Site Designs and Habitat Mapping for Increasing Organizational Capacity of an Alaskan Outdoor Education Organization

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A project submitted
in partial fulfillment of the requirements
for the degrees of
Master of Science and Master of Landscape Architecture
(Natural Resources and Environment)
at the University of Michigan

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ABSTRACT

The Center for Alaskan Coastal Studies is a 501-c-3 nonprofit organization based in Homer, Alaska, with three educational facilities that encompass temperate coastal forest, marine coastal, and freshwater habitats. The Center aims to foster land stewardship, community, and scientific knowledge of marine ecosystems. Their programming is founded upon the provision of residential outdoor learning spaces, professional development opportunities, and teaching resources based on experiential-based education. They serve the local community as well as a large number of statewide visitors. Their main facility, the Peterson Bay Field Station, is the only residential outdoor education site in Alaska which services a diversity of visitors, from high school groups to families.

The Center has a need for expanded educational spaces and resources to facilitate a burgeoning number of visitors, grown from 1,000 visitors at the start of the program up to 12,000 annually. In collaboration with a secondary client, Corvus Design, our team created site designs and habitat maps for the Center's three properties: the Peterson Field Bay Station, the Wynn Nature Center (a 140-acre boreal forest wildlife preserve), and their offices within Homer. Our deliverables will help to guide the organization's growth over the next 20 years, and serve as a fundraising tool for the improvement of their facilities.

The main goals for our site designs were to create a unifying aesthetic that elucidates the values of the Center (especially as they relate to Alaskan marine culture), and to create designs that are practical and cognizant of the wide age ranges that employ these spaces. Our inspiration and information arose from exploring the properties, conducting informal interviews with the staff, volunteers, and users, and participating in the guided tours and lessons.

We also collected vegetation data to identify the natural communities existing on the three properties. With this data we created habitat maps. Our methodology followed the protocols set by the U.S. National Vegetation Classification and by an Alaskan graduate student conducting similar activities at the Wynn Nature Center. The habitat map will be used as a resource for the organization's curriculum as well as provide information for visitors.

ACKNOWLEDGEMENTS

We would like to take the opportunity to thank everyone that made this endeavor possible: our advisors, Bob Grese and Karen Marzonie, who made themselves available at all stages of the project; Neil and Kyra Wagner, for opening up their beautiful home to us for the length of our visit to Homer; Peter Briggs of Corvus Design, for assisting in our site visits and offering much appreciated design recommendations after our return to Michigan; our client, the Center for Alaskan Coastal Studies and Elizabeth Trowbridge, for trusting us with such a wonderful opportunity to test our skills and knowledge, and for showing us the beauty of the Kachemak Bay.

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THE CENTER FOR ALASKAN COASTAL STUDIES (hereafter referred to as the Center) is a 501-c-3 nonprofit organization originally known as the China Poot Bay Society. Started in 1981 to promote responsibility and understanding of Kachemak Bay in Alaska, the Center is now headquartered in Homer, AK, a small town in the south-central part of the state. The organization boasts 350 members, 100 volunteers, and a dedicated staff of naturalists and educators.

HISTORY

Though now a very well-established operation, our client had humble beginnings in the early eighties. In their first year, they purchased an unfinished cabin from Dr. James Wong located across the Kachemak Bay on a pristine piece of forest. The site is very rustic, and can be reached only by boat from the Homer Boat Harbor. The year after its purchase, the Center completed construction of the cabin. The site became known the Peterson Bay Field Station. In 1983, students and teachers from the Paul Banks Elementary School visited the facility to partake in the Center's overnight educational programming. Soon after they began to offer day tours of the trails and tide pools to an increasing number of visitors. Initial funding for these early projects came from the Rasmuson Foundation.

The Center would expand further rather quickly. In 1990, a former homestead in the north-east part of Homer was donated by the Carl E. Wynn Foundation, "in response to the commitment of CACS to care for and manage the land in accordance with the late Carl Wynn's wishes" (AK Coastal Studies 2015).

Since their establishment, the Center has continued to offer new and exciting programming to school groups and tourists alike. They offer place-based ecology education programming for their visitors, especially students from the local community and greater Alaska. "Place-based education" refers to programs that allow students to attain standard subject material (science, language, math, etc.) through experiential learning. Children are exposed to local cultures and landscapes and learn in a more participatory manner than in a typical classroom environment. This method of teaching can instill in young people a stronger connection to their local environment and community, and demonstrate that they can have positive effects on their piece of the world.

To achieve this, the Center's teaching methods are numerous, and are by no means limited to the boundaries of their facilities. The list of programs includes natural History Tours, a variety of education programs including Alaska Coastal Ecology, Alaska Coastal Ecology Outreach, Onboard Oceanography, Beluga Wetlands Field Trips, CoastWalk, Junior Naturalist Camp, Marine Mammal Camp, Eco-Teen Camp, high school internships, Wynn Programs (including Trackers, Budding Botanists, Bio-Kids, and Preschool), SPIT Kids, fall school programs, teacher trainings and many more special events (Peterson Bay Staff Manual). During our visit, the Center organized a marine debris art exhibit at a gallery downtown. Their Kachemak Bay CoastWalk is in its twenty-ninth year, and has done tremendous work in tracking changes to the local shorelines due to anthropogenic impacts. The Center hopes to continue this great work in the years still to come.

PROJECT OVERVIEW

BACKGROUND

Our client sought the help of masters students to help them during a period of tremendous growth. The Center seeks to accommodate a burgeoning number of visitors over the next 10 to 20 years. Since 1982, they have grown from serving 1,000 people a year to over 12,000. This is a significant achievement in a state with a very low population density. This is especially true for their main facility, the Field Station, which is the only residential outdoor education site in Alaska. As part of their developmental goals, the Center requires fundraising tools. So far, they have received a conceptual site master plan for the Field Station in thanks to pro bono planning and design services from Corvus Design Landscape Architecture and Planning and ECI/Hyer Architecture. The deliverables the Center has requested from our team will also be used as a fundraising tool to meet their developmental goals and increase organizational capacity.

For the Master's Project, the Center proposed three different needs that correspond strongly with three of the different tracks at SNRE: 'Ecological', 'Planning and Landscape Architecture', and 'Curriculum'. This was an effective method of matching the Center's goals while still providing the team with incredible flexibility for fulfilling their needs in professional development and skill acquisition. Part of their original proposal was thus written:

"Ecological – inventory and analysis of the ecological systems (terrestrial and aquatic) that surround our facility. The intent of this would range from identifying additional curriculum opportunities, to understanding our facility's "student carrying capacity" to ensure that we don't damage the ecologies that we study.

Planning and Landscape Architecture – we have a conceptual master plan that we are leveraging for funding and to guide our growth. This plan could be developed further based on more assessment, and there are components within it that could be developed further.

Curriculum – while we have established programs and curriculum, we are excited at the prospect that we might not only offer more learning and experience opportunities, but effectively tie them directly to the resources that are around us."

Of the three proposed needs, our team chose to concentrate on 'Ecological' and 'Planning and Landscape Architecture,' as they align more closely with the fields of study represented on our graduate student team. Our team has knowledge and experience accounting for environmental education and outreach within our respective specialties, but we concluded that it was outside the scope of our project to follow the 'Curriculum' route due to limitations in time, expertise, and manpower.

Under the 'Planning and Landscape Architecture', the team and the client decided that the appropriate deliverables would be site designs for all three properties. This includes master plans and conceptual detail designs. Under the 'Ecological' route, the final assessment was to focus on inventory and analysis mapping of the vegetation at the three sites. The team produced partial plant lists of all three sites and habitat maps for Wynn and the Field Station.

Though our Master's Project does not include curriculum development, our end products complement the Center's twin goals of science-based education and land stewardship. By endeavoring to provide them with habitat maps, vegetation inventories, and improved site designs, we are implicitly creating opportunities for the growth of their curriculum.

PROJECT DESCRIPTION

At the beginning of the project, we established a set of goals with our client:

1. Creation of habitat maps and vegetation inventories for the properties
2. Creation of a unifying aesthetic for the three sites that encompasses outdoor education and the land stewardship values of the Center
3. Purposefully delineate ecological components and processes for use as learning spaces
4. Guide site design for the three properties

Within our system are interactions between landscape planning and design with a focus on nature, environmental education, and interpretive practices. These are informed by knowledge based on rigorous scientific study of the marine, coastal, and boreal/temperate forests. In addition to the habitat map and vegetation inventories, the site design relied on data collected from user groups of the three properties as well as an assessment of the landscapes and existing infrastructures.

Our data collection proceeded in several phases, beginning early in the project prior to our departure for Homer. Our preliminary research consisted of reviewing information regarding the character of our client organization and their three properties. We researched case studies of outdoor education programs, field stations, and biological stations that have implemented projects parallel to our own to inform our methodology for our site designs. To finalize the procedure for vegetation sampling, we consulted a variety sources, but chose three (one of which was provided by our client). The team also conferred on methods for interviewing and working with user groups; options included one-on-one interviews, small group discussion, brainstorming sessions with students, and surveys. The latter methodologies are explained in full in their respective sections.

Our field visits occurred between the dates of July 8-18, 2014. The trip began with numerous site tours and general program observation. The team was often broken up to experience as much as possible, with some members joining guided tours and children's programs while others informally interviewed staff and user groups. The bulk of the trip, starting on the second day, was devoted to the vegetation sampling

(methods described on PAGE 31). Because we were working with a very limited time block, we split into groups of two each day. This allowed us to sample plots simultaneously.

The site visits were not limited to the client's three properties. The Center is deeply connected with the local community, a fact that became clear to us early in the trip. Our off-site visits included joining the day campers for their weekly outing to the Homer Spit–a long, narrow peninsula that juts into the Kachemak Bay. In addition to beaches, this is also a major tourist destination and the location of the Homer Boat Harbor. More field trips took us to local museums, art galleries, and the stunning local library. These side trips proved to be incredibly valuable in providing our team with context for design development, and were enhanced by the knowledge of Peter Briggs from Corvus Designs. We were surprised and delighted by the overwhelming presence of local craftsman and community pride. Additionally, we learned a great deal about the local landscape aesthetic preferences. Formalized garden settings did certainly exist, but the overwhelming preference was for landscapes that fade easily into the surrounding natural vegetation. These experiences and observations served us well during design development.

