US Army Corps of Engineers®
Alaska District

DRAFT Feasibility Report and
Environmental Assessment

Homer Navigation Improvements
Homer, Alaska
Appendix O: Ecological Model

May 2026

Modeling the drivers and stressors of ecosystem response for the Homer Navigation Improvements Study

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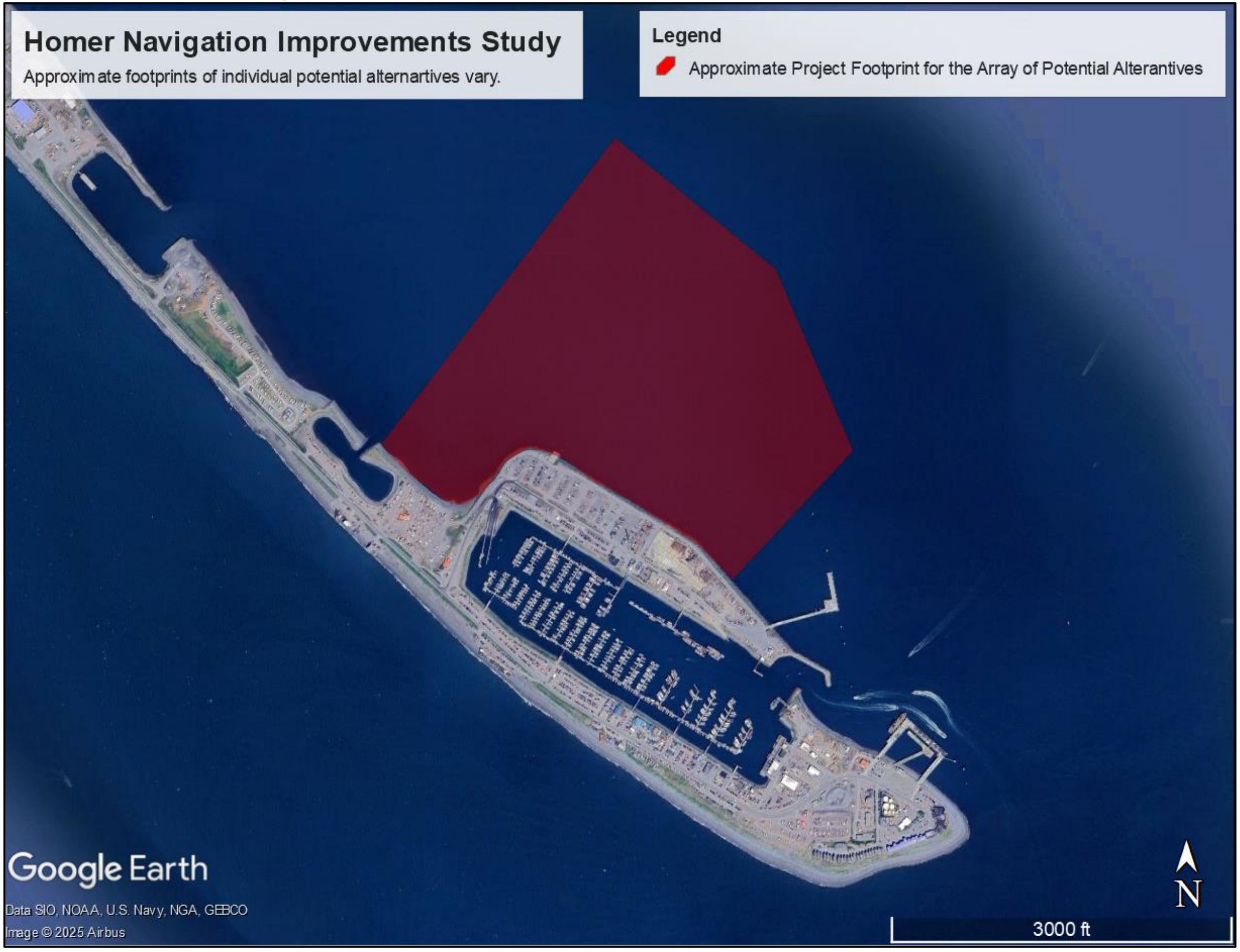
BACKGROUND

The economic value of a harbor, both regional and national, is derived from its impact on infrastructure. Harbors have inherent impacts, which may include risks to environmental resources. The conversion of natural habitat into anthropogenically modified habitat can lead to an increased potential for the introduction of invasive species, contamination of sediments, increased vessel traffic, and heightened risk of hazards and accidents. Application of environmental stewardship considerations in the design, construction, operations, and maintenance of a harbor is necessary to maintain the balance between economic growth and environmental impacts.

The City of Homer's economy is dependent on their access to Kachemak Bay. Industries such as commercial fishing, tourism, and transportation rely on safe and efficient navigation. The current harbor, Homer Harbor, experiences overcrowding and limited access for larger vessels. The Homer Navigation Improvements Study (HNIS), a project of the U.S. Army Corps of Engineers Alaska District (USACE POA) is developing, screening, and evaluating potential alternatives to address this issue.

The potential alternatives are located at the end of the Homer Spit on the eastern side (Figure 1). These alternatives are within relative proximity to the current harbor and are all within Kachemak Bay. The Homer Harbor is a major economic driver within the community and involves multiple stakeholders across Federal, state, local, and non-governmental agencies. Reaching consensus among large stakeholder groups can be difficult, as each has their own perspective and requirements for management.

Figure 1. Approximate footprint of alternatives in the HNIS



ENVIRONMENTAL CONCERNS

Kachemak Bay is a complex ecosystem, rich in biological resources that are supported by the physical characteristics of the area, and is impacted by both natural phenomenon and by anthropogenic activities. Considerable value is derived from Kachemak Bay and its environmental resources. While navigation improvements to the Homer Harbor through the HNIS will focus on addressing the economic need and purpose for increased vessel moorage, demand, and fleet size; potential impacts to Kachemak Bay's environmental resources must be considered to minimize adverse effects to Kachemak Bay.

EXISTING CONDITIONS

Abiotic Environment

The area surrounding Homer, Alaska, consists of a bench underlain by glacial lake deposits composed of poorly sorted clay and silt. These deposits lay on top of the Kenai formation of poorly consolidated and interbedded sandstone, siltstone, and clay stone with minor amounts of conglomerate (USACE POA 2007; 2019). The Homer Spit's foundation is the remnant of a terminal glacial moraine, and is composed of silts, sands, gravels, and some boulders that overlie marine clay. The Homer Spit is a dynamic system in which change is a normal process. On the exposed coast (i.e., the Cook Inlet side) the direction of littoral sediment transport is toward the southeast, and the movement of sand-sized material from along shore and also possibly onshore is a result of wind-generated wave processes. The sheltered environment of Coal Bay (known to the local community as Mud Bay), located along the Kachemak Bay side, is a zone of fine-grained sediments that are transported primarily in suspension. The transport direction in Mud Bay converges from the northeast along the north shore of Kachemak Bay and from the southeast along the north shore of Homer Spit. Because of deep water off the distal point of Homer Spit, it is believed that little sediment is transported around to the north shore from the more exposed south shore.

Water quality in Kachemak Bay and lower Cook Inlet is minimally impacted by the current level of human development, but there are several local sources of potential contamination including fish processing outfalls and the potential release of petroleum products associated with the harbor. Natural turbidity around the Homer Spit varies significantly depending where along the Spit the reading is taken, the depth, tide level, and the prevailing wind and current conditions. During periods with high surf or surface runoff, for example, nearshore waters can be turbid for extended periods. The mudflats on the east side of the Homer Spit north of the harbor would most likely have higher turbidity readings than on the west side or end of the Homer Spit because of its shallow depth and the mud in the zone of deposit. Data characterizing natural turbidity in waters surrounding the Homer Spit is limited.

Biotic Environment

The Homer Spit and the surrounding marine waters host a variety of marine species, including many migratory birds, marine mammals, benthic invertebrates and different communities of submerged aquatic vegetation (SAV). Primary producers such as SAV, provide habitat and oxygen that supports an array of marine life. Higher trophic level marine species occupy various habitats within the area. Nearshore areas provide essential fish habitat and refugia for many fish species across various life stages. Harbor infrastructure attracts several species of bird, including gulls, shorebirds, and bald eagles (*Haliaeetus leucocephalus*). Various species of sea duck, including Steller's eider (*Polysticta stelleri*), overwinter within Kachemak Bay. Marine mammals, such as harbor seal (*Phoca vitulina*) and northern sea otter (*Enhydra lutris kenyoni*), Steller sea lion (*Eumetopias jubatus*) and and the Cook Inlet beluga whale (*Delphinapterus leucas*) occupy the area at various times throughout the year.

MODEL PURPOSE

The purpose of this model is to describe the critical processes, stressors, and interactions that affect socio-ecological dynamics resulting from the HNIS within Kachemak Bay, Alaska. The model is intended to distinguish environmental impacts between project alternatives, including the Future Without Project (FWOP), to help inform decision-making in identifying the Recommended Plan.

MODEL DEVELOPMENT PROCESS

The HNIS conceptual model was developed following the workshop-based mediated modeling process described by Herman et al. (2019). The development of the quantitative model followed Grant and Swannack, 2008 and Swannack et al., 2012.

Mediated modeling is a technique that facilitates consensus building among stakeholders and provides a transparent roadmap for decision-making. For this effort, USACE POA and the Integrated Ecological Modeling (EcoMod) of the US Army Engineer Research and Development Center (ERDC) partnered for a multi-stakeholder mediated modeling workshop to build a conceptual model that depicts the relevant processes impacting environmental dynamics within Kachemak Bay. This conceptual model was used to inform a habitat suitability model that will be used to distinguish among different potential project alternatives.

CONCEPTUAL MODELING WORKSHOP OVERVIEW

Conceptual models were developed during an in-person EcoMod Workshop with HNIS environmental stakeholders. The goal of the EcoMod Workshop was to conceptualize a model that would qualitatively and quantitatively inform environmental impacts of the HNIS alternatives through holistic evaluation. A quantitative and qualitative assessment of potential impacts informs aspects of the HNIS. This information is used to compare the degree of impacts between the array of potential alternatives. The results of the conceptual model are then used as baseline inputs for the economic analysis that evaluates each potential alternative.

The workshop structure follows the protocols established by Herman et al. (2019) for interactive stakeholder modeling workshops. USACE POA and the ERDC EcoMod Team partnered to host and facilitate an integrated ecological modeling workshop in Homer, Alaska, on April 11–12, 2024. Subject Matter Experts (SMEs) from local, State, and Federal agencies, non-governmental organizations (NGOs), and representatives from the private sector and community attended the workshop (Table 1).

Table 1. HNIS integrated ecological modeling workshop attendee list.

Attendee	Affiliation(s)
Aaron Yeaton	City of Homer Public Works Department
Donna Aderhold	Homer City Council Prince William Sound Science Center
George Matz	Kachemak Bay Birders
Kaitlynn Cafferty	Alaska Department of Fish and Game
KC Kent	HDR
Kris Holderied	Kasitsna Bay Laboratory of the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science
Lauren Sutton	Staff of Kachemak Bay National Estuarine Research Reserve Staff University of Alaska Anchorage
Laurie Daniel	Community Council of Kachemak Bay National Estuarine Research Reserve
Penelope Haas	Kachemak Bay Conservation Society
Robert Archibald	Friends of Kachemak Bay State Parks Kachemak Bay State Park Citizen's Advisory Board Homer Parks and Recreation Commission Prince William Sound Regional Citizens' Advisory Council
Ross Whippo	Kasitsna Bay Laboratory of the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science
Shea Winterberger	United States Coast Guard *Aspen* Commander
Susan Saupe	Cook Inlet Regional Citizens Advisory Council

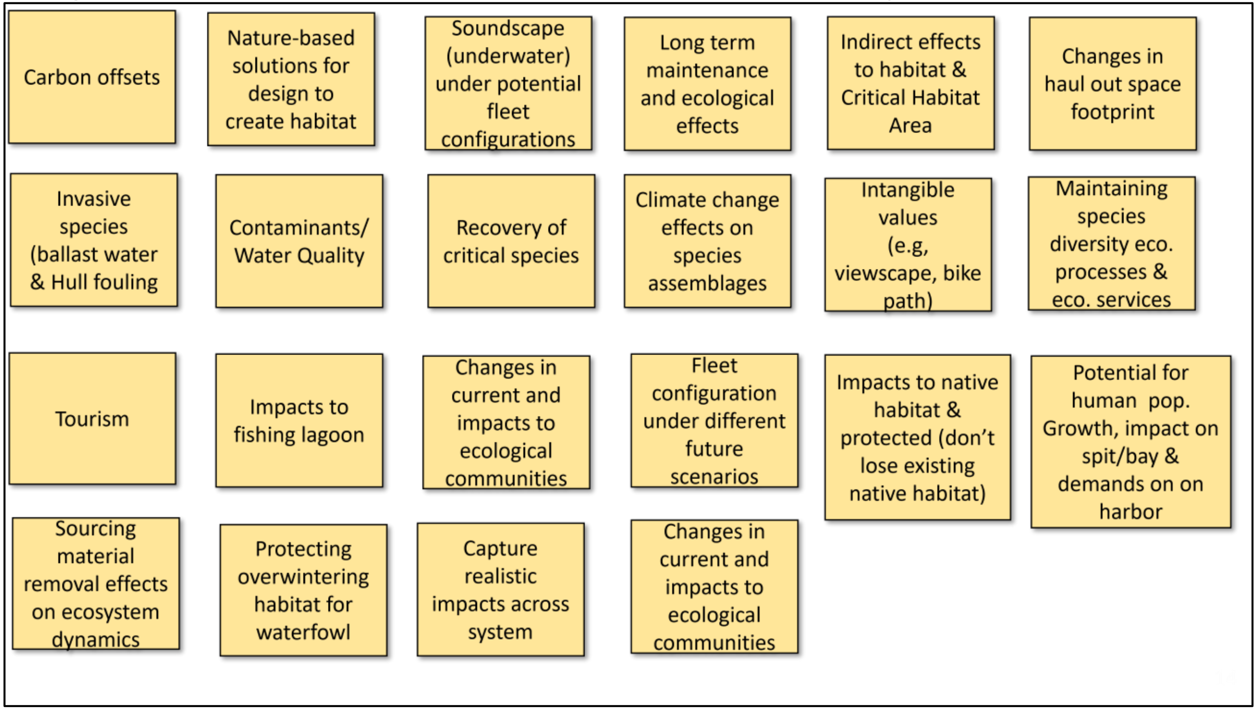
On April 11, USACE POA opened with a presentation on the project background and desired outcomes for the workshop. The ERDC EcoMod Team then provided an overview of the foundation of environmental modeling for USACE, followed by a discussion on conceptual modeling and how to develop these models for USACE feasibility study alternative analysis.

The workshop participants were randomly split into two breakout groups, with roughly equal representation from each organization and discipline, to develop their own conceptual models on the drivers and stressors of the HNIS on the socio-ecological system of the Homer Harbor and the surrounding area of Kachemak Bay. The first stage of conceptual model development focuses on developing a shared viewpoint or narrative of the HNIS on the environment. Participants were asked to tell their ‘story’ of the potential effects of the HNIS by answering the following questions:

- What are the most important factors to consider for Homer Harbor?
- What critical factors driving environmental response within and around the Homer Harbor?
- What should the conceptual model seek to do?
- Who is the target audience for the conceptual model?
- What variables or processes should appear in your conceptual model? What are the major components of your conceptual model?

Responses to these questions were summarized (Figure 2) and then used as a starting point for each group’s conceptual model.

Figure 2. Concerns, Drivers, and Stressors for HNIS as Identified by Workshop Participants.



Each group then developed their own conceptual model with the processes and variables they identified. Each group's conceptual models are described below in detail within "Summary of the Breakout Group Discussions."

On April 12, USACE POA opened the workshop with a brief recap and review of the conceptual models and was followed by a presentation by the ERDC EcoMod Team on model quantification; specifically, how to use a conceptual model as a template for quantitative ecological modeling. The breakout groups reconvened to work on developing functional forms and equations for their conceptual model. The workshop closed with a summary of the quantitative breakout sessions and a summary of the next steps.

SUMMARY OF BREAKOUT GROUP DISCUSSIONS

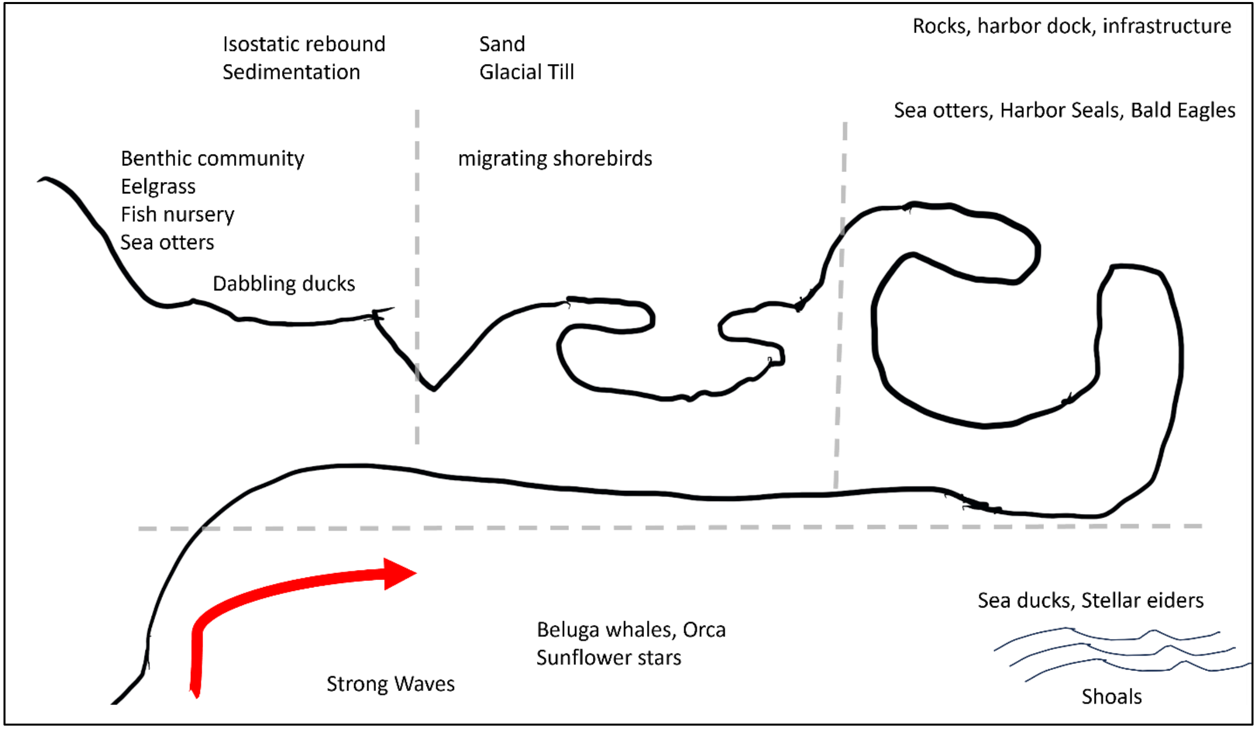
Conceptual Model Development

Workshop participants were divided into two separate breakout groups. The results of the breakout group activity were two conceptual models that each focused on different elements of the environmental resources within Kachemak Bay. Overall, the conceptual models developed by the breakout groups represented the complexity of the environmental resources within Homer Harbor and the surrounding region. However, the groups' models focused on different resources, which was likely due to the expertise of the individuals within each group.

