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CASS Technical Report

Ventura Shellfish Enterprise: Aquaculture Siting Analysis Results

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INTRODUCTION

Spatial planning for aquaculture operations, wherein spatial data representing key environmental and space use conflicts are synthesized to identify areas with the highest likelihood for compatibility with aquaculture operations, is a critical first step to ensure environmentally and economically sustainable aquaculture industry development. Aquaculture siting analyses involve the use of geospatial analytical tools (e.g., GIS – Geographic Information Systems) to integrate pertinent spatial data and generate map-based products that can be used to inform policy and permitting decisions regarding where aquaculture operations can be located.

The Ventura Shellfish Enterprise (hereafter 'VSE') is a multi-party initiative seeking to permit twenty 100-acre plots of ocean space for aquaculture production of the Mediterranean mussel (*Mytilus galloprovincialis*) via submerged long lines in federal waters within the Santa Barbara Channel, proximate to Ventura Harbor, California, USA. The key participants in the VSE, including Coastal Marine Biolabs, The Cultured Abalone Farm, and the Ashworth Leninger Group, have worked with the Ventura Port District to develop a "Strategic Permitting Plan," with a suite of other resources and project related information and tools that can be found on the VSE website: venturashellfishenterprise.com, or by contacting the VSE Co-Project Managers, Everard Ashworth at EAshworth@algcorp.com or Brian Pendleton at BPendleton@venturaharbor.com.

NOAA's Coastal Aquaculture Siting and Sustainability (CASS) Program conducted a comprehensive and objective siting analysis for the proposed VSE project, which is the subject of this technical report. This siting analysis utilized the best available, high-resolution spatial data to represent key potential environmental and space use conflicts that constrain the siting of an aquaculture operation within the Santa Barbara Channel region of interest. This siting analysis was guided by quantitative input provided by VSE regarding specific project requirements and was iteratively developed with input provided by the United States Army Corps of Engineers (USACE) Los Angeles District, NOAA (including the National Marine Fisheries Service and the National Ocean Service), the State of California Aquaculture Coordinator, the California Coastal Commission, and the VSE team.

The **Coastal Aquaculture Siting and Sustainability (CASS)** program supports works to provide science-based decision support tools to local, state, and federal coastal managers supporting sustainable aquaculture development. The CASS program is located within the Marine Spatial Ecology Division of the National Centers for Coastal Ocean Science, National Ocean Service, NOAA.

To learn more about CASS and how we are growing sustainable marine aquaculture practices visit https://coastalscience.noaa.gov/research/marine-spatial-ecology/aquaculture/ or contact Dr. James Morris at James.Morris@noaa.gov.

METHODS

Data Inventory

A comprehensive spatial data inventory was developed for the Santa Barbara Channel region to inform the VSE siting analysis. Specifically, the data inventory included data layers from the following categories: military, industry and recreation, commercial fishing, navigation, natural resources, and oceanographic / biophysical. We conducted an exhaustive search and survey to identify web-based resources and contacts to obtain pertinent data resources. A broad suite of state and federal agencies (e.g., NOAA National Marine Fisheries Service, U.S. Department of Defense, Bureau of Ocean Energy Management, California Department of Fish and Wildlife) and academic institutions (e.g., University of California at Santa Barbara) contributed spatial data. Data was checked for completeness and quality to ensure that the most authoritative source was used. The complete data inventory generated for this siting analysis can be found in Table 1.

Project Requirements

We obtained quantitative requirements for the VSE project directly from the technical coordinator for the VSE team. These requirements included a request for the following items of information regarding preferred project parameters: 1) spatial boundaries of region of interest, 2) preference for state or federal waters, 3) preferred project location coordinates (if available), 4) approximate proposed project size, 5) preferred port, 6) maximum distance from preferred port, 7) species to be cultivated, 8) acceptable depth range, 9) acceptable seawater temperature range, 10) acceptable current velocity range, 11) maximum allowable wave energy, and 12) additional comments or specifications. This information was obtained from the VSE team via a Google Form. All fields were optional.

Spatial Analytical Approach

The spatial analysis for the VSE project was conducted within ArcMap 10.5 (Esri 2016), and is a type of spatial multi-criteria analysis known as suitability analysis. Suitability analyses allow for integration of multiple spatial data layers to identify areas of highest suitability, or areas with the highest likelihood of compatibility. When utilized within an aquaculture spatial planning context, suitability analyses integrate data representing environmental or space-use constraints to identify areas that minimize potential conflicts and have the highest likelihood for compatibility with aquaculture operations. Within a suitability analysis, each individual spatial data layer is re-scaled according to a defined suitability relationship (e.g., locations associated with the highest vessel traffic are assigned a score of '0', locations of lowest vessel traffic are assigned a score of '1'). Each re-scaled spatial data layer can be subsequently assigned a weight (all weights must sum to 100%; higher weights = more important conflict considerations), and all data layers can be integrated within the spatial analysis to identify locations with the highest likelihood for compatibility across all factors considered within the analysis. It is important to note that while weights can be assigned to individual spatial data layers, each layer can also be assigned an equivalent weight such that no individual factor has a greater impact on the final scores and output of the spatial analysis.

Based upon the project requirements criteria defined by VSE, we established a boundary for the 'area of interest' (hereafter 'AOI;' Figure 1). We subsequently established a uniform grid within this boundary with a grid cell size of 10 acres (Figure 2). This grid cell size was selected based on the spatial resolution of the available data and the proposed size of the VSE project. Utilizing the comprehensive data inventory we had previously developed for the Santa Barbara Channel region, we projected each spatial data layer to visualize and assess which layers were contained within the AOI.

Spatial data layers not contained within the AOI were not considered further within the VSE suitability analysis, but were mapped for visualization purposes within this report. Spatial data layers contained within the AOI were subsequently converted onto the previously established grid using a custom Python script. For example, total vessel traffic density was projected onto the established grid wherein each grid cell was assigned a value corresponding to the vessel traffic density for a given cell's location. After projection of each spatial data layer onto the grid, individual grid cell values were re-scaled according to a pre-defined rule (e.g., locations associated with the highest vessel traffic are assigned a score of '0', locations of lowest vessel traffic are assigned a score of '1'). Re-scaling of each spatial data layer was essential to ensure each factor was on a common scale (0 – less compatible, to 1 – more compatible). Within GIS, the overall suitability of each cell (S_j) for siting the VSE aquaculture operation was calculated as:

$$S_j = \sum_{x=1}^{n} \left(L_{xj} \cdot W_x \right)$$

where S_j is the cumulative value of cell j calculated as the product of the suitability score L of cell j and the associated weight W for factor x summed across all factors. It is important to note that within this analysis, all factors were considered to have equivalent weighting. After calculation of overall suitability scores using the function described above, a secondary calculation was conducted to remove (i.e., assign a score of '0') grid cells that received a score of '0' for any individual factor. This second-order calculation was necessary to ensure that grid cells associated with locations of known incompatibility were removed from further consideration. On a scale of 0 to 1, grid cell suitability scores for siting the VSE operation were ranked from highest (most suitable) to lowest (least suitable).

Identification of Alternative Sites

Multiple alternative sites for siting of the proposed VSE project were identified within the overall AOI. The final suitability grid that incorporated all identified constraining factors was used to guide the identification and delineation of two specific alternative locations and configurations for the proposed VSE project. Specifically, the highest scoring grid cells (i.e., most compatible locations across all criteria considered) were used to guide delineation of two alternative locations and configurations of the twenty 100-acre parcels associated with the proposed VSE project. In addition to the proposed project's siting criteria (i.e., within federal waters of a suitable depth for mussel long-line gear, see 'Project Requirements' below) the twenty 100-acre parcels were also configured and delineated so that the long-lines (or the side of the parcel facing shore) run parallel to the shoreline to maximize longshore currents.

Additional Considerations

Certain spatial criteria (e.g., cetacean density and distribution along the California coast, fishery landings receipt data by California Department of Fish and Wildlife reporting block), while relevant to understanding the broader regional context and setting of the proposed VSE project, were inappropriate for inclusion within the siting analysis given the coarseness of the resolution of spatial data representing these criteria (e.g., kilometer-scale spatial resolution). Protected cetacean species, for example, are highly mobile and create a complex set of spatial and temporal considerations. Commercial fishery landings by reporting block (10 minute by 10 minute scale, approximately equivalent to 8.25 nm by 10 nm) provide insight into regional trends in fishery landings, however, as they represent an area in the 10,000s of acres (i.e., approximately 50,000 – 70,000 acres) range and landings are unable to be spatially differentiated within an individual block, these data are inappropriate for inclusion within the siting analysis. Furthermore, other available fishery data and statistics (e.g., total landings by harbor or by species) also provide valuable regional perspective with regards to commercial fisheries, but do not provide information at a sufficient spatial scale or resolution to discern relative compatibility of discrete areas of ocean space (at the scale of 1's or 10's of acres required within a siting analysis) with aquaculture operations or other activities. While we describe these factors and considerations to the greatest extent possible given the best available spatial data to represent them within the 'Discussion' section below, it is important to consult with regional experts regarding these considerations prior to final site selection.

RESULTS

Project Requirements

We received the following project requirements from the VSE team. Note that all fields were optional.

1. *Spatial Boundaries of Region of Interest*:	Santa Barbara Channel
2. *Preference for State or Federal Waters*:	Federal Waters
3. *Preferred Project Location Coordinates:*	*empty*
4. *Approximate Proposed Project Size*:	20 x 100-acre plots (2,000 acres total)
5. *Preferred Port*:	Ventura Harbor
6. *Maximum Distance from Preferred Port*:	9 nautical miles
7. *Species to be Cultivated*:	*Mytilus galloprovincialis*
8. *Acceptable Depth Range*:	25 – 37 m
9. *Acceptable Seawater Temperature Range*:	5 – 30 degC, optimal 20 degC
10. *Acceptable Current Velocity Range*:	0.025 – 0.1 m^{-s}
11. *Maximum Allowable Wave Energy*:	(depth range selected due to wave climate)
12. *Additional Comments or Specifications*:	(communicated through email), longlines are proposed for use for mussel cultivation

Based on the project requirements received from the VSE team, we identified an overall 'area of interest' (AOI) for the VSE project of ~20,000 acres within 9 nm of the Port of Ventura within federal waters between 25 and 37 m depth (Figure 1). A grid containing ~2,000 10-acre grid cells was established within the AOI (Figure 2).

Spatial Analysis Development

All potential environmental and space use factors that could constrain the siting of the VSE project for which an authoritative spatial data source was identified for (Table 1) were first plotted and mapped to compare against the identified AOI for the VSE project.

Military Interactions – No interactions were identified between the AOI and existing military space uses, inclusive of the Point Mugu Sea Range and existing danger zones and restricted areas (Figure 3).

Industry Interactions – An interaction was identified between the AOI and active oil and gas leases, drilling platforms, pipelines, and submarine cables (Figure 4). Active oil and gas leases intersect the central and southern portions of the AOI; oil and gas pipelines and submarine cables intersect the central and southernmost portion of the AOI; a single drilling platform is located in the southern portion of the AOI. However, no interaction was identified between the AOI and ocean disposal sites.

Commercial Fishing Interactions – Commercial fishing, including trawl and squid fisheries, interactions were identified with the AOI (Figure 5); these interactions were further examined at the regional scale for trawl fisheries (Figure 6) and the squid fishery (Figure 7). Trawl fishery interactions occur throughout the AOI (Figure 6) and were examined in more detail in the subsequent suitability analysis. Squid fishery interactions are more prevalent in the southern and central portions of the AOI, with some identified interactions in the northernmost portion of the AOI (Figure 7).

Navigation Interactions – Navigation space use interactions were identified within the AOI, including vessel traffic and wrecks and obstructions interactions (Figure 8). Aids to navigation, artificial reefs, maintained channels and designated shipping lanes do not intersect the AOI. Vessel traffic (based on total vessel count for 2013, determined to be representative of modern vessel traffic for the region) is most significant in the central and southern portions of the AOI. Wrecks and obstructions are present in the southern portion of the AOI.

Natural Resource Interactions – Multiple levels of natural resource interactions for which authoritative spatial data was available were examined. Cetacean distribution and density data was examined, but the coarse spatial resolution of these data precluded their ability to be incorporated (Figure 9). Hardbottom habitat and deep-sea coral distribution does not interact with the AOI, but does occur within its proximity (Figure 10).

Interactions Incorporated within the Spatial Analysis – Based on examination of the broad suite of potential interactions for which authoritative spatial data were available to represent, we were able to identify which factors do not intersect the AOI and thus were not incorporated within the spatial analysis (Figure 11), and those factors that do intersect the AOI and thus were incorporated (Figure 12). Specific interactions that were subsequently incorporated within the spatial analysis included the following: 1) oil and gas, 2) commercial fisheries, 3) navigation, and 4) submarine cables and wrecks and obstructions.

Spatial Analysis Output and Identification of Alternative Sites

Table 2 provides an overview of all factors included in the grid-based suitability analysis to identify specific locations with the highest-to-lowest compatibility with the proposed Ventura Shellfish Enterprise (VSE) project. Included within this table are the scores associated with each factor (range from 0 [least suitable] to 1 [most suitable]), and the weights used to integrate all suitability factors within the final suitability grid that allows for identification of areas of highest-to-lowest likelihood for compatibility with the proposed VSE project. All factors integrated in the suitability analysis received equal weighting within the final suitability grid (i.e., no individual factor received greater priority than another).

Oil and Gas Suitability – The following rules were applied to develop the oil and gas suitability grid: a score of ‘0’ was assigned to grid cells intersecting oil and gas drilling platforms and pipelines (including areas within a 500-m radius of these features), a score of ‘0.5’ was assigned to grid cells intersecting the active lease area due to the increased coordination required to site and manage the proposed project within the active lease area, and a score of ‘1’ was assigned to grid cells outside of leases and not intersecting oil and gas platforms or pipelines. This restricted the most suitable locations based on oil and gas interactions to the northernmost and central-eastern portions of the AOI (Figure 13).

Commercial Fishing Suitability: Trawl Fishery – Compatibility with trawl fisheries was determined by assigning a relative rank from low-to-high (scores ranging from ‘0’ to ‘1’) to grid cells with low-to-high densities of trawl tracks. Trawl track densities for each grid cell were calculated by summing the total number of trawl track lines that passed through a given grid cell. The highest suitability was identified in western and central portions of the AOI, while lower suitability was identified in the northeastern and southern portions of the AOI where higher levels of interaction with the trawl fishery occur (Figure 14).

Commercial Fishing Suitability: Squid Fishery – Compatibility with the squid fishery was determined by assigning a relative rank from low-to-high ('0' to '1') to grid cells corresponding with low-to-high total squid landings by California Department of Fish and Wildlife reporting microblock. The highest suitability was identified in the western and central portions of the AOI, while lower suitability scores were identified in the southern and northernmost portions of the AOI (Figure 15).

Vessel Traffic Suitability – A relative rank from low-to-high ('0' to '1') was assigned to grid cells based on level (low-to-high) of interaction with vessel traffic (i.e., total vessel density for 2013 based on automatic identification system, 'AIS,' vessel density data for cargo, tanker, fishing, passenger and pleasure/sailing vessels). The highest suitability was identified in the northern portions of the AOI, while lower suitability scores were identified in the central portion of the AOI, and the lowest suitability scores were identified in the central and southernmost portions of the AOI (Figure 16).

Submerged Cables and Wrecks and Obstructions Suitability – The following rule was applied to develop the submerged cables and wrecks and obstructions suitability grid: a score of '0' was assigned to grid cells intersecting submarine cables or wrecks and obstructions and the areas within 500 m of these features, a score of '1' was assigned to all other grid cells outside of these areas. Application of this rule yielded identified areas of incompatibility in the central and southern portions of the AOI.

Final Suitability Results – The final suitability grid incorporated all major identified interactions to identify locations (grid cells) with the highest likelihood of compatibility. All identified interactions were considered with equal weighting within the analysis. Specifically, the following weights were assigned to individual suitability grids to calculate the final suitability grid: 1) oil and gas suitability – 33%, 2) commercial fishing suitability – 33% (16.5% for trawl fishery and squid fishery, each), 3) vessel traffic suitability – 33%. As the submerged cables and wrecks and obstructions grid included scores of only '0' and '1,' this grid was not weighted, but was included in the analysis as a binary factor. As described within the 'Methods' section above, if a given grid cell was assigned a score of '0' for any individual factor, it was assigned a score of '0' in the overall final suitability grid.

Based on the outcome of the final suitability calculation, the areas of highest identified suitability occur in the northern portion of the AOI (i.e., scores > 0.66; Figure 18). Areas in the southern and central portion of the AOI were generally identified as less suitable. The maximum observed suitability score for any given grid cell within the AOI was 0.90, meaning that all grid cells interacted with one or more factors within the suitability analysis.

Identified Alternative Sites – The proposed alternative site configurations for the twenty 100 acre plots (2000 acres total) were developed based on two farm configurations proposed by VSE, and were located within the areas corresponding with the highest observed suitability. Importantly, these alternative configurations do not change the amount of total area, gear, or the number of mussel long-lines included within each of the proposed farm parcels, but rather dictate how the long-lines would be arranged into rows within the parcels.

The first configuration considered (Alternative #1, Figure 19) was based on the initial configuration proposed by the VSE project team. This configuration includes 20 farm parcels of a 1,900' by 2,300' size that are configured and clustered based on optimized suitability scores from this analysis. The 20 parcels are divided across 2 blocks of 10 parcels each with a 600-ft wide navigational corridor between the blocks of parcels. This configuration allows for two long lines across each row and 12 rows (24 long lines total) per parcel, with 150’ spacing between each row. The average suitability score within the 2,000 acres that this configuration covers was 0.813.

The second configuration considered (Alternative #2, Figure 20) was based on the alternative configuration proposed by the VSE project team. This configuration includes 20 farm parcels of a 1,175’ by 3,707’ size that are configured and clustered based on optimized suitability scores from this analysis. The 20 parcels are condensed within a single block with no navigational corridor needed. No navigational corridor is needed because this configuration allows for only two rows of parcels, where every parcel has vessel access along the perimeter of the site. This configuration allows for one longline across each row, with 24 rows per farm parcel (24 long lines total) and 150’ spacing between each row. The average suitability score within the 2,000 acres that this configuration covers was 0.809.

The corner coordinates associated with each alternative are depicted in map and table form in Appendices 1-4. Maps representing each of the individual factors considered within the suitability analysis relative to Alternative #1 are provided in Appendices 5-9.

***Caveats* –** The suitability analysis described here for the proposed VSE project incorporated the best available, authoritative spatial data as of August 2018 to represent major potential interactions based on a thorough review of available resources (Table 1). While all efforts were made to incorporate the best available data, it is important to recognize that for some interactions (e.g., protected species), spatial data is unavailable or exists at an inappropriate scale for consideration within this analysis.

DISCUSSION

The siting analysis described here represents an objective, data-driven approach to identify the locations with the highest likelihood for compatibility with the proposed Ventura Shellfish Enterprise (VSE) project. Through mapping available modern, authoritative spatial data associated with major identified environmental and space use interactions, this siting analysis provides essential information needed to inform the permitting decision-making process for the proposed VSE project. The results of this siting analysis indicate that the northern portion of the area of interest (AOI) has the highest likelihood of compatibility given equal consideration of existing space use conflicts (Figures 18-20). We identify and describe two alternative configurations within the northern portion of the area of interest with the highest likelihood for compatibility given the various interactions considered within this analysis.

Across all identified space use conflicts that were incorporated within the siting analysis, the northern portion of the AOI has the highest likelihood of compatibility with the proposed project (Figures 18-20). Oil and gas, vessel traffic, and submarine cables and wrecks and obstructions interactions are minimized or non-existent within the northern portion of the AOI (Figures 13, 16, and 17). Commercial fishing interactions are present within the northern portion of the AOI, with increased trawl fishing interactions in the northwestern portion of the AOI in the areas nearest to the state-federal waters boundary (Figure 14) and some interactions with the squid fishery in the northernmost portion of the AOI (Figure 15). Importantly, as evident in the final suitability grid, the location (grid cells) with the highest likelihood for compatibility that minimize these interactions are located in the northwestern portion of the AOI (Figure 18). Despite minimization of potential interactions, the highest possible score in the final suitability grid was 0.90, indicating that even the grid cell locations with the highest likelihood for compatibility had some level of interaction with at least one factor.

Locations within the central portion of the AOI have more substantial interactions with oil and gas (Figure 13), vessel traffic (Figure 16) and submerged cables and wrecks and obstructions (Figure 17). Within the southern portion of the AOI, interactions exist with oil and gas, vessel traffic, submerged cables and wrecks and obstructions, and both the trawl and squid fisheries (Figures 14 and 15). Importantly also, the southern portion of the AOI also borders closely to the designated shipping lane and known areas of hardbottom habitat and deep-sea corals (Figure 11).

As shown in Figure 6, the northern portion of the AOI does interact with areas of known trawl fishery activity. Importantly, the known area of highest trawl fishery intensity occurs in the portion of the Santa Barbara Channel to the northwest of the AOI. For the squid fishery, the southern portion of the AOI, and areas further south of the AOI, represent the most substantial intensity and volume of landings. It is important to note that while these data represent the best available, authoritative data to represent these fisheries, there remains a need for discussion with commercial fishery stakeholders regarding spatial compatibility.

Based on the results of the suitability analysis, we identified two alternative configurations for the proposed VSE project that maximize likelihood of compatibility with existing space uses in the region. The first alternative (Figure 19) and second alternative (Figure 20) do not differ substantively in average suitability score (0.813 and 0.809, respectively). Within the first alternative, the configuration of the farm parcels requires a navigational corridor (600 feet) to allow access to the center farm parcels. The configuration of the farm parcels within the second alternative is such that a navigational corridor is not required to access the individual parcels. In developing the alternative sites, contiguous sites and those with a more uniform shape were preferred over other dispersed alternatives. During the process of obtaining criteria from the VSE project team, it was expressed that in previous stakeholder engagements, a preference was indicated by local fishermen and other ocean users for a design that was clustered to minimize navigational challenges.

Additional Considerations

This siting analysis serves as an authoritative resource to inform the permitting decision-making process regarding where the proposed VSE project is most likely to be compatible from an environmental and space-use perspective. However, additional factors should be the subject of consideration during the permitting decision-making process that are beyond the scope of this siting analysis, including consideration of potential protected species entanglement risks, carrying capacity limitations, and farm design specifications. Below, we provide additional detail regarding engagements with state and federal government agencies to obtain the best available data for protected species for this siting analysis.

