Gulf of Alaska CoastWatch

Activity Guide

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Front cover photo credit: CACS

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Introduction

Welcome to the Gulf of Alaska CoastWatch, an inquiry-based educational experience for students in grades 5-12 who are eager to learn about the rocky intertidal environment and the Gulf of Alaska marine ecosystem that is an important part of our extensive Alaskan coastline. CoastWatch is an environmental monitoring opportunity for you and your students that, in its most advanced form, will allow you to collaborate in local, regional and global efforts to collect information on change in our coastal ecosystems. Environmental monitoring requires repeated sampling of the same area over a period of time to provide evidence about how the environment changes over time. It provides the means to detect and measure the impact of specific changes on the ecosystem involved. The collaboration is not one-sided – students can provide scientists with scientific data they need over large geographic areas that would be very expensive for them to collect. Thus, the students can be engaged in "real science" and gain the understanding of the scientific process related to questions and problems that may be global in nature.

Why monitor the intertidal zone?

The reasons for monitoring the intertidal zone are well-stated in a description of the LiMPETS program established for several Marine Sanctuaries on the West Coast of North America.

> "We have established an intertidal monitoring program because we believe in the importance of tracking organisms over time. The rocky intertidal on the west coast of North America supports one of the richest and most diverse biotas in the world. This biota is subject to constant change, today largely from anthropogenic (human) causes. At some sites, especially in southern California, harvesting and trampling have lead to dramatic decreases in the abundance and diversity of the biota. The very accessibility of the intertidal has lead to more and more people visiting it. And while reckless collecting might be decreasing now in response to better understanding, simply walking around on the rocks may be disturbing to some species, leading to unpredictable changes.
>
> Moreover, by its very nature, the intertidal zone, both on rocky benches and sandy beaches, is exposed to many of the pollutants produced by human society. Contaminants released into the air fall on the surface of the sea and are carried into the intertidal, as are chemical contaminants such as oil spills. Waste materials dumped on the land are washed into the sea across the intertidal, some of it remaining there. Indeed, the animals and plants of the intertidal may be affected more severely by human activities than those in most other parts of the sea. Fortunately, because of their accessibility, they also may be the easiest to monitor, and so can serve as our marine canaries.
>
> In addition, there are dramatic geological and climatic disruptions along these shores (earthquakes, severe storms, El Niño events, global warming) that could generate change in the biota. In response to a rise in both air and sea temperatures, we can expect the

distribution of species along our coast to change. Along the west coast of North America, many intertidal species are found from Alaska to Point Conception (northern species) or from northern California to Baja California (southern species), both co-occurring in central California. Global warming may result in a northward shift in the distributions of these species. Indeed, that was what was seen when species abundance was compared between the early 1930s and the mid 1990s at one site in Monterey Bay: Several common southern California species that were rare or absent in the 1930s are now abundant in the Monterey Bay area.

Moreover, global warming will likely cause a rise in sea level. The tightly organized zonation patterns of the intertidal, with species sorted into bands according to tidal height, may be particularly sensitive to global warming. A rise in sea level not only could shift the different zones higher on the shore, but the zonation pattern itself could change as the shoreline configuration and associated wave forces change. In addition, long-term, interannual cycles of sea level could influence zonation patterns.

This intertidal monitoring program will provide long-term data that can be used to follow changes, and it will also introduce people of all ages to the rich biota of the intertidal, hopefully building up a group of informed, concerned citizens who will watch over this fascinating habitat in the future."

What is CoastWatch?

CoastWatch students will be led through a series of activities introducing them to the process of using scientific protocols and collecting, entering and analyzing data. Pre-trip activities focus on identification and classification of marine invertebrates and seaweeds, the concept of scientific sampling, practice with data collection protocols, and beach etiquette. A sequence of beach field trip activities provides a continuum from discovery to data collection and on-site communication of results. Post-trip activities include data entry and analysis and environmental issue identification and an introduction to problem solving. The environmental issues begin with choices about how to behave on the beach field trip itself ("beach etiquette") and proceeds to identification of issues relevant to the beach that they visit.

The CoastWatch Curriculum is focused on activities at the beach and extended learning opportunities designed to provide "real science" experience for your class and opportunities to examine environmental issues relevant to the lives of your students. These "real science" opportunities include:

- A Discovery Hike to the Beach to make observations and develop inquiries
- Conducting a CoastWalk and entering data into the CACS database
- Participating in GLOBE, an international school-based coastal monitoring program by collecting, entering ,and analyzing data using the GLOBE protocols for the intertidal

Background

Field trips to rocky beaches with high biodiversity are exciting, filled with teachable moments about the incredible changes of the tides, the colorful and seemingly bizarre shapes and forms of the marine invertebrates, the obvious communities of seaweeds and animals arranged in bands and zones related to their tolerance to wave force and salt and exposure to air. Squishy encounters with mud and slime and the grasping of tentacles and tube feet never fail to engage the senses and pique curiosity in people of all ages, generating a starting point to an inquiry-based learning experience.

CoastWatch environmental monitoring activities will help increase your student's awareness of the importance of these organisms found on your beach field trip as it fits into the overall health of the coastal ecosystem. Students will engage in examining the biodiversity of intertidal organisms by measuring the number of different organisms found in an area. Over time the students will be able to relate both positive and negative changes in biodiversity on the beach to changes taking place in their communities. Our learning objectives address six basic biological concepts important to your student's understanding of what constitutes a healthy ecosystem

Shield Limpet

CoastWatch Learning Objectives:

Students will gain

- an increased awareness of their local environment
- knowledge of specific ecological relationships and their importance
- awareness of the importance of biodiversity to the health of our coasts
- knowledge of the role of keystone species and their importance as indicator species
- awareness of environmental issues related to the role of humans in causing change in nearshore environments
- an understanding of the role of natural disasters or global climate change on nearshore habitats and the marine ecosystem
- an understanding that change occurs at different scales of time and space and the causes of such change can be natural phenomena, human activities or a combination of both
- an understanding about how scientists are collecting long-term data for the Gulf of Alaska Monitoring and Research program (GEM)

As a class you will decide on which animal groups and/or species you would like to monitor. We have developed a species list that represents organisms that are important to monitor in the Gulf of Alaska. The species have been chosen for one or more of the following reasons:

- They are easy to find and/or identify
- They are important to the intertidal community because they are a:
  - Space occupier
  - Grazer
  - Predator
  - Filter feeder
- They are sensitive to disturbance and are therefore a good indicator species
- They are important to the human community
- They are representative of a trophic level
- Other special characteristics

By participating in this program students will gain skills in observing, measuring, collecting data, analyzing data and communicating results within the scientific community. They will also get a concrete understanding of the tidal zones and how different organisms adapt to survival in a constantly changing environment. They will develop the skills that will provide the tools for forming inquiries to begin exploring cause and effect in a coastal ecosystem by starting out with a local emphasis and branching out to explore global questions.

Intertidal Species being monitored:

Primary Species	*Seaweeds:*	*Secondary Species:*
Periwinkles	*Fucus*	*Hairy Triton*
Katy Chiton	Alaria	*Moon snails*
All Chitons	*Ulva*	*Nudibranchs*
Mussels	*Sea Sac*	*Clams*
Limpets	*Coralline Algae*	*Cockles*
All Seastars		*Sea Cucumbers*
Sea urchins		*Crabs*
Barnacles		*Octopus*
Anemones		

CoastWatch Components

Our CoastWatch coastal monitoring program is divided into three components. Each component requires a different time commitment by your class. You will need to evaluate your time and decide which option best fits your curriculum needs and school schedule. The three options for involvement are as follows:

Unit 1: Beach Discovery
Unit 2: CoastWalk
Unit 3: GLOBE coastal monitoring program

A brief description of the options can be found below. As a teacher, you are not limited to choosing only one option – feel free to adapt these activities as you see fit.

Unit 1: Beach Discovery

Involvement at this level requires a minimal time commitment. The focus here is to get your students out to the beach and begin exploring the various communities found at the different tidal zones. Activities include beach discovery hikes, creation of species lists, doing timed counts as a focus to searching for various key organisms and getting your students familiar with the beach environment. Your main task at this point is to get them excited about being out and discovering this ever changing dynamic ecosystem. Expected time commitment would be one or two classroom sessions to familiarize your students with the beach environment and the intertidal organisms that can be found there, plus at least one field trip to the beach and then a follow-up classroom session to make an intertidal atlas or species list.

Unit 2: CoastWalk

CoastWalk is a unique community science and stewardship program sponsored with a three part mission to: build community awareness of the importance of our local marine habitats, gather data to detect long-term trends in biodiversity, and to observe the effects of human impacts on our shore. 2003 was the 19th year that the Center for Alaskan Coastal Studies (CACS) coordinating the annual effort on the Kachemak Bay shoreline. Participating in a CoastWalk survey takes the learning associated with a beach hike one step further by involving you and your students in a structured urvey of a wide variety of marine and terrestrial animals, signs of human impact, beach debris and other things while walking a predetermined stretch of beach during the month of September and/or April and May.

The necessary time commitment would be similar to the Beach Discovery option except that you would need to spend an additional class period doing an activity to prepare your students to use the CoastWalk data forms. Completed data forms will then be sent to the CACS for entry in the CACS

Coastwalk data base. Follow-up activities include determining issues that affect your stretch of beach and designing an inquiry to guide further beach explorations as well as analyzing findings and comparing them to other CoastWalk data.

Unit 3: GLOBE coastal monitoring

The GLOBE (Global Learning and Observations to Benefit the Environment) program is a n environmental monitoring program sponsored by the National Science Foundation and NASA. Participating in this collaborative science project is the most intensive of the three options but also the most rewarding in terms of data collected and time spent learning about the intertidal organisms and their role in the beach ecosystem. Participation at this level allows you and your students to go beyond just looking at local questions about organisms and their habitats to branching out to explore global questions about climate change and sharing information with students and scientists worldwide. GLOBE monitoring involves using data collection protocols such as quadrat counts of various animal groups as a means to detect global change in coastal habitats, timed counts which measure species abundance at a particular site, and/or vertical transects which assess species diversity along the intertidal zones. Following practice, the quadrat counts are very simple to perform. They involve looking for an area where a species is very abundant and doing a maximum density count and a random count in the same area. The timed counts are performed over a certain area of beach for 10 minutes and are similar to a species scavenger hunt. The vertical transects require the most detailed work, but provide an excellent picture of the distribution of animals along the tide zones and set up the best method for measuring change over time. All of these protocols are explained in detail in the Activities section of this activity guide.

Including all of these units in your science curriculum will provide the best experience of place and metacognitive facilitation for your students to succeed. Whichever option you chose, you will find pre-field trip activities to prepare your class for field work, detailed descriptions of the field activities an
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History of Coastal Monitoring in Kachemak Bay

The Center for Alaskan Coastal Studies (CACS) has conducted educational programs in Kachemak Bay for more than 20 years. Our Field Station in Peterson Bay, accessible only by boat, has been the site of overnight Coastal Ecology Trips by more than 10,000 Alaskan students with their teachers and parent chaperones from Homer to Barrow. Field trips to rocky beaches, in an area where the tidal range is as much as 27 feet, are invariably the highlight of the excursion.

