MARINE PROTECTED AREAS OF THE UNITED STATES

VISUALIZING THE THREE-DIMENSIONAL FOOTPRINT OF OCEAN USES

A GUIDE TO BUILDING AND APPLYING SPACE USE PROFILES FOR OCEAN MANAGEMENT

https://marineprotectedareas.noaa.gov/ November 2020

Primary Authors
Charles M. Wahle, Ph.D., Senior Scientist (retired) *
Mimi D'Iorio, Ph.D., Data Manager **
Julia Townsend, Policy Analyst
National Marine Protected Areas Center

Contributors
Maggie Chory
Katherine Darr
Jordan Gass
Nicholas Hayden
Rachel Kelly
Melis Okter
Hugo Selbie

* contact address: Charles.Wahle@gmail.com
** contact address: Mimi.Diorio@noaa.gov

National Oceanic and Atmospheric Administration

U.S. Secretary of Commerce
Wilbur Ross

Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator
Neal A. Jacobs, Ph.D.

Acting Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service
Nicole R. LeBoeuf

Office of National Marine Sanctuaries
John Armor, Director

National Marine Protected Areas Center
Lauren Wenzel, Director

Cover photo: Collage of ocean use images depicting the wide array of activities that are routinely underway in ocean spaces. Photo: NOAA

Table of Contents

Acknowledgements

NOAA's National Marine Protected Areas Center would like to thank all the dedicated staff and partners who assisted in the collection of data, facilitation of meetings and workshops, and compilation of resources that have culminated in this report. We are grateful to the many subject area experts and ocean use communities nationwide for their invaluable insights and contributions, and to those many partners continuing to advance the fundamentals of marine spatial planning for ocean resource management.

Executive Summary

The Need for a More Holistic View of Space Requirements of Ocean Uses

America's ocean is becoming increasingly crowded with human activities. More than half the U.S. population lives near the ocean, and millions of people visit the coasts to recreate every year. Additionally, ocean industries, including fishing, shipping, aquaculture, tourism, mining, and energy production, continue to grow and seek new operating areas. Ocean uses can create social and economic benefits to coastal communities and the nation. However, their growing footprint on the seascape also poses challenges for planners, managers and stakeholders who are responding to this trend, especially in areas where multiple distinct uses are operating together.

Ocean uses are typically depicted and managed either as simple shapes on a map showing the use's maximum spatial extent, or, as conceptual cross-sectional illustrations of the use in a general ocean setting. These inherently "flat" and often qualitative perspectives cannot fully quantify or convey the three-dimensional footprint of the entire use across ocean space. Effective ocean planning requires new ways to document, visualize, and understand how any use operates in, on, and under the water, and how that resulting three-dimensional footprint affects other uses.

A New Tool to Envision Ocean Uses in Three Dimensions: NOAA's Space Use Profiles

This report introduces a new framework to help ocean planners, managers, and stakeholders envision the full three-dimensional space requirements of different ocean uses, and to understand how their spatial footprints can create conflicts with other ocean uses in the same area. This methodology, and the insights it generates can benefit many forms of place-based ocean planning, including permitting specific activities, zoning marine protected areas, or comprehensive marine spatial planning of multiple ocean uses. This report is a guide to understanding, creating, and applying space use profiles in real-world ocean planning situations.

Building a Space Use Profile

The space use profile for any ocean use describes the key functional characteristics that define how that activity operates in, and occupies, three-dimensional ocean space. This information was derived from a combination of public sources and expert advice from specialists, industry, scientists, and others familiar with the uses.

Part 1 of the report provides an introduction and context for the report, and describes how it should be used. Part 2 introduces the six sections of the space use profiles. Part 3 describes applications and implications of the space use profiles.

The six sections of the space use profiles are:

General Description – A description of how and where in ocean space the use is typically pursued, including (a) what activities the use typically entails, and what similar activities are excluded from consideration; (b) where the use typically occurs in the ocean and coastal realm; (c) what functional components it typically involves; and, (d) any assumptions made in defining the scope of the use.

Three-Dimensional Space Use – A categorization of the use's typical three-dimensional spatial footprint based on where it occurs across horizontal and vertical zones.

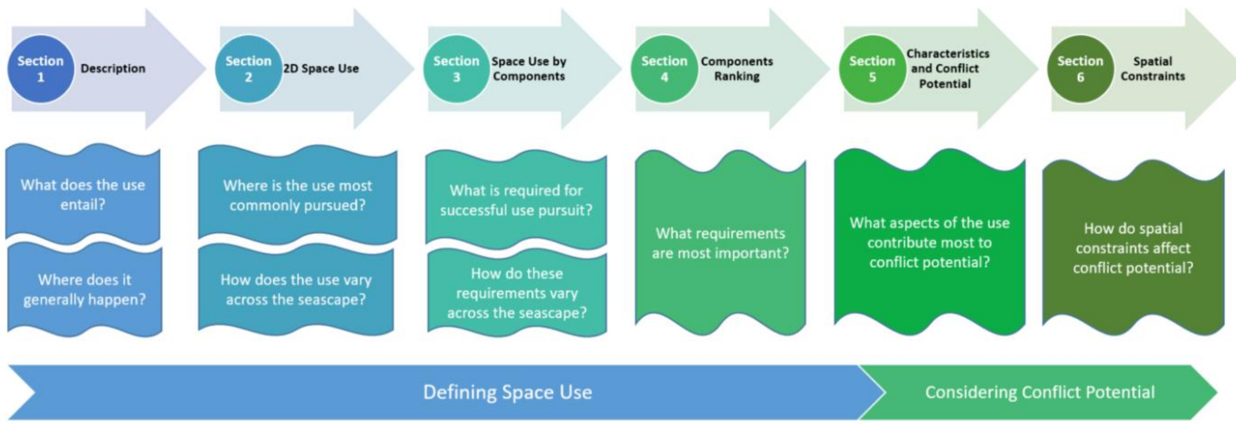
Space Occupied by the Use's Functional Components – A categorization of where the use's functional components (e.g., people, vessels, anchors, moving gear, and installed infrastructure) are most likely to occur when it is pursued in a given area.

Importance of the Use's Functional Components – A scoring of the use's functional components relative to their importance to its successful pursuit in a typical setting.

Operational Characteristics of the Use – A scoring of how the use occupies space and its potential for conflict with other co-occurring uses through interference or exclusion.

Spatial Constraints – A scoring of the relative influence of spatially-based operational constraints (site-dependence and spatial management) on the use's potential to create or avoid conflict with other uses in the same place.

The figure below illustrates these six sections and how they describe an ocean use in functional terms. The first four sections define the use, its operating area, and its key functional components. The last two sections describe fundamental characteristics of the use that influence how it operates and occupies space, and how that may create conflict with other uses. When combined, the six sections of a space use profile provide a holistic and meaningful understanding of an activity's place in the seascape and its potential relationships to other co-occurring ocean uses.



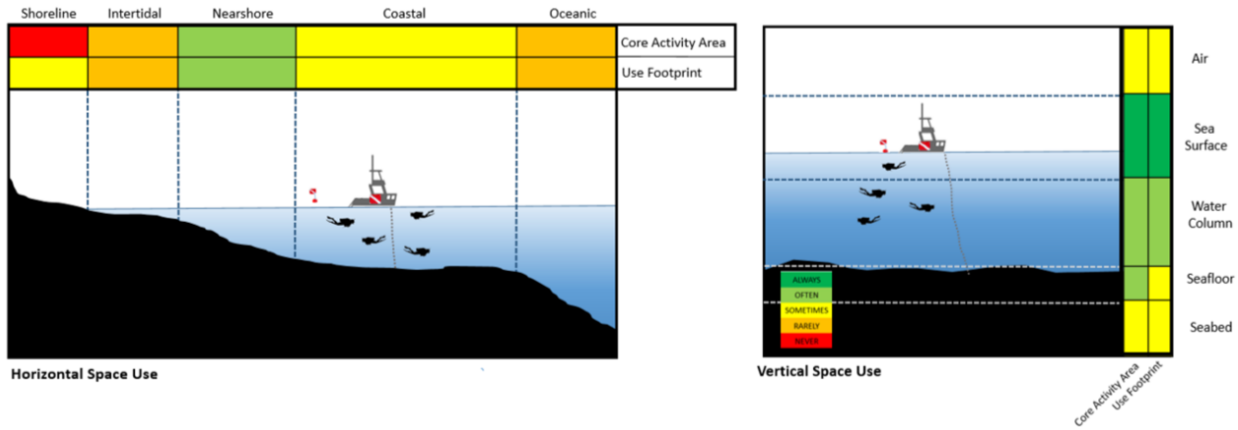
Elements of the space use profiles showing the six fundamental characteristics of any ocean use.

Examples of Space Use Profiles

To illustrate how space use profiles are constructed and can be used, Part 2 presents complete profiles for three familiar ocean uses having very different modes of operation: Scuba/snorkeling; non-commercial (i.e., recreational) fishing with benthic mobile gear; and renewable energy. Part 2 also contrasts the profiles of these three uses to reveal differences in requirements for ocean space and the potential for conflict with other uses.

How Space Use Profiles Can Enhance Ocean Management

With ocean uses of all kinds growing, the space use profiles fill an important gap in our understanding of how people use the ocean. Every space use profile provides a detailed depiction of how the use, and its components, occupy defined horizontal and vertical zones; from the shoreline to the furthest reaches of the exclusive economic zone (EEZ), and from the air above the sea surface to the seabed.



Occupancy of specific horizontal and vertical zones by scuba diving, shown for both the core activity area (i.e., dive site) and the overall use footprint (including vessel transit).

By revealing how ocean uses operate in, on, and under the water, and how their resulting three-dimensional footprints shape their interactions with other co-occurring uses, the space use profiles provide a structured, quantifiable, and repeatable framework for understanding human activity in the seascape.

Future Applications of the Space Use Profiles

The insights provided by the space use profiles into the nature and consequences of the three-dimensional space requirements of ocean uses can provide vital data to inform many ocean management and conservation issues. Among these are:

- Marine Protected Areas – design of marine zoning schemes to ensure that allowed uses have minimal impacts on other uses and on the protected ecosystem.
- Marine Spatial Planning – allocation of ocean uses to specific operating areas where they are less likely to interact and conflict with other co-occurring uses.
- Ecosystem Management – assessment of potential impacts of a use's holistic three-dimensional footprint, including its functional components, on ecosystem integrity and services.
- Single Use Management -- evaluation of whether a use's requirements for ocean space are compatible with the objectives or constraints of a specific operating area (e.g., navigation routes, marine protected areas, or ocean recreation areas).

An Invitation to Test, Adapt and Share the Space Use Profiles

The space use profiles represent a novel and flexible conceptual framework for understanding the full dimensionality of ocean uses and their impacts. They provide a lens for envisioning and considering the full dimensionality of ocean space and its uses in a consistent, quantifiable and repeatable way.

Most ocean uses are context-specific, varying widely in important ways across geographies, seasons and cultures. The authors encourage the ocean community to apply the space use profiles to real-world ocean management needs and to modify them to meet local conditions. Those adaptations might range from altering the definitions of specific ocean uses, to changing the nature or spatial distribution of their functional components, to modifying the scores and weights assigned here to the features described by the Profiles. Sharing the lessons learned from those trials will strengthen the tool and advance our collective ability to manage and conserve our ocean.

Understanding Ocean Uses in Three Dimensions

The Growing Importance of Ocean Space

America's ocean is growing busier. Over half of the U.S. population lives near the ocean, and millions of Americans and international tourists visit the coasts every year. Ocean industries, including fishing, shipping, aquaculture, and energy production are also expanding, creating the potential for conflicts among co-occurring uses. Growing ocean uses demand new approaches for understanding, planning, and managing activities. Effective approaches must balance ocean uses in a way that provides social and economic benefits while also sustaining the healthy and productive ocean ecosystems they depend on. Understanding how ocean uses operate in, on, and under the water, as well as how that spatial footprint impacts other uses and surrounding ecosystems, is increasingly critical to effective spatial management of our ocean and coasts.

Understanding the Footprint and Implications of Ocean Uses

Typically, ocean uses are depicted on a map as simple two-dimensional polygons showing the horizontal geographic extent of the use across the ocean's surface (Figure 1, left). Alternatively, they may be illustrated as generic illustrations of the primary activity occurring in an undefined ocean space (Figure 1, right).

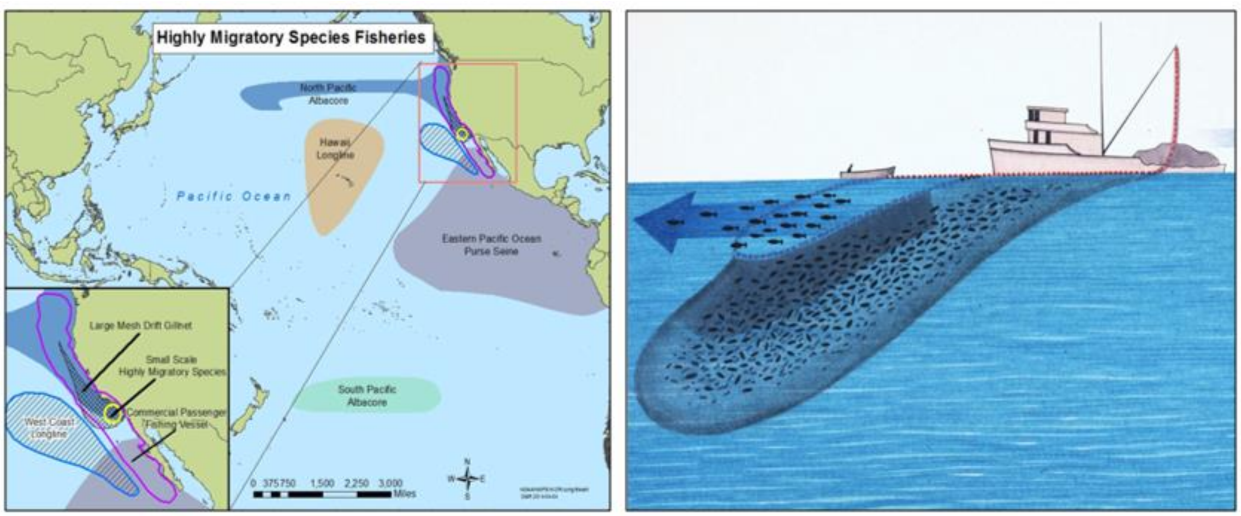


Figure 1. Examples of typical depictions of fishing shown as polygons on a map (left) or as generic representations of how the activity operates in a generalized setting (right). Source: NOAA.

While informative, these visual representations can be misleading and often lack important details about exactly how and where specific ocean uses occupy the volume of water around them from the sea surface to the seabed. Such incomplete perspectives can impede effective planning and management of ocean uses and lead to conflicts among uses, especially when several are operating in the same space at the same time. Understanding the three-dimensional footprint of ocean uses allows a fuller assessment of their potential impacts on other co-occurring ocean uses, as well as their potential to impact surrounding ecosystems.

Envisioning Ocean Uses in Three Dimensions: Space Use Profiles

To better understand how ocean uses operate in ocean spaces, we need new tools that take into account the full operational requirements of all uses over their entire spatial footprints. For example, Figure 2 illustrates the three-dimensionality of one common use – scuba diving. It depicts the vertical footprint of a typical scuba dive occurring at the dive site and involving people (the divers), a vessel, an anchor, and a buoy (left), and illustrates the horizontal extent of this use, showing both the dive area as well as the transit path of the dive boat to and from that site (right). Taken together, they comprise the overall three-dimensional footprint of scuba diving.