Group 1 - Concept Focused on Habitat

Group 1 focused on conceptualizing the habitat along the Homer Spit using a spatial scale (Figure 3). Participants drew a rough map of the action area, specifically the Homer Harbor.

Figure 3. Group 1 Conceptual Model



The conceptual map of Homer Spit was divided into three vertical sections running north to south. These three sections accounted for major distinct habitat types within the area. The furthest inland section included Mud Bay, which was characterized with high levels of sedimentation and isostatic rebound. The middle section was characterized as being composed largely of sand and glacial till. The distal end of the Homer Spit was characterized by the Homer Harbor and harbor infrastructure (i.e., rubble-mound breakwaters and docks).

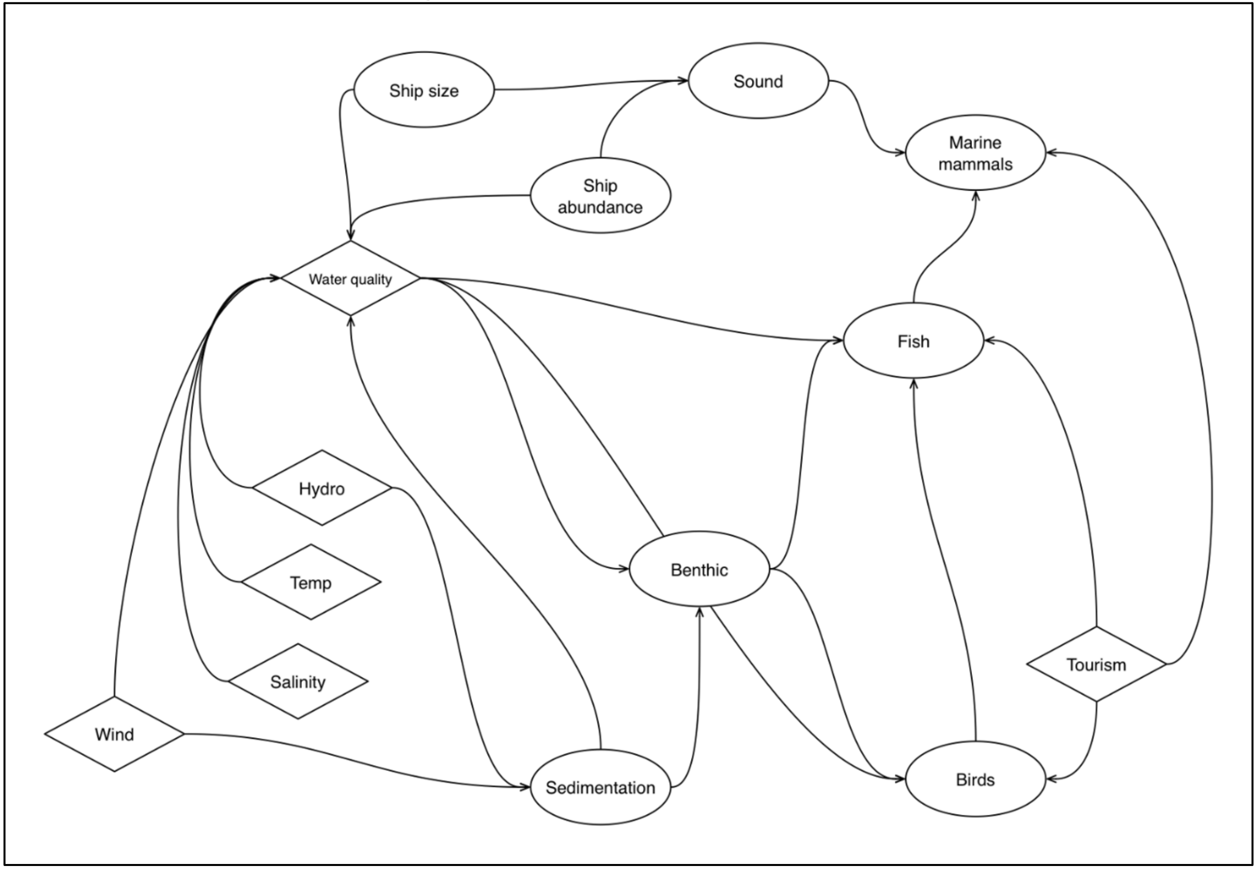
The conceptual map developed was then divided laterally to represent the difference in the abiotic environment found in Kachemak Bay (eastern shore) versus Cook Inlet (western shore). The lateral division of Homer Spit focused on accounting for differences in oceanography between Kachemak Bay and Cook Inlet. These variables included wave action and current that influence levels of sedimentation and shoaling. Across all sections of the conceptual map, participants determined variables of the biotic environment. These included important species, threatened and endangered species (e.g., Cook Inlet beluga whale), and marine organisms important for primary production.

Group 2 - Concept Focused on Relationship between Biological and Physical Factors

Group 2 focused on identifying connections between Kachemak Bay's biological and physical resources, processes, and characteristics along with the likely anthropogenic activities that would result from the HNIS potential alternatives. Initially, the group identified key resources, characteristics, processes, and activities. Then the relationships were determined between key variables. Relationships were signified via a line connecting from one variable to the other.

The end result was similar to Figure 4, which is a second iteration of Group 2's conceptual model. Group 2's initial conceptual model included other variables (e.g., delineated between construction activities and post-construction activities of the alternatives) and took certain variables one step further (e.g., specific species of importance like salmon under fish and different types of kelp under benthic) compared to the simplified conceptual model reflected in Figure 4.

Figure 4. Group 2 Conceptual Model



Final Conceptual Model

The final conceptual model represents a collaboration between the National Oceanic and Atmospheric Administration (NOAA) Kasitsna Bay Laboratory, ERDC, and USACE POA. The final conceptual model represents an iteration of Figure 5 that was developed by R. Whippo, PhD, from Kasitsna Bay Laboratory. The model focuses on the submerged aquatic vegetation (SAV) within Kachemak Bay.

SAV is the dominant primary producer and one foundation of the trophic web in Kachemak Bay and is sensitive to hydrodynamic and structural changes within the bay. To capture the complexity of the dynamics throughout Kachemak Bay, three types of SAV were considered: canopy kelp, seagrass, and understory algae. The model captures how habitat suitability for each of these groups is distributed geographically based on critical driving factors (i.e., natural factors that directly or indirectly cause ecosystem changes; Table 2).

Table 2. Variables Included in each SAV Community Submodel

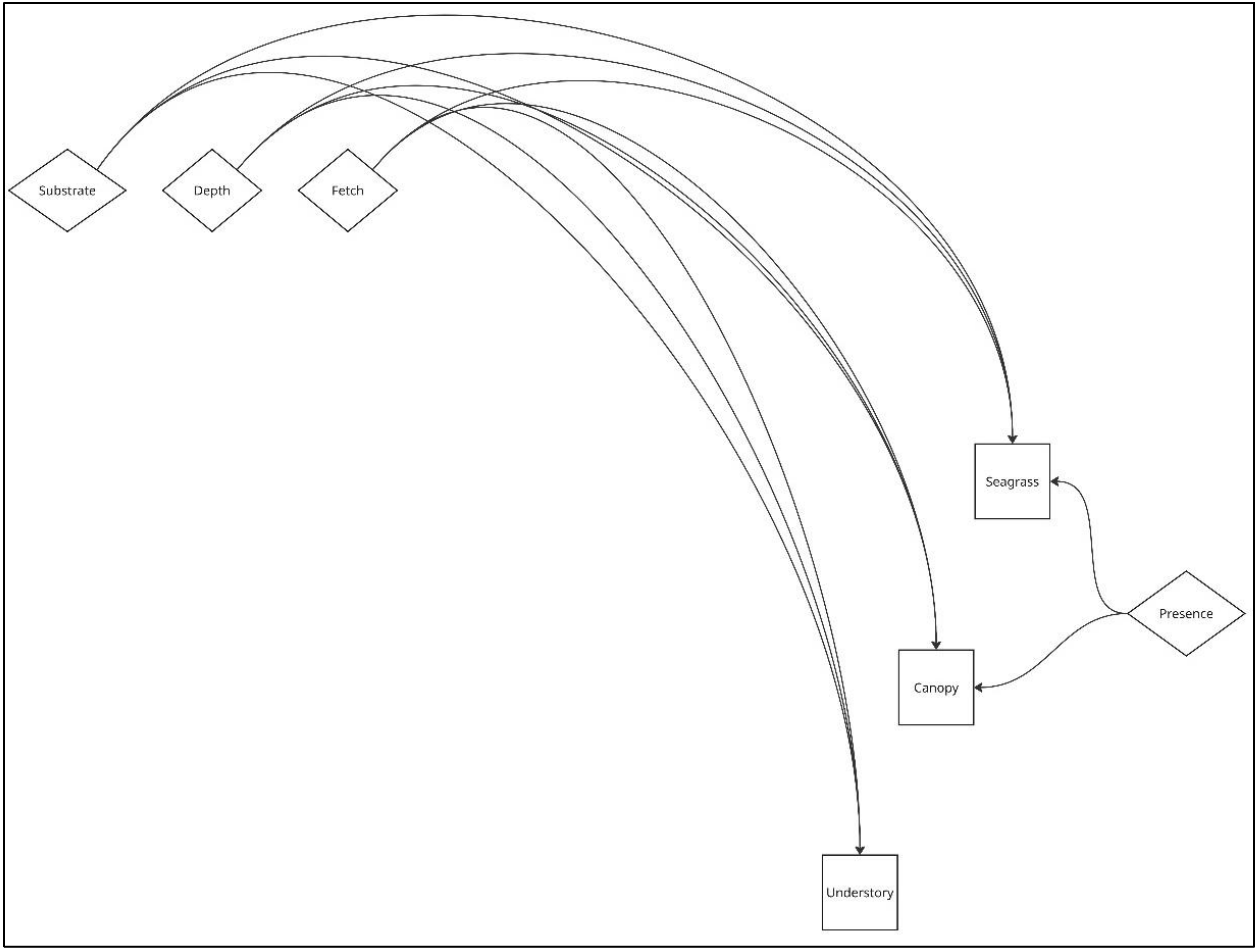
Community type	Model variables (driving factors)
Canopy Kelp	*Depth, Fetch, Substrate, Presence*
Seagrass	*Depth, Fetch, Substrate, Presence*
Understory	*Depth, Fetch, Substrate*

Canopy kelps in Kachemak Bay are comprised primarily of bull kelp (*Nereocystis luetkeana*), and to a lesser extent dragon kelp (*Eualaria fistulosa*) and giant kelp (*Macrocystis pyrifera*). Canopy kelps provide habitat for important species including rockfish, salmon, and sea otters, and form fringing beds around much of the outer bay west of the Homer spit (Paxton and Freedman 2024). Bull kelp was mapped over several years earlier this century, however no current maps of their extent in Kachemak Bay exist.

Understory algae in Kachemak Bay—or those species that do not possess gas filled bladders to suspend them in the water column—consist of a suite of algae including brown, green, and red varieties that are prevalent on many hard substrates from the intertidal to the edge of the photic zone (30 meters depth). However, the exact distribution of these algae are not well known due to the logistical constraints of accessing subtidal habitat in these areas.

Seagrass communities in unconsolidated substrate in the bay consist of the single eelgrass species *Zostera marina*. Eelgrass colonized low intertidal and shallow subtidal soft sediments and are used as a nursery ground for fish species including rockfish and herring. They also support a large diversity of small invertebrates that are a food source for migratory shore birds (Hemminga and Duarte 2000). The eelgrass meadows of Kachemak Bay were mapped nearly a decade ago, and select beds around the bay have been monitored annually by the Gulf Watch Alaska program, however, the current overall state of eelgrass distribution is unknown.

Figure 5. Final conceptual model for the Homer Harbor Navigation Improvement Study



Quantitative Model

Four variables were identified that are likely the strongest drivers of habitat suitability of canopy kelp and seagrass in and around Homer: *Depth*, *Fetch*, *Substrate*, and *Historical Presence*. These variables were chosen for their known impact on SAV distributions, and the reliability of modeling the variables with limited available data. The habitat suitability of the understory SAV communities were modeled with three of the four driving variables mentioned, *Depth*, *Fetch*, and *Substrate*. In total, the habitat suitability for these SAV communities is represented quantitatively by 25 total empirical equations (*Depth* and *Fetch*) and 2 categorical variables (*Substrate* and *Presence*). Existing datasets for Kachemak Bay were identified for the current model and synthesized to provide bathymetry (used to calculate *Depth*), substrate type, and SAV presence (only for canopy kelps and seagrass) layers. Spatial data layers can be processed in R (R version 4.4.2) or in ArcGIS Pro. The model has been implemented in three platforms for users; it was developed as an R script, implemented in Excel and ArcGIS Pro using the GSI Toolbox (Saltus et al. 2022). The functional forms of model equations were developed in the Interactive Toolkit for interActive Modeling (TAM) (Carrillo et al. 2022). Excel Workbooks.

Input Data Sources

Data inputs for the habitat suitability model include bathymetry for depth, substrate types for substrate, and fetch for canopy kelp, seagrass, and understory SAV communities. Data inputs for presence were provided for canopy kelp and seagrass.

Bathymetry (Depth)

Bathymetric data were used to quantify the *Depth* variable. Bathymetry was generated by Martin Renner from NOAA’s National Geophysical Data Center using the Kachemak Bay Digital Elevation Map (DEM) for tsunami modeling (NOAA 2010); NOAA essential fish habitat smooth sheets (Zimmermann and Benson 2013, Zimmermann and Prescott 2014, 2015), and GMRTv4.2 (2024). Grids were produced by reprojecting and bi-cubically up-sampling each existing grid where appropriate, and manually filling in all missing values. Some irregularities and artifacts are expected at the boundaries between coverages. This produced an elevation map of Kachemak Bay that was a combination of both bathymetric and topographic sources.

Substrate Type (Substrate)

Substrate type data were taken from the National Centers for Environmental Information (NCEI) archives as a thematic map of benthic habitat classification in Kachemak Bay created by multibeam echosounder data, automated image processing techniques, and on-screen editing for subtidal locations (Field et al. 2020). Intertidal substrate types were extracted from high resolution mapping shapefiles derived from aerial survey (Pegau 2005).

Fetch (Fetch)

Fetch was calculated from the full bathymetry layer as reference for land and water features using functions modified from the 'get_fetch()' command in the fetchR package (Seers 2020).

SAV Presence (Presence)

Both canopy kelp and seagrass presence data were extracted from the Alaska Ocean Observing System (AOOS) Workspace and included canopy kelp cover polygons of Kachemak Bay for 2000-2002 and seagrass polygons from 2005.

CANOPY SUBMODEL

The canopy submodel represents the habitat suitability for the bull kelp (*Nereocystis luetkeana*), a species of canopy kelp, based on four variables (Figure 5). Depth and fetch are represented as empirical step functions with linear interpolations between successive steps. Substrate and presence are represented as categorical variables.

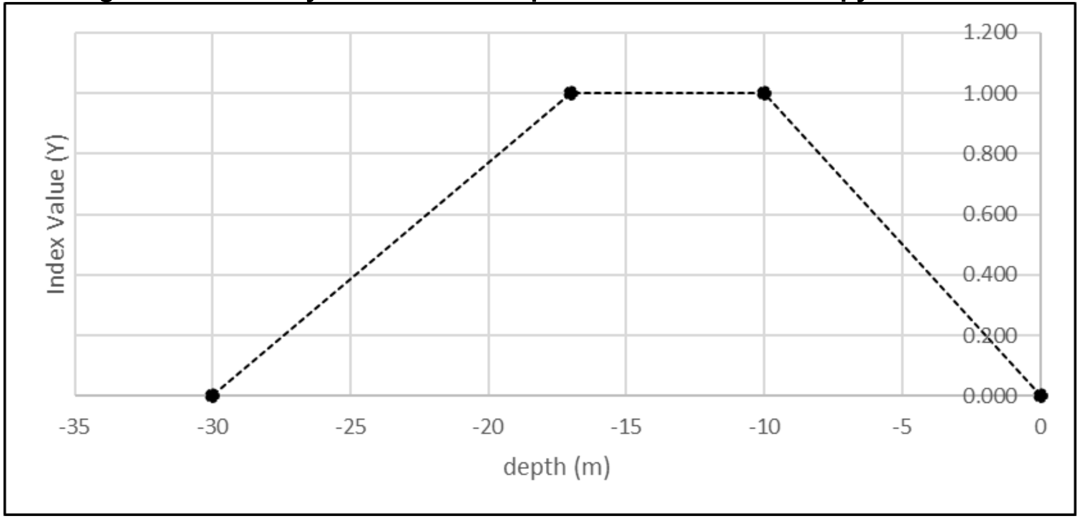
Canopy Depth

The relationship between depth and canopy suitability is based on Springer et al. (2010) and consists of four breakpoints (Table 3) with the ideal depth being between -17 meters and -10 meters mean lower low water (MLLW; Figure 6).

Table 3. Equations for the Depth variable for the canopy submodel.