Our beach field trips are opportunities for experiential, inquiry-based learning. Teachers who participate in our Alaskan Coastal Ecology program use the beach field trip experiences as an essential part of quality learning related to important concepts included in the National and Alaska State Standards for science education. The concepts of biodiversity, adaptation, ecological interrelationships, and the forces that shape the earth are illustrated repeatedly in the context of both scientific inquiry and the “wow” factor. The field experience lends itself to inquiry-based, hands-on teaching methods identified in the standards for quality teaching practices. CACS sponsors teacher training workshops and provides traveling naturalist visits to align field trip, pre-trip preparation, and post-trip wrap-up activities with these standards and develop ways to extend and reinforce the learning in the classroom.

But beaches are more than sites for fun science education. They are among one of the most dynamic environments on earth and thus a good subject for the study of change, both in response to small and large-scale natural forces and the activities of people, who are drawn in increasing numbers to the shoreline for recreation and residential, commercial, and industrial activities. The nearshore zone, the combination of the intertidal zone and adjacent shallow subtidal zone, is a dynamic and interactive component of the marine ecosystem whose health and productivity are important to Alaskan communities and the world. Understanding the significance and consequences of changes in the nearshore zone can provide jumping off points for learning in geography, social studies, and environmental education. In addition, the learning can be developed in a culturally-relevant way in Alaska’s Native communities where observations may be long in the collective memory of elders and the culture.

COASTWALK Kachemak Bay Monitoring

To address the study and consequences of environmental changes in the nearshore: CACS began, in 1984, to organize and support an annual Kachemak Bay CoastWalk. Citizen volunteers, including school classes and youth groups were encouraged to walk a stretch of the Bay coastline and we provided the means to conduct a survey of biological communities, physical conditions, and evidence of human use and impacts. Active stewardship through beach clean-up has also been a feature most years and has resulted in the removal and disposal of tons of trash and marine debris.

History of Coastal Monitoring in Kachemak Bay *continued...*

At the “local” scale of Kachemak Bay communities, the Kachemak Bay CoastWalk program was developed as a program to increase awareness about the condition of specific areas on the shoreline and the overall health of Bay environments. Surveys of plant and animal life and human activities and impacts serve as an “early warning” system for major changes (erosion, erosion control) and for unusual events (e.g., large jellyfish blooms, mussel die-offs). The long-term survey has provided the basis to track areas near communities receiving heavy use and devise access and education efforts to minimize or avoid damage to biological communities.

GEM Ecosystem Monitoring

In 2002, CACS also became a partner in GEM, the Gulf of Alaska Environmental Monitoring and Research Program sponsored and supported by the *Exxon Valdez* Oil Spill Trustee Council. CACS began work on a community involvement plan for GEM to provide opportunities for schools and community-based organizations to participate in this ambitious ecosystem-scale program to detect and understand environmental change in the aftermath of the impacts that occurred from the *Exxon Valdez* Oil Spill.

At the "ecosystem" scale, GEM is an ambitious science based program with a broader mission to sustain a healthy and diverse ecosystem and the human uses of marine resources in that ecosystem. The central scientific hypothesis of GEM is that natural forces and human activities working over local to global scales cause short-term and long-lasting changes in biological communities that support birds, fish, shellfish, and marine mammals. The program is being designed to **detect** change, **understand** the origin of change in relation to natural factors and human activities, **inform** people about change and its origins, **solve** problems, and **predict** change.

The Gulf of Alaska nearshore environment that extends from the highest reach of the tides to 20 meters in depth has been characterized as both the most productive habitats in the region and the most threatened. These habitats were most severely affected by the *Exxon Valdez* oil spill. They provide important feeding grounds for terrestrial and aquatic birds, mammals, invertebrates, and large fish. Humans depend on food from these rich meeting places of sea and river nutrients. In addition, they are the nursery areas for young marine organisms, unique habitats for specialized animals and major sources of seaweed production. The nearshore will be one of the four habitats in which GEM will focus monitoring efforts. The productivity in this zone is inextricably linked to supplies of nutrients and food from both the Alaska Coastal Current and offshore habitats and from watersheds. In turn, the nearshore provides nutrients and foods to the many animals that also depend on watershed habitats. The detection of changes in nearshore communities will thus be a lens into larger-scale ecosystem changes. Nearshore monitoring protocols suitable for student and community participation have not yet been developed but will likely be similar in nature to the CoastWalk and GLOBE protocols contained in this teaching unit.

History of Coastal Monitoring in Kachemak Bay *continued...*

More information about the programs of the **Exxon Valdez Oil Spill Council** is available at http://www.evostc.state.ak.us and about **GEM** at http://evostc.state.ak.us/gem.

GLOBE Coastal Monitoring

In 2002, CACS became a partner in the GLOBE program. GLOBE is an international, hands-on, inquiry-based environmental science and education partnership. Sponsored by the National Science Foundation and NASA, the program brings together students, educators, scientists, schools, and communities to collaborate on environmental research directed at detecting and understanding climate change. At the heart of GLOBE are standardized data collection protocols, especially developed to be feasible for students to perform, and on-line data entry and analysis. GLOBE provides the opportunity for all students in K-12 classrooms to engage in authentic hands-on science research. Students essentially learn science by doing science.

At the "global" scale, the GLOBE program added coastal monitoring protocols to its other protocols focused on weather, land, and fresh water in order to involve students and community members in determining the potential effects of global climate change on marine organisms. Data collection protocols were developed to collect data at rocky shore sites on the density of common marine invertebrates, on estuarine and sandy shore sites on the abundance of common marine invertebrates, and on the vertical distribution of common marine invertebrates at permanent transects on a rocky shore site. Through the GLOBE program, individuals all over the world collect data on the density and abundance of certain common organisms found in the intertidal zone using simple protocols, which can then be compared to similar data from other areas of the world. The common organisms, which are being monitored, have been identified as “indicator species” whose abundance will change if subjected to a change of water temperature, tidal zonation, or a disturbance to their habitat by either a man-made or natural event.

GLOBE Web site: http://www.globe.gov

Natural History of the Intertidal Zone

What Lives Where? And Why?

Imagine that you are a mussel. Where would you live in the intertidal zone? What do you think are the most important aspects of the environment that would affect your survival? Or imagine you are a sea star. How will you manage to find as many mussels and clams as you need to eat higher up on the beach without drying out before the tide comes back? Questions of this sort have fascinated scientists, naturalists, and anyone who spends time roaming a rocky beach at low tide. The major and controlling factor in the life of this area is the range and timing of the tides. The action of the tides moves the water's edge up and down the land in a predictable and regular fashion, creating living space for plants and animals and transporting nutrients and food items. Wave action can extend the intertidal zone even higher up on the land or sweep away whatever is not clinging or firmly attached. Plants and animals sort themselves out, either permanently by attaching to a rock or other hard substrate or temporarily by crawling or burrowing, somewhere along an invisible gradient of conditions from the lowest low tide to the highest high tide and splash of salty water.

Scientists have sought answers to these questions through studies on beaches and shores all around the world. The intertidal environment is a dynamic and harsh environment to which plants and animals must have adaptations that allow them to cope and survive. It is more crowded at the lower tidal levels where complex dramas are played out to find space and food while avoiding becoming food. The distribution of plants and animals in the intertidal zone appears to be a combination of responses to physical conditions and to biological interactions of competition and predation. Upper limits for plants and sessile (fixed) animals are generally set by their tolerance to physical factors while the lower limits are often set by biological interactions. For mobile animals, however, behavior often provides important adaptations that influence their distribution.

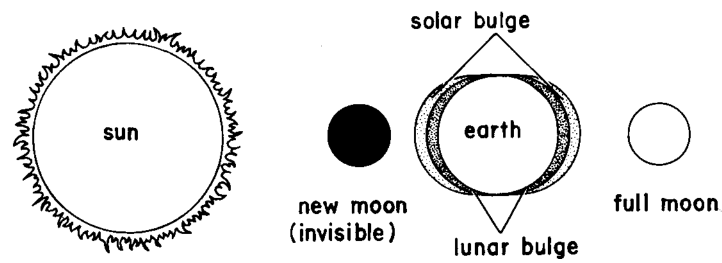
Four important physical gradients help explain plant and animal distribution: 1) a vertical gradient from terrestrial (land) to marine (ocean) conditions, 2) a horizontal gradient of exposure to air and variable temperatures, 3) a gradient of particle size from bedrock to silt (mud) in substrates, and 4) gradients of salinity.

Tides

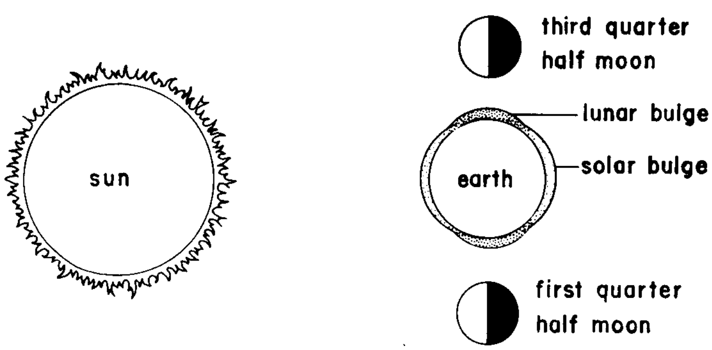
The movements of the tides create the conditions for life in the intertidal zone as they carry nutrients and food items along with larval forms of many animals that spend their adult life in the intertidal zone. Kachemak Bay has two tide cycles daily and a very large tidal range. The tide cycles are unequal with a high low and high tide and a low high and low tide over the two cycles. Because of the high latitude, Kachemak Bay, like all of Alaskas coastal areas have a large tidal range, with the

Natural History of the Intertidal Zone *continued...*

maximum being 28.5 feet and the average 15.4 feet (Upper Cook Inlet has an even greater tidal range of up to 38 feet because the tides are constricted by the geography of the inlet north of Kachemak Bay. This constriction creates the fast-moving tidal bore that moves up Knik and Turnagain Arms, the second largest tidal bore in North America after the Bay of Fundy).



To understand the way the tides affect conditions for life, its important to understand that tidal range is measured vertically, as if on a cliff. If a pole was placed in the intertidal zone, the water would move up and down along the pole a total of 28.5 feet over the course of a year. Another important concept for understanding how tides are measured is the concept of the zero-tide level, which is the average (mean) of the low low tides over the course of a month. The tide level above or below zero in relation to the tidal range provides an indication of the amount of the total intertidal zone that is exposed at a particular place at a particular time. For example, a -2.0 tide at China Poot Bay (with an extreme low tide level at around -5.0) would expose only a portion of the



Life in the Zone

Vertical zonation is most distinct on the faces of large boulders or bedrock outcrops where all plants and animals are adapted to life on the same type of rock substrate. While band-forming plants and animals like mussels, barnacles, and fucus or rockweed (also called popweed) can predictably be found in the upper, middle, or lower portion of the intertidal zone, other plants and animals respond to variable local substrate conditions as well as to other factors. This is true of animals that hide under rocks when the tide goes out and animals that burrow in areas where sand and mud have accumulated. The addition of new habitat niches under and on smaller rocks and in sandy and muddy pockets increases habitat diversity and results in a larger species diversity (number of different types of species that can find suitable habitat) compared to that of a rock habitat. However, the plants and animals that may be found at each tide level is less predictable.

Tide Zone Characteristics

intertidal zone and communities compared to a -2.0 tide at a southern California beach where a -2.0 tide is the lowest tide of the year.