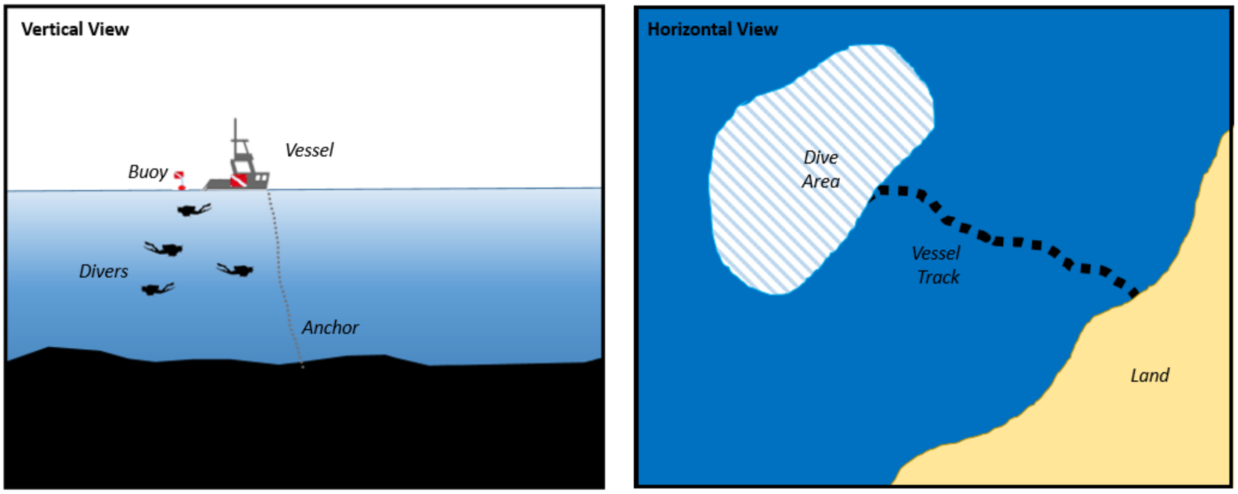


Figure 2. Three-dimensional depiction of a typical scuba dive, showing how it occupies ocean space in the vertical and horizontal dimensions.

This report describes a new tool and conceptual framework – space use profiles – designed to help ocean planners and managers better understand the three-dimensional space requirements of different ocean uses, and how their resulting spatial footprints can create conflicts or compatibilities with other ocean users and/or with place-based management objectives. The insights generated from this analysis can benefit many forms of place-based ocean planning, including permitting specific activities, zoning marine protected areas, or comprehensive marine spatial planning of multiple ocean uses. This report is an initial guide to understanding, creating, and applying space use profiles in real-world ocean planning situations.

For each use, the space use profiles identify, illustrate, quantify, and reveal its: overall spatial footprint in a typical ocean setting; common functional components involved in the use (e.g., people, vessels, anchors, moving gear, and installed infrastructure); requirements for vertical and horizontal space in specific ocean zones; and inherent potential for creating conflicts with other uses in the same space.

Here, we present the concept of space use profiles, describe how they are constructed, and discuss their implications for spatial management of the ocean.

Using This Document

This product is part of a long-term initiative by NOAA’s National Marine Protected Areas Center (MPA Center) to understand and highlight the importance and influence of human uses in the conservation and management of the ocean. It provides: (i) a description of how a space use profile is created for any given ocean use; (ii) examples of profiles for three common uses; (iii) an illustration of how those uses differ functionally in their utilization of three-dimensional ocean space; (iv) an overview of how space use profiles can inform spatial planning and management in the ocean; and (v) examples of three complete space use profiles for three separate ocean uses. Extensive resources supporting the development and application of space use profiles, as well as profiles for 32 different ocean uses can be accessed in the Pacific Regional Ocean Uses Atlas Project (PROUA) report, discussed further in the concluding chapter.

This report is intended to help ocean planners, managers, scientists, and stakeholders understand the purpose, construction, and application of space use profiles by providing a conceptual framework and set of tools for envisioning the three-dimensional footprint and space requirements of common ocean uses. The profiles are designed to be applied, tested, and adapted further in real-life ocean planning and management contexts.

Building a Space Use Profile

NOAA initially created individual space use profiles for 32 common ocean uses as a tool to help inform ocean planning. There were few readily accessible and comprehensive descriptions of the functional components of ocean uses, or of their typical occupation of three-dimensional ocean spaces. As a result, these initial profiles were constructed based on diverse expert input from: (i) relevant industries and user groups; (ii) ocean scientists, experts, managers, and policy-makers familiar with ocean uses; and (iii) published documents and official websites of relevant industries, user groups, and other interested parties.

Space use profiles represent an initial effort to conceptualize, visualize, and parametrize individual ocean uses in a consistent but flexible way that can inform and stimulate further exploration of their implications. They offer a prototype framework that can be modified and adapted for particular geographies, as the nature and three-dimensional footprint of specific uses may vary considerably among locations, seasons, and specific applications.

Key Characteristics of Ocean Uses

For any given use, the space use profile describes six fundamental functional characteristics that largely define how that activity operates in and occupies three-dimensional ocean space. A use profile's six sections describe:

1. **General Description** – A summary of the use describing how and where in ocean space it is typically pursued, including (a) what activities the use typically entails, and what similar activities are excluded from consideration; (b) where the use typically occurs in the ocean and coastal realm; (c) what functional components it typically involves; and (d) any assumptions made in defining the scope of the use.
2. **Three-Dimensional Space Use** – A categorization of the use's typical three-dimensional spatial footprint based on where it occurs across horizontal and vertical zones.
3. **Spaces Use by Functional Components** – A categorization of where the use's functional components (i.e., people, vessels, anchors, moving gear, and installed infrastructure) are most likely to occur when the use is being pursued in a given area.
4. **Importance of Functional Components** – A scoring of the use's functional components relative to their role or importance in its successful pursuit in a typical setting.
5. **Operational Characteristics of Space Use** – A scoring of how the use occupies ocean space relative to its potential for conflict with other co-occurring uses through either interference or exclusion.
6. **Spatial Constraints -** A scoring of spatially-based operational constraints (site-dependence and spatial management) relative to the use's potential to create or avoid conflict with other uses in the same place.

For each section of the profile listed above, this report provides a brief overview of that characteristic; a description of how that section is constructed; examples of the completed sections for three common uses; and a summary of insights revealed by that section about how that particular characteristic of the use influences its three-dimensional space occupancy and conflict potential.

This report will describe how a space use profile is created and used for three examples of familiar ocean uses (Figure 3):

- Scuba/Snorkeling
- Non-Commercial Fishing with Benthic Mobile Gear
- Renewable Energy

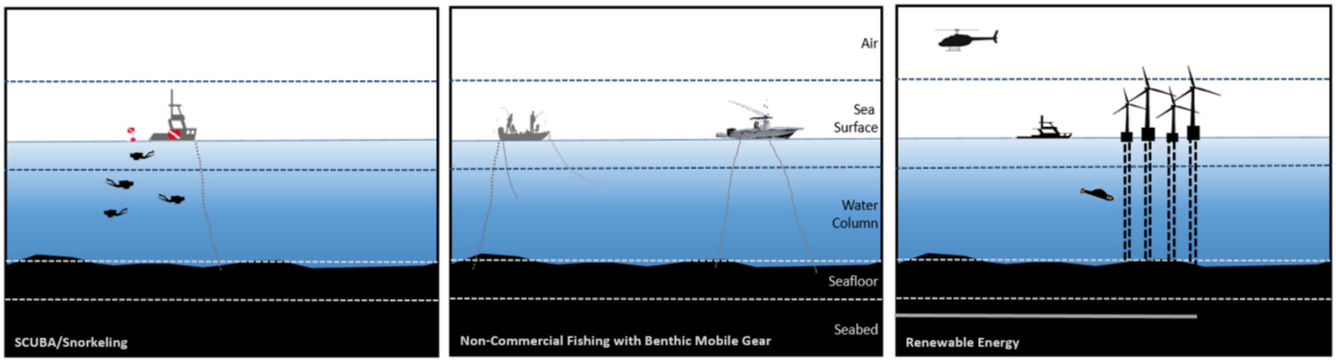


Figure 3. Vertical cross-sectional perspective of three example ocean uses that will be explored in detail throughout this report.

Profile Section 1: General Description

Section 1 of each space use profile describes three fundamental aspects of the use:

- Definition -- the particular activities typically included in, and excluded from, the specific use.
- Location -- the typical overall footprint and core operating area of the use.
- Components -- the key functional components typically employed during the use (i.e., people, vessels, anchors, moving gear, and installed infrastructure).

Definition of the Use

Many categories of ocean use, such as boating or fishing, have a wide variety of forms in which they are pursued in three-dimensional space. For example, trolling, kite fishing, and spearfishing are fundamentally different activities in terms of space occupancy, but they are all forms of "fishing". Similarly, motor boating, sailing, and operating personal watercraft all involve boats, but in very different places and ways. To minimize confusion when considering the diversity of existing ocean uses, space use profiles characterize uses functionally with two important descriptors:

- The specific activities (including functional components) that the use typically *includes*.
- Specific examples of other seemingly similar activities that are *excluded* from this use due to important operational differences.

By explicitly identifying which activities are included versus excluded from the use's definition, the profiles can help avoid confusion when considering a variety of ocean uses with different functional and operational characteristics. For example, the profile definition for scuba/snorkeling includes scuba diving, surface supplied diving, and snorkeling or free diving. It excludes, however, surface swimming without such gear (mask, fins, snorkel, air supply, etc.), as well as fishing while scuba diving or snorkeling; each of which involves different purposes, functional characteristics, three-dimensional footprints, and potential impacts on other uses.

Location of the Use

Many ocean uses involve different activities occurring in different locations across the seascape over time. For example, human uses typically occurring offshore or in deeper water, such as scuba/snorkeling, often require transit by boat from land to and back from the main area of operation (Figure 4).

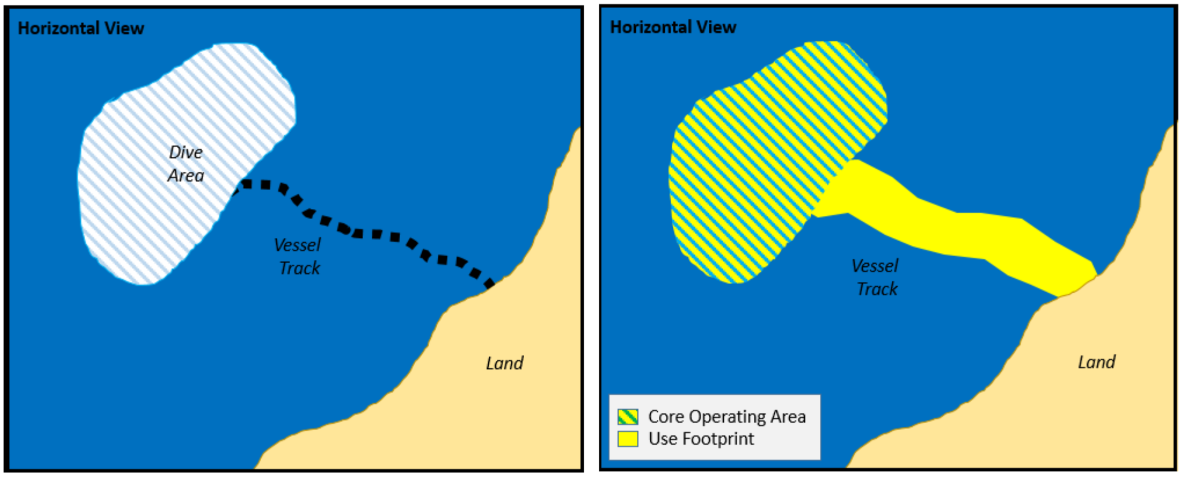


Figure 4. Depiction of scuba/snorkeling for the horizontal dimension, showing (left) the dive area and vessel transit track for a typical scuba dive; and (right) those distinct areas combined to reveal the use's overall use footprint.

In such cases, the entire use involves transit by boat across a narrow, temporary, and often flexible swath of water along the ocean's surface, coupled with a more localized and three-dimensional occupation of the area where the diving activity actually occurs. To capture each of these distinct phases of a single use, Section 1 distinguishes between the core activity area and the overall use footprint (see box for definitions of these terms). Figure 4 depicts the horizontal extent of the dive area and vessel tracks, and shows how those distinct, and often overlooked, areas combine to contribute to the overall use footprint of scuba diving.

Components of the Use

In addition to the human participants, many common ocean uses also involve a variety of physical objects, such as vessels, fixed or moving gear, and sometimes installed infrastructure. The functional components section of each profile specifies five types of functional components of any use that, taken together, paint a more holistic picture of how the use may occupy three-dimensional ocean spaces when they are employed. These functional components - people, vessels, anchors, moving gear, and installed infrastructure – are defined in Figure 5.

Core Use Area and Overall Footprint

Core Activity Area(s): describe the types of ocean areas where the primary activities of the use are typically conducted.

Overall Use Footprint: includes all the ocean areas potentially involved in the pursuit of the use, including core activity area(s) and other ocean spaces traversed when moving to, from, and among them.

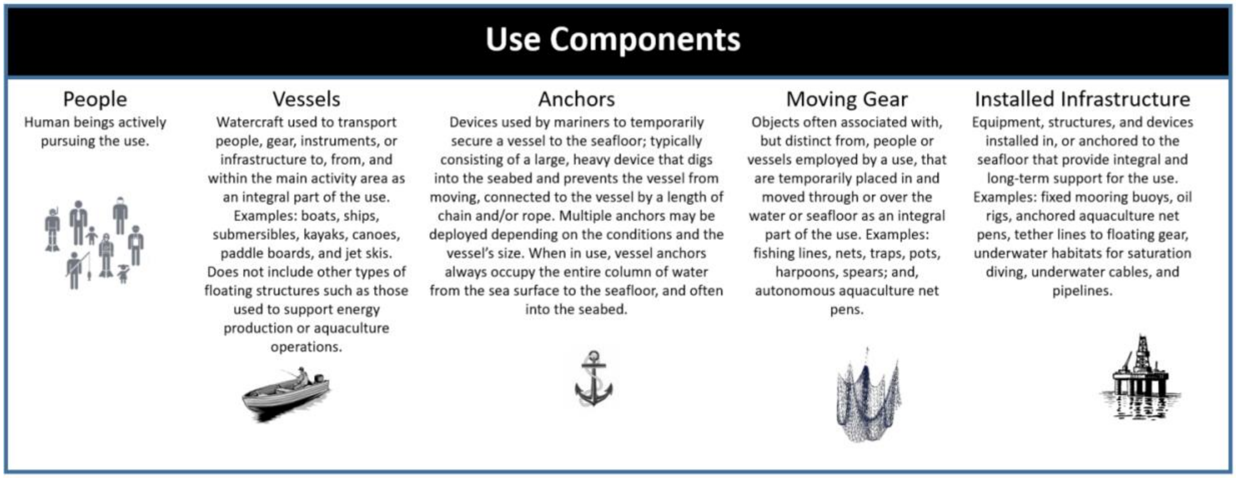


Figure 5. Definitions of the functional components employed by various ocean uses.

Examples

Table 1 provides the general descriptions developed for the three examples of ocean uses. Each subsequent section will characterize these same three examples to illustrate how the profiles can be used to compare and contrast across different kinds of ocean uses.