Regarding carrying capacity limitations, the environmental conditions corresponding with the proposed VSE project's AOI generally appear favorable for the species and gear combination proposed. The annual average surface current velocity in relation to the AOI is generally within the optimal range for blue mussels of 0.025 and 0.10 m/s (Appendix 10)[1]. Sufficient current velocity is essential to ensure adequate food (i.e., naturally occurring phytoplankton) delivery to the cultivated species (i.e., Mediterranean mussels), and also to ensure adequate dispersal of waste products. With regards to chlorophyll *a*, which is a proxy for the availability of naturally occurring phytoplankton, the

[1] Longdill, P.C., Healy, T.R., and Black, K.P. 2008. An integrated GIS approach for sustainable aquaculture management area site selection. *Ocean and Coastal Management* 51, 612-624.

optimal range for chlorophyll *a* for blue mussels of 0.5 – 40 µg/l corresponds with the annual average chlorophyll *a* concentration for the AOI (Appendix 11)[2]. The mean water temperature in the area immediately adjacent to the proposed project AOI is within the acceptable water temperature range of 3 – 29 degrees Celsius, and remains near the optimal water temperature of 20 degrees Celsius for nearly half of the year (Appendix 12)[3,4,5]. Carrying capacity considerations are likely to be most dependent upon the final farm design selected rather than environmental limitations. Furthermore, farm design considerations are critical to minimize entanglement risks to cetaceans and sea turtles. A recent review of documented cases of marine animal entanglements in mussel aquaculture gear identified mussel spat collection ropes as yielding the greatest risk of entanglement.[6] Careful attention must be paid to ensure the farm design, gear, and associated activities minimize the risk of protected species entanglement.

The best available data to represent potential protected species interactions with the proposed VSE project were obtained from state and federal government agencies. Regarding pinniped species, spatial data from the NOAA Southwest Fisheries Science Center (Mark Lowry) were unavailable to represent California sea lions and Pacific harbor seals as ongoing observation efforts are land-based. Loggerhead sea turtle aerial survey and satellite telemetry data were cross-referenced with the proposed project's AOI, and no sightings or tracks as recorded by NOAA's National Marine Fisheries Service (Jeffrey Seminoff and Tomo Eguchi) intersected the area. In both cases, with regards to pinnipeds and sea turtles (including monitored loggerhead, as well as green turtles and leatherbacks that are not monitored), it was acknowledged that the lack of data representing interactions does not preclude the potential for the proposed project's AOI to interact with these protected species.

Habitat-based predicted density and distribution models for multiple cetacean species for the California coast, including: beaked whales (multiple species), blue whales, dolphins (multiple species), Dall's porpoise, fin whales, humpback whales, and sperm whales was obtained from NOAA National Marine Fisheries Service (Pers. Comm., Karin Forney and Elizabeth Becker). Cetacean species with the highest likelihood for potential interaction with the proposed VSE project based on this data include: blue whales and bottlenose dolphins (Appendix 13), long-beaked common dolphins (Appendix 14), and Rissos and short-beaked common dolphins (Appendix 15). There is a lower likelihood for potential interaction with Baird's beaked whales and beaked whales (Appendix 13), Dall's porpoises and humpback whales (Appendix 14), northern right whale dolphins and Pacific white sided dolphins (Appendix 15), and sperm whales and striped dolphins (Appendix 16). It is important to note that these data represent predicted distribution of these species and do not preclude the potential for interaction with any species.

As described within 'Methods: Additional Considerations' above, additional commercial fishery data beyond the trawl fishery track lines and squid landings by microblock data provided by the California Department of Fish and Wildlife were considered for inclusion within the siting analysis, but were determined to be incompatible for use within the analysis due to a lack of sufficient spatial resolution to differentiate the relative compatibility of discrete areas of ocean space (at the scale of 1's or 10's of

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[2] Sara, G., Manganaro, A., Cortese, G., Pusceddu, A., and Mazzola, A. 1998. The relationship between food availability and growth in *Mytilus galloprovincialis* in the open sea (southern Mediterranean). *Aquaculture* 167, 1-15.
[3] Widdows, J. 2009. Combined effects of body size, food concentration and season on the physiology of *Mytilus edulis*. *Journal of the Marine Biological Association of the United Kingdom* 58, 109-124.
[4] Newell, R.I.E. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North-Mid Atlantic): Blue Mussel. *U.S. Army Corps of Engineers report TR EI-82-4.*
[5] Almada-Villela, P.C., Davenport, J., and Gruffydd, L.D. 1982. The effects of temperature on the shell growth of young *Mytilus edulis*. *Journal of Experimental Marine Biology and Ecology* 59, 275-288.
[6] Young, M.O. 2015. Marine animal entanglements in mussel aquaculture gear: Documented cases from mussel farming regions of the world including first-hand accounts from Iceland. *M.S. Thesis, University of Akureyri*.

acres required within a siting analysis) for aquaculture operations or other activities. The best available spatial data to represent commercial fisheries within the region included those provided by the California Department of Fish and Wildlife, including: trawl fishery track lines, squid landings by microblock, and the fishery landings receipt data by block (Appendix 17). Trawl fishery track lines and squid landings by microblock data were incorporated within the siting analysis. However, the fishery landings receipt data by block (represented by average total landings across all reported species for the period of 2012-2017) is of insufficient spatial resolution for incorporation within the siting analysis. As depicted in Appendix 17, the 1,953 grid cells that represent the ‘area of interest’ for the siting analysis correspond with 4 reporting blocks. Other data, such as commercial fishery landings by species for the region or by harbor provide regional perspective with regards to commercial fisheries, but at an insufficient spatial scale for use within a siting analysis. The available data indicates that the proposed VSE project would intersect California Department of Fish and Wildlife reporting block #665, which is a block associated with a moderate quantity of average total landings for the period of 2012-2017 relative to the 9 adjacent blocks for which data is available. The average total landings for block #665 for the period of 2012-2017 was 872,164 lbs, relative to the adjacent block with the lowest total landings (block #652, furthest northwest, 155,237 lbs) and the block with the highest total landings (block #683, furthest southeast, 5,375,358 lbs).

TABLES

Table 1. Data layers integrated within the comprehensive data inventory developed for the Santa Barbara Channel region to inform the siting analysis for the proposed Ventura Shellfish Enterprise (VSE) project.

Data Layer:	**Description:**	**Source:**
Military		
Danger Zones and Restricted Areas	These data represent the location of Danger Zones and Restricted Areas within coastal and marine waters, as outlined by the Code of Federal Regulations (CFR) and the Raster Navigational Charts (RNC). The CFR defines a Danger Zone as: "A defined water area (or areas) used for target practice, bombing, rocket firing or other especially hazardous operations, normally for the armed forces. The danger zones may be closed to the public on a full-time or intermittent basis, as stated in the regulations."	Code of Federal Regulations (CFR) and the Raster Navigational Charts (RNC)
Unexploded Ordnances	Unexploded ordnances are explosive weapons (bombs, bullets, shells, grenades, mines, etc.) that did not explode when they were employed and still pose a risk of detonation, potentially many decades after they were used or discarded. Sea disposal of munitions was an accepted international practice until 1970, when the Department of Defense prohibited the practice, and Congress followed up by passing the Marine Protection, Research, and Sanctuaries Act in 1972, generally banning sea disposal.	NOAA Office of Coast Survey (OCS)
Point Mugu Sea Range	Point Mugu Sea Range is the world's largest instrumented over-water range encompassing up to 220,000 square miles of ocean space. It provides extensive test and training capabilities for the U.S. Navy and allied forces and is located adjacent to the Santa Barbara Channel.	U.S. Navy
San Pedro Channel Operating Area	Offshore military operating area within the San Pedro Channel for the U.S. Navy and allied forces.	U.S. Navy
Industry and Recreation		
Oil and Gas Drilling Platforms, Pipelines and Active Leases	Infrastructure for oil and gas offshore activities including drilling platforms for extracting minerals, particularly oil and gas, pipelines for transporting to onshore facilities, and the active leases, which include a portion of the Outer Continental Shelf (OCS) Lease Blocks that are currently leased to private entities for oil and/or gas mining rights. Importantly, active leases include those that are exploratory, non-producing, and producing.	Bureau of Ocean Energy Management (BOEM)
NOAA Charted Submarine Cables	These data depict the occurrence of submarine cables in and around U.S. navigable waters.	NOAA Office of Coast Survey (OCS)

Data Layer:	Description:	Source:
Ocean Disposal Sites	Ocean disposal sites, including both active and discontinued or historical sites. Nearly all material ocean dumped today is dredged material (sediments) removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas.	NOAA Office of Coast Survey (OCS)
Wind and Marine Hydrokinetic Planning Areas	Planning areas for renewable energy, such as wind and marine hydrokinetic (MHK) development, as defined by the U.S. Bureau of Ocean Energy Management (BOEM).	Bureau of Ocean Energy Management (BOEM)
Marine Minerals and Sand Resource Blocks	This layer contains Outer Continental Shelf (OCS) block outlines and delineated polygons containing sediment resources and areas of disposal.	Bureau of Ocean Energy Management (BOEM)
Administrative Kelp Beds	Kelp beds open to state-managed commercial harvest within the state waters of California.	California Department of Fish and Wildlife
Existing Aquaculture Areas	The presence and location of aquaculture sites were derived from multiple state websites and include only those in coastal and marine saltwater areas. The following states are included in this layer: Alaska, California, Connecticut, Florida, Louisiana, Maine, New York, North Carolina, Rhode Island, and Virginia.	NOAA Office for Coastal Management (OCM) & other state and federal agencies
Commercial Fishing		
Trawl Fishery Track Lines	Logbook-derived state-managed trawl fishery track lines; inclusive of all state-managed trawl fisheries between 2010 and 2016 (connected line between start and stop location for trawls).	California Department of Fish and Wildlife
Squid Landings by Micro-Block	Total squid landings (in short tonnes) by microblock (~700 acres) for the period of 2012-2017.	California Department of Fish and Wildlife
Fishery Landings Receipt Data by Block	Total landings by fishery landings block for the period of 2012-2017, inclusive of multiple (20+) commercial fisheries species (e.g., halibut, spiny lobster, squid, etc.).	California Department of Fish and Wildlife
Navigation		
Principal Ports	Principal Ports are defined by port limits or US Army Corps of Engineers (USACE) projects, these exclude non-USACE projects not authorized for publication. The determination for the published Principal Ports is based upon the total tonnage for the port for the particular year; therefore the top 150 list can vary from year to year.	U.S. Army Corps of Engineers (USACE)
Shallow Draft Ports	National database of shallow draft ports, or ports accessible by small commercial and/or recreational vessels.	U.S. Army Corps of Engineers (USACE)
Aids to Navigation	Structures intended to assist a navigator to determine position or safe course, or to warn of dangers or obstructions to navigation. This dataset includes lights, signals, buoys, day beacons, and other aids to navigation.	U.S. Coast Guard
Environmental Sensors and Buoys	Buoys or structures, often near the surface of the water column, intended to collect water quality or other environmental data.	NOAA National Data Buoy Center

Data Layer:	Description:	Source:
Artificial Reefs	An artificial reef is a human-made underwater structure, typically built to promote marine life in areas with a generally featureless bottom.	NOAA Office for Coastal Management (OCM) & other state and federal agencies
Wrecks and Obstructions	In 1981, NOAA’s National Ocean Service (NOS) implemented the Automated Wreck and Obstruction Information System (AWOIS) to assist in planning hydrographic survey operations and to catalog and store a substantial volume of reported wrecks and obstructions that are considered navigational hazards within U.S. coastal waters. AWOIS is not a comprehensive record of wrecks in any particular area.	NOAA Office of Coast Survey (OCS)
Maintained Channels	This layer shows coastal channels and waterways that are maintained and surveyed by the U.S. Army Corps of Engineers (USACE).	U.S. Army Corps of Engineers (USACE)
Shipping Lanes	Shipping zones delineate activities and regulations for marine vessel traffic. Traffic lanes define specific traffic flow, while traffic separation zones assist opposing streams of marine traffic.	NOAA Office of Coast Survey (OCS)
AIS Vessel Count (including total count and by vessel type)	Automatic Identification Systems (AIS) are a navigation safety device that transmits and monitors the location and characteristics of many vessels in U.S. and international waters in real-time. This dataset represents vessel counts by vessel type for 2013. Vessel count raster data layers were created by CASS Spatial team and are derived from vessel density raster data layers generated from raw AIS data.	Bureau of Ocean Energy Management (BOEM)
Anchorage Areas	An anchorage area is a place where boats and ships can safely drop anchor.	NOAA Office of Coast Survey (OCS)
Natural Resources		
Deep-Sea Corals	The National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research and Technology Program (DSCRTP) have developed a National Database for Deep-Sea Corals and Sponges (database).	NOAA National Centers for Coastal Ocean Science (NCCOS)
Hardbottom Habitat	Distribution of known hardbottom habitat within the Santa Barbara Channel region. Hardbottom habitat generally occurs in the ocean where rocks or other hard surfaces are exposed from bottom sand or mud; this structure can serve as habitat for fish and invertebrate species.	California Geological Survey and Moss Landing Marine Lab / UC Santa Barbara
Cetacean Predicted Density and Distribution	Habitat-based predicted density and distribution models for multiple cetacean species, including: beaked whales (multiple species), blue whales, dolphins (multiple species), Dall’s porpoise, fin whales, humpback whales, and sperm whales.	NOAA National Marine Fisheries Service

Data Layer:	Description:	Source:
Seagrass	Aquatic vascular vegetation beds dominated by submerged, rooted, vascular species or submerged or rooted floating freshwater tidal vascular vegetation. This is not a complete collection of seagrasses on the seafloor, nor are the locations to be considered exact.	NOAA Office for Coastal Management (OCM) & other state and federal agencies
Essential Fish Habitat / Habitat Areas of Particular Concern	Essential Fish Habitat (EFH) represent important habitat areas for every life stage of federally managed species. Habitat Areas of Particular Concern (HAPC) are discrete subsets of Essential Fish Habitat (EFH) that provide extremely important ecological functions or are especially vulnerable to degradation.	NOAA National Marine Fisheries Service (NMFS)
Marine Protected Areas	The MPA Inventory is a comprehensive catalog that provides detailed information for existing marine protected areas in the United States.	NOAA National MPA Center
Oceanographic and Biophysical		
Bathymetry (water depth)	High-resolution bathymetry data was obtained from NOAA's National Geophysical Data Center (NGDC). This bathymetric data is a composite of various sources, including NGDC, U.S. National Ocean Service (NOS), U.S. Geological Survey (USGS), the Federal Emergency Management Agency (FEMA), and other federal, state, and local government agencies, academic institutions, and private companies. DEMs are referenced to the vertical tidal datum of Mean High Water (MHW) and horizontal datum of World Geodetic System 1984 (WGS84).	NOAA National Geophysical Data Center (NGDC)
Water Temperature	MODIS Global Level 3 Mapped SST (via MGET) mean/min/max climatologies for 20 year period 1997 – 2016.	NASA MODIS Aqua
Current Velocity and Direction	Surface current velocity and direction data from HYCOM + NCODA Global 1/12 Degree Reanalysis, experiments 19.1 (1995-2012). Directional data are represented by U and V vector data.	HYCOM
Salinity	Salinity data from HYCOM + NCODA Global 1/12 Degree Reanalysis, experiments 19.1 (1995-2012).	HYCOM
Significant Wave Height	Significant wave height (SWH or H_s) is defined traditionally as the mean wave height (trough to crest) of the highest third of waves ($H_{1/3}$).	AVISO
Chlorophyll *a*	NASA GSFC OceanColor L3 SMI (via MGET) mean/std dev climatologies for 10 yr period 2007 – 2016.	NASA OceanColor
Administrative Boundaries		
Federal / State Waters Boundary	The Submerged Lands Act (SLA) boundary line (also known as State Seaward Boundary or Fed State Boundary) defines the seaward limit of a state's submerged lands and the landward boundary of federally managed OCS lands.	Bureau of Ocean Energy Management (BOEM)

Data Layer:	Description:	Source:
Channel Islands National Marine Sanctuary Boundary	Boundary for the Channel Islands National Marine Sanctuary.	NOAA Office of National Marine Sanctuaries (NMS)

Table 2. Factors included in the grid-based suitability analysis to identify specific locations with the highest-to-lowest compatibility with the proposed Ventura Shellfish Enterprise (VSE) project. Included within this table are the scores associated with each factor (range from 0 [least suitable] to 1 [most suitable]), and the weights used to integrate all suitability factors within the final suitability grid that allows for identification of areas of highest-to-lowest likelihood for compatibility with the proposed VSE project. *All factors integrated in the suitability analysis received equal weighting within the final suitability grid (i.e., no individual factor received greater priority than another); note that the 33.33% weighting assigned to commercial fishing was split evenly between trawl and squid fishery considerations.*

Factors:		**Suitability scores for each factor:**	**Weight for factor within final suitability grid:**
Oil and Gas		0 = grid cells intersecting oil and gas drilling platforms and pipelines (within a 500 m radius) 0.5 = grid cells intersecting an active lease area 1 = grid cells outside of leases and not intersecting oil and gas platforms and pipelines	33.33%
Commercial Fishing	Trawl	Relative rank from low-to-high (0-to-1) trawl track density; low (or no) trawl density considered most compatible, high trawl density considered least compatible	16.67%
	Squid	Relative rank from low-to-high (0-to-1) squid landings by microblock; lower (or no) squid landings considered most compatible, higher squid landings considered least compatible	16.67%
Vessel Traffic		Relative rank from low-to-high (0-to-1) vessel density; low (or no) vessel traffic considered most compatible, high trawl traffic considered least compatible	33.33%
Submerged Cables and Wrecks and Obstructions		0 = grid cells intersecting submarine cables or wrecks within a 500 m radius 1 = grid cells outside of these areas	*Scores only range between 0 and 1, thus this factor was used solely to exclude areas corresponding to these features*

FIGURES

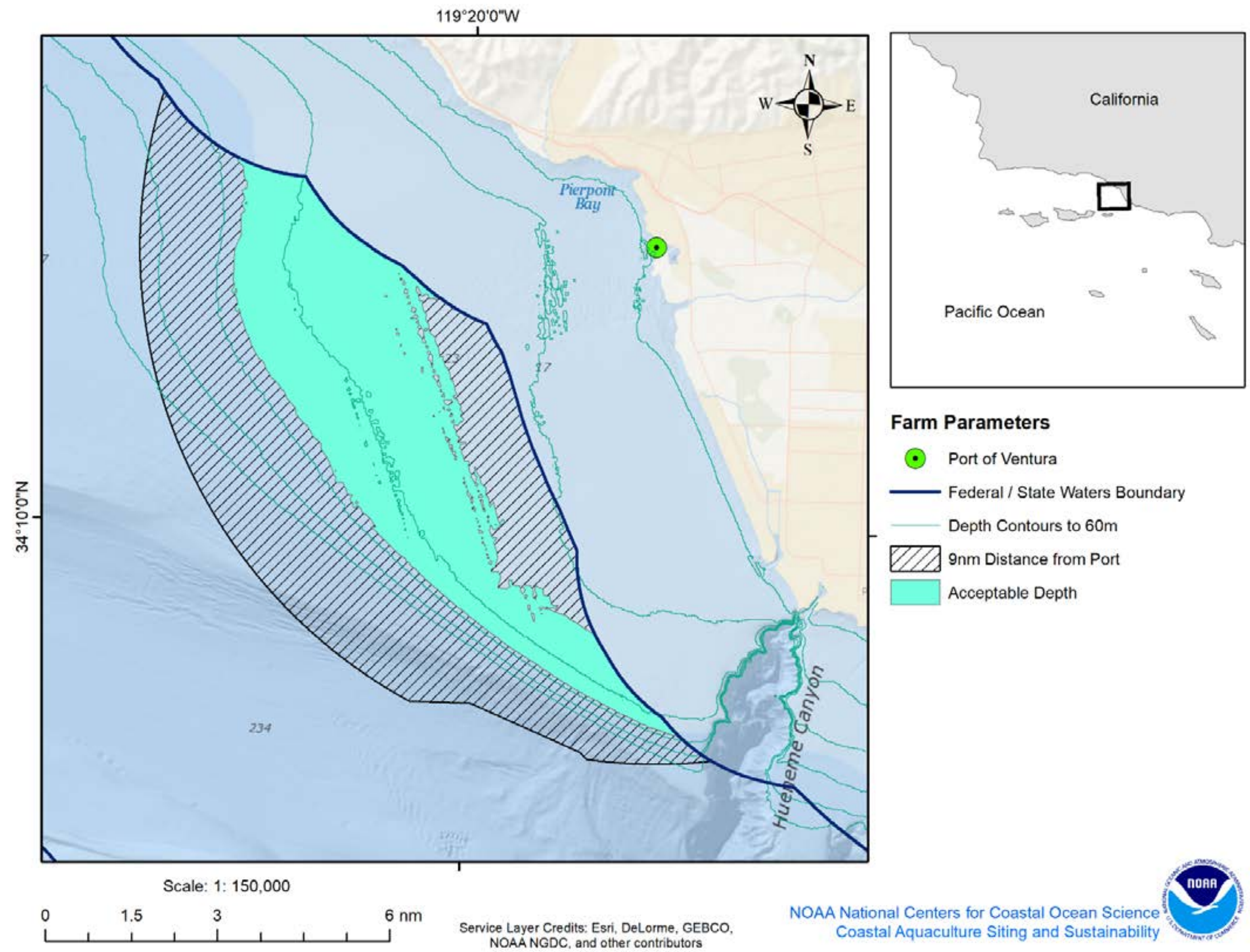


Figure 1. Map of the 'area of interest' for the proposed Ventura Shellfish Enterprise (VSE) project based on project requirements provided by VSE. The primary constraining criteria defined by VSE included: 1) federal waters only, 2) maximum 9 nautical mile distance from the Port of Ventura, and 3) a required depth range of 25 – 37 meters for the proposed Mediterranean mussel (*Mytilus galloprovincialis*) cultivation gear. The defined 'area of interest' is represented by the light green polygon denoted as 'Acceptable Depth' in the map legend. Note that the VSE project is seeking 2,000 acres within the ~20,000 acres within the overall 'area of interest'.

