SAVE THE WAVES COALITION

SURF CONSERVATION INDEX

The Azores Autonomous Region

Portugal

AUTHORS

Claudia Meca van den Berg

Mara Arroyo

Diego Sancho Gallegos

João de Macedo

Trent Hodges

Contributors:

Martin Dietz

Published: August 2021

Photos by Ryan Craig

SPECIAL THANKS

Flotilla

FOUNDATION

TABLE OF CONTENTS

SUMMARY 2

INTRODUCTION 2

BACKGROUND 3

METHODOLOGY 5

RESULTS 10

CONCLUSIONS 16

RECOMMENDATIONS 18

REFERENCES 20

SUMMARY

The objective of the Surf Conservation Index is to prioritize individual site locations within the archipelago of the Azores Autonomous Region based on surf quality, human pressure and response, and key social and ecological indicators. Publicly available data was used to create an index for surf quality and location, which was later overlaid with ecological and socioeconomic indicators. A final set of indices were applied to the surf breaks to identify priority subregions for surf break conservation. The methodology was based on the Pressure-State-Response framework used for the Surf Conservation Index developed for Mexico and Costa Rica, initially adapted from a Multicriteria Analysis methodology developed for Indonesia. The indicators of the Surf Conservation Index identified anthropogenic activities that affect the surf break, their impact on the surrounding environment, and human responses to these threats. This framework helps understand the complexity between humans and the environment and should facilitate communication between different groups of relevant stakeholders (Arroyo et al., 2020).

INTRODUCTION

Save The Waves Coalition (STW) is an international nonprofit that works in coalition with like-minded organizations dedicated to protecting surf ecosystems. STW's Surf Protected Area Network (SPAN) program is a new approach for marine and coastal conservation that combines the legal protection of ecosystems with sustainable community development. This approach follows a six-step process to identify, implement, and manage Surf Protected Areas around the world. Identifying priority areas for conservation includes carrying out surfonomics studies, developing Regional Profiles and multi-criteria analyses to identify priority areas for the SPANs program. These studies provide invaluable data to support the assessment and preservation of surf breaks and coastal ecosystems and to develop specific Surf Protected Area Networks strategies for each region. STW has focused on working with grassroots partners to protect surf ecosystems and establish a systematic approach in developing SPANs in several different countries.

The Azores SPAN project is an ongoing effort that is intended to support the work Waitt Institute, Oceano Azul Foundation and the Regional Government of the Azores, under the Blue Azores program, as well as supply information for the ongoing work of the Azores Surfing Association, the Azores chapter of Surfrider Foundation Europe, and other organizations working on coastal conservation. The objective of this project is to harness the power of the sport of surfing and surf communities to create additional marine protected areas in line with the IUCN 30 x 30 goals in the Azores and incorporate surfing into current protected area management plans.

BACKGROUND

The Azores Autonomous region (PT: Região Autónoma dos Açores) is an archipelago of nine islands lying on the Mid-Atlantic Ridge between a latitude of 36° and 43° N and longitude of 25° and 31° W. They are divided into the occidental, central and oriental groups (fig. 1). The location of the Azores, mid North Atlantic, makes it ideal for swells from both the southern and northern hemispheres, and there is a significant surf culture and history, cultivated throughout many generations of locals and foreigners with surf playing a key part in the Azorean local economy (Medeiros Fonseca, 2017). There has been ongoing support from the surf community, government, NGOs, businesses and academia for the application from the Azores to become a World Surfing Reserve.

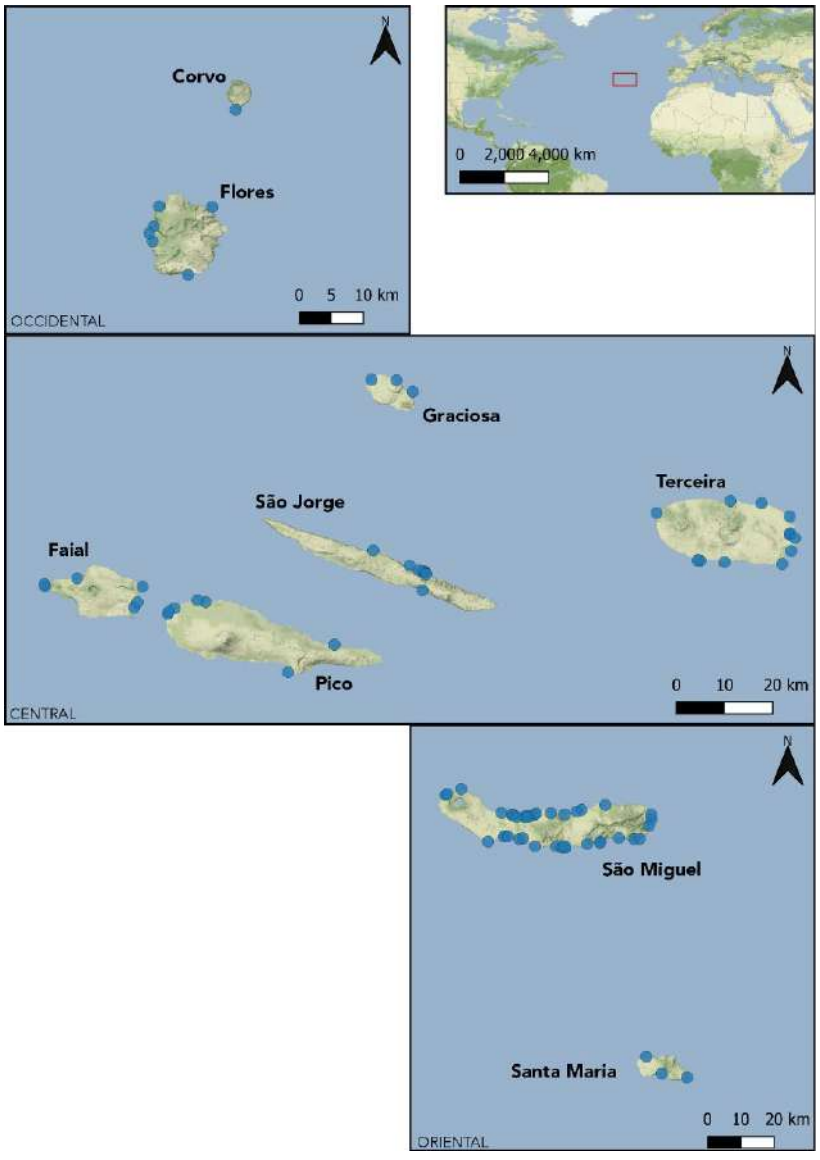


Figure 1- Map of surf spots (blue dots) in the Azores Autonomous Region

The Azorean economy is largely dependent on its nature-based sustainable tourism as well as the fishing and cattle industries (Ponte et al., 2018). Agricultural practices dominate the converted landscape across all the islands and urban sprawl, as well as industrial practices, are relatively contained. As of 2019, there were around 1500 licensed fishers across the Azores archipelago, with 11 registered ports for fishing (DGRM, 2019). Incidentally, 35% of these licensed fishers were under the age of 34, indicating a well-founded and thriving fishing culture. In total, over 1,700 people were employed in the fishing industry and different artisanal fishing practices adopted by local communities in coastal areas, in both benthic and pelagic zones (DGRM, 2019).

Both commercial and private fishing create pressure on coastal and marine biodiversity yet the Azores is considered a biodiversity hotspot for marine as well as terrestrial species. The Azores is one of the five Macaronesian archipelagos with 420 terrestrial endemic species of lichen, plants and animals documented at the time of writing. Oceanic islands are fundamentally important for biodiversity conservation due to their high endemism rates and small population sizes and many have been identified as biodiversity hotspots. The Azores sits within the Mediterranean biodiversity hotspot and is regarded as a refuge for endemic species such as bryophytes ((Borges et al., 2010); Patiño et al., 2016).