Table 1a. General descriptions for scuba and snorkeling ocean uses.

Scuba/Snorkeling 	
These forms of diving tend to occur relatively close to shore and in shallow water. As a result, the core activity area and overall footprint often overlap considerably, unless vessels are used to visit distant dive locations, or in the case of shore-entry dives. The use (e.g., the person and/or anchor) may extend from the surface to the seafloor depending on the habitat and purpose of the dive.	
Use Includes:	Scuba diving, surface supply diving, or snorkeling (e.g., free diving).
Use Excludes:	Swimming and dive fishing.
Use Footprint:	Typically encompasses dive sites and relatively narrow tracks followed by vessels to reach and return from dive sites.
Core Activity Area:	Dive site(s), including areas traversed on drift dive, typically occurring in relatively shallow nearshore or coastal waters reachable via swimming or vessels, and extending from the sea surface to the seafloor. See Table 2 for occurrence in horizontal and vertical zones.
Functional Components:	People (e.g., divers, boat operators), vessels, anchors, moving gear (e.g., towed sleds, marker buoys) infrastructure (e.g., mooring buoys, navigational aids).
Notes and Assumptions:	Assumes a typical dive profile and gear (i.e., no extreme depths or saturation divers in underwater habitats).

Table 1b. General descriptions for non-commercial fishing with mobile benthic gear.

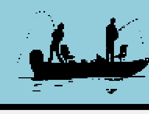
Non-Commercial Fishing with Mobile Benthic Gear 	
This mobile use involves a slow-moving vessel pulling, lowering, and/or raising fishing gear on the seafloor, sometimes over relatively long distances within the core operating area. The overall footprint of this use also includes surface transit routes to and from port.	
Use Includes:	Fishing from private or charter boats using moving gear to catch benthic fishes and invertebrates for non-commercial purposes or traditional and customary practices.
Use Excludes:	All other forms of fishing.
Use Footprint:	Use footprint includes the active fishing areas and areas transited from and back to port.
Core Activity Area:	Benthic mobile fishing can occur throughout the nearshore, coastal and oceanic zones in all depths, including the intertidal when submerged at high tides. See Table 2 for occurrence in horizontal and vertical zones.
Functional Components:	Vessel(s) (e.g., motorized, sailing, or paddled); crew (i.e., people); anchors; fishing gear (e.g., lines, hooks, pulled nets, trawls, dip nets, spears, harpoons) in the water.
Notes and Assumptions:	Harpoons and spears are used for benthic fishing only in very shallow water where bottom-dwelling fish are visible and reachable. Excludes illegal fishing methods such as explosives or poison. Assumes that other forms of fishing are not combined during the same activity.

Table 1c. General descriptions for renewable energy.

Renewable Energy 	
This stationary and permanent ocean use involves extraction of energy resources from wind, waves, or currents using installed infrastructure in a fixed location that is connected to subsurface transmission cables running on or under the seafloor, ultimately connecting to a shore-based facility. Vessels and aircraft are used periodically to service the facility and its crew. The core activity area can extend from the air above the sea surface to below the seabed, while the often-extensive overall footprint also encompasses vessel transit routes to and from the facility as well as the paths of underwater cables and infrastructure.	
Use Includes:	Systems designed to generate electricity from wind, wave, currents, tidal power, hydrothermal energy, or ocean thermal energy conversion (OTEC) using turbines, fixed or floating platforms, buoys, dams, and other installations and the associated offshore infrastructure including substructures, transmission hubs, generators, cables, and service platforms.
Use Excludes:	Onshore power grids; solar energy structures
Use Footprint:	The overall use footprint comprises the core activity area(s), and the areas covered by associated underwater cables and devices connected to shore, operational vessels (surface and submarine), and aircraft.
Core Activity Area:	Core activities involve the in-situ capture and generation of energy using an installed device. These typically occur in nearshore and coastal zones, but may occur in oceanic zones with floating, tethered structures. See Table 2 for occurrence in horizontal and vertical zones.
Functional Components:	Infrastructure (e.g., turbines, fixed or floating platforms, buoys, and/or dams, and associated offshore infrastructure including substructures, transmission hubs, generators, cables, and service platforms); support vessels; and crew (people).

Insights

A comparison of the general descriptions of these three distinct uses illustrates some important differences in how they operate and occupy three-dimensional ocean space. For example: (i) their overall footprints differ widely, mainly due to difference in use of installed infrastructure along the seabed (e.g., renewable energy requires transmission cables, and a transit path for dive boats); (ii) their core operating areas target different horizontal zones (e.g., shallow nearshore dive sites vs. deeper offshore wind turbine sites) and different vertical zones (e.g., air vs. water column vs. seafloor) in the seascape; (iii) they involve different types and degrees of moving or installed components that may affect other users; and (iv) they may place nearby humans at potential risk in different ways throughout their overall footprint.

Profile Section 2: Three-Dimensional Space Use

Section 2 of the space use profiles provides more spatial specificity about where the use occurs across the horizontal seascape and in the vertical water column. Each use is scored according to where it can be expected to typically occur across five horizontal zones running from the shoreline seaward, and across five vertical zones running from the air above the sea surface downward into the seabed (Figure 6).

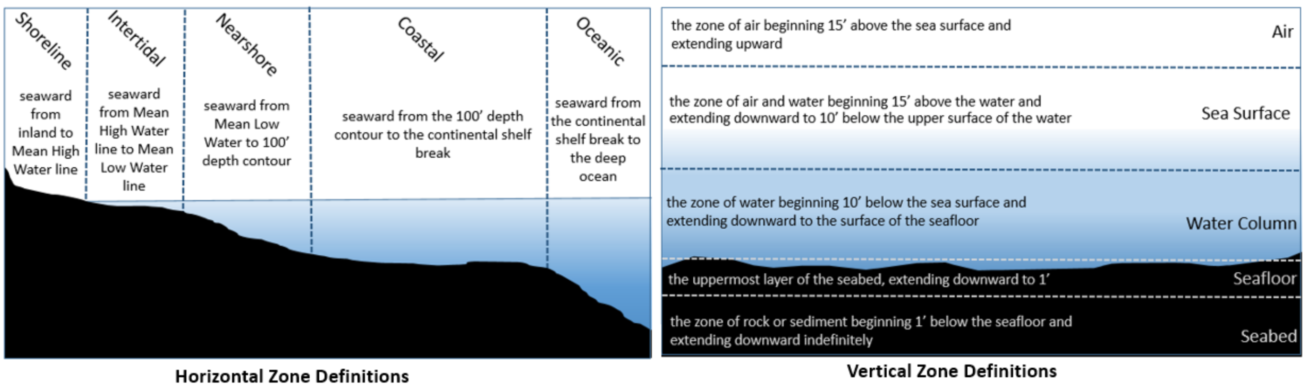


Figure 6. Horizontal and vertical zone definitions.

Definitions of Horizontal and Vertical Zones

The bounds of the horizontal and vertical zones include considerations of how, and for what purposes, different ocean zones are typically occupied by human uses. For example, within the horizontal zones, the seaward limit of the nearshore zone ends at the 100-foot depth line, reflecting the outermost extent of many typical recreational ocean uses. Additionally, within the vertical zones, the surface zone includes the first 15 feet of air above the sea surface in order to include activities occurring on the surface using small boats and other devices that extend only slightly into the air. This allows the profiles to realistically distinguish the spatial requirements of common, small-scale, and largely boat-based uses (e.g., diving) vs. larger-scale, industrial uses involving larger vessels with taller superstructures, aircraft, and/or installed infrastructure (e.g., commercial fishing or renewable energy).

Creating the Profile

Each use is scored by how often its core activity area(s) and overall use footprint are likely to occupy specific horizontal or vertical spaces when the use is being pursued in a typical ocean setting. In other words, where would a typical user likely go to pursue this use? Assigned location scores range from always, often, sometimes, rarely, to never.

Examples

Table 2 illustrates, for each example use, how likely its core activity area and overall use footprint are to occur in specific horizontal and vertical zones.

Table 2a. Space use in horizontal and vertical zones for scuba and snorkeling.

Scuba/Snorkeling

These forms of diving tend to occur relatively close to shore and in shallow water. As a result, the core activity area and overall footprint often overlap considerably, unless vessels are used to visit distant dive locations, or in the case of shore-entry dives. The use (e.g., the person and/or anchor) may extend from the surface to the seafloor depending on the habitat and purpose of the dive.

Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
Core Activity Area	Never	Rarely	Often	Sometimes	Rarely	Diving typically occurs in depths less than 100 feet, but may occur in deeper open ocean or intertidal areas. Snorkeling typically occurs in very shallow water less than 50 feet, but may occur deeper in certain areas with clear water (e.g., coral reefs).
Use Footprint	Sometimes	Rarely	Often	Sometimes	Rarely	Footprint may include entry/exit from shore, which can be the norm in some areas.
Vertical Zone	**Air**	**Sea Surface**	**Water Column**	**Seafloor**	**Seabed**	**Notes**
Core Activity Area	Sometimes	Always	Often	Sometimes	Sometimes	Divers typically occur from the sea surface to the seafloor; large vessels may extend up into the air and/or use anchors or moorings extending into the seabed. Snorkelers typically do not extend into the water column, but may contact the seafloor in shallower waters.
Use Footprint	Sometimes	Always	Often	Often	Sometimes	See above.

Table 2b. Space use in horizontal and vertical zones for non-commercial fishing with benthic mobile gear.

Non-Commercial Fishing with Benthic Mobile Gear

This type of recreational fishing typically uses moving vessels and bottom gear placed or pulled along or near the bottom. It generally occurs in the nearshore, coastal or oceanic horizontal zones, and occasionally the shoreline and intertidal in the case of shore-launched vessels (e.g., kayaks). It typically extends vertically from the seafloor up to the Surface, and may involve the seabed when anchors are used, or into the air depending on vessel size.

Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
Core Activity Area	Never	Sometimes	Often	Often	Sometimes	Fishing efforts typically peak in the nearshore and coastal zones, and decrease in extreme depths.
Use Footprint	Rarely	Sometimes	Often	Often	Sometimes	Small boats may be launched and retrieved from shore.
Vertical Zone	**Air**	**Sea Surface**	**Water Column**	**Seafloor**	**Seabed**	**Notes**
Core Activity Area	Rarely	Always	Often	Often	Sometimes	Assumes trawls can disturb sub-surface sediments and assemblages in the seabed.
Use Footprint	Rarely	Always	Often	Often	Often	Large vessels may extend into the air; anchors or fishing gear may rest on seafloor and seabed.

Table 2c. Space use in horizontal and vertical zones for renewable energy.

Renewable Energy

This use depends on installed infrastructure and thus its overall use footprint extends horizontally from the shoreline, through the intertidal (e.g., transmission cables) seaward to energy facilities in both the nearshore, coastal and, rarely, the oceanic zones (e.g., tethered). Both the overall footprint and the core activity area(s) extend vertically from the air down to into the seabed.

Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
Core Activity Area	Never	Never	Sometimes	Often	Rarely	The location will vary with bathymetry, energy distributions (e.g., wind fields), and oceanographic conditions.
Use Footprint	Always	Always	Always	Often	Rarely	Cables run from generation site(s) to onshore.
Vertical Zone	**Air**	**Sea Surface**	**Water Column**	**Seafloor**	**Seabed**	**Notes**
Core Activity Area	Often	Always	Always	Always	Always	Assumes most but not all devices extend upward into air, and all extend down into seabed.
Use Footprint	Often	Always	Always	Always	Always	See above.

Insights

Section 2 provides critical insight into the relative importance of different ocean spaces for the successful pursuit of the use. Section 2 can reveal important differences both within and among specific uses in their relative reliance on, and thus their potential for creating conflicts in, different ocean spaces within their core activity areas and overall use footprint. Figures 7 and 8 illustrate the information contained in Section 2 for the horizontal (Figure 7) and vertical (Figure 8) zones. Figure 7 compares the space occupancy requirements of the three example ocean uses across horizontal zones (columns), showing both core activity areas and overall use footprint for each (paired rows). The green-red color ramp depicts the always-often-sometimes-rarely-never reliance scores from Section 2, with green indicating always and red indicating never.

Figure 7 reveals, for all three uses, an overall dependence on the nearshore and coastal zones, with less reliance – and therefore fewer potential interaction and conflicts – in the oceanic, intertidal, or shoreline zones. The important exception to this pattern is renewable energy. In contrast, its overall footprint requires constant access to all five horizontal zones shoreward from the core activity area. Additionally, for each use, there is strong correspondence in reliance between its core activity areas and overall footprint, except in the most shoreward zones where differences begin to emerge, particularly for renewable energy.

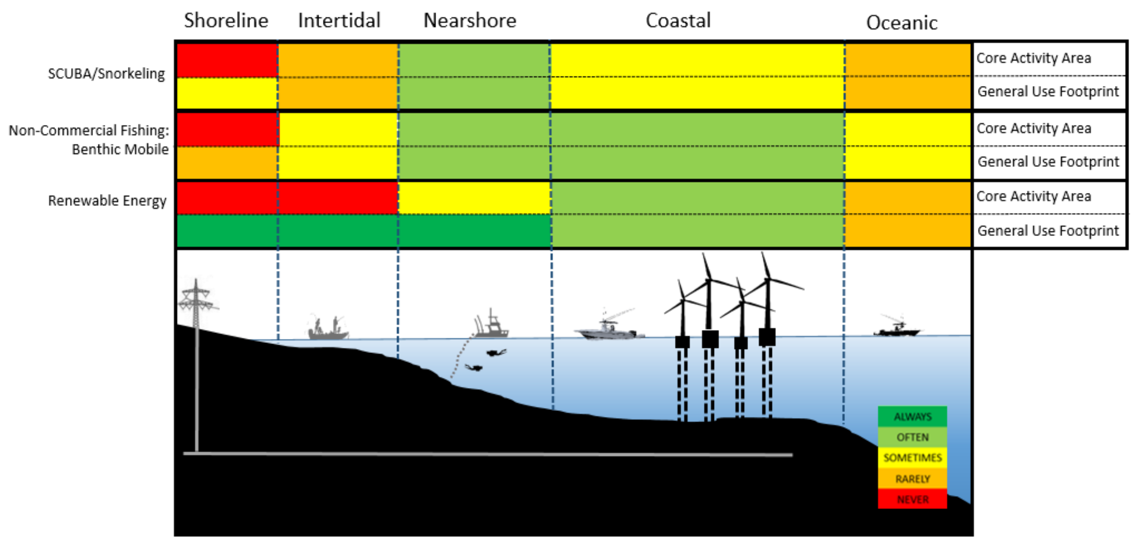


Figure 7. Comparison of horizontal space use for three example ocean uses.

Figure 8 compares space occupancy requirements across the vertical zones (rows) for each use's core activity area and overall use footprint (paired columns).