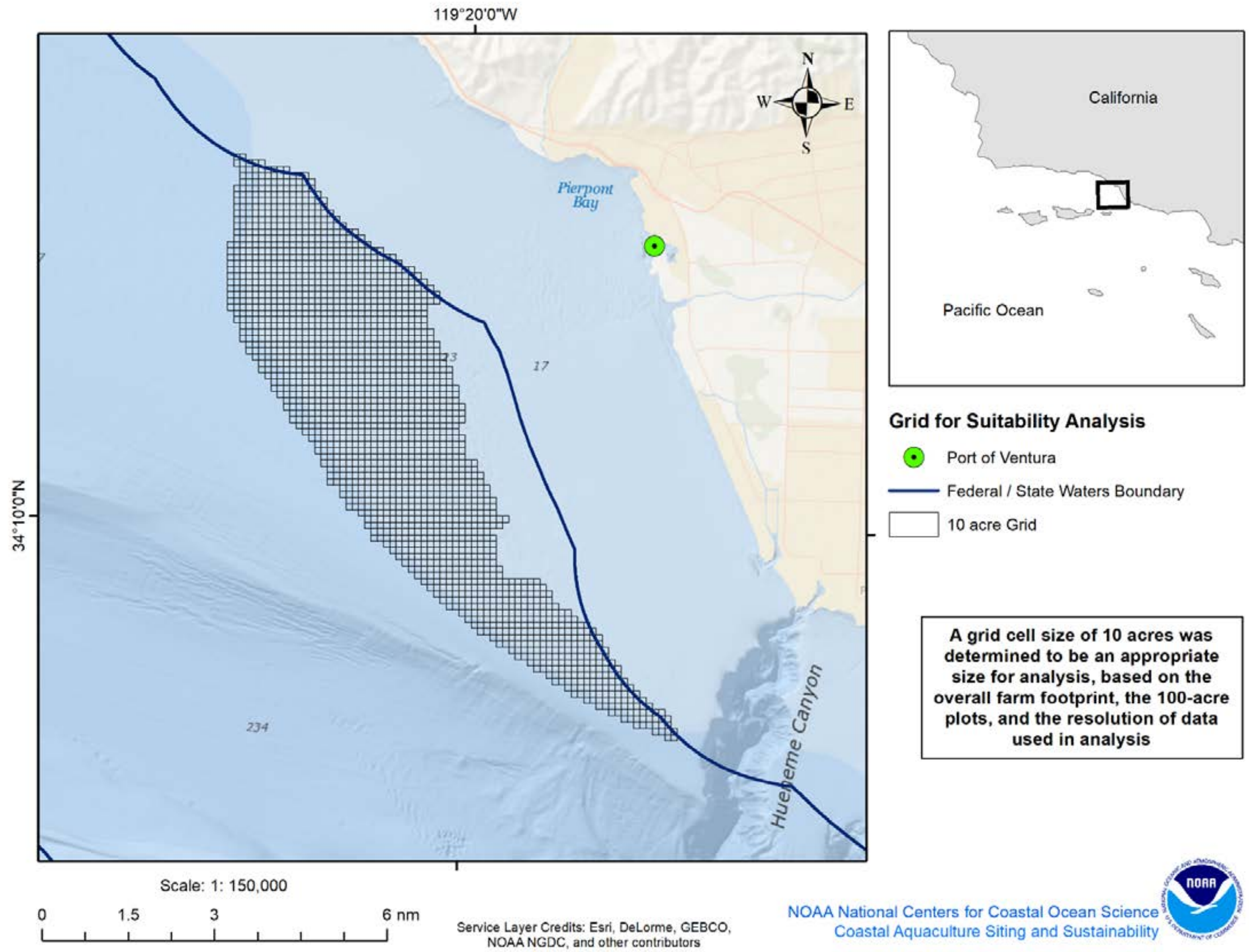


Figure 2. Grid established within the proposed Ventura Shellfish Enterprise (VSE) ‘area of interest’ for use in the siting analysis. A grid cell size of 10 acres was determined to be appropriate for use in the spatial analysis. The grid contains 1,953 grid cells, equivalent to 19,530 acres total. Note that the VSE project is seeking 2,000 acres within the ~20,000 acres within the overall ‘area of interest’ described by the grid.

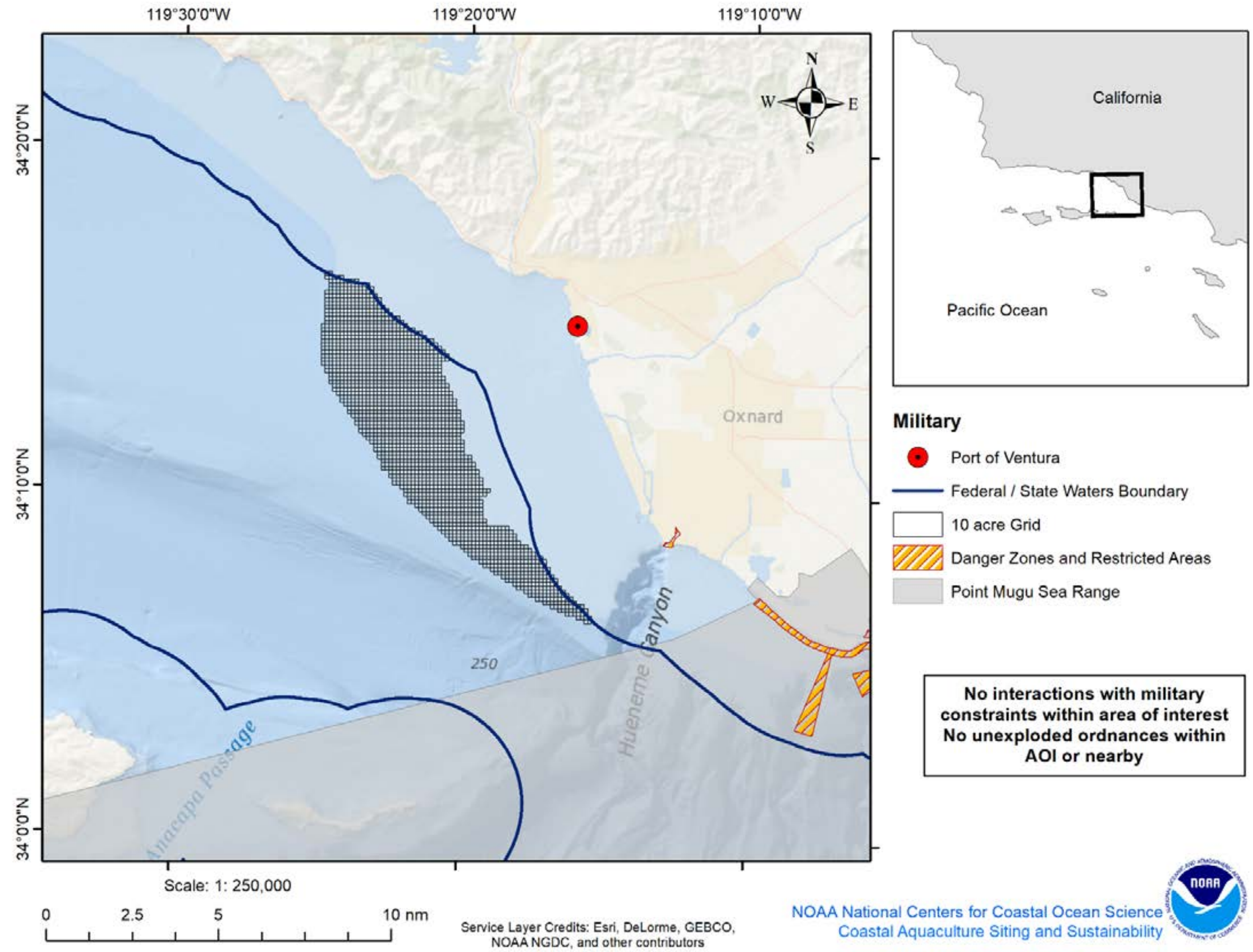


Figure 3. Military space use within the Santa Barbara Channel region in relation to the Ventura Shellfish Enterprise (VSE) 'area of interest'. No military interactions occur within the 'area of interest'.

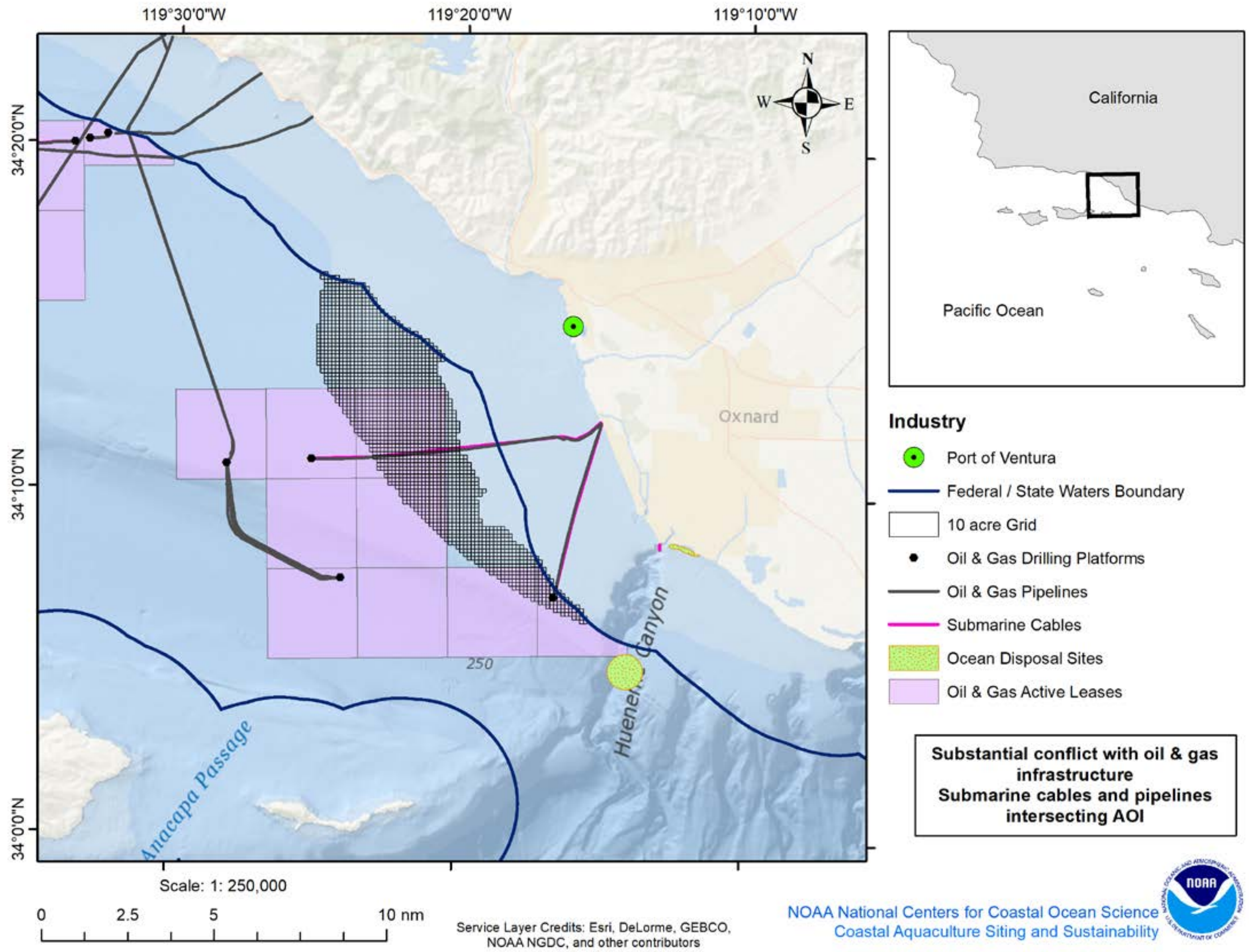


Figure 4. Industry space use within the Santa Barbara Channel region in relation to the Ventura Shellfish Enterprise (VSE) 'area of interest'. Oil and gas infrastructure (active leases, drilling platforms, and pipelines) and submarine cables interactions occur within the 'area of interest'.

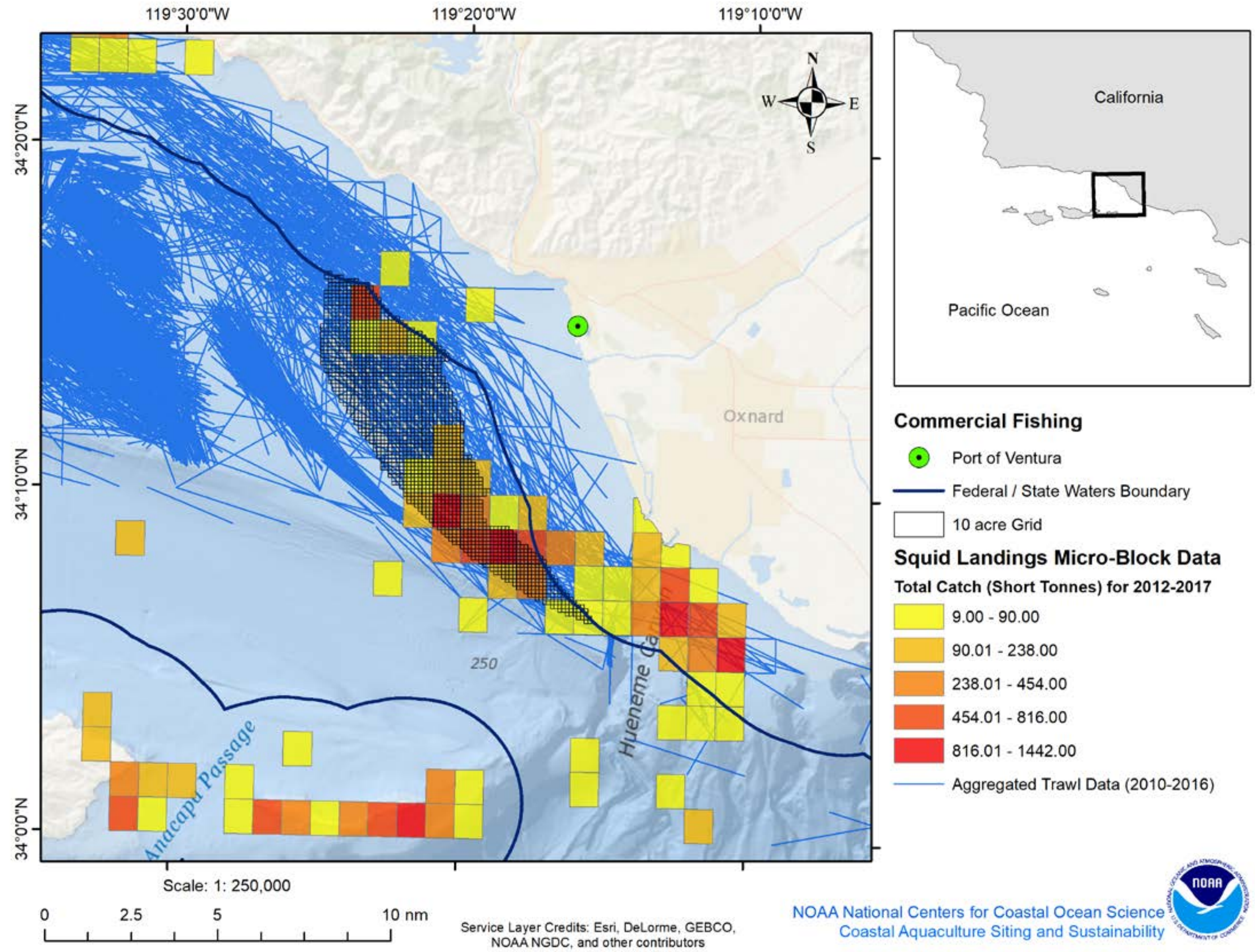


Figure 5. Commercial fishery space use within the Santa Barbara Channel region in relation to the Ventura Shellfish Enterprise (VSE) 'area of interest'. Commercial trawl and squid fishery interactions occur within the 'area of interest'.

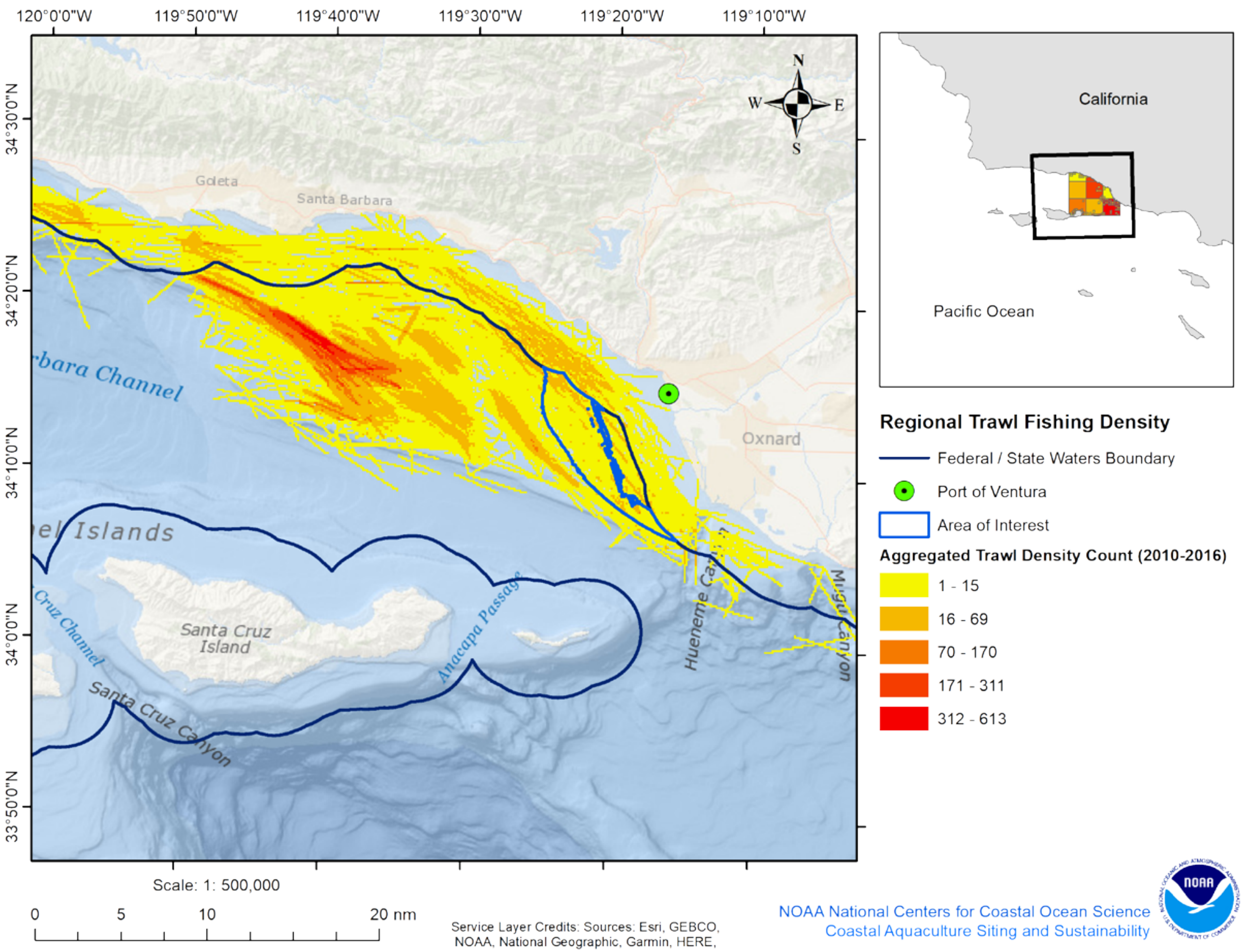


Figure 6. Regional perspective of commercial trawl fisheries within the Santa Barbara Channel region. Note that trawl fishery interactions occur within the 'area of interest,' however, the highest density of trawl fishery activity occurs northwest of the 'area of interest'.

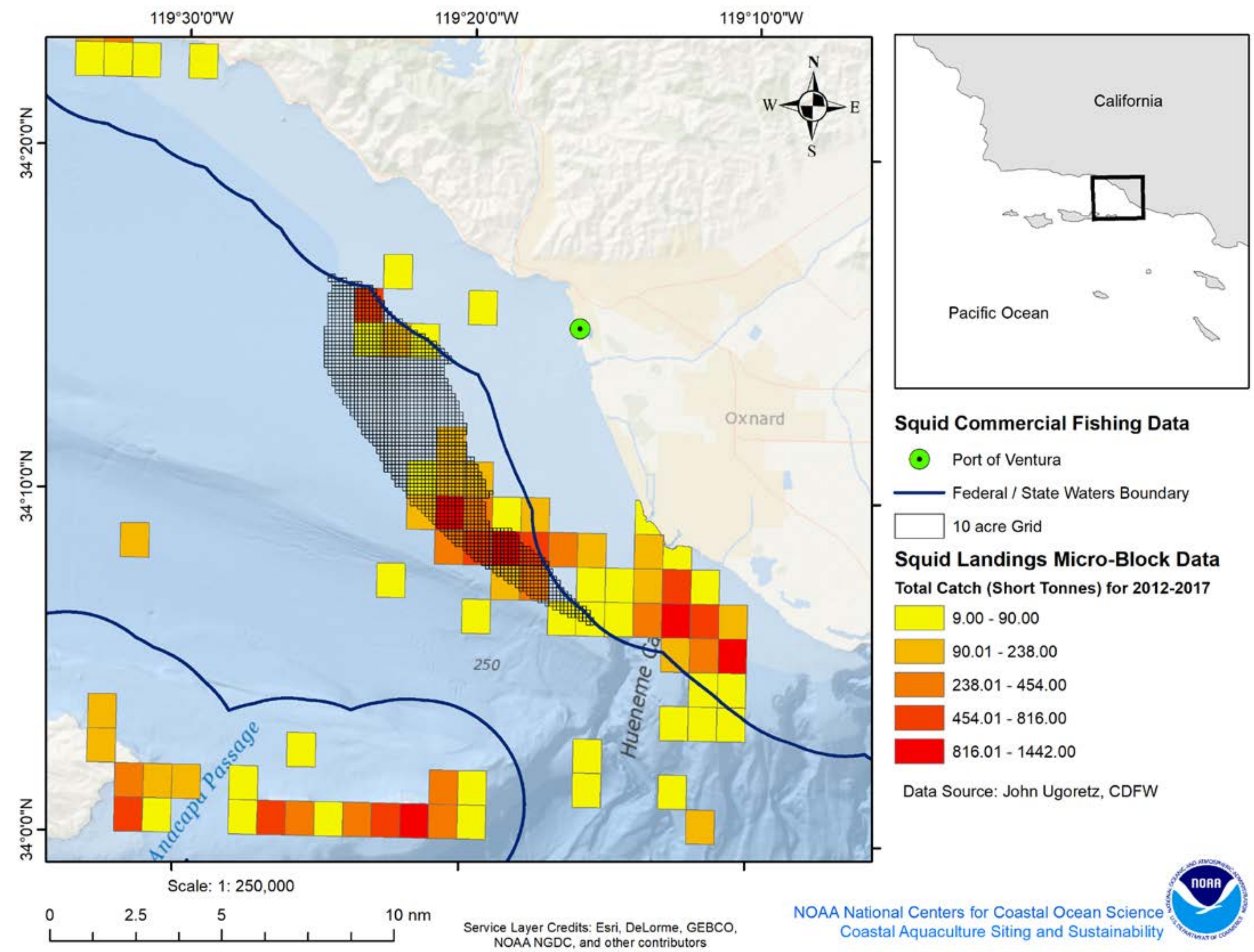


Figure 7. Regional perspective of the commercial squid fishery within the Santa Barbara Channel region. Note that trawl fishery interactions occur within the 'area of interest,' however, the highest density of trawl fishery activity occurs northwest of the 'area of interest'.