Values	Intercept	Slope	Equation	Eq. #
0 - -10	0.00	-0.1000	Y= -0.1 * depth (m)	(1)
-10 - -17	1.00	0.0000	Y= 1	(2)
-17 - -30	2.31	0.0769	Y= 2.31 + (0.0769 * depth (m))	(3)
-30 -	0.00	0.0000	Y= 0	(4)

Figure 6. Suitability curve for the Depth variable for the canopy submodel



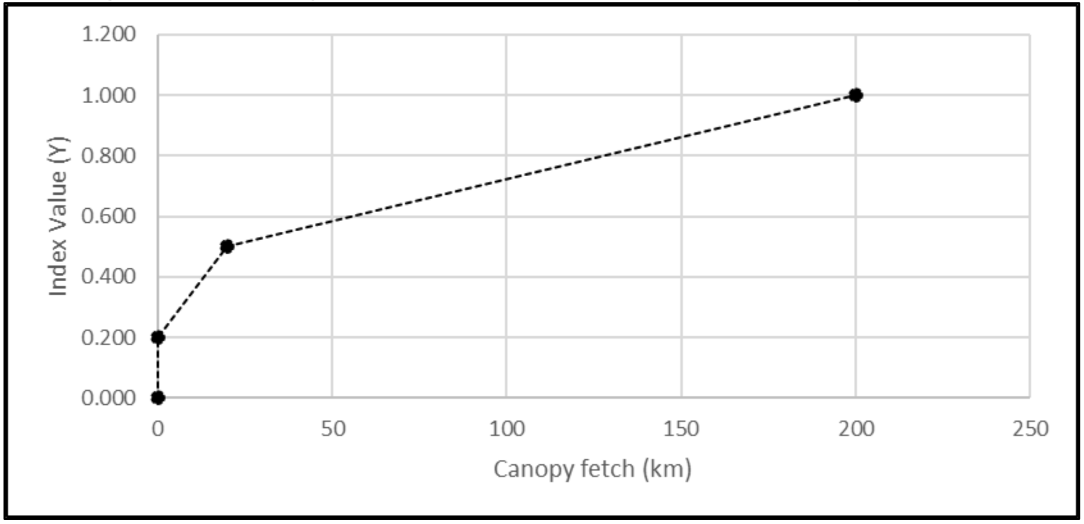
Canopy Fetch

The relationship between fetch and canopy suitability is based on Smale et al. (2016) and consists of four breakpoints (Table 4) with the ideal fetch being 200 kilometers from a georeferenced point containing a stand of canopy kelp (Figure 7).

Table 4. Equations for the Fetch variable for the canopy submodel

Values	Intercept	Slope	Equation	Eq. #
0 - 0.01	0.00	20.0000	Y= 20 * Canopy fetch (km)	(5)
0.01 - 20	0.20	0.0150	Y= 0.2 + (0.015 * Canopy fetch (km))	(6)
20 - 200	0.44	0.0028	Y= 0.44 + (0.0028 * Canopy fetch (km))	(7)
≥200	0.00	0.0050	Y= 1	(8)

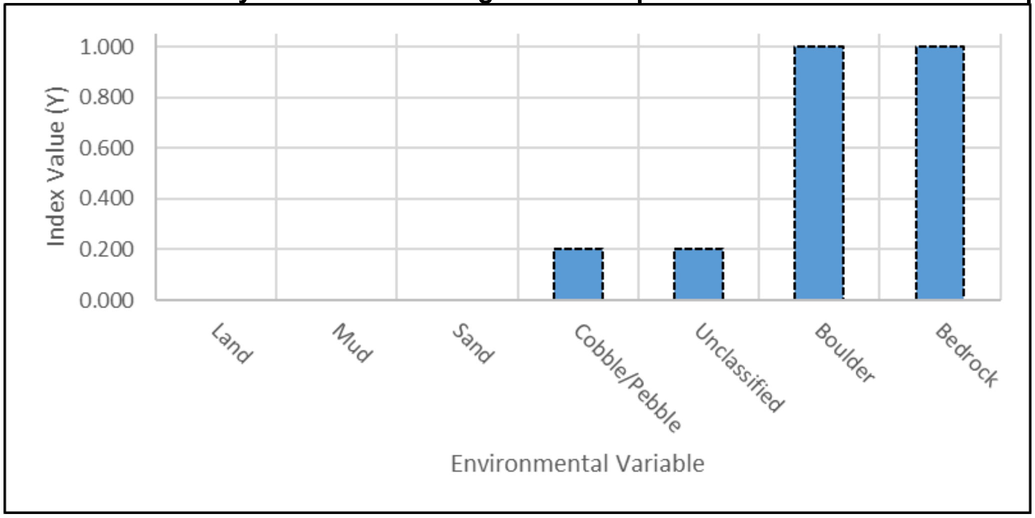
Figure 7. Suitability curve for the Fetch variable for the canopy submodel



Canopy Substrate

The relationship between substrate and canopy suitability is based on Dayton et al. (1985) and formulated as a categorical variable (Figure 8). Canopy kelp requires a hard substrate, so boulder and bedrock are considered ideal, while cobble/pebble and unclassified hard substrates were poorly suitable for canopy kelp. Soft substrates like mud and sand or exposed patches (e.g., land) were not viewed as suitable at all.

Figure 8. Habitat suitability indices describing relationship between Substrate and Canopy Kelp



Canopy Presence

Canopy kelp presence was based on historical data from 2000 to 2002. Shapefiles of kelp cover were extracted from the AOOS Workspace. If canopy kelp were present at a given georeferenced area historically (Schoch 2001), then this area was considered ideal (i.e., a suitability index score of 1) for kelp in the model.

Both canopy kelp and seagrass presence data were extracted from the AOOS Workspace and included canopy kelp cover polygons of Kachemak Bay for the years 2000–2002 and seagrass polygons from the year 2005.

SEAGRASS SUBMODEL

The canopy submodel represents the habitat suitability for eelgrass (*Zostera marina*), a species of seagrass, based on *four variables* (Figure 5). Depth and fetch are represented as empirical step functions with linear interpolations between successive steps. Substrate and presence are represented as categorical variables.

Seagrass Depth

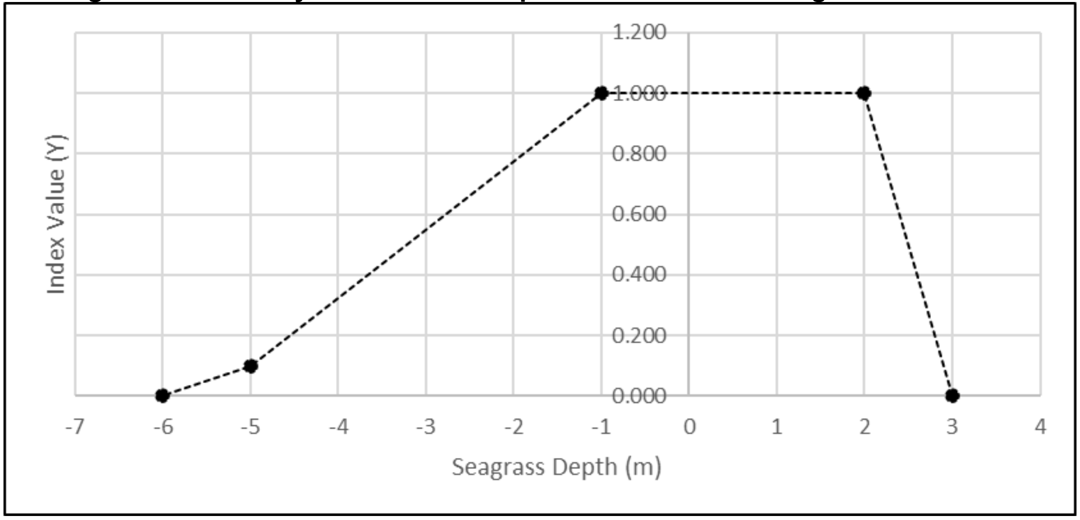
The relationship between depth and seagrass suitability is based on Thom et al. (2008) and consists of five breakpoints (Table 5) with the ideal depth being between -1 meter and +2 meters MLLW (Figure 9).

Table 5. Equations for the *Depth* variable for the seagrass submodel.

Table 5. Equations for the Depth variable for the seagrass submodel

Values	Intercept	Slope	Equation	Eq. #
3 - 2	3.00	-1.0000	Y= 3 + (-1 * Seagrass Depth (m))	(9)
2 - -1	1.00	0.0000	Y= 1	(10)
-1 - -5	1.23	0.2250	Y= 1.23 + (0.225 * Seagrass Depth (m))	(11)
-5 - -6	0.60	0.1000	Y= 0.6 + (0.1 * Seagrass Depth (m))	(12)
-6 -	0.00	0.0000	Y= 0	(13)

Figure 9. Suitability curve for the Depth variable for the seagrass submodel



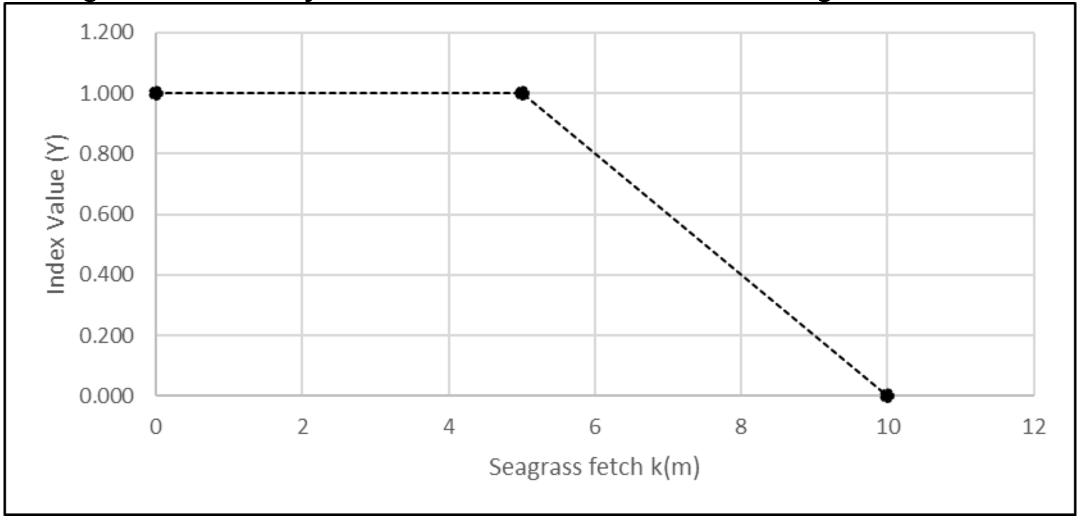
Seagrass Fetch

The relationship between fetch and canopy suitability is based on Oreska et al. (2021) and consists of three breakpoints (Table 6) with the ideal fetch being 5 kilometers or less from a georeferenced point containing seagrass (Figure 10).

Table 6. Equations for the Fetch variable for the seagrass submodel.

Values	Intercept	Slope	Equation	Eq. #
0 - 5	1.00	0.0000	Y= 1	(14)
5 -10	2.00	-0.2000	Y= 2 + (-0.2 * Seagrass fetch k(m))	(15)
10 -	0.00	0.0000	Y= 0	(16)

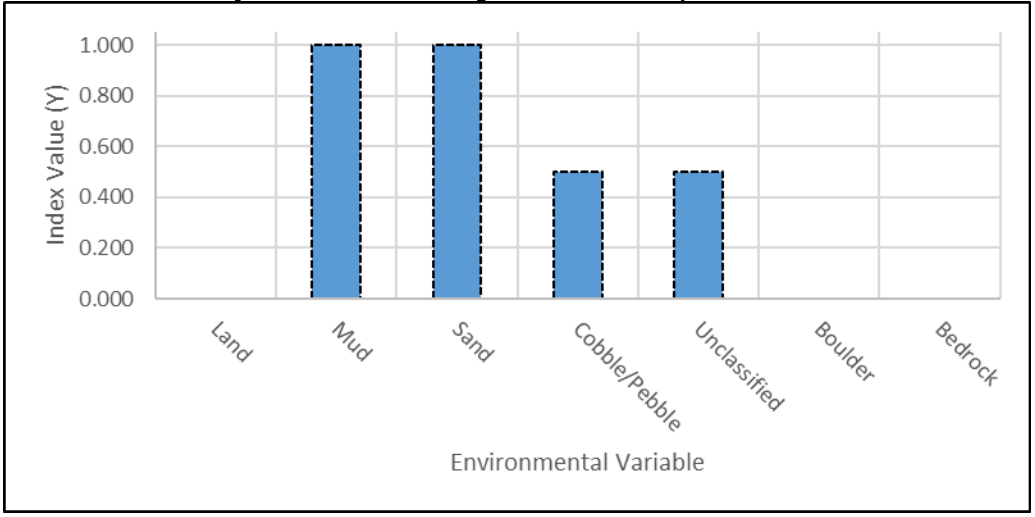
Figure 10. Suitability curve for the Fetch variable for the seagrass submodel



Seagrass Substrate

The relationship between substrate and seagrass suitability is based on Larkum et al., (2006) and is formulated as a categorical variable (Figure 11). Unlike kelp, seagrass requires soft substrate, so mud and sand were considered ideal (i.e., suitability values of 1), whereas cobble and unclassified substrates were moderately suitable. Hard substrates and exposed land were not considered suitable.

Figure 11. Habitat suitability indices describing the relationship between Substrate and seagrass



Seagrass Presence

Seagrass presence was based on historical data from 2005 (Field et al. 2005; Field et al. 2020). A shapefile of seagrass cover was extracted via API from the ArcGIS REST service. If seagrass was present at a given georeferenced area historically, then this area was considered ideal (i.e., a suitability index score of 1) for seagrass in the model.

UNDERSTORY SUBMODEL

The understory submodel represents the habitat suitability for understory kelp, based on three variables (Figure 5). Depth and fetch are represented as empirical step functions with linear interpolations between successive steps. Substrate is represented as categorical variables.

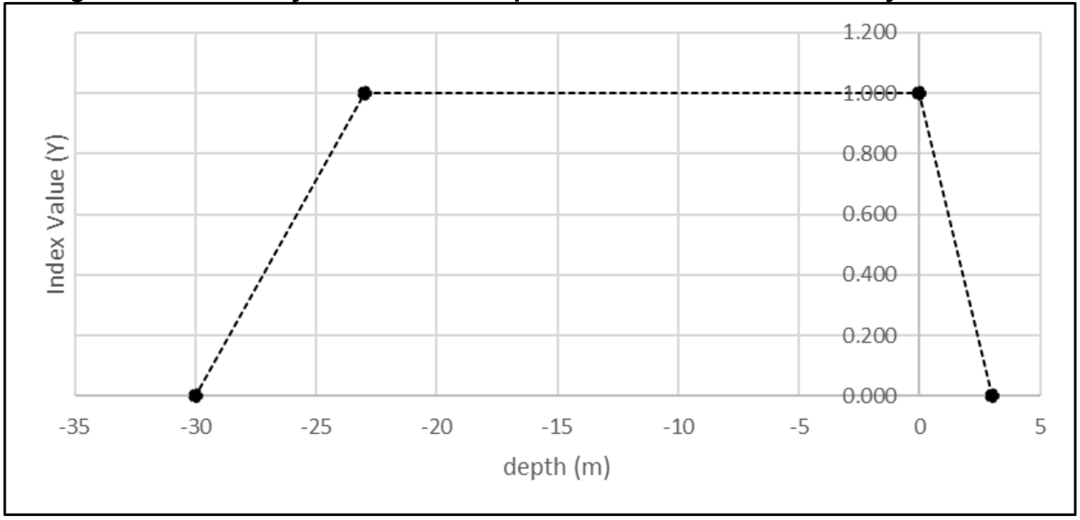
Understory Depth

The relationship between depth and understory suitability is based on Bekkby et al., (2019) and consists of four breakpoints (Table 7) with the ideal depth being between -30 meters and 0 meters MLLW (Figure 12).

Table 7. Equations for the Depth variable for the understory submodel.

Values	Intercept	Slope	Equation	Eq. #
3 - 0	1.00	-0.3333	Y= 1 + (-0.3333 * depth (m))	(17)
0 - -23	1.00	0.0000	Y= 1	(18)
-23 - -30	4.29	0.1429	Y= 4.29 + (0.1429 * depth (m))	(19)
-30 -	0.00	0.0000	Y= 0	(20)

Figure 12. Suitability curve for the depth variable for the understory submodel



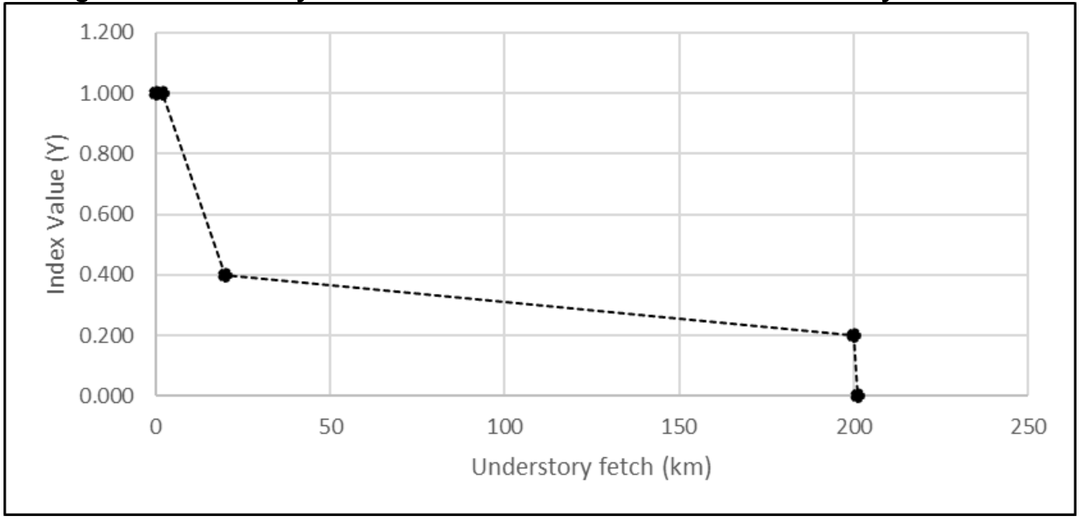
Understory Fetch

The relationship between fetch and understory suitability is based on Bekkby et al. (2011) and consists of five breakpoints (Table 8) with the ideal fetch being 2 kilometers or less from a georeferenced point containing understory (Figure 13).