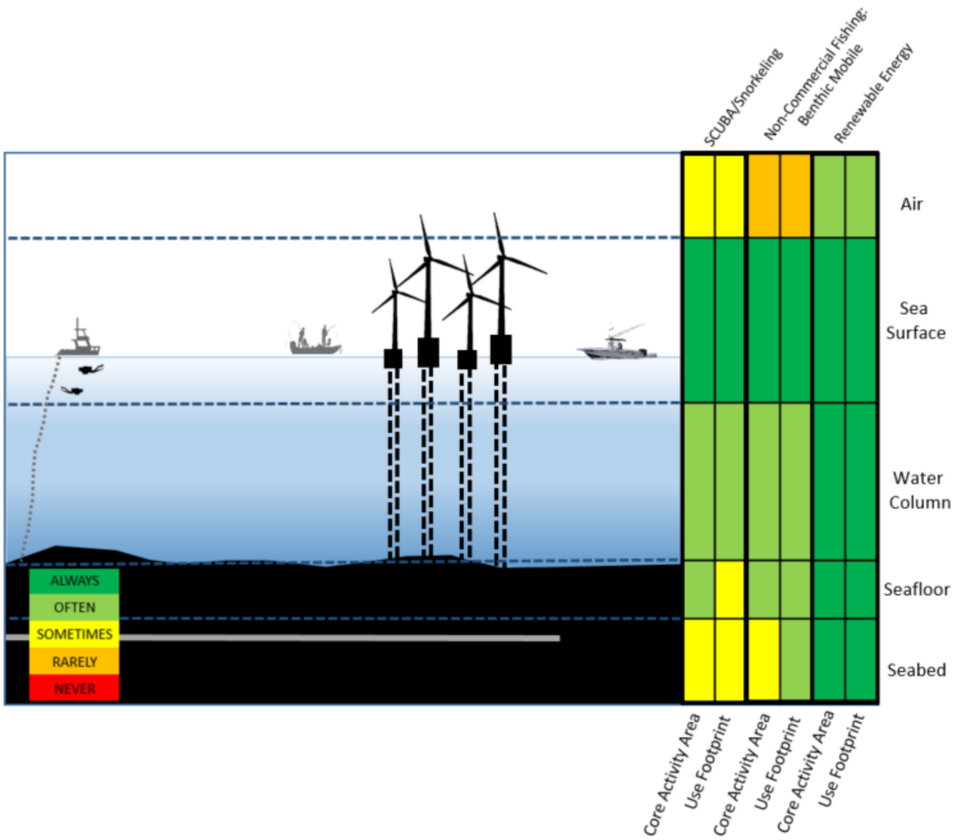


Figure 8. Comparison of vertical space use for three example ocean uses.

Several meaningful patterns emerge from Figure 8. First, certain vertical zones (i.e., the sea surface and water column) are important to the pursuit of all three uses, both in their core activity areas and overall use footprints. Differences among the uses become more pronounced at both extremes of the vertical gradient, particularly in their relative reliance on the air zone and seabed. Second, individual uses tend to be fairly consistent across both their core and footprint areas in their requirement for specific vertical zones, especially above the seafloor. Third, one use – renewable energy – requires near-constant access to all vertical zones from the air to the seabed for its successful pursuit, while others are more variable and potentially flexible in their siting.

Profile Section 3: Space Use by Functional Components

In addition to the people engaged in the use, many typical ocean uses often involve various types of physical gear. The space use profiles describe five categories of functional components for any given ocean use and illustrate the likelihood that they will be employed in specific horizontal and vertical zones:

- People
- Vessels
- Anchors
- Moving Gear
- Installed Infrastructure

For any use, each of the five functional components (Figure 5) has a unique three-dimensional footprint and is employed at specific places and times during the use. Often critical to the successful pursuit of the use, the functional components can determine the full spatial extent of the overall footprint of their use (e.g., permanent mooring buoys for dive boats; fishing gear towed behind vessels; transmission cables connecting wind turbines to onshore grids). Consequently, the horizontal and vertical distribution of a use's functional components can profoundly shape whether, where, and how it may interact or conflict with other co-occurring activities. For example, a towed fishing line (moving gear) may snag a nearby scuba diver (people) far below the boat, or an underwater energy transmission cable (installed infrastructure) may entangle bottom-tending fishing gear (moving gear).

Creating the Profile

Section 3 of the profiles describes, for the five possible functional components of a use, where in the horizontal and vertical zones each component is likely to occur throughout the core activity area and overall use footprint during a typical pursuit. As a result, it paints a more detailed, and quantifiable, picture of the total three-dimensional space occupancy of the use by separately considering the likely locations of all of its functional components: people, vessels, anchors, moving gear, and/or installed infrastructure. Space occupancy by each functional component is scored using the qualitative "always-to-never" scoring scale employed in the previous section. Scores were assigned using the following approach for the horizontal and vertical zones. See the 'notes' column in Table 3 for definitions and clarifying remarks about how each functional component operates within specific horizontal or vertical zones.

- Occupation of horizontal zones -- Section 3 assesses the relative likelihood that each of the use's five specific functional components will be employed within a given horizontal zone, when the overall use is occurring in that horizontal zone.
- Occupation of vertical zones – Section 3 also assesses the likelihood that a specific functional component will be used within a given vertical zone, assuming that the component is being employed somewhere by that use.

Examples

Table 3a. Space use by functional components for scuba and snorkeling.

Scuba/Snorkeling 						
In addition to the divers themselves, these types of diving often involve other functional components, such as vessels and anchors. The role of these components, and their occurrence in different horizontal zones, often increases with distance from shore, reflecting the greater logistical constraints of accessing and diving in deeper, offshore water. Similarly, the distribution of functional components throughout vertical zones reflects the varying requirements of diving in different depths, with differences in component usage often becoming more pronounced toward the bottom.						
Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
People	Always	Always	Always	Always	Always	By definition, if the use is occurring, it involves people (i.e., divers) wherever it occurs.
Vessels	Sometimes	Rarely	Often	Always	Always	Diving from boats is more common as depth and distance from shore increase.
Anchors	Sometimes	Rarely	Often	Always	Always	Anchors for dive vessels are often used in relatively shallow water but not in extreme depths.
Moving gear	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes	In all zones, moving gear (e.g., tow lines and sleds, dive site markers, lift bags) may be used during the dive.
Infrastructure	Rarely	Rarely	Sometimes	Sometimes	Never	Mooring buoys and site markers may be used in moderate depths.
Vertical Zone	Air	Sea Surface	Water Column	Seafloor	Seabed	Notes
People	Never	Always	Often	Often	Never	Divers (always a component of the use) begin and end at the surface, often enter the water column, often contact the seafloor but never excavate the seabed.
Vessels	Always	Always	Sometimes	Sometimes	Never	When used, dive boats typically occupy the sea surface and sometimes are intentionally beached on the seafloor. Larger, deep-draft vessels may also extend upward into the air.
Anchors	Never	Always	Always	Always	Often	When used, anchors typically extend from the sea surface to the seabed.
Moving gear	Never	Always	Often	Sometimes	Never	When used, moving gear (e.g., lines, floats, marker flags) is most often employed in the upper layers of the water column but may be temporarily anchored on the seafloor.
Infrastructure	Sometimes	Always	Always	Always	Often	When used, fixed mooring buoys or navigation marks extend from sea surface to the seabed.

Table 3b. Space use by functional components for non-commercial fishing with benthic mobile gear.

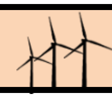
Non-Commercial Fishing with Benthic Mobile Gear

Recreational bottom fishing can occur throughout most horizontal zones and often tends to be concentrated between the nearshore and coastal zones. As the activity's location moves horizontally seaward, some common functional components (e.g., anchors, buoys) become less critical to its pursuit. Looking vertically, some components (e.g., people, vessels) vary widely across depth zones, while others (e.g., anchors, moving gear and infrastructure) are more consistently present throughout the vertical zones.

Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
People	Not Applicable	Always	Always	Always	Always	The main activity does not occur on the shoreline, and only at high tide in the intertidal. Elsewhere, people are always involved (by definition).
Vessels	Not Applicable	Always	Always	Always	Always	The main activity does not occur on the shoreline, and only at high tide in the intertidal. Elsewhere, vessels are always involved (by definition).
Anchors	Not Applicable	Sometimes	Sometimes	Rarely	Never	The main activity does not occur on the shoreline, and only at high tide in the intertidal. Typically, anchors are used for short periods, overnight or to ride out bad weather.
Moving gear	Not Applicable	Always	Always	Always	Always	All fishing gear is, by definition, moving gear. The main activity does not occur on the shoreline, and only at high tide in the intertidal.
Infrastructure	Not Applicable	Rarely	Sometimes	Sometimes	Rarely	Installed infrastructure can be used to secure vessels or as navigation aids. The main activity does not occur on the shoreline, and only at high tide in the intertidal.
Vertical Zone	**Air**	**Sea Surface**	**Water Column**	**Seafloor**	**Seabed**	**Notes**
People	Never	Always	Never	Never	Never	Always involved. People occur exclusively at the sea surface, and by definition, in vessels.
Vessels	Rarely	Always	Sometimes	Rarely	Never	Always involved, some large vessels extend up into the air zone; some down into the water column and some intentionally beached on the seafloor as part of the fishing activity.
Anchors	Never	Always	Always	Always	Always	When used, anchors run from the sea surface to the seabed.
Moving gear	Rarely	Always	Often	Often	Sometimes	Mobile benthic gear is suspended from the sea surface to the seafloor and sometimes into the seabed; it occasionally extends into the air on davits or other devices; and it often extends downward through the water column (except in the intertidal) to the seafloor (except when fishing immediately above the bottom).
Infrastructure	Rarely	Always	Always	Always	Often	When used, infrastructure extends from the sea surface to seabed, and sometimes into the air.

Table 3c. Space use by functional components for renewable energy.

Renewable Energy



This multi-faceted industrial use involves installed wind turbines anchored to the seabed and connected to the shore-side electric grid via a network of undersea transmission cables. Looking horizontally, infrastructure is the only constant component of this use, always occurring in all of the five zones. People and vessels occur sometimes as needed, and mainly in the coastal, offshore and oceanic zones. The vertical distribution of components, and thus their potential impacts on other uses, varies across depths as well, with people and vessels being the most common and clustered in the upper zones.

Horizontal Zone	Shoreline	Intertidal	Nearshore	Coastal	Oceanic	Notes
People	Rarely	Rarely	Sometimes	Sometimes	Sometimes	People occur intermittently on structures for maintenance and operational activities.
Vessels	Never	Rarely	Sometimes	Sometimes	Sometimes	Vessels are involved in installation and maintenance and are more frequently used further offshore.
Anchors	Never	Never	Sometimes	Rarely	Never	Anchors may be used by vessels during temporary visits to site(s); their use depends on depth and bottom type.
Moving gear	Never	Rarely	Rarely	Rarely	Rarely	Moving gear includes installation and maintenance, but not the moving parts of the devices.
Infrastructure	Always	Always	Always	Always	Always	Renewable energy generally always involves infrastructure spanning from generation sites (devices) to the shoreline and potentially beyond.
Vertical Zone	**Air**	**Sea Surface**	**Water Column**	**Seafloor**	**Seabed**	**Notes**
People	Sometimes	Always	Rarely	Rarely	Never	Assumes people are on rigs, vessels and aircraft at or above the sea surface, and rarely in or under the water.
Vessels	Sometimes	Always	Sometimes	Never	Never	Assumes vessels are only surface boats and ships, not submarines. Larger vessels may extend up to air and down to water column.
Anchors	Never	Often	Always	Always	Always	When used, anchors run from the sea surface to the seabed.
Moving gear	Sometimes	Often	Often	Often	Sometimes	When used, moving gear may include submarines, remotely operated vehicles, trenching and cable laying machines, and helicopters.
Infrastructure	Often	Always	Always	Always	Always	Assume that infrastructure extends from sea surface to seabed, and some extend into the air.

Insights

The tables above show how each of the three ocean uses involves a distinct suite of functional components (people, vessels, anchors, gear, and installed infrastructure), and that each of those components has its own individual three-dimensional footprint in ocean space. Figures 8 and 9 present the above results graphically using the green-red color ramp reflecting the spectrum of importance from always to never. They reveal important differences among uses in how their respective overall functional components occupy space in different horizontal and vertical zones.

Figure 9 illustrates the relative occurrence of each use's functional components (grouped rows) across five horizontal zones (columns). It reveals that while the three ocean uses may overlap spatially in three dimensions across their overall footprints, the three-dimensional distribution of their functional components differs widely within that footprint and across their operating ranges. As a consequence, the uses' potential for interaction and conflict may be driven largely by certain functional components most likely to come into contact with other co-occurring uses.

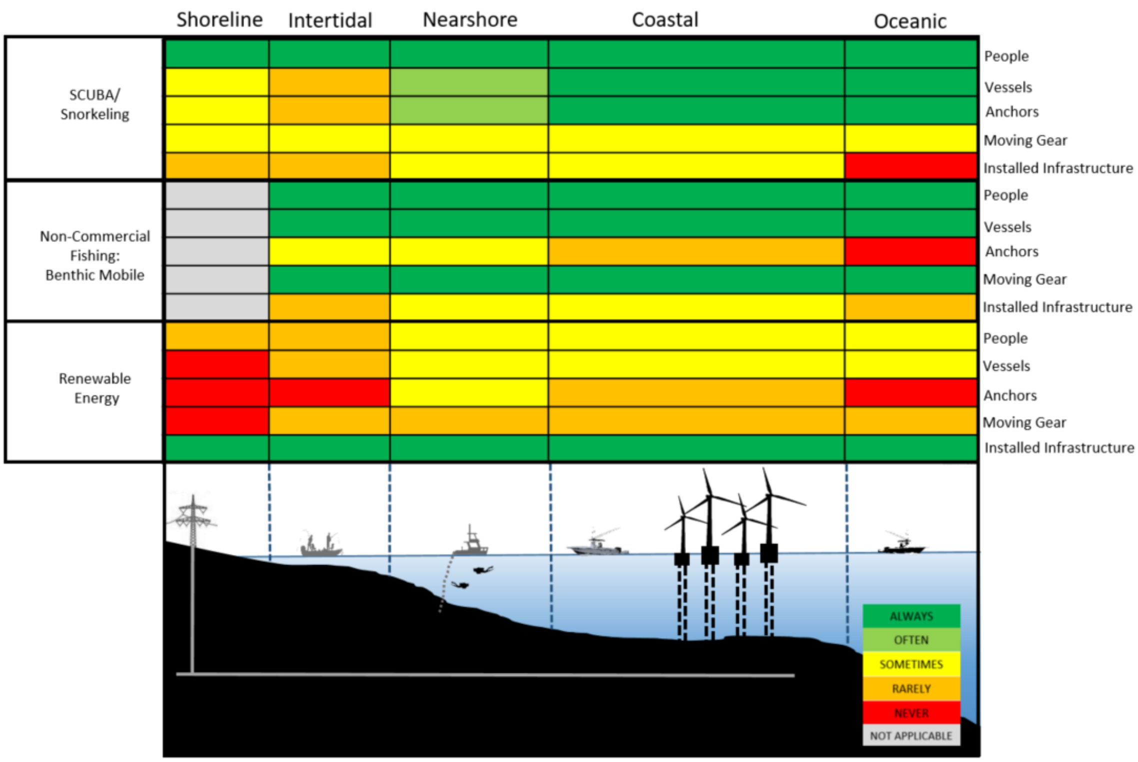


Figure 9. Horizontal space use by functional components for three example ocean uses. Read down the columns for component rankings in each horizontal zone.

Figure 10 shows the relative occurrence of each use's functional components (grouped columns) across the five vertical zones (rows). It reveals that, as expected, most of the three uses' functional components occupy space in the sea surface zone when being employed. However, the prevalence of functional components tends to decrease and become more variable among uses moving upward to the air zone and downward to the seabed zone. Three functional components – anchors, moving gear, and infrastructure – tend to occupy the widest range of vertical zones from the sea surface downward. This pattern may influence the role of these components in generating potential conflicts with other uses.