Splash Zone:

Area wetted by wave splash, rarely covered by tide

Sample of species found:

Black Seaside Lichen band (*Verrucaria maura* - forms an almost continuous band)

Orange Lichen (*Xanthoria spp.*)

Periwinkles - lower portion

Acorn Barnacle (*Chthamalus dallii*)

Upper Intertidal Zone:

Sample of species found:

Rockweed (*Fucus spp.*) - distinct band

Pacific Blue Mussel (*Mytilus trossulus*) may be intermixed in this zone or a distinct lower band

Barnacles - Acorn Barnacle (*Balanus glandula*) and Northern Rock Barnacle (*Semibalanus balanoides*)

Periwinkles

Limpets - Mask Limpet (*Tectura persona*)

Middle Intertidal Zone:

Sample of species found:

Pacific Blue Mussel (*Mytilus trossulus*) may be intermixed in rockweed band

Dogwinkle Snails (*Nucella spp.*)

Red Algae - Sea sac (*Halosaccion glandiforme*), Nori/Laver (*Porphyra spp.*), and other species

Six-rayed Star (*Leptasterias hexactis*)

Limpets - Shield Limpets (*Lottia pelta*) and Plate Limpets (*Tectura scutum*)

Lower Intertidal Zone:

Sample of species found:

Kelps/Brown Algae - Ribbon Kelp (*Alaria spp.*)

Thatched Barnacle (*Semibalanus cariosus*)

True Star (*Evasterias troschellii*)

Leather Star (*Dermasterias imbricata*)

Black Katy Chiton (*Katharina tunicata*)

Lined Chiton (*Tonicella spp.*)

Christmas Anemone (*Urticina crassicornis*)

Crumb-of-bread Sponge (*Halichondria panicea*)

Green Sea Urchin (*Strongylocentrotus droebachiensis*)

Bryozoans

Pacific Giant Octopus (*Octopus dolfleini*)

Extreme Intertidal Zone: -

Area rarely exposed by the tide (lower than -4.0); most species are also subtidal.

Sample of species found:

Kelps/Brown Algae - Sugar Wrack (*Laminaria saccharina*)

Nudibranchs - various species

Dunce cap Limpet (*Acmaea mitra*)

Gumboot Chiton (*Cryptochiton stelleri*)

Sea Cucumbers

Tunicates

Natural History of the Intertidal Zone *continued...*

Friends and Anemones

In addition to physical factors, relationships between and among organisms also affect and often control survival at any specific site. The crowded conditions of the lower intertidal zone are thinned by competition, grazing, and predation. Behavior patterns of different animals also help explain where some are found or not found. Mobile animals, such as limpets and sea stars, rarely move so high up in the intertidal zone that they are exposed to conditions that they cannot tolerate. Barnacle larvae have chemical sensing capabilities and settle in areas where the scar of a dead barnacle is present rather than on bare rock. Small sea stars, worms, limpets and snails move to the underside of rocks as the tide goes out where they are in a wetter micro-climate. Brittle stars clump together under rocks as do larger sea stars on the surface, which helps conserve water more than if the individuals were alone. Animals find shelter under seaweeds from drying and extreme temperatures.

Intertidal Food Webs

Producers

Phytoplankton and seaweeds are the producers in the intertidal zone. Phytoplankton are small, unicellular organisms capable of photosynthesis and light enough to float in the upper layer of the water which receives enough light to support photosynthesis. Phytoplankton include microalgae, one-celled monerans, and bacteria. Diatoms and dinoflagellates are common phytoplankton in Kachemak Bay. Some diatoms are sessile, or attached, and appear as a slimy scum on intertidal rocks. Phytoplankton is either captured by zooplankton and other small animals in the water column, many of which are the larva of animals that settle and attach themselves to rocks in the intertidal zone such as barnacles and mussels, or filtered from the water by filter-feeders such as the clams, mussels, and barnacles.

Seaweeds, or macroalgae, are more similar in form to flowering plants, but they attach and glue themselves to rocks and other hard surfaces (even the shells of molluscs) with holdfasts rather than rooting in mud or sand, have a stipe instead of a stem, and have blades instead of leaves. They reproduce by microscopic, floating spores rather than by seeds. The distribution of seaweeds in the intertidal zone is related to their ability to photosynthesize at varying light levels, exposure to desiccation and grazing. Seaweeds are consumed by grazers such as limpets, some snails, chitons, and sea urchins.

Natural History of the Intertidal Zone *continued...*

Seaweeds are classified as green, red, and brown. (The color of the plant does not always match the classification because the grouping is based on many factors, not the color.) As a general rule, green algae are more often found in the upper intertidal zone, red algae in the middle zone, and brown kelp seaweeds in the lower zone and subtidally. Kelps that are annuals, in particular, are among the fastest-growing organisms in the world during May and June.

Filter feeding

A number of intertidal animals consume organic material, including phytoplankton, zooplankton, and detritus (dead material). Their feeding method is called filter feeding. The filter-feeding method of animals such as sponges, clams, and mussels involves passing water through their bodies using siphons, pores, cilia and other structures, capturing particles in mucus and moving the food particles to their mouth or place where food is digested. But other methods are also used - worms ingest sediment and sort out the organic particles, sea cucumbers extend tentacles covered with mucus and contract them one at a time into their mouth to clean off the particles, and brittle stars move across the substrate and use their tube feet and mucus to pass particles to their mouth.

Grazing

Grazing occurs at both the micro- and macro-level. Several species of molluscs like periwinkles and limpets are microherbivores, using their radula (whip-like tongue with teeth) to scrape off films of diatoms and microalgae on rocks on other hard surfaces. Sea urchins and larger molluscs such as chitons can bite or rasp off chunks of seaweeds. Seaweeds have few defenses against grazers because they are fixed in place. Some grow in dense patches and tend to lose less mass to grazers. Others are encrusting species that adhere tightly to rocks; the calcification of the coralline algae limit the grazers to just a few species who are micro-herbivores. Some species have noxious substances that grazers avoid. Rockweed, for example, contains chemicals that make it indigestible by most species, so is rarely grazed. There is even an Acid Kelp (*Desmarestia spp.*) that produces and secretes sulphuric acid that can damage nearby seaweeds and erode cavities in the teeth of sea urchins hungry enough to feed on the seaweed.

Predation

Intertidal predators also come in all sizes, from the microscopic zooplankton and larva in the water column that capture phytoplankton to the Giant Pacific Octopus that can grow to be 100 feet long in deeper waters. Most are mobile so have a large advantage over the many animals which are sessile, but some remain in one place, like the sea anemone that relies on its stinging cells to attack prey that happen to come in contact with their tentacles. Slow-moving predators may have adaptations to open the shells of bivalves (the tube feet of sea stars) or to bore into their shells (radula of whelks and moon snails).

Natural History of the Intertidal Zone *continued...*

Intertidal prey species have evolved a variety of passive responses to predators, including spines, thick shells, tough exoskeletons, noxious chemicals, and camouflage. A periwinkle that withdraws into its shell, closes its operculum, and seals the door with mucus can survive being swallowed and digested by a sea anemone for 20 hours! Prey have also developed behavioral responses such as the chemical detection of predatory sea stars by several bivalves, followed by rapid movement away. Prey can escape predation if they can develop refuges either temporally (shift activity to a time when the predator is not active such as nighttime, time larval settlement to a time when predation or competition is lower) or spatially (adapt to a zone out of the reach of predators). Or they can grow so fast that they escape in size by becoming too large for a predator to successfully attack.

Scavenging and Decomposing

While a large amount of detritus is recycled by the suspension-feeders, other animals feed on larger chunks of dead matter. Several types of crabs and amphipods are the clean-up crew in the intertidal zone, but sea urchins, usually an herbivore, will also feed opportunistically on dead matter. Detritus passes through what can be thought of as a series of sieves in the intertidal zone. Crabs eat big chunks, beach hoppers eat minute particles or break up large pieces into small ones, sea cucumbers and brittle stars buried in the substratum sweep surfaces with tentacles, limpets and periwinkles sweep the rocks, other animals like brittle stars, sea cucumbers, and annelid worms eat dirt and sand to extract nourishment. The smallest particles are attacked by bacteria and recycled into nutrients that phytoplankton and seaweeds can use in photosynthesis.

Other Ecological Relationships

The intertidal zone is a wonderful opportunity to study ecological relationships beyond those of "who eats who". Examples of competition and the varieties of symbiotic relationships - commensalism, parasitism, and mutualism - abound.

Competition: Occurs when a number of individuals of the same or different species utilize a resource that is in short supply. Competition occurs in the intertidal zone for space, for food, and for light. Some plants and animals compete by growing on top of other organisms. Competition is avoided by specializing and adapting to conditions that other species are not able to match. Species that dominate large areas such as barnacles, mussels, and rockweed are good competitors for space.

Example Species:

Limpets, Barnacles: Limpets compete successfully for space by removing newly-settled young barnacle spat by bulldozing them off of the rock. When the barnacles reach a large enough size, they are no longer susceptible to bulldozing.

Natural History of the Intertidal Zone *continued...*

Symbiotic Relationships

Mutualism: A relationship in which both members of the relationship benefit from the association.

Example Species:

Black Seaside Lichen, Orange Lichen: The lichens that grow in the splash zone are a combination of an alga and a fungus. The fungus provides structural support but cannot photosynthesize and the alga makes food for both partners by photosynthesis and benefits from the structural support of the fungus.

Burrowing Anemone, Algae: Some anemones have microscopic algae living in their tissues. These anemones have a greenish color as a result from the photosynthesis occuring. Photosynthesis results in some leaked mineral products that provide nutrients to the anemone and the algae are protected from grazers by their residence inside the anemone who is well-protected by stinging cells from predators.

Commensalism: a relationship where one member of the relationship benefits from the association and one is not affected positively or negatively.

Example Species:

Commensal Scaleworms, Gumboot Chiton, Sea Stars: The commensal scaleworms that live on sea stars and gumboot chitons are an example of this type of relationship. The scaleworms benefit by feeding on food particlesaround the mouth of the partner, but the sea stars and gumboot chiton are not really harmed by having the scaleworm living on them.

Hermit crabs, Snails: Hermit crabs benefit from the use of snail shells as their portable shelter, with no effect on the dead snail.

Parasitism: a relationship where one member of the relationship benefits from the association and one member is harmed.

Example Species:

Boring sponge,Hermit Crab: The boring sponge is able to secrete a substance that dissolves the calcareous shells of mollusks and barnacles, so it penetrates the shell and takes up residence. The parasite seriously weakens the shell. The wandering sponge encrusts on the shell of a hermit crab and hitches a ride with the crab wherever it moves. It eventually dissolves the shell, destroying the commensal relationship of the crab with its snail shell.

PRE-FIELD TRIP ACTIVITIES

Classification Game

Target Students:

♦ 5th & 6th grade
♦ Students who are not familiar with classification schemes

Objective:

To become familiar with the scientific approach to classifying organisms and why this is important.

Concept:

Scientists sort all living things into groups that are related because of certain characteristics or adaptations.

You Will Need:

♦ 10–15 different objects (shoes, writing implements, etc.)
♦ Ziploc bags containing 10 different school supplies - enough for 1 bag per group of students
♦ *Classification Worksheet*

What to Do:

Introductions:

Explain to your students that they will be investigating how scientists organize all the different organisms that are found around the world. Ask them what they know about how plants or animals are classified. Brainstorm ideas about why it might be important to group plants and animals. This activity will prepare your students for the next activity *The Fab Four*. If your class is already familiar with classification skip this activity.