Threats

The main drivers of change in marine and coastal ecosystems include land use change and habitat loss, overfishing and destructive fishing methods, pollution and nutrient loading, and climate change. These drivers are further exacerbated by seafood demand, illegal fishing, population growth, and globalization (Brown et al., 2006). The cumulative effect of buying from illegal fisheries rather than regulated, licensed fishers can affect fishery quotas and management, especially for benthic species used for typical Azorean dishes.

Tourism and recreation, including surf tourism, form a significant part of the coastal economy in the Azores. Some regions rely on tourism as the main source of income, suggesting that it should be managed sustainably and existing regional policies should reflect this and focus on the quality of the tourist experience instead of the quantity of tourists. Tourism-specific pressures include waste management inefficacy and expanding urban infrastructure.

For surfing, climate change impacts wave quality and frequency through sea-level rise, coastal erosion, and changing weather patterns (Buckley, 2017). Ocean-front coastal development can also impact wave quality when combined with these impacts of climate change. Furthermore, surfer health can be affected by anthropogenic biological impacts on water quality created by sewage outfall and runoff (Martin & Assenov, 2014).

METHODOLOGY

In order to apply the Surf Conservation Index for an archipelago setting, and to make it compatible with the islands' geography, it was necessary to make adaptations to the methods and layer. As an island setting, the Azores are also uniquely affected by natural, and physical drivers of change which were taken into account when deciding on the indicators. Socio-economically and culturally, there is significant variation across islands, therefore treating islands as units will show strong correlations of the indicators for the surf breaks.

The radius of the buffer was reevaluated for the Azores SCI. For previous SCI (Sancho, 2019; Arroyo et al., 2021), including large islands, a standard radius of 10 km was used. However, this was found to give a disproportionately large area of influence around each surf break, incompatible with the size of the islands. Given that the objective of the SCI results is to aid in the creation of protected areas by identifying relevant biological and social components that affect the ecosystem, it was found that a 5 km radius buffer is a more applicable scale for a small archipelago. This allows for variation within each subindex while accounting for the interdependence of surf sites within each island. The caveat being, within an archipelago, the mobility of surfers generally extends to entire islands, so a buffer may not be representative. Culturally speaking, surf breaks beyond a 5 km buffer zone may be equally important and certain services such as surf schools serve the entire island, regardless of its size. There is further a unique sense of mobility with regular and daily commuting between islands, such as the São Jorge triangle.

Individual surf breaks were identified for each island using online portals, from both the regional tourism administration and crowd-sourced databases and the 2017 World Surfing Reserve application. Due to the popularity and geographically unique location, online websites are available which are reasonably accurate at forecasting surf quality and weather (Medeiros Fonseca, 2017). These sources include a public-evaluated ranking of the surf breaks and were used to allocate scores of wave quality (1-5) and wave frequency (1-5) for each surf break. Additionally, the type of surf break (point/reef) was noted and whether it forms part of a surf spot cluster. Ultimately, 87 individual surf breaks were identified. It is important to note that the produced dataset is a non-exhaustive list and may be edited and refined with increased knowledge, while also respecting local traditions and "secret spots". Ground truthing of the identified surf breaks was conducted using satellite imagery provided by ESRI (2015-2017), aided by a local expert.

For the prioritization of surf breaks, the pressure-state-response framework (OECD, 1993) was used to develop a final surf conservation index using a set of representative indicators for each index of pressure, state, and response (figure 1). A literature and data review were conducted for each indicator at publicly available open-source databases, government portals and non-governmental sites (table 1). The ESRI online portal was also searched specifically for geospatial data. All data management and analyses were conducted in ArcGIS Pro (version 2.6.1, 2020). Throughout the process, there was continuous consultation with local experts, university associates, and contacts from relevant institutions.

The indicators were adapted from the protocol used by Arroyo et al. (2021) and adjusted to reflect the geographic and political layout of an island archipelago and to reflect a broader socioeconomic view of surf conservation importance through community and socio-cultural lenses. For each index and sub-index,

the indicator layers were overlaid with the buffer layer and reclassified to create a score of low to high priority. The final surf conservation priority was obtained by summing all subindices together, where higher values indicate a higher priority.

The pressure index was divided into land and coastal indicators, using regional census data and geospatial land use layers (Carta de Ocupação do Solo (2018) RAA), as well as the location of airports, resource extraction and point source pollution, military presence, ports and coastal fishing activity and ferry routes, for each buffer zone. The census data and land use layers had different spatial resolutions, where average values at the municipal level were used for the demographic indicators. Thus, the difference in the pressure subindices of the surf breaks is derived from the road and land use indicators.

The state index was further divided into three subindices of biodiversity, surf and social factors. For biodiversity, geospatial layers on areas of high biodiversity importance, presence of deep-sea coral and red algae, and a plant and vertebrate species richness index were used. A formula was used to calculate the surf break index using measures of wave quality, wave frequency and the density of surf break clusters within each individual surf break buffer. The original formula also accounts for experience level and wave direction scores with a smaller weighting but these data were not consistently available for all the surf breaks in the Azores and therefore were left out. For the social index, surf tourism and culture were added as an integral part of the equation, particularly in the context of the Azores. This included the presence of surf schools, surf shops and surf hostels as a proxy for a well-established surf culture and tourism and accessible recreation, as well as geospatial layers on recreation services, number of tertiary sector establishments and employment in the tertiary sector.

For the response index, all conservation zones, regardless of protection status or type were identified. The objective of this index is to account for conservation management and response. Marine and terrestrial protected areas, and RAMSAR sites were obtained, as well as cultural heritage sites, including traditional vineyards and sites of archaeological importance, and coastal defense management. The world surfing reserve indicator was not included because it is not applicable to the Azores.

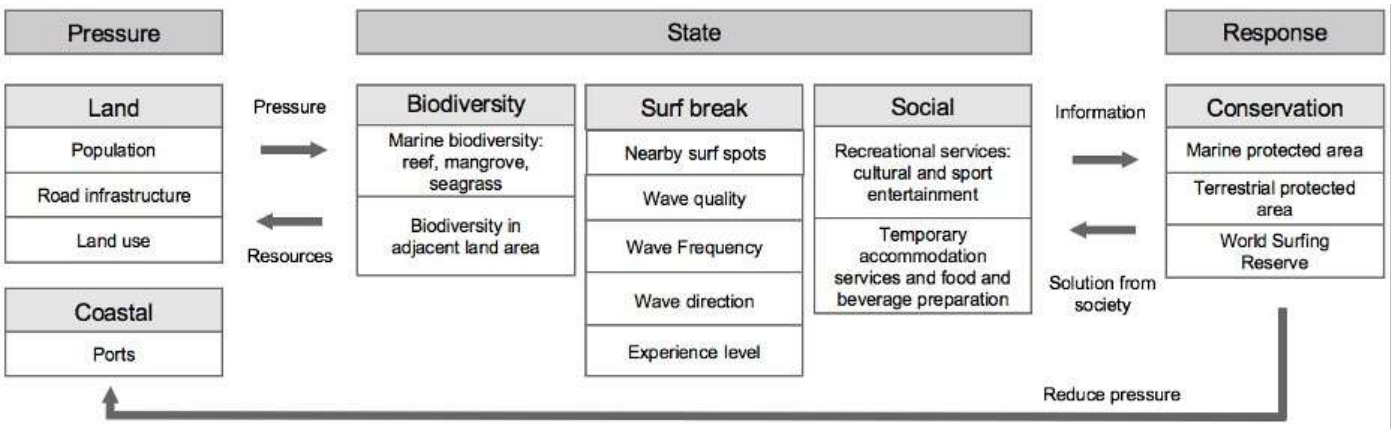


Figure 2- Surf Conservation Index Model (adapted from Arroyo et al, 2021)