After our return to the lower 48, the team did not assemble again until September. At this time we synthesized our data and looked for gaps. Our trip supplied us with ample information, but also introduced us to new topics and issues we had not expected. In order to complete our site analysis, we conducted more research on topics we considered relevant for the design development: marine debris art and local artists, case-studies of outdoor learning facilities, natural playscapes, and ethnobotany. We compiled information in an organized manner for the future use of all designers on the team. At this point, each of the three landscape architect members selected a property for generating a site analysis and, later, a master plan. Chang headed the Peterson Bay Field Station, Lumin the headquarters, and Jenny the Wynn Nature Center. Designers met weekly to share their work and offer critique. We met with the client via Skype for major design reviews, and sent them working documents for redlining. Simultaneously, Daniella compiled information from the vegetation inventory to begin creating habitat maps.

The final phase of the project was devoted to detailed design. For this effort, the designers changed tactics. In order to ensure that we would have unifying elements from site to site, each designer took a particular type of space to design at each of the client's properties. Lumin designed playscapes, Chang designed gardens, and Jenny took on gathering spaces. The designers continued to meet weekly, in addition to checking in with the client for major reviews. Final productions included site plans, planting plans, and detailed descriptions of major new elements.

With this report we outline the proposal set forth by the Center and the development of the team's project. So far, we have briefly illuminated the background of our client and the nature of this project. In the following pages, we include the information we gathered through the field session and later research that helped us contextualize the problem and goals of the project as well as inform and inspire the site designs. This is followed by detailed and comprehensive explanations of the different stages in the process of conceiving the site designs and the habitat maps, from the vegetation sampling field methods to identifying the plant communities. All of the team's deliverables are included with this report.

II. SITE CONTEXT

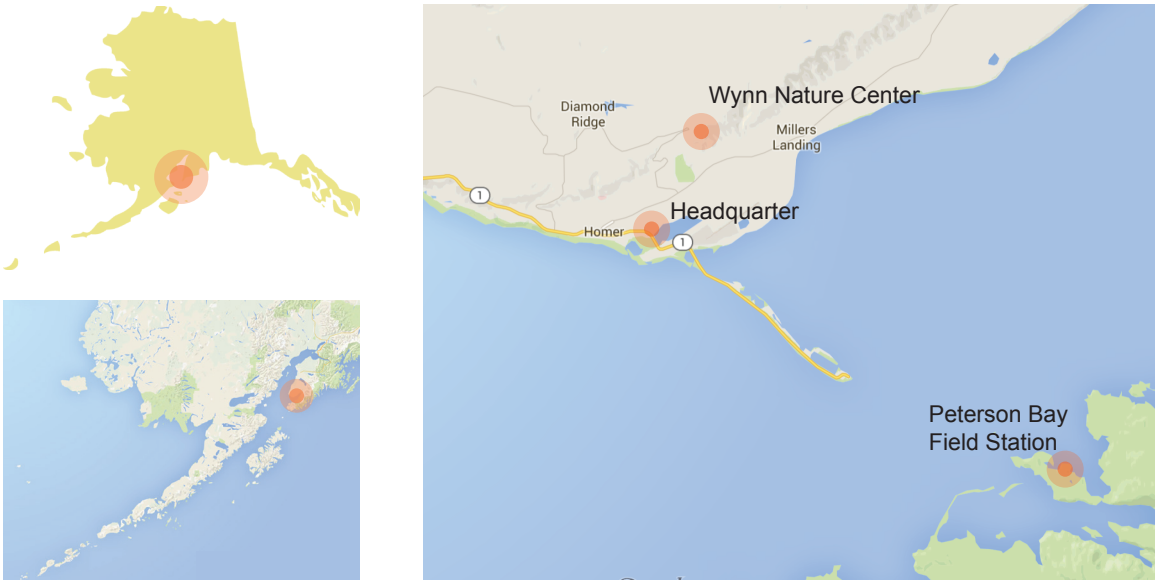


Figure 1. Site Locations in Homer Alaska

KACHEMAK BAY

Our client's three properties are located on the Kachemak Bay, designated as a Critical Habitat Area. Kachemak Bay is an estuary, and is "one of the richest, most diverse marine and intertidal areas in Alaska" (ACE). It has the highest use in the state due to recreational opportunities and fishing industries (Field and Walker 2003). Tides move in and out of the bay twice daily, with predictable water levels that vary depending on the date.

The variable habitat of the bay is influenced by the diverse geology of the region. The bay contains three main varieties of coastline: steep, rocky beaches, eroding shorelines with tidal flats, and pocket beaches of mixed rock, cobble, and mud (ACE). The north and south side of the bay also vary geologically. The north side is primarily composed of rocks that are "sedimentary and terrestrial in origin." The south side "largely sedimentary or metamorphic, with a minor igneous component, and are marine in origin" (ACE). Another line of contrast exists in the region's forests. The bay contains both coastal forest and boreal forest (both of which occur on the Center's properties). These two forest types exist as a result of the area's variable climate and topography. The south side of the bay exhibits forests typical of north

temperate coastal rainforests. The north side is dominated by boreal forest ecosystems. The terrestrial and marine environments are vast and varied. Written in this report is only a brief summary of it.

Complementing this rich natural history is a human history that goes back nearly 10,000 years. Drawn by the moderate climate and abundance of resources offered by the sea and the tides, a number of native Alaskan cultures have thrived on the bay. Evidence of two cultures is well-documented at sites along the edge of the bay: Alutiiq-Sugpiak and the more interior Dena'ina Athabaskan cultures. More recent history has of course included miners, homesteaders, and trappers transplanted from the lower 48, Russia and beyond. Economic interests in the region drove the establishment of Homer.

HOMER

The city of Homer is a small coastal town of 5,000, nestled on the edge of the Kachemak Bay. The city was established in the late 1800s following the discovery of a coal mine. Similar to many Alaskan settlements, Homer rapidly transitioned from one industry to another over the decades. After coal came gold, then fox farming, fishing, and homesteading ("Homer's History"). Today, the predominant industries are tourism, fishing, and logging.

The climate here is mild in comparison to Alaska as a whole. Due to the direct presence of the Pacific Ocean, Homer experiences warmer winters and cooler summers than the interior of the state. The average annual snowfall is 54.9 (City of Homer). The Alaska Range to the west of Cook Inlet also plays a part in this, as it protects Homer from the arctic cold fronts (Field and Walker 2003). The winters have become increasingly warmer as a result of climate change. During our visit, many of the local wildflowers were blooming as much as a month early. Fireweed, usually the final grand display of summer in the month of August, was in full bloom by mid-July.

Upon arrival in Homer, we immediately saw a glacier from the small airport terminal. We soon learned that it was the Grewingk Glacier, central to the Homer's identity and rapidly retreating due to climate change (Armstrong 2009). It is one of nine alpine glaciers on the

1500 square mile Harding Ice Field. Glaciation is an important of the natural history of Homer. Grewingk Glacier is a most popular hiking spot, but is also responsible for the geographical composition of the area. The retreats and advances have formed mountain peaks and fjords. The Homer Spit is the submarine-end moraine of a former glacier (Field and Walker 2003).

Found in the Field Station are "ghost forests" which are labeled on previous maps of the site. These ghost forests are found in Halibut Cove, in China Poot Bay, and outwash plains of Grewingk Glacier. The subsidence caused by past earthquakes caused salt water to infiltrate forests leaving behind dead trees. This is distinct from tree death caused by the Spruce bark beetle (*Dendroctonus rufipennis*). Beetle infestations have occurred since the mid-1880s, but an outbreak in the 80s and 90s resulted in the death of over 2.3 million acres of spruce on the Kenai Peninsula, making it a serious ecological disturbance (Field and Walker 2003). The forests at the Field Station appear to have been affected by this, too.

The local community hosts a large number of talented local artists and crafters. Our tours of downtown took us to numerous local galleries. Businesses of all kinds displayed pieces inside and out. The community also enjoys two very fine museums: The Pratt Museum and the Alaska Islands and Oceans Visitors Center. These sights and experiences played heavily into our design development.

III. SITE ANALYSIS

HEADQUARTERS

The Headquarters building is stationed in downtown Homer. It is open year-round and offers exhibitions and rental equipment to visitors, houses administrative offices, and hosts the first and last hour of the summer day camp during weekdays. The Center would like a redesign of the outdoor space, one with educational value that is consistent with the organization's mission. Additionally, the new space should have strong visual linkages to the natural characteristics of their other two properties. Habitat mapping and site inventory was necessary for the redesign, and will be a valuable resource to the client as they continue to develop and restructure over the next 20 years.

Figure 2. Headquarter Site Inventory

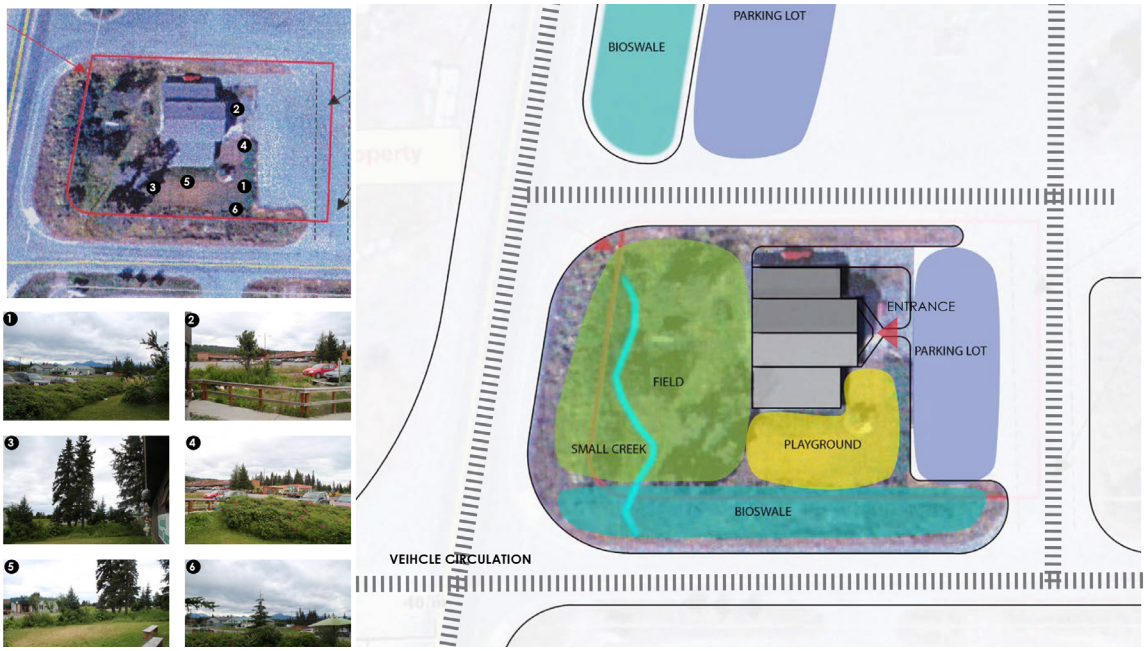


Figure 3. Headquarter Site Analysis

WYNN NATURE CENTER

The Wynn Nature Center is a 140-acre boreal forest wildlife preserve overlooking Homer. This location was formerly a homestead, and was donated to the center in 1990 by the Carl E. Wynn Foundation. The site is open for a variety of activities year-round, including educational programs and guided hikes. Amenities include a paved parking lot, interpretive log cabin with a large deck, covered pavilion, 800 feet of boardwalk (including a trail for the visually impaired), 5+ miles of trail, two viewing platforms, and a staff yurt. The Nature Center is notable for possessing both an abundance of wildlife and wildflowers. This site has a documented habitat inventory, which proved a valuable guide to the masters project team. The client would like to see new development for outdoor play and education, with a strong conceptual plan that can be taken to construction development by summer 2015.

