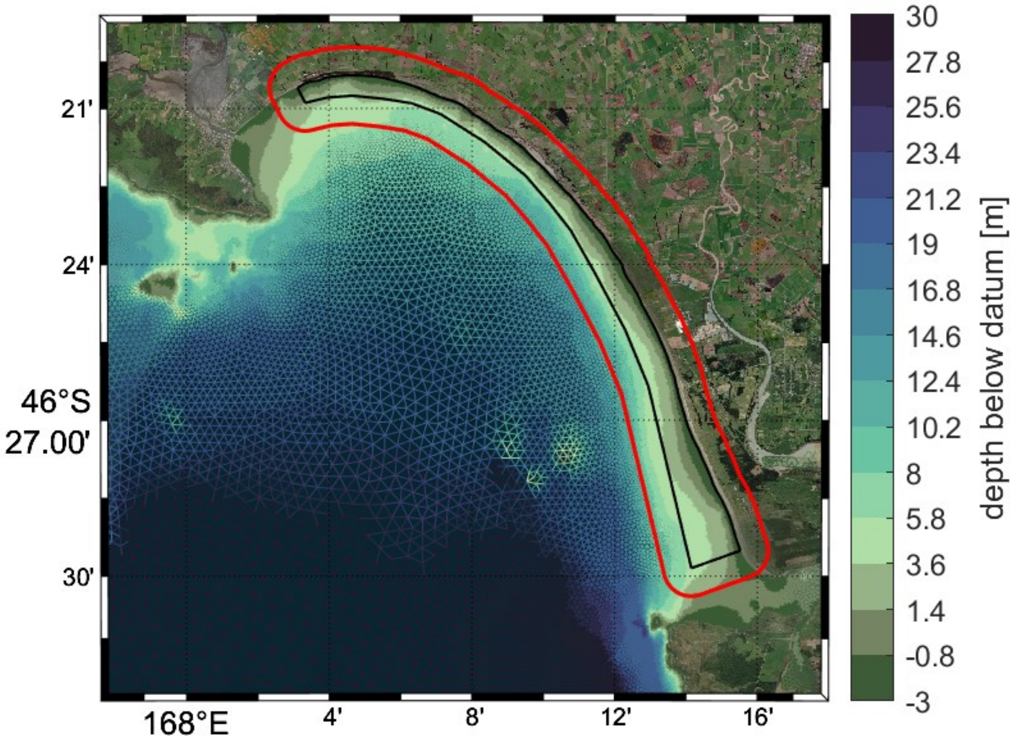

Figure 7.9: Initial delineation (black) and SBA (red) for Oreti Beach.

Haldane Bay

The SBA at Haldane Bay (Figure 7.10) encompasses the sandy embayment and the surrounding rocky reefs. The offshore extent boundary intersects the 10 m contour and extends from the eastern headland to 1 km west of the eastern headland.

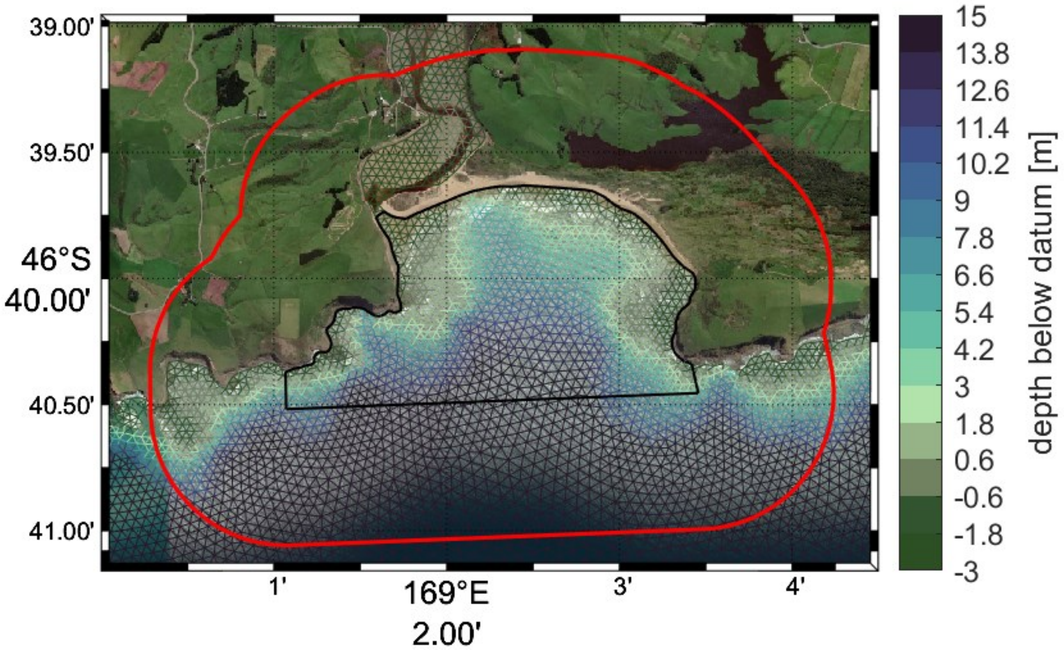

Figure 7.10: Initial delineation (black) and SBA (red) for Haldane Bay.

Porpoise Bay

The Porpoise Bay SBA (Figure 7.11) includes the reef complex extending from South Head and the associated bombie, the inlet mouth, shoreward of North Head, and the entire stretch of beach in the embayment. While the offshore edge of the SBA could move shoreward at the eastern end, it is more conservative to keep it inclusive given that the extent and role of the offshore reef complex, from limited bathymetric data, is largely unknown.

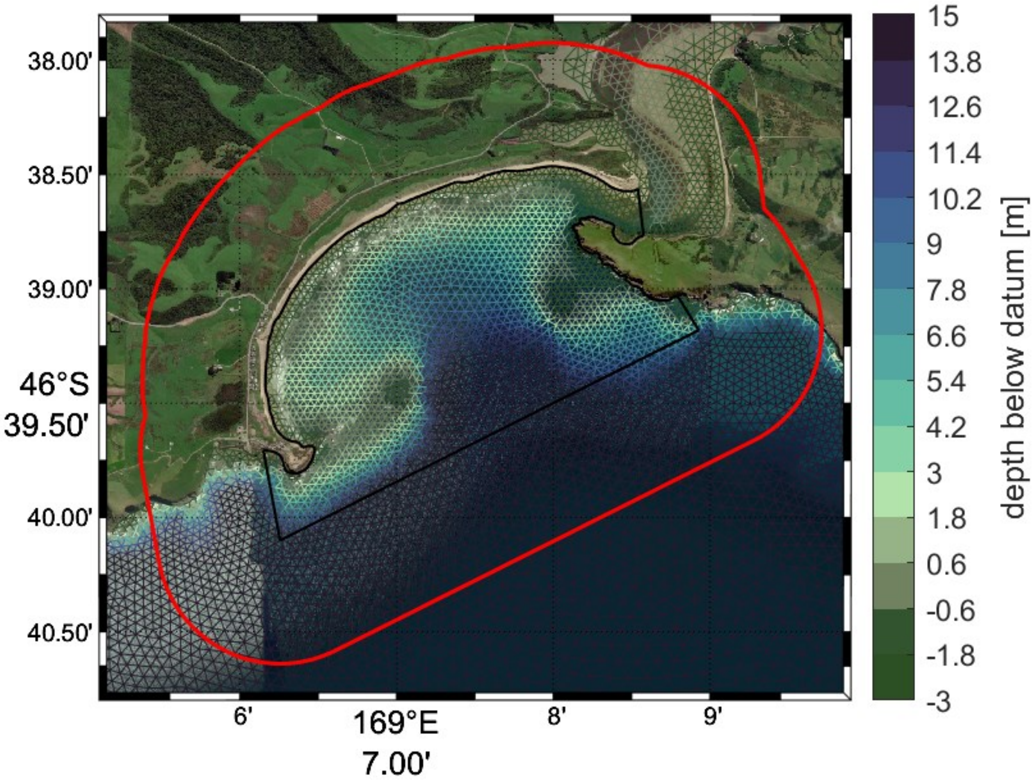

Figure 7.11: Initial delineation (black) and SBA (red) for Porpoise Bay.

8 Swell Corridors

Figure 8.1 through Figure 8.11 present the swell corridors for each of the SBRS. For the purpose of this report, the Relative Percentage Activity (RPA; Atkin and Greer, 2019) is provided. RPA was calculated on a rectilinear grid with a spatial resolution of 0.00044°-0.00063° (~50 m) and populated by binning and normalising all filtered traces for a given SBA.