INDEX	SUBINDEX	INDICATOR	LAYER	SOURCE
Pressure	Land	Population	Municipal population density	INE, dados.gov.pt
			Municipal population change	INE, dados.gov.pt
			Island population density	INE, dados.gov.pt
		Infrastructure	Road network density	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
		Land use	% transformed land cover	RAA 2018, snig.dgterritorio.gov.pt, http://ot.azores.gov.pt
			Airport type	Google Earth Pro, 2021
			Resource exploitation	EU data portal, emod-net.eu
			Industrial pollution	EU data portal, emod-net.eu
	Coastal	Port	Port type	EU data portal, emod-net.eu
			Industrial fishing	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
			Passenger and commercial ferry routes	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
			Military presence	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
State	Biodiversity	Marine biodiversity	Vertebrate and plant species richness	GBIF, gbif.org
			Coral distribution	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
			Red algae distribution	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
		Terrestrial Biodiversity	Vertebrate and plant species richness	GBIF, gbif.org
			Coastal priority zones	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
	Surf	Wave quality		wannasurf.com, surf-forecast.com
		Wave frequency		wannasurf.com, surf-forecast.com
		Cluster density		wannasurf.com, surf-forecast.com
	Social	Recreational services	Coastal recreational density	EU data portal, emod-net.eu
			Number of surf operators, events and establishments	Google Earth Pro
		Accommodation and catering services	Tertiary sector establishment density	INE, dados.gov.pt
			Municipal tertiary employment density	INE, dados.gov.pt
Response	Conservation	Marine protected areas	Protected areas	WDOECM, https://www.protectedplanet.net
		Terrestrial protected areas	Protected areas	WDOECM, https://www.protectedplanet.net
			RAMSAR sites	WDOECM, https://www.protectedplanet.net
			Cultural heritage sites	SIGAM, http://sig-sraa.azores.gov.pt/SIG(
			Coastal management	SIGAM, http://sig-sraa.azores.gov.pt/SIG(

RESULTS

From a global perspective, the Azores islands are considered relatively pristine and face much lower magnitudes of pressure than other known surf locations in Portugal (including the WSR, Ericeira) and across the world. This project seeks to identify which surf breaks have high Surf Conservation Index values and whether these sites overlap with protected terrestrial and marine areas of the Azores. The most useful existing public database of surf breaks of regional importance is the tourism portal, which is tourism-oriented and may not reliably provide surf communities with adequate conservation tools. This highlights the need to create a surf break database that assesses surf spots based on various indicators. It is also important to identify where surf breaks overlap with existing legal protection frameworks so that they can be actively considered in management plans.

The goal of the SCI is to provide guidance and help prioritize sites and areas for conservation projects. Beyond the prioritization, this analysis may also help understand where there is a need for an improved response. For example, the north coast of São Miguel has a highly developed surf activity yet ranks low in the prioritization due to a limited response. It is further worth considering whether there is a noticeable increase in interest to protect surf zones when a region is declared a World Surfing Reserve. Based on the World Surfing Reserve example in Ericeira, mainland Portugal, Carvalho et al. (2015) argue that declaring a location a WSR will significantly alter the dynamics of the local economy and increase access to businesses and industries, while generating a large employment base.

The following sites were identified as the highest priority for potential surf conservation (figure 3):

- Corvo- Porto do Corvo;
- Faial- Praia do Norte;
- Flores- Ponta Ruiva, Fajãzinha;
- Graciosa- Baía da Barra, Ilhéu da Praia;
- Santa Maria- Formosa;
- São Jorge- Fajã do Ouvidor, Esquerdas da Igreja, Direitas do Paço, Feiticeiras;
- São Miguel- João Bom, Milícias, Mosteiros, Formosa;
- Terceira- Quatro Ribeiras.

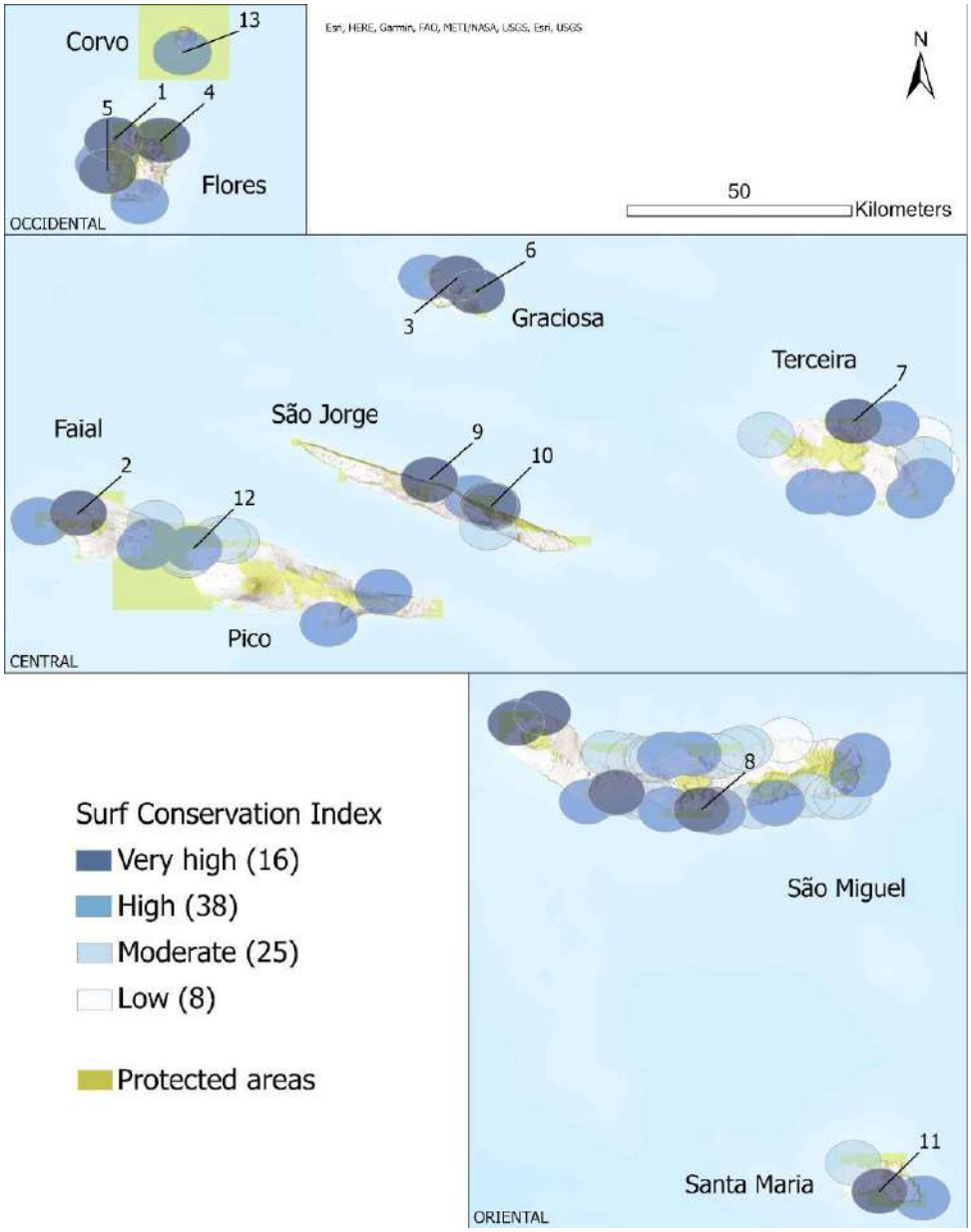


Figure 3- Map of surf conservation index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Quebrada Nova Fanais, 2- Praia do Norte, 3- Baía da Barra, 4- Ponta Ruiva, 5- Fajãzinha, 6- Ilheu da Praia, 7- Quatro Ribeiras, 8- Praia do Degredo, 9- Fajã do Ouvidor, 10- Esquerdas da Igreja) and the top ranking surf breaks in remaining islands (11- Formosa, 12- Baía da Barca, 13- Porto do Corvo).