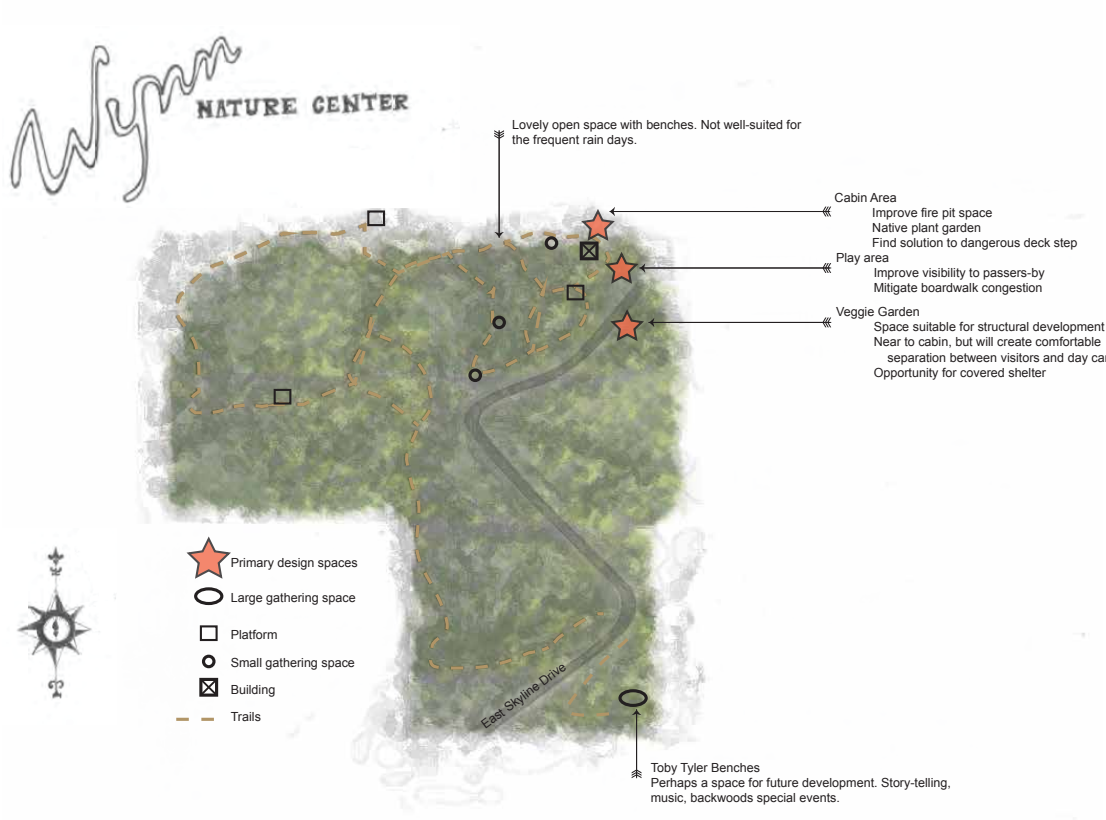


Figure 4. Wynn Site Analysis

PETERSON FIELD STATION

The Peterson Bay Field Station is located on the south shore of Kachemak Bay, and is accessible only by boat from Homer. Visitors are exposed to the habitats and life forms of extreme tides. This site, opened from April 15th until early October, includes a rustic, two-story main building that serves as a classroom, mess hall, and resting space, a wrap-around deck, composting toilet restrooms, and five 16' circular yurts used used for overnight lodging for classes and visitors. The building, yurts, and other smaller storage and compost restrooms rest on the four acre area owned by the Center. The rest of the Field Station, including the trail system, is utilized by the Field Station for programming with permission from another organization. Their interaction with owners from neighboring properties is also higher than at Wynn. Their current map shows a trail crossing through private property that is to be used only in an emergency, and neighbors who gain access to their personal yurt by crossing through the outskirts of the Field Station. Recently, the Center received a pro bono conceptual master plan for the Field Station from Corvus Design, a landscape architecture and planning studio based out of Anchorage. This rough plan has been used to procure funding for the project—a process that is still ongoing. The client desires that this plan be taken into more detailed development as the push for funding continues.

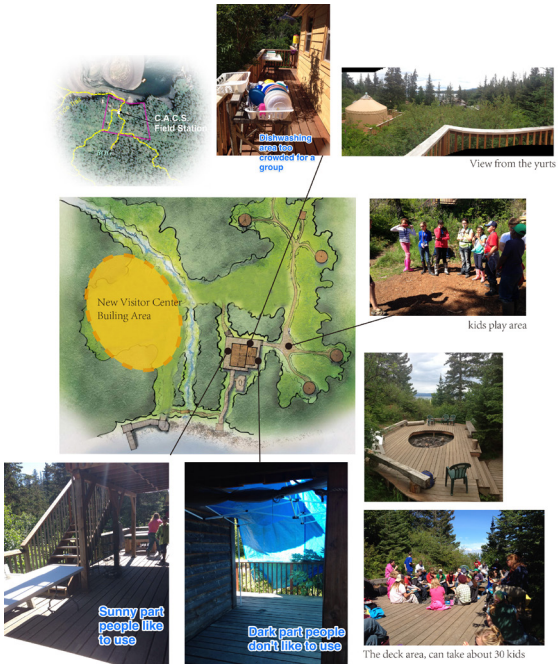


Figure 5. Peterson Field Station Site Analysis

DESIGN DEVELOPMENT

The goals of the site designs are to:

1. Create a unifying aesthetic for the three sites
2. Reorganize the spaces to fully satisfy the needs of a growing number of staff and visitors
3. Facilitate the multiple uses of the sites, and enhance the outdoor education components.

In the case of the Field Station, the site design builds on a pre-existing master plan. It adds details based on the team's site analysis and goals for the project.

DESIGN CHALLENGES

Each of the sites offered its own set of design challenges, though some applied across the board.

Headquarters was in some ways, perhaps, the most unique. As an urban site, it differed significantly from the other two locations, and yet needed to reflect the character of both the boreal forest and the tide pools of the bay. In addition to creating these aesthetic linkages to the other properties, the site suffers from several programmatic issues. Visibility from the road is low. Native vegetation on site, though beautiful and abundant, blocks signage and much of the building face. And, despite the frequent presence of daycamp and administrative staff, the landscape is sorely lacking in playscapes, gathering spaces, and areas for general relaxation. Spaces suitable for formalized planting (and marine debris art) are left mostly unused, though the Center has identified two suitable places on site for rain gardens.
The Wynn Nature Center suffers from some of the aforementioned issues, but in a slightly different manner. Like Headquarters, Wynn needs some visual references that unite it with the Center as a whole. The client would like some way of conceptually bringing the ocean to the forest. At the core of the Center's image is the marine coastal ecosystems, but it is difficult to bring out this aspect in Wynn because the site is distant from the Kachemak Bay. However, the main challenge of this site is overcrowding. Even though the property is quite expansive, activity is primarily limited to a small space around the administrative cabin, with some traffic going to scattered trail benches and a natural playscape between the cabin and the parking lot along the boardwalk. Some of this is due to the fact that development on this site has been limited in order to protect habitat, but much of it is also due to the

programming of the current developed space. The intermingling of day camp and tourist activities at the main cabin leads to confusion for visitors coming for guided hikes. From speaking with staff, we discovered a need for more covered activity spaces suitable for the frequent rain days. We also observed complications with gathering for educational activities. Oftentimes the full group of day campers would be asked to sit on the deck or the boardwalks, inhibiting the movement of other site users. Additional issues pertained to low visibility of the play area, and a lack of diverse play elements.

Peterson Bay Field Station is the one property where the natural ecosystems of the Center's landscapes already collide. Even so, the property in many ways still requires connection to the other locations (aesthetic linkages, as mentioned previously). This site is also the most crowd-stressed. Groups as large as 50 students cross the bay for overnight trips, putting a great deal of strain on the limited existing infrastructure. Design challenges previously identified by Corvus Design included a need for new building infrastructure, a welcome space for incoming visitors, new spaces for seating large and small group education sessions, and places for rest and play. The purpose of the new building infrastructure is to address the crowding and create separate spaces for visitors and staff. Because this site recently had significant renovations, changes here will be less immediate. The renovations include a larger, modern kitchen and a metal dock and ramp where we were present for the celebratory party. With these renovations in mind, we were asked to keep our planning for this site highly conceptual.

IV. FINAL DESIGN SUGGESTIONS

HEADQUARTERS

The Headquarter's master plan consists of a gathering and learning space, a playscape, two rain gardens, an open lawn, a deck along the creek and a working space around the shed. The populations of fireweed (*Chamerian angustafolium*), planting beds, and the bioswale would be retained (Figure 6).