All the swell corridors are dominated by waves approaching from south through west. Nicks Point (Figure 8.5) and Riverton Rocks (Figure 8.8), both sheltered point breaks, have a swell corridor component on the east of Rakiura. Awarua (Figure 8.7), Haldane Bay (Figure 8.10) and Porpoise Bay Figure 8.11) all have a component to their swell corridor that is inside Aotearoa New Zealand's territorial sea but traverses the regional authority.

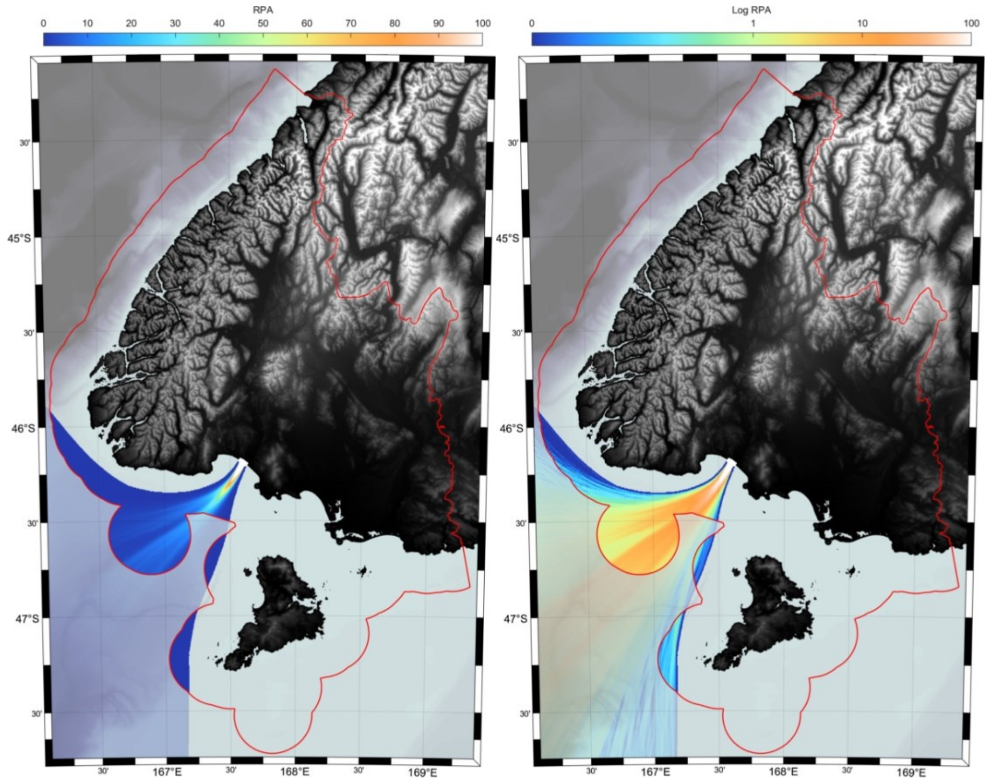

Figure 8.1: Blue Cliffs swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

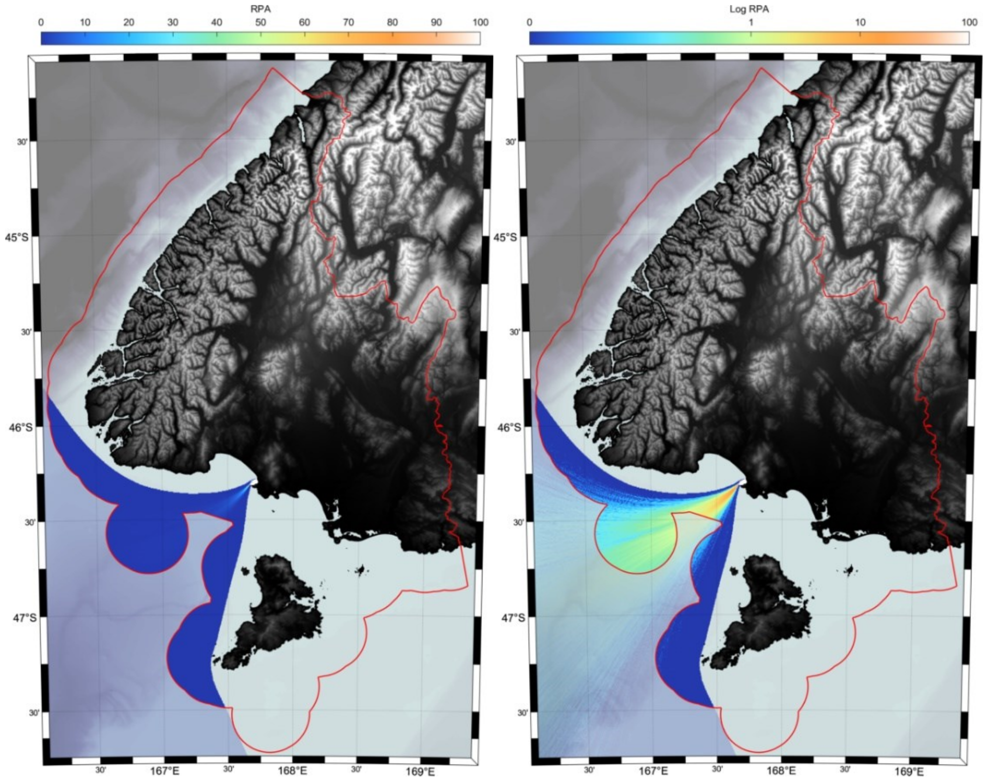

Figure 8.2: Frenches Reef swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