São Miguel has sites with low scores (most pressure), due to the proximity of many of the surf breaks to the capital and other highly developed areas (figure 4). Graciosa and Terceira islands have the most converted land within surf break buffers with over 70% transformed land area, whereas São Jorge (4.85%) and Flores (20.83%) have the least transformed land with the highest percentage of intact natural landscape within the buffer zones. São Miguel and Terceira have the highest population densities across the islands. Except for São Miguel, Santa Maria, and Corvo, all of the islands show decreasing population rates between 2001 and 2011. The major ports are found in São Miguel, Terceira, and Faial, which is also where the heaviest shipping traffic and road density is found. The 8 breaks with the highest score (lowest pressure) are located on São Jorge, with Direitas do Paço showing the highest potential. São Miguel hosts the 4 breaks with the lowest score (most pressure), with Santa Clara having the lowest potential.

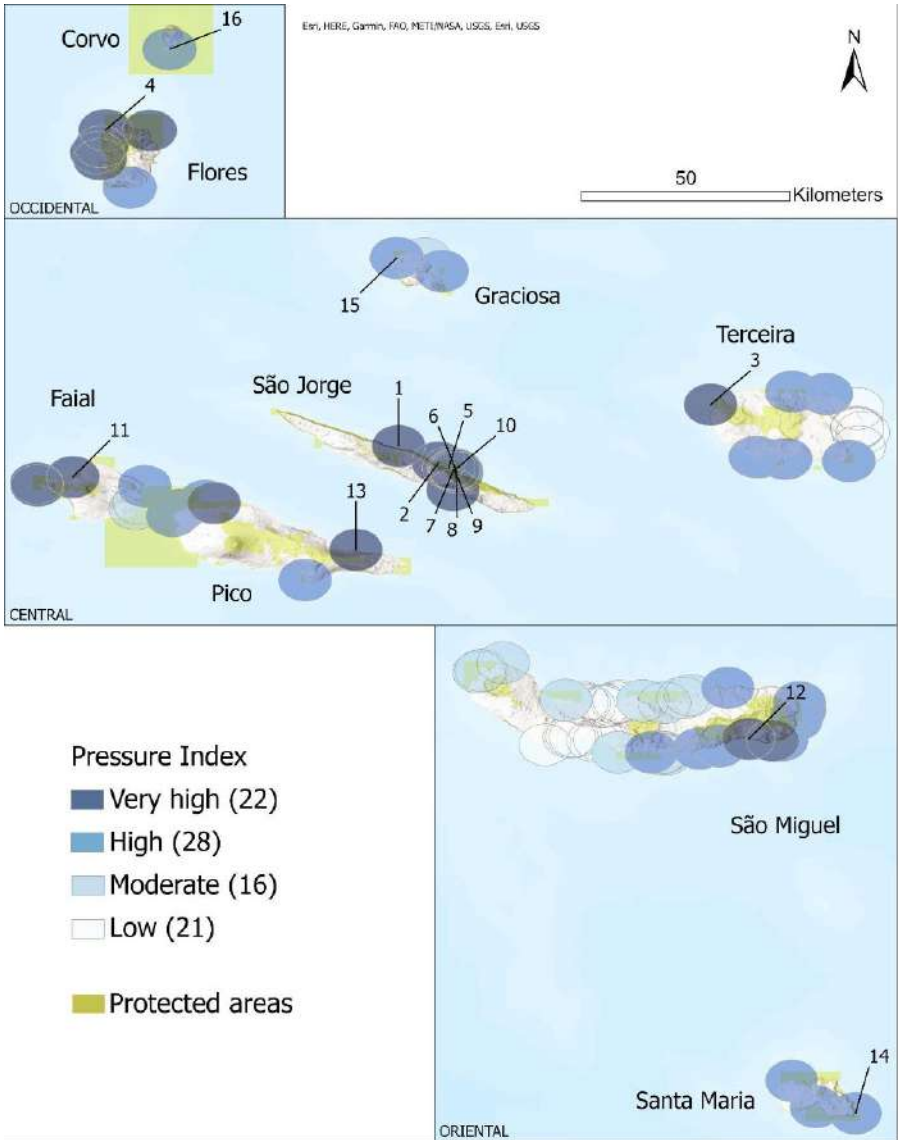


Figure 4- Map of pressure index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Fajã do Ouvidor, 2- Fajã dos Cubres, 3- Ponta do Queimado, 4- Quebrada Nova Fanais, 5- Fajã do Belo, 6-Largo do Linho, 7- Direitas do Paço, 8- Esquerdas da Igreja, 9- Feiticeiras, 10- Caldeira) and the top ranking surf breaks in remaining islands (11- Praia do Norte, 12- Recife da Povoação, 13- Santa Amaro Baía do Canto, 14- Baía da Maia, 15- Calhau Miúdo, 16- Porto do Corvo).

The State Index was generally very low for all the islands compared to the surf breaks near the capital Ponta Delgada, on São Miguel. The distribution for the state index is likely skewed by a few surf breaks on São Miguel (figure 1) where there is a greater density of tourism and surf establishments as well as employment in the tertiary sector. São Miguel has the 6 surf breaks with the highest state score, with Milicias showing the highest potential. There is a clear inverse correlation seen between the pressure index and the social index where the more developed areas are likely to score lower due to existing pressure but higher in terms of socioeconomic opportunities.

The highest species richness was found in surf break buffers on Terceira and Flores, whereas Pico, Graciosa and Faial indicate the lowest average species richness inside buffer zones (figure 5).