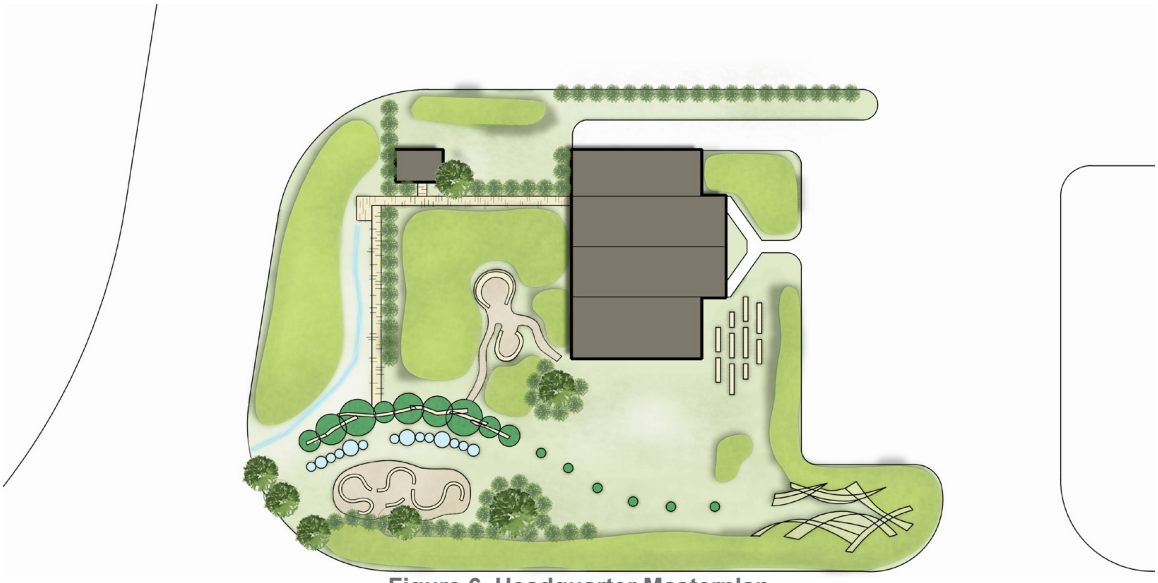


Figure 6. Headquarter Masterplan

Gathering Areas: High Tide-Low Tide

The gathering and learning space is a multi-functional and adaptable space that may be used for education, play, and rest. The design concept is to bring symbolic elements of the coastal habitat to the inland sites. This design calls for the addition of two seating areas: an in-ground seat wall and a "Sea Star" bench. The forms for this space were inspired by the life of the tide pools and educational games played by the day campers. The two seating elements conceptually represent high-tide and low-tide. While seated on the in-ground wall, a user will be well below the height of the vegetation–safe and enclosed. On the Sea Star bench, the user will be able to see over the vegetation–high and exposed. The Sea Star bench, inspired by its namesake, can be used to gather small groups, eat lunch, or to balance on. This design is simple enough that it can be adapted for use at all three sites. The ultimate

construction of these should be open to some interpretation, allowing local crafters to give each bench a slightly unique appearance.

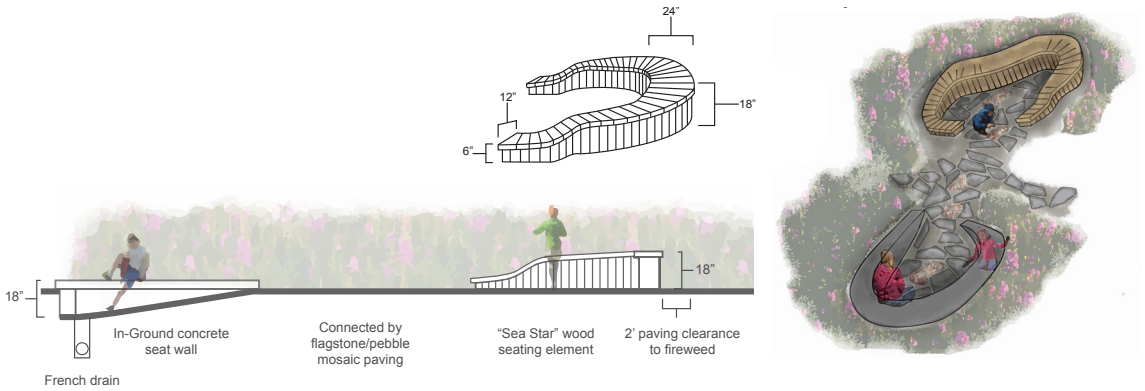


Figure 7. Sea Star Bench

The suggested paving for this space is flagstone intermingled with embedded marine debris/ pebble mosaics. The mosaics may be made to look like the life of the tide pools. We see this project as an opportunity to engage the community and the day campers. Children would be able to help with composing the mosaics, and the project fits in nicely with the day camp's daily art block.

Figure 8. Materiality

Playing

Headquarters is the morning and afternoon gathering spot for the Center's day camp program. The children are dropped off and picked up here before Center staff and volunteers escort them to the activity's location, usually Wynn or the beach at the Spit. A safe, natural

playscape design would be of great benefit. The playscape is designed for children between 5 to 14 years old. Play structures should be constructed of natural materials and the space should give children an experience of forest. Art and marine debris should also incorporated to reflect the artistic atmosphere of Homer. Suggested items for the playscape follow.

"Forest" Activities

The forest activities consist of water ponds, balancing trunks, and climbing walls. The ponds serve two purposes: they give children the opportunity to play with water and mitigate rain water on the site. By creating a space for water to temporarily collect on site, we are also creating a link to the Field Station and its tide pools. Another dual purpose element suggested are cut trunks. These are designed for balancing activities, and may be also used for seating and resting. Finally, we also encourage the construction of a small climbing wall, inspired by tides and waves and decorated with marine debris mosaics (described in detail below). These play structures could be adapted for use at all three sites.

Figure 9. Pond

Figure 10. Balancing Trunks

Figure 11. Climbing Wall

Marine Debris Art Mosaic

The Center has a volunteer program to clean the beach and has collaborated with local artists to hold marine debris art exhibits. This program aims to remind the public that there is a huge amount of in the ocean and on beaches which can be destructive force to ocean ecosystems and wildlife. During our visit to Homer, we were shown a marine debris art in a local gallery put on by the Center. We decided to incorporate debris art into our design to reflect this aspect of the Center's mission, and to encourage sustainable construction. In the case of the climbing wall, marine debris is sorted by color and used to create a mosaic. The debris mosaic would be embedded onto the artistic walls for aesthetic value.

Figure 12. Marine Debris Art

Planting

The planting designs for the three properties seek to merge local aesthetics, ecology, and cultural history. Plant lists were developed using the vegetation inventories and two helpful books: *Wildflowers and Other Plant Life of the Kodiak Archipelago* and *Discovering Wild Plants: Alaska, Western Canada, and the Northwest*. In addition to being a part of the local ecosystems, the selected plants have a cultural value as traditional foods and medicine used by the native Alaskan cultures. We suggest incorporating signage to describe these ecological and human benefits to visitors and students.

Though the designs take into account the lovely colors and forms of the native plants, the ultimate goal of these plantings is to have them blend in to the natural ecosystems. For the first several years after installation, these gardens will appear somewhat artificial, but in time

they will become increasingly similar to the natural, wild landscapes that surround them.To encourage visitor interaction, the rain gardens include rough-cut wood boards as a pathway to serve as viewing platforms and balancing challenges.

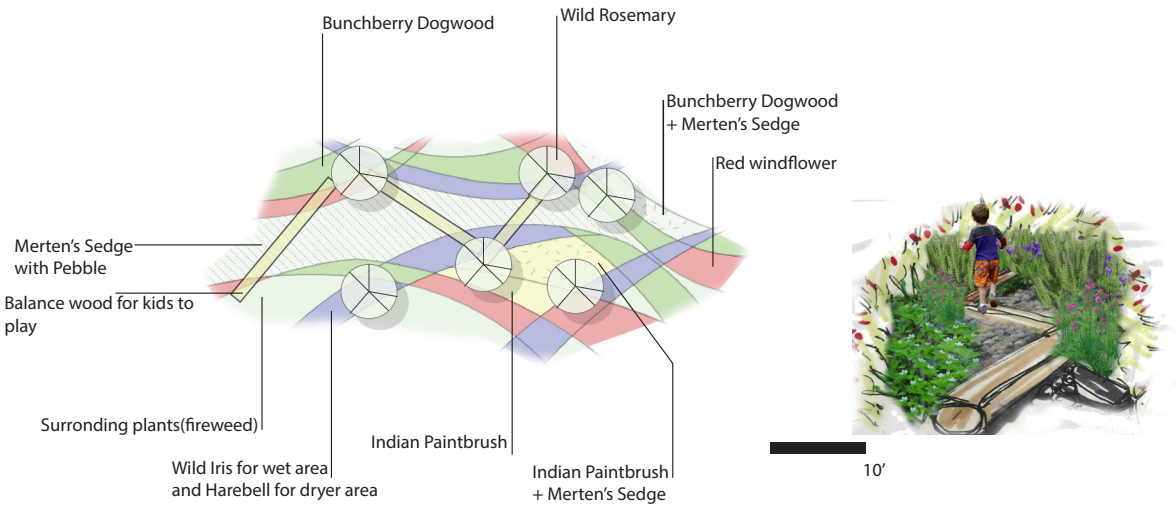


Figure 13. Rain Garden

WYNN

Notable elements suggested for the Wynn Nature Center include renovations to the deck space, a new fire pit, ethnobotanical gardens, an improved natural playscape, and a new pavilion space for gathering during rainy days.

The Cabin

From the first day of our visit, it was apparent that the space around the cabin required some changes. This design makes several suggestions that will alleviate crowding and create new opportunities for education programs. The design calls for a completely reimagined fire pit space. The current one is overgrown by midsummer, and lacks a direct connection from the cabin deck. The Sea Star bench discussed for the headquarters design is repeated here in an adapted form, with two bench elements entwined around a raised, stone firepit. A new staircase is added to the back of the deck leading directly to this space, which is suggested to

have packed dirt for surfacing. The site design also calls for improvements to the deck as a whole; we suggest increasing the height of the deck to one level plane, removing the existing "hazard step."

On the opposite side of the cabin, we suggest installing a new ethnobotanical garden. This space will serve as an educational opportunity for visitors and campers, and be a place for rest or play. The design of this garden reflects the Center's preference of blending with their natural surroundings. Such a garden space will also create visual linkages among all three properties. As with Headquarters, we want to encourage users to interact closely with these gardens. Again, we suggest the use of descriptive signs. The design also calls for the inclusion of natural seating elements bordering the planting beds, either in the form of wood benches or large stones.