Procedures:

Begin with a fun activity such as putting one shoe from each student together in the center of the room. You can also use ten to fifteen different writing instruments or anything else that is handy in the classroom. Challenge the students to figure out how to group, or categorize, to be able to tell them apart and to be able to find their exact shoe when the time comes. Once categorized, have them try to divide them further into smaller groups until each item is its own group. Discuss the different techniques the students used to group the shoes and why some worked while others did not.

Next, divide the class into smaller groups (2-4 to a group works best) and hand out the ziploc baggie containing ten different school supply items (or whatever you choose to use - as long as each baggie contains the same objects). Hand out the *Classification Worksheet* and have each group complete the page. Discuss the results as a class. Note the similar ways groups classified items and the different schemes that they used and discuss the benefits of each as a class.

Background:

Scientists use seven groups to classify all living things: kingdom, phylum, class, order, family, genus and species. All living things have a specific place in each group. The lower the group, the more alike the organisms will be. Understanding classification will help your students to identify intertidal organisms that are not familiar to them by helping them look for certain characteristics and then know where to look in an identification book. The *Fab Four* activity will provide more specific information and practice with the main groups or phyla of intertidal organisms that are the focus of the coastal monitoring programs.

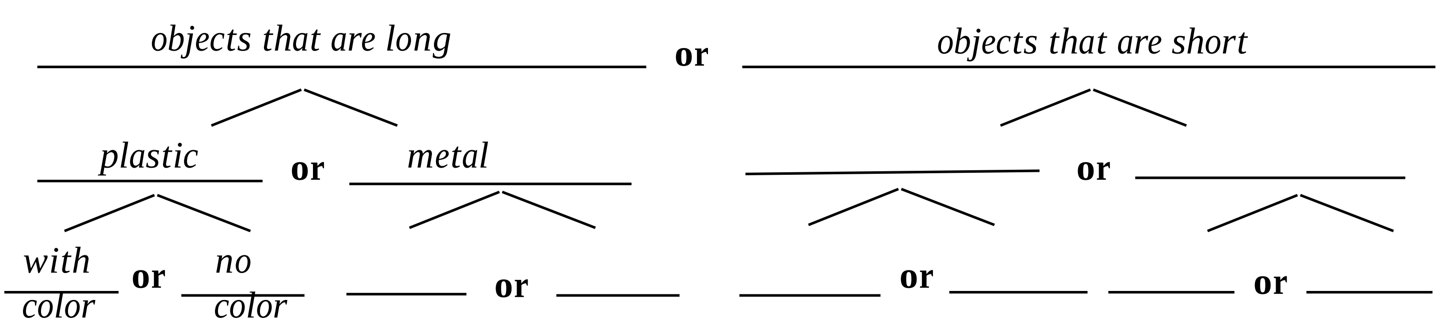
Classification Game

Worksheet

Examine the objects in your bag carefully. Using the space below, list five different "rules" for sorting, or classifying, your objects. Base your rules on obvious characteristics of your objects such as size, shape, color, or what it is made of. You may not use the same characteristic as a rule more than one time. Once you have identified a characteristic, or "rule," you must develop an opposite characteristic, or "rule," for the remaining objects to be grouped under.

Characteristic		**Opposite Characteristic**
1. *objects that are long*	**or**	*objects that are short*
2. ____________	**or**	____________
3. ____________	**or**	____________
4. ____________	**or**	____________
5. ____________	**or**	____________

Now, take one rule from above and try to classify your objects into even smaller groups using the diagram at the bottom of the page as an example for your format. Draw a blank version of this diagram as big as possible on another sheet of paper. You can add more branches if neeeded.



This activity was adapated from: *The Mailbox, The Idea Magazine For Teachers*, Intermediate Level, Aug/Sept. 2003.

The Fab Four-A Guide to Identifying Marine Invertebrates

Objective:

To become familiar with the four most abundant marine invertebrate phyla that will be monitored and the defining characteristics of each.

Concept:

By understanding the defining characteristic of each phylum, or animal division, to be monitored, students will be able to identify intertidal organisms and make assumptions about where to find these animals in the tidal zone. They will have the tools for formulating inquiries about the organism's abundance at their monitoring site and assessing potential impacts to the species being monitored..

You Will Need:

- Marine Invertebrate ID books
- *Fab Four Information Sheet*
- *Searching for Answers Invertebrate Research Worksheet*
- *Six-Sided Cube Template*
- *Range Map*
- Space for a rocky intertidal bulletin board dis-

What to Do:

Introductions: Get your students excited to learn about marine invertebrate phyla by

- Showing a slide show on various marine organisms
- Use the CACS *"Who's Who in the Intertidal Zone? Atlas* or marine books
- Providing the class with a variety of intertidal identification books to look through

Your students will benefit from becoming familiar with the general characteristics of the four phyla of intertidal organisms we are focusing on in our monitoring program. It is important to note that we are focusing only on the largest and most often seen phyla in the intertidal zone. There are over 26 marine invertebrate phyla. Introduce the four phyla we are covering and their scientific name. Discuss the meaning of the scientific names and how knowing the scientific name can help the students identify what phyla an organism belongs in.

Procedures:

Following your introduction, divide your class into research teams. Assign the teams the job of

- Researching an intertidal organism
- Determining defining characteristics for grouping the organism into the right phyla.

Begin by having each research team find a picture of their organism and sketch their organism on the back of their *Searching for Answers Research Worksheet*. As a class, review the four major phyla that the organisms of focus belong to. Have teams list characteristics of their organism next to their sketch and then try to place them in the appropriate phylum. Ask the teams for justification for the placement of their organism.

Next, give each team an intertidal identification book or card, copies of the worksheets for this activity and at least one class period to complete their research on their organism. If you have time plan to make a three dimensional model of your organism or at the very least, a drawing that can be placed on a class bulletin board. Students should complete the *Searching for Answers*

Invertebrate Research Worksheet, the *Six-Sided Cube* and the *Range Map* and use these tools in the presentation of their organism.

Once the research is complete have the teams present their organism to the class, adjust their organism's phylum placement if necessary and place a picture or 3-dimensional model of their organism in the appropriate place in the class intertidal zone bulletin board. After the team presentations discuss, as a class, similar characteristics that organisms have for survival in their tidal zone and reasons for not being found in other tidal zones. Try to come up with clues that will help the class to easily identify unknown animals or at least be able to group them into the right phylum.

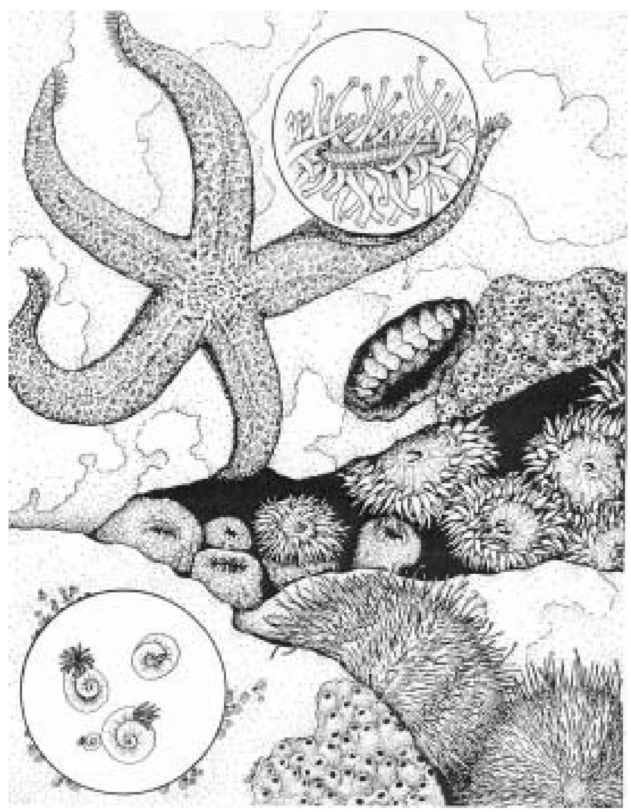
Class intertidal bulletin board: This can be as elaborate as you want. At the very minimal you should have signs for the four intertidal zones: low, mid, high and spray. Students can put their organisms under the correct heading. If time allows, or as a way to integrate art into the science activity, build a rocky shore on your bulletin board - see examples in the appendix.

Alternative Lesson:
Adopt an Ocean Critter

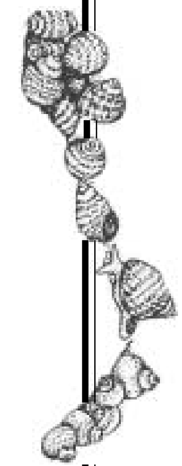
This is a less intensive activity where students will choose an intertidal animal to observe as a focus to the Beach Discovery Walk. They can use the research worksheet to guide any additional information you want them to collect and they can complete the six-sided cube to present their information to the class. Students can make drawings or 3-dimensional models to display on an intertidal bulletin board. Focus should be on adaptations for survival in the tide zones. Less attention is given to the phyla and classification of the organisms.

Classification System:

Kingdon
Phylum
Subphylum
Class
Order
Family
Genus
Species



Fab Four Information Sheet



Phylum Arthropoda *("jointed foot")*

- Incredibly large diverse group
- Bilaterally symmetrical
- Animals with jointed legs
- Exoskeleton
- Generally grow by molting exoskeleton

Class Crustacea *("a crust")*

- Head bears 5 pairs of appendages
- 2 pairs of antennae
- Pair of compound eyes
- Respire through gills

Some members of this phylum include:
barnacles
shrimp
crabs

Phylum Mollusca *(soft)*

- Muscular foot used for locomotion
- Mantle that secretes an internal or external shell
- Soft-bodied
- varied feeding methods
  - filter feeders
  - grazers
  - predators
- grazers and predators have a radula: a file-like organ used for scraping, grasping, biting, drilling and tearing

Some members of this phylum include:
Bivalves: clams, cockles & mussels
Polyplacophores: Chitons, including Katy Chitons
Gastropods: snails (periwinkles, Hairy triton, moon snail), limpets & nudibranchs
Cephalopods: octopus

Fab Four Information Sheet

Phylum Cnidaria *("stinging thread")*

- Animals with stinging cells (nematocysts) used for protection and predation
- Radial symmetry
- Single sac-like body space (coelenteron) used for gas exchange and digestion (mouth and digestive cavity)
- Primarily carnivorous
- Two body forms: polyp & medusa
- Hydrostatic skeletons

Some members of this phylum include:
sea anemones
jellyfish

Phylum Echinodermata *("spine skin")*

- 5-pointed (pentameral) radial symmetry
- Unique water vascular system which allows for movement of "tube feet"
- Calcareous skeletal structures which makes endoskeleton

Some members of this phylum include:
sea stars
sea urchins
sea cucumbers

Search for Answers

Marine Invertebrate Research

Name of your marine invertebrate: ______________________________

Scientific Name: ______________________________

Organism's Phyla: ______________________________

Describe your organism's habitat: ______________________________

Low tide survival adaptations: ______________________________

____

High tide survival adaptations: ______________________________

____

What does your organism eat? ______________________________

Does your organism have any predators? ______________________________

Is this organism abundant on your beach? ______________________________

How does your organism reproduce? ______________________________

How does your organism move? ______________________________

Does your organism have larval stage? if so, what does it look like? ______________________________