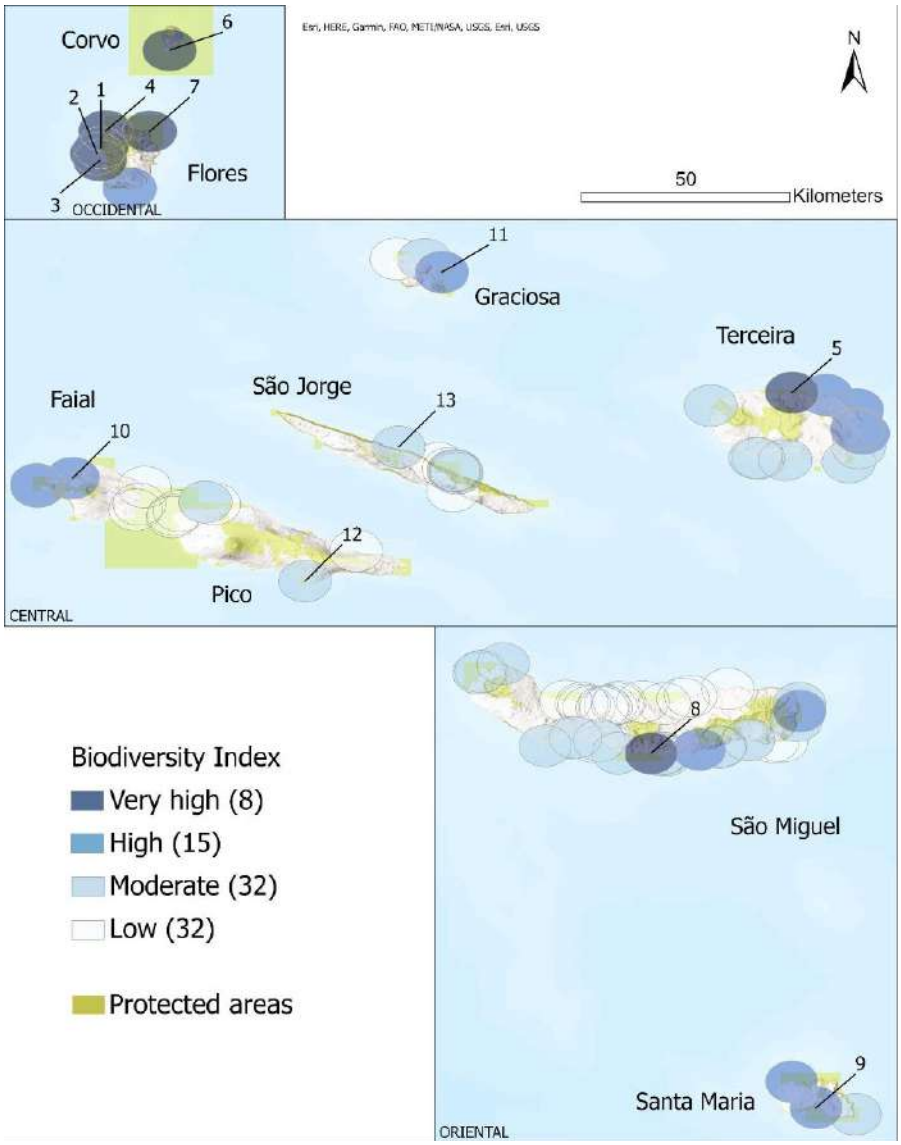


Figure 5- Map of biodiversity index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Fajã Grande, 2- Recife da Coelheira, 3- Fajãzinha, 4- Quebrada Nova Fanais, 5- Quatro Ribeiras, 6-Porto do Corvo, 7- Ponta Ruiva, 8- Praia do Degredo, 9- Formosa, 10- Praia do Norte) and the top ranking surf breaks in remaining islands (11- Ilhéu da Praia, 12- Lajes, 13- Fajã do Ouvidor).

The highest average surf quality was found on São Jorge and the lowest surf quality on Faial. São Miguel has the most identified surf breaks and shows the biggest range in quality and frequency (figure 6).

São Miguel, São Jorge and Terceira are the only islands with established surf schools, shops and events (figure 7). São Miguel also hosts a World Surf League six-star event (Medeiros Fonseca, 2017). Other sporadic surf events, hosting some of the most legendary surfers in the world, have taken place in São Miguel, such as the Azores Airlines World Masters Championships in 2018.

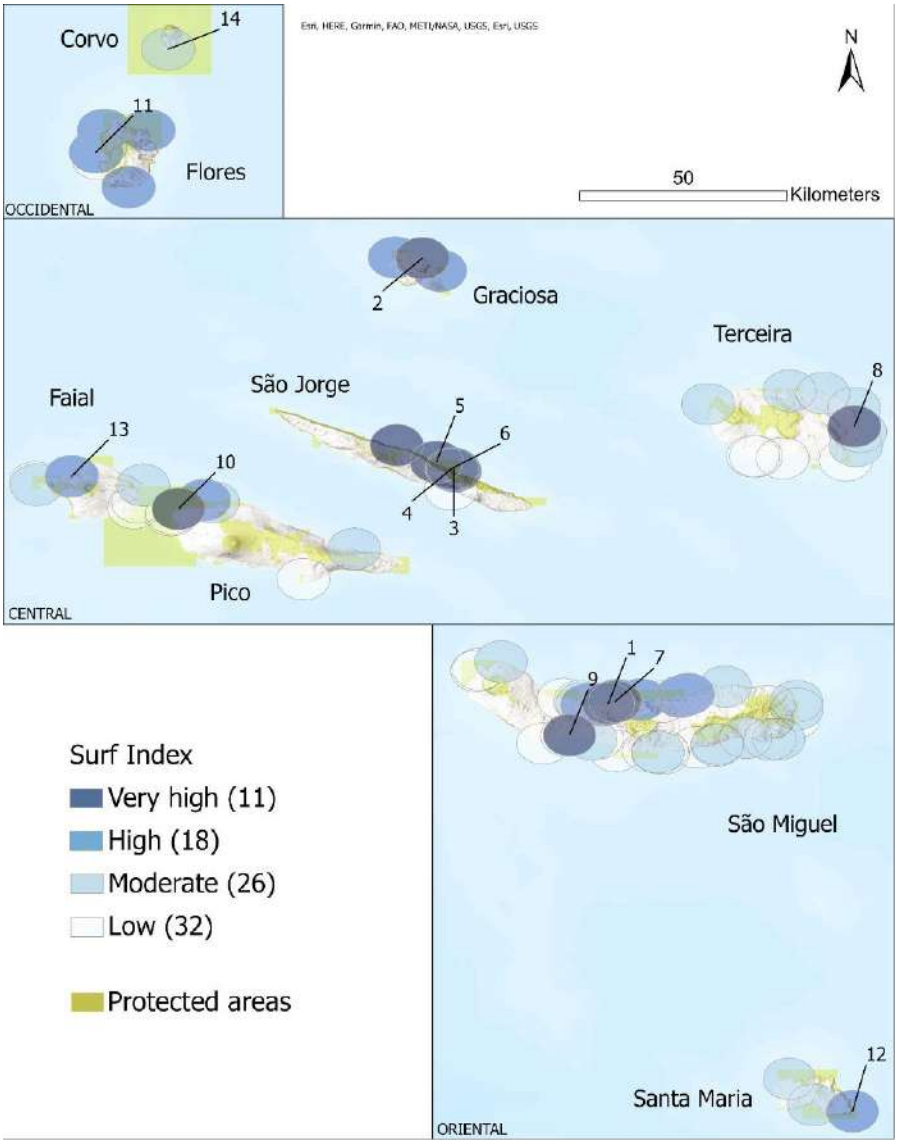


Figure 6 - Map of surf index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Areais de Santa Bárbara, 2- Baía da Barra, 3- Esquerdas da Igreja, 4- Direitas do Paço, 5- Fajã dos Cubres, 6-Feiticeiras, 7- Monte Verde, 8- Praia da Vitória, 9- Milícias, 10- Baía da Barca) and the top ranking surf breaks in remaining islands (11- Recife da Coelheira, 12- Baía da Maia, 13- Praia do Norte, 14- Porto do Corvo).

Further, São Jorge hosts international competitions including surf at Ribeira Grande, windsurf at Praia da Vitória, SUP at Mosteiros and Vila Franca do Campo, and cliff diving at Vila Franca do Campo. Regional competitions include surf at Praia da Vitória and Mosteiros. Additionally, surfing in the Fajã de Santo Cristo in São Jorge has been featured internationally, as well as Pico Island's whaling regattas. There was an application for establishing a WSR in 2017 but there has been no final decision yet. São Miguel and Terceira show the highest employment and establishment density in the tertiary sector, reflecting the highest population densities across the islands overall. However, other islands such as Graciosa, Faial and Pico show higher numbers of recreational services within surf buffer zones, such as beaches and parks.