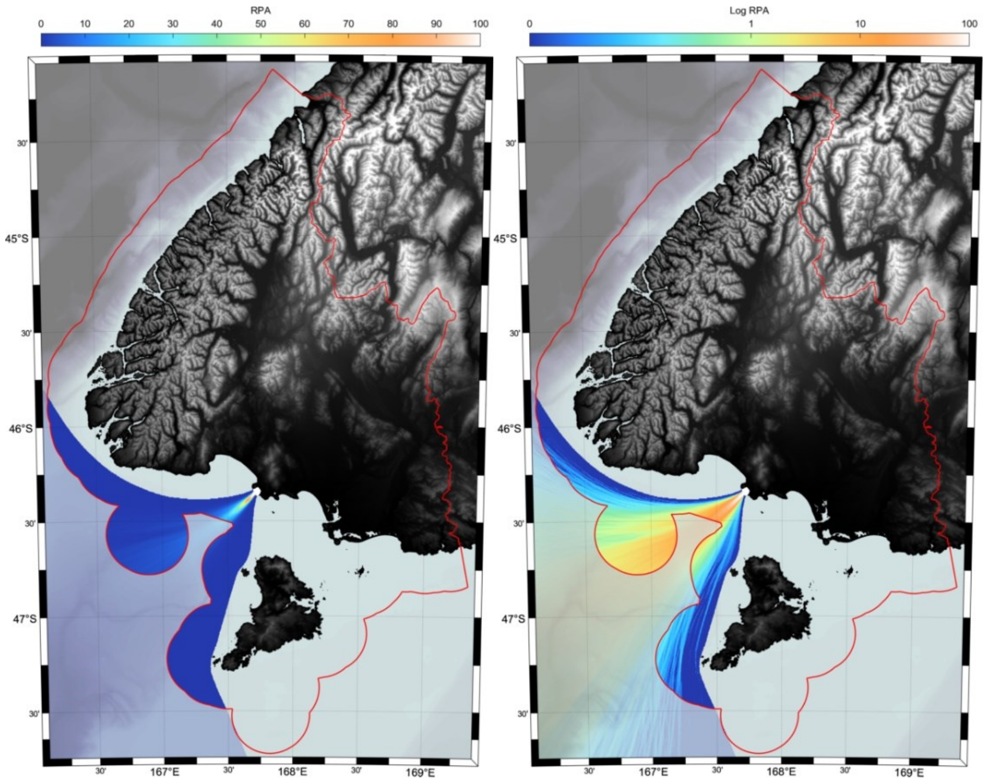

Figure 8.3: Pahia swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

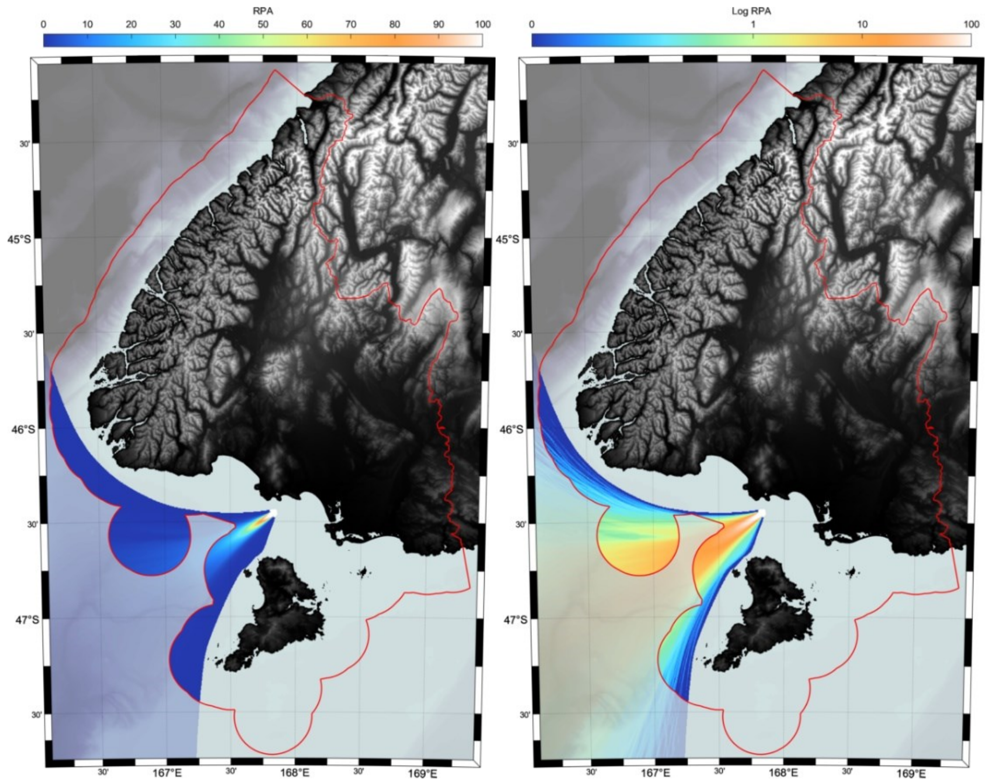

Figure 8.4: Raratoka swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

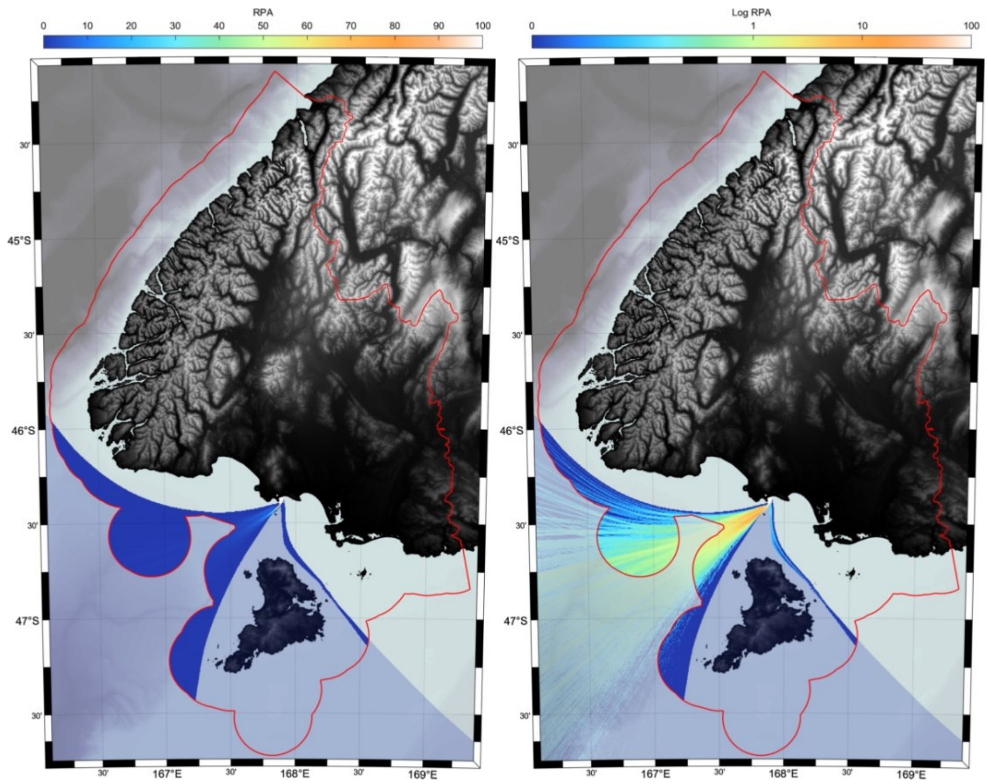

Figure 8.5: Nicks Point swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

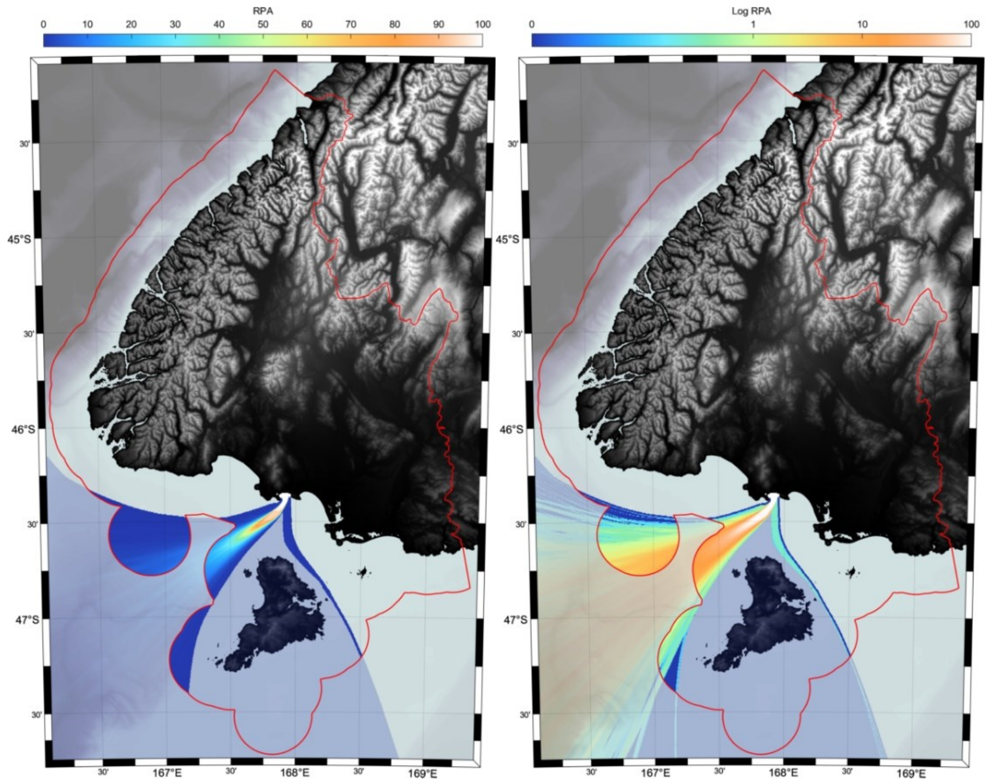

Figure 8.6: Colac Bay swell corridor overlain on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and RPA on a log scale (right) to visualize the full range.