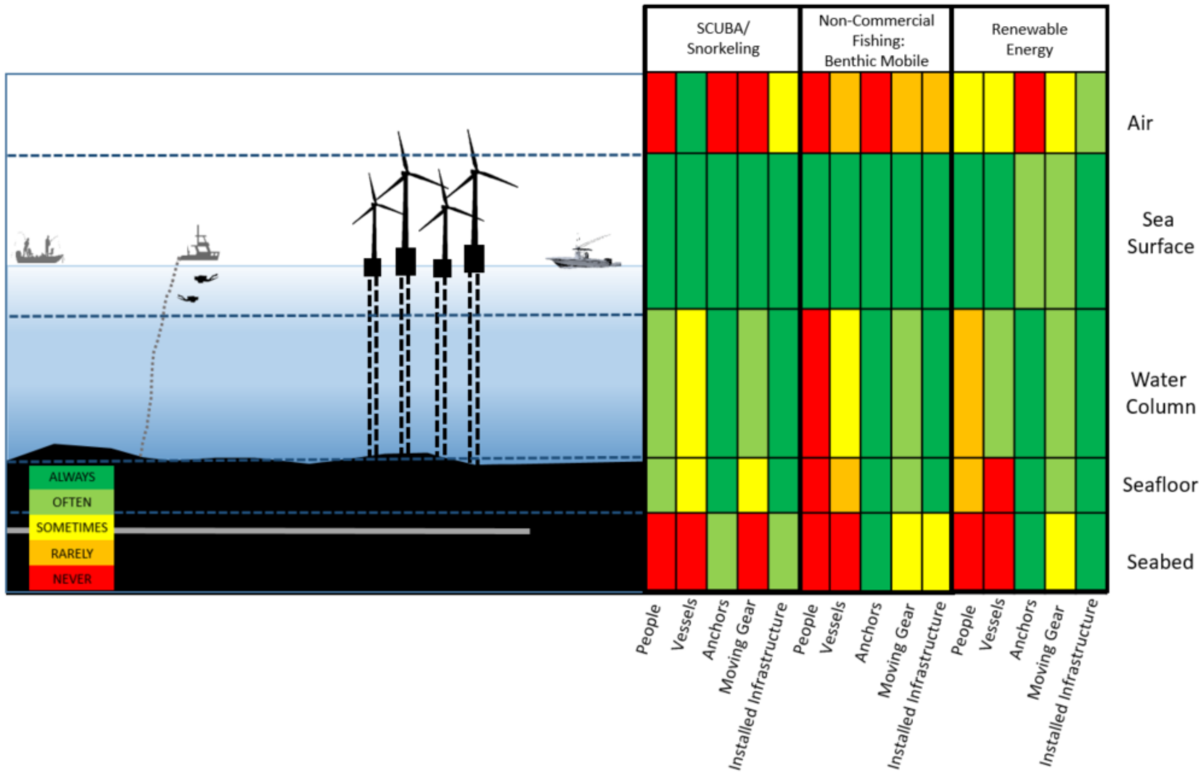


Figure 10. Vertical space use by functional components for three example ocean uses. Read across the rows for component rankings in each vertical zone.

Profile Section 4: Importance of Functional Use Components

Section 4 of the profiles identifies which of the use's five functional components (people, vessels, moving gear, anchors, and installed infrastructure) are most important to its successful pursuit, and therefore which are most likely to be employed when the use is occurring. The profiles rank each of the functional components as either primary, secondary, or not applicable aspects of the use (see box for definitions).

Use Component Rankings:

Primary = essential and routinely used in the core activity area(s)

Secondary = may be used in the core activity area(s) and/or in the overall footprint of the use

Not Applicable = rarely or never employed by the use anywhere within the overall footprint

Examples

Table 4a. Functional component rankings for scuba and snorkeling.

Scuba/Snorkeling		
Component	**Ranking**	**Notes**
People	Primary	Activity always involves people as diver(s) or boat crew.
Vessels	Secondary	Boats are sometimes used to transport divers and gear to and from dive sites, depending on the area.
Anchors	Secondary	Anchors are sometimes used to secure boats to the seafloor.
Moving Gear	Secondary	Moving gear is sometimes used to operate boats (e.g., sea anchors), mark dive sites, or tow divers.
Infrastructure	Secondary	Fixed mooring or navigation buoys are sometimes used by vessels.

Table 4b. Functional component rankings for non-commercial fishing with mobile benthic gear.

Non-Commercial Fishing with Mobile Benthic Gear		
Component	**Ranking**	**Notes**
People	Primary	People (fishermen) are always involved in this activity.
Vessels	Primary	Fishing vessels are always involved in this activity.
Anchors	Secondary	Fishing vessels may use anchors to secure to the seabed.
Moving Gear	Primary	The gear used in this type of fishing is always mobile.
Infrastructure	Secondary	Fishing vessels may use mooring buoys or navigation markers.

Table 4c. Functional component rankings for renewable energy.

Renewable Energy		
Component	**Ranking**	**Notes**
People	Secondary	People are intermittently involved onsite for maintenance and management but typically not for routine operations.
Vessels	Secondary	Vessels are involved mainly to ferry people to the sites, to conduct assessments, and make repairs of the infrastructure and devices.
Anchors	Secondary	Anchors may be used by vessels during temporary operations at the sites.
Moving Gear	Secondary	Moving gear may be temporarily employed by vessels. This component does not include moving parts of the energy-generating devices themselves, which may rotate or oscillate in place, but are fixed spatially and do not change location over time.
Infrastructure	Primary	Infrastructure includes all devices, platforms, tethers, cables, and other equipment installed at the site as part of the generation and distribution of renewable energy.

Insights

Primary components noted in Table 4 are shown graphically in Figure 11, superimposed on the likelihood of space use by components in each horizontal and vertical zone (derived from Section 3). Here, cells marked with an asterisk (*) indicate specific locations in three-dimensional ocean space where that use's primary functional components are typically employed.

Cells coded green and * indicate areas in horizontal and vertical space where that primary component is most likely to occur and to interact with other co-occurring uses.

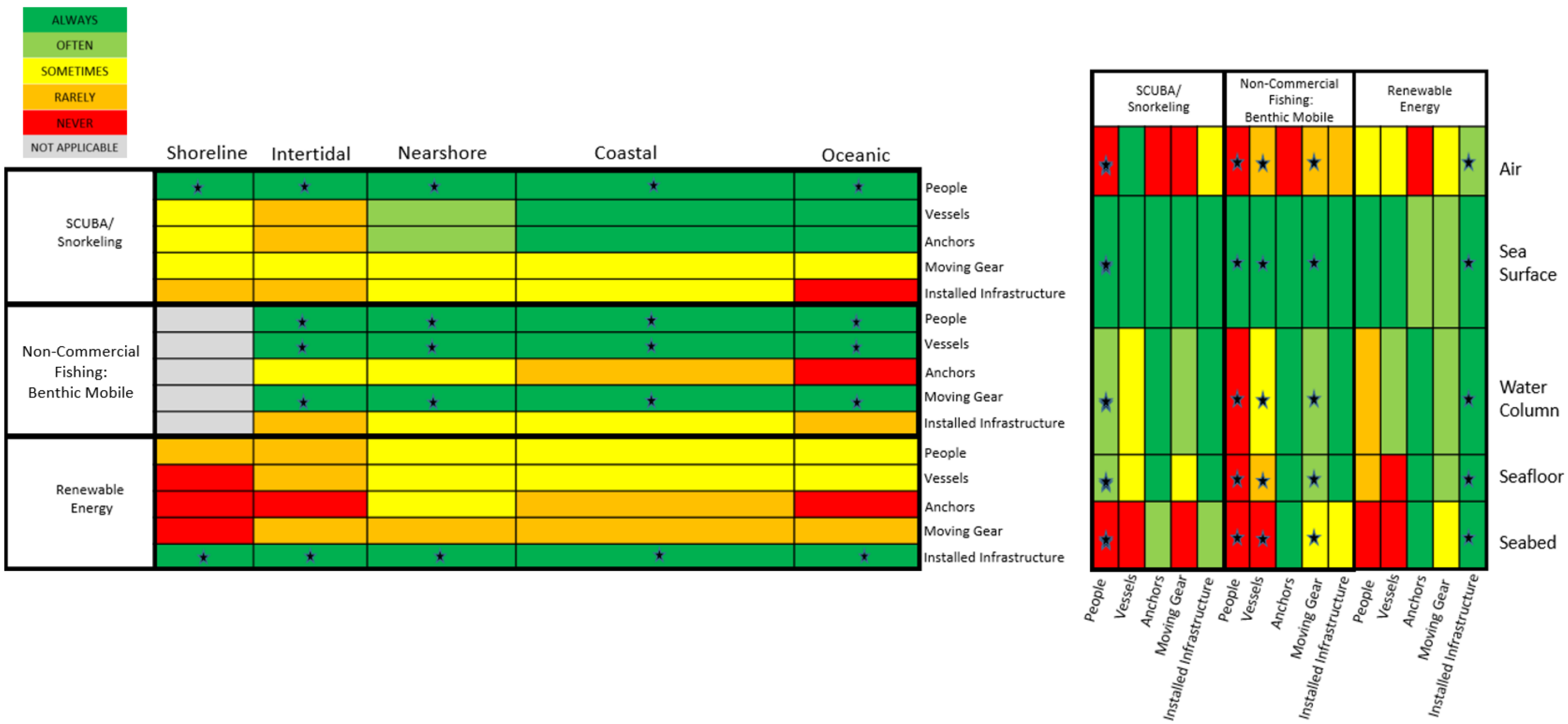


Figure 11. Likelihood of occurrence of primary functional components (*) across horizontal (left) and vertical (right) zones.

Figure 11 shows considerable variation among the three uses in the importance of specific three-dimensional spaces for their five functional components. In addition to people, vessels are the main commonality among two of the three uses across the horizontal dimension (Figure 11, left). Of the three uses, non-commercial fishing with mobile benthic gear has the greatest reliance on specific horizontal zones for both its primary functional components (i.e., people, vessels, moving gear) and its core activity area.

Figure 11 (right) further illustrates the importance of where a use's functional components occur in creating the conditions for conflict across the vertical dimension. First, the sea surface zone is the most important vertical zone to the greatest number of primary functional components across the three uses, reflecting its central role in the conduct of most ocean uses. Second, the consistency among different functional components begins to diverge markedly moving upward to the air zone and downward to the seabed. Third, the results also reveal the potential conflict between non-commercial fishing with benthic mobile gear and renewable energy on the seafloor. Both require routine access to that vertical zone by critical functional components (i.e., moving gear and infrastructure) that may not be compatible in operation (For example, fishing gear could snag cables.)

The relative importance of a given use's functional components in specific horizontal and vertical zones indicates whether and how those components may contribute to interactions with other co-occurring uses. This knowledge allows planners and operators to both identify and potentially avoid component-mediated conflicts among uses operating in the same space. For example, scuba diving from shore or from a dive boat tethered to a permanent mooring is unlikely to interact adversely with fixed infrastructure on the seabed, such as fishing gear or transmission cables. Securing the dive boat with an anchor rather than a mooring, on the other hand, could directly conflict with such bottom-dwelling components, leading to potentially serious consequences.

Profile Section 5: Operational Characteristics of Space Use

The remaining sections of the space use profile explore how the operation of any ocean use can influence the potential for conflict with other co-occurring uses. Section 5 illustrates how a use's operational characteristics can create conflicts through either exclusion of other uses from the operating area, or interference with other uses' normal and successful pursuit (see box for definitions).

Exclusion as a Source of Conflict

The likelihood that a given ocean use may directly exclude other uses from the same operating area is influenced by two key operational characteristics of the use: permanence of space occupancy and buffer zones.

Two Types of Conflict

Exclusion: the predictable long-term occupation of a particular ocean space by one use that physically precludes or excludes other uses from operating in the same area: typically involving large permanently installed infrastructure (e.g., oil rigs, underwater cables, channel markers, jetties).

Interference: active interactions between different ocean uses that directly diminish the successful pursuit, value or enjoyment of one or both uses through risk of direct damage or harm to humans vessels, anchors, mobile equipment, or installed infrastructure.

Permanence of Space Occupancy

The physical occupation of ocean space can prevent other uses from occurring in the same area. Different ocean uses vary widely in the level of permanence by which they occupy particular ocean areas. Familiar examples illustrating a spectrum of permanence include:

- Permanent or very long-term (e.g., multiple decades) installations of large energy, communication or sewage discharge infrastructure and associated pipes and cables;
- Long-term, but ultimately moveable, floating offshore renewable energy facilities;
- Anchored aids to navigation, mooring buoys, and floating platforms;
- Floating and anchored offshore aquaculture pens;
- Other ocean uses, both commercial and recreational, that are officially allocated to dedicated special use zones (e.g., swimming beaches).

Buffer zones

Restricted access zones around specific ocean uses (e.g., oil platforms, military firing ranges) can effectively prevent uses occurring beyond the immediate boundaries of that area. Different ocean uses vary in their employment of buffer zones and other spatial allocation schemes. Examples include:

- Strict, exclusion (no-go) zones in force at all times (e.g., certain military and offshore energy installations);

Operational Characteristics Contributing to Exclusion

Permanence of Space Occupancy– the degree to which the use typically occupies a fixed area of ocean indefinitely (e.g., wind turbines pylons and transmission cables, oil pipelines).

Buffer zones - the degree to which the use's core activity area is typically surrounded by an official, governmentally established buffer or exclusion zone that prohibits or limits approach by other uses for safety, security or other reasons (e.g., energy facility safety zone or military exclusion zone).

- Seasonal exclusion zones coinciding with cyclical events (e.g., spawning aggregations);
- Activity-based exclusion zones that prohibit or restrict certain uses in the area (e.g., fishing with benthic mobile gear near energy facilities; vessel transit in security zones; space launches; VIP visits);
- Temporary exclusion zones coinciding with short-term operational or management needs for restricted access (e.g., cruise ship anchoring, military training, sporting events).

Interference as a Source of Conflict

While interference between two conflicting uses may be less apparent or more transitory than outright exclusion, interference can, nonetheless, determine whether one or both uses can be successfully (including safely) pursued in the same operating area at the same time. The likelihood that a given use will interfere with others is determined, in part, by two basic characteristics: its degree of operational mobility, and whether the use routinely involves moving gear.

Operational Mobility

While a high mobility ocean use, such as motorized boating, may create conflicts with other uses that it encounters directly, it also has the potential to avoid such interactions either by selecting an operating area that is likely to be free of other users, or by changing its course or location in real time to avoid direct contact with nearby uses. In contrast, low mobility uses, such as some fishing operations using bottom gear, dredging, or anchored vessels, are often located in specific areas where targeted resources (e.g., the fish, the sand); are often relatively immobile in real-time, and cannot easily avoid imminent and potentially harmful interactions with other uses in the area. Consequently, low operational mobility translates into high conflict potential.

Operational Characteristics Contributing to Interference

Operational Mobility – the degree to which the use typically can select or modify in advance or in real time, its area of operation and thus control its movements and location (both horizontally and vertically) in response to the surrounding environment, including the presence of other uses or their components. Low operational mobility translates into high potential for conflict.