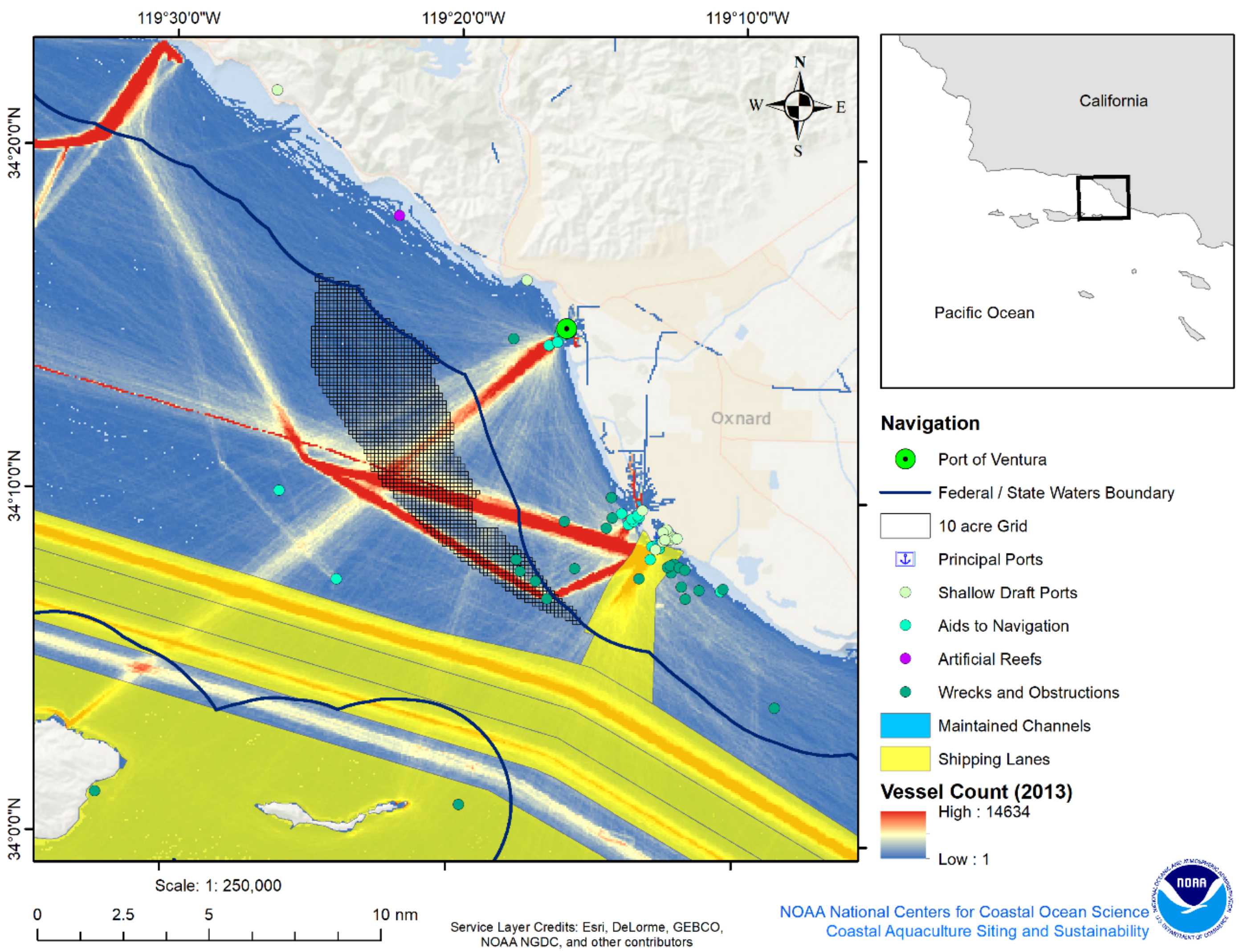


Figure 8. Navigation space use within the Santa Barbara Channel region in relation to the Ventura Shellfish Enterprise (VSE) ‘area of interest’. Vessel traffic and wrecks and obstructions interactions occur within the ‘area of interest’.

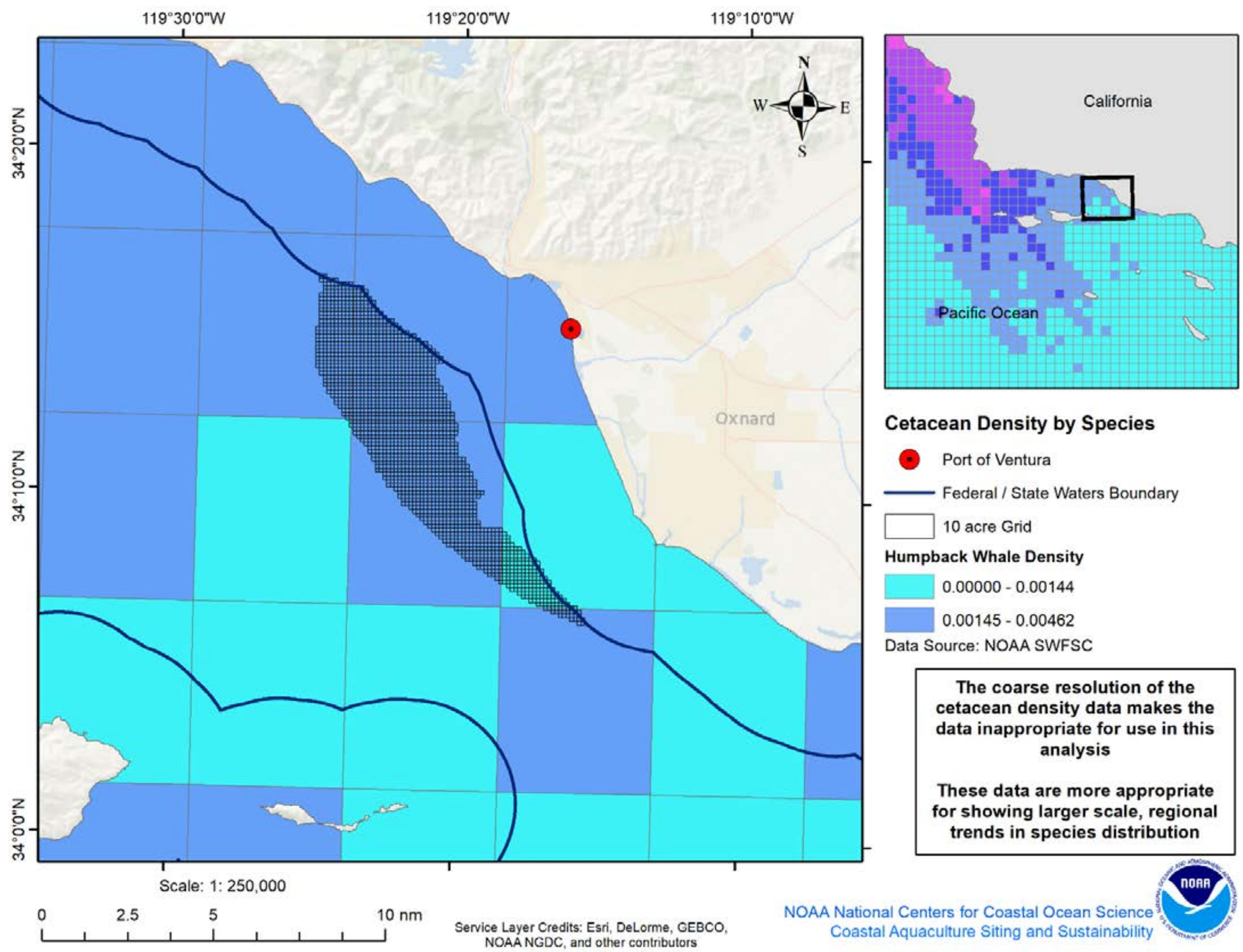


Figure 9. Cetacean (i.e., humpback whale) predicted density in relation to the VSE 'area of interest. Note that due to the coarse spatial resolution of this data, it was inappropriate for use within the VSE suitability analysis. The inset map (upper right) shows the large-scale, regional trends of cetacean (i.e., humpback whale) distribution.

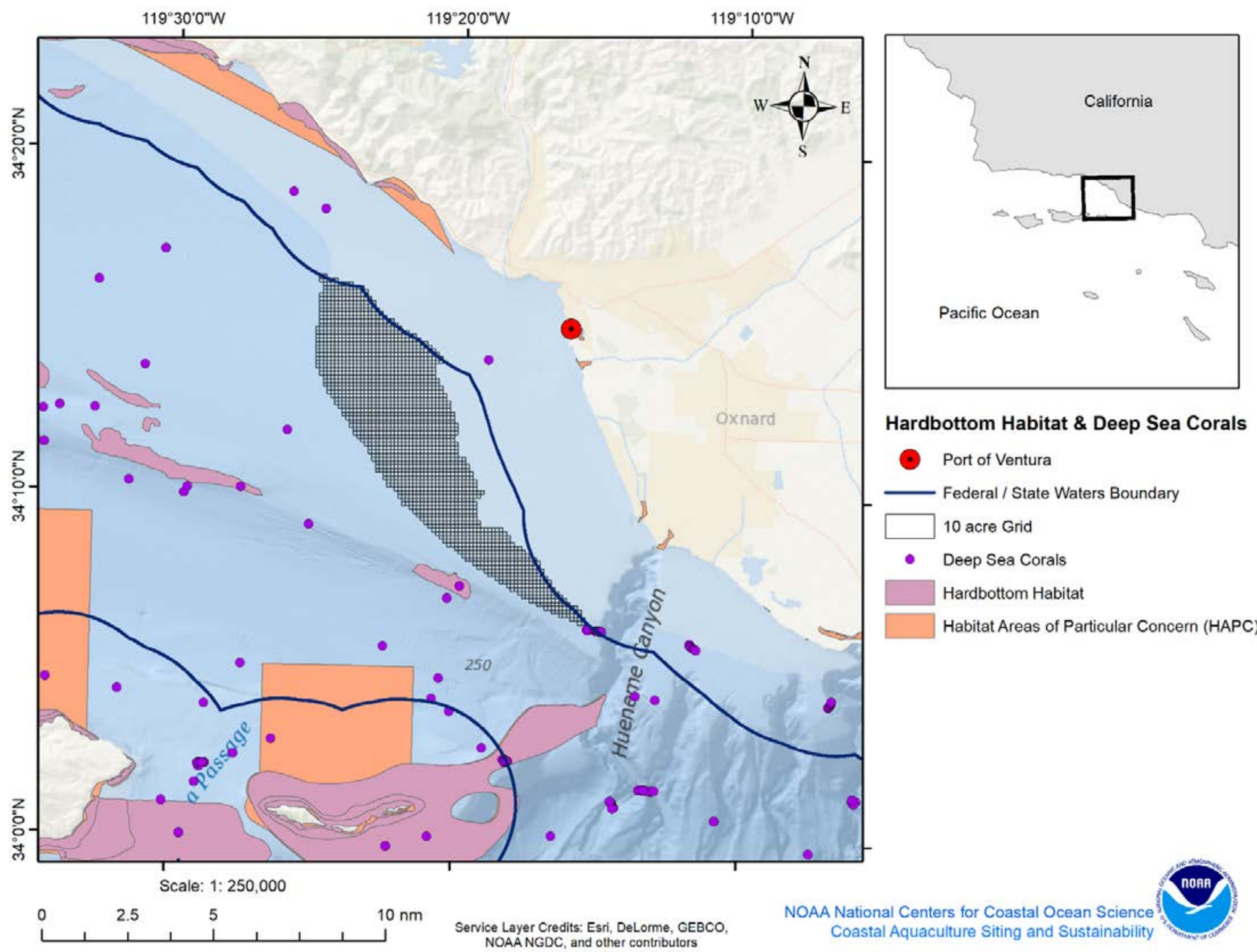


Figure 10. Distribution of hardbottom habitat and deep-sea corals in relation to the VSE 'area of interest'. Note that records of deep-sea corals and hardbottom habitat occur within proximity of the VSE 'area of interest,' but not within it.

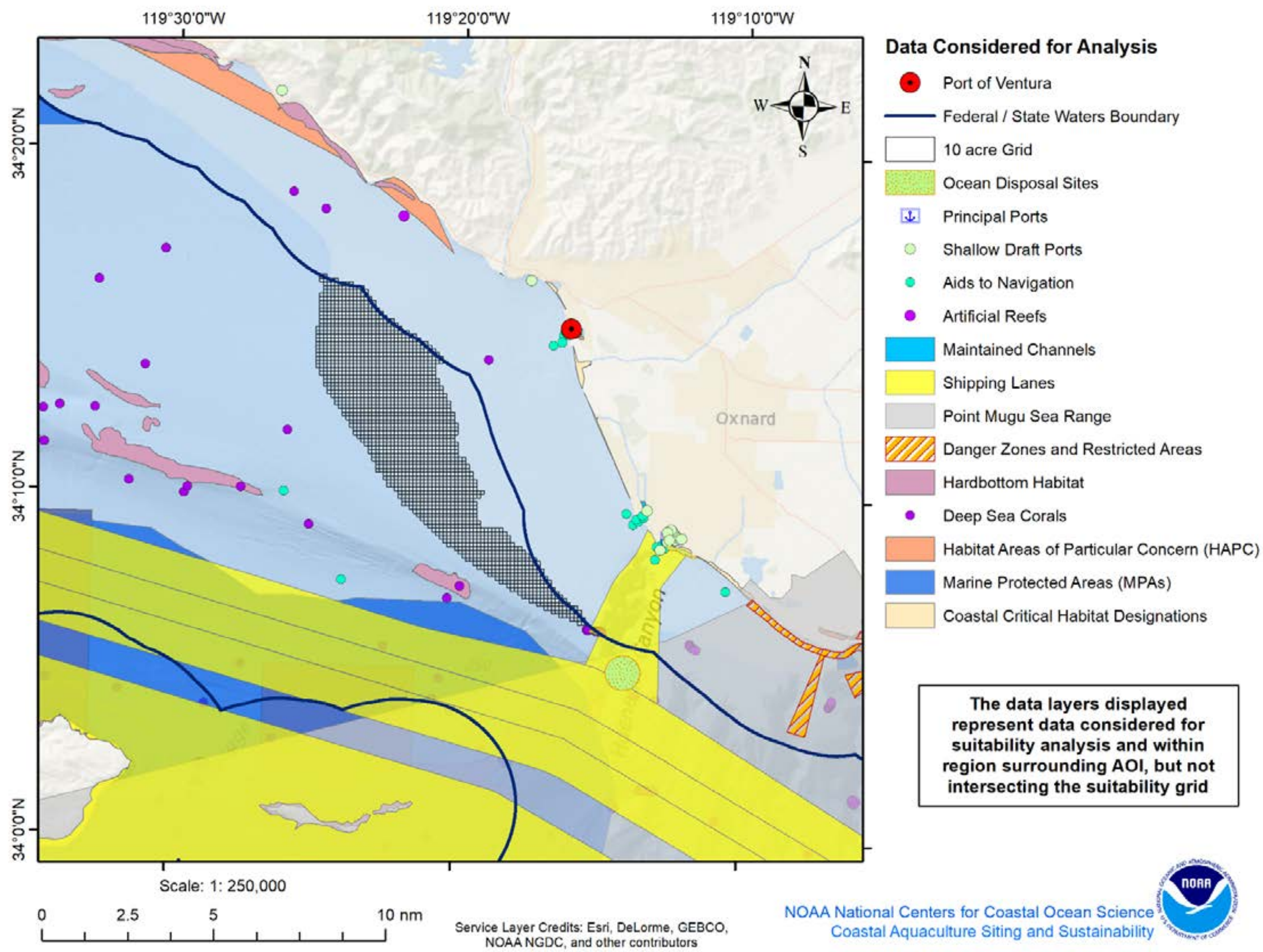


Figure 11. Distribution of all major spatial data layers representing potential space-use conflicts (e.g., military, navigation, natural resources) that were considered, but do not intersect the VSE 'area of interest' and were thus not incorporated within the suitability analysis.

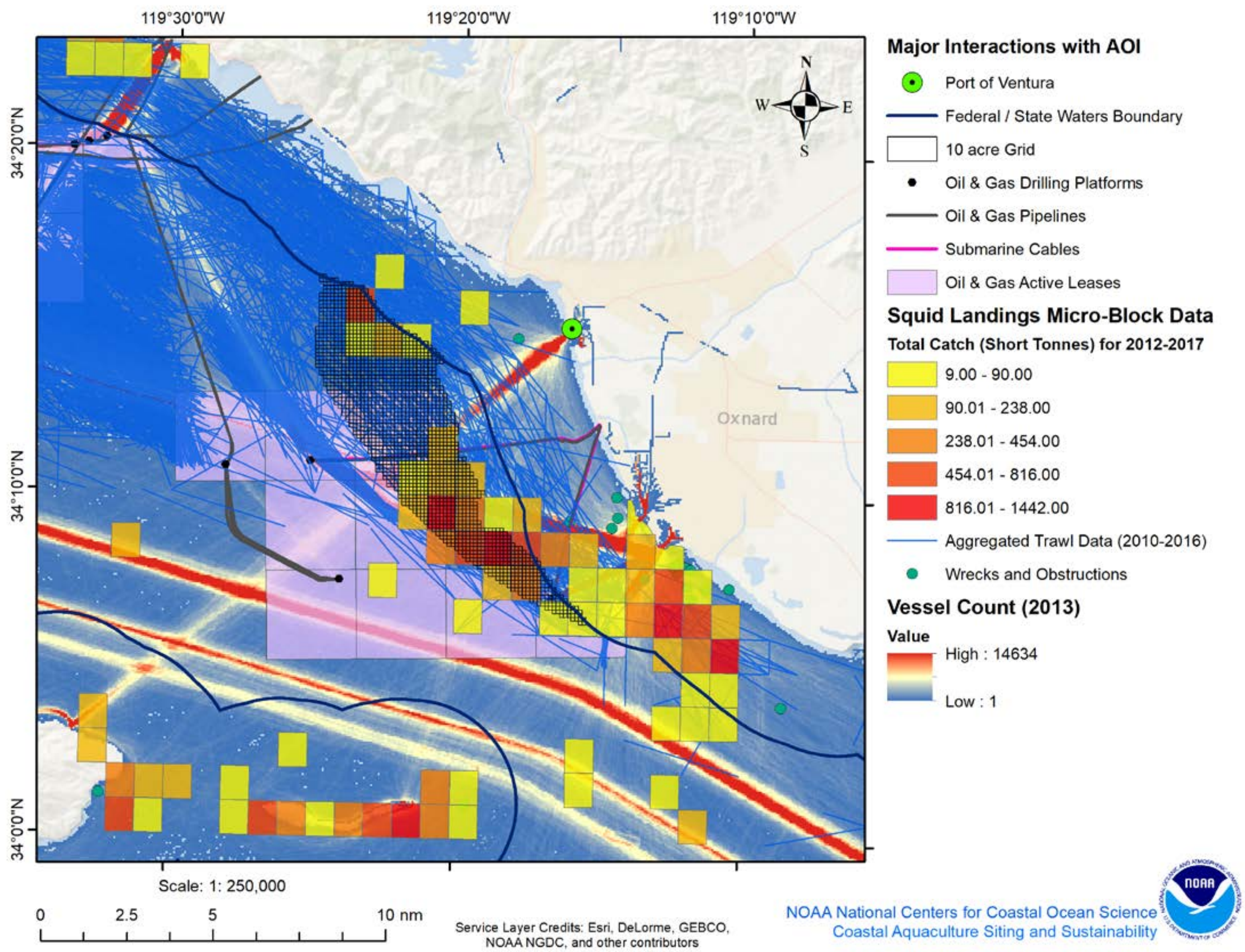


Figure 12. Distribution of all major spatial data layers representing potential space-use conflicts that intersect the VSE 'area of interest' and were incorporated within the suitability analysis. These include: (1) oil and gas leases, drilling platforms, and pipelines, (2) submarine cables, (3) commercial trawl and squid fisheries, (4) wrecks and obstructions, and (5) vessel traffic.

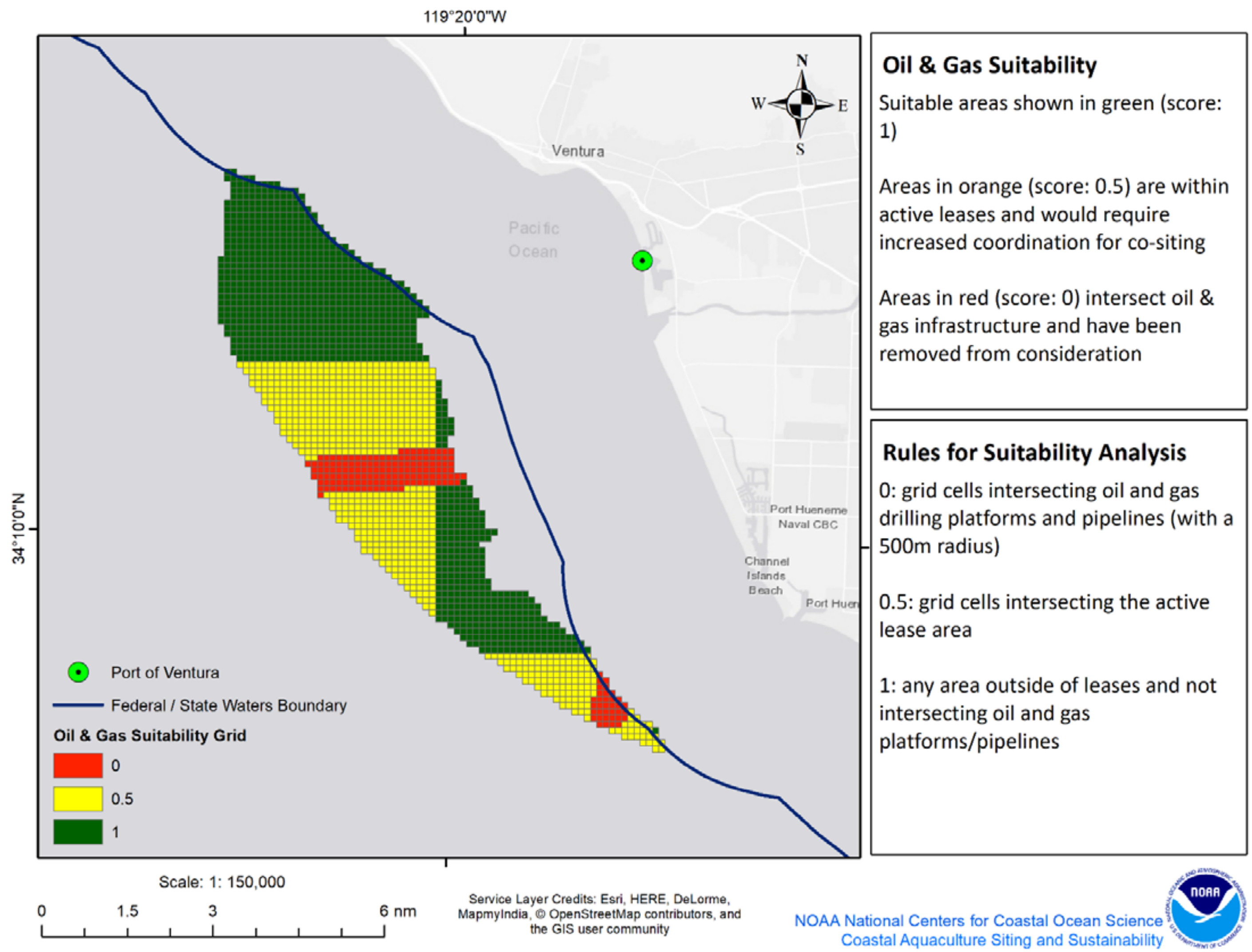


Figure 13. Oil and gas suitability layer incorporated within the overall VSE suitability analysis. Areas within a 500 meter radius of active oil and gas pipelines and drilling platforms were assigned a score of '0' (least compatible), areas within an active oil and gas lease were assigned a score of '0.5' (moderately compatible), and those outside of active oil and gas interests were assigned a score of '1' (most compatible).