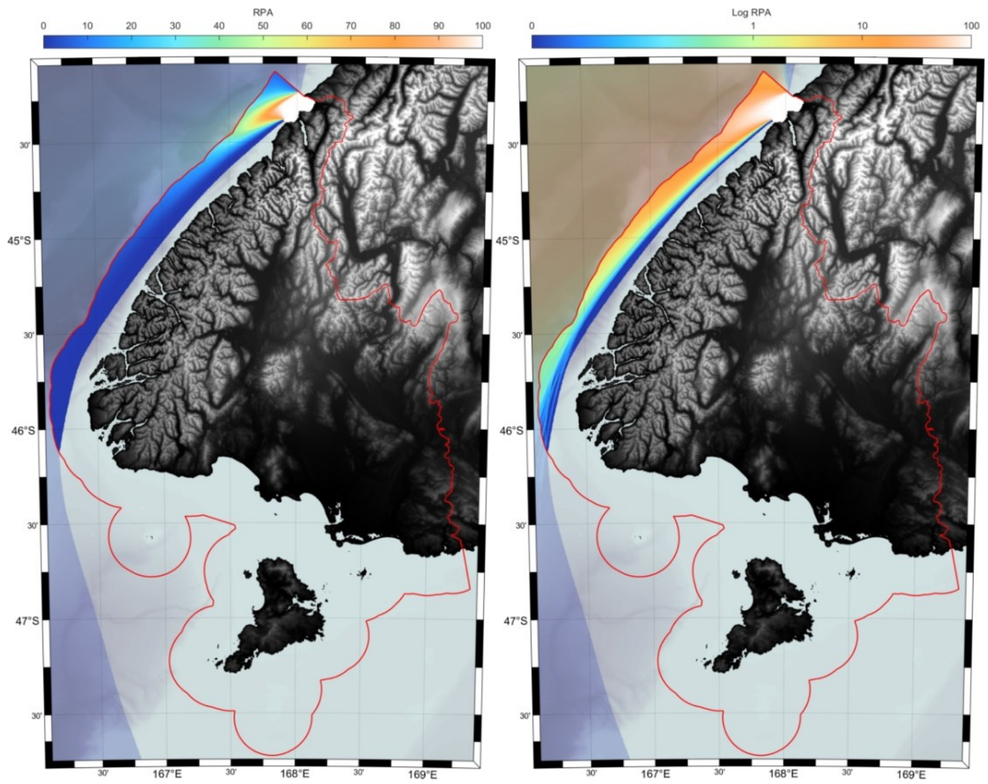

Figure 8.7: Awarua swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

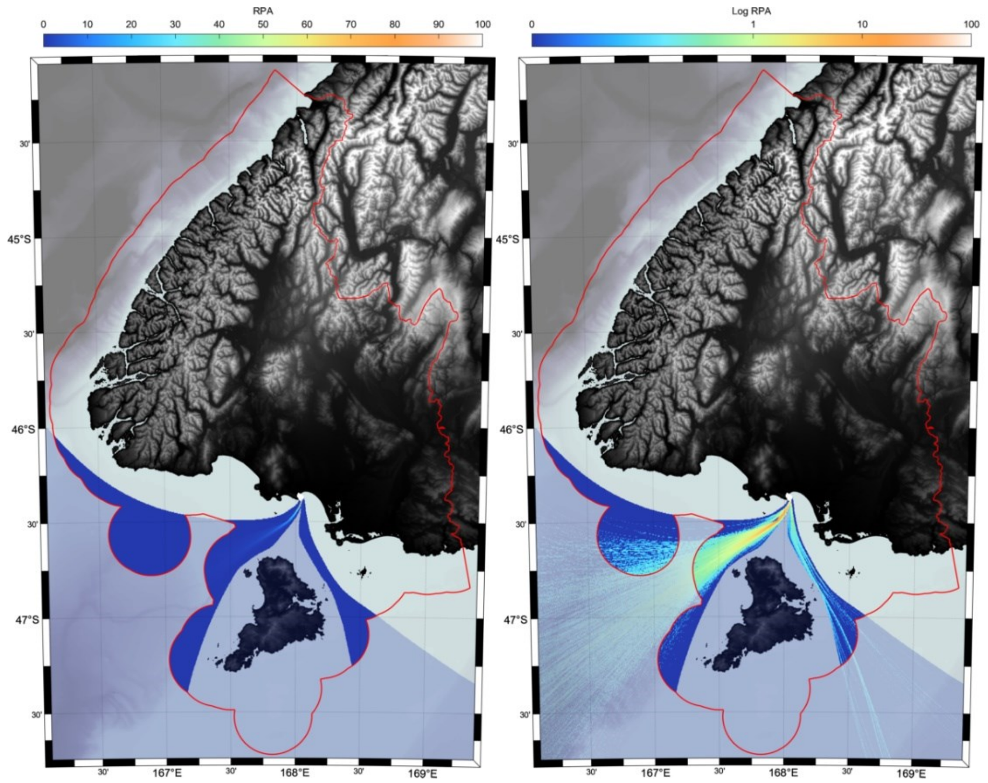

Figure 8.8: Riverton Rocks swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