Moving Gear – the degree to which the use typically involves non-human components (e.g., fishing nets) that are lowered, raised, dragged or propelled in the air, at the sea surface, through the water column, along the seafloor and/or the seabed with little or no real-time ability to either sense of respond to the immediate operating environment, including the presence of other uses of their components. High reliance on moving gear translates into high potential for conflict.

Moving Gear

In contrast to ocean uses that are relatively self-contained with a limited spatial footprint (e.g., diving, swimming, kayaking sailing), ocean uses that routinely employ moving gear, such as fishing by trawling or trolling, can have a much larger effective footprint at any given time, resulting in potentially greater chances of encountering and conflicting with other uses in their path. Importantly, although the vessel towing the moving gear may itself be relatively maneuverable, its moving gear may extend far beyond the vessel, and be inherently less agile, and therefore be less able to adapt quickly to changing situations like obstacles in the surrounding water. Consequently, high reliance on moving gear translates into high conflict potential.

Creating the Profile

The four operational characteristics described above influence how any given use may interact, and potentially conflict, with other co-occurring uses. In order to assess the likelihood of such conflicts, the use's four operational characteristics are scored qualitatively based on their relevance and importance (high, medium, low) to the successful, routine operations of that use (see box for definitions). Tables 6 and 7 then translate those values into the uses' likelihood to exclude or interfere with other uses in the same area at the same time.

Scale of Likelihood

High: the characteristic either always applies or is highly likely to apply to use.

Medium: the characteristic may apply to the use depending on how, why or under what conditions or management regime it is being pursued.

Low: the characteristic never applies or is unlikely to apply.

Examples

Table 5a. Operational characteristics of space use for scuba and snorkeling.

Scuba/Snorkeling			
Exclusion	Permanence	Low	Other than saturation diving, typical dives are short-term, mobile and do not occupy space for long periods.
	Buffer zones	Low	Diving and snorkeling are not typically accompanied by official buffer zones around divers.
Interference	Mobility	Medium	Divers and snorkelers have some flexibility in selecting a dive site especially by boat, but have somewhat limited maneuverability once in the water.
	Moving Gear	Medium	Diving and snorkeling may involve safety lines, site markers, floats, lift bags, flags, etc. that may be towed or raised up through the water.

Table 5b. Operational characteristics of space use for non-commercial fishing with benthic mobile gear.

Non-Commercial Fishing with Benthic Mobile Gear			
Exclusion	Permanence	Low	Benthic fishing with moving gear is inherently transitory and only temporarily occupies ocean spaces.
	Buffer zones	Medium	Fishing operations may involve official safety zones when underway, depending partly on the type of vessel and gear used.
Interference	Mobility	Medium	Benthic mobile fishing operations are relatively maneuverable before moving gear has been deployed. Afterward, their flexibility may be considerably more limited in real-time.
	Moving Gear	High	This activity routinely involved lowering, pulling or raising gear (e.g., lines, nets, traps, dredges) through the water column and along the seafloor.

Table 5c. Operational characteristics of space use for renewable energy.

Renewable Energy		
Permanence	High	Renewable energy infrastructure is permanently installed in the seabed, along the seafloor to the shoreline, and up to the sea surface or air.
Buffer zones	High	Energy generation devices typically have an official exclusion zone surrounding their operating area for safety and security purposes.
Mobility	Low	Once installed, renewable energy infrastructure is immobile and cannot move to avoid obstacles or other uses.
Moving Gear	Low	This use sometimes involves moving gear in connection with installation, maintenance or temporary trips to support vessels.

Insights

Comparing the three example ocean uses reveals important differences in how they occupy ocean space and their potential consequences for other co-occurring uses. The following sections examine the relevance and implications of uses' operational characteristics as determinants for conflict potential.

Relevance of Operational Characteristics to the Use

Using the results for each use presented above, Table 6 presents the degree to which a use's four distinct operational characteristics may contribute to its potential for conflict through exclusion or interference with other uses seeking to operate in the same area, as scored from high (red), to medium (yellow) to low (green). The relationships between each characteristic's relevance to the use (above) and its corresponding influence on conflict (Tables 6 and 7) potential is shown below.

The results illustrate considerable variability among uses in how operational characteristics define the use of three-dimensional ocean space and create potential conflict with others. Specifically, results highlight marked differences in the uses' likelihood of creating exclusion conflict (e.g., renewable energy), and in the role of moving gear in creating interference conflicts (e.g., fishing).

Table 6. Operational characteristics and the potential for conflict. Color key: green=low, medium=yellow, red=high. * Note: For permanence, buffer zones and moving gear, relevance scores above translate directly to the potential for creating conflict (e.g., high permanence = high conflict; low buffer zones = low conflict). In contrast, for operational mobility, relevance scores are inversely related to conflict potential (e.g., low mobility = high conflict potential).

	Exclusion Due To		**Interference Due To**	
Ocean Uses	**Permanence**	**Buffer zones**	**Operational Mobility**	**Moving Gear**
Scuba/Snorkeling	Low	Low	Medium	Medium
Non-Commercial Fishing with Benthic Mobile Gear	Low	Medium	Medium	High
Renewable Energy	High	High	High	Low

Combined Potential for Conflict by either Interference or Exclusion for each Use

Table 7 further examines the relationship between operational characteristics and conflict potential at a higher level by aggregating the two components of exclusion (i.e., permanence and buffer zones) and the two components of interference (i.e., operational mobility and moving gear) into single scores for each type of conflict.

The results show that the three uses' relative likelihood to create conflict by exclusion, when ranked from least (green) to most (red) are: (i) scuba, (ii) non-commercial fishing with benthic mobile gear, and (iii) renewable energy. A similar pattern, although less pronounced, is seen for conflict by interference, with scuba being the least likely to interfere with other uses.

Table 7. Combined potential for conflict created by interference or exclusion. Color ramp ranges from low (dark green) to high (red).

	Combined Conflict Potential Via	
Ocean Uses	**Exclusion**	**Interference**
Scuba/Snorkeling	Low potential	Medium potential
Non-Commercial Fishing with Benthic Mobile Gear	Low-medium potential	Medium-high potential
Renewable Energy	High potential	Medium-high potential

Managing conflict among co-occurring ocean uses can benefit from a fuller understanding of how they occupy three-dimensional space. Clearly, each use's operational characteristics shape its spatial footprint and influence its likelihood of interacting and conflicting with other uses seeking to share the same ocean space.

Section 6: Spatial Constraints

The final section of the space use profiles characterize a use's degree of flexibility or choice in selecting specific operating areas in order to avoid conflict with other uses. The characteristics of every ocean use – spatial constraints – shape a use's potential for encounters, interactions and conflicts with others by defining where it and other uses may and may not operate. Every use's spatial constraints comprise two factors:

- Site Dependence – high site dependence may create conflicts over specific areas
- Spatial Management – actively managed uses may preclude or limit access by others to their operating areas

Creating the Profile

As in Section 5, each use is scored by the relative degree to which site dependence and spatial management apply to the routine operation of the use (see box right). Using available documents and expert advice, each factor was scored as either high, medium, or low, reflecting its relevance or importance to the use.

Spatial Constraints

Site Dependence: the degree to which the successful pursuit of the use requires access to specific ocean areas that possess certain essential and unevenly distributed resources, ecosystem features, or environmental conditions that are integral to the use (e.g., oil platforms, near oil deposits, wind farms in areas of reliable wind, surf spots new consistent surf breaks, fishing areas where fish are abundant). High site dependence can lead to high conflict potential.

Spatial Management: the degree to which the use's operating area is typically influenced by a government agency or planning entity that determines where, how and when it may operate with a broader ocean setting (e.g., offshore discharge pipes, trawling zones, shipping lanes).

Examples

Table 8a. Spatial constraints for scuba and snorkeling.

Scuba/Snorkeling 		
Site Dependence:	Medium	Successful diving and snorkeling can be done in a fairly wide range of safe and optimal environmental conditions, including safe sea states, clean water, healthy ecosystems, and low crowding by other uses.
Spatial Management:	Low	Diving and snorkeling are occasionally managed spatially at a localized scale, generally within an MPA or as part of other broader management schemes.

Table 8b. Spatial constraints for non-commercial fishing with benthic mobile gear.

Non-Commercial Fishing with Benthic Mobile Gear 		
Site Dependence:	High	Successful benthic fishing requires the presence of target species and favorable operating conditions (e.g., sea state, weather, crowding).
Spatial Management:	Medium	Benthic fishing with moving gear is sometimes managed spatially at a localized scale, generally within an MPA or as part of other broader fisheries management schemes.

Table 8c. Spatial constraints for renewable energy.

Renewable Energy 		
Site Dependence:	High	Successful energy generation depends heavily on the reliable presence and optimum distribution of the target energy resource (e.g., wind, waves, current) in the operating area.
Spatial Management:	High	Renewable energy is heavily regulated and operating areas are determined by government agencies.

Insights

Applying these criteria and the result above to the three ocean use examples again reveals important differences in how these distinct ocean uses occupy three-dimensional space, and how that occupation may impact other uses' access to the same areas. For example, both types of spatial constraint can lead to potential conflicts. High scores for site dependence and spatial management translate directly to high conflict potential, while low scores indicate lower conflict potentials.

Potential for Conflict Due to Spatial Constraints

Table 9 presents the results from Section 6 as they relate to the spatial characteristics' role in creating potential conflict with the individual scores (high, medium, low) color-coded as red, yellow, and green, respectively. For example, high site dependence in a use can create conflict with others seeking to operate in the same area (e.g., renewable energy), while lower scores for site dependence can indicate greater flexibility in selecting or sharing operating areas (e.g., scuba). High values for spatial management (e.g., renewable energy) are assigned to uses that have inflexible operating areas (often designated and mandated by management authorities). Similarly, lower scores for spatial management suggest the potential for the use's spatial footprint to adjust to local conditions and potentially avoid conflicts with other uses (e.g., scuba/snorkeling).

Table 9. Resulting conflict potentials created by spatial constraints for three example ocean uses. Color Key: green=low, medium=yellow, red=high.

	Conflict Potential Due To	
Ocean Uses	**Site Dependence**	**Spatial Management**
Scuba/Snorkeling	Medium	Low
Non-Commercial Fishing with Benthic Mobile Gear	High	Medium
Renewable Energy	High	High

The results reveal considerable variation among the three uses in the degree to which their choice of operating areas, and the resulting potential for conflict, is influenced by spatial constraints. Interestingly, site dependence leads to high conflict potential in two of the three uses (down the column), while spatial management is more variable in its role in creating conflicts.

Contrasting the Profiles of Three Common Ocean Uses

The space use profile for any use describes six important characteristics of its requirements for three-dimensional ocean space.

1. General Description
2. Three-Dimensional Space Use
3. Space Occupied by the Use’s Functional Components
4. Importance of the Use’s Functional Components
5. Operational Characteristics of the Use
6. Spatial Constraints

Combined, these six distinct characteristics paint a unique and detailed picture of how that use operates and functions above, on, in, and under the water (Figures 12-14). The resulting profile provides insight into whether, where, and how the use is likely to interact and potentially conflict with other co-occurring uses in the same operating area, as well as how it might impact the surrounding environment. The three use examples outlined above – scuba, non-commercial fishing with benthic mobile gear, and renewable energy – are compared below in light of their space use profiles.

Scuba/Snorkeling

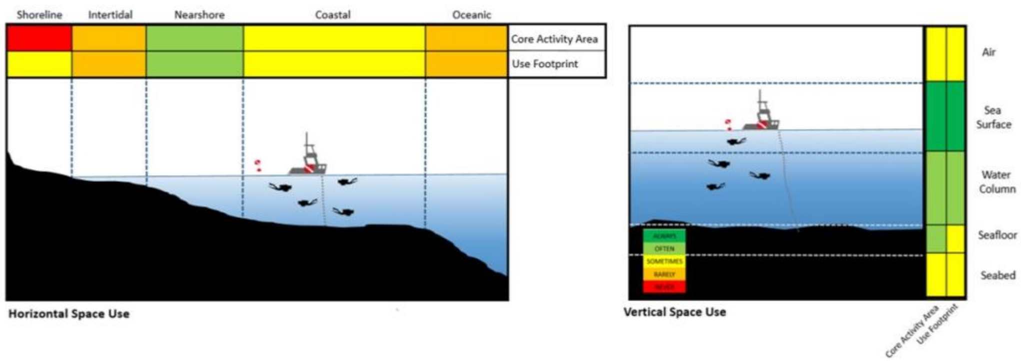
This use is defined as diving with scuba, snorkeling, or surface supplied air while swimming on or in the water. The overall footprint includes the core activity areas (i.e., relatively shallow dive sites) and the often extensive, linear tracks followed by dive boats bringing divers to and from the sites. Horizontally, diving and snorkeling are most common in the nearshore zone and diminish moving seaward with greater depths. Vertically, diving and snorkeling always begin at the surface, often involve the water column and sometimes involve contact with the seafloor. In addition to the divers, this use often involves other functional components, such as vessels and anchors, sometimes extending into the air and seabed zones, respectively.

The distribution of functional components throughout vertical zones reflects the varying requirements of diving in different depths, with differences in component usage often becoming more pronounced toward the bottom in deeper water. People (the divers) are always the primary use component, while vessels, anchors, moving gear and infrastructure are often of secondary importance to the main use. People occur throughout the depth zones wherever the use is happening, while other functional components (e.g., vessels) occur only at the surface. The occurrence, relative importance, and contribution to conflict potential of specific functional components varies across horizontal and vertical zones, depending largely on the depth of the dive site and its distance from shore.

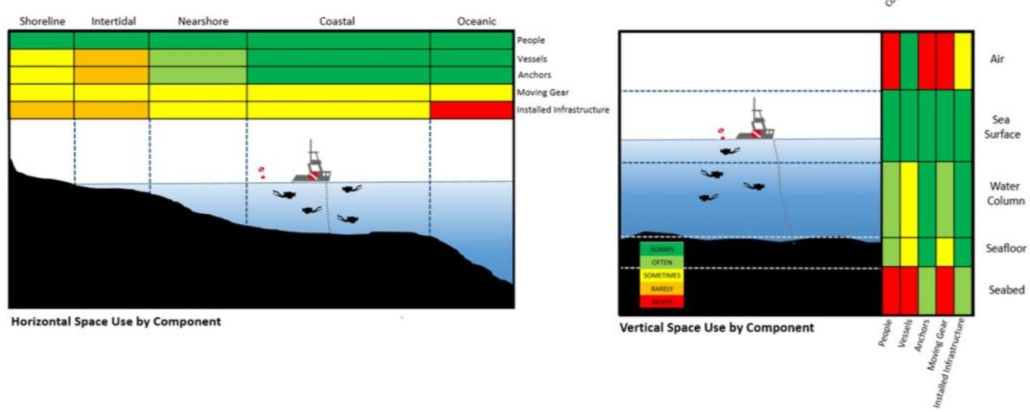
Section 1: General Use Description

SCUBA/Snorkeling: These forms of diving tend to occur relatively close to shore and in shallow water. As a result, the core activity area and overall footprint often overlap considerably, unless vessels are used to visit distant dive locations, or in the case of shore-entry dives. The use (e.g. the person and/or anchor) may extend from the surface to the seafloor depending on the habitat and purpose of the dive.	
Use Includes:	SCUBA diving, surface supply diving or snorkeling (e.g., free diving).
Use Excludes:	Swimming, Dive Fishing.
Use Footprint:	Typically encompasses dive sites and relatively narrow tracks followed by vessels to reach and return from dive sites.
Core Activity Area:	Dive site(s), including areas traversed on drift dive, typically occurring in relatively shallow near-shore or coastal waters reachable by swimming or vessels, and extending from the sea surface to the seafloor.
Functional Components:	People (e.g., divers, boat operators), vessels, anchors, mobile gear (e.g., towed sleds, marker buoys) infrastructure (mooring buoys, navigational aids).
Notes and Assumptions:	Assumes a typical dive profile and gear (i.e., no extreme depths or saturation divers in underwater habitats).