Table 8. Equations for the Fetch variable for the understory submodel

Values	Intercept	Slope	Equation	Eq. #
0 - 2	1.00	0.0000	Y= 1	(21)
2 - 20	1.07	-0.0333	Y= 1.07 + (-0.0333 * Understory fetch (km))	(22)
20 - 200	0.42	-0.0011	Y= 0.42 + (-0.0011 * Understory fetch (km))	(23)
200 - 201	40.20	-0.2000	Y= 40.2 + (-0.2 * Understory fetch (km))	(24)
201 -	0.00	0.0000	Y= 0	(25)

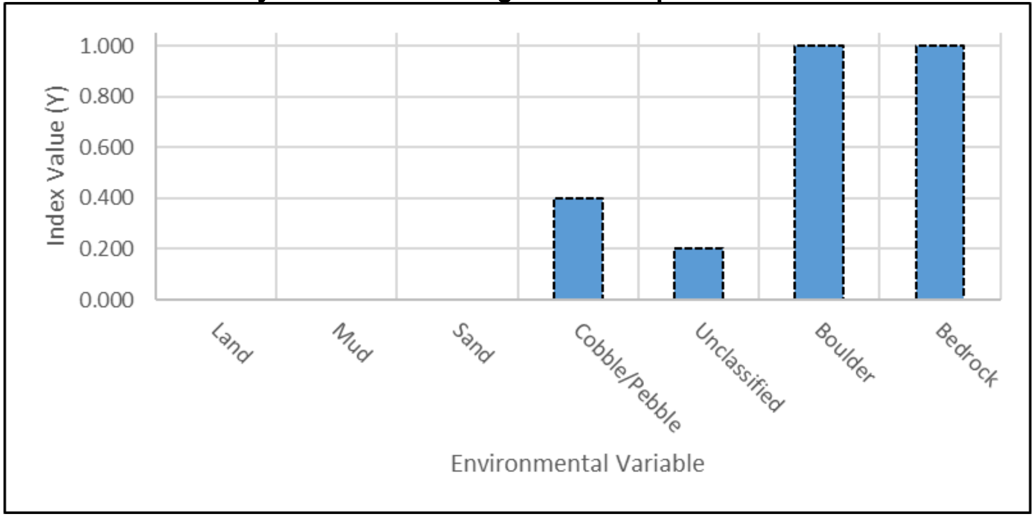
Figure 13. Suitability curve for the fetch variable for the understory submodel



Understory Substrate

The relationship between substrate and understory suitability is based on Dayton et al. (1985) and is formulated as a categorical variable (Figure 14). Similar to canopy kelp, understory kelp requires a hard substrate, so boulder and bedrock are considered ideal, while cobble/pebble and unclassified hard substrates are moderately or poorly suitable, respectively. Soft substrates like mud and sand or exposed patches (e.g., land) were not viewed as suitable at all (Figure 14).

Figure 14. Habitat suitability indices describing relationship between Substrate and understory



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Attachment 1: Spreadsheet Model and TAM Tables

Kachemak Bay Submerged Aquatic Vegetation Model

Current Version of Spreadsheet Calculator: April 1, 2026

Introduction:

The Kachemak Bay Submerged Aquatic Vegetation Model was developed in collaboration with the U.S. Army Corps of Engineers Alaska District and National Centers of Coastal Ocean Science, Dr. Ross Whippo. The purpose of the model is to assist in the Feasibility and Preliminary Engineering and Design Phases of the H*omer Navigation Improvemetns Study, AK* . The model has the ability to capture current (baseline) conditions of an area of concern, at different landscape scales and quantify system-level changes under future scenarios. Parameters were developed to capture primarily physical characteristics of submerged aquatic vegetation habitat that play critical roles in the suitability of the environment. Full documentation of model development

User Instructions: Each parameter (variable) is quantified with a Habitat Suitability Index (HSI), which is scaled from 0 to 1. Zero (0) representing poor condition and 1 representing optimal condition of parameter.

1. Click tab labeled HSI calculator
2. Enable content.
3. Enter values in the colorfilled cells in the "HSI Calculator" tab under the baseline columns. Once colored cells are populated the HSI output for variables are automatically populated based on the relationship depicted in the corresponding equation tab. Data cells that are not green should not be filled in as they are not part of the specific Habitat Type module that was chosen in the drop down lists. NOTE: clear all green cells for each new model run to avoid errors of hold over values from different habitat types.
4. The Overall HSI is the geometric mean of the individual HSI variable outputs.
5. Enter a value for Quantity (typically acres, but can be other units) for each time step, located at bottom of
6. Habitat Units (HUs) are automatically calculated by multiplying the Overall HSI by quantity.
7. Area for comments can be expanded to accommodate detail as needed.
8. Use citation for reporting purposes (Fill in current version and date of spreadsheet used): Swannack T., K. N. Campbell, and R. Whippo. 2025. Submerged Aquative Vegetation Model for Kachemak Bay: Development and User's Guide. DRAFT Technical Report, Environmental Laboratory, U. S. Army Corps of Engineers.

Generating Multiple Calculators for FWOP/FWP Alternatives:

1. Click tab of HSI Calculator
2. Copy all cells in tab
3. Create a new sheet. Rename the new sheet as indicative of alternative.
4. Right click the "Select all Cells" button, select the "Paste" option.
5. Clear all the colored cells before creating new calculations.

Certification: NOT APPROVED - This model has not yet been approved for regional use in accordance with the documented geographic range. The certification of the model is currently scheduled to occur in Preliminary Enginnering and Design Phase of the Homer Navigation Improvements Study, AK. Certification would be conducted by the U. S. Army Corps of Engineers, Ecosystem Restoration National Center of Expertise (Eco-PCX).

Model Documentation:

Development and User's Guide. DRAFT Technical Report, Environmental Laboratory, U. S. Army Corps of Engineers.

Habitat Suitability Index Calculator

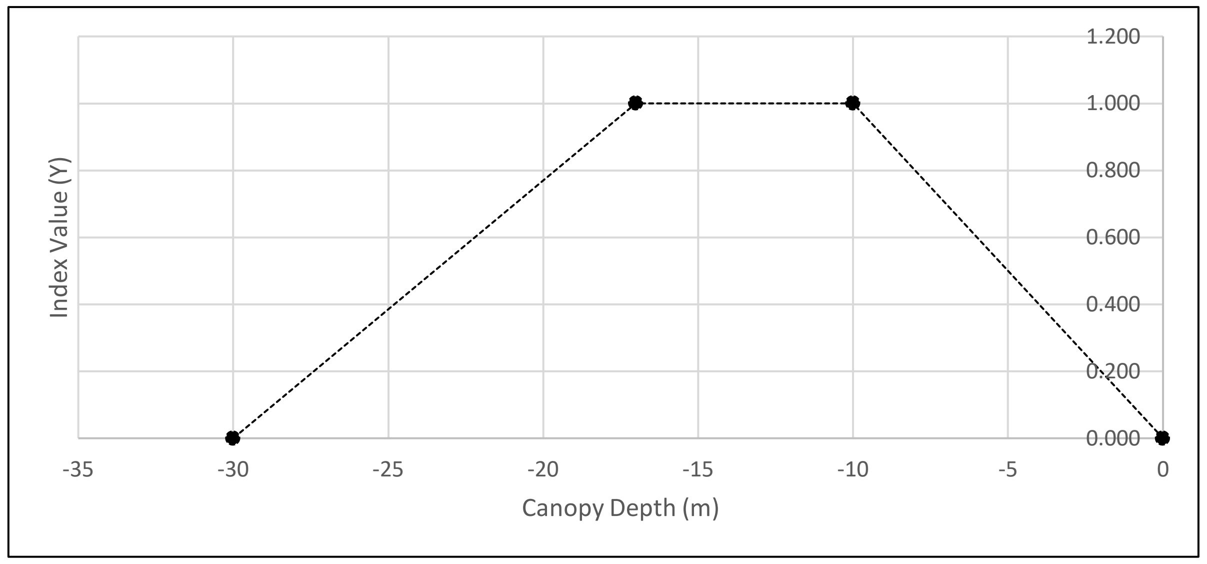
Description	Baseline	0	Year	1	Year	5	Year	10	Year	25	Year	50
	Data	HSI	Data	HSI	Data	HSI	Data	HSI	Data	HSI	Data	HSI
Canopy Depth		0.00		0.00		0.00		0.00		0.00		0.00
Canopy Fetch		0.00		0.00		0.00		0.00		0.00		0.00
Canopy Substrate		#N/A		#N/A		#N/A		#N/A		#N/A		#N/A
Canopy Presence		#N/A		#N/A		#N/A		#N/A		#N/A		#N/A
Seagrass Depth		1.00		1.00		1.00		1.00		1.00		1.00
Seagrass Fetch		1.00		1.00		1.00		1.00		1.00		1.00
Seagrass Substrate		#N/A		#N/A		#N/A		#N/A		#N/A		#N/A
Seagrass Presence		#N/A		#N/A		#N/A		#N/A		#N/A		#N/A
Understory Depth		1.00		1.00		1.00		1.00		1.00		1.00
Understory Fetch		1.00		1.00		1.00		1.00		1.00		1.00
Understory Substrate		#N/A		#N/A		#N/A		#N/A		#N/A		#N/A
Canopy Suitability Score		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**
Seagrass Suitability Score		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**
Understory Suitability Score		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**
Overall Suitability Score		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**
Quantity												
Habitat Unit(s)		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**		**0.00**

ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Canopy Depth (m)	Index Value (Y)
1	0	0.000
2	-10	1.000
3	-17	1.000
4	-30	0
5		

Values	Intercept	Slope	Equation
0 --10	0.00	-0.1000	Y= 0 + (-0.1 * Canopy Depth (m))
-10 --17	1.00	0.0000	Y= 1 + (0 * Canopy Depth (m))
-17 --30	2.31	0.0769	Y= 2.31 + (0.0769 * Canopy Depth (m))
-30 -	0.00	0.0000	Y= 0 + (0 * Canopy Depth (m))

Documentation
Springer, Y. P., C. G. Hays, M. H. Carr, and M. R. Mackey. 2010. Toward ecosystem-based management of marine macroalgae—The bull kelp, Nereocystis luetkeana. In Oceanography and Marine Biology. 48:1-42.

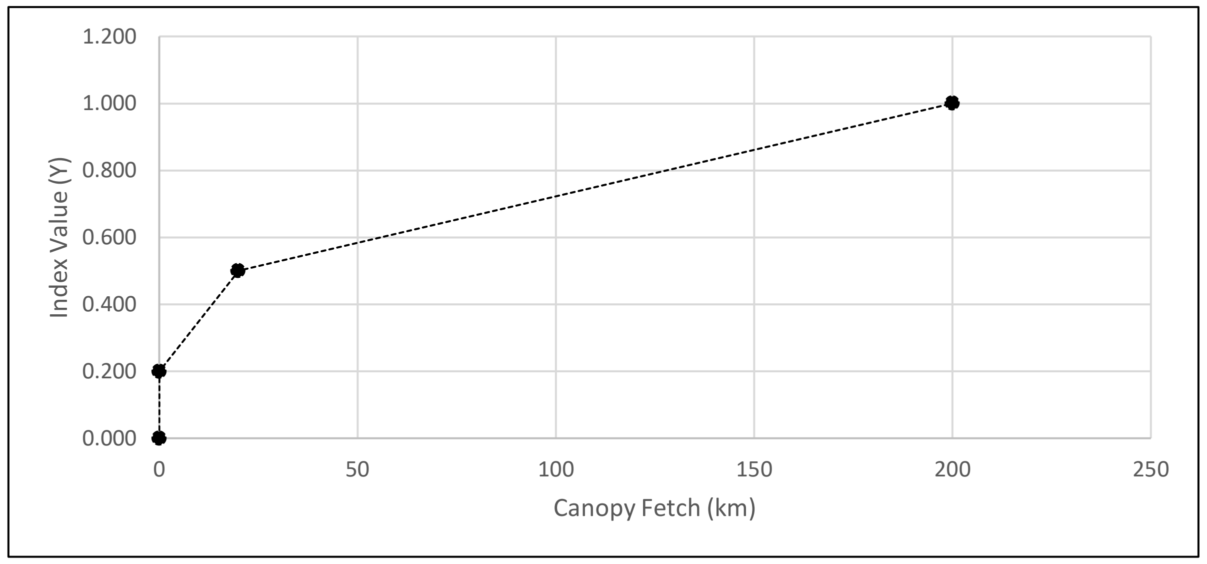


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Canopy Fetch (km)	Index Value (Y)
1	0	0.000
2	0.01	0.200
3	20	0.500
4	200	1.000
5		

Values	Intercept	Slope	Equation
0 -0.01	0.00	20.0000	Y= 0 + (20 * Canopy Fetch (km))
0.01 -20	0.20	0.0150	Y= 0.2 + (0.015 * Canopy Fetch (km))
20 -200	0.44	0.0028	Y= 0.44 + (0.0028 * Canopy Fetch (km))
200 -	0.00	0.0050	Y= 0 + (0.005 * Canopy Fetch (km))

Documentation
Smale, D. A., M. T. Burrows, A. J. Evans, N. King, M.D. Sayer, A. L. Yunnie, and P.J. Moore. 2016. Linking environmental variables with regional-scale variability in ecological structure and standing stock of carbon within UK kelp forests. In Marine Ecology Progress Series. 542: 79-95. https://doi.org/10.3354/meps11544.

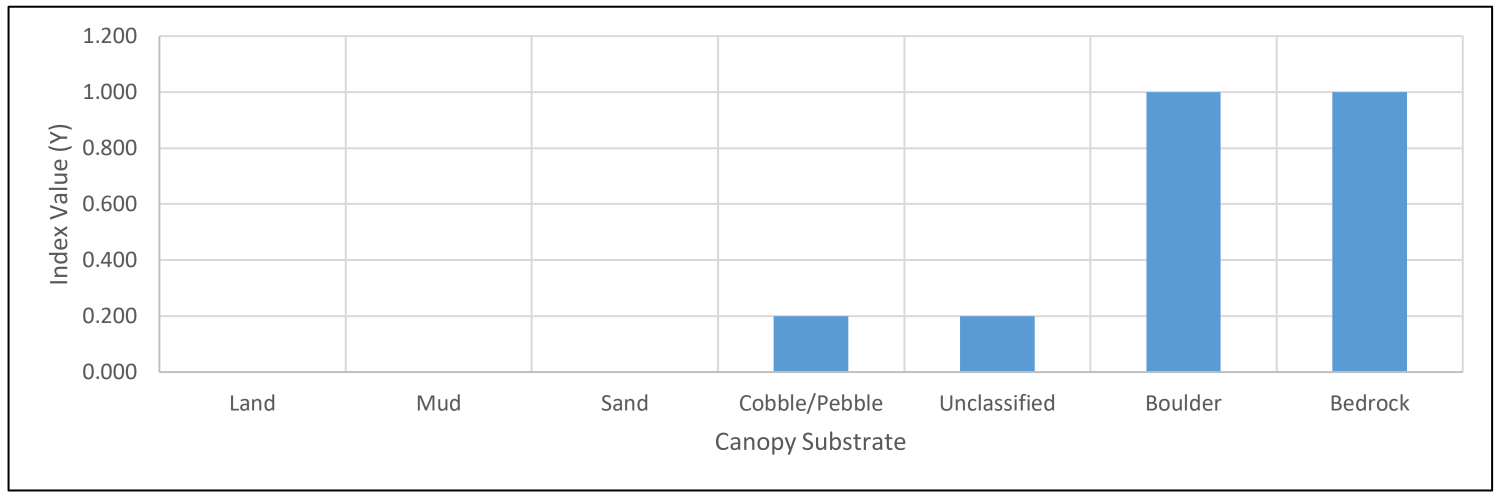


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Canopy Substrate	Index Value (Y)
1	Land	0.000
2	Mud	0.000
3	Sand	0.000
4	Cobble/Pebble	0.200
5	Unclassified	0.200
6	Boulder	1.000
7	Bedrock	1.000

Values	Intercept	Slope	Equation
Not Applicable			

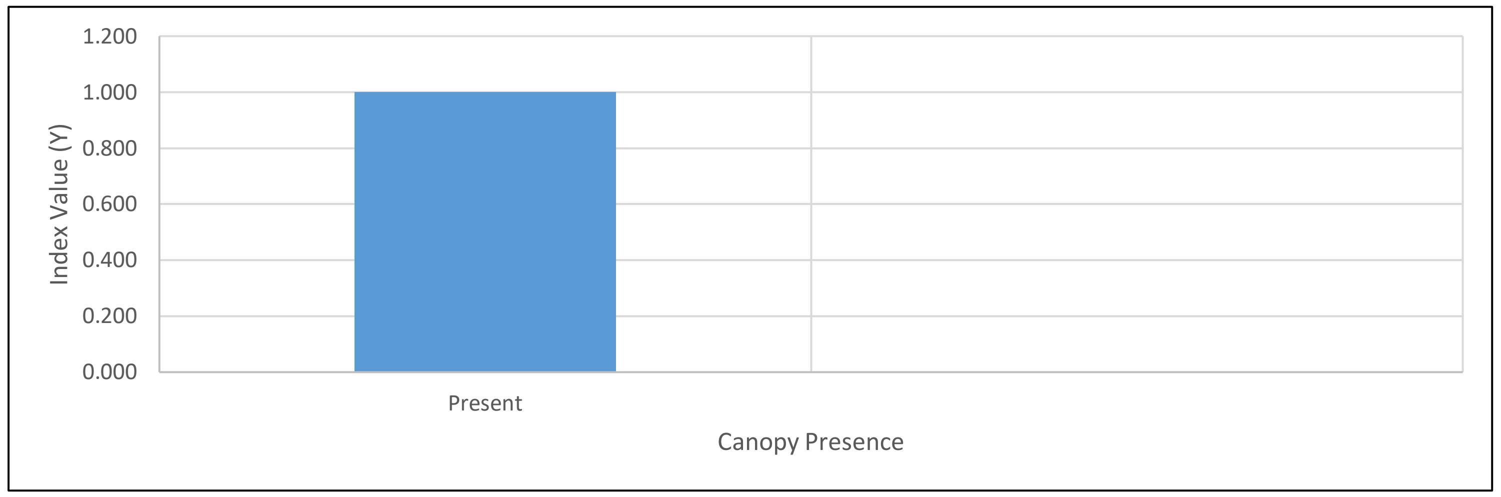
Documentation
Dayton, P. K. 1985. Ecology of Kelp Communities. In Annual Review of Ecology and Systematics 16: 215–45. http://www.jstor.org/stable/2097048.



ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Canopy Presence	Index Value (Y)
1	Present	1.000
2		

Values	Intercept	Slope	Equation
Not Applicable			



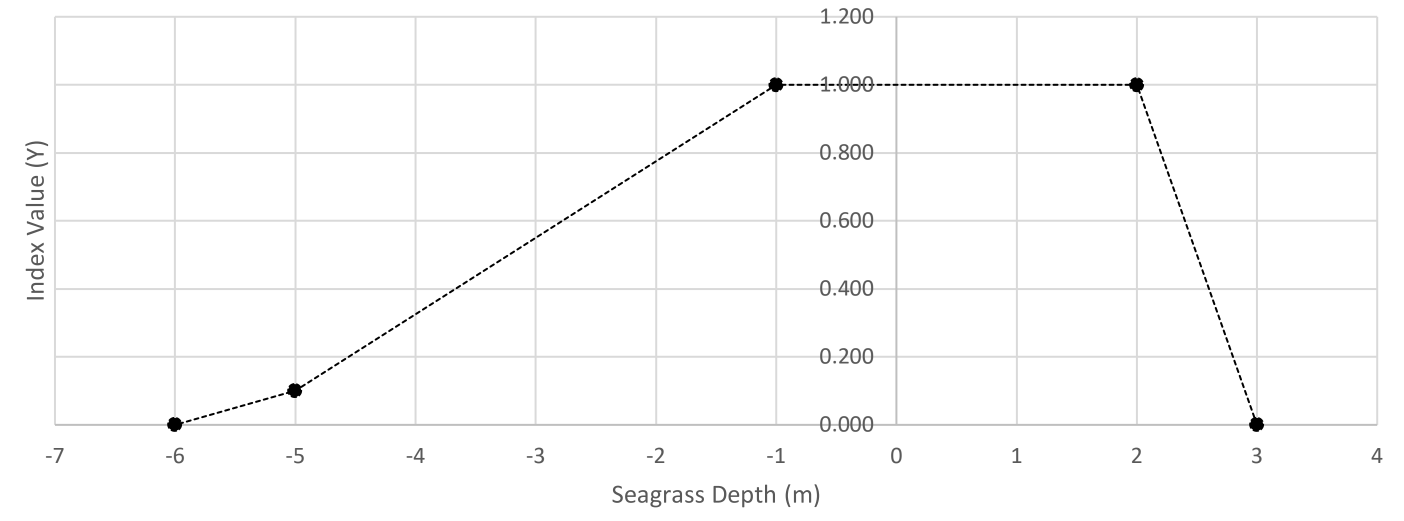
Documentation
Schoch, G. C. 2001. The spatial distribution of Bull Kelp (*Nereocystis leutkeana*) in the Kachemak Bay research reserve. Kachemak Bay Research Reserve. https://kachemakbayreserve.org/wp-content/uploads/2024/01/Schoch-2001-The-spatial-distribution-of-bull-kelp-Nereocystis-leutkeana-in-the-Kachemak-Bay-Research-Reserve.pdf

ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Seagrass Depth (m)	Index Value (Y)
1	3	0.000
2	2	1.000
3	-1	1.000
4	-5	0.100
5	-6	0.000
6		

Values	Intercept	Slope	Equation
3 -2	3.00	-1.0000	Y= 3 + (-1 * Seagrass Depth (m))
2 --1	1.00	0.0000	Y= 1 + (0 * Seagrass Depth (m))
-1 --5	1.23	0.2250	Y= 1.23 + (0.225 * Seagrass Depth (m))
-5 --6	0.60	0.1000	Y= 0.6 + (0.1 * Seagrass Depth (m))
-6 -	0.00	0.0000	Y= 0 + (0 * Seagrass Depth (m))

Documentation
Thom, R. M., S. L. Southard, A. B. Borde, and P. Stoltz. 2008. Light requirements for growth and survival of eelgrass (*Zostera marina L.*) in Pacific Northwest (USA) estuaries. In Estuaries and Coasts. 31:969-80. https://doi.org/10.1007/S12237-008-9082-3.

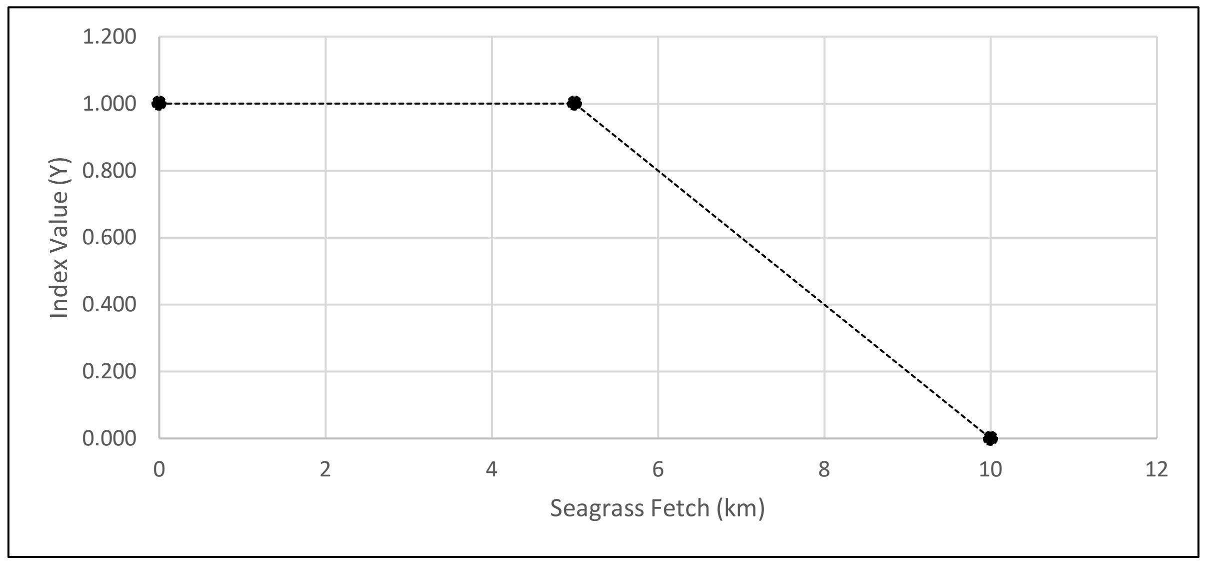


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Seagrass Fetch (km)	Index Value (Y)
1	0	1.000
2	5	1.000
3	10	0.000
4		

Values	Intercept	Slope	Equation
0 -5	1.00	0.0000	Y= 1 + (0 * Seagrass Fetch (km))
5 -10	2.00	-0.2000	Y= 2 + (-0.2 * Seagrass Fetch (km))
10 -	0.00	0.0000	Y= 0 + (0 * Seagrass Fetch (km))

Documentation
Oreska, M. P., K. J. McGlathery, P. L. Wiberg, R. J. Orth, and D. J. Wilcox. 2021. Defining the *Zostera marina* (eelgrass) niche from long-term success of restored and naturally colonized meadows: Implications for seagrass restoration. In Estuaries and Coasts. 44 (2): 396-411.

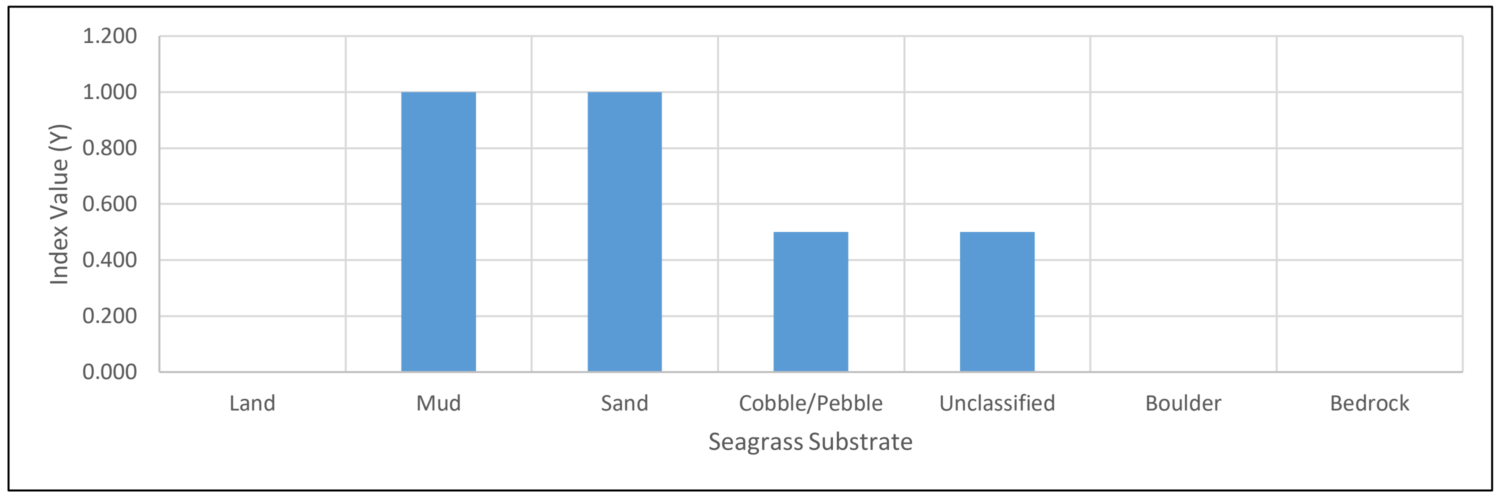


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Seagrass Substrate	Index Value (Y)
1	Land	0.000
2	Mud	1.000
3	Sand	1.000
4	Cobble/Pebble	0.500
5	Unclassified	0.500
6	Boulder	0.000
7	Bedrock	0.000

Values	Intercept	Slope	Equation
Not Applicable			

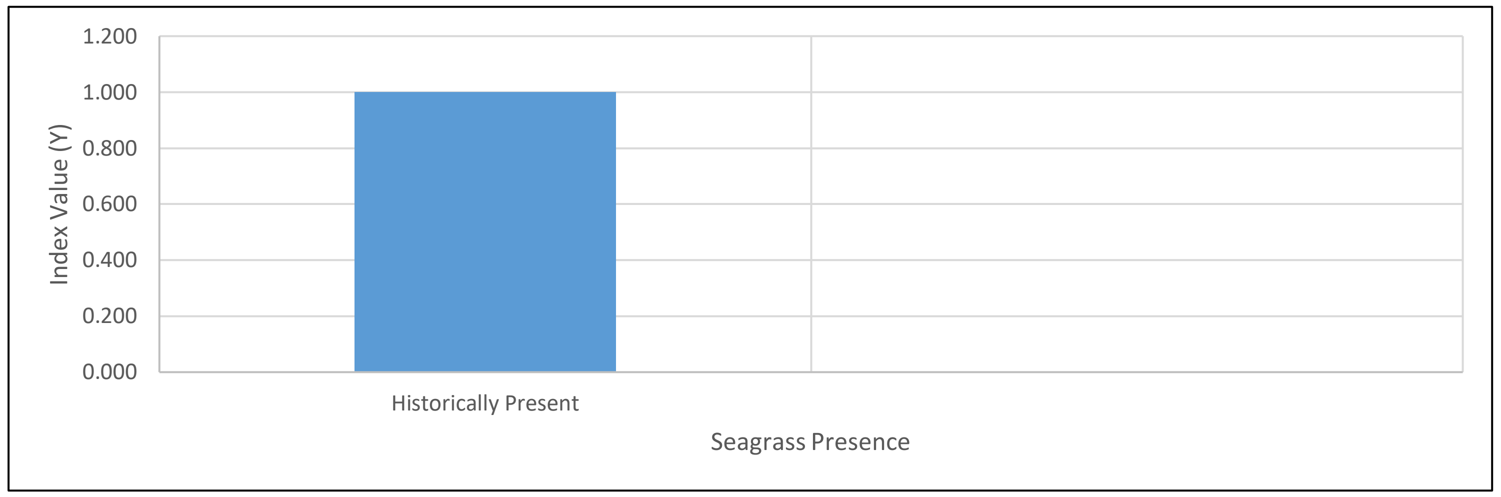
Documentation
Larkum. A. W., R. J. Orth, and C. M. Duarte. 2006. Seagrasses: Biology, Ecology and Conservation. In Phycologia. 45 (5): 5. https://doi.org/10.1007/978-1-4020-2983-7.



ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	**Seagrass Presence**	**Index Value (Y)**
1	Historically Present	1.000
2		

Values	**Intercept**	**Slope**	**Equation**
Not Applicable			



Documentation

Field, D., A. Malhotra, K. Holderied, and C. Taylor. 2020. NCCOS mapping: seafloor mapping products for Kachemak Bay, Cook Inlet, AK, from 2005-07-06 to 2017-07-19 (NCEI Accession 0209109). National Oceanic and Atmospheric Administration National Centers for Environmental Information. Dataset. https://doi.org/10.25921/2nha-4780.

Field, D., A. Malhotra, and K. Buja. 2005. Seagrass. In Benthic Mapping Kachemak Bay (Map Server). National Centers for Coastal Ocean Science. https://gis.ngdc.noaa.gov/arcgis/rest/services/nccos/BenthicMapping_KachemakBay/MapServer.

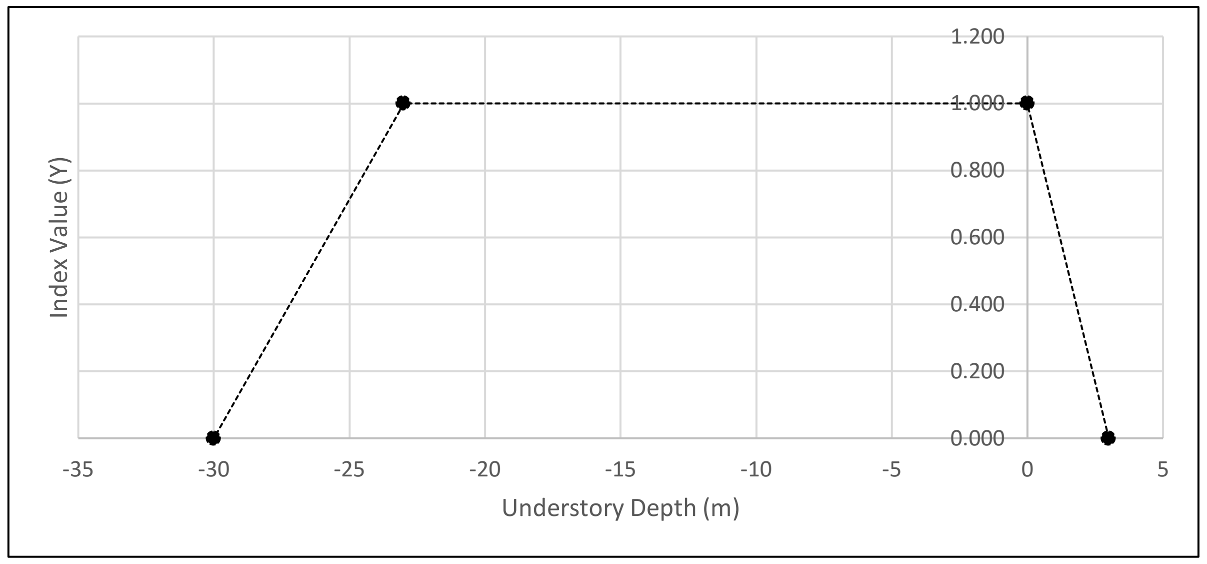
Additional seagrass data collected by National Centers for Coastal Ocean Science (Dr. Ross Whippo) is currently unpublished.

ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Understory Depth (m)	Index Value (Y)
1	3	0.000
2	0	1.000
3	-23	1.000
4	-30	0
5		

Values	Intercept	Slope	Equation
3 -0	1.00	-0.3333	Y= 1 + (-0.3333 * Understory Depth (m))
0 --23	1.00	0.0000	Y= 1 + (0 * Understory Depth (m))
-23 --30	4.29	0.1429	Y= 4.29 + (0.1429 * Understory Depth (m))
-30 -	0.00	0.0000	Y= 0 + (0 * Understory Depth (m))

Documentation
Bekkby, T., C. Smit, H. Gundersen, E. Rinde, H. Steen, L. Tveiten, J. K. Gitmark, S. Fredriksen, J. Albretsen, and H. Christie. 2019. The Abundance of Kelp Is Modified by the Combined Impact of Depth, Waves and Currents. In Frontiers in Marine Science 6. https://doi.org/10.3389/fmars.2019.00475.

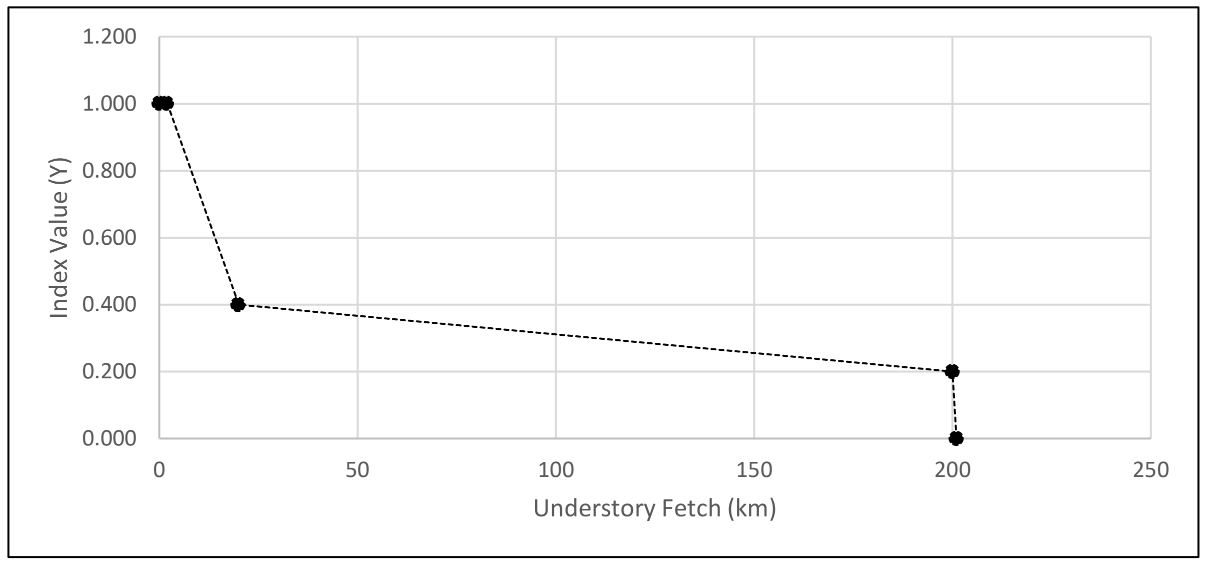


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Understory Fetch (km)	Index Value (Y)
1	0	1.000
2	2	1.000
3	20	0.400
4	200	0.2
5	201	0
6		

Values	Intercept	Slope	Equation
0 -2	1.00	0.0000	Y= 1 + (0 * Understory Fetch (km))
2 -20	1.07	-0.0333	Y= 1.07 + (-0.0333 * Understory Fetch (km))
20 -200	0.42	-0.0011	Y= 0.42 + (-0.0011 * Understory Fetch (km))
200 -201	40.20	-0.2000	Y= 40.2 + (-0.2 * Understory Fetch (km))
201 -	0.00	0.0000	Y= 0 + (0 * Understory Fetch (km))

Documentation
Bekkby, T., and F. E. Moy. 2011. Developing spatial models of sugar kelp (*Saccharina latissima*) potential distribution under natural conditions and areas of its disappearance in Skagerrak. In Estuarine, Coastal and Shelf Science 95 (4): 477-83. https://doi.org/10.1016/j.ecss.2011.10.029.