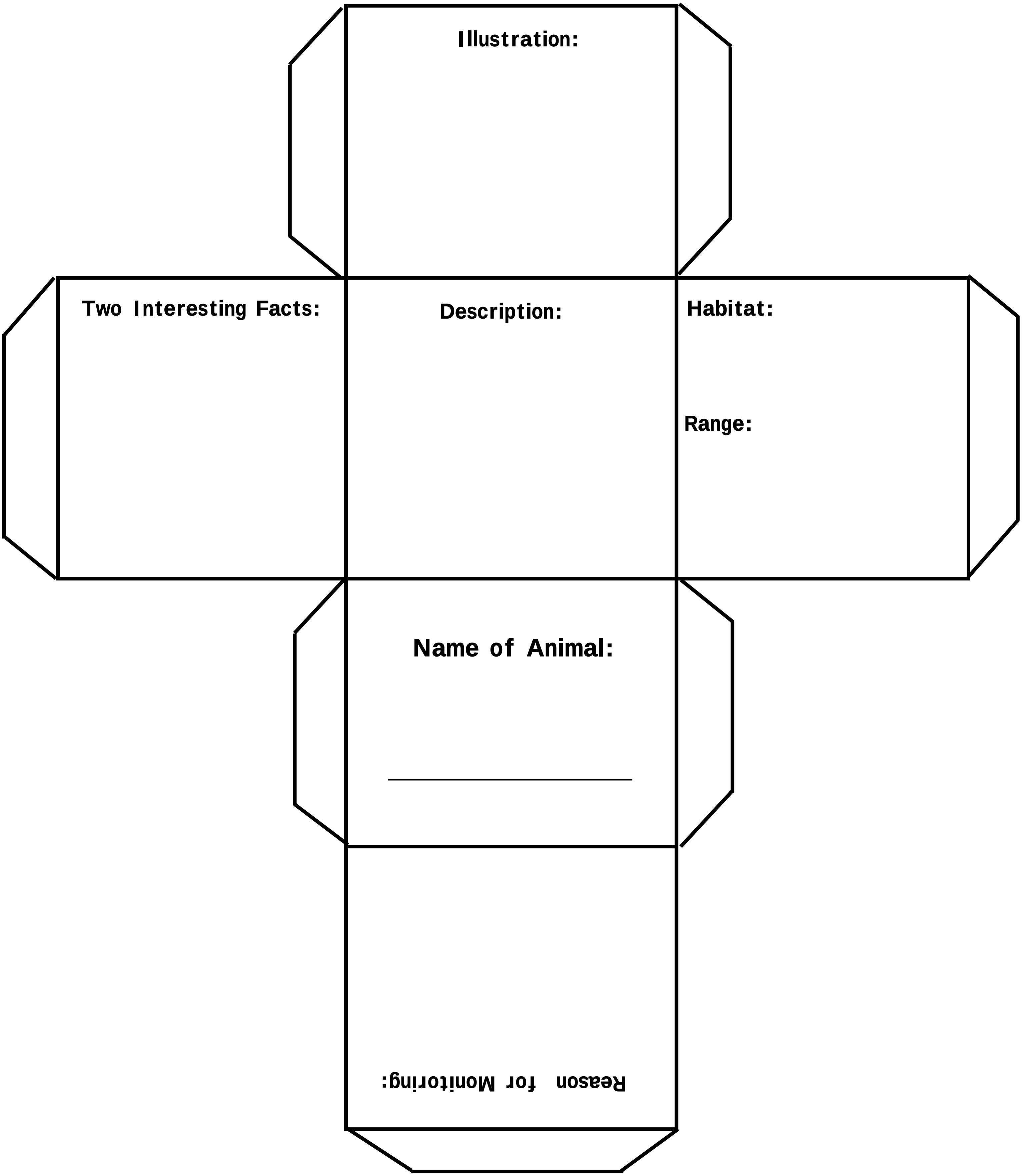
Gee Whiz Fact 1: ______________________________

Gee Whiz Fact 2: ______________________________

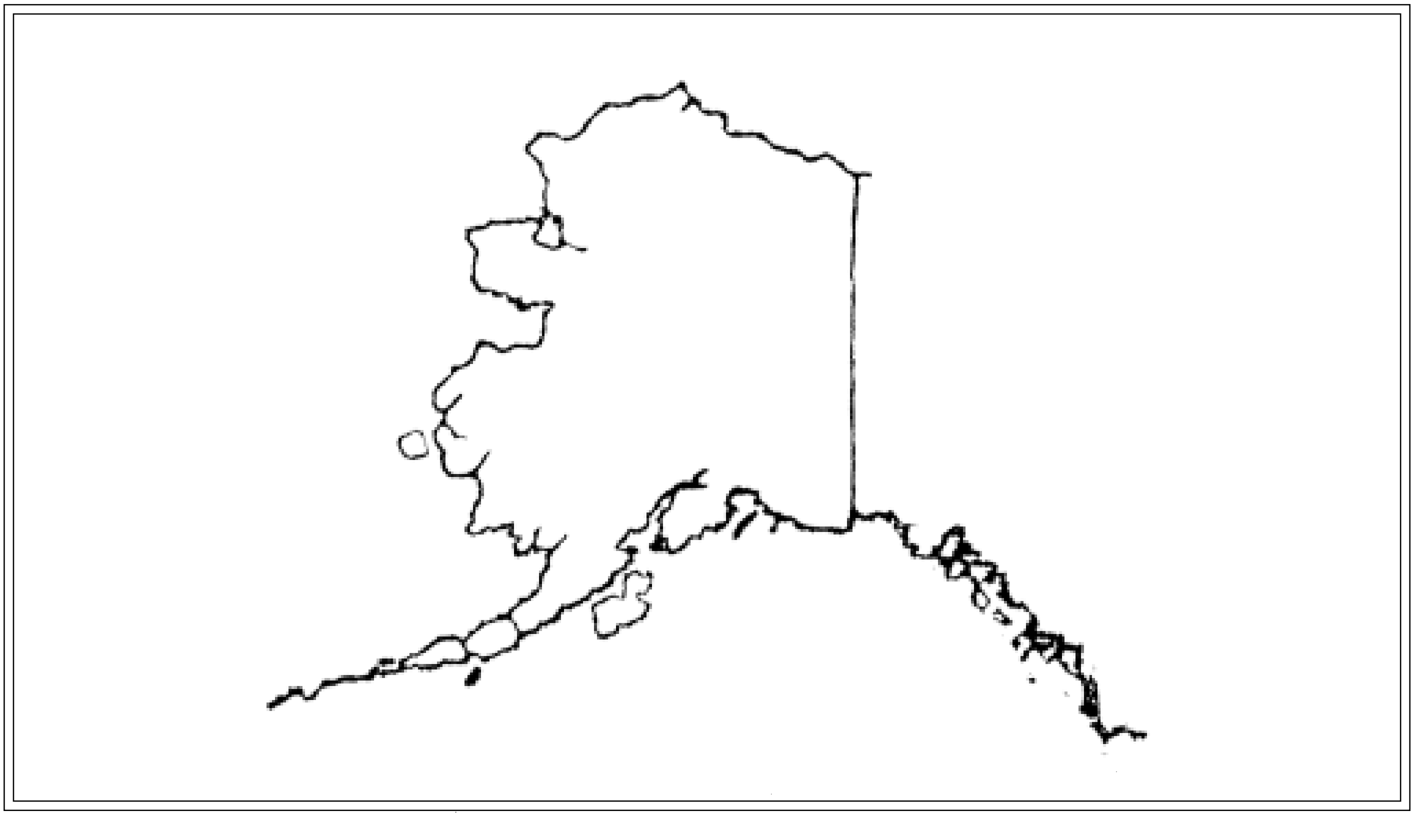
How is your organism used by humans? ______________________________

Share your favorite intertidal recipe: ______________________________

Six-sided Cube Display



Range Map



Know Your Seaweed

Objective:

To become familiar with the main types of seaweed found in the intertidal zone.

Students will be able to:

- ♦Identify several local seaweeds
- ♦Understand reasons for seaweeds' colors and relationships to tidal height
- ♦Classify seaweeds into three color groups
- ♦Identify differences and similarites between marine and terrrestrial plants

Concepts:

There are three main groups of seaweed: green, brown and red. Many factors influence seaweed's distribution. Marine and terrestrial plants share many characterisitics but have special adaptations for their unique habitats.

You Will Need:

- ♦3 or 4 samples of about 12 different seaweeds (or as many as you can find)
- ♦4 buckets
- ♦4 large shallow basins
- ♦15 ID Keys
- ♦15 or more seaweed products
- ♦Algae product list
- ♦Seaweeds to eat
- ♦Seaweed collection permit

What to Do:

****Note: This activity takes special Preparation.**

If you are unable to make a separate trip to the beach to collect seaweed, you can collect seaweed during your first trip to the beach if you are participating in the Coastal Monitoring Unit or during your Discovery Hike.

Procedures:

You will need to go to the beach prior to doing this activity and collect a variety of seaweeds. Most often you can find some nice specimens washed up in the high tide line. Make sure to have several examples of the species you will be monitoring!!! Add a small amount of clean, cold saltwater to the collection bucket to prevent the seaweed from drying out. In addition to the bucket of seaweed, collect a half bucket of saltwater.

Directly before the class divide the seaweeds evenly between the 4 buckets making sure to have a good variety of seaweeds in each bucket. Set-up 4 groups each with one basin with a small amount of saltwater at the bottom

Introductions:

Seaweed plays an important role in the health of the intertidal ecosystem as food and shelter for intertidal organisms. Seaweed also plays a key role in subsistence use of the intertidal zone for many of the residents of coastal Alaska. Your exploration of seaweed will help the students to begin to understand more about this important role and will set the stage for further activities.

Briefly review your exploration of how organisms are classified. Tell the students that they will now have an opportunity to sort different kinds of seaweed. Split the class into 4 groups and assign each group to one basin. Now bring out each groups bucket of seaweed.

Know Your Seaweed *continued...*

Sorting the Seaweed

1. Have each group pick a trait and sort seaweeds into three piles in basin. Remind them there is no wrong way to sort. Encourage them to use their imaginations.
2. When each group is done sorting, have each group explain how they sorted.
3. Have them sort one more time using a new trait and then share again.
4. Explain to the students that none of these ideas are wrong, but seaweed scientists have chosen color to sort by. If you have time, let them sort by whatever colors each team sees.
5. Next, have the student tell you the colors they think scientists use. With guidance they will come up with red, green, and brown. Let them know that a good rule to follow is green is grass green, brown is olive brown, and almost everything else is red.
6. Have them sort by these colors. Make sure they all have completed this sorting correctly. Then have them quickly clean-up.

Follow-Up

Ask the students to define seaweed. Discuss the difference in the terms: seaweed, algae, alga, phytoplankton, kelp and macroalgae.

Try to identify some of the seaweed students have been looking at with the identification keys. Have a bucket of your own and hold up samples. Have teams of two try to figure out its name.