Section 2: Space Use in Horizontal and Vertical Zones



Section 3: Space Use by Components



Section 4: Functional Component Ranking

Component	Ranking	Notes
People	Primary	Activity always involves people as diver(s) or boat crew.
Vessels	Secondary	Boats are sometimes used to transport divers and gear to and from dive sites, depending on the area.
Anchors	Secondary	Anchors are sometimes used to secure boats to the seafloor.
Moving Gear	Secondary	Mobile gear is sometimes used to operate boats (e.g., sea anchors), mark dive sites, or tow divers.
Infrastructure	Secondary	Fixed mooring or navigation buoys are sometimes used by vessels.

Section 5: Operational Characteristics

Exclusion	**Permanence**	Low	Other than saturation diving, typical dives are short-term, mobile and do not occupy space for long periods.
	Buffer Zones	Low	Diving and snorkeling are not typically accompanied by official buffer zones around divers.
Interference	**Mobility**	Medium	Divers and snorkelers have some flexibility in selecting a dive site especially by boat, but have somewhat limited maneuverability once in the water.
	Moving Gear	Medium	Diving and snorkeling may involve safety lines, site markers, floats, lift bags, flags, etc. that may be towed or raised up through the water.

Section 6: Spatial Constraints

Site Dependence:	Medium	Successful diving and snorkeling can be done in a fairly wide range of safe and optimal environmental conditions, including safe sea states, clean water, healthy ecosystems, and low crowding by other uses.
Spatial Management:	Low	Diving and snorkeling is occasionally managed spatially at a localized scale, generally within an MPA or as part of other broader management scheme.

Figure 12. Compiled graphical space use profile for scuba/snorkeling.

Potential for Creating Conflict

Diving has a low potential for exclusion of other uses, whether through permanent space occupancy or through buffer zones. In contrast, this use has a medium risk of interference with other uses due to its frequent use of moving components in the water column (e.g., lines, markers, floats), or through the moderate flexibility of the user to select or move to a different operating area. Site dependence is medium due to the divers' desire for optimal habitat conditions, and levels of spatial management of diving and snorkeling tend to be low. Taken together, these functional characteristics of scuba reflect a relatively low potential for conflict with other co-occurring ocean uses.

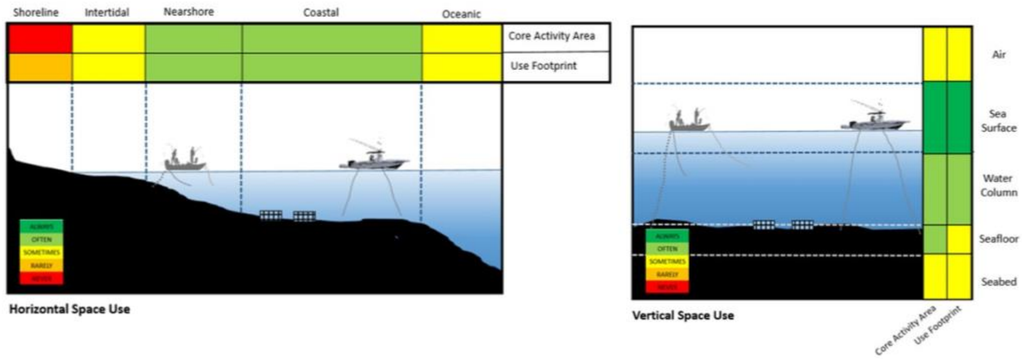
Non-Commercial Fishing with Benthic Mobile Gear

This use is defined as fishing from boats for benthic species for recreational, traditional, or customary purposes. The core operating areas and overall use footprint for this common ocean use: often concentrated in nearshore and coastal areas; always involve the surface zone; and, often extend and move throughout the water column. As the activity's location moves horizontally seaward, some common functional components (e.g., anchors, buoys) become less critical to its pursuit. Looking vertically, some components (e.g., people, vessels) vary widely across depth zones, while others (e.g., anchors, moving gear and infrastructure) are more consistently present throughout the vertical zones. Important functional components include people, vessels, and mobile fishing gear, while anchors and infrastructure may be of secondary or optional importance for the typical activity. When in use, some functional components are typically restricted to the surface (e.g., people, vessels), while others extend into and move through the water column (e.g., moving gear), sometimes along the seafloor (e.g., gear) or into the seabed (e.g., anchors, infrastructure).

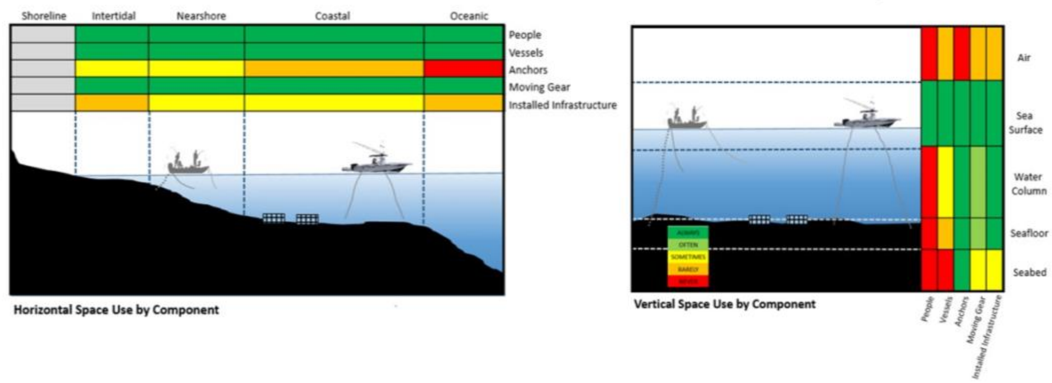
Section 1: General Use Description

Non-Commercial Fishing with Benthic Mobile Gear: This mobile use involves a slowly moving vessel pulling, lowering and/or raising fishing gear on the seafloor, sometimes over relatively long distances within the core operating area. The use footprint of this use also includes surface transit routes to and from port.	
Use Includes:	Fishing from private or charter boats using mobile gear to catch benthic fishes and invertebrates for non-commercial purposes or traditional and customary practices.
Use Excludes:	All other forms of fishing.
Use Footprint:	Use footprint includes the active fishing areas and areas transited from and back to port.
Core Activity Area:	Benthic mobile fishing can occur throughout the nearshore, coastal and oceanic zones in all depths, including the Intertidal when submerged at high tides.
Functional Components:	Vessel(s) (e.g., motorized, sailing or paddled); crew (i.e., people); anchors; fishing gear (e.g., lines, hooks, pulled nets, trawls, dip nets, spears, harpoons) in the water.
Notes and Assumptions:	Harpoons and spears are used for benthic fishing only in very shallow water where bottom-dwelling fish are visible and reachable. Excludes illegal fishing methods such as explosives or poison. Assumes that other forms of fishing are not combined during the same activity.

Section 2: Space Use in Horizontal and Vertical Zones



Section 3: Space Use by Components



Section 4: Functional Component Ranking

Component	Ranking	Notes
People	Primary	People (fishermen) are always involved in this activity.
Vessels	Primary	Fishing vessels are always involved in this activity.
Anchors	Secondary	Fishing vessels may use anchors to secure to the seabed.
Moving Gear	Primary	The gear used in this type of fishing is always mobile.
Infrastructure	Secondary	Fishing vessels may use mooring buoys or navigation markers.

Section 5: Operational Characteristics

Exclusion	**Permanence**	Low	Benthic fishing with mobile gear is inherently transitory and only temporarily occupies ocean spaces.
	Buffer Zones	Medium	Fishing operations may involve official safety zones when underway, depending partly on the type of vessel and gear used.
Interference	**Mobility**	Medium	Benthic mobile fishing operations are relatively maneuverable before mobile gear has been deployed. Afterward, their flexibility may be considerable more limited in real-time.
	Moving Gear	High	This activity routinely involved lowering, pulling or raising gear (e.g., lines, nets, traps, dredges, etc.) through the water column and along the seafloor.

Section 6: Spatial Constraints

Site Dependence:	High	Successful benthic fishing requires the presence of target species and favorable operating conditions (e.g., sea state, weather, crowding).
Spatial Management:	Medium	Benthic fishing with mobile gear is sometimes managed spatially at a localized scale, generally within an MPA or as part of other broader fisheries management scheme.

Figure 13. Compiled graphical space use profile for non-commercial fishing with benthic mobile gear.

Potential for Creating Conflict

This use has a relatively low potential for creating conflict by exclusion of other co-occurring uses due to its low degree of permanent space occupancy and its medium use of buffer zones surrounding the activity. In contrast, the potential to interfere and conflict with other uses is high due to its widespread use of mobile fishing gear moving along the surface, in the water column, and/or along the bottom, combined with the moderate operational mobility of the vessels while engaged in fishing. This form of fishing can often be managed spatially in ways that either minimize or increase its impacts on other uses. Finally, like many types of fishing, especially for benthic species, this use can be highly site dependent and relies on access to specific habitats to catch the target species. Overall, the space use profile for this use suggests a medium risk of creating conflict, but also a potential for effective spatial management in relation to conflict with other uses.

Renewable Energy

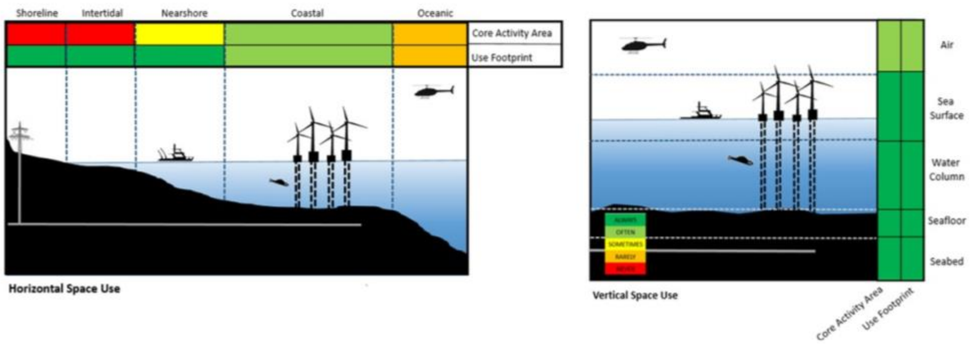
This multi-faceted, long-term, industrial use involves installed wind turbines that are anchored to the seabed and connected to the shore-side electric grid via a network of undersea transmission cables. The overall footprint of renewable energy extends from the shoreline (i.e., cables) out to the coastal or oceanic zone (i.e., the turbines). It includes the relatively limited core activity areas (i.e., production) as well as the associated and potentially extensive tracts of the seafloor and seabed supporting the underwater cables connected to shore or operational vessels. Installed infrastructure is the sole primary functional component of renewable energy, while others (e.g., vessels, people, moving gear and anchors) are generally secondary to how the main activity occupies three-dimensional ocean space.

Unlike the other two ocean uses examined, the installed infrastructure and transmission cables mean that renewable energy permanently occupies space in every vertical zone in the seascape (i.e., air, sea surface, water column, seafloor, and seabed) consistently throughout both the overall footprint and in the core operating areas. Its occupation of horizontal space is more variable, except for the transmission cables which extend across the entire seascape from the turbines to the onshore connection to the electric grid. Other than infrastructure, however, most of the other functional components (e.g., vessels, people) are much more circumscribed in their spatial extent.

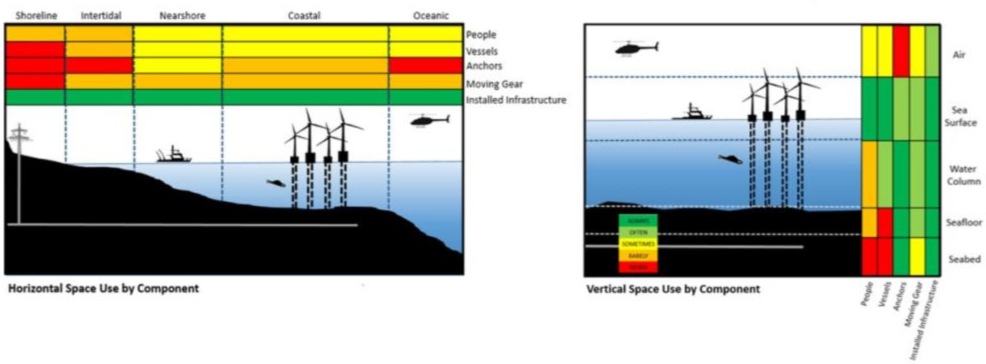
Section 1: General Use Description

Renewable Energy: This stationary and permanent ocean use involves extraction of energy resources from wind, waves or currents using installed infrastructure in a fixed location that is connected to subsurface transmission cables running on or under the seafloor, ultimately connecting to a shore-based facility. Vessels and aircraft are used periodically to service the facility and its crew. The core activity area can extend from the air above the sea surface to below the seabed, while the often-extensive overall footprint also encompasses vessel transit routes to and from the facility as well as the paths of underwater cables and infrastructure.	
Use Includes:	Systems designed to generate electricity from wind, wave, currents, tidal power, hydrothermal energy or ocean thermal energy conversion (OTEC) using turbines, fixed or floating platforms, buoys, dams, and other installations and the associated offshore infrastructure including substructures, transmission hubs, generators, cables and service platforms.
Use Excludes:	Onshore power grids; Solar Energy structures
Use Footprint:	The overall use footprint comprises the core activity area(s), and the areas covered by associated underwater cables and devices connected to shore and operational vessels (surface and submarine) and aircraft.
Core Activity Area:	Core activities involve the in situ capture and generation of energy using an installed device. These typically occur in nearshore and coastal zones, but may occur in oceanic zones with floating tethered structures.
Functional Components:	Infrastructure (turbines, fixed or floating platforms, buoys, and/or dams, and associated offshore infrastructure including substructures, transmission hubs generators cables, and service platforms); support vessels, and crew (people).
Notes and Assumptions:	Assumes no solar.

Section 2: Space Use in Horizontal and Vertical Zones



Section 3: Space Use by Components



Section 4: Functional Component Ranking

Component	Ranking	Notes
People	Secondary	People are intermittently involved onsite for maintenance and management but typically not for routine operations.
Vessels	Secondary	Vessels are involved mainly to ferry people to the sites, to conduct assessments and repairs of the infrastructure and devices.
Anchors	Secondary	Anchors may be used by vessels during temporary operations at the sites.
Moving Gear	Secondary	Moving gear may be temporarily employed by vessels. This component does not include moving parts of the energy generating devices themselves, which may rotate or oscillate in place but are fixed spatially and do not change location over time.
Infrastructure	Primary	Infrastructure includes all devices, platforms, tethers, cables and other equipment installed at the site as part of the generation and distribution of renewable energy.

Section 5: Operational Characteristics

Exclusion	**Permanence**	High	Renewable Energy infrastructure is permanently installed in the seabed, along the seafloor to the shoreline, and up to the sea surface or air.
Exclusion	**Buffer Zones**	High	Energy generation devices typically have an official exclusion zone surrounding their operating area for safety and security purposes.
Interference	**Mobility**	Low	Once installed, renewable energy infrastructure is immobile and cannot move to avoid obstacles or other uses.
Interference	**Moving Gear**	Low	This use sometimes involves moving gear in connection with installation, maintenance or temporary trips to support vessels.