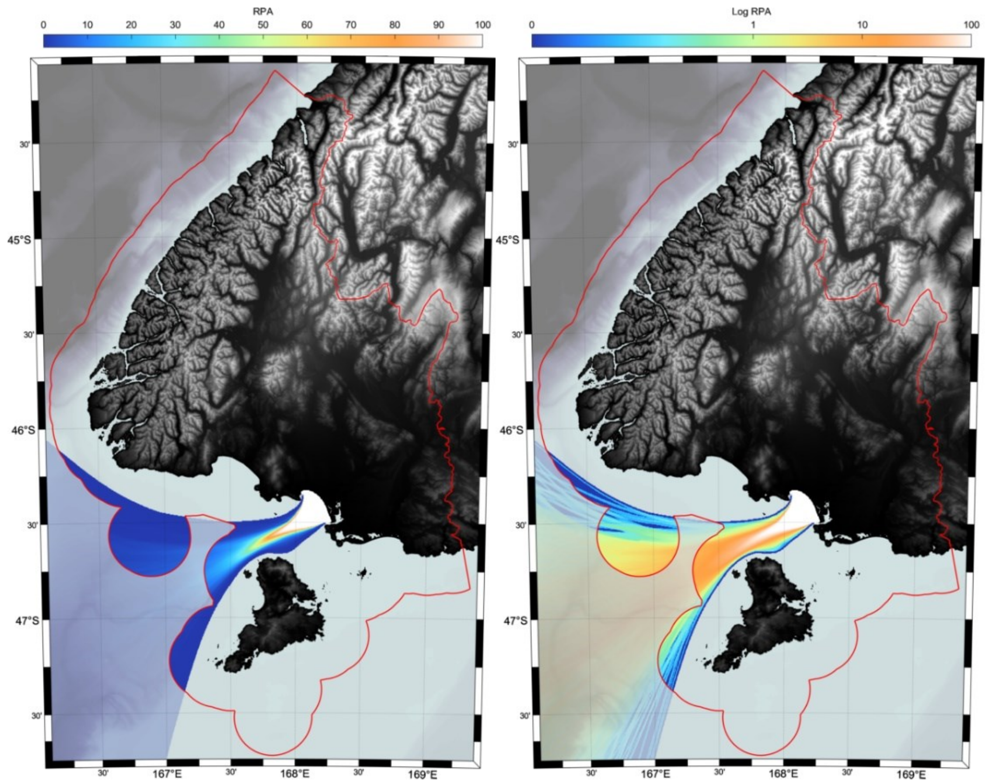

Figure 8.9: Oreti Beach swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

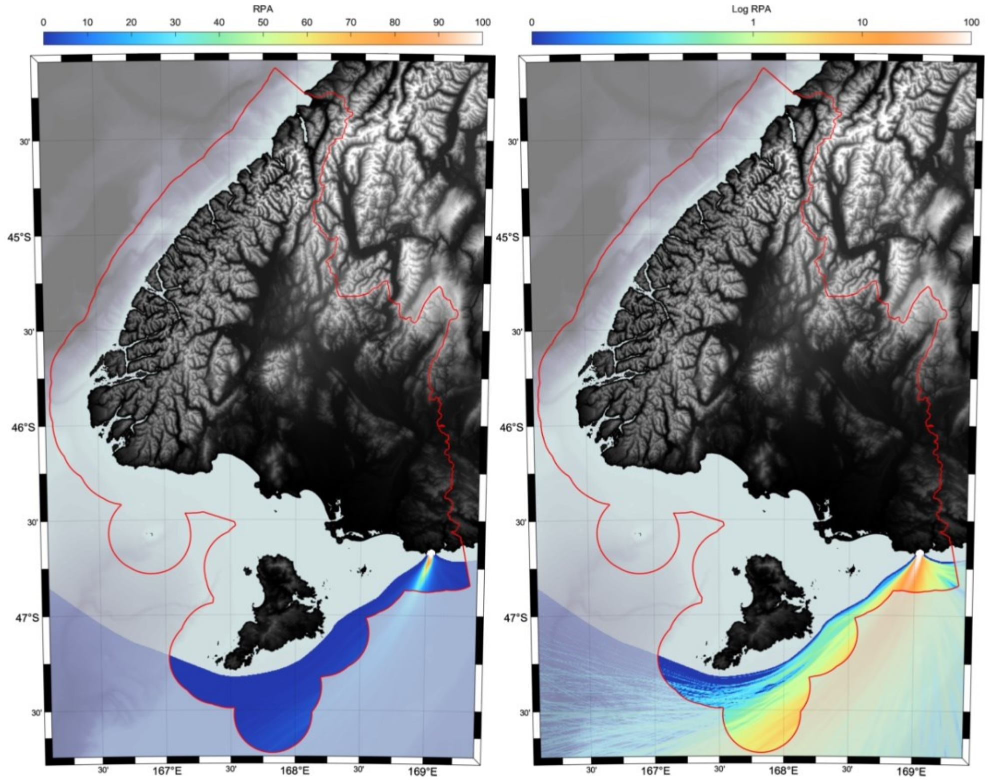

Figure 8.10: Haldane swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

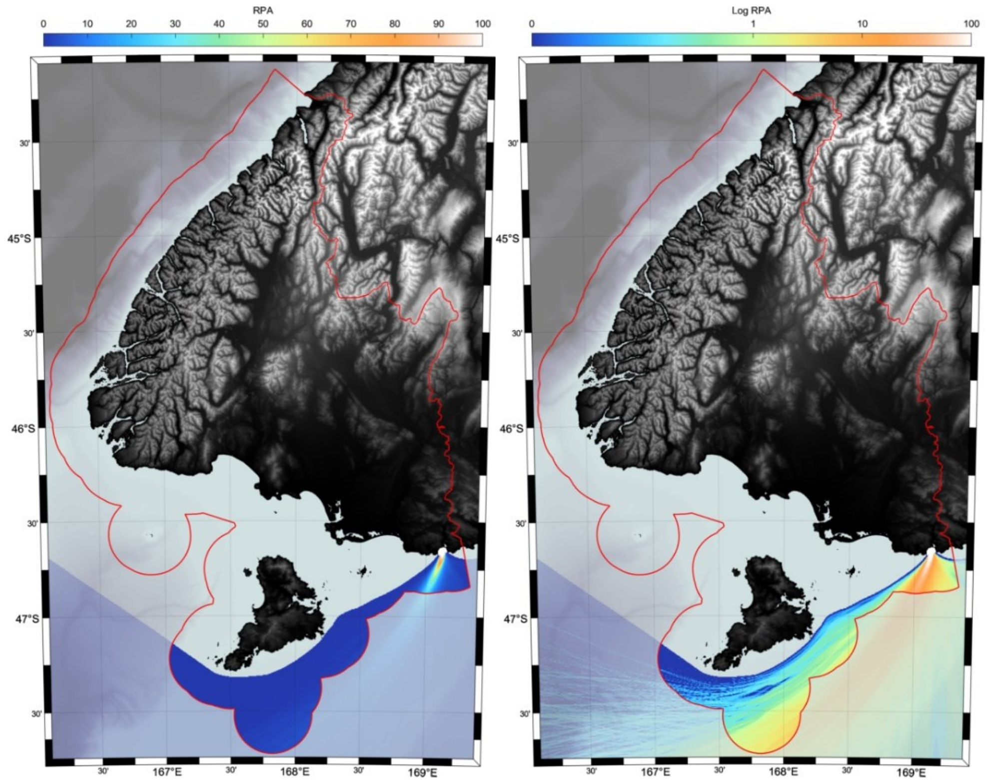

Figure 8.11: Porpoise swell corridor overlaid on topography and model bathymetry. The red line is Environment Southland's jurisdictional area. The swell corridor outside the territorial sea is translucent. Graduated colour of the swell corridor is RPA (left) and provided on a log scale (right) to visualize the full range.

9 Threats and Risk

The Management Guidelines for Surfing Resources (Atkin *et al.*, 2019) provide 34 threats and/or activities that can impact on surf breaks (Appendix A). These examples are considered here within context of SBRS in Southland. Considering threats and risk beyond the 34 threats and/or activities is currently beyond the scope of this work as it is lacking local insight. Stakeholder engagement is required to identify and document a comprehensive list of both real and perceived threats that can then be systemically, and site specifically, evaluated for risk.

Threats range in both temporal and spatial scales not only in terms of the activity but in the potential extent of impact. The existence of many surf breaks can be attributed to natural features and coastal processes which can be impacted on by both marine and terrestrial developments, both distal and proximal to a surf break. There are obvious risks to surf breaks such as construction within the SBA, but also less obvious risks such as those associated with land management. Physical impacts on the surf breaks include activities within and SBA, water quality and access, activities in an SBA's swell corridor, the effects of sea level rise, and changes in sediment supply and associated drivers.

Surfers are a unique set of users of the coastal marine area, as they spend extended periods of time immersed in the receiving environment, water quality issues are a significant threat to the use and enjoyment of surf breaks. Many surf breaks are located next to or near to where rivers and streams discharge into coastal waters. Water quality issues can accompany activities in all of the following subgroups: Hinterland, Catchment and Waterways; In and around a Surf Break Area (SBA); Nearshore, Offshore and Swell Corridor; and, Social and Technological. Activities most readily associated with water quality issues include nearshore dredge disposal, dredging, stormwater outfalls, wastewater outfalls, aquaculture, forestry, farming and urbanization.

Hinterland, Catchment and Waterways

Land management practices in Southland will be reflected in the contents of the rivers, streams and estuaries that discharge on to the coast. Blue Cliffs is directly associated with the Waiau River, Riverton Rocks is directly adjacent to Aparima River, and Oreti Beach to the New River Estuary; Haldane Bay, Porpoise Bay, Martins Bay and Big Bay have tidal estuaries, making all these sites more readily exposed to riverine threats.

According to Land Air Water Aotearoa[19] the long-term grade of recreational water quality for most open coastal sites in Southland is good to excellent, noting that there are only ~7 test open coast sites. All available river testing sites are considered poor. The water quality at Omaui, at the entrance to the New River Estuary adjacent to Oreti Beach, is also considered poor.

It is a common practice in Aotearoa New Zealand to direct both stormwater and treated sewage in to the nearshore. There is a Sewage treatment plant at Clifton which discharges into the New River Estuary. Runoff from rural and urban point and diffuse sources can also contribute to microbial contamination in coastal water bodies, but also discoloration, especially where agricultural practices are poor such as allowing stock to access waterways and a disregard for riparian separation.

The forestry industry is active in the Southland region and poor forestry practices can result in lower water quality at the coast. Rivers and streams can also deliver large quantities of waste trees and associated timber (slash) to the coast, which can pose a significant health and safety risk if encountered in the water.

The dredging of gold has reportedly shaped many of the dune backed beaches in Southland (Konlechner, 2016). Much of the Southland coast is host to unconsolidated material that may be the targeted of extraction. If not undertaken sustainably, long term dredge operations can an impact on coastal geomorphology with repercussions for surfing wave quality.

Port/marina construction can affect a surf break in a number of ways, especially if it is in or adjacent to the SBA. The effects of alterations to the tidal prism, and knock-on effects to sediment transport systems, can have an impact on surf breaks both near and far-field. While such an activity would warrant an extensive Assessment of Environmental Effects (AEE), there are limited locations for such infrastructure. The most readily adopted locations are tidal inlets.

Of the SBRS, Riverton Rocks, Haldane Bay and Porpoise Bay all have tidal inlets; Oreti Beach is directly adjacent to the New River Estuary inlet. These SBRS are also susceptible to the impacts of river/stream training, which stabilizes the course of an otherwise meandering section of river/stream, often at the inlet mouth. Major potential impacts are associate with disruption to coastal sediment budgets, but also the formation of ebb tidal deltas, or bar type surf breaks, of which there are many global examples.

[19] LAWA

In and around an SBA

Like port/marina construction and river/stream training schemes, the construction of jetties, groynes, breakwaters, boat ramps and other hard structures in the nearshore, such as rock armour for land defence, can affect the seabed directly and/or coastal processes. This could happen at any of the surf breaks considered in this document, some of which already host nearshore structures. Colac Bay is a good example with rock armour along the Colac Foreshore Road. In the late 2019 aerial photography was closed due to failure. Structures such as the Colac Bay revetment can lead to loss of high tide beach as they fail to encourage the retention of sand; they can also result in wave reflections disrupting breaking patterns. A comprehensive AEE would include field investigations and modelling of coastal processes to understand the environment first, so that the existing surfing resource values can be maintained.

Sand dune systems in New Zealand are largely dominated by non-native plants and there are very few examples of natural sand dunes. Colac, Riverton beach breaks, Oreti, Haldane's beach break and bar, and Porpoise Bay's beach and bar are all backed by dune systems. None of the dune systems maintain significant populations of native plant species and are dominated by the invasive marram grass (Konlechner, 2016). There are examples of dune planting and restoration schemes in New Zealand, especially as a component of holistic management schemes. The transformation of dune flora (either way) can change coastal geomorphology, which can have knock on effects to surfing wave quality – these may be positive or negative.

Nearshore, Offshore and Swell Corridor

It can be seen in Section 8 that a swell corridor can occupy space in multiple jurisdictional areas, which occurs at several surf breaks across the country (*e.g.,* Atkin and Mead, 2017; Atkin and Greer, 2019). The management of the area occupied by a surf break's swell corridor may require collaboration between regional level authorities (Atkin and Greer, 2019).