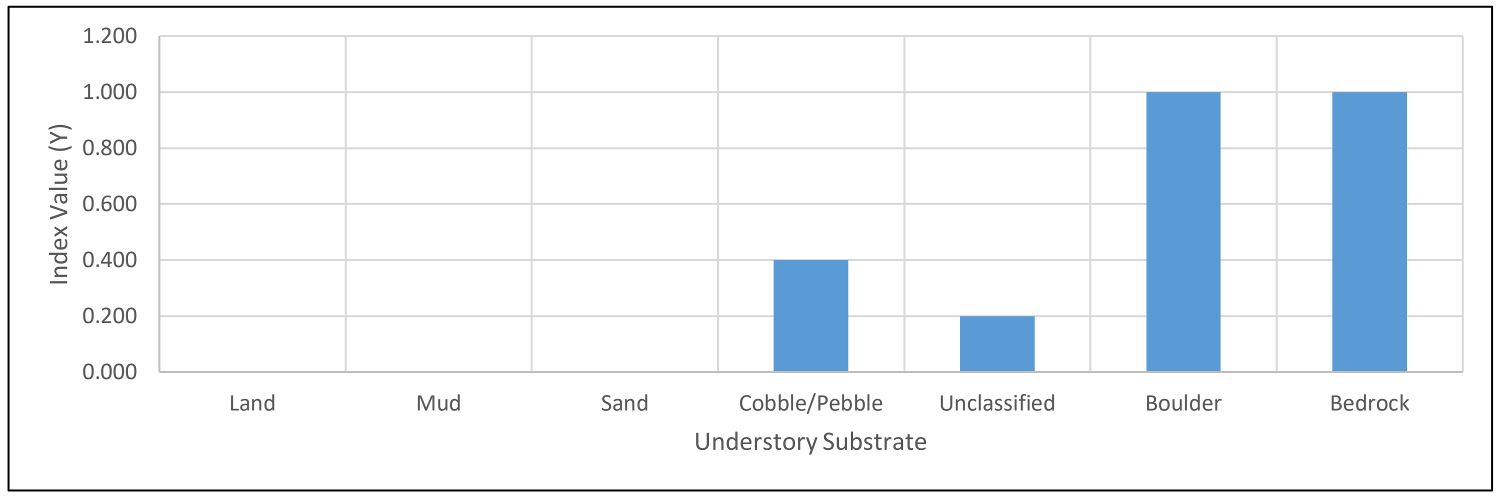


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	Understory Substrate	Index Value (Y)
1	Land	0.000
2	Mud	0.000
3	Sand	0.000
4	Cobble/Pebble	0.400
5	Unclassified	0.200
6	Boulder	1.000
7	Bedrock	1.000

Values	Intercept	Slope	Equation
Not Applicable			

Documentation
Dayton, P. K. 1985. Ecology of Kelp Communities. In Annual Review of Ecology and Systematics 16: 215–45. http://www.jstor.org/stable/2097048.



Attachment 2: Workshop Attendance Sheet

PARTICIPANT ATTENDANCE AND CONTACT SHEET
Homer Navigation Improvements Study, AK
Ecological Workshop

Workshop Participants

#	Last Name	First Name	Organization	Contact Information		Sign-In Signature	
				Email Address	Phone #	Day 1	Day 2
1	Aderhold	Donna	Homer City Council, Prince William Sound Science Center	donnaaderhold@ci.homer.ak.us	907.244.4388	Donna	
2	Archibald	Robert	Friends of Kachemak Bay State Parks (rep), Kachemak Bay State Park Citizen's Advisory Board, Homer Parks and Recreation Commission, Prince William Sound Regional Citizens' Advisory Council	robert.e.archibald@gmail.com		Robert Archibald	
3	Cafferty	Kaitlynn	Kenai Peninsula Area Manager, ADF&G Habitat Section	kaitlynn.cafferty@alaska.gov	907 714 2401		
4	Daniel	Laurie	KBNERR Community Council	alaska.bioworks@gmail.com	235-4349		
5	Holderied	Kris	NOAA Kasitsna Bay Lab, National Centers for Coastal Ocean Science	kris.holderied@noaa.gov	907-399-4412	K Holderied	K Holderied
6	Kent	KC	HDR	kc.kent@hdrinc.com	907 632 2244		
7	Matz	George	Kachemak Bay Birders	geomatz41@gmail.com	235-9344		
8	Saupe	Susan	Cook Inlet Regional Citizens Advisory Council (CIRCAC)	saupe@circac.org	907-398-6214	Susan Saupe	Susan Saupe
9	Sutton	Lauren	KBNERR Staff, University of Alaska Anchorage	lsutton7@alaska.edu	907-235-1504		Lauren Sutton
10	Whippo	Ross	NOAA Kasitsna Bay Lab, National Centers for Coastal Ocean Science	ross.whippo@noaa.gov	206 890 7261		
11	Winterberger	Shea	USCG Aspen Commander	shea.g.winterberger@uscg.mil	907 299 7598		
12	Yeaton	Aaron	City of Homer	ayeaton@ci.homer.ak.us	907 435 3137		
13	Haas	Penelope	Kachemak Bay Conservation Society	kbayconservation@gmail.com	907-419-4029		
14	Hondolero	Dominic	NOAA KBL	Dominic.Hondolero@noaa.gov	907-590-2149		
15							

Workshop ERDC Instructors and Supporting Roles

#	Last Name	First Name	Organization
1	Swannack	Todd	USACE ERDC - Ecological Modeling Team
2	Piercy	Candice	USACE ERDC - Ecological Modeling Team
3	Campbell	Kayla	USACE Alaska District - Study NEPA Lead / Workshop Notetaker/Assistant
4	Spaulding	Fern	USACE Alaska District - Biologist and Alterante NEPA Coordinator / Workshop Notetaker/Assistant
5	Lee	Curtis	USACE Alaska District - Study Project Manager
6	Clarke	Matt	City of Homer Port and Harbor (P&H) - Non-Federal Sponsor Representative / Speaker. Jenny Carroll or Amy Woodruff may also fulfill a similar role for P&H.

Carroll Jenny COH

For questions and/or concerns regarding the Ecological Modeling Workshop, the point of contact is **Kayla Campbell** from USACE Alaska District at -

Email: Kayla.n.campbell@usace.army.mil

or

Office Phone: (907) 753 - 2757

Attachment 3: Workshop Agenda

Homer Navigation Improvements Study
Environmental Modeling Workshop
11 & 12 April, 2024

Day	Date	Time	Lecture / Tasks	Leader
Thursday	11-April	0900	Sign-in, Welcoming remarks, classroom orientation / logistics, introductions, and review course objectives / schedule	Swannack
		1045	Overview of Homer Navigation Improvements Study, objectives, & potential alternatives and decision framework	District/District partners
		1015	Lecture: Modeling basics and process	Swannack
		1045	BREAK	N/A
		1100	Lecture: Conceptualization	Swannack
		1200	LUNCH	N/A
		1315	Lab 1: Conceptualization	Breakout groups
		1500	Team Report-outs & Daily Review	Breakout groups
		1600	ADJOURN	N/A
Friday	12-April	0900	Review Day 1	Swannack
		0930	Modeling 3: Quantification	Swannack
		1000	BREAK	N/A
		1015	Lab 3: Quantification	Breakout Group
		1130	Discussions and path forward	Swannack
		1200	ADJOURN	N/A

Attachment 4: Post-Workshop Model Follow-up with Participants

Meeting Minutes
Homer Navigation Improvements Study, AK
June 30, 2025 & July 11, 2025

Meeting: Homer Navigation Improvements Study – Ecological Model Workshop Follow-up Meeting (Virtual on Microsoft Team)

Attendance:

June 30

USACE – Todd Swannack, Kayla Campbell

Non-USACE Project Delivery Team Members – Bryan Hawkins, Jenny Carroll

Workshop Participants – Donna Aderhold, Kris Holderied, Lauren Sutton, Ross Whippo, Laurie Daniel, KC Kent

July 11

USACE – Todd Swannack, Kayla Campbell

Non-USACE Project Delivery Team Members – Jenny Carroll

Workshop Participants – George Matz, KC Kent, Laurie Daniel, Kaitlynn Cafferty

Meeting Notes:

June 30, 2025

- ❖ Todd presented a PowerPoint (attached) that provided a review of the prior workshop and its conceptual models and the current developed ecological model. This was followed by the "Next Steps" of the model process.
    - ➢ Highlighted needed an ecological model that capture the complexity of the system while showing a response to the changes based on the project and included enough inputs for forecasting. This is lead to a focus on the submerged aquatic vegetation (kelp/seagrass) as the predominate/primary producers in Kachemak Bay.
    - ➢ Included review of the collaborations with NCCOS Dr. Ross Whippo and HDR KC Kent. NCCOS Kelp model is basis of the ecological model and KC Kent sediment and wave circulation model will provide inputs for ecological model outputs.
- ❖ Open discussion followed the presentation.
    - ➢ Lauren Sutton – Liked the model, and asked clarification on what the output will be for the ecological model.
        - ▪ Todd provided the outputs will present a map. The baseline model provides the foundation for scenario modeling that can be used to complete a comparative

analysis between “future without project” and the results of potential alternatives. The model will provide outputs based on Habitat Suitability Index (HSI) metrics.

- Lauren asked if further outputs would inform impacts higher up the chain.

  - Todd and Ross provided that the inference of impacts would come as a cascading effect. I.e., impacts to submerged aquatic vegetation will infer impacts to high trophic species.

- Lauren asked what would be added to the model (e.g., higher trophic levels not dependent on eelgrass). Provided something measurable is preferred.
  - Ross provided HSI can be applied to any species and that NCCOS is interested in continuing progressing their model(s).

  - Todd provided due to constraints of funding/time with studies, USACE will continue forward with what is available/prudent to inform the study. I.e., noted that incorporating further variables is ideal but not necessarily possible.

- Lauren provided the model stressor focus on sedimentation is an important one for the study and SAV is a great way to move forward, but wondered if there is additional consideration to other stressors.

  - KC provided some examples of what will be looked at outside of SAV, and that the vessel stressor is not a major concern as it is intended to result in the same number of vessels and not necessarily new vessels.

  - Todd provided that the model could be further developed in the future.

- Laurie appreciated presentation. She inquired if at this point the project delivery team has started applying the ecological model to the alternatives.

  - KC provided that HDR is working on their modeling piece still and just got some required variables to run the HDR model for outputs to the ecological model. However, the Tentatively Selected Plan will continually be reviewed and further assessed past/through the September release of the draft report.

  - Todd provided we have the baseline but have not yet ran the alternatives, which are pending, but once we have information we can get outputs relatively quickly.

  - Kayla provided inputs will continually be updated based on the most recent, available data and initial outputs will be attained in the next couple/few weeks. Further provided the analysis will continue beyond the draft release in September and the level of NEPA will be subject to change continuously throughout the process.

- Laurie is concerned with the timeline and release of the draft report. Her concern is the draft report is the community’s chance to impact the design. Ross

  - Kayla provided that the model will be applied to all alternatives for TSP but the only TSP and LPP will be continually updated/refined to get updated outputs during refinement processes.

  - Laurie still concerned about September being the only touchpoint for consideration. Laurie wants the ecological model applied across the alternatives to inform TSP selection.
    - KC acknowledged and provided that a lot of the information is going to address a lot of the concerns being brought up.
    - Kayla reaffirmed TSP will have outputs from model and applied to alternative to be later captured in the draft and that the schedule was not reduced. The study was paused but not extended/reduced.
  - Donna inquired if all comments will be saved/responded to and asked how the environmental analysis informs alternative selection and design.
    - Kayla provided all comments are saved and responded to but how those show up in the report can vary.
  - Kayla shared PAO contact information to provide another way to inquire about USACE policy/process outside of the project delivery team.
  - Todd offered a touchpoint in September to go over model and describe outputs before ending the meeting.

<u>July 11, 2025</u>

- Todd presented a PowerPoint (attached) that provided a review of the prior workshop and its conceptual models and the current developed ecological model. This was followed by the "Next Steps" of the model process.
  - Highlighted needed an ecological model that capture the complexity of the system while showing a response to the changes based on the project and included enough inputs for forecasting. This is lead to a focus on the submerged aquatic vegetation (kelp/seagrass) as the predominate/primary producers in Kachemak Bay.
  - Included review of the collaborations with NCCOS Dr. Ross Whippo and HDR KC Kent. NCCOS Kelp model is basis of the ecological model and KC Kent sediment and wave circulation model will provide inputs for ecological model outputs.
- Open discussion followed presentation:
  - Kaitlynn Cafferty asked if she could get the slide show to review and digest for potential follow-on questions.
    - It was confirmed the PowerPoint and the notes would be shared to the original participants.
  - Laurie asked about other environmental concerns and how they relate to the model (e.g., acoustic noise and upland impacts) and HDR component of the ecological model.

    - Todd confirmed extent of ecological model coverage and data it provides and variables considered.

    - Clarified that the SAV is an indicator across taxonomic groups but the model does not directly supply data/information to each species that occurs within the study footprint.

    - Kayla clarified the ecological model is a component of the study used to assess environmental baseline and impacts but not the sole tool and should not be considered the extent of analysis being conducted by USACE with regards to the environment and potential impacts.

  - Laurie reinforced Mud Bay and its importance throughout the year to various species; bird and marine mammals, in Kachemak Bay, and the anticipated impacts from the construction of an alternative under the current array of alternatives.

    - Todd brought up that the model will give data for potential impacts to Mud Bay. Just are not there yet as HDR inputs are a main input for those outputs. HDR outputs are not yet integrated.

- Kayla provided the meetings do not show or indicate all the analysis ongoing.

- Laurie gave concern of the timeline and inflexibility of USACE's study process.

  - Todd reinforced this is a 1st step in the process and part of the planning process, but does not mean there is no potential for modifications or a way to alter an alternative / supplement analysis to ensure potential are sufficiently addressed.

  - KC reinforced community involve on the project has heavily involved stakeholders compared to other projects for consideration beyond more typical 30-day window commentary.

- George provided in chat due to mic issues the following: "Thanks for the presentation. How would all this information be applied to one species on particular, Steller's Eider which use the projected harbor expansion for winter foraging. For instance, how would dredging channels to the harbor affect their feeding area." And : "But the ecological impacts may require a change in design. So is the cart ahead of the horse in terms of timing."

  - Todd reinforced this model will not address birds specifically but the outputs can be used to infer potential impacts and how those impacts. Provide the process is iterative for analyses and design refinement.

- George provided, "benthic organisms will define where they feed."

  - Todd shared that will be a good connection to infer impacts to Steller's eiders.

Homer Navigation Improvement Study

Team

Todd M. Swannack (US Army ERDC)

Kayla Campbell, Fern Spaulding (USACE-POA)

Ross Whippo (NCCOS)

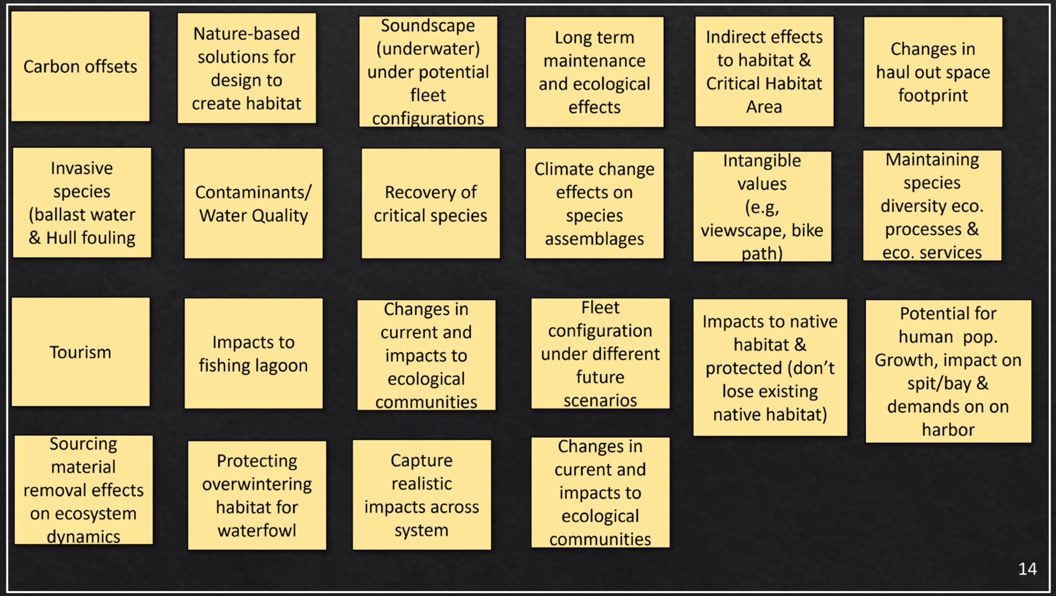
KC Kent (HDR)

Agenda

- Recap of model development workshop (April 2024)
- Update on model development
- Discussion/next steps

Recap of April 2024 Workshop

- Attended by 13 (USACE not included) across different agencies and organizations
- Mediated modeling approach for model development



Carbon offsets

Nature-based solutions for design to create habitat

Soundscape (underwater) under potential fleet configurations

Long term maintenance and ecological effects

Indirect effects to habitat & Critical Habitat Area

Changes in haul out space footprint

Invasive species (ballast water & Hull fouling

Contaminants/ Water Quality

Recovery of critical species

Climate change effects on species assemblages

Intangible values (e.g, viewscape, bike path)