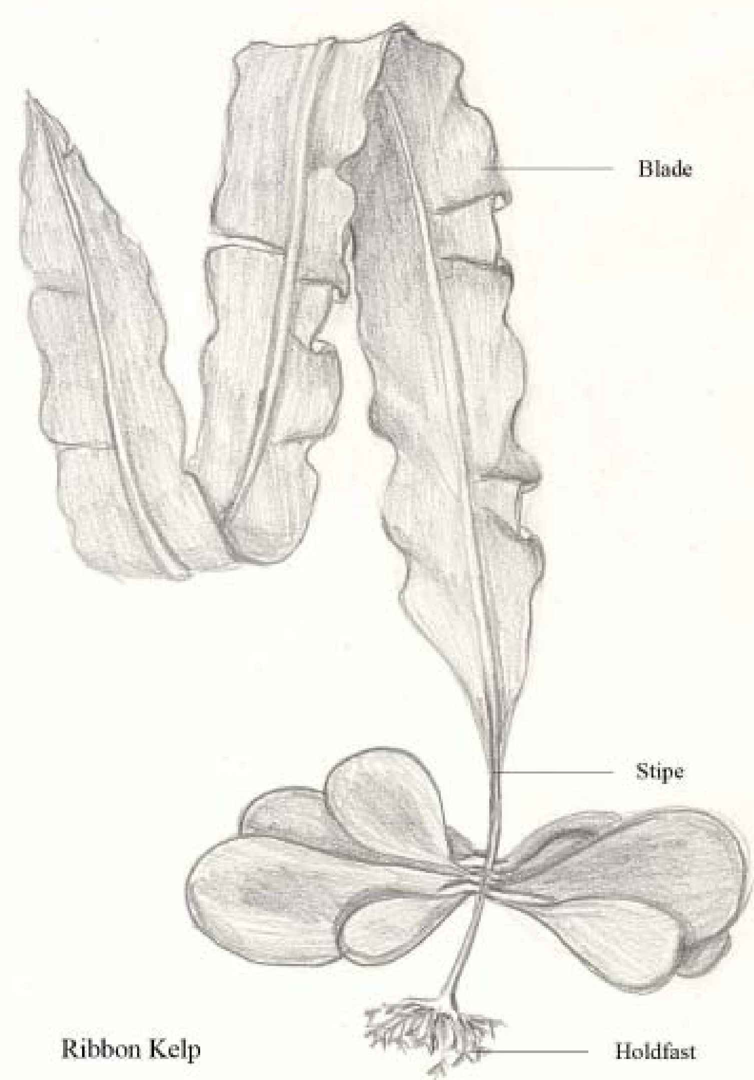
Review the three colors of seaweed and write them on the board. Discuss the concept of distribution of seaweed in the intertidal zone. Ask students if they know which colors of algae are generally seen higher on the beach. Discuss what happens as one goes down into the water. It gets colder and darker. Explain that sunlight has hard time penetrating water. Light is made up of the many colors of the rainbow and as the different colors are reflected back at different depths. The color that penetrates the shortest distance is red, followed by orange, yellow, green and blue. Green seaweeds use the same color of light, red, as land plants doe to make food. Both land plants and green seaweed use a green pigment called chlorophyll to collect energy from the sunlight. However, brown and red seaweeds have different color pigments in addition to chlorophyll to help gather the colors of light that reach deeper into the water. These accessory pigments hide or mask the green chlorophyll and give the seaweed its red or brown color. With older students, introduce the scientific names of each group of seaweeeds. Green is Chlorophyta, brown is Phaeophyta, and red is Rhodophyta. The pigment each seaweed color contains gives it its name.

Color is just one factor that influences distribution of seaweed. Ask your students what else could affect distribution. Discuss other factors such as wave energy, resistance to desiccation, freshwater presence, predation, etc.

Next, ask a student to draw a land plant, including leaves and flowers, on the board. Have students label all the parts. Then draw a bull kelp on the board and label the parts (stipe, frond or blade, holdfast) as you compare and contrast them to those of the land plant. Make sure to point out that seaweeds photosynthesize over the entire body not just on the tops of the leaves as in most plants. Also, comment on the difference between roots and holdfast.

Know Your Seaweed *continued*

Next, hold up a few samples and see if the if the students can guess why seaweeds have ribs, wrinkles, holes and ruffles. (To increase surface area for nutrient uptake).



Extensions:

- ❖ Watch an underwater video of a kelp forest.
- ❖ Press Seaweed. (They will gluethemselves to wet paper, but the mounts require absorbent cloth such as old sheeting in the press to absorb the water as they dry.)
- ❖Spend some time talking about how humans have used seaweed in the past. Have students brainstorm how they could use seaweed if they were shipwrecked on an island with only seaweeds. Think of food, water, clothing, shelter, tools, etc. Encourage the students to be creative.
- ❖ Ask students if they have ever eaten seaweed before. Then ask who has eaten ice cream, yogurt or brushed their teeth. Next on the board write the words Algin, Carrageenan, and Agar. Then hand out sample products to see what seaweed extract is in them. Algin is from the cell walls of kelp and is used as a thickener, emulsifier and stabilizer. Carrageenen is from red seaweeds and it is used like algin in dairy products. Agar is also from reds and is used in gels, pills, Jell-O and more. These uses are all aside from eating it directly in soups, salads and other foods like sushi. Hand out sections of prepared nori sheets to students who are interested in tasting seaweed.

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Counting Beads and Bobbles

Objective:

Students will experiment with a sampling technique and form inquiries about effective sampling techniques.

Concept:

It is important to have a uniform sampling tool and guidelines, protocols, for selecting how and where to sample so that data that is collected is an accurate representation of what was sampled and can be compared with data collected in other areas using the same protocol worldwide.

You Will Need:

- ♦Bucket of beads and plastic shapes
- ♦slide holders
- ♦large cafeteria trays
- ♦*Beads and Bobbles Data Sheet*

What to Do:

Introductions:

This activity is best done with younger students (grades 5-7). It can also be done as an introductory lesson in sampling techniques followed by the Sampling for the "e" Organism activity as a reinforcement activity.

Introduce the activity by telling your students that the class will need to determine how many of a certain type of bead are found on your "Bead Beach," which is represented by all the trays in the classroom. Each group of students has been assigned a certain area of the "Bead Beach" to sample, represented by their individual tray. Ask students for ideas on strategies that could be used to count the beads in your sample area and also determine the total number of beads on the beach. List all possibilities. Discuss the meaning of "sampling" and what some objectives might be for sampling various things.

Procedures:

Distribute cafeteria trays with various beads and bobbles on them to each student or group of students. Groups of 2-3 students work best. Tell them they will be counting the number of a certain type of bead found on their "beach" tray. Each beach tray represents a section of a beach and their goal is to find out how many of a certain kind of bead can be found on the beach. Each group needs to get an estimate of the total number of these beads found on their "beach" tray. Give them 30 seconds and tell them to begin counting. After 30 seconds discuss the results with the students. Brainstorm ideas for more a more efficient way to sample their "beach." Introduce the idea of "random sampling" to get an estimate of population density. Discuss possibilities for making the sampling uniform. Introduce the slide holder which will represent a quadrat - a common unit for sampling - as a means of getting a "population" estimate. Instruct the students to randomly toss their quadrat onto their "beach" tray and count the number of beads in the quadrat. Continue to follow the instructions on the *Beads and Bobbles Data Sheet*. When everyone has finished share your results and discuss the follow-up questions as a class.

Follow-up

Questions to discuss as a class:

1. How close was your answer to your estimate?
2. Were there any steps on the instructions on the *Beads and Bobbles Data Sheet* that were not clear? If so, what would make the instructions clearer?
3. Did we really answer the question of how many beads are in on our "beach"? If not, how could we?
4. How does this relate to how you might count the number of snails on a seashore?

Beads and Bobbles Data Sheet

1. Estimate how many beads you think are on the beach. __________

2. Toss a slide holder (your quadrat) onto your beach tray.

3. Count the number of beads in the quadrat. __________

4. Repeat steps 2 and 3. Record the number of beads. __________

5. Repeat steps 2 and 3. Record the number of beads. __________

6. Add the number of e's in the three quadrats (steps 3-4). __________

7. Divide the answer in step 6 by the number 3 to get the average number of beads in a quadrat.

   __________ /3 = __________

8. Measure the area of the beach tray. __________

9. Measure the area of the quadrat. __________

10. Divide the answer on step 8 by the answer in step 9 (area of beach tray/area of quadrat) to get the total number of quadrats in a beach tray.

    __________ / __________ = __________

11. Multiply the answer in step 10 by the answer in step 7 (number of quadrats on a tray times the number of beads per quadrat) to get the average number of beads on a tray.

    __________ x __________ = __________

12. Multiply the answer in step 11 by the number of trays on the "beach" to get the average number of beads on the beach.

    __________ x __________ = __________

Sampling for the "e" Organism

Objective:

Students will experiment with a sampling technique and form inquiries about effective sampling techniques.

Concept:

It is important to have a uniform sampling tool and guidelines, protocols, for selecting how and where to sample so that data that is collected is an accurate representation of what was sampled and can be compared with data collected in other areas using the same protocol worldwide.

You Will Need:

- ♦Newspapers
- ♦*Sampling the "e" Organism Data Sheet*
- ♦Slide frames
- ♦Rulers
- ♦Calculator (optional)

What to Do:

Introductions:

This activity is best done by older students (grade 7-12) or as a follow up to the Beads and Bobbles Activity. Introduce the activity by telling your students that the class has the task of determining how many "e's" are used in a newspaper. Ask students for ideas on strategies that could be used to count the "e's" in your sample newspapers. List all possibilities. Discuss the meaning of "sampling" and what some objectives might be for sampling various things.

Procedures:

Distribute a section of newspaper to each student. Tell them they will be counting the number of "e's" used in their section of paper to get an estimate of the total number of "e's" found in a newspaper. Give them 3 minutes and tell them to begin counting. After 3 minutes discuss the results with the students. Brainstorm ideas for more a more efficient way to sample the newspaper. Introduce the idea of "random sampling" to get an estimate of population density. Discuss possibilities for making the sampling uniform. Introduce the slide holder which will represent a quadrat - a common unit for sampling - as a means of getting a "population" estimate. Instruct the students to randomly toss their quadrat onto a sheet of newspaper and count the number of "e's" in the quadrat. Continue to follow the instructions on the *Sampling the "e" Organism Data Sheet*. When everyone has finished share your results and discuss the follow-up questions as a class.

Follow-up

Questions to discuss as a class:

1. How close was your answer to your estimate?

2. Were there any steps on the instructions on the *Sampling the "e" Organism Data Sheet* that were not clear? If so, what would make the instructions clearer?

3. Did we really answer the question of how many "e's" are in a newspaper? If not, how could we?

4. How does this relate to how you might count the number of snails on a seashore?

This activity was designed by GLOBE teacher Peggy Lubchenco in Santa Barbara, CA.

Sampling the "e" Organism Data Sheet

1. Estimate how many "e's" you think are in the newspaper ________

2. Toss a slide holder (your quadrat) onto a single sheet of newspaper.

3. Count the number of "e's" in the quadrat. ________

4. Repeat steps 2 and 3. Record the number of "e's." ________

5. Repeat steps 2 and 3. Record the number of "e's." ________

6. Add the number of "e's" in the three quadrats (steps 3-4) ________

7. Divide the answer in step 6 by the number 3 to get the average number of "e's" in a quadrat.

   ________ /3 = ________

8. Measure the area of the newspaper page ________

9. Measure the area of the quadrat ________

10. Divide the answer on step 8 by the answer in step 9 (area of newspaper page/ area of quadrat) to get the total number of quadrats in a newspaper page.

    ________ / ________ = ________

11. Multiply the answer in step 10 by the answer in step 7 (number of quadrats on a page times the number of "e's" per quadrat) to get the average number of "e's" on a page.

    ________ x ________ = ________

12. Multiply the answer in step 11 by the number of pages in the paper to get the average number of "e's" in the newspaper.

    ________ x ________ = ________

Practicing Protocols

Objective:

Students will become familiar with the specific data entry forms for the monitoring activity you have chosen by practicing in the classroom.