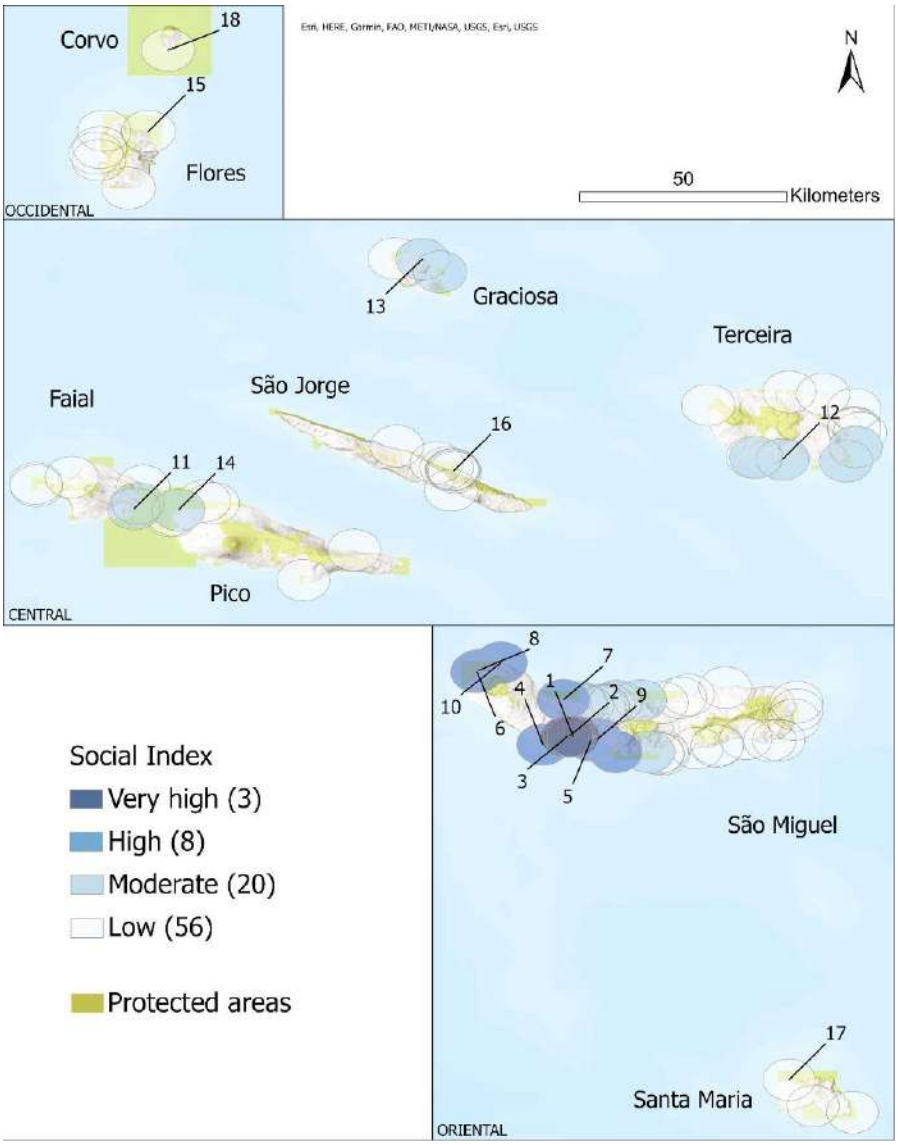


Figure 7 - Map of social index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Praia do Pópulo, 2- Milícias, 3- Praia de São Roque, 4- Santa Clara, 5- Carneiros, 6-Mosteiros, 7- Fenais da Luz, 8- Mosteiros Porto, 9- Santa Cruz, 10- João Bom) and the top ranking surf breaks in remaining islands (11- Praia da Conceição, 12- Baía da Salga, 13- Baía da Barra, 14- Baía da Barca, 15- Ponta Ruiva, 16- Esquerdas da Igreja, 17- Anjos, 18- Porto do Corvo).

The Response Index for the archipelago was relatively evenly distributed, with Ilhéu da Praia given the highest response score on São Miguel. Nearly all the identified surf breaks in the archipelago sit within 1 km of at least one protected area (figure 8). Notable protected areas which overlap with high ranking and culturally important surf breaks include the surf clusters on the North and South coasts of São Miguel, the East coast of Terceira, Southeast coast of Faial, the North Coast of Flores and the North coast of São Jorge. Protected areas of interest are both near and far from dense urbanization. The government of the autonomous region of the Azores established the first marine protected areas in the 1980's. In 2011, the regional network of protected areas in the autonomous region of the Azores was revised and a legislative decree was issued by the Legislative Assembly in order to establish the structure, components and functions of the Marine Park of the Azores (DRE, 2011). This proposed marine park of the Azores integrates the marine protected areas including Natura 2000, OSPAR convention, LIFE IBAs Marinhas, and other miscellaneous areas of interest.

CONCLUSIONS

São Miguel dominates this analysis as the capital of the autonomous region. It has by far the greatest number of known surf spots, as well as the highest concentration of fishing, tourism, and ports. However, there is significant potential in the other smaller islands to develop a well-grounded tourism base, given future trends (Cale, 2012). For this analysis, indicators for surf culture including school, shops, hostels, competitions and international recognition were added to reflect the rich and traditional surf and nautical culture of the Azores. The buffer zone of 5 km requires some assumptions and may not reflect the reality of the effects of some of the indicators, particularly because the islands differ in size and population drastically. The score weightings are affected by state and pressure and we see that surf breaks that have buffers overlapping with the capital, Ponta Delgada, create extreme indicator values which skew the distribution of the score. Making the project scalable and generic compromise vs. island setting is part of adapting the SCI to an archipelago. Surveying of surf breaks also includes a bias towards the more well known and developed islands, where surf breaks in São Miguel were more accurately verified than Graciosa or Corvo. This SCI further relies on available geospatial data. For the Azores archipelago, the current open- sourced available data are incomplete and occasionally inaccurate. The most inaccurate was the Geospatial road layer which was not available from a government source.

The objective of ranking surf breaks using a variety of criteria is to provide potential conservation opportunities. This does not provide an objective overview of better or worse surf breaks and does not imply that one island has better surf conditions than another island. Higher scores indicate the higher identified potential for surf conservation given a multitude of factors. Flores and Graciosa host a low population density and less developed surf culture, so they only score high due to the relatively lower pressure. On the other hand, the north coast of São Miguel does not contain surf spots of high priority but is widely regarded as one of the most accessible and high-quality surfing areas. This is why it's also important to look at the pressure, state and response index, and the biodiversity, surf, and social sub-indices separately. Each sub-index will provide better context to the surf conservation index as a whole.