Maintaining species diversity eco. processes & eco. services

Tourism

Impacts to fishing lagoon

Changes in current and impacts to ecological communities

Fleet configuration under different future scenarios

Impacts to native habitat & protected (don't lose existing native habitat)

Potential for human pop. Growth, impact on spit/bay & demands on on harbor

Sourcing material removal effects on ecosystem dynamics

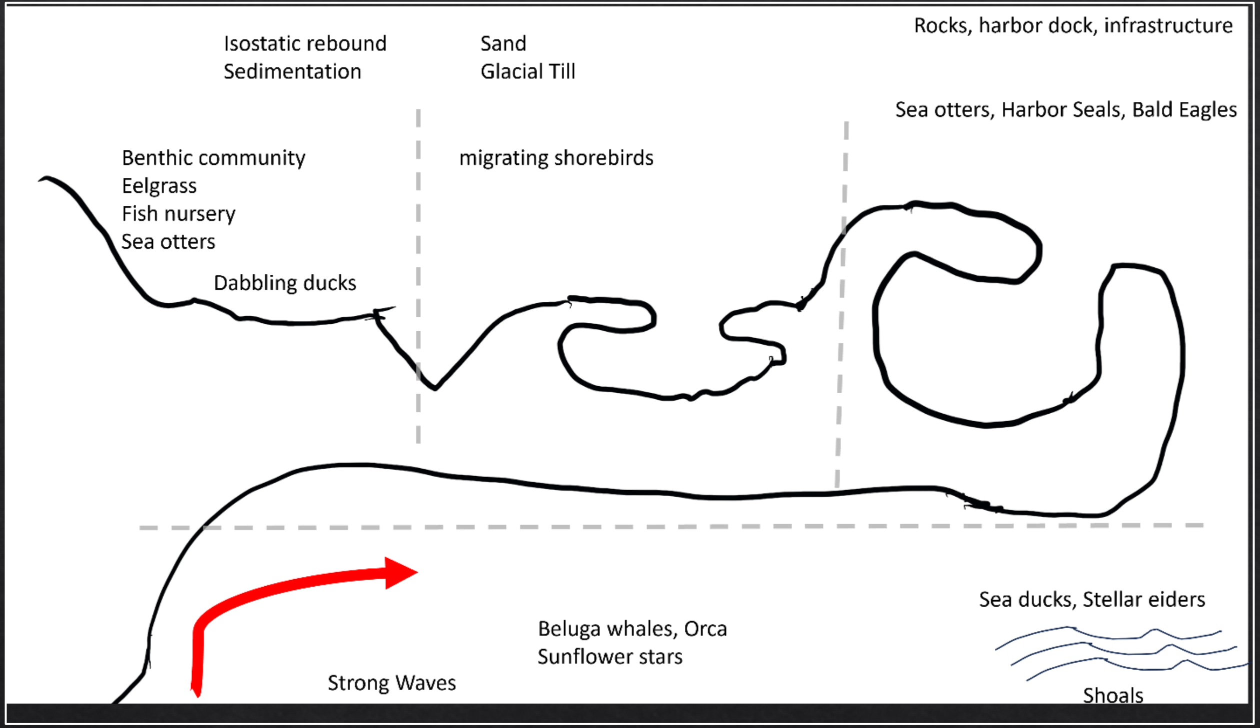
Protecting overwintering habitat for waterfowl

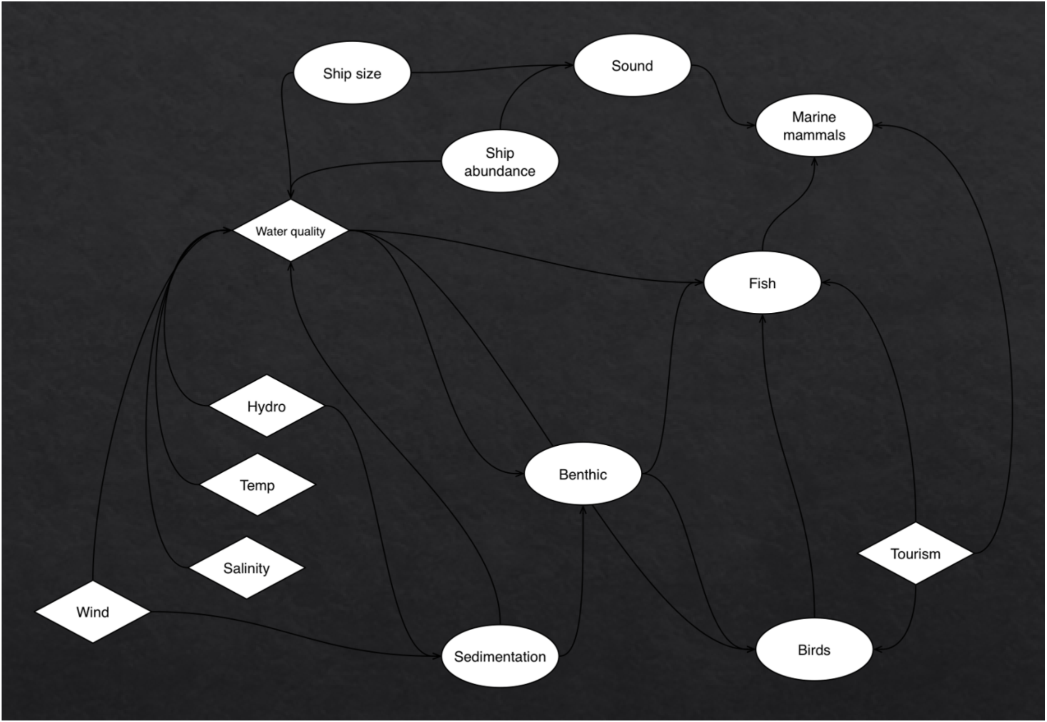
Capture realistic impacts across system

Changes in current and impacts to ecological communities

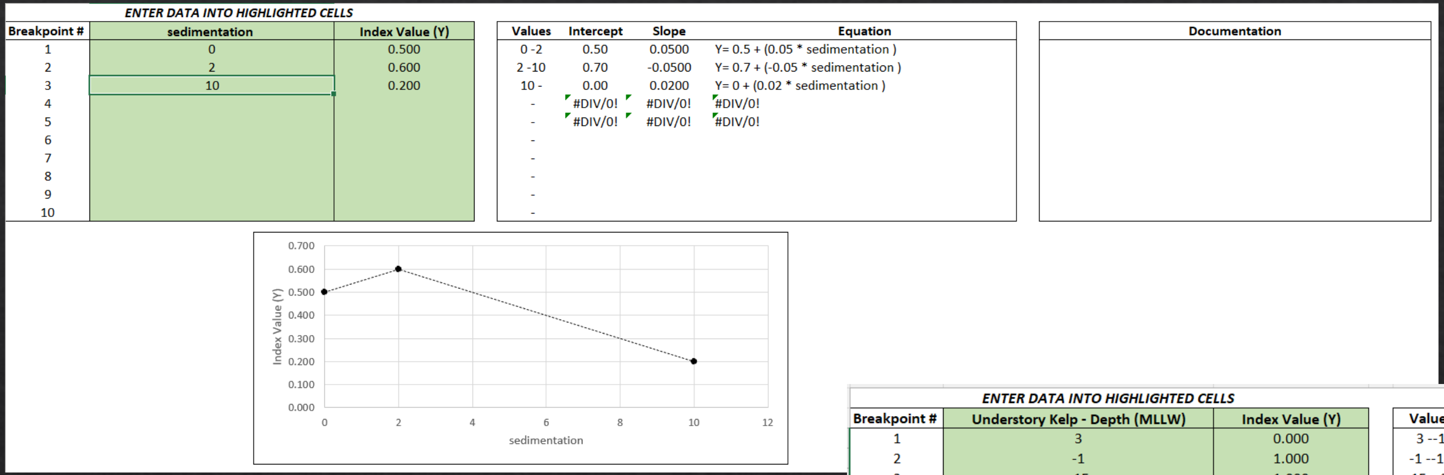
Identified drivers and stressors

Conceptual Models





Drafted quantitative index functions

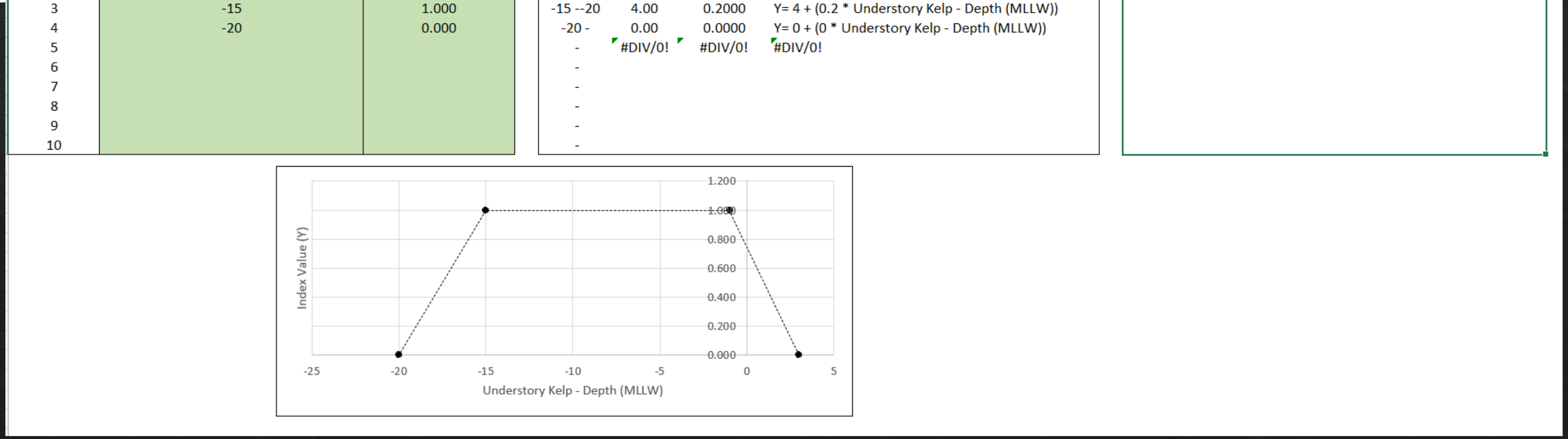


ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	**sedimentation**	**Index Value (Y)**
1	0	0.500
2	2	0.600
3	10	0.200
4		
5		
6		
7		
8		
9		
10		

Values	**Intercept**	**Slope**	**Equation**
0 -2	0.50	0.0500	Y= 0.5 + (0.05 * sedimentation)
2 -10	0.70	-0.0500	Y= 0.7 + (-0.05 * sedimentation)
10 -	0.00	0.0200	Y= 0 + (0.02 * sedimentation)
-	#DIV/0!	#DIV/0!	#DIV/0!
-	#DIV/0!	#DIV/0!	#DIV/0!
-			
-			
-			
-			
-			

Documentation



ENTER DATA INTO HIGHLIGHTED CELLS

Breakpoint #	**Understory Kelp - Depth (MLLW)**	**Index Value (Y)**
1	3	0.000
2	-1	1.000
3	-15	1.000
4	-20	0.000
5		
6		
7		
8		
9		
10		

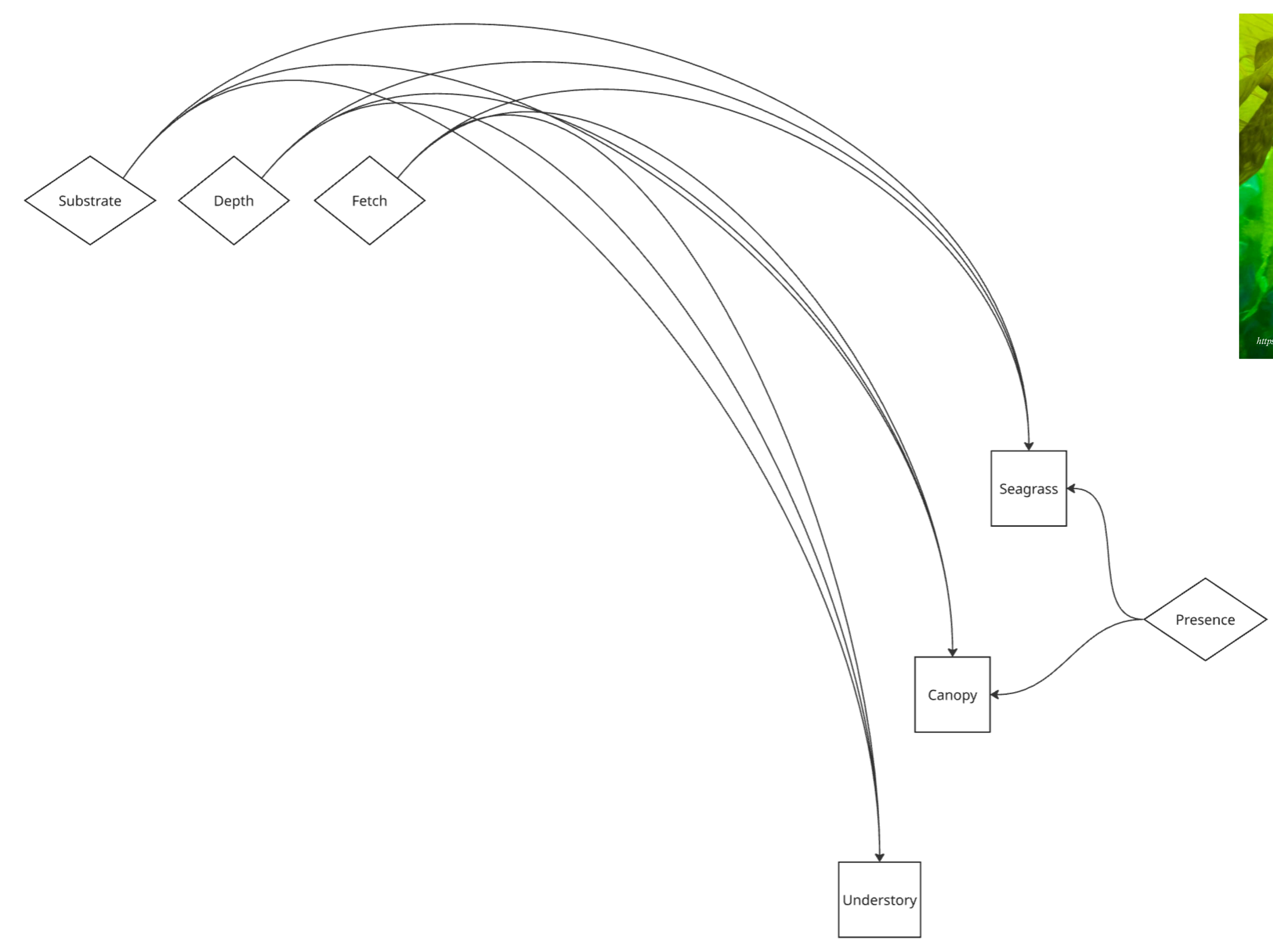
Values	**Intercept**	**Slope**	**Equation**
3 --1	0.75	-0.2500	Y= 0.75 + (-0.25 * Understory Kelp - Depth (MLLW))
-1 --15	1.00	0.0000	Y= 1 + (0 * Understory Kelp - Depth (MLLW))
-15 --20	4.00	0.2000	Y= 4 + (0.2 * Understory Kelp - Depth (MLLW))
-20 -	0.00	0.0000	Y= 0 + (0 * Understory Kelp - Depth (MLLW))
-	#DIV/0!	#DIV/0!	#DIV/0!
-			
-			
-			
-			
-			

Documentation
Studies done on kelp with good data on HSI values and kelp. Tanya in Mud Bay.

Model development since workshop

- Focused on refining model
  - Needed model that would capture complexity of system, while showing ecological response to changes based on project and that had enough data to forecast
- Decided on using an indicator taxa
- Submerged aquatic vegetation (Kelp and Seagrass)
  - Why?
    - Respond quickly to change
    - Primary producers and foundation of food web
    - Located throughout the bay,
    - Without it, the system doesn’t function ecologically
    - Active studies and monitoring (~5 decades of data)

Collaboration with Dr. Ross Whippo (NCCOS, Kasitsna Bay Laboratory)