Concept:

By becoming familiar with the data forms used on the beach to collect data in the field, students will be able to maximize their time in the field and will collect better quality data.

You Will Need:

- ♦copies of the data sheets
- ♦large photo of the beach
- ♦quadrat
- ♦stopwatch

What to Do:

Introductions:

This activity is best done after you have completed the sampling activities and prior to your beach monitoring or coastwalk trip.

Explain to your students that you will be practicing with the real data sheets that will be used during your field trip and the more familiar they are with the data sheets and the information that is to be collected - the better their experience at the beach.

Procedures:

Choose one of the following activities to do with your class based on which beach field activities you have chosen to do with your class.

Coastwalk Scavenger Hunt

Divide the class into pairs. Using your *Coastwalk Data Sheet* and the *Coastwalk Basic Beach Illustration Worksheet* do a scavenger hunt to find as many items on your Coastwalk data sheet as possible. When you have completed your organism scavenger hunt go outside (or to the lunch room) and look for signs of human impact in your schoolyard and collect data on trash found. Come back together as a class and discuss your findings and answer any questions that came up while practicing the Coastwalk protocols.

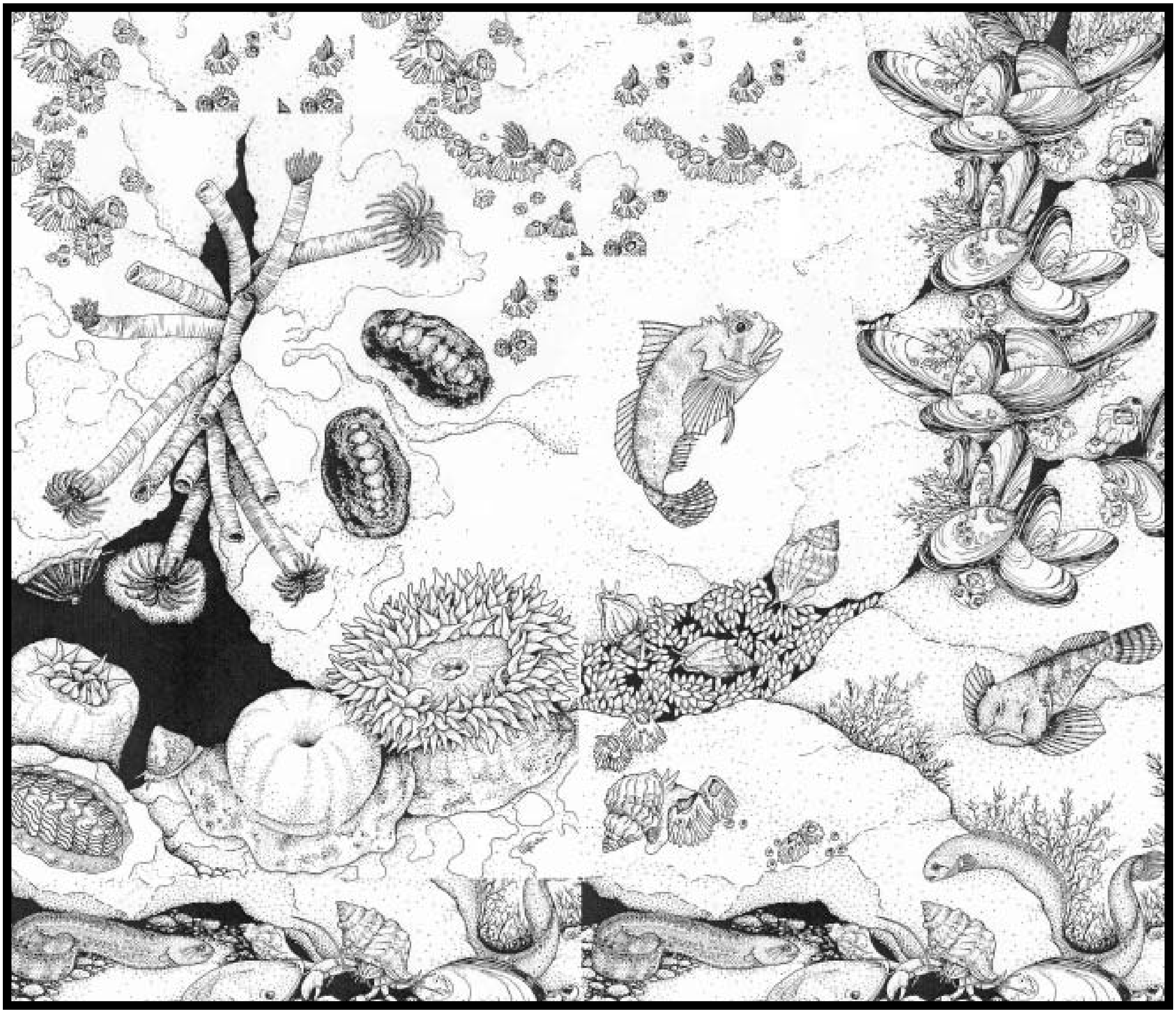
Playground Protocols - Timed Counts

Divide your class into groups of 4 and assign each group an "animal" to count. Your "animals" can be anything that is found in some quantity on your playground. For example, you can count trash, certain color rocks, pre-planted items such as cones, balls, and popsicle sticks. Give the groups their data sheets and use a whistle to signal the start time. You may want to modify the count time to be only 5 minutes if your area is small or there are not very many of the items you are counting. Have students count their "animals" for the designated time and, when signaled, stop counting and regroup to go over their findings. Lead a discussion about what assumptions can be made about playground use based on their findings. Go over any problems or situations that may have come up such as picking up the item and moving it or keeping it, more than one person counting the same item, how to spread out and cover the most ground as a group, etc. Switch items to count and do the activity again if time permits.

Photo Quadrat Practice

Using enlarged photos of a section of beach and your quadrat data sheets, have students work in groups of 4 to practice counting organisms in the quadrat and recording data. Have students practice looking for the area where their organism seems most dense and counting and randomly tossing their quadrat and counting organisms. Discuss the protocols for counting organisms that are only partway in the quadrat. Tally your findings and try to identify your organisms. Practice on various photographs - or beach sections - if there is time.

Coastwalk Basic Beach Illustration Worksheet



Organism Count	Organism Count	Organism Count	Organism Count

Beach Etiquette

Objective:

Students will learn the proper etiquette for field trips to the beach.

Concept:

By reviewing proper beach etiquette students will be properly prepared for both the field trip experience and the ways in which their presence and activities on the beach could impact the beach habitat they are trying to study.

You Will Need:

- ♦Beach etiqutte grab bag (see content list at end of activity)
- ♦Beach etiquette hand-out

What to Do:

Introductions:

Prepare students for their beach field trip by discussing possible impacts their presence at the beach might have and ways in which they can help to minimize the impact and prepare themselves for a successful trip.

Procedures:

Have students come up, one at a time, and pull an item out of the grab bag. Ask the student to try to think of a way that their item symbolizes a beach etiquette "rule" that should be followed or action they should take at the beach.

Once all of the items have been pulled from the bag distribute the Beach Etiquette brochure and discuss any other items that are useful to your group.

Beach Etiquette Grab Bag

Boot: Walk single file over areas of attached plants and animals. Walk don't run and watch where you step!

Rock covered with barnacles on one side: Return rocks to original position. Turn rocks over gently. Don't turn over really large rocks or you might crush the animals who live below!

Snail shell: If you find an animal tightly attached, leave it attached! Don't collect shells and other "beach stuff" because they can be a home to other animals.

Toy/Plastic crab: Hold animals close to the ground...they may be slippery, slimy or quick. Use small tubs and buckets if possible to view animals. Cup hands and keep them moist with a little bit of water if you are holding animals.

Toy shovel: Fill in holes! Small animals left underneath a big pile of mud and sand can be killed and someone could fall in the hole and get hurt.

Hat: Dress warmly!

Litter: Don't litter, in fact - let's pick up trash!

Designing an Inquiry

Objective:

Students will develop their own inquiries designed to investigate the intertidal zone.

Concept:

Inquiry-based education provides students with an optimal learning environment and helps them to develop higher level thinking skills such as observing, hypothesizing, planning investigations, interpreting findings and drawing conclusions and communicating. Coastal monitoring programs offer a prime opportunity to reinforce these concepts and this learning style.

You Will Need:

- ♦ Data sheets from your initial beach exploration trip
- ♦ Data sheets from the monitoring program you have chosen

What to Do:

Introductions:

Once you have made at least one trip to the beach you are ready to begin designing an inquiry with your students. Older students can individually develop inquiries as mini-research projects or as a way to guide them in their scientific exploration of the intertidal zone and the monitoring program you have chosen. If you have younger students you may wish to develop one or two inquiries as a class and work through the various stages of the project together so your students gain a sound understanding of the inquiry process.

Applaud your students on their efforts to collect data at the beach (no matter what level you have chosen as your monitoring unit). Encourage the class to discuss some of their observations of the beach, the intertidal zone and the organisms they observed. Tell the students that they will continue their investigations by following a similar process that all scientists use to answer questions and conduct research.

Procedures:

After your general discussion review the steps for developing an inquiry

1) Identify questions and concepts that guide their scientific investigation
2) Design and conduct their scientific investigation
3) Formulate and revise scientific explanations and models using logic and evidence
4) Recognize and analyze alternative explanations and models
5) Communicate and defend a scientific argument

Using the above steps as a guideline to assist your students in developing an inquiry:

1) Instruct the students to work in pairs to develop a question that they would like to investigate throughout their monitoring program. Once they have their question they need to design their investigation - this will involve choosing the appropriate kind of protocol to collect data that addresses their question. This type of inquiry should be different than the invertebrate research in that students should be looking at addressing a question about how their organism interacts in the intertidal environment, or how a certain observable change will affect the beach, it's inhabitants, perhaps even the humans.

2) Students should review the various sampling techniques described in this manual and choose

the one that would best provide the data necessary to investigate their question. They will conduct their research while participating in the beach monitoring trips that the class is conducting throughout the year. If you are working with older students it is possible to have them develop and conduct their own sampling and research at other times throughout the year.

3) The third stage of conducting an inquiry is to research the topic, which can involve reading about their topic, doing internet searches, talking to others in the class who are conducting similar investigations and basically just collecting as much information, or evidence, on their topic as possible.

4) Once the students have gathered information and done some additional research and data collecting they need to move into the analyzing and presenting phase where they will try to draw some conclusions and then put their ideas up for peer review within the class. Students can use the data analyzing guidelines found in this manual or come up with their own graphing technique that will best illustrate their data and help them draw some conclusions. Once they have analyzed their data they are ready to present their information and put their inquiry up for peer review.

5) Students will develop a poster display of their inquiry to display at a class poster session. A poster session is a way for scientists to visually share research results and can be followed by a panel discussion or a general question and answer session. Posters should be well organized and attractive with few words and more graphics to illustrate your project. Make sure each poster includes the following components:

Title
Problem or hypothesis
Introduction
Procedures
Discussion of Results
Conclusions
Acknowledgments
Visuals of procedures and results
(graphs tables)

Following the poster session, have the class fill out the peer review forms for each presenter. You can divide the class into groups of scientist to review each other's work or have the entire class review each project. Peer review should be done on both the design of the project and the research completed and the presentation of the project.. Suggested questions to ask on the peer review include:

Is the research question clearly defined?
Are the procedures clearly described?
How well do the procedures and/or protocols chosen address the research question?
What were the strengths of this research project?
Are the data presented clearly?
Do you agree with the conclusions and are they supported by the research?
What suggestions can you make for improving this research or report?
Is the poster attractive and easy to read and understand?