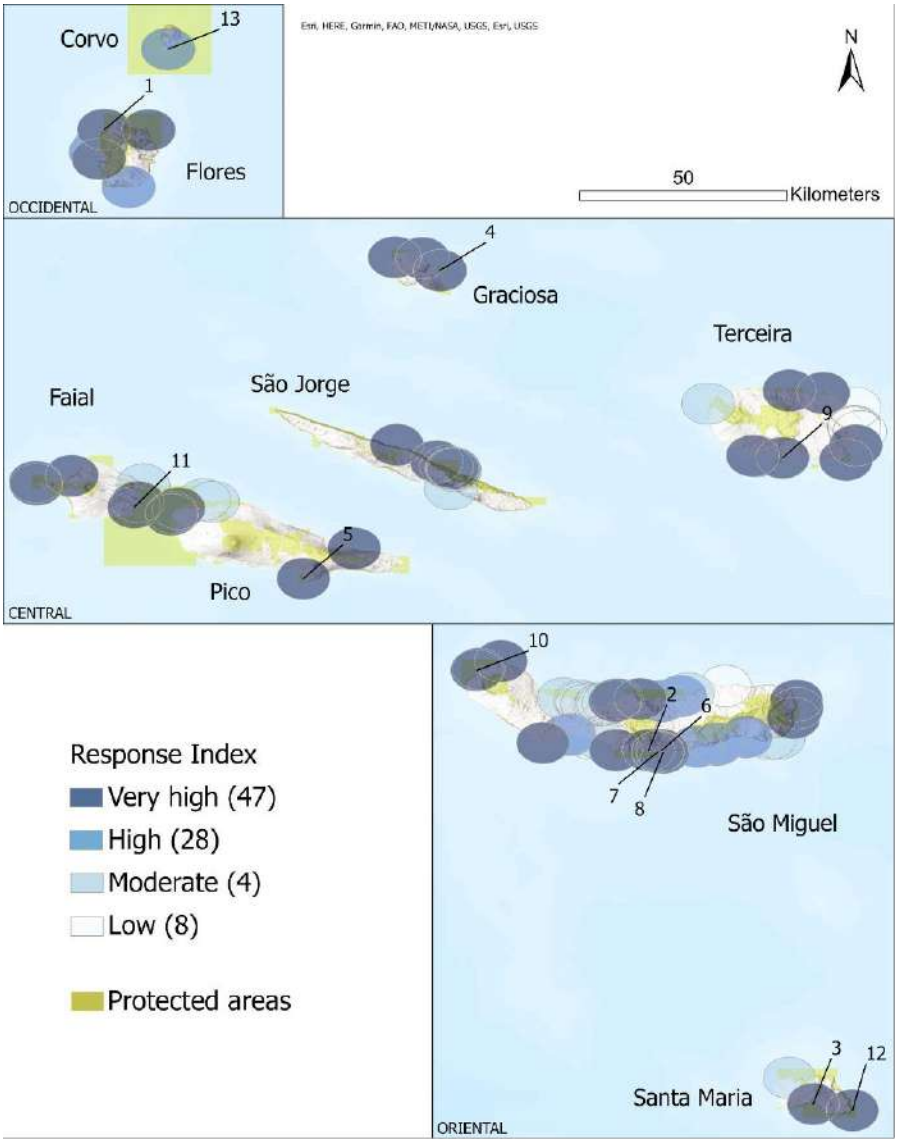


Figure 8- Map of response index prioritization, and overlapping PAs with the highest ranking surf breaks labelled as very high (1- Quebrada Nova Fenais, 2- Praia do Degredo, 3- Formosa, 4- Ilhéu da Praia, 5- Lajes, 6- Vinha da Areia, 7- Vila Franca do Campo Porto, 8- Baixio da Vila, 9- Baía da Salga, 10- Mosteiros) and the top ranking surf breaks in remaining islands (11- Praia da Conceição, 12- Porto do Corvo).

RECOMMENDATIONS

With the continued improvement and access to more holistic data, future iterations of this SCI may incorporate more accurate prioritizations of the identified surf breaks. Wave quality was defined using a crowd-sourced score from public websites, based on relative interpretation, which introduces bias and lacks consistent methodology. The definition of wave quality is a subjective measure that is defined by each surfer's experience level, preferred type of wave, and definition of an "ideal" surfing experience. Different wave quality sources had to be used in order to compliment incomplete surf spots, therefore the scales may not be comparable across sources. It is noted that generally the surf index for the SCI will also include wave direction and experience, however due to lack of available data in the Azores it was not included. It is recommended for this to be included in future iterations of the model. Lastly, human data tends to be clustered by national jurisdiction (Sancho, 2019) and may not match the scale of surf and ecological data. This was true for some of the indicators used such as fishing capacity, population metrics and employment data.

Academics, surfers and decision-makers provide irreplaceable knowledge to the process of surf conservation. The surf communities especially form a significant part of both the cultural heritage and local economy and can provide crucial local ecological knowledge and personal experience of the coastal environment as well as key information on the history and future trends of surfing (Arroyo et al., 2020; Reineman, 2016). For marine protected areas, the fisher community is particularly vocal and future engagement would benefit from drawing out the voices of the surf community to a similar level, particularly because surfing and commercial fishing pressures often overlap where populations and ports are more concentrated.

Ideally, future iterations of the SCI in the Azores would include qualitative and quantitative community input such as public surveys, transect walks with local experts and key actors, focus groups with local councils and surf community representatives, and participatory mapping (Arroyo et al., 2020). Martin and Assenov (2014) also carried out semi-structured interviews with both foreign and national surfers, taking advantage of the surfing contest season. Surf datasets also tend to be crowdsourced or with sparse spatial resolution (Sancho, 2019). There is also the issue of crowd-sourced databases being biased by tourists and foreigners who do not possess an intimate knowledge of the region. Stakeholder consultation through interviews and surveys with the surf community would be particularly useful to improve upon the surf break database and its subjective variables such as wave quality and frequency (Atkin et al., 2019). It may also be useful to identify surf breaks located in communities which are dependent on most tourism-driven coastal resources for their local economies. Surf breaks which are located near high pressure areas should not necessarily be of lower priority for conservation but rather may require a more urgent response to preserve the habitat.

Key habitats in coastal ecosystems provide significant economic value to people in the form of beaches for recreation, good water quality, protection from storm surges and waste assimilation (Brown et al., 2006). Habitat loss is a major threat with only 5% of Macaronesian forest still remaining in the Azores and an estimated decrease in suitable microclimates for biodiversity of up to 50% in the next 50 years, risking extinction for many species (Patiño et al., 2016). Climate change is a further threat with an average temperature increase and average precipitation decrease over the last five decades, indicating the emergence of a warmer and drier climate (Patiño et al., 2016). Climate change phenomena may further

impact water quality, wave frequency, coastal delineations and water depth which will affect both reef and beach surf breaks. Increasing vulnerability to natural hazards, acidification and deoxygenation of waters due to rising atmospheric carbon levels will continue to affect the productivity, biodiversity and distribution of marine fauna as well as compromising ecosystem services and commercial fishing (Morato et al., 2020). This will also need to be accounted for in coastal planning and management. Ng et al., (2013) explore the potential for multifunctional artificial reefs as mitigation against development and natural hazards for São Miguel where the surf culture and tourism potential is the highest. Given that the idea of a successful surf protected area relies on a network, further projects may account for more specific conservation factors such as fragmentation.

As stated in Sancho (2019), the process of the SCI is meant as a guideline for the prioritization of surf ecosystem conservation and should complement a qualitative assessment of community engagement and local conservation principles which may not be quantifiable. STW continues to work with partners as well as engage with local stakeholders and communities, Surfrider and the Regional Tourism Board. The Azorean Biodiversity Portal (ABP) is also a project seeking to provide unrestricted, detailed information on the distribution of species and therefore contributing to the conservation efforts in the Azores, as well as encouraging citizen participation, education and outreach (Borges et al., 2010). Protected area networks around priority surf ecosystems have the potential to create better connectivity between protected areas (Sancho, 2019) and there is a unique opportunity in the Azores to implement this management given that most surf breaks already sit within a protected area.

REFERENCES

Martin, S. A., & Assenov, I. (2014). Developing a Surf Resource Sustainability Index as a Global Model for Surf Beach Conservation and Tourism Research. Asia Pacific Journal of Tourism Research, 19(7), 760–792. https://doi.org/10.1080/10941665.2013.806942

Arroyo, M., Levine, A., Brenner, L., Seingier, G., Leyva, C., & Espejel, I. (2020). Indicators to measure pressure, state, impact and responses of surf breaks: The case of Bahía de Todos Santos World Surfing Reserve. Ocean & Coastal Management, 194, 105252. https://doi.org/10.1016/j.ocecoaman.2020.105252

Arroyo, M., Seingier, G., Passalacqua, G., & Sancho, D. (2021). Surf Conservation Index: Mapping priority zones for Surf Protected Areas in Mexico. Facultad de Ciencias Marinas, Universidad Autónoma de Baja California.