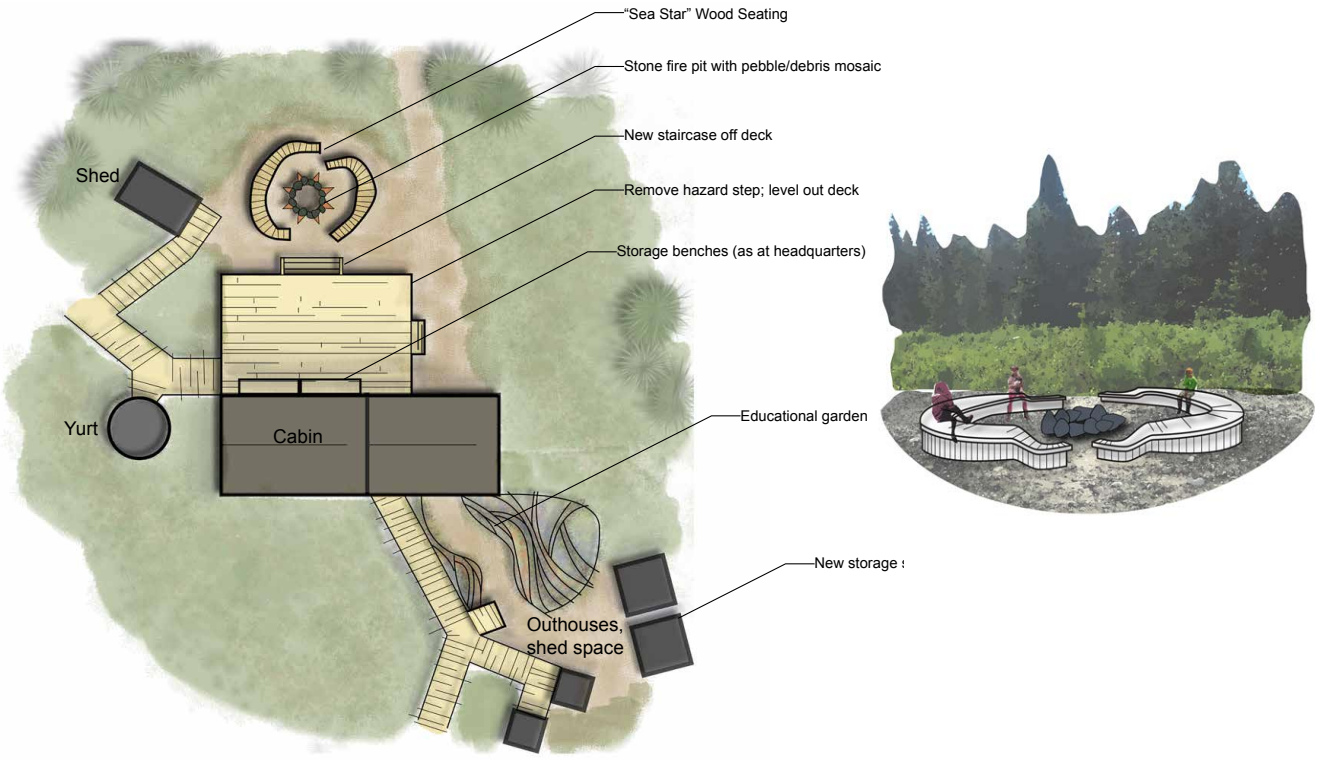


Figure 14. The Cabin

The Playscape

Wynn's established play area has room for a greater diversity of play elements. The design suggestions include a new structure of balancing elements (that may also be used for seating away from the boardwalk), as well as a tunnel structure made from branches. This site may also incorporate play elements suggested for Headquarters, in adapted forms.

Figure 15. The Playscape

The Veggie Garden

One new piece of building infrastructure is suggested for the Wynn property, and that is a covered pavilion by the existing vegetable garden. Constructing a covered learning space here keeps children in contact with a space regularly used for education while alleviating crowding at the main cabin. Immediately adjacent to the new pavilion is a cob oven. The oven opens up new opportunities for learning in the vegetable garden. It may also be used for special events that take place at the Wynn. This structure is yet another that could be completed with an invitation to the local community.

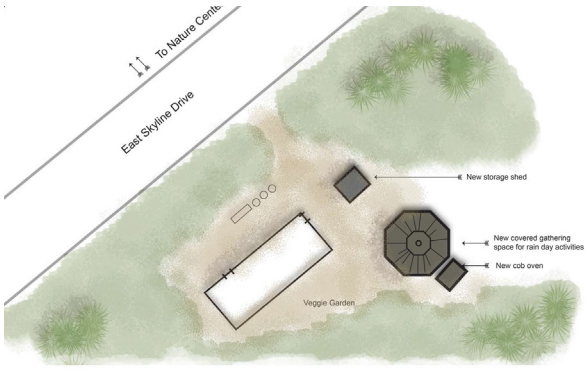


Figure 16. The Veggie Garden

FIELD STATION

We have one concept plan for the Field Station and a brief renovation suggestion for the existing site. Beyond the master plan, we have supplied a toolbox of suggestions rather than site-specific designs. These toolbox suggestions align with elements already proposed for Headquarters and Wynn.

Future Concept Plan

In our concept design for the Field Station, the space is divided in two. One space is dedicated for visitors and the other for staff and volunteers. For the visitor area, we suggest areas for education and gathering, an ethnobotanical garden, and a natural playscape. This design preserves ecologically-sensitive areas identified during our field visit. We want to minimize habitat disturbance as much as possible. Currently, space is a limiting constraint for managing large groups on the site. With the new design, the Field Station is able to accommodate not only larger groups but also more diverse activities. Multiple family tours and kid camps can be hosted without interfering with each other.

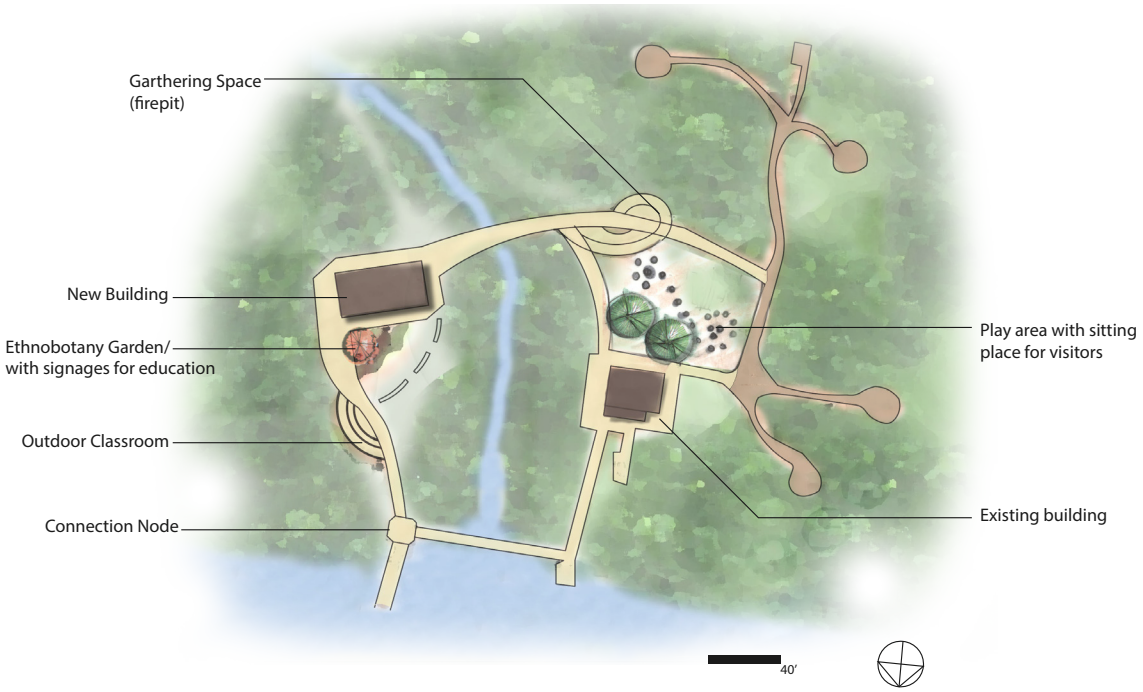


Figure 17. Future Concept Plan of Field Station

Existing Site Suggestions

Much like Wynn, forest dominates the landscape of the Field Station. From our interviews with staff and visitors, we found out people enjoy the rustic, natural feel of the site. Therefore, instead of major redesigns to the existing infrastructure, we suggest doing a renovation to the area circled in red, and to develop it into a mix of gathering and play spaces. For the sitting area, we suggest using log benches to keep the rustic style of the site, and using the balancing design feature from Headquarters. This can be a consistent element across the three sites but also serve as sitting place for visitors.

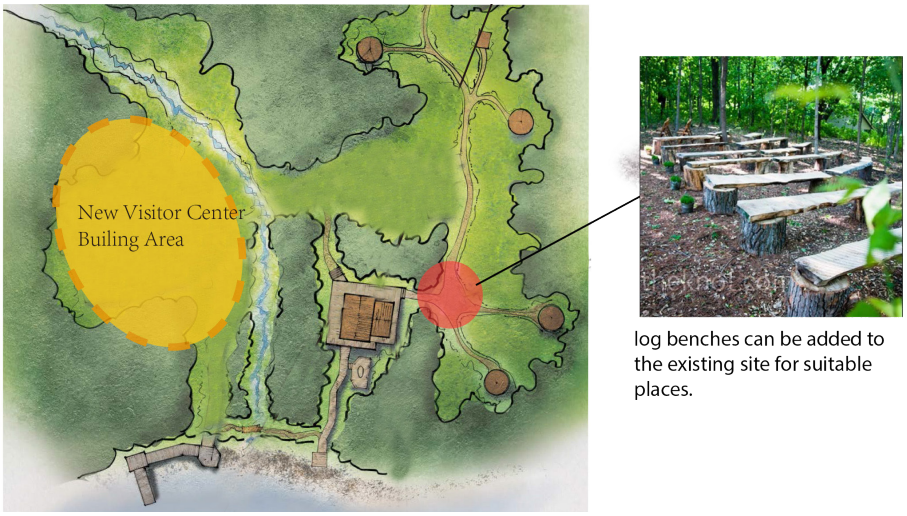


Figure 18. Existing Site Suggestions for Field Station

V. HABITAT MAPPING

PURPOSE AND MAP ELEMENTS

The deliverables for this phase of the project are two habitat maps, for Wynn and the Field Station. This is in addition to plant lists needed to identify the natural communities at the two sites (see Appendix I). The latter information is also available for Headquarters, though the habitat map was not developed for reasons outlined below. The purpose of the habitat map is threefold. First, it forms part of the site analysis collected to inform the site designs by the team. This has already been described in some detail. Second, it is to be used as a resource for future curriculum development. In the Center's original Project Proposal, site-based curriculum recommendations were requested. The plant lists can be used to fulfill these two purposes. In this case of Wynn, they can supplement to the existing plant list. Together, they compose a comprehensive inventory of the vegetation found at the site. For the Field Station, this can serve as a starting off point for continued plant inventory. The last purpose of the habitat map is to provide visitors an aid to navigating the two sites and their ecosystems. Thus the following elements are included in the maps:

1. The 'Natural Plant Communities' are labeled. Identifying the communities is the primary purpose of the habitat maps. The two sites already possess vegetative classifications; that is, they are broadly known as boreal forest habitats and temperate coastal rainforests. However, the natural communities that are identified are more specific to the region and are characterized by the local vegetation. The plant communities that are labeled subscribe to Level IV of the floristic levels of the vegetation classification hierarchy as described by Viereck et al. 1992, which will be exemplified further on in the report. Plant communities in Level V have a finer resolution than communities in Level IV, but Level IV names are more appropriate for lay audiences and map clarity.
2. The 'Trails' are included for navigation purposes and to grasp a physical sense of the location of the different habitats. They are represented as dotted, yellow lines and are labeled with the corresponding trail name. There are two exceptions, though. The private trail labeled as 'For Emergency Use Only' is colored dark red and not yellow on the Field Station; and in Wynn, the boardwalk, near the Daisy Lee Bitter Cabin, is represented by a gray, thin line.
3. Other roads or paths are labeled. This is applicable only to Wynn, however, which has the East Skyline Drive and another road to the west side of the Daisy Lee Bitter Cabin

accessed via E. Skyline Dr.