Impacts in swell corridors are caused by disruption to waves propagating through the swell corridors to the surf breaks. Structures on the surface of, and/or through the water column can form a barrier to wave propagation. A barrier can reduce the amount of wave energy reaching the shore and/or change the direction of waves. Breakwaters or similar, wave-farms, windfarms and large-scale aquaculture all have the potential to impact waves moving through a swell corridor.

Modification of the seabed can impact on swells through the processes of refraction/diffraction. Activities such as seabed mining and associated tailing disposal; maintenance dredging and associated disposal can all modify the seabed and the propagation of waves. Refraction and diffraction while propagating shoreward can also reduce the disturbance made to wave crests by offshore structures (e.g., Black, 2007; Mead, 2013), although a significant distance may be required before the waves re-conform to a pre-disturbance condition.

Aquaculture that can impact on surfing resources includes mussel, salmon, and oyster. In Southland, the majority of aquaculture activities occur in Big Glory Bay on Rakiura, far from any current SBRS. Southland SBRS should be considered in planning of future aquaculture operations. The whole Southland coast has been previously evaluated for inshore aquaculture purposes (Bonisch Environmental, 2013; MWH, 2014, Environment Southland, 2014). More recently the Ministry for Primary Industries commissioned the Cawthron Institute to undertake ecological assessments for a number of 2,000-hectare sites in Southland, specifically for open ocean salmon aquaculture. The effects of large-scale finfish nets/cages on swell propagation are little understood, and require a precautionary approach (e.g., Pegasus Bay Mussel Farm Limited, 2001; Atkin, Mead and Davies-Campbell, 2019; Mead, 2019 a, b). Shellfish aquaculture can dissipate and dampen short period wave energy, but long period waves can travel through these developments with little impact on the waves (Stevens *et al*., 2008).

Sea Level Rise (SLR) can pose a long-term threat to surfing wave quality, it could also improve conditions paving the way for new surfing resources. Rocky reefs are particularly susceptible to the effects of SLR. Unlike sand bottomed surf breaks, which can respond to changes in sea level, rocky reefs cannot. Impacts of SLR on surfing resources have not yet been reported. Reineman *et al*., (2017) undertook a surf community engagement study. The study projected that by 2100 SLR will endanger, threaten/change and possibly improve 16, 18 and 5% of 105 Californian surf breaks, respectively. Another environmental process associated with climate change is increased storm intensity and larger nominal wave heights (Hemer et al, 2013; Ministry for the Environment, 2017). Combined with SLR, this will likely exacerbate coastal erosion, but the impact on unconsolidated seabed surf breaks would still be a function of shoreline response. Larger wave heights may be welcomed by some parts of the surfing community, revealing the potential of new surf breaks, but could also limit participation for others.

Social and technological

Of the surf breaks considered in this document, there are two that require permission from private landowners prior to access: Porridge and Beaton’s. Both surf breaks can be accessed openly from the sea, but this is not a common method of access for most participants in surfing. The threat to resource enjoyment is restriction of the access by landowners. Any type of restriction could lead to discord between the landowners and surf community. Similarly, any type of restriction could be the product of a previous discord.

Social and technological issues are broad and varied but generally do not have the potentially to affect the physical components of a surf break. Appendix A contains more details regarding Social and technological issues.

Sensitivity

The Management Guidelines for Surfing Resources (Atkin *et al*., 2019) provide a sensitivity-based threat assessment framework that considers the geomorphological character and environmental setting (Figure 9.1); and consequence categories draw on examples of known surf break degradation.

	Potential Break Type	General Material Size	Wave Quality Reliance on Sediment Transport Regime
1	Rock Ledge; Reef	Consolidated Rock	Low
2	Reef; Point		
3	Point; Beach; Delta		
4	Beach; Delta		
5	Delta	Fine Sand	High

Figure 9.1: Surf Break Sensitivity Rating from least sensitive (1) to most sensitive (5) based on geomorphological characteristics, from the Management Guidelines for Surfing Resources.

In this section a preliminary sensitivity rating and rationale is provided for each surf break type in each SBA (Table 9.1). Within an SBA, the sensitivity rating relates to a surf break's dependence on the processes that maintain surfing wave quality. The sensitivity rating, the information provided in this document, and knowledge of a proposed activity will enable users of Management Guidelines for Surfing Resources (Atkin *et al*., 2019) to undertake a risk evaluation as and when required.

Table 9.1: Preliminary Sensitivity Ratings for surf breaks in the SBAs identified in Section 3.

SBA	Considerations	Rating
Blue Cliffs	Very exposed location dominated by waves. Unconsolidated sediments. Ephemeral morphology. High quality waves likely dependent on spit breach morphology and/or complex wave-wave interactions.	3
Frenches Reef	Exposed rocky reef point break. Unconsolidated material evident at shoreline, wave quality dependency on sediment transport unknown.	3
Porridge	Exposed rocky reef and boulder point break.	2
Beatons	Exposed rocky reef and boulder point break.	2
Raratoka Island	Offshore location. Rocky reef. Deep water.	1
Nicks Point	Sheltered point break with a mix of sand and boulders.	3
Colac Bay	Beach of unconsolidated sand (west) and pebbles (east). No clear evidence of wave preconditioning by offshore reefs. Beach morphology likely key component of wave quality.	4
Riverton Rocks	Sheltered sand bottom point break adjacent to large tidal inlet and associated ebb tidal delta.	4
Martins Bay	Potential for a range of surf break types including ebb tidal delta.	5
Big Bay	Potential for a range of surf break types including ebb tidal delta.	5
Oreti Beach	Exposed sandy beach break of no notable/consistent wave quality. Reef complexes offshore may contribute to wave breaking processes. Relatively close to large tidal inlet.	3
Haldane Bay – reef breaks	No notable dependence of wave quality on sediment transport system. Nearshore reef surrounded by sand. Lack of data.	2
Haldane Bay – beach break	Evidence of complex nearshore morphology (rips) producing high quality surfing waves.	4
Haldane Bay - delta break	Hypersensitive ebb tidal delta exhibiting high quality wave breaking patterns.	5
Porpoise Bay - bombie	Deep water reef, large wave conditions required. No evidence of it as a utilised surf break.	1
Porpoise Bay beach break	Very high-quality surfing waves based on complex nearshore sandy beach geomorphology, and potentially the influence of offshore submerged reef complex.	4
Porpoise Bay - delta break	Waves breaking in over, or in association with hypersensitive coastal features (tidal inlet).	5

10 Conclusions and Recommendations

Environment Southland requested the identification of Surf Breaks of Regional Significance in Southland (SBRS). A conservative approach has been taken with respect to the designation of regional significance and the delineation of SBA's. The conservative approach is required as, to date, this process has not included community engagement.

This work has leveraged a range of surf guides and online resources to identify 19 recognised surf breaks in Southland and characterise them within the context of their geographical location and access, wave type(s) and functionality, wave quality and value attributes. All but 6 of the 19 were evaluated as SBRS.

The 13 SBRS, from west to east these are Big Bay, Martins Bay, Blue Cliffs, Frenches Reef, Porridge, Beatons, Raratoka, Nicks Point, Colac Bay, Riverton Rocks, Oreti Beach, Haldane Bay and Porpoise Bay. They are each delineated with an individual SBA, except for Porridge and Beatons, which share the Pahia SBA, and Martins Bay and Big Bay which share the Awarua SBA. The Riverton SBA includes the point break and beach breaks as notable nursery breaks. It is recommended that these surf breaks and SBAs be included within the proposed coastal plan as Surf Breaks of Regional Significance.

This work also identified surf breaks on Rakiura and at the far western end of Te Waewae Bay. It was not possible to evaluate these surf breaks within the context of regionally significance due to a lack of information. It is recommended that further investigation is undertaken to determine the significance of these surf breaks, with public consultation the most likely method. In the interim, Mason Bay, Saber Reef, Avalanches, 2nd Break and 3rd Break should be at least considered Surf Breaks of Local Significance, or flagged as potential SBRS. The western end of Te Waewae Bay, from Rowallan Burn to Sand Hill Point should be designated as a Known Surfing Coastline.

The list of SBRS, SBLS and recommended KSCs are not definitive. As the number of participants using surf breaks increases there will more pressure on the known surfing resources. This is likely to provoke users to frequent lesser-known surf breaks to reduce user numbers. The designation of SBRS, SBLS and KSCs may also be different if revaluated with input from public consultation. In summary, value attributes will change with both time and increased community input.