Section 6: Spatial Constraints

Spatial Management:	High	Renewable Energy is heavily regulated and operating area are determined by government agencies.
Site Dependence:	High	Successful energy generation depends heavily on the reliable presence and optimum distribution of the target energy resource (e.g., wind, waves, current) in the operating area.

Figure 14. Compiled graphical space use profile for renewable energy.

Potential for Creating Conflict

Renewable energy poses a relatively high potential for conflict with other uses seeking to operate in the same area. The permanent space occupancy of the installed infrastructure (both vertically and horizontally) can potentially exclude other uses from the core area and overall footprint area due to risks of collision or entanglement. Buffer zones around renewable energy facilities can further expand the zone of exclusion conflict by preventing access to the area. Once installed, the infrastructure involved in renewable energy is effectively immovable over medium-long time horizons, making it very challenging to adapt the use's location to the needs of other uses (low mobility). Additionally, renewable energy is highly site dependent, with installations located in areas of predictably reliable wind energy. Finally, renewable energy is heavily regulated by federal and state entities that determine allowable areas for its pursuit. Taken together, the elements of the space use profile for renewable energy illustrate the challenges, and perhaps some opportunities, for avoiding conflicts with other ocean uses.

Using the Space Use Profiles to Enhance Ocean Management

A New Way to Envision Ocean Uses

Human uses of the ocean are expanding rapidly and so must our tools for managing them to minimize their impacts and maximize their benefits. The space use profiles provide a novel approach to understand the full complexity of ocean uses in ways that are directly relevant to ocean management. For any given ocean use, the space use profile transforms our current, fairly simplistic sense of the activity (Figure 15) into a structured, repeatable, and quantifiable framework for understanding precisely how and where the use operates on and under the water (Figure 16).

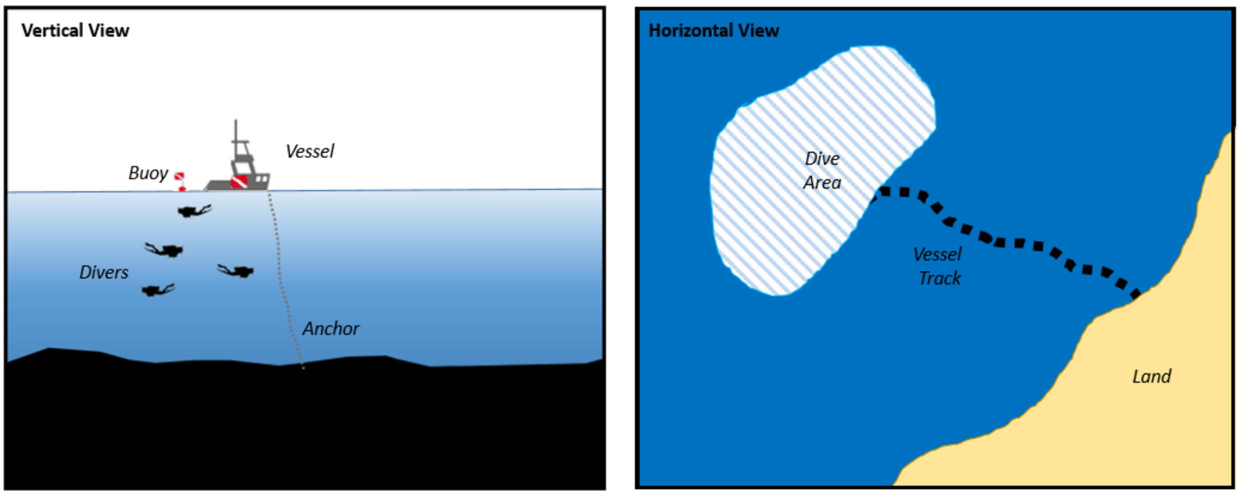


Figure 15. Basic depiction of the vertical horizontal extent of scuba diving showing the dive area, functional components, and vessel track.

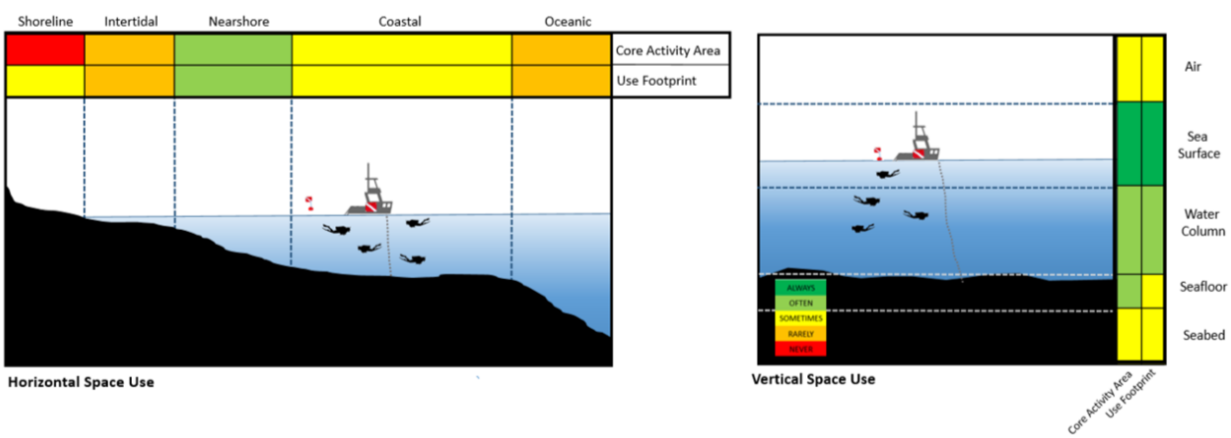


Figure 16. Occupancy of specific horizontal and vertical zones by scuba diving, shown for both the core activity area (i.e., dive site) and the overall use footprint (including vessel transit).

Space Use Profiles: Thinking in Three Dimensions

The space use profiles begin by defining what is included in, and what is excluded from, the working definition of each ocean use (Section 1). By defining the specific horizontal and vertical footprint of a use, and of its key functional components, the profiles then provide a three-dimensional visualization of its requirements for ocean space (Sections 2-4). Sections 5 and 6 examine the influence of each use's fundamental operational characteristics and spatial constraints on the nature of its interactions with other uses.

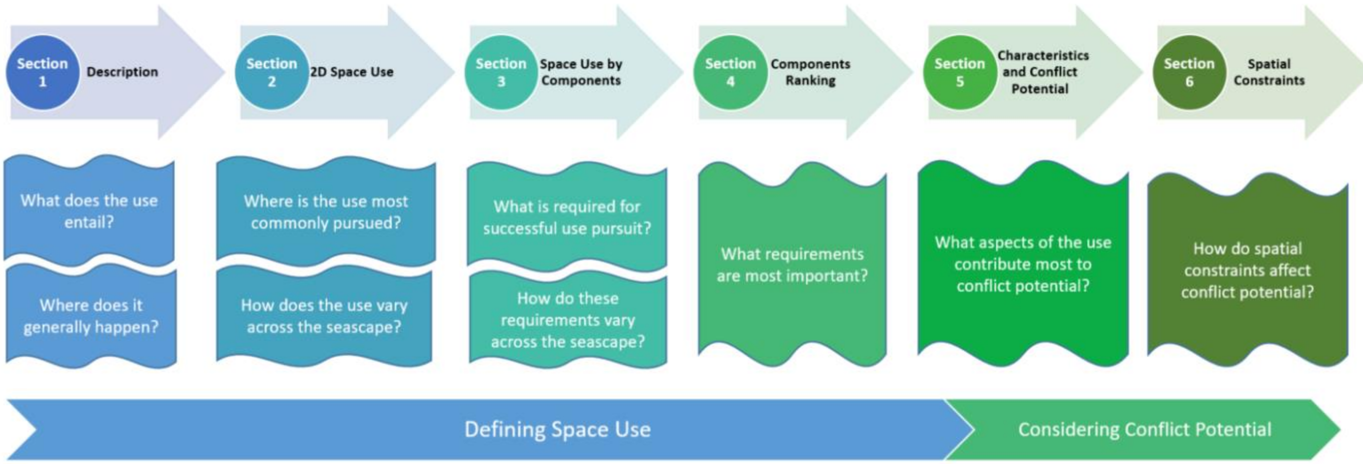


Figure 17. Showing the six characteristics of any ocean use that comprise its space use profile.

Combined, this information provides insight into the potential for any ocean use to create potential conflicts with other uses based on their respective space requirements. Summarized below are some useful applications of this information for ocean planning and management.

Profiles Enhance Spatial Planning and Management

Individually, each space use profile provides a detailed depiction of how the use, and its components, occupy defined horizontal and vertical zones of the seascape, from the shoreline to the furthest reaches of the EEZ, and from the air above the sea surface to the sediments below the seafloor. When used in the context of considering a single ocean use, the space use profiles provides interested parties (e.g., ocean planners, managers, stakeholders, researchers, industry, conservationists) with a structured way to better understand and discuss the full impacts and spatial requirements of that use. For any given use, the profiles paint a picture of its overall footprint and core activity area, and of how and where the use relies on important functional components, like vessels, moving gear, or infrastructure, important to its successful pursuit. Having such a three-dimensional and functional understanding of how an ocean use operates allows for a more effective assessment of its spatial footprint, of its potential impacts, and, of its compatibility with the objectives and resilience of specific ocean areas (including marine protected areas).

Clearly, most ocean uses do not occur alone, and instead operate in a complex spatial and temporal mosaic of other activities occurring in the same seascape. Marine spatial planning provides an approach to evaluate, site, and manage multiple uses in ocean areas where they can function effectively while having acceptable impacts on nearby ecosystems or other uses. The space use profiles are designed to inform this process, and other place-based management, by providing an objective and quantifiable method to assess requirements for three-dimensional ocean space, and the resulting potential for contact, interaction and conflict with other uses. The profiles can be used in two ways to contribute to marine spatial planning.

Qualitative Picture of Ocean Uses

As presented in this report, the space use profiles provide a framework to envision the full scope of any ocean use within the broader seascape. This tool allows planners and other interested parties to categorize, evaluate and, where needed, further investigate the implications of proposed or existing ocean uses in specific areas.

Quantitative Assessment of the Potential for Ocean Use Conflict

The space use profiles are designed to be used in quantitative assessments of the potential for any given ocean use, or a pair of uses, to conflict in the same space. By assigning values and weights to the characteristics described in the profiles, they can be used to identify the likelihood of contact and conflict among uses and their functional components. The approach was used in the Pacific Regional Ocean Uses Atlas Project (PROUA), conducted with the Bureau of Ocean Energy Management from 2012-2015. That effort used participatory mapping to document patterns of ocean use in Oregon, Washington, and Hawai'i. Additionally, it created and quantified the space use profiles of 32 common ocean uses in those areas, and evaluated their potential for conflict with renewable energy installations under consideration. A proof of concept of the utility of the space use profiles in marine spatial planning, the PROUA project demonstrated the power of applying a rigorous three-dimensional lens to understanding and planning multiple ocean uses.

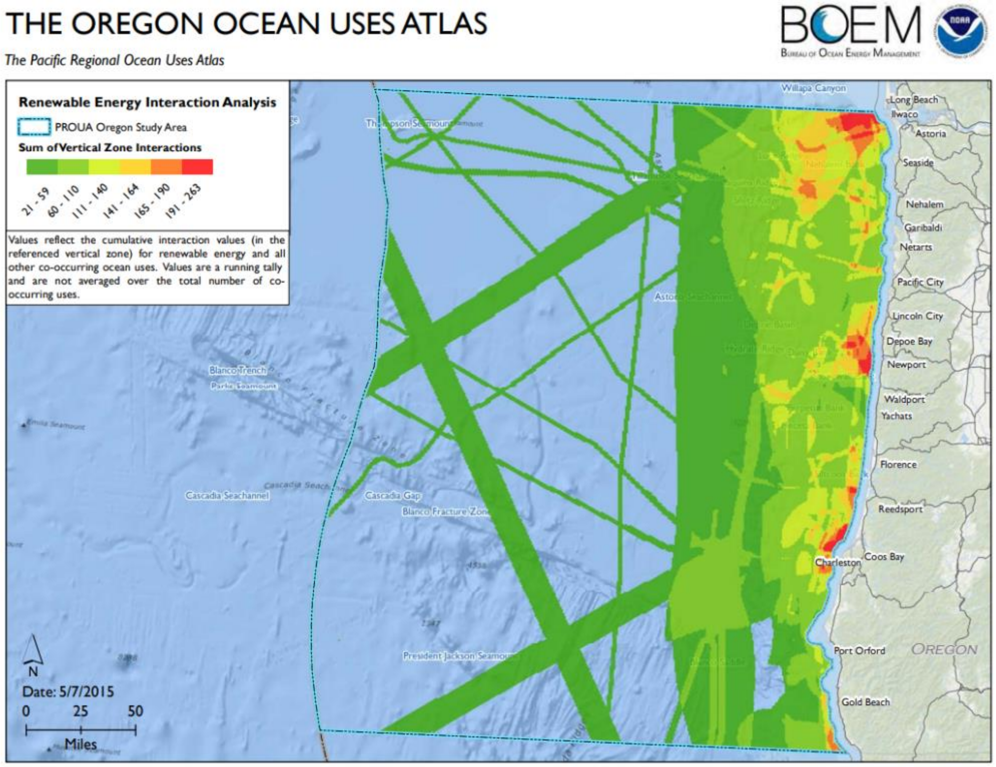


Figure 18. Map illustrating how space use profiles were used to quantify the likelihood of contact, interaction, and potential conflict in the vertical dimension between renewable energy and other mapped ocean uses in Oregon waters.

The Path Forward

The space use profiles provide a consistent way of thinking about how ocean uses actually function in three-dimensional ocean spaces. As such, the profiles represent a useful tool to apply to today's pressing ocean management issues, as well as an invitation to build and improve upon them to advance ocean conservation. Below, we offer some ideas for how the profiles might be used by others in the future.

Future Applications of the Space Use Profiles

The insights provided by the space use profiles into the nature and consequences of the three-dimensional space requirements of ocean uses can provide vital data to inform many timely ocean management and conservation issues. Among these are:

- Marine Protected Areas – design of marine zoning schemes to ensure that allowed uses have minimal impacts on other uses and on the protected ecosystem.
- Marine Spatial Planning of Multiple Uses – allocation of ocean uses to specific operating areas where they are less likely to interact and conflict with other co-occurring uses.
- Ecosystem Management – assessment of potential impacts of a use's holistic three-dimensional footprint, including its functional components, on ecosystem integrity and services.

- Single Use Management – evaluation of whether a use's requirements for ocean space are compatible with the objectives or constraints of a specific operating area (e.g., navigation routes, marine protected areas, or ocean recreation areas).

Testing and Adapting the Profiles

The space use profiles are intended to be a "living" tool to be applied and tested in real-world ocean management contexts. We urge others to use and modify them as needed to match local needs. Those adaptations might range from altering the definitions of specific ocean uses, to changing the nature of their functional components, to modifying the scores and weights assigned to the features described by the profiles, and creating new profiles for emerging uses. Sharing the lessons learned from those trials will strengthen the tool and advance our collective understanding of ocean uses.

NATIONAL

Marine Protected Areas

CENTER