4. 'Points of Interests' are labeled. There are only two on the Field Station: the Lost and Found Lake and the Peterson Field Station. They are represented by light-colored symbols which are simplified starfish shapes--a small way to tie in the marine coastal ecosystems which are important to the Center's programming and mission. For Wynn, these points of interests are numerous – the Bog Platform, Toby Tyler Benches, etc. They are represented by brown circles, but the Daisy Lee Bitter Cabin and and Veggie Garden are represented by simplified starfish shapes.
5. For Wynn, the extent of the map is limited by to the Center's property. Private land is also obscured by shaded polygons. The extent of the Field Station was chosen to encompass the trail system. The trail system extends beyond the Center's property lines thus it was expedient to map the entirety of the land accessible by the trails and part of the Lost and Found Lake.
6. The three bays (China Poot Bay, Peterson Bay, and Kachemak Bay) are also labeled in the Field Station's map.
7. Finally, following convention, the north arrow, scale and credit for the image source are included.

As a habitat map for Headquarters does not fulfill at least two of the three stated purposes and most of the map elements described above would be superfluous, it was not created.

VEGETATION SAMPLING

The methodology chosen to sample the vegetation was a combination of a previous research study done by an Alaskan graduate student, Leanna Spjut Ballard, M.S., in June-August 2001, whose report is found at the Center, vegetation sampling methods outlined in the book titled, *Practical Field Ecology* (Wheater et. al 2011), and the official process established by the U.S. National Vegetation Classification (NVC). The dates for the week-long field session were ideal for vegetation sampling as many plants were in bloom and vegetation classification can be accomplished with only one outing.

Vegetation plots were nested square quadrats of varying sizes to target individual species by different strata based on growth form and height: 20m x 20m, 15m x 15m, and 2m x 2m.

Plots of 400m2 fall within the size range of appropriate sizes for temperate hardwood and coniferous forests, and it is a quick and effectual method for discerning vegetation composition (Jennings et al. 2009). Within these plots, plants are counted and their species identified. At the 20m quadrat, only adult trees are recorded. In the next 15m quadrat, shrubs and saplings with a diameter of less than 20cm and that are a meter off the ground (above the knee) are recorded. Herbaceous cover is recorded at the 2m quadrat. No quadrats were set up for missing vegetation layers. If there were no adult trees in the area, then we only set up 15m x 15m and 2m x 2m quadrats. If there were no shrubs or saplings, then we only set up a quadrat for the herb layer. At each plot, the team attempted to identify all plants to species or subspecies level, if possible. For the plants that were not readily identified in the field, samples were taken for later identification. To accomplish this, we mainly used Flora of Alaska and Neighboring Territories (Hulten 1968) and Plants of Pacific Northwest Coast (Pojar et al. 1994). GPS coordinates are taken at each of these plots as well.

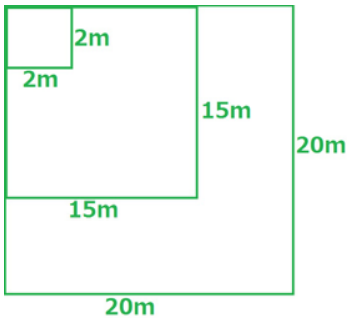


Figure 19. Vegetation Plot Size and Design

Vegetation plots were established in various locations on the three different sites. Rather than being randomly selected, the plots were purposely chosen along the trails where accurate vegetation data would be most useful to visitors passing through. This is plausible because the diagnostic species used to define the natural community are few, though there may be a diversity of plants. In other words, species like the Lutz Spruce adult trees which visibly tended to dominate throughout the area, both on-the-ground and through satellite images, could be extrapolated to the whole area from one plot. An explanation on identifying natural communities follows in the next section. The plots had to be located in relatively homogeneous areas to prevent misidentification of the plant communities. For example, plots

could not be located covering half a meadow and half a forest. The distribution patterns of bryophytes and herbs, however, occur at a smaller scale. Their pattern can vary widely across a single transect. A greater number of plots set up randomly across the site would be needed to approach the true characterization of the herb layer. Despite this, the vegetation classification methodology is sufficient for development of the habitat map. According to the U.S. NVC's protocol, plant community classification should be conducted at an intermediate scale and not at a lower level or at a landscape level.

At Wynn, the team set up plots corresponding to seven transects established by the aforementioned research study. We chose approximate locations according to a map from the research study (Appendix IV). At Headquarters, the vegetation area is not very large. It is only herbaceous cover with a few adult specimens, so we set up two plots with a couple of meters separating the two as space allowed. At the Field Station, there were no previous studies that established transects or permanent plots. We set the plots near trails, in fairly homogeneous spaces with seemingly different habitats, and fairly distributed across the entire area. There were five plots (Appendix III).

IDENTIFYING HABITAT

To help describe the plant communities, we used the Alaska Vegetation Classification by Viereck et al. 1992. There are five levels in this classification system from broad to specific. Levels I, II, and III are broad vegetation types (e.g. I.Forest, II. Needleleaf forest, and III. Closed needleaf forest). Level IV and Level V are more specific and are the desired level for a habitat map. 'Sitka spruce' is an example of a Level IV plant community. An example of a Level V vegetation type is Picea sitchensis/Oplopanax horridus-Rubus spectabilis/Cornus canadensis. The slashes in the plant community name separate the three plants that dominate their respective strata. Picea sitchensis is the dominant plant in the tree stratum. In the tall shrub and sapling layer, there are two dominant species, Oplopanax horridus and Rubus spectabilis, which are separated by a hyphen. The plant name behind the third slash is the dominant species in the herb layer.

To develop a habitat map, the habitats identified are, as defined by the U.S. NVC, "a vegetation classification unit defined on the basis of a characteristic range of species composition,

diagnostic species occurrence, habitat conditions, and physiognomy" (Jennings et al. 2009). This definition is given to an association, the lowest level in the U.S. NVC vegetation classification system which is equivalent to Level V of the Alaska Vegetation Classification system. As mentioned previously, in this system, vegetation types have only one name instead of a scientific name and an English name. Thus, we used the Level IV naming convention for the map even though our target level for vegetation type is Level V. Vierek et al. based the Alaska Vegetation Classification system on species composition only. Vierek et al. and the U.S. NVC exclude barren or agricultural land. Vierek et al. has a 2% vegetation cover threshold. On this basis, we excluded a ghost forest located on the area surrounding the Field Station.

At Wynn, the plant communities had previously been described by Ballard's research study. Therefore, the methodology treated the plots as occurrence plots instead of classification plots. The difference between the two plots is the required and optimal attributes collected during sampling to describe a vegetation type. Occurrence plots are used for locations for where the vegetation type has previously been described. This reasoning was carried over to the Field Station and Headquarters since it can be assumed that there is not a great diversity of natural communities.

NATURAL PLANT COMMUNITIES

At the seven different plots in Wynn, we described seven different habitats (Table 1). There were some challenges in identifying the correct community. This could be attributed to insufficient vegetation data, and to using the Alaska Vegetation Classification report which was published over two decades ago. For two of the plots, the Level IV is Subarctic Lowland Herb Wet Meadow, but the Level V classification is different because of the difference in presence of the diagnostic species. However, the Level V communities are not mentioned in the report. A similar situation occurs with Mixed Herbs since the particular combination of Rubus arcticus-Trientalis europea does not appear. Out of all three sites, identifying the site known as "The Bog" was problematic , and we could only classify to Level III Wet Graminoid Herbaceous. We were able to calculate the vegetation type for Closed Black Cottonwood Forest (*Populus balsamifera trichocarpa*) and Fireweed (*Chamerion angustifolium*), however, the report acknowledges that, as of the published date, there were no existing references describing the habitat Fireweed in detail. Lastly, the report does not recognize Lutz Spruce

Forest as a species, so the Level IV and Level V categories were created for purposes of this report. The description for this habitat is based on the descriptions for Closed Sitka Spruce Forest.

The 'Subarctic Lowland Herb Wet Meadow' is dominated by herbs, but not by grasses or sedges though they can be present. 'Mixed Herbs' is dominated by herb species, but sedges, grasses, ferns, and mosses can be found at these sites. It is found throughout most of subarctic Alaska. 'Wet Graminoid Herbaceous' is reserved for vegetation types that are dominated by graminoids and in fairly wet soils. 'Closed Black Cottonwood Forest' are dominated by black cottonwood; older stands allow the understory to thrive. 'Fireweed' and 'Closed Lutz Spruce Forest' are not described in the report (Viereck et al. 1992). Compared to the Field Station habitat map, at Wynn some areas were not given a designated community type. This was because the areas from the satellite image appeared vastly different from the vegetation types identified at the different vegetation plots. Therefore, we have no vegetation data on those areas, and it would have been highly inaccurate to assign a vegetation type to them.

Table 1. Wynn Nature Center

Level IV	Level V
Subarctic Lowland Herb Wet Meadow	*Stellaria* spp.
Subarctic Lowland Herb Wet Meadow	*Castilleja unalaschensis*
Mixed Herbs	*Rubus arcticus-Trientalis europea*
Fireweed	*Epilobium angustifolium*
Level III. Wet Graminoid Herbaceous	*Poa* spp.-*Oxycoccus microcarpus-Betula nana*
Closed Black Cottonwood Forest	*Populus balsamifera trichocarpa*
Closed Lutz Spruce Forest	*Picea sitchensis* x *glauca/Gymnocarpium dilata-Rubus pedatus*

For Headquarters and the Field Station, there were no particular challenges that deviated from those stated above. 'Open Lutz Spruce Forest' has three different Level V habitats. We can also surmise that this particular habitat exists because of the impact the Spruce Bark Beetle (*Dendroctonus rufipennis*), since all of the plots contained fallen Lutz Spruce trees. The 'Closed Lutz Spruce Forest' is similar to Wynn's, but there are only two dominant species named in the Level V categorization, and does not include Gymnocarpium dilata. 'Mesic

Sedge-Grass Meadow Tundra' is dominated by both grasses and sedges. Lichens and mosses may be common which we did find in our plot. This area, known also as the Bog (compare to Wynn's Bog), was relatively small. Our plot extended to the tree line of the surrounding forest, so we captured a few adult trees; however, this did not have an impact on the vegetation type since their abundance was low.