The SBRS have been considered within the management tool of Surf Break Areas (SBAs). SBAs offer delineation of the resource and can also include different elements of value associated with surf breaks, and multiple surfing opportunities and geomorphological types. A swell corridor, as an offshore extension of each SBA, has been constructed using historical wave climate data. The paths of incident wave conditions are combined to form the footprint of the swell corridor. In line with the precautionary approach of the NZCPS, a buffer zone around each SBA was included.

The swell corridors and SBAs have been compiled in GIS format. This dataset can be used, in a similar way to regional scale coastal hazard zoning, to do a first order assessment that would flag the potential for impacts of proposed activities on the Southland coast. More detailed, site-specific assessment may be required should this system identify overlapping interests.

The method used here for delineating SBAs, like that used in the Greater Wellington region and the Waikato region, leverages the Land Information New Zealand coastal polygon. Alone, the coastal polygon can fail to encompass key access points and routes, which are an important component of the surfing resource (see Policy 16; Department of Conservation, 2010). The buffer employed here increases the footprint of the SBA and offers a delineation that can contain important access points.

Common threats to surf breaks are discussed within the context of the Southland region. The discussion provides Environment Southland with some examples of how surf breaks could be impacted, and highlights some of the most relevant activities with water quality being a common theme to activities in Southland. A sensitivity rating for each surf break and/or SBA has been provided. The sensitivity rating can be used with the threat and risk assessment framework in the Management Guidelines for Surfing Resources (Atkin *et al*., 2019) for specific activities that require evaluation. A full range of sensitives are apparent, which is a testament to the variety of surf break types on offer in Southland.

The information/characterisation and management tools provided in this work are for first order assessments to aid in day-to-day management. In order to assess potential and actual impacts under a specific activity, an in depth, site-specific understanding of the surf break's characteristics is required to determine any consenting decision or conditions.

Limitations and Recommendations

The approach used to identify SBRS in this work utilised a range of surf guides, online resources and technical expert knowledge. While it serves a purpose in creating a list of SBRS, information on surf breaks in Southland is held by local knowledge holders, including surf breaks not listed in guides, and details of each surf break that help to manage the resource, have not been included.

Applying a community led process would not only mean a superior management framework through a thorough understanding, but also ownership and acceptance of the results. Public engagement regarding coastal resources is considered best practice (e.g., Ministry for the Environment, 2017; Atkin *et al*., 2019). A lack of open consultation can result in critical information being left out.

Community engagement would provide characterisation beyond the geophysical and allow an understanding of what the actual value of each surfing resource is to the community. As threats are contingent on value, this would further inform the SBRS threat assessment. An advantage to this approach is the generation of a defensible evidence base that informs the significance assessment and can be leveraged for other purposes such as monitoring and impact assessments.

Prior to finalising the draft coastal plan, it is recommended that this work goes in to a second phase that is focussed on participation. The best approach to a second phase is to use an inclusive data gathering process (e.g., survey and/or workshop). This would allow for a community informed assessment with thresholds for significance determined by stakeholders and local experts, while adding valuable information to a database regarding surfing resources for both Environment Southland and the Southland surfing community, and ultimately providing an acceptable management strategy. At a bare minimum, a local expert panel or local experts suitable for interviews should be identified. The expert panel will fill in any information gaps, modify and/or verify SBA delineation. This should be followed by community consultation on the content of this work.

Further Recommendations

Surfing resources in Southland should be revaluated prior to each iteration of the coastal plan and/or at a time frame deemed suitable by Environment Southland that accommodates changes to the surfing community.

It is difficult, if not impossible, to manage resources that are not well understood. The final recommendation is that knowledge gaps regarding the Southland’s Surf Breaks of Regional Significance are identified and addressed.

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Appendix A. Activities, Threat and/or Source list from the Management Guidelines for Surfing Resources.

Activity, Threat and/or Source	Potential Effects on Surfing Resources	Examples/References	Potential Mitigation Options
Hinterland, Catchment and Waterways			
Forestry	Sediment runoff into waterways creating sediment plumes in the CMA and reducing water quality in an SBA. Increased number of felled trees and branches in an SBA poses a health and safety risk to users. Additional sediment may benefit some surf breaks. Discolouration of waters following rain events. Impacts on the natural setting/ wilderness experience, and also impacts on ecological aspects at a surf break.	Resource Management (National Environmental Standards for Plantation Forestry) Regulations 2017	Manage stormwater, sediment and wood debris runoff using forestry industry best practice techniques.
Quarrying	Water quality issues as above.		Suitable silt and stormwater management, including the application of sediment ponds
Material extraction in waterways (e.g., dredging)	Sediment plumes in waterways delivered to SBA. Changes to sediment transport pathways.	Whangamata Bar, NZ Matakana Island, NZ	Best practice management should be applied, including measures such as silt curtains and bunding, and extraction methods such as cutter-suction that reduce sediment plumes into the surrounding waters.
Port and marina construction, development and maintenance	Alterations to tidal prism can change hydrodynamics and, subsequently sediment transport regime; and morphology. Direct and indirect alterations to refraction patterns. Delta breaks particularly susceptible. Increased vessel activity: vessel wakes reduce wave quality; sharing of space and access points. Requirement for dredging activities (see Dredging). Water quality issues associated with marina and increased boat activity. Noise associated with construction activities.	Whangamata Bar, NZ (Atkin *et al*., 2017) Mundaka, Spain (Liria *et al*., 2009)	Undertake field and modelling studies to predict effects of the developments and modify design to minimise impacts. Determine baseline conditions and monitor changes. Enforce speed limits for vessels using entrance channels. Educate users on sharing space.

Restriction of access by landowners	No access through private agricultural land. Industrial and residential developments in the CMA.	Whiterock, NZ Broad Bench, UK The Ranch, USA	Negotiate access as mitigation and condition of consent.
Runoff from rural and urban point and diffuse sources	Runoff contaminated with animal waste from farms; and discharges for outfalls, drains and septic tanks give rise to water quality issues. Can result in increased algal growth on rocky shore presenting a slip hazard to users of an SBA.	Manu Bay/Whale Bay (Atkin *et al*., 2017)	Manage runoff at source. Follow Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (Ministry for the Environment, 2002).
Transgressive dune field: Planting or; development.	Inhibits delivery of material to an SBA either directly, or indirectly to the local sediment cell.	Shipwreck Bay, NZ St Francis Bay, South Africa	Undertake studies to determine whether sand supply is important to surf break functionality and manage planting accordingly.
In and around an SBA			
Beach nourishment	Changes in seabed morphology. Alters existing sediment budget. Effects can be positive or negative. Beach can overfill with sediment. Short-term water quality issues. Short-term access restrictions to SBA during works.	Gold Coast, Aus. Benedet *et al*. (2007) Dally and Osiecki (2018)	Undertake field investigations and modelling of coastal processes and iterate with proposed fill volumes and placement to produce desired outcome.
Construction of jetties, groynes, breakwaters, boat ramps and other hard structures in the nearshore	Structure can change the seabed directly and/or coastal processes. Significant knock-on effects. Changes in wave quality can be both positive and negative. Complete or partial occupation of the SBA. Water quality issues during construction. Loss of natural character and change in landscape.	Manu Bay, NZ Ti Point, NZ Bastion Point, Aus. Kirra Point, Aus. Scarfe *et al*. (2003)	Undertake field investigations and modelling of coastal processes and iterate with proposed structure designs to minimise effects.
Dune planting programs	Reduced access by fencing off areas of the dune/beach. Building up the height and volume of the dunes restricts views. Limits cross shore exchange.	Piha, NZ (Dahm, 2013) North Narrabeen, New South Wales, Aus.	Provide walkway access to beach. Set limits on height of dunes. Promote native dune species.