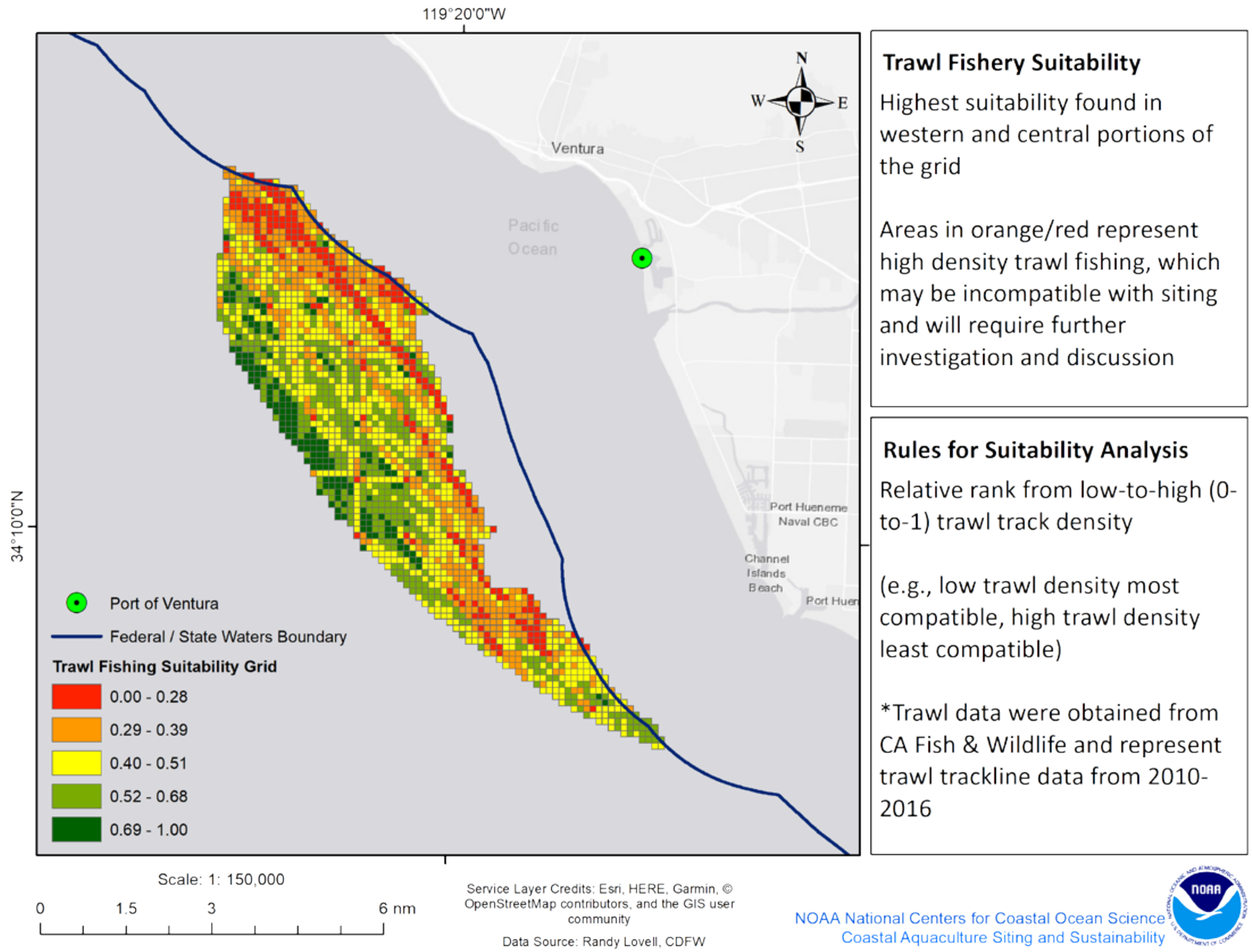


Figure 14. Commercial trawl fishery suitability layer incorporated within the overall VSE suitability analysis. Areas corresponding to the highest density of trawl track line intersections were assigned a score of ‘0’ (least compatible) and areas of lowest density of trawl track line intersections were assigned a score of ‘1’ (most compatible). Continuous scores between ‘0’ and ‘1’ were assigned for all other grid cells across the low-to-high density gradient.

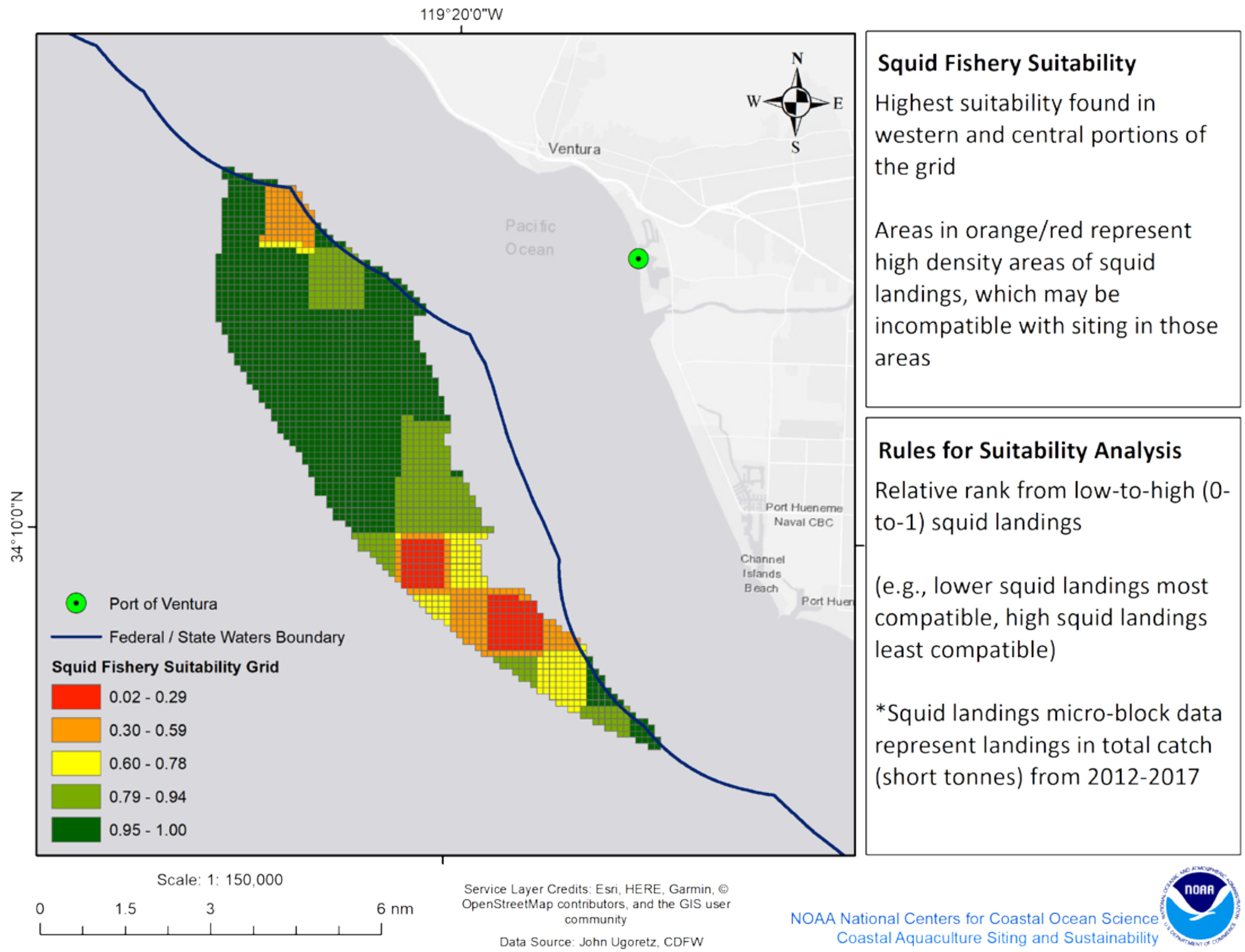


Figure 15. Commercial squid fishery suitability layer incorporated within the overall VSE suitability analysis. Areas corresponding to the highest total squid landings by microblock were assigned a score of '0' (least compatible) and areas of lowest total squid landings by microblock were assigned a score of '1' (most compatible). Continuous scores between '0' and '1' were assigned for all other grid cells across the low-to-high total squid landings by microblock gradient.

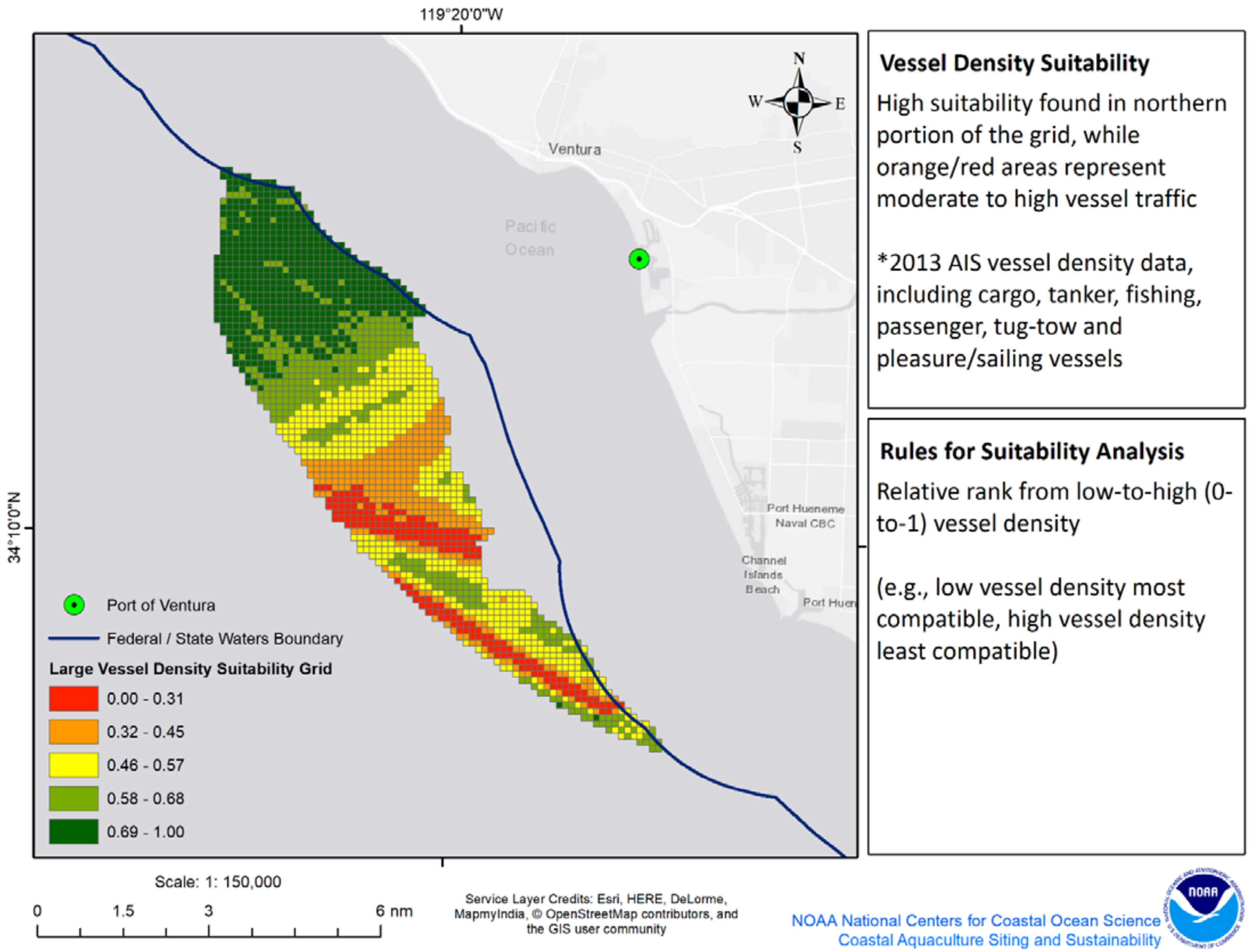


Figure 16. Vessel density suitability layer incorporated within the overall VSE suitability analysis. Areas corresponding to the highest total vessel density were assigned a score of '0' (least compatible) and areas of lowest total vessel density were assigned a score of '1' (most compatible). Continuous scores between '0' and '1' were assigned for all other grid cells across the low-to-high density gradient.

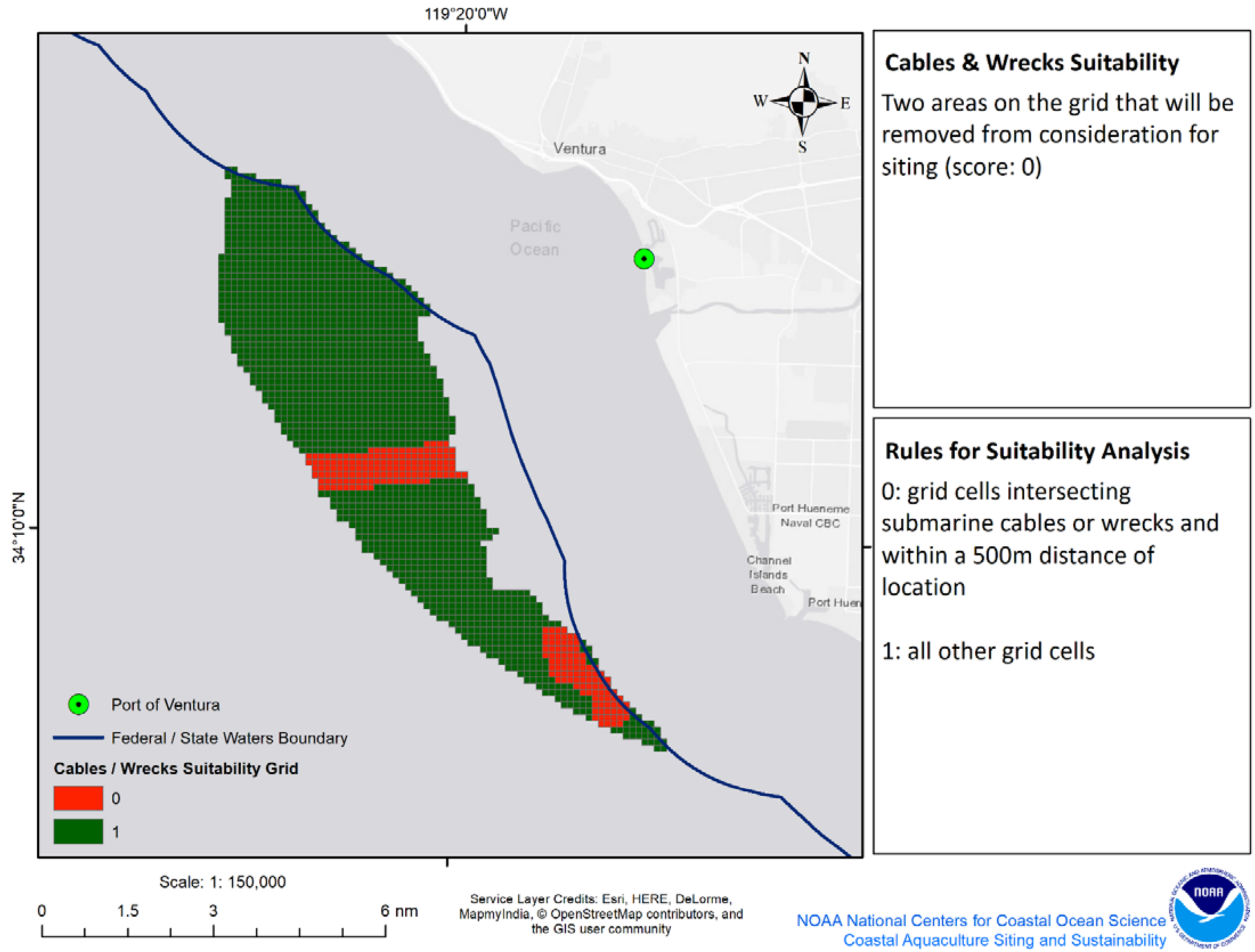


Figure 17. Submerged cables and wrecks and obstructions suitability layer incorporated within the overall VSE suitability analysis. Areas within a 500-meter radius of submerged cables and wrecks and obstructions were assigned a score of '0' (least compatible) while areas outside of a 500-meter radius of submerged cables and wrecks and obstructions were assigned a score of '1' (most compatible).

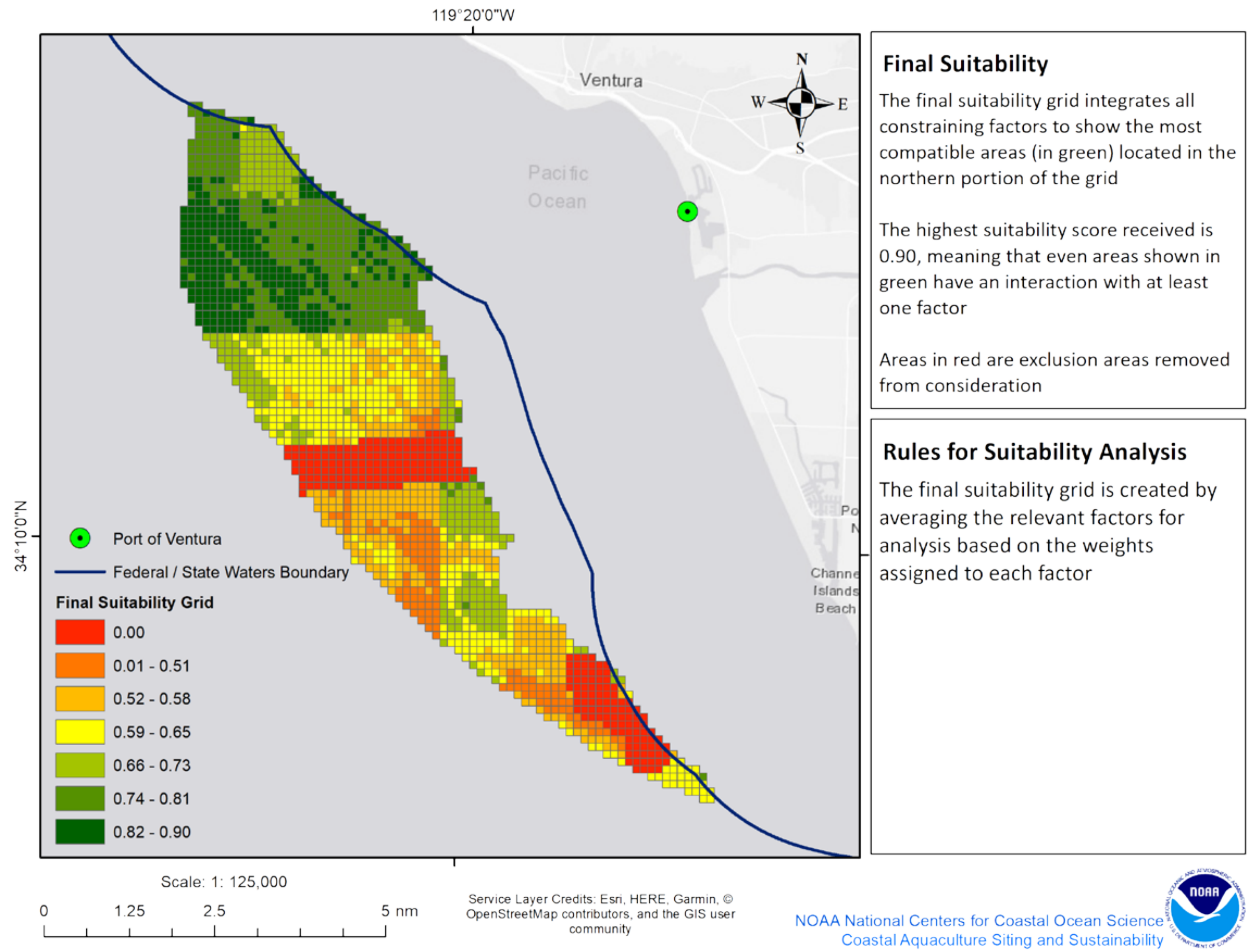


Figure 18. Final suitability grid generated through integration of all individual suitability layers (i.e., oil and gas, commercial trawl fishery, commercial squid fishery, vessel traffic, and submerged cables and wrecks and obstructions). Note that all layers were assigned equal weights within the analysis.

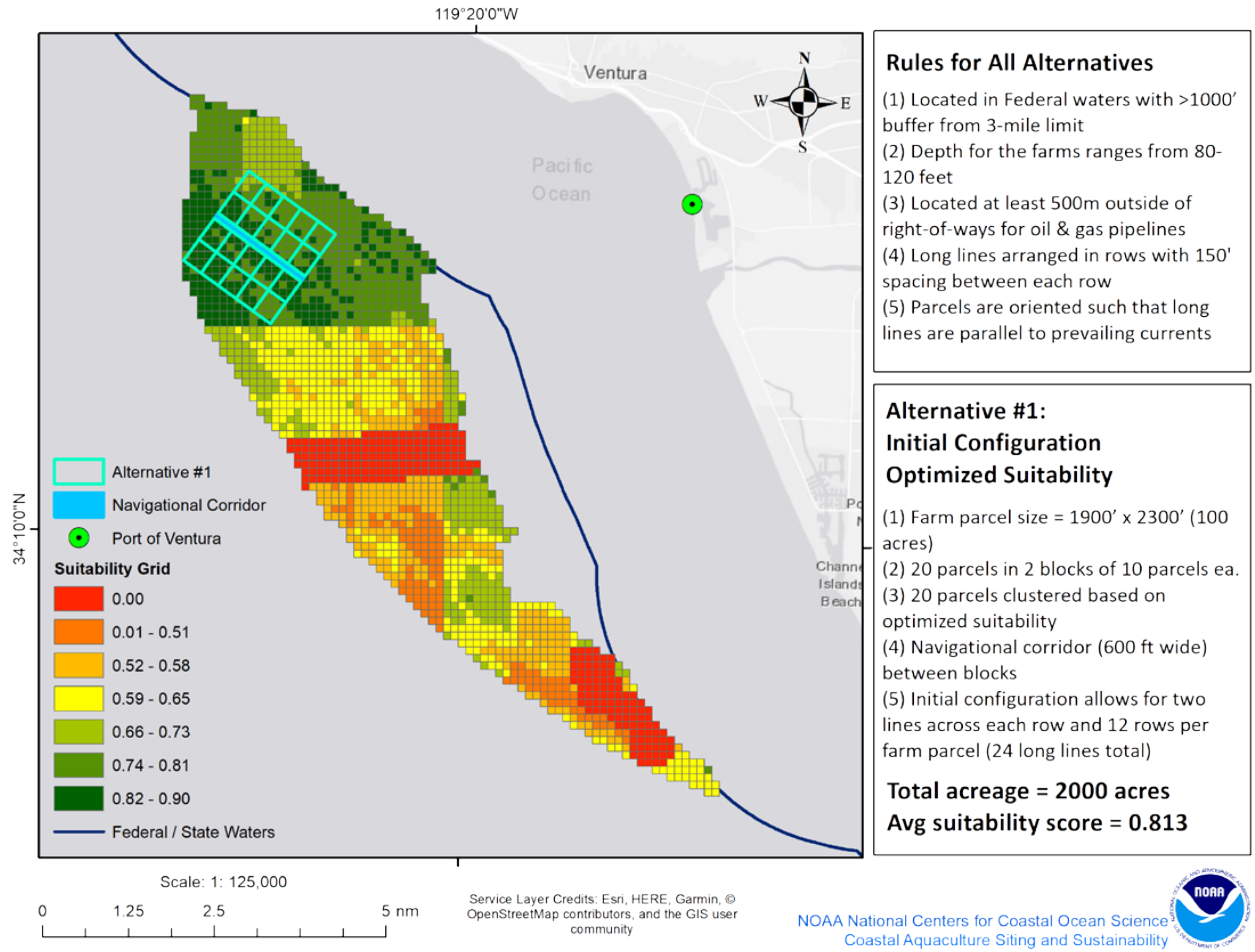


Figure 19. Alternative 1. The first alternative site for VSE was created using their initial configuration, in which the farm parcel design is a 1,900' by 2,300' plot. The alternative site contains 20 parcels, clustered into two blocks, with a 600' navigational corridor between the two blocks. The alternative site was positioned within the 'area of interest' based on optimizing suitability.