Substrate

Depth

Fetch

Seagrass

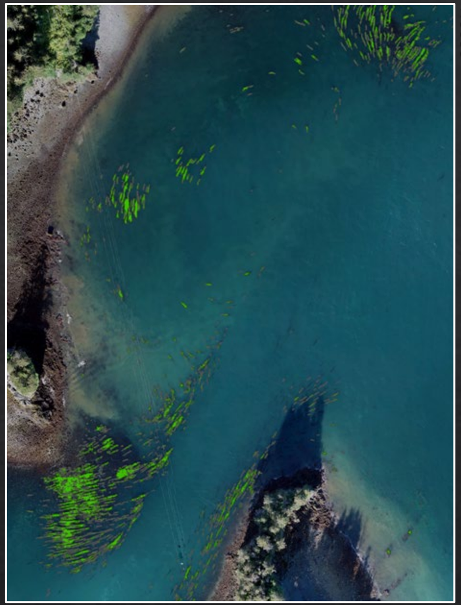
Canopy

Understory

Presence

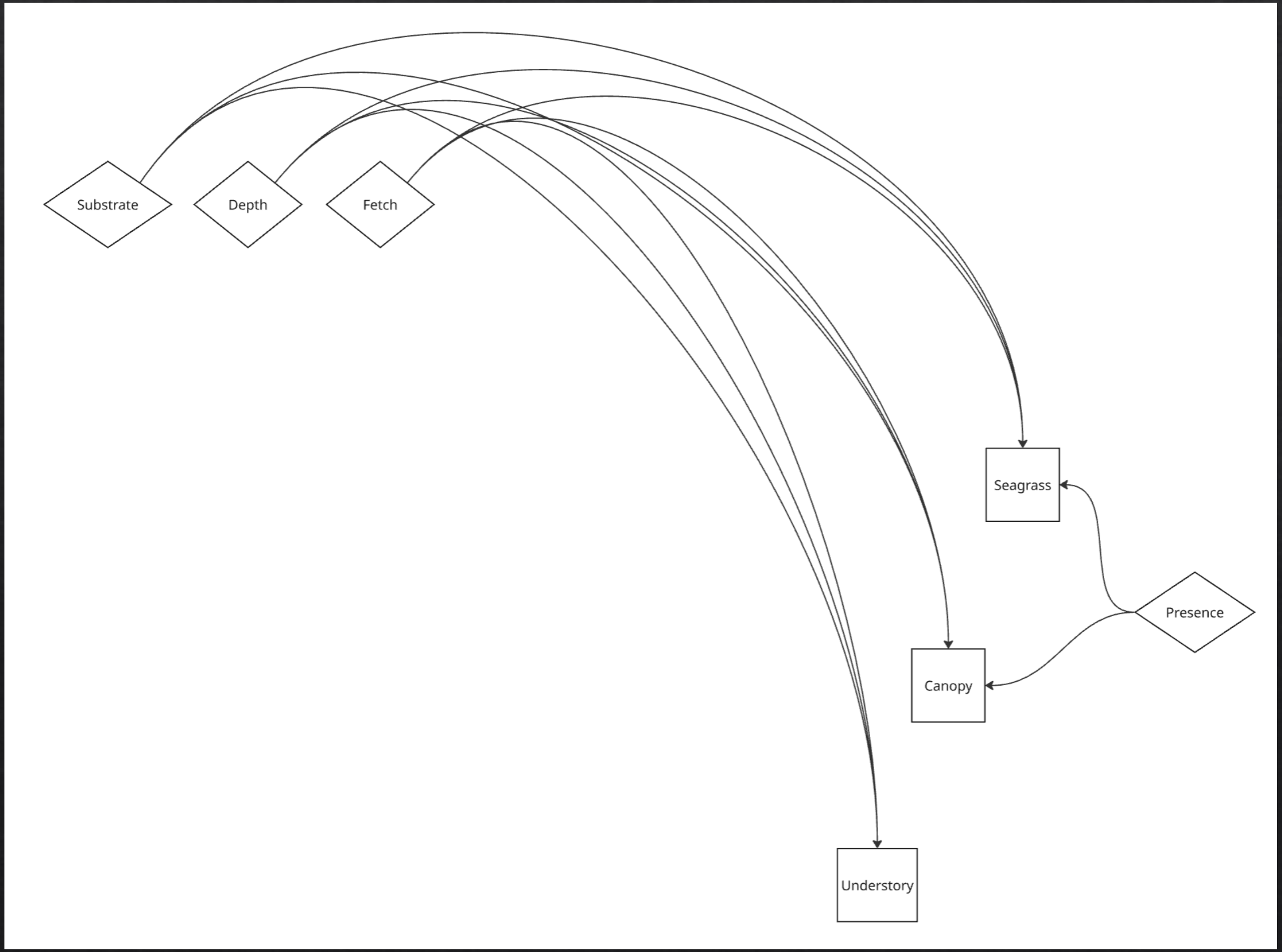
https://www.homernews.com/life/creative-endeavours-on-display-in-august-first-friday-exhibits/

Marcelle McDannel

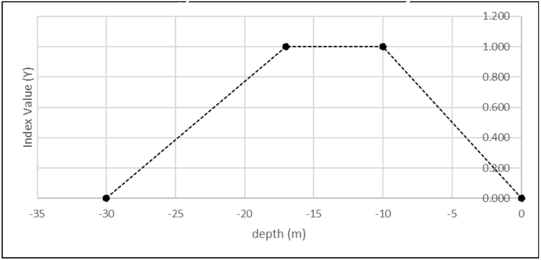


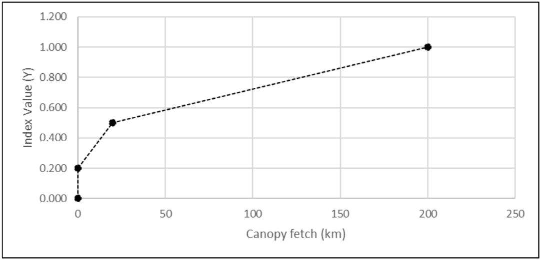
NCCOS

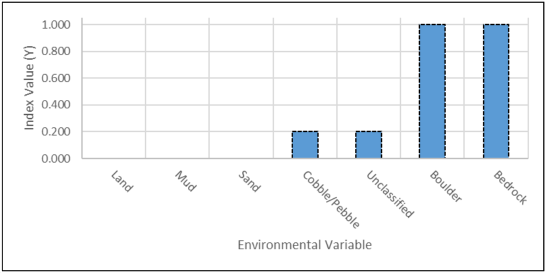
Collaboration with Dr. Ross Whippo (NCCOS, Kasitsna Bay Laboratory)



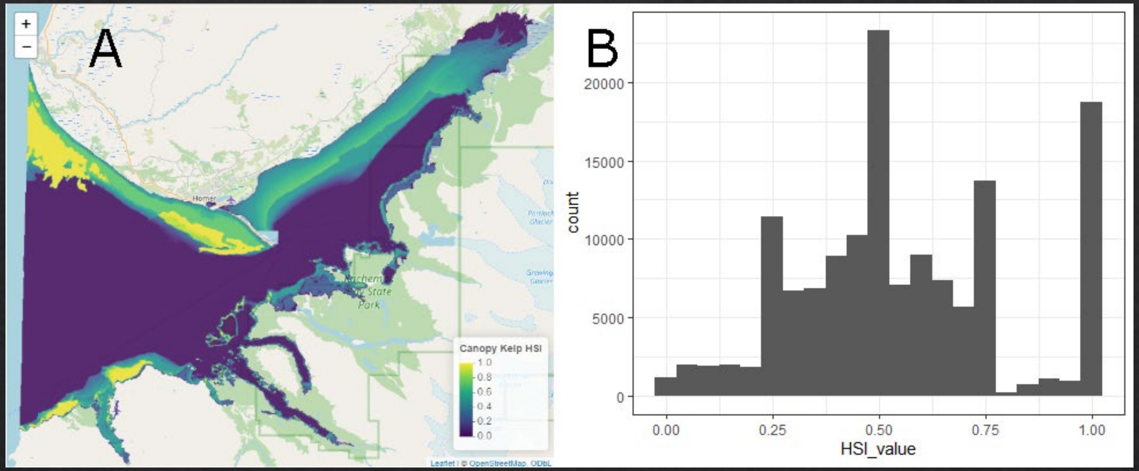
Canopy curves (*seagrass and understory not shown*)

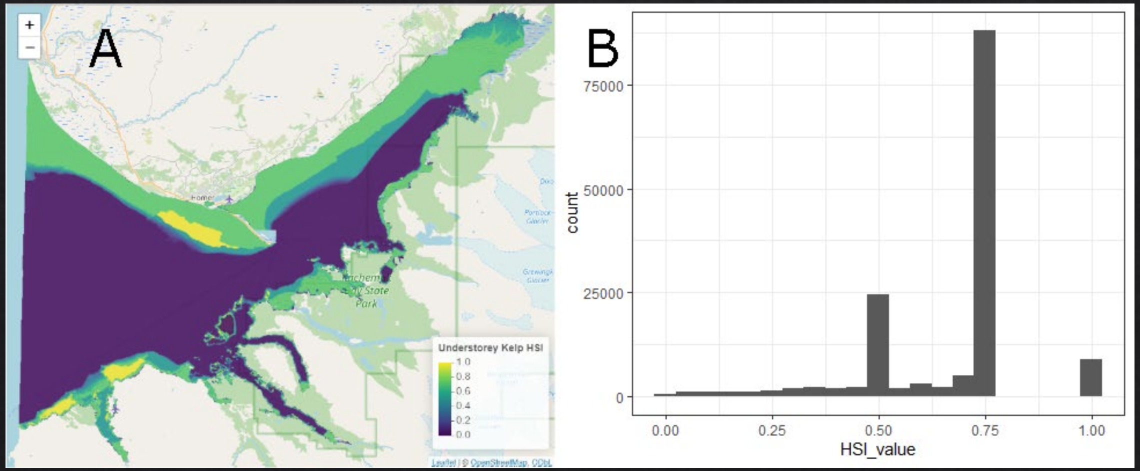


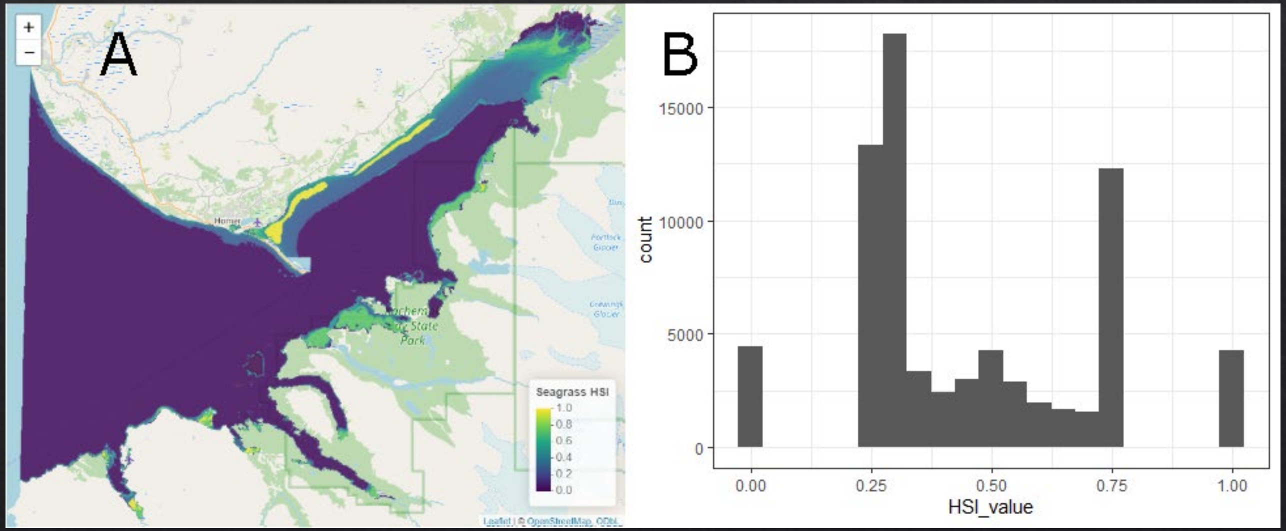




Collaboration with Dr. Ross Whippo (NCCOS, Kasitsna Bay Laboratory)

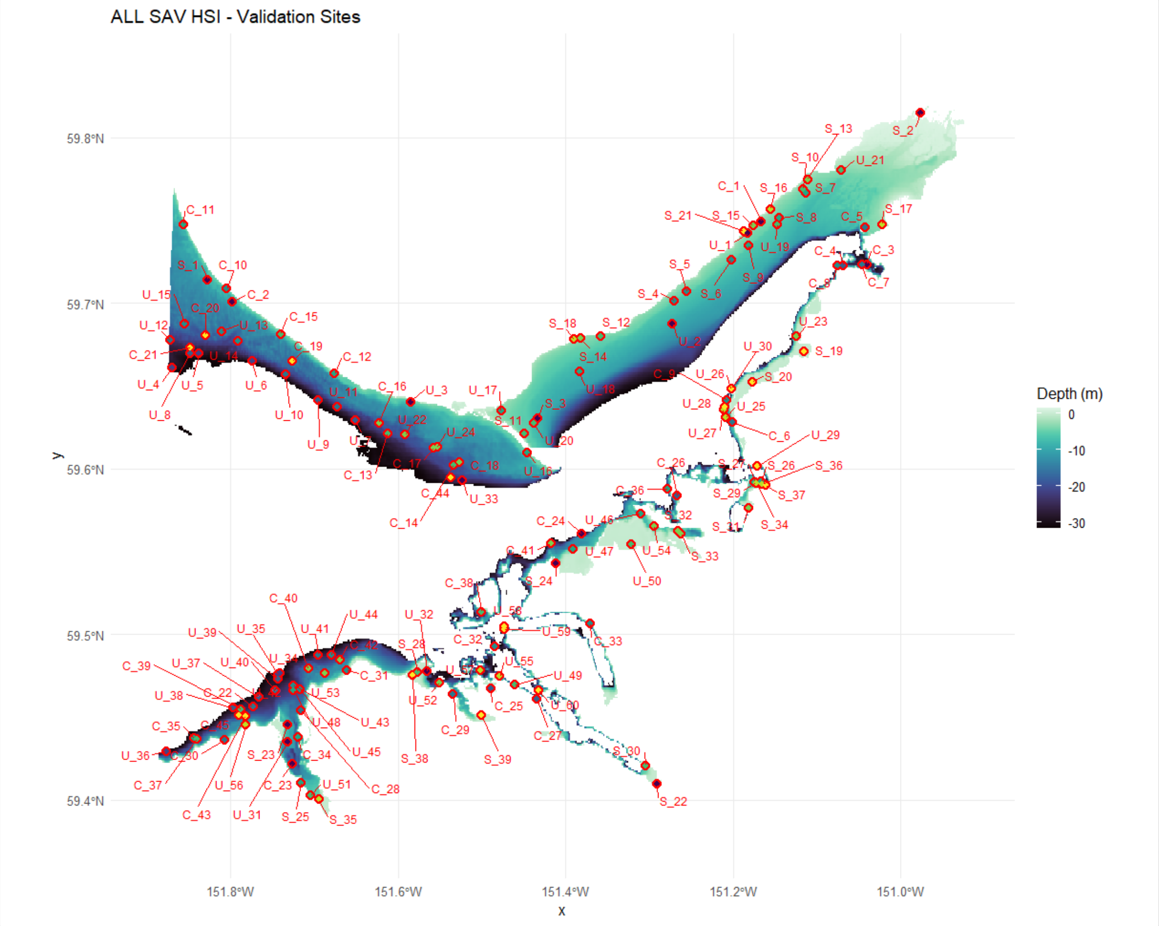






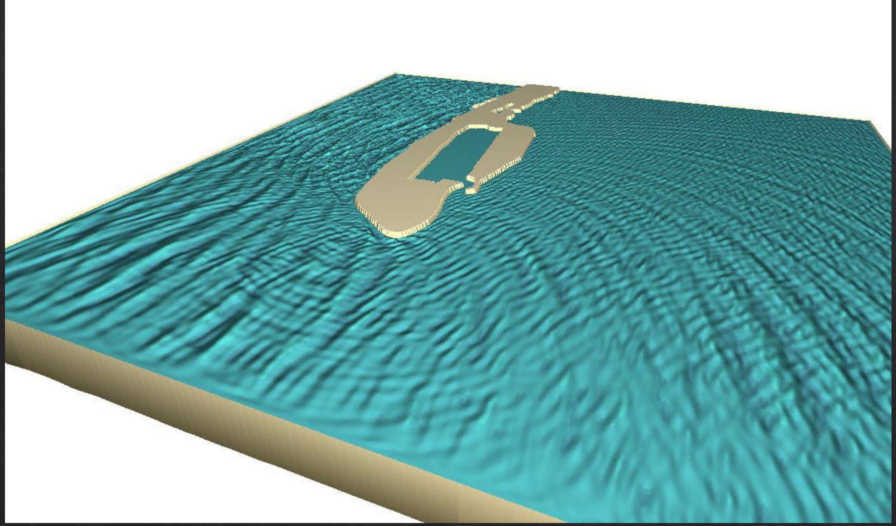
Inhabitable area in model: 374 km^2 (144 mi^2)

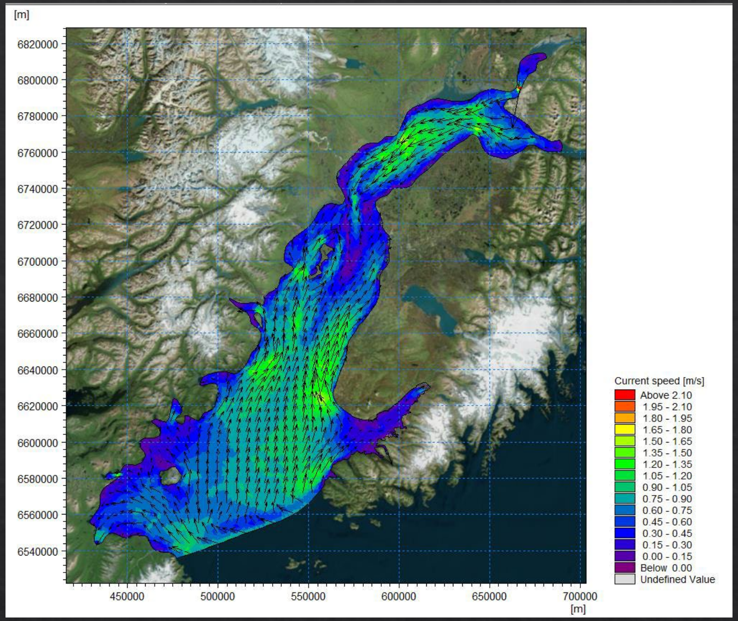
Collaboration with Dr. Ross Whippo (NCCOS, Kasitsna Bay Laboratory)

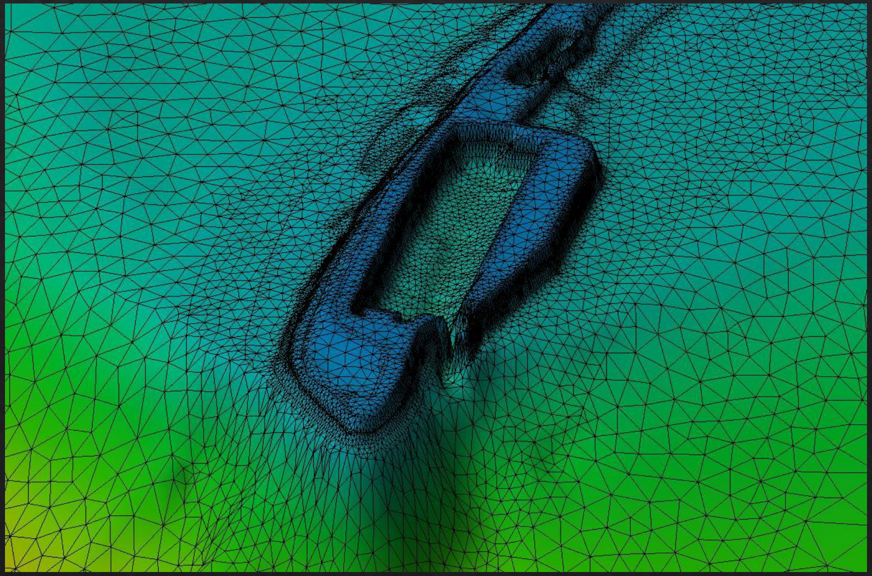


Validation data being collected

Hydrodynamic modeling (KC Kent, HDR Inc.)







All images: HDR Inc.

Next Steps

- Continue model integration
- Run model for future without project conditions (required by USACE)
- Evaluate model results
- Complete documentation

Open Discussion