Table 2. Field Station

Level IV	Level V
Open Lutz Spruce Forest	*Picea sitchensis* x *glauca/Oplopanax horridus-Gymnocarpium dryopteris*
Open Lutz Spruce Forest	*Picea sitchensis* x *glauca/Oplopanax horridus-Gymnocarpium dryopteris-Equisetum sylvaticum*
Open Lutz Spruce Forest	*Picea sitchensis* x *glauca /Dryopteris dilatata*
Closed Lutz Spruce Forest	*Picea sitchensis* x *glauca/Rubus pedatus*
Mesic Sedge-grass Meadow	*Carex* spp.-*Poa* spp.-*Viola langsdorfii*

Table 3. Headquarter

Level IV	**Level V**
Subarctic Lowland Herb Wet Meadow	*Equisetum arvense*

Development of the habitat maps were done mostly through ArcMap, part of Esri's ArcGIS software programs for geospatial analyses. The coordinate system for the maps is NAD 1983 (2011). The background image for the maps is GINA Best Available Data Layer (BDL) downloaded from ArcGIS Online database. Trails, property boundaries, and points of interests were added to the maps by georeferencing the existing trail maps that the Center has available for visitors. Natural community information was added through to the maps as a point shapefile based on the GPS coordinates that were taken in the field. We visually extrapolated from the types of vegetation communities that were identified at the coordinate points, and identified the natural plant communities in the rest of the map area within the property boundaries. Final design changes were made through Adobe Illustrator.

FUTURE IMPROVEMENTS

There were a few limitations to the development of the habitat maps. Future projects would be best served by improving on the methodology that was undertaken. First, choose an updated vegetation classification system. The Vierek et al. system was published in 1992. It doesn't list all the plant communities that are present in Homer, AK, or in the three sites and is missing information on diagnostic species that define certain plant communities; for example, the Lutz Spruce is a hybrid between White Spruce (*Picea glauca*) and Sitka Spruce (*Picea sitchensis*), but it is not described in Vierek et al. Instead, we followed community descriptions of similar Level IV and V vegetation types where the diagnostic species was Sitka Spruce as mentioned previously. An alternative is to use the vegetation classification system developed by the U.S. National Vegetation Classification (U.S. NVC). The U.S. NVC is is a partnership between the U.S. Forest Service, USGS Core Science Systems, NatureServe, Ecological Society of America, NGOs, and the Federal Geographic Data Committee Vegetation Subcommittee. It is used to produce a national vegetation inventory through a standardized process for vegetation sampling and classification with the latest classification published in 2008. Though there are still some levels of the vegetation classification system that are under review, the have extensive vegetation plot data through their VegBank, and they have described many levels throughout the nation. The reason this was system was not utilized for this project is because the USNVC has concentrated on the contiguous United States, and Alaska and Hawaii are still forthcoming. In the Vegbank, there are already a number of vegetation plot data available through VegBank, but communities are not yet described. Fortunately, the Alaska Natural Heritage Program through the University of Alaska Anchorage is working on the 888 associations described in Vierek et al. and adding them to the U.S. NVC database. They have a Plant Association List on their website though it is password protected.

We identified the natural communities based on abundance of the different species, but were not able to calculate percent canopy cover. The satellite image was not of a high enough resolution to allow for this. We used Geographic Information Network of Alaska's Best Data Layer (GINA's BDL) downloaded from ArcGIS Online, and it is also available through the Statewide Digital Mapping Initiative and Alaska Mapped. The GINA BDL is an attempt to create the best available imagery base layer by combining spatial data from various sources. Aside from calculating cover, a high resolution image is also needed to more accurately and

precisely make out the distinctions between natural communities when attempting to extrapolate from coordinate points with known communities to the rest of the map area. This part of the process is reliant on the mapmaker to make those distinctions, so it is subjective and more difficult when the raster images are blurry. Future projects will benefit from the USGS Alaska Mapping Initiative. Their current mapmaking efforts is to create higher quality maps equal to that of the rest of the United States.

VI. CONCLUSION

The purpose of this project was to help guide our client into their next 30 years of operation by providing them with fundraising tools and ideas for increasing organizational capacity. The Center wants to expand their curriculum, improve their facilities' operations, and create a unifying aesthetic across all three properties that draws from their mission and values. Our final materials offer them an excellent start in achieving these goals.

The master plans generated by our team will serve as guides to our client as they start implementing their development goals this year. Our analyses have exposed issues with the sites' current programming, and have identified ways in which they can be creatively solved. With these suggestions, we are hopeful that the Center will be better able to manage their growing number of programs and site users.

We have created in our designs, elements that both model the Center's dedication to education and stewardship, and that visually unify the three properties. By imagining spaces and infrastructure that are readily adaptable and open to interpretation, we are also inviting the local community to express themselves in the actual production of these concepts. In this way, the designs will reflect the local, closely-knit community of Homer.

The habitat maps and vegetation lists will allow our client to identify areas that possess a high potential for inclusion in their education programs and provide a navigation aid to visitors. These tools may also assist the Center in educating the public about the changing landscape. Homer is likely to continue experiencing the effects of climate change, and if our studies are repeated in the years to come, they may create an interesting record of an evolving ecosystem.

Moving forward, we hope that our deliverables have provided the Center with a useful fundraising package. We also hope that these materials will serve as an excellent foundation for future teams (SNRE or otherwise) as they continue to work on projects to further the Center's development goals and help make construction a reality. The Center for Alaskan Coastal Studies is a vital member of the Homer community. We are optimistic that our work will serve the organization well as they continue to flourish in the decades to come.

APPENDICES

APPENDIX I

Lists of at least 51 different plant species found at all of the plots at the three sites. It excludes plants the team was unable to identify.

Wynn Nature Center

Scientific Name	Common Name
Aruncus sylvester	Goatsbeard
Athyrium filix-femina	Lady Fern
Betula nana	Bog Birch
Carex Mertensii	Merten's Sedge
Castilleja unalaschensis	Coastal Indian Paintbrush
Delphinium glaucum	Larkspur
Epilobium angustifolium	Fireweed
Equisetum arvense	Field Horsetail
Equisetum spp.	Horsetail
Galium triflorum	Sweet-scented Bedstraw
Geranium erianthum	Northern Geranium
Geum macrophyllum	Largeleaf Avens
Gymnocarpium dryopteris	Oak Fern
Heracleum lanatum	Cow Parsnip
Moehringia lateriflora	Sandwort
Oxycoccus microcarpus	Bog Cranberry
Pedicularis oederi	Oeder's Lousewort
Picea sitchensis x glauca	Lutz spruce
Poa spp.	Grass
Polemonium acutiflorum	Jacob's Ladder
Populus balsamifera trichocarpa	Black Cottonwood
Pyrola asarifolia purpurea	Pink Pyrola
Pyrola secunda secunda	Sidebells pyrola
Rubus arcticus	Nagoonberry
Rubus chamaemorus	Cloudberry
Rubus pedatus	Trailing Raspberry
Salix spp.	Willow
Sanguisorba stipulata	Sitka Burnet
Stellaria spp.	Chickweed
Streptopus amplexifolius	Watermelon Berry
Trientalis europaea	Arctic Starflower
Veratrum viride	False Hellebore

Peterson Field Station

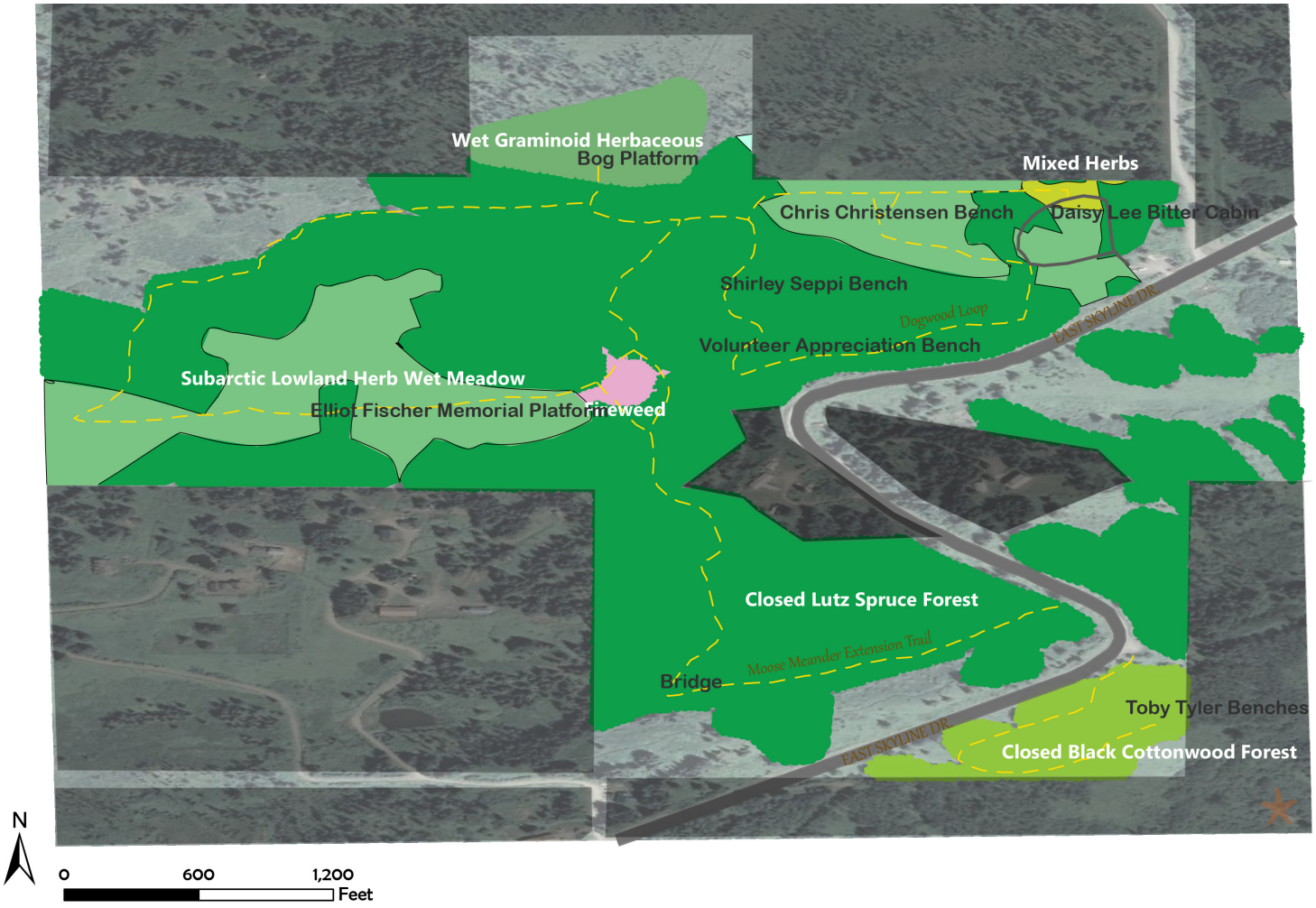
Scientific Name	Common Name
Alectoria sarmentosa	Witch's Hair Lichen
Alnus spp.	Alder
Alnus viridis ssp. Sinuata	Sitka Alder
Betula nana	Bog Birch
Carex flacca	Blue Sedge
Carex spp.	Sedge
Dasiphora fruticosa	Cinquefoil
Dryopteris dilatata	Wood Fern
Epetrum nigrum	Crowberry
Epilobium angustifolium	Fireweed
Equisetum pratense	Meadow Horsetail
Equisetum sylvaticum	Woodland Horsetail
Gymnocarpium dryopteris	Oak Fern
Menyanthes trifoliata	Buckbean
Menziesia glabella	False Azalea
Oplopanax horridus	Devil's Club
Oxycoccus microcarpus	Bog Cranberry
Picea sitchensis x glauca	Lutz Spruce
Poa spp.	Grass
Poa spp.	Grass
Rubus pedatus	Trailing Raspberry
Sambucus racemosa	Red Elderberry
Sphagnum spp.	Moss
Streptopus amplexifolius	Watermelon Berry
Viola langsdorfii	Alaska Violet