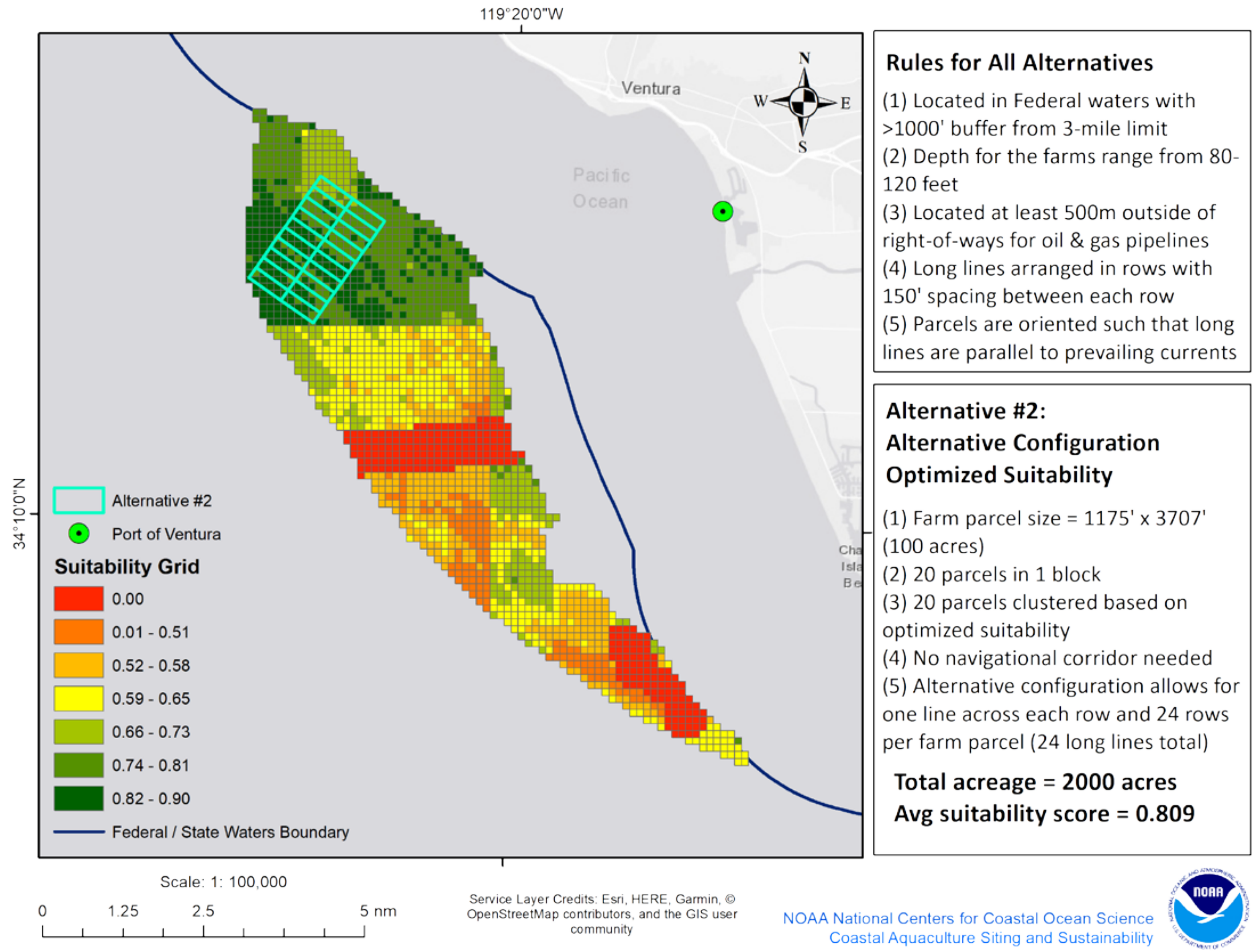
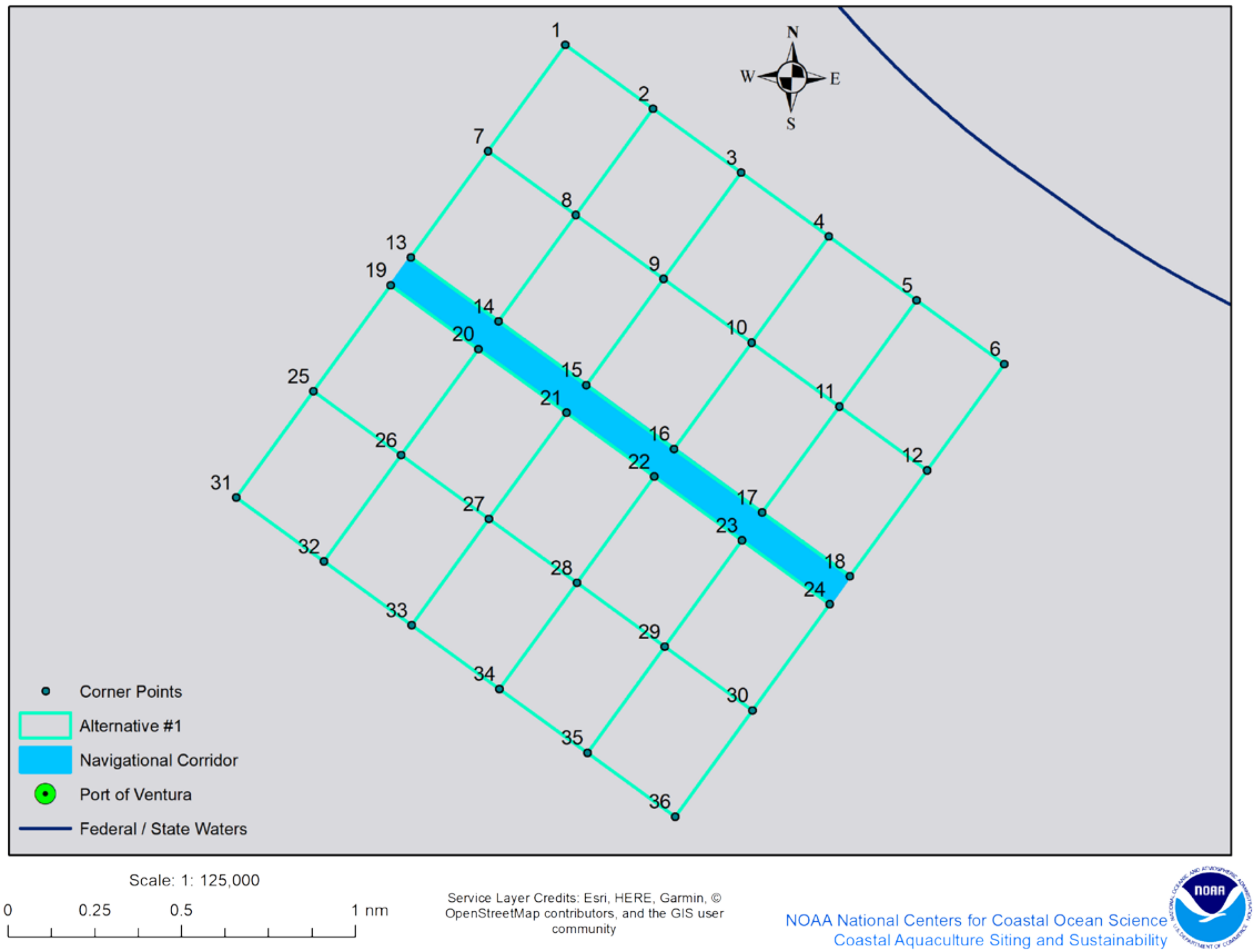


Figure 20. Alternative 2. The second alternative site for VSE was created using their alternative configuration, in which the farm parcel design is a 1,175' by 3,707' plot. The alternative site contains 20 parcels, clustered in one contiguous block. A navigational corridor was not needed since all parcels can be reached on the perimeter of the site. The alternative site was positioned within the 'area of interest' based on optimizing suitability.

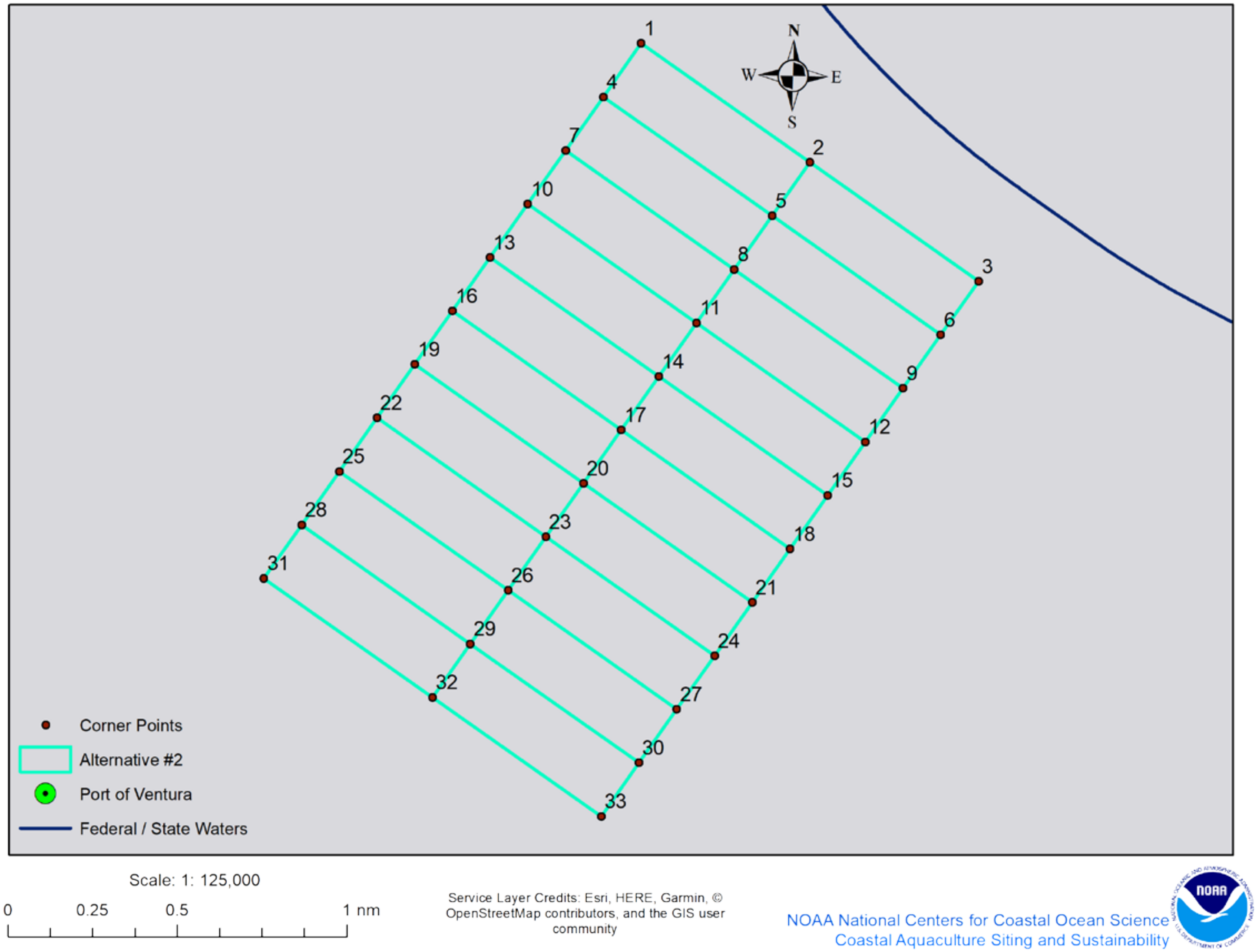
APPENDIX



Appendix 1. Corner points associated with Alternative #1 for the proposed VSE project. Note that the labelled points correspond with the latitude and longitude coordinates described in Appendix 2.

Appendix 2. Corner points and associated latitudes and longitudes for Alternative #1 for the proposed VSE project.

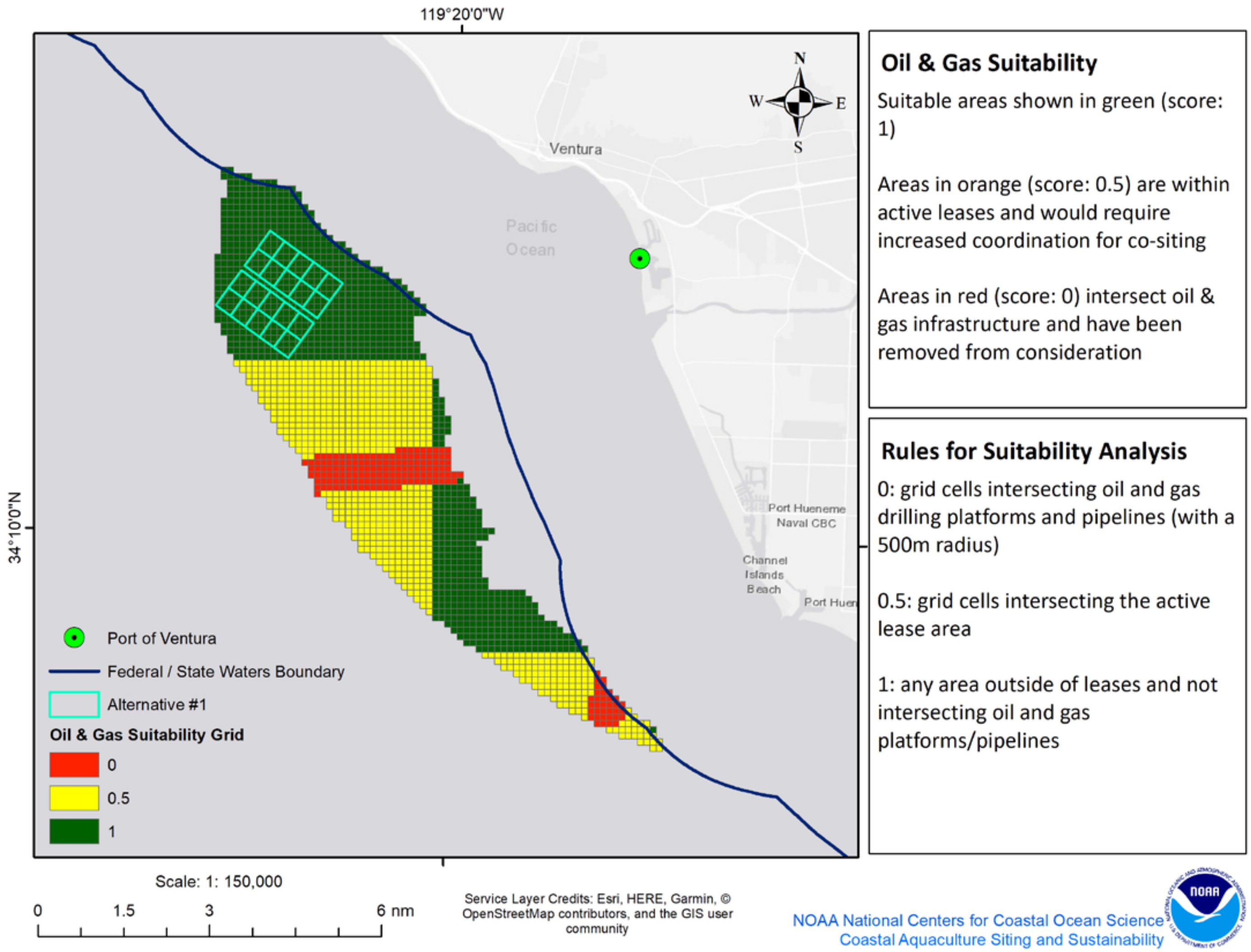
Corner ID	Latitude	Longitude
1	34° 15' 17.528" N	119° 23' 56.582" W
2	34° 15' 6.837" N	119° 23' 37.972" W
3	34° 14' 56.145" N	119° 23' 19.363" W
4	34° 14' 45.452" N	119° 23' 0.755" W
5	34° 14' 34.759" N	119° 22' 42.149" W
6	34° 14' 24.064" N	119° 22' 23.544" W
7	34° 14' 58.821" N	119° 24' 12.166" W
8	34° 14' 48.130" N	119° 23' 53.557" W
9	34° 14' 37.439" N	119° 23' 34.949" W
10	34° 14' 26.747" N	119° 23' 16.342" W
11	34° 14' 16.054" N	119° 22' 57.736" W
12	34° 14' 5.361" N	119° 22' 39.132" W
13	34° 14' 40.113" N	119° 24' 27.749" W
14	34° 14' 29.423" N	119° 24' 9.140" W
15	34° 14' 18.733" N	119° 23' 50.532" W
16	34° 14' 8.041" N	119° 23' 31.926" W
17	34° 13' 57.349" N	119° 23' 13.321" W
18	34° 13' 46.656" N	119° 22' 54.718" W
19	34° 14' 35.223" N	119° 24' 31.808" W
20	34° 14' 24.533" N	119° 24' 13.199" W
21	34° 14' 13.843" N	119° 23' 54.592" W
22	34° 14' 3.151" N	119° 23' 35.986" W
23	34° 13' 52.459" N	119° 23' 17.381" W
24	34° 13' 41.766" N	119° 22' 58.777" W
25	34° 14' 16.514" N	119° 24' 47.388" W
26	34° 14' 5.826" N	119° 24' 28.780" W
27	34° 13' 55.136" N	119° 24' 10.173" W
28	34° 13' 44.445" N	119° 23' 51.568" W
29	34° 13' 33.754" N	119° 23' 32.964" W
30	34° 13' 23.061" N	119° 23' 14.361" W
31	34° 13' 57.806" N	119° 25' 2.966" W
32	34° 13' 47.118" N	119° 24' 44.359" W
33	34° 13' 36.428" N	119° 24' 25.753" W
34	34° 13' 25.738" N	119° 24' 7.148" W
35	34° 13' 15.048" N	119° 23' 48.544" W
36	34° 13' 4.356" N	119° 23' 29.942" W



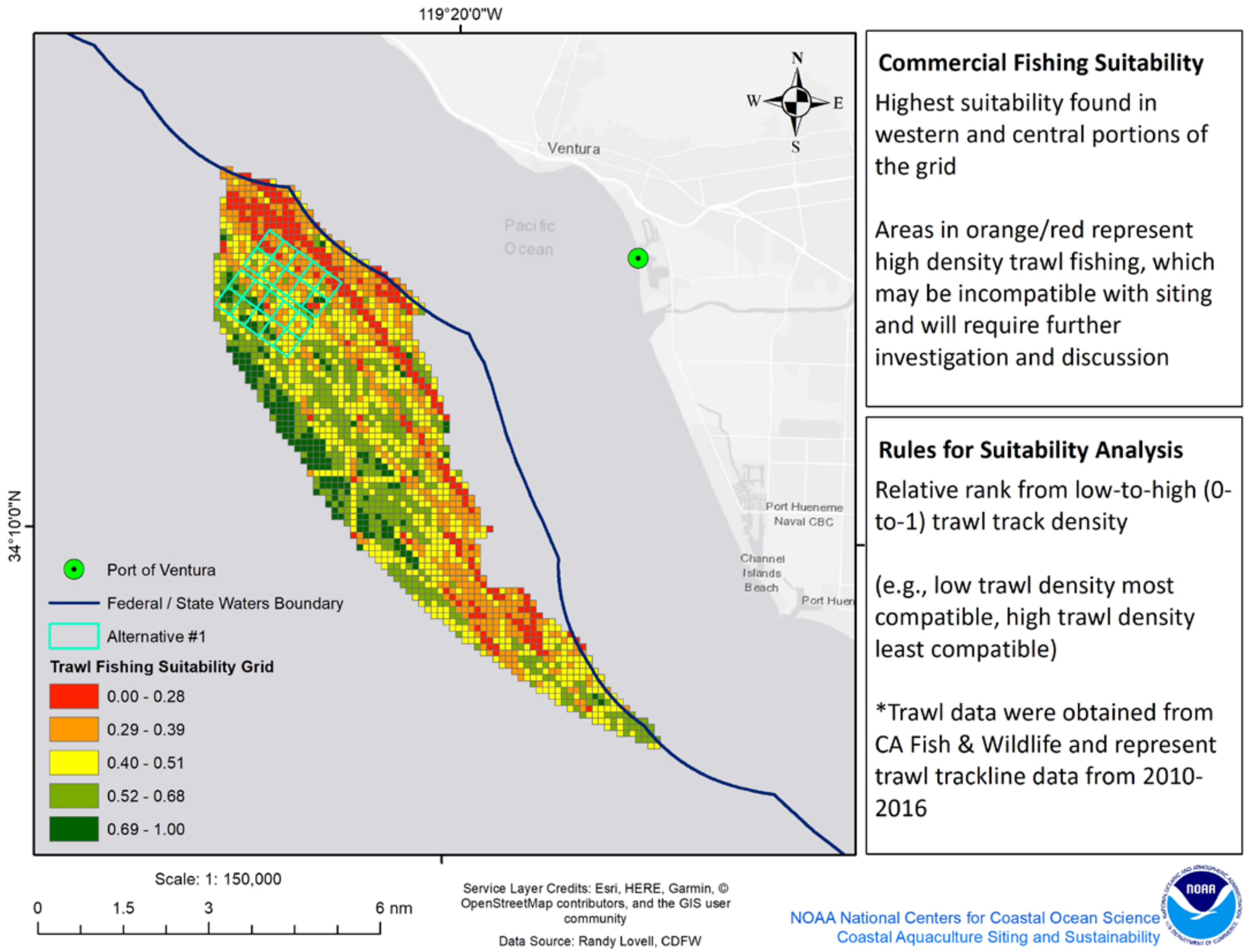
Appendix 3. Corner points associated with Alternative #2 for the proposed VSE project. Note that the labelled points correspond with the latitude and longitude coordinates described in Appendix 4.

Appendix 4. Corner points and associated latitudes and longitudes for Alternative #2 for the proposed VSE project.