Sancho, D. (2019). Mapping Surf Conservation Capacity in Costa Rica. Stanford University.

Surf Protected Area Networks Process Guide. (2020). Save the Waves.

Medeiros Fonseca, R. J. (2017). Azores World Surf Reserve Project. ABSA.

Ponte, J., Couto, G., Universidade dos Açores, Portugal, Pimentel, P., Universidade dos Açores, Portugal, Oliveira, A., & Fundo de Maneio, Ponta Delgada, Portugal. (2018). Tourism activities and companies in a sustainable adventure tourism destination: The Azores.

DGRM. (2019). Estatísticas da Pesca. INE.

BORGES †, P. A. V., GABRIEL †, R., ARROZ †, A. M., COSTA †, A., CUNHA †, R. T., SILVA †, L., MENDONÇA †, E., MARTINS †, A. M. F., REIS †, F., & CARDOSO †, P. (2010). The Azorean Biodiversity Portal: An internet database for regional biodiversity outreach. Systematics and Biodiversity, 8(4), 423–434. https://doi.org/10.1080/14772000.2010.514306

Patiño, J., Mateo, R. G., Zanatta, F., Marquet, A., Aranda, S. C., Borges, P. A. V., Dirkse, G., Gabriel, R., Gonzalez-Mancebo, J. M., Guisan, A., Muñoz, J., Sim-Sim, M., & Vanderpoorten, A. (2016). Climate threat on the Macaronesian endemic bryophyte flora. Scientific Reports, 6. https://doi.org/10.1038/srep29156

Brown, C., Corcoran, E., Herkenrath, P., & Thonell, J. (2006). Marine and Coastal Ecosystems and Human Well-Being. UNEP.

Carvalho, A., Cunha, C. R., & Mesquita, A. (2015). A importância da atribuição do galardão de Reserva Mundial de Surf na Ericeira. International Conference on Tourism. https://bibliotecadigital.ipb.pt/handle/10198/11955

DRE. Estrutura o Parque Marinho dos Açores, 28/2011/A § 1 (2011).

Reineman, D. R. (2016). The utility of surfers' wave knowledge for coastal management. Marine Policy, 67, 139–147. https://doi.org/10.1016/j.marpol.2016.01.023

Morato, T., González-Irusta, J., Dominguez-Carrió, C., Wei, C., Davies, A., Sweetman, A. K.,

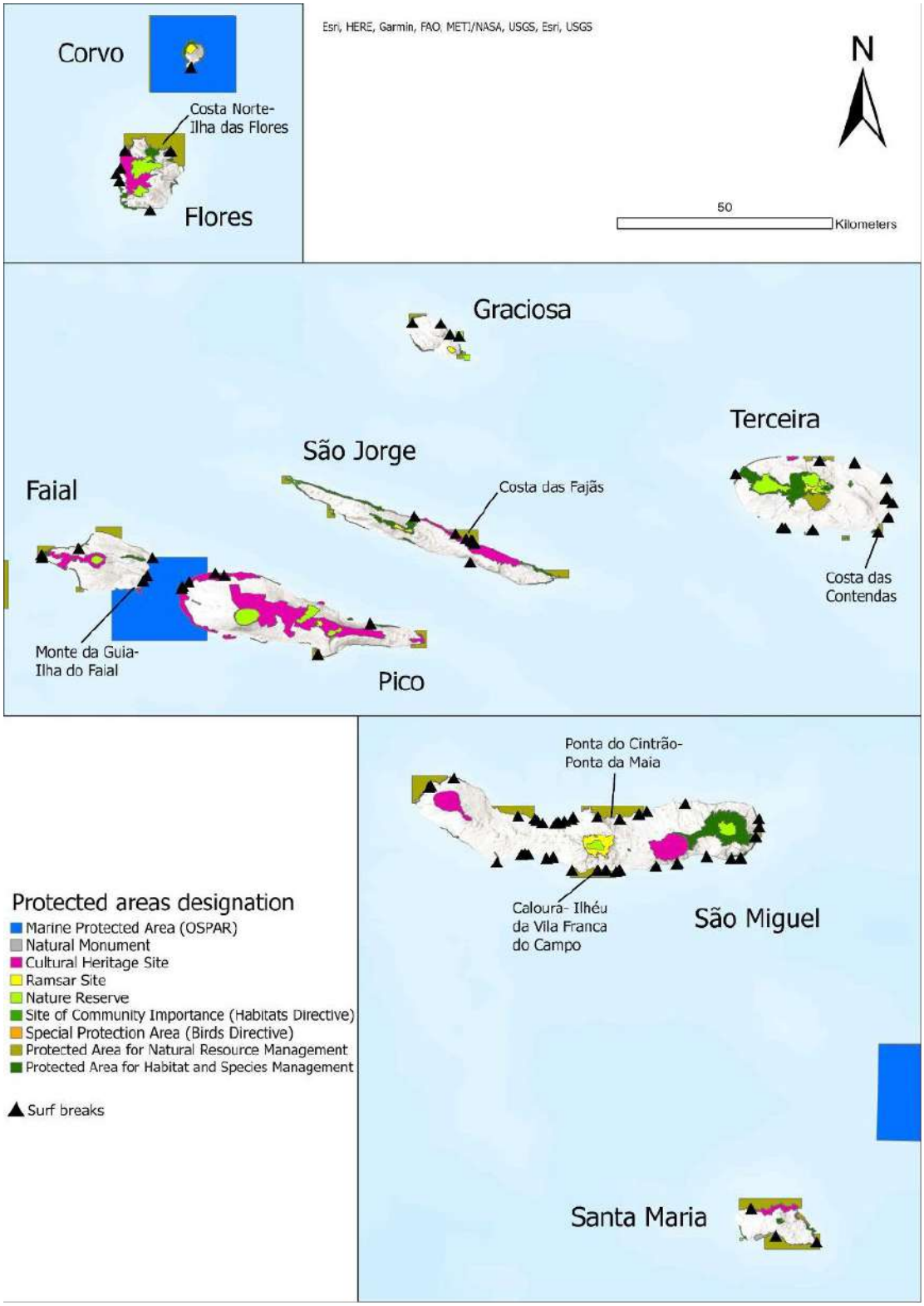
Taranto, G. H., Beazley, L., García-Alegre, A., Grehan, A., Laffargue, P., Murillo, F. J., Sacau, M., Vaz, S., Kenchington, E., Arnaud-Haond, S., Callery, O., Chimienti, G., Cordes, E., … Carreiro-Silva, M. (2020). Climate-induced changes in the suitable habitat of cold-water corals and commercially important deep-sea fishes in the North Atlantic. Global Change Biology, 26(4), 2181–2202. https://doi.org/10.1111/gcb.14996Ng, K., Phillips, M. R., Calado, H., Borges, P., & Veloso-Gomes, F. (2013). Seeking harmony in coastal development for small islands: Exploring multifunctional artificial reefs for São Miguel Island, the Azores. Applied Geography, 44, 99–111. https://doi.org/10.1016/j.apgeog.2013.07.013

LIST OF FIGURES

- Figure 1- Map of surf spots in the Azores Autonomous Region
- Figure 2- MCA process indicators and indices, surf conservation index model
- Figure 3- Map of surf conservation index prioritization
- Figure 4- Map of pressure index
- Figure 5- Map of biodiversity state subindex
- Figure 6- Map of surf state subindex
- Figure 7- Map of social state subindex
- Figure 8- Map of response state index

LIST OF TABLES

- Table 1- Indicators and data sources



Map 1- Protected areas in the Azores, by designation type, overlaid by the identified surf breaks. Notable protected areas are labeled.

SAVETHEWAVES.ORG