Headquarters

Scientific Name	Common Name
Alnus viridis spp. *sinuata*	Sitka Alder
Conioselinum chinense	Hemlock Parsley
Dryopteris dilatata	Wood Fern
Epilobium angustifolium	Fireweed
Equisetum sylvaticum	Woodland Horsetail
Heracleum lanatum	Cow Parsnip
Picea sitchensis x glauca	Litz Spruce
Poa palustris	Fowl Bluegrass
Stellaria spp.	Unknown
Streptopus amplexifolius	Twisted Stalk
Taraxacum officinale	Dandelion

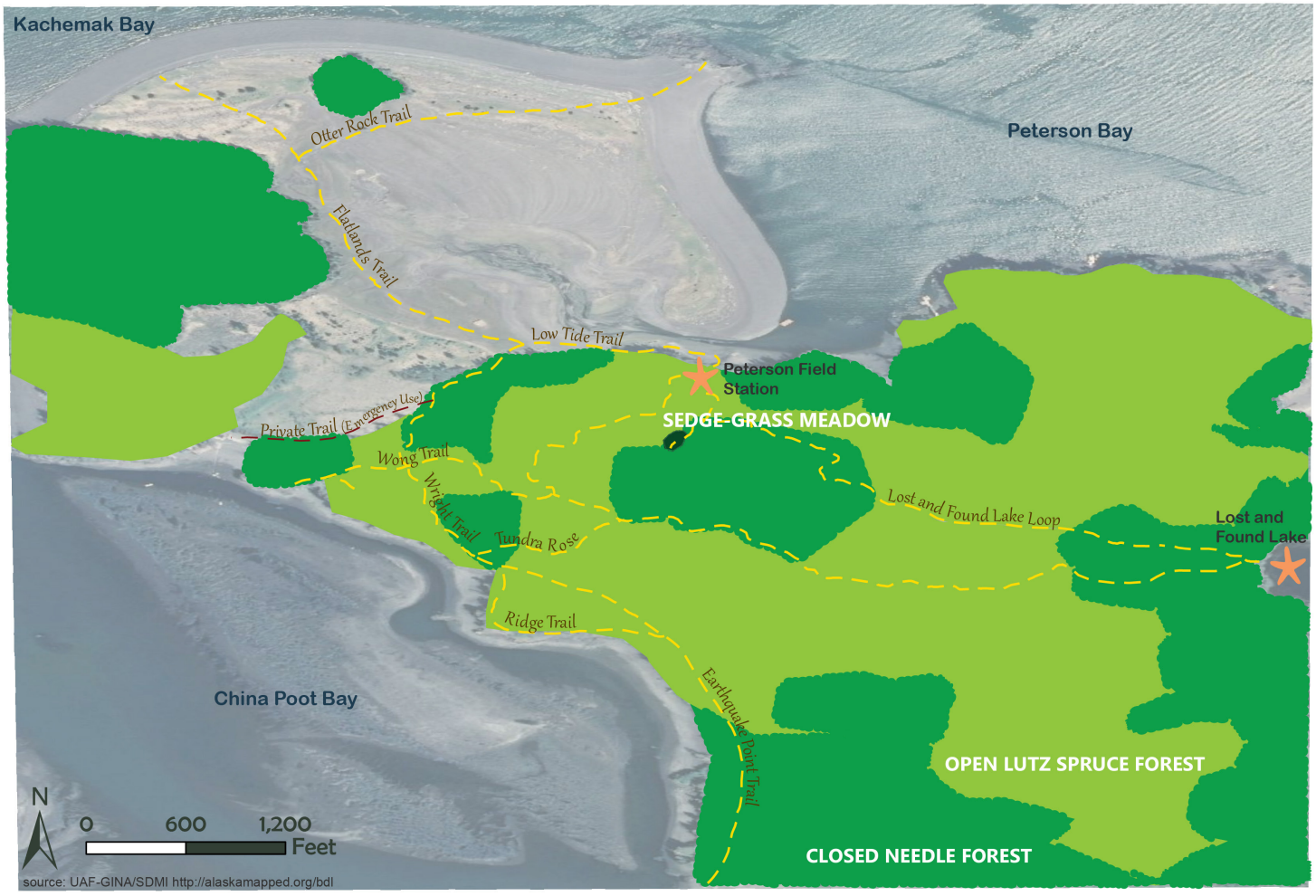
APPENDIX II

Habitat Map of Wynn Nature Center



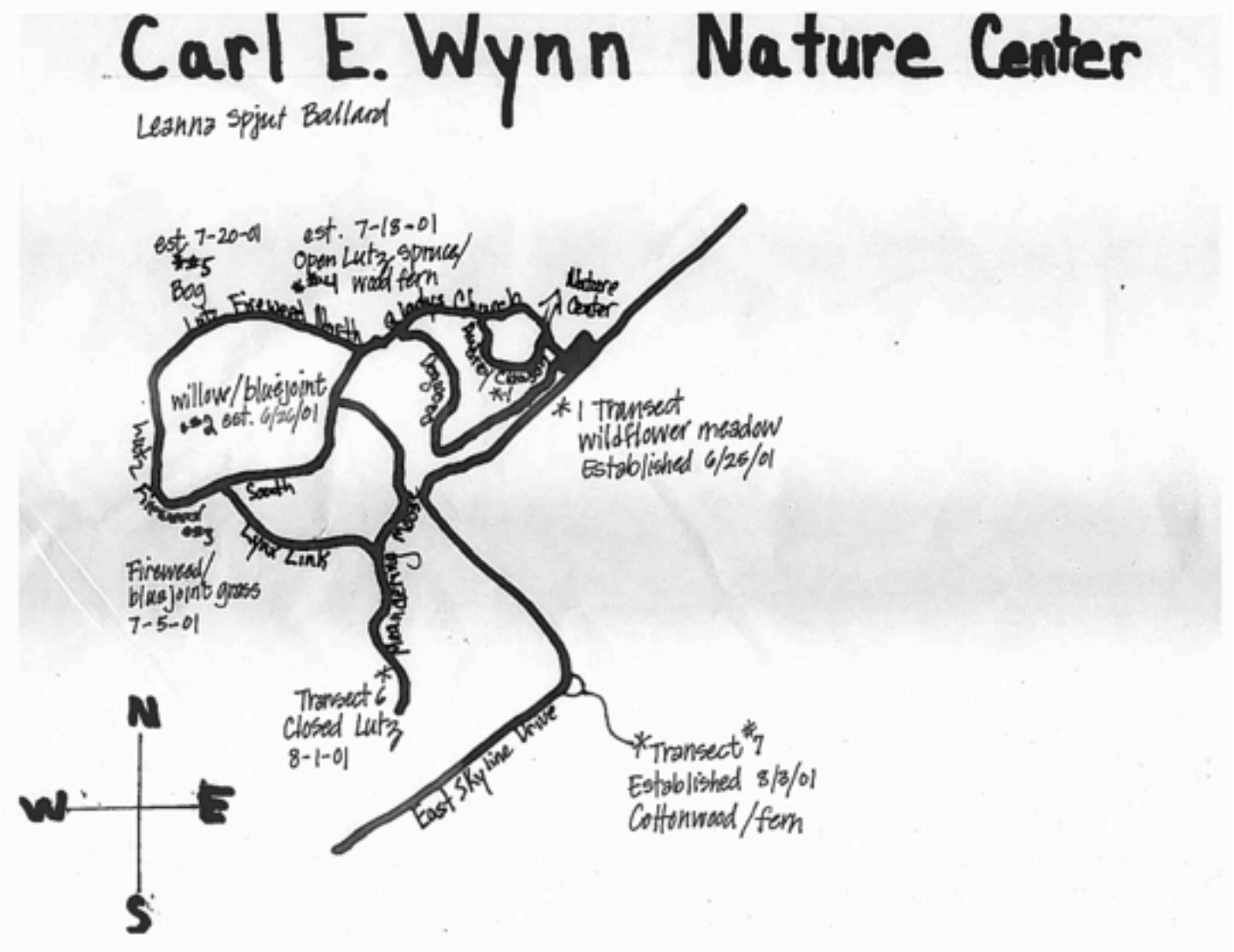
APPENDIX III

Habitat Map of Peterson Bay Field Station



APPENDIX IV

Map of transects set by Leanna Spjut Ballard's research study at Wynn Nature Center. We set our vegetation plots in the general area of these transects.



APPENDIX V

Vegetation plots established at Wynn Nature Center and Peterson Field Station.


Open Lutz Spruce Forest
Sedge-Grass Meadow
Open Lutz Spruce Forest
Open Lutz Spruce Forest
Open Lutz Spruce Forest
Open Lutz Spruce Forest
Closed Lutz Spruce Forest
Closed Lutz Spruce Forest
Open Lutz Spruce Forest
Open Lutz Spruce Forest

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