Nearshore dredge operations	Removes sand directly from the nearshore bars and leaves (temporary) pits in the seabed. May alter wave refraction.	Pakiri, NZ Hilton (1989)	Undertake field investigations and modelling of coastal processes to predict and quantify effects to inform decision making.
Reclamation	See construction of jetties, groynes, breakwaters, boat ramps and other hard structures in the nearshore.	Wellington Airport Extension, NZ Mangamaunu Point, NZ Kuta Beach, Indonesia	See construction of jetties, groynes etc.
Recreational fishing	Conflicts between users sharing space, access, and occupation of specific areas. Entanglement of surfers in lines and tackle from boat and beach fishers, including remotely operated fishing devices (e.g., Kontiki). Burley can attract dangerous marine animals (e.g., sharks). Vehicular traffic on beach.	Manu Bay, NZ Whangamata Bar, NZ Atkin *et al.* (2017)	Educational signage at access points to beach.
River/Stream training	Changing or fixing the location of beach streams which naturally meander back and forth along the shore and along the beach may reduce the complexity of the nearshore. Can result in less ephemeral features and the creation of new established surf breaks.	Piha, Auckland, NZ Dahm (2013)	Undertake investigations of coastal processes to predict effects and inform decision making.
Shoreline armouring	See construction of jetties, groynes, breakwaters, boat ramps and other hard structures in the nearshore. Major effect from reflection of wave energy on both beach erosion (accelerated) and surfing wave quality.	St Clair, NZ	See construction of jetties, groynes etc.
Nearshore, Offshore and Swell Corridor			

Aquaculture	Wave are attenuated when passing through structures. Reductions in wave height and possible changes to wave direction. Can affect wave quality directly by modification to incident wave climate; and indirectly by altering existing coastal processes and sediment transport regime, resulting in change to the seabed. Increase in dangerous animals (e.g., sharks). Direct or partial occupation of SBA. Water quality issues. Access limitations.	Martha Lavinia, Aus. Taylor and Dempster (2016) Plew (2005)	Field investigations and modelling of coastal processes and iterate with options for farm structure in the model to minimise effects.
Dredging of port/harbours approach channels	Modification to incident waves. Sediment trap reducing littoral transport. Altered seabed configuration. Water quality.	Port of Tauranga, NZ Port of Napier, NZ Centreport, NZ	Field investigations and numerical modelling of coastal processes and iterate with options for channel alignment/depth/width/length in the model to minimise effects.
Dredge spoil disposal	Mounds on the seabed affect waves by refraction, diffraction and shoaling. Altered seabed configuration impacts on incident wave conditions; impacts on SBA morphology; over filling of beaches; erosion if not placed correctly. Water quality. See Beach nourishment. Can result in positive impacts.	Aramoana, NZ Whareakeake, NZ Main Beach, NZ Superbank, Aus. Cronulla, Aus. (Pitt, 2009; 2010)	Field investigations and modelling of coastal processes and iterate with various option for mound dimensions and location to minimise effects at the SBA.
Large scale seabed mining	Pits and mounds in/on the seabed affect waves by refraction/diffraction Can result in changes to surfing wave quality either directly by modifying wave climate or indirectly through changes to sediment transport. Water quality issues.	South Taranaki Bight, NZ (Hume et., 2013; Mead, 2013)	Field investigations and modelling of coastal processes and iterate with various option for pit/mound dimensions and location to minimise effects at the SBA.
Oil Spills	Health and safety risk.	Rena Incident (New Zealand Coastal Society, 2014)	Follow oil spill prevention standards.

		New Zealand Marine Oil Spill Readiness and Response Strategy 2018-2022	
Wind or wave energy arrays	See Aquaculture. Potential to affect multiple surf breaks.	The Wave Hub, UK (Black, 2007) Port Fairy, Aus. (Flocard and Hoeke, 2017)	Field investigations and modelling of coastal processes and iterate with options for array structure in the model to minimise effects.
Social and technological			
Beach closure for events	Temporary occupation of SBA and nearshore (e.g., SLSNZ events, Surf Competitions, Training, Memorials, Festivals etc.). Competition for space. Exclusion from SBA to those not part of the event- raises "right to surf" conflicts. Water quality and littering issues associated with event.		Notify events well in advance via news channels and social media. Organised clean up after events.
Different surfing abilities	Learner surfers pose a significant health and safety issue due to a lack of experience and control. This is critical at more challenging surf breaks where an inexperienced surfer can be quickly out of their depth. Common occurrences are related to positioning and users getting in each other's way, the inability to control equipment especially around take off zones and when duck diving waves. Advanced surfers taking all the waves.	www.aotearoasurf.co.nz	Educate users about surfing etiquette: how to behave in the surf. Signage and education to push learners to safer areas.
Different surfing (water) craft	Shortboards, longboards, body boards, foil boards, Stand Up Paddleboards (SUPs), kite surfers, sail boarders, kayaks, surf/wave skis, body surfers all compete for water space and waves. Can result conflicts between users and injury.	Smallman (2018)	Educate users about surfing etiquette: how to behave in the surf.

Improved equipment	Improved wetsuits allow surfers to remain in the water for longer meaning less turnover of users and more users in the water at one time. New craft for wave riding being developed.	Bourne and Ponting (2017)	Bylaws and designating areas (e.g., specific areas for foil boards).
Improved facilities, infrastructure and access	Paved roads to sites lead to more users. New or improved facilities onshore (e.g., parking and toilets) make the experience more user friendly. More accessible air travel. The result may be overcrowding. Increased usage of surf breaks and the potential for conflicts at popular spots.	Manu Bay, NZ Seal Rocks, Aus.	Educating users about surfing etiquette.
Increasing surfer population	Overcrowding. Environmental damage through litter and damage to intertidal habitat. Potential for conflicts at popular spots.	Bourne and Ponting (2017)	Provision of facilities for parking, rubbish disposal, and camping. Signage and clearly delineated access routes.
Management requirements	Potentially exposes Surf Breaks of Local Significance and secret spots.	Atkin (2017) Orchard *et al*. (2019)	Designate broad areas without specifying particular breaks (e.g., Known Surfing Areas).
Overcrowding	Puts pressure on lesser-known surf breaks. Leads to conflict between users. Pressure on existing facilities.	Bourne and Ponting (2017)	Improve facilities and signage educating users about surfing etiquette.
Surf forecasts and knowledge	Improved ability to predict good surfing conditions results in overcrowding when conditions are good; potential for conflicts at popular spots.	Mach *et al.* (2018)	
Surf tourism	See Improved facilities, infrastructure and access. Overcrowding.	Bourne and Ponting (2017)	
Use of SBA beyond surfing	See Recreational Fishing. Beach closure for (non-surfing) events.		Bylaws and dedicated areas (e.g., Ski lanes).

Appendix B. Attribute Typology of Orchard *et al*. (2019)

Primary attributes	Description	Secondary attributes*from Orchard (2017c)
Rarity of surf break types	How representative is the surf break in terms of its type in the region	surf break types as defined by suitability for different activities, *e.g.* beginner surfers, big wave surfing etc. oceanographic & morphological characteristics (*e.g.* point break, beach break; see Mead and Black, 2001)
Wave quality	Quality of the waves for the wave riding activities practiced there, as assessed under near optimum conditions.	length of ride; wave shape; wave power; wave height range
Consistency	Frequency of surfable conditions	surfable days/year or season; consistency of quality
Uniqueness	Recognises the importance of the location to the regional surf break resource in conditions when other breaks are not favourable	relationships with other surf breaks in different weather and swell conditions
Naturalness	Recognises the degree to which the surf break is free from modifications to the natural environment *e.g.* in relation to the presence of particular flora and fauna, and absence of man-made structures and pollutants. This attribute was combined with Wilderness by NRC (2016b)	proximity and design of structures or other modifications to the natural environment; occurrence of particular ecosystems, vegetation types, or wildlife; condition and legibility of landforms and/or formative coastal processes; water quality parameters / pollutants *e.g.* plastics; sounds and smells
Wilderness value	The level of remoteness / isolation or exposure to the elements the location offers. This attribute was combined with Naturalness by NRC (2016b)	level of exposure to the elements, difficulty of human access or commitment required to reach the location; low number of users
Amenity value (Taranaki only)	Recognises the importance of aspects that contribute to the pleasantness of the location including aesthetic aspects, the perception of beauty or memorability of the location, and others such as the ease of access and the presence of facilities	presence of services and facilities; proximity to home; scenic qualities and other aesthetics; memorability
Level of use	Recognises the popularity of the surf break in terms of the frequency of use and number of people who derive value from it	frequency of use; diversity of uses or associations with the surf break; numbers of people involved
Economic value to the community (Taranaki only)	Recognises the level of economic importance of the surf break for local communities and/or the wider regional community	promotional value for visitors to the local area or region, including as a component of international appeal; economic activity associated with visitation modes; contributions associated with events or contest venues
Historic, heritage, and cultural associations (Taranaki only)	Recognises the contribution of the surf break to historical and heritage values	long standing boardriding or surf lifesaving clubs; historical events; importance to contemporary coastal culture; contribution to the local sense of place; tangata whenua[†] values associated with the surf break
Education (Northland only)	Focus for skills learning, including encouragement of younger/learner surfers to participate and socialise. This attribute was an aspect of Rarity in Orchard (2017c)	recognition of surf break types as defined by suitability for different activities including learning