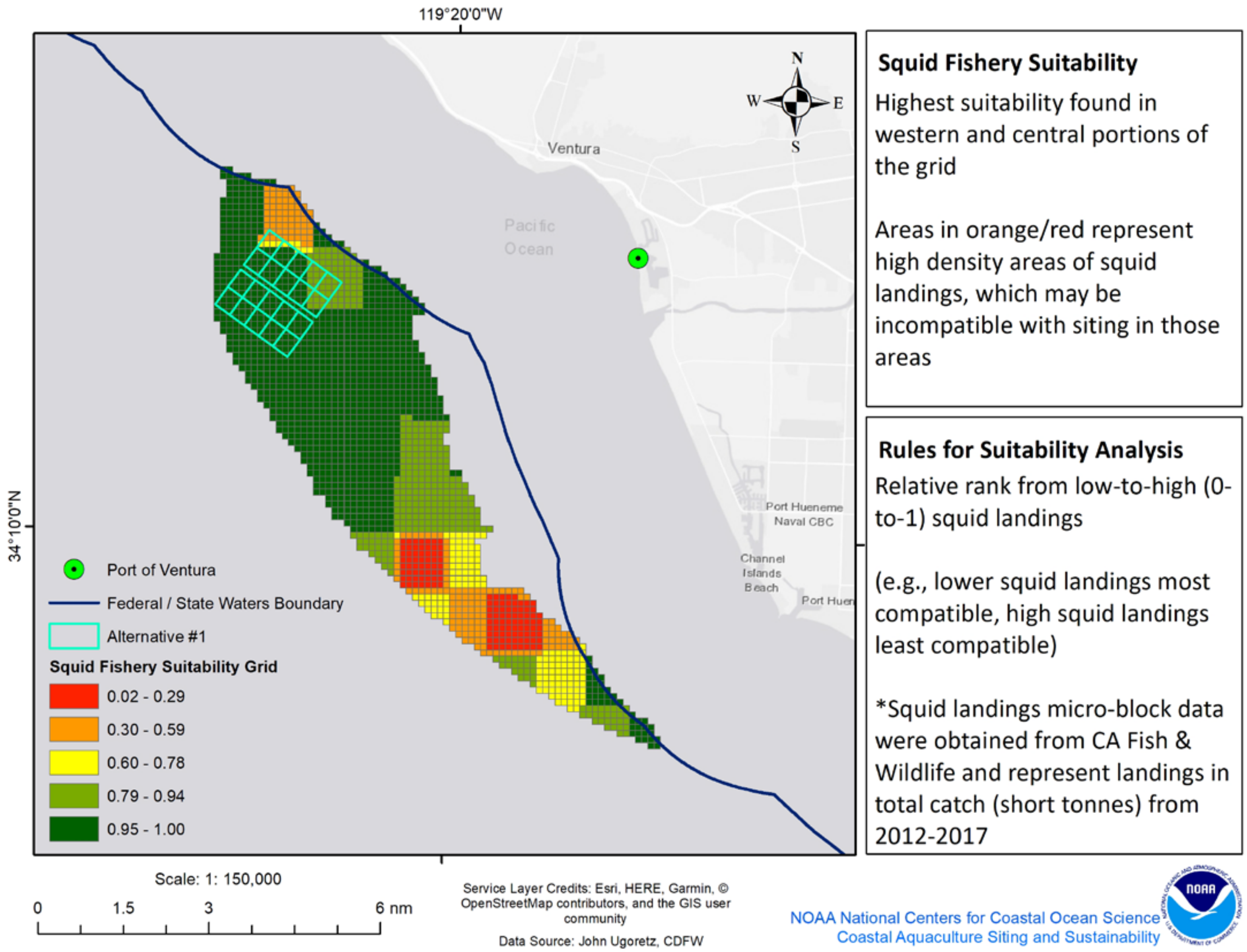
Corner ID	Latitude	Longitude
1	34° 15' 21.520" N	119° 23' 42.518" W
2	34° 15' 1.105" N	119° 23' 5.841" W
3	34° 14' 40.687" N	119° 22' 29.169" W
4	34° 15' 11.867" N	119° 23' 50.309" W
5	34° 14' 51.453" N	119° 23' 13.633" W
6	34° 14' 31.035" N	119° 22' 36.962" W
7	34° 15' 2.214" N	119° 23' 58.101" W
8	34° 14' 41.801" N	119° 23' 21.425" W
9	34° 14' 21.384" N	119° 22' 44.755" W
10	34° 14' 52.561" N	119° 24' 5.891" W
11	34° 14' 32.148" N	119° 23' 29.217" W
12	34° 14' 11.731" N	119° 22' 52.547" W
13	34° 14' 42.908" N	119° 24' 13.682" W
14	34° 14' 22.495" N	119° 23' 37.008" W
15	34° 14' 2.079" N	119° 23' 0.339" W
16	34° 14' 33.254" N	119° 24' 21.471" W
17	34° 14' 12.842" N	119° 23' 44.798" W
18	34° 13' 52.427" N	119° 23' 8.130" W
19	34° 14' 23.601" N	119° 24' 29.261" W
20	34° 14' 3.189" N	119° 23' 52.588" W
21	34° 13' 42.775" N	119° 23' 15.921" W
22	34° 14' 13.947" N	119° 24' 37.050" W
23	34° 13' 53.536" N	119° 24' 0.378" W
24	34° 13' 33.122" N	119° 23' 23.711" W
25	34° 14' 4.293" N	119° 24' 44.838" W
26	34° 13' 43.883" N	119° 24' 8.167" W
27	34° 13' 23.470" N	119° 23' 31.501" W
28	34° 13' 54.639" N	119° 24' 52.626" W
29	34° 13' 34.230" N	119° 24' 15.956" W
30	34° 13' 13.817" N	119° 23' 39.290" W
31	34° 13' 44.985" N	119° 25' 0.413" W
32	34° 13' 24.576" N	119° 24' 23.744" W
33	34° 13' 4.164" N	119° 23' 47.079" W



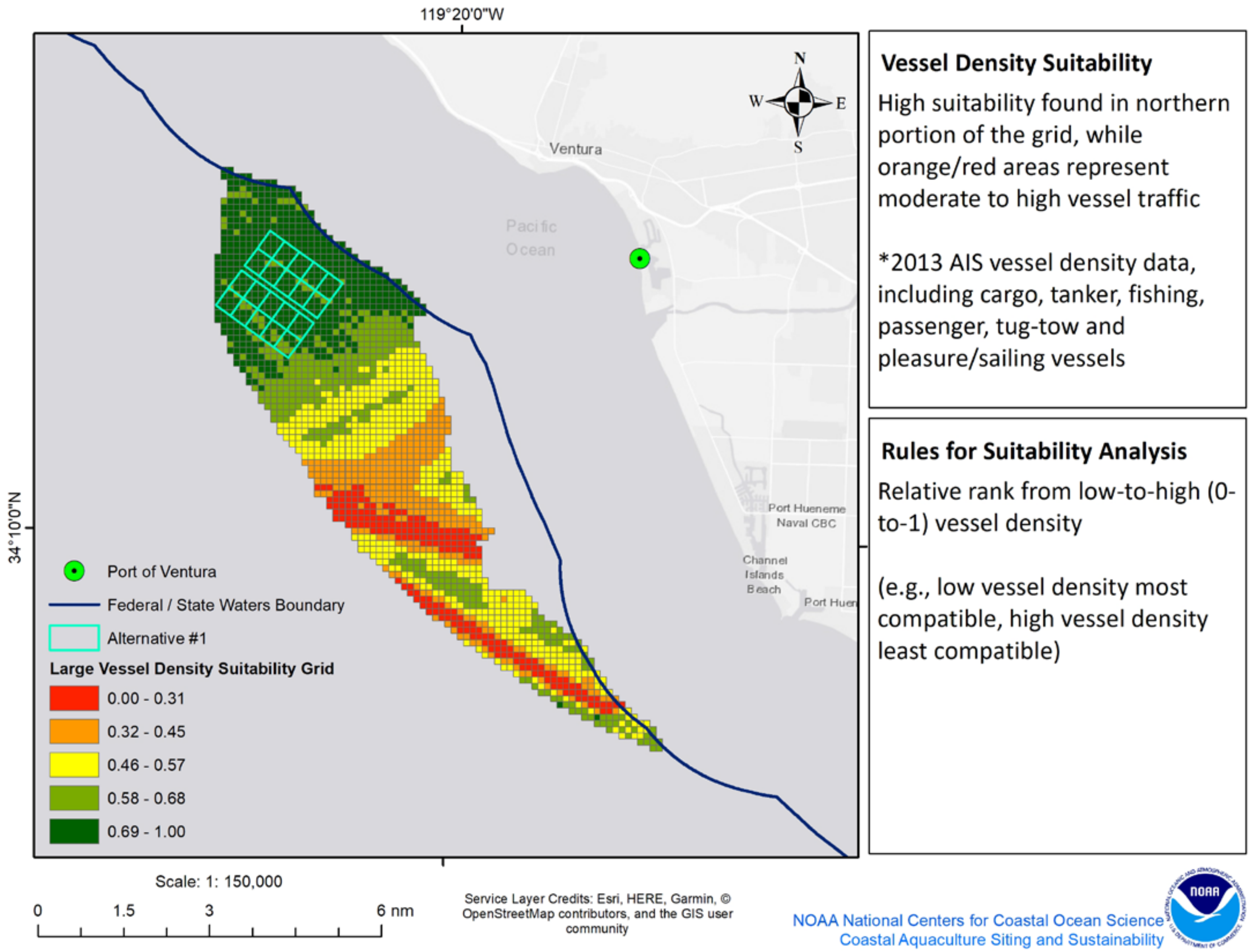
Appendix 5. Oil and gas suitability layer incorporated within the overall VSE suitability analysis relative to identified Alternative #1. Areas within a 500 meter radius of active oil and gas pipelines and drilling platforms were assigned a score of '0' (least compatible), areas within an active oil and gas lease were assigned a score of '0.5' (moderately compatible), and those outside of active oil and gas interests were assigned a score of '1' (most compatible).



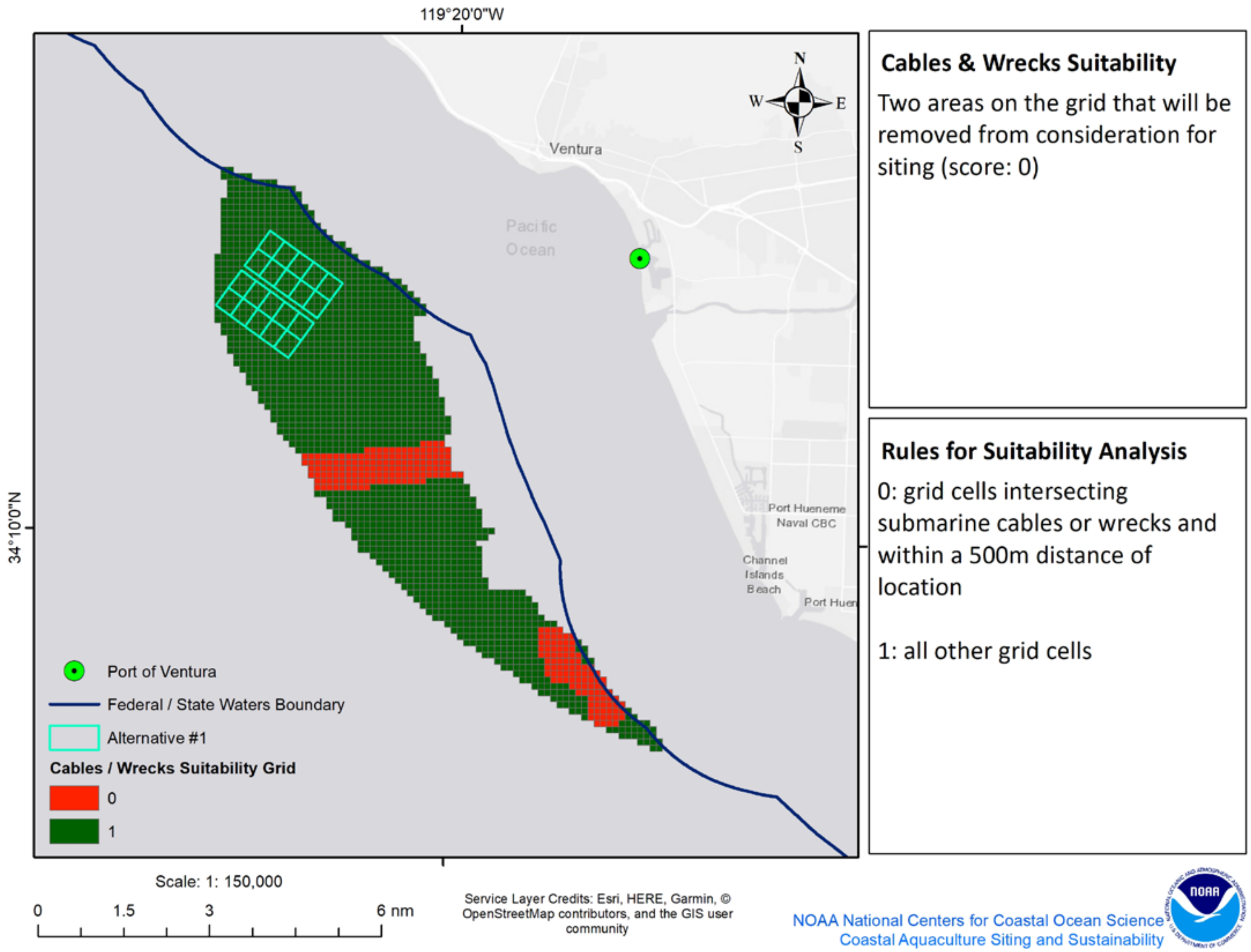
Appendix 6. Commercial trawl fishery suitability layer incorporated within the overall VSE suitability analysis relative to identified Alternative #1. Areas corresponding to the highest density of trawl track line intersections were assigned a score of ‘0’ (least compatible) and areas of lowest density of trawl track line intersections were assigned a score of ‘1’ (most compatible). Continuous scores between ‘0’ and ‘1’ were assigned for all other grid cells across the low-to-high density gradient.



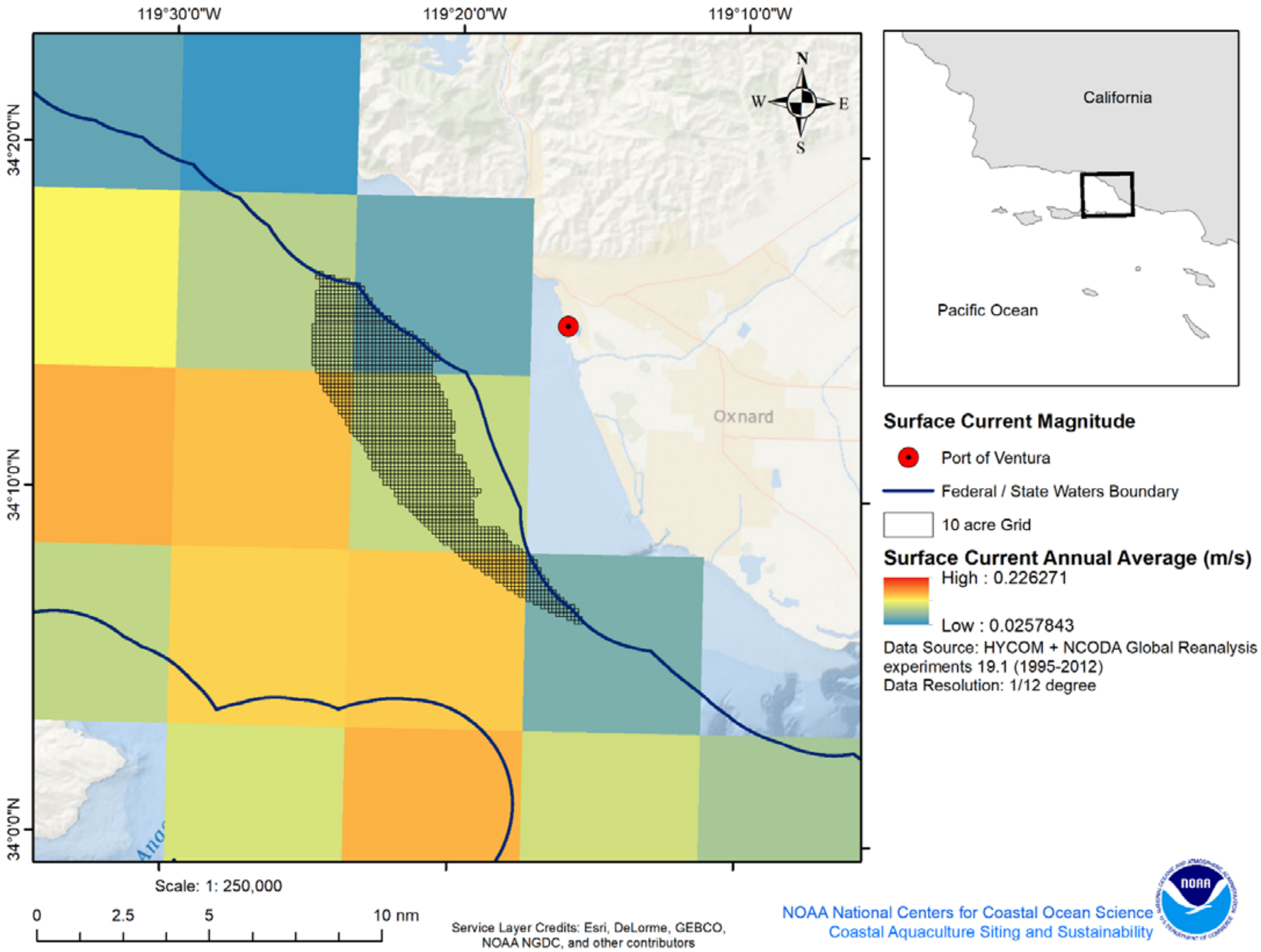
Appendix 7. Commercial squid fishery suitability layer incorporated within the overall VSE suitability analysis relative to identified Alternative #1. Areas corresponding to the highest total squid landings by microblock were assigned a score of '0' (least compatible) and areas of lowest total squid landings by microblock were assigned a score of '1' (most compatible). Continuous scores between '0' and '1' were assigned for all other grid cells across the low-to-high total squid landings by microblock gradient.



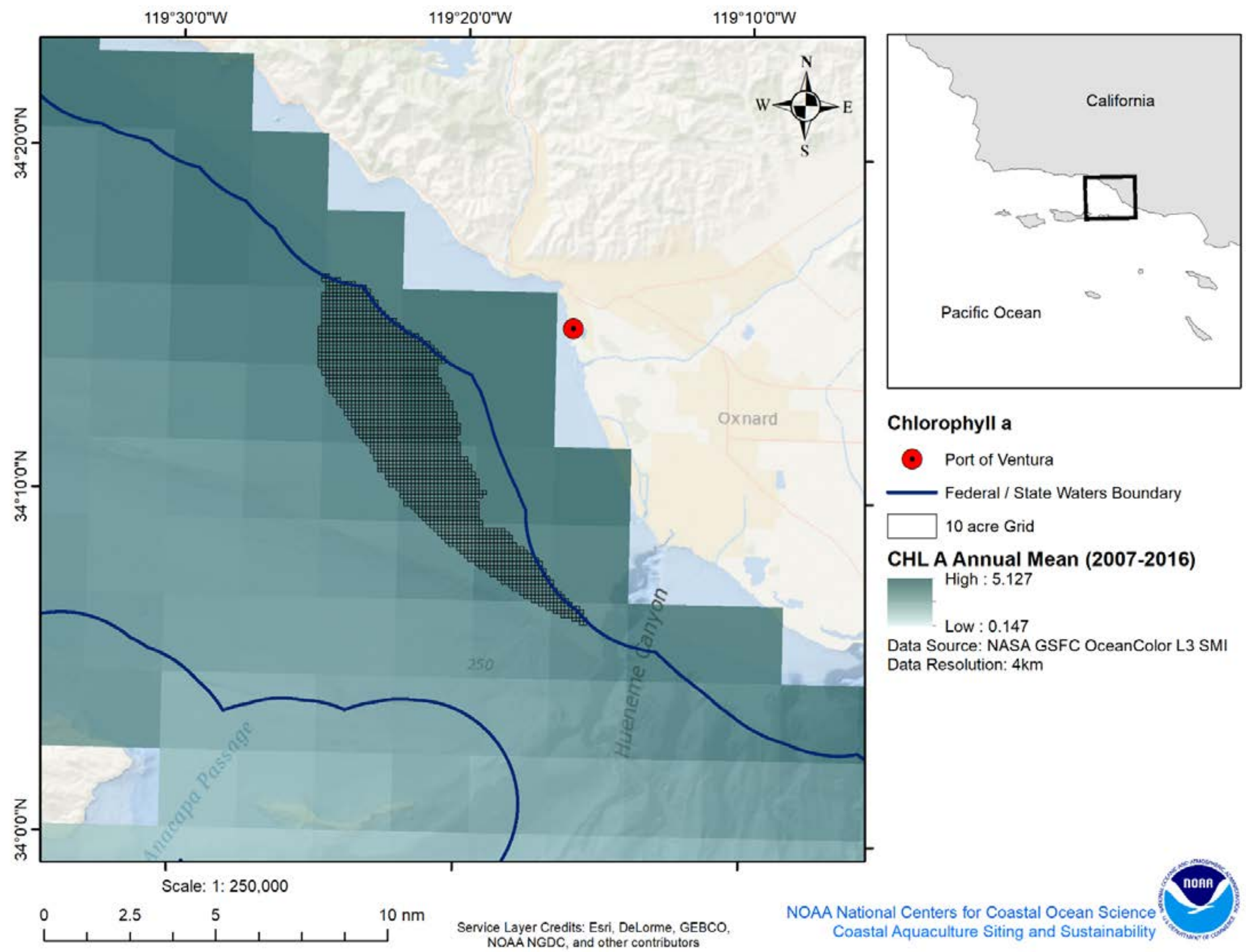
Appendix 8. Vessel density suitability layer incorporated within the overall VSE suitability analysis relative to identified Alternative #1. Areas corresponding to the highest total vessel density were assigned a score of '0' (least compatible) and areas of lowest total vessel density were assigned a score of '1' (most compatible). Continuous scores between '0' and '1' were assigned for all other grid cells across the low-to-high density gradient.



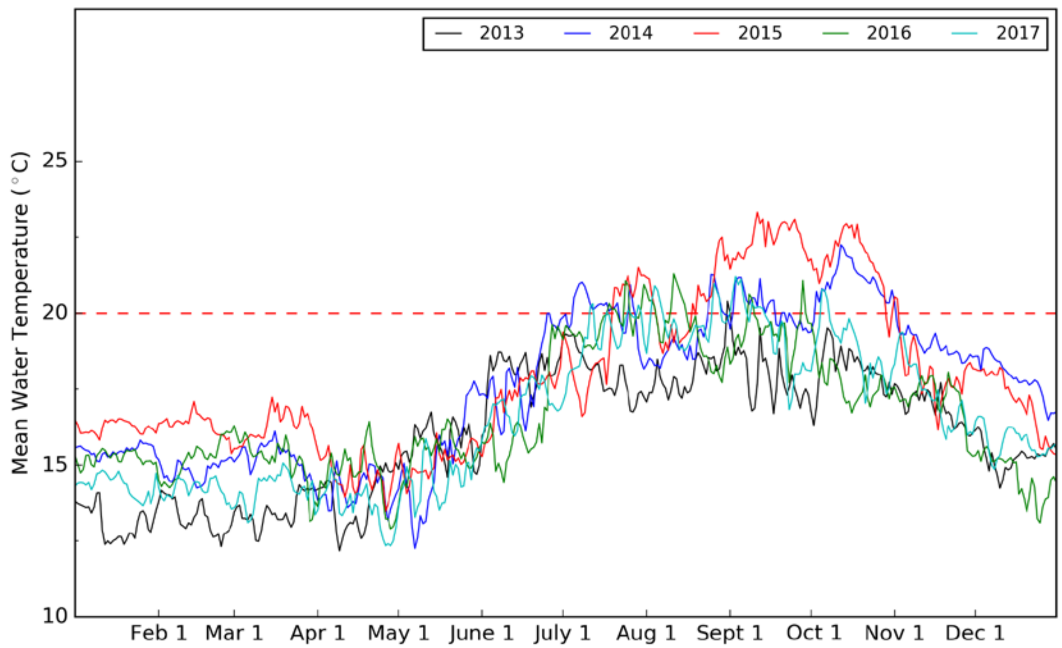
Appendix 9. Submerged cables and wrecks and obstructions suitability layer incorporated within the overall VSE suitability analysis relative to identified Alternative #1. Areas within a 500-meter radius of submerged cables and wrecks and obstructions were assigned a score of ‘0’ (least compatible) while areas outside of a 500-meter radius of submerged cables and wrecks and obstructions were assigned a score of ‘1’ (most compatible).

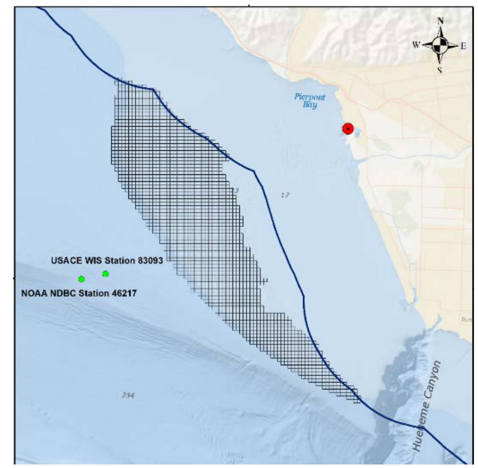


Appendix 10. Annual average surface current velocity (m/s) in relation to the area of interest for the proposed VSE project. The optimal current velocity range for blue mussel (*Mytilus galloprovincialis*) longlines is between 0.025 and 0.10 m/s (Longdill et al., 2008), which generally corresponds with annual average current velocity for the area of interest.

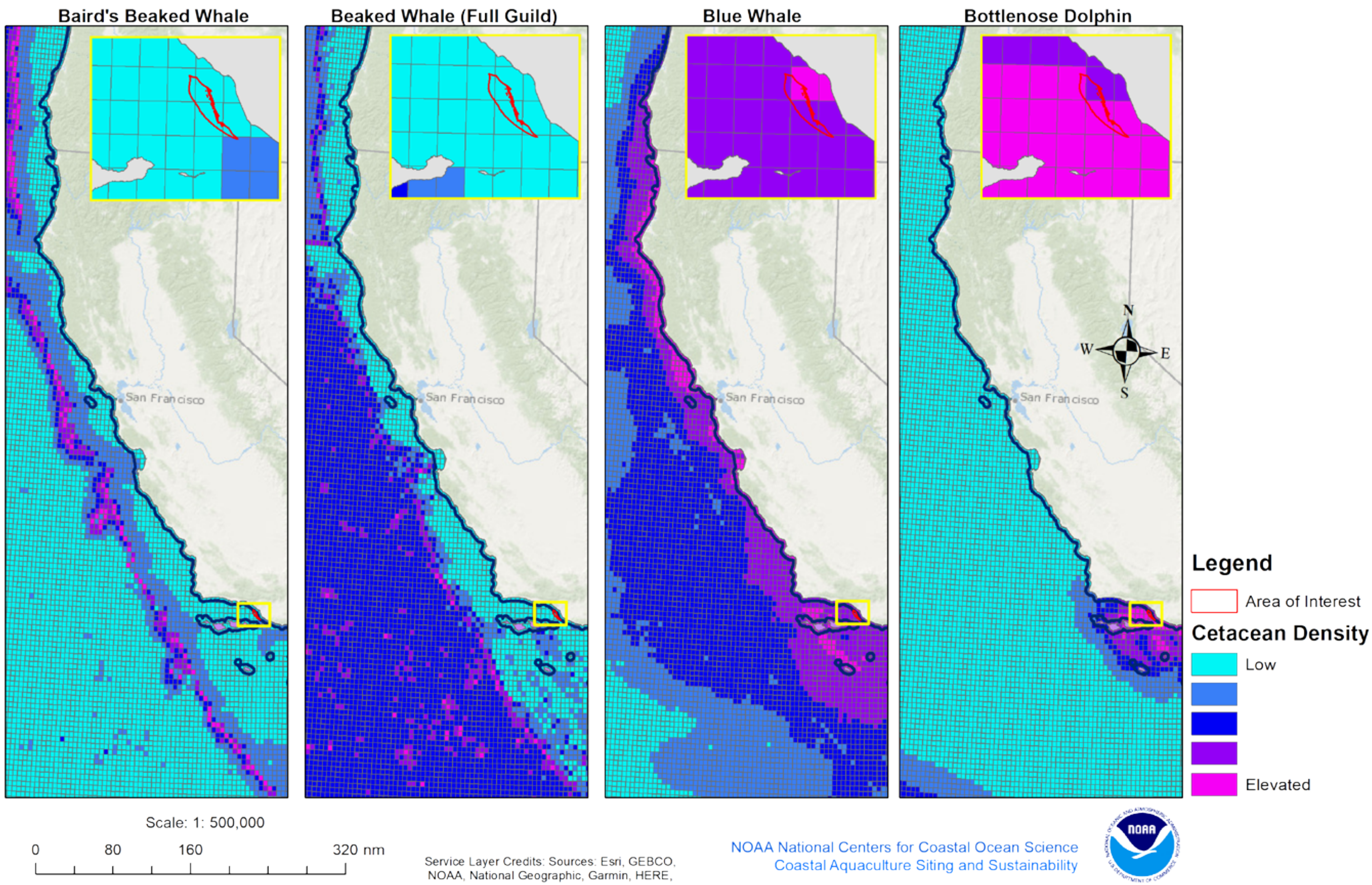


Appendix 11. Annual average chlorophyll *a* concentration (in micrograms per liter) in relation to the proposed VSE project. The optimal chlorophyll *a* range for blue mussels (*Mytlius galloprovincialis*) is between 0.5 and 55 µg/l (Sara et al., 1998), which corresponds with the annual average chlorophyll *a* concentration for the area of interest.

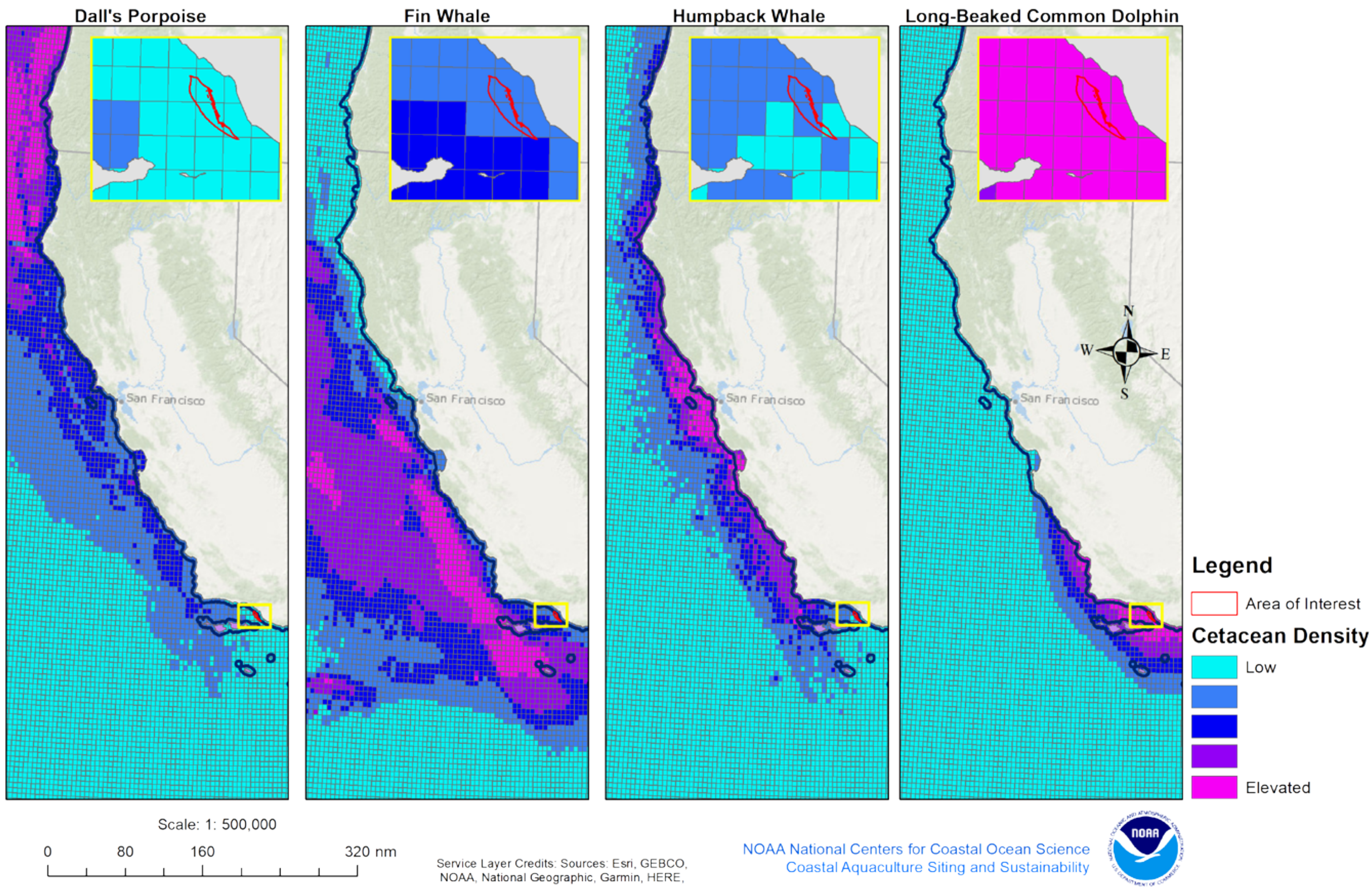




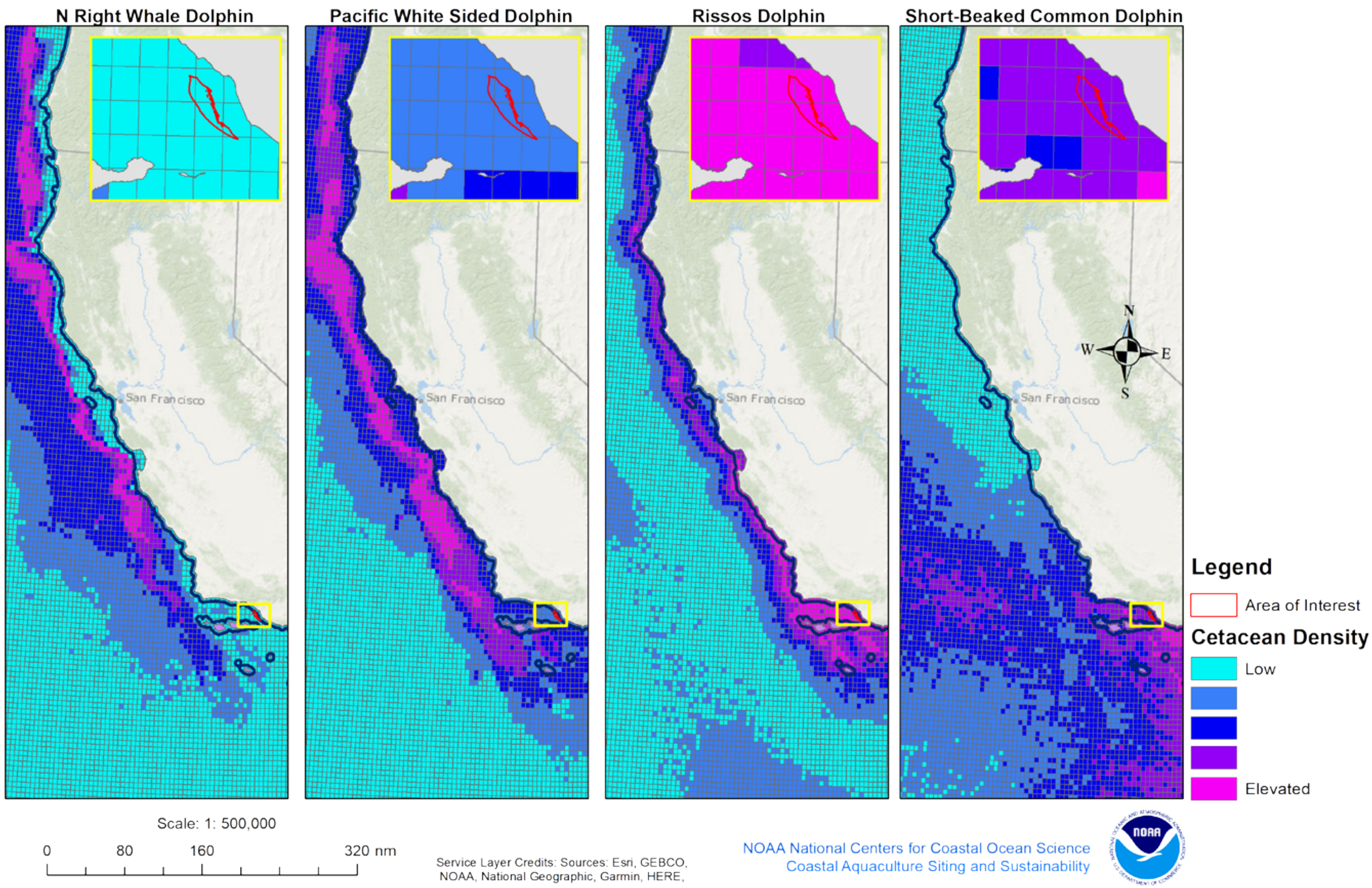
Appendix 12. Mean water temperature over a 5-year period as measured by the NOAA data buoy adjacent to the proposed VSE project area of interest. The acceptable water temperature range for blue mussels (*Mytlius galloprovincialis*) is between 3 and 29 degrees Celsius, with an optimal temperature of 20 degrees Celsius (denoted by the dashed red line in the figure above; Widdows 1978, Newell 1989, and Almada-Villela et al. 1982).



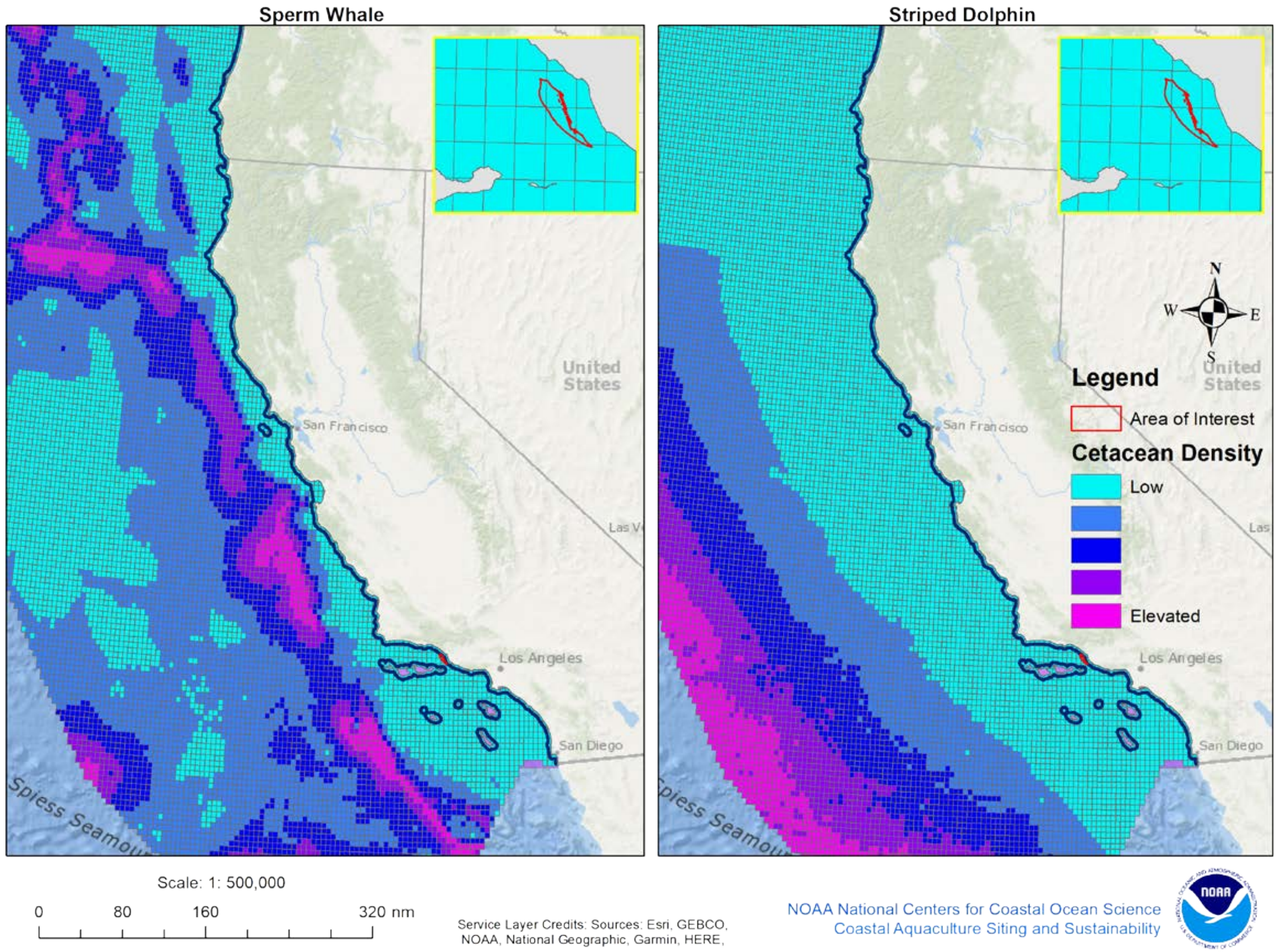
Appendix 13. Predicted habitat-based density and distribution models for multiple cetacean species, derived from NOAA National Marine Fisheries Service's CetSound database. Light blue colors indicate low predicted densities whereas purple colors indicate elevated predicted densities. Note that these maps represent predicted density, but do not necessarily correspond with actual distribution or definitive probability of encountering these species.



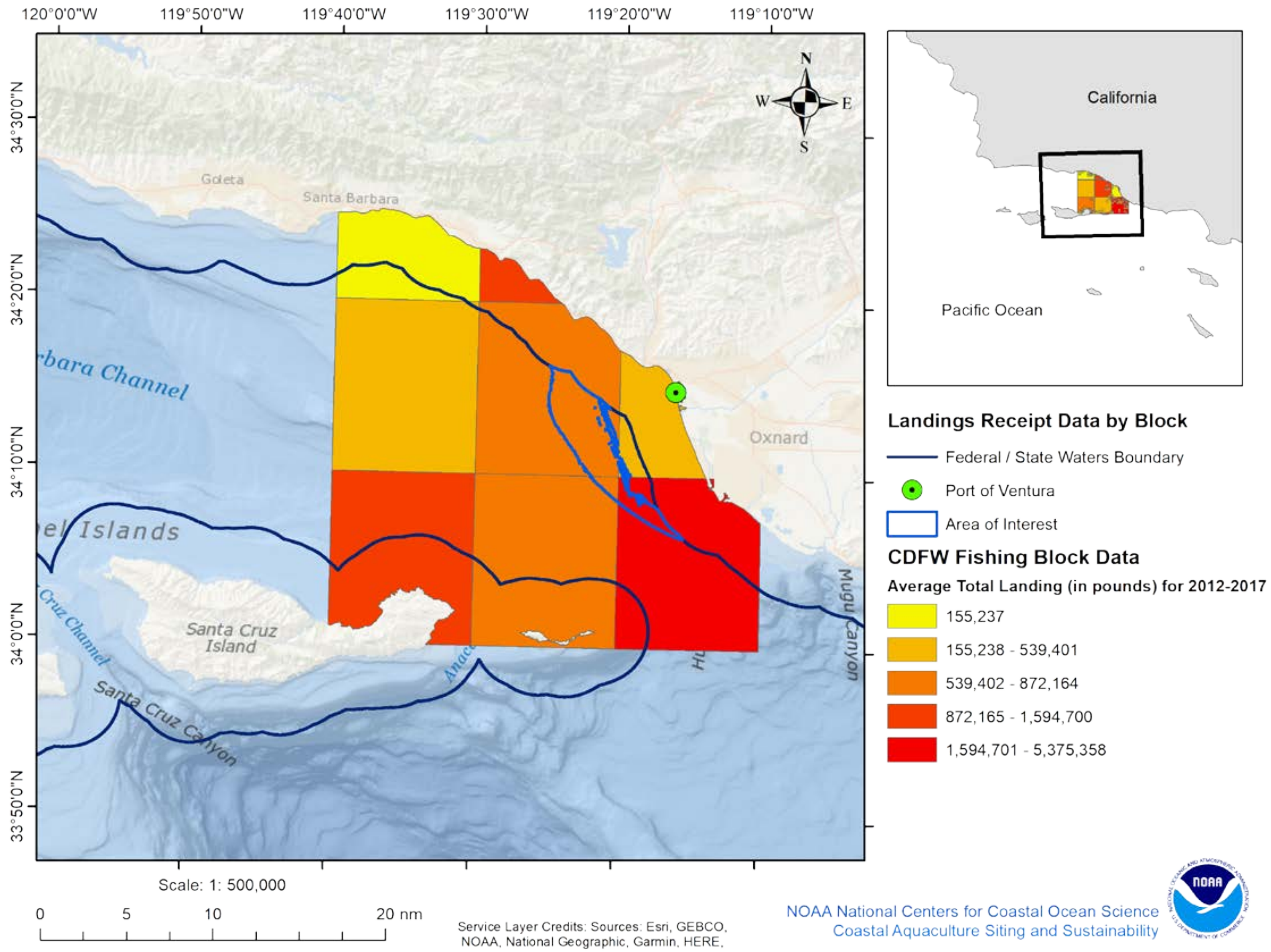
Appendix 14. Predicted habitat-based density and distribution models for multiple cetacean species, derived from NOAA National Marine Fisheries Service's CetSound database. Light blue colors indicate low predicted densities whereas purple colors indicate elevated predicted densities. Note that these maps represent predicted density, but do not necessarily correspond with actual distribution or definitive probability of encountering these species.



Appendix 15. Predicted habitat-based density and distribution models for multiple cetacean species, derived from NOAA National Marine Fisheries Service's CetSound database. Light blue colors indicate low predicted densities whereas purple colors indicate elevated predicted densities. Note that these maps represent predicted density, but do not necessarily correspond with actual distribution or definitive probability of encountering these species.



Appendix 16. Predicted habitat-based density and distribution models for multiple cetacean species, derived from NOAA National Marine Fisheries Service's CetSound database. Light blue colors indicate low predicted densities whereas purple colors indicate elevated predicted densities. Note that these maps represent predicted density, but do not necessarily correspond with actual distribution or definitive probability of encountering these species.



Appendix 17. Broader perspective of commercial fishery landings by California Department of Fish and Wildlife reporting block in relation to the VSE project 'area of interest.' Fishery landings represent average total landings (across all species requiring reporting by block) for the period of 2012-2017. Note that the entirety of the 'area of interest' (represented by the blue outline in the map) which was further subdivided into 1,953 grid cells within the siting analysis, overlaps with four reporting blocks rendering this data incompatible for incorporation within the siting analysis.