Ideas for *Designing an Inquiry* were adapted from Invasion Ecology, Marianne E. Krasny and the Environmental Inquiry Team, Cornell Scientific Inquiry Series, NSTA Press, 2003.

Extending Inquiries:

Use this format to develop inquiries into potential beach use issues arising from observations made during Coastwalk monitoring.

FIELD ACTIVITIES

Selecting and Mapping a Site

Objective:

To select a beach site suitable for one of the monitoring options and record it's location and landmarks for future monitoring or exploring.

Concept:

The more you are familiar with the site you will be monitoring or exploring the better the field experience will be for you and your students.

You Will Need:

- *Tide Book*
- *GPS*
- *Camera (Digital is best)*
- *Art materials for sketching your site*
- *Clip boards*
- *Pencils*
- *Beach Map Data Sheet*

What to Do:

Introductions:

Discuss the objectives of your explorations with your students. If you have more than one beach option available discuss with your students the pros and cons of various sites to use for your field activities. Discuss the importance of selecting a site that is easily accessible, yet still offers the availability of a diversity of organisms. Brainstorm different ideas for mapping your site so that you can find the exact same spot time after time.

Procedures:

Prior to doing the site selection and mapping activities with your students you should go to the site and visually assess your options taking into consideration the diversity of organisms and how easily species to be monitored can be found, the accessibility of the beach, the safety of your students and which monitoring options might work for your location. If possible visit the beach at a good low tide to see how much beach is exposed.

Once at your beach assign students different jobs to complete the mapping of your site.

GPS reading: Have a student who is familiar with a GPS (an adult can do this if no students are able) to take a reading at your site. Record your location on the Beach Map.

Photo Recording: Have a student photograph or videotape the site facing in all four directions (4 photos). This way you can keep track of major changes in the site over time. Photograph any visual landmarks as well and document them on your Beach Map.

Sketch Map: Assign a student (or two) to make a sketch map of the site which can include notes about any special characteristics.

Time and Tide: Assign a student the job of recording the time of your visit, the low tide mark at the beginning of your visit and the tide mark by the end of your visit so you can get an idea of how fast the tide come in and how much time you will have when you return to do your monitoring.

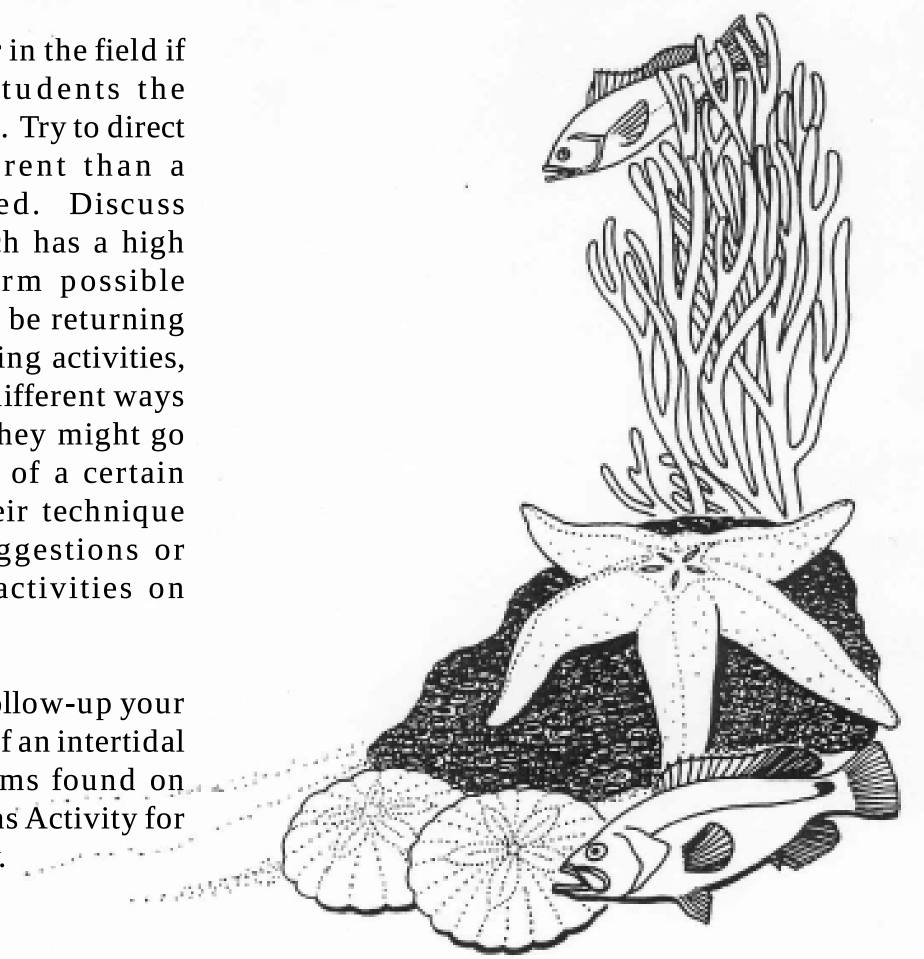
Beach Exploration:
If you have chosen Option 1 - this portion will be the focus of your field work. If you are doing Option 2 or 3, use this trip as an exploratory time to assess the animal and seaweed diversity and make an initial species list for your class.

Selecting and Mapping a Site continued...

Give your students 15-30 minutes to explore the beach within the boundaries that you have set. Have them work in pairs to record the various plants and animals they find. Have them estimate the abundance of the different types of plants and animals - noting how many of each different types they see. If this is your only trip to the beach, have students sketch the plants and animals they find noting any characteristics that might be useful for identification. Your students will use these notes to complete their species atlases when you return to your classroom.

Wrap-Up:

After you return to the classroom (or in the field if you have the time) allow the students the opportunity to share their discoveries. Try to direct them to report something different than a classmate has previously reported. Discuss whether or not they think the beach has a high diversity of organisms, brainstorm possible reasons for this. If you are going to be returning to this site to do one of the monitoring activities, brainstorm with the students about different ways you could count the animals, how they might go about finding out the abundance of a certain species and what would make their technique "scientific" or not. Use their suggestions or realizations as a lead in to the activities on sampling.



If this is your only trip to the beach, follow-up your discovery walk with the completion of an intertidal atlas showing the different organisms found on your beach. See the Making and Atlas Activity for detailed instructions for this activity.

Discovery Hike

Objective:
To explore the beach and become familiar with the plants and animals in the marine intertidal habitat while collecting some basic observational data.

Concept:
Students need time to "discover" the beach. An initial Discovery Hike can provide a hands-on learning environment by familiarizing the students with common abundant organisms and an introduction to tide zones.

You Will Need:
- ♦ *Species Diversity Checklist*
- ♦ Clipboards
- ♦ Marine invertebrate guides or ID charts
- ♦ Stopwatch

What to Do:

Introductions:
All classes should participate in a beach discovery walk as an initial filed trip to observe local organisms, check out the various types of organisms to be found at the different tidal heights and to do an initial species biodiversity checklist. This will help classes who are participating in the Coastwalk and/or GLOBE data collecting pick their species to monitor and get the students excited about their field work.

Procedures & Activities:
Make sure you have done the pre-trip activities relevant to this field trip. Students should be dressed warmly and have an idea of what they will be looking for on their beach walk. Tell the students that they are going on a Discovery Hike which means they should walk with eyes wide open - exploring every nook and cranny on the beach, searching under rocks, beneath seaweed and looking for plants and animals in every tide zone.

As a class you should decide on one of the following activities to do while you are at the beach as a way to structure your field experience. At the very least you should do the Species Diversity Checklist, which will provide data on the organisms that can be found at your beach and can provide the beginnings for further inquiry activities if you choose to do them. Timed counts can be a very exciting way to focus your search for animals and is highly recommended. Students who do the timed counts will not be turning over rocks and seaweed.

Species Diversity Checklist:
Use this list to check off all of the organisms you observe on the beach while on your Discovery Hike. Positively identify your organism by checking with your identification guide and matching the scientific name if possible. You can divide your class into tide zones and have groups of students exploring tidal bands on the beach or you can have different groups walk a vertical band by beginning at the water's edge and working their way up to the highest level on the beach where an organism can be found. Once done, the class data can be combined to get a final comprehensive species diversity list.

Timed Counts:
Timed counts are a beach scavenger hunt! They are a way to count one species (or animal group)

Discovery Hike *continued...*

of intertidal organism at a time for a 10 minute period. The goal is to count as many of the organisms as possible to give you an idea of the overall abundance of the organism on your beach. Students should only count those organisms they can see on the surface and should not turn over rocks or search under seaweed. This activity should be done after you have spent at least 15 minutes doing a general beach exploration. Following your initial beach exploration the class can help to choose the animal groups to count based on what they saw in their explorations. They should search for animals in areas where they are thought to be abundant.

If you have a large class, pairs of students can count the same animals but search in different areas of the beach. The numbers can then be combined for data analysis. If you are doing timed counts as a group, a student or the teacher can be assigned to give the signal for starting and stopping the counts. Count only one category of animal at time. Groups doing timed counts will need to search in a limited area where the category of animal is known to occur. For example, if you are searching for seastars, go to where you know that seastars occur, then start your 10 minutes of counting. At the end of 10 minutes, gather students together to share observations. Do the Scientific Convention Activity, as a wrap up, if there is time. This would also be a good time to make a list of all of the students' questions, group them in categories and discuss what makes a good "inquiry" or testable question.

Follow-Up Activity:

Hold a Scientific Convention

This is a great activity to use as a guide for your explorations or a follow-up activity.
Students will have an opportunity to talk about differences in observation techniques and scientific monitoring methodology and encourages peer learning and teaching.

After all the groups have finished with their guided beach explorations (timed counts, species diversity list, etc.), gather the group together and have a “scientific convention.” Students will act as the groups of “scientists” who will report on their findings to the rest of the group. It is fun if the lead educators are quirky convention reporters during this convention, so that key questions can be asked to the scientists: “How did you come about these findings?” and, to a member of the ‘audience’: “How would you have gone about answering this question?” In particular, it is key to prod students to ask and answer their own questions about the data they are collecting and the merits of their methodology.

This activity is a great one to stress that scientists are just everyday people who have questions and go out and try to get the answers to them. It also stresses that sometimes you can begin with one hypothesis but over time it can change with more observation or knowledge, because oftentimes it happens during the activity itself. You can also stress the importance of sharing scientific knowledge within not only the scientific community, but the entire community at large as well.

CoastWalk Survey

Objective:

To explore the beach and become familiar with the plants and animals in the marine intertidal habitat while collecting some basic observational data. To build community awareness of the importance of our local marine habitats. To gather data to detect long-term trends in biodiversity and to observe the effects of human impact.

Concept:

CoastWalk is a unique community science and stewardship program that encourages students and community members to participate in general observations about their coastal environments. Stewardship programs promote a better understanding of the environment and a sense of responsibility for its future.

You Will Need:

- CoastWalk *Data Sheets*
- Map of your stretch of beach
- Pencils
- Binoculars
- Identification guides

What to Do:

Introductions:

Review your checklist materials with the class prior to your CoastWalk to familiarize yourself with what you might see on your field trip. Review the tide zones so that students are sure of where they are to be conducting their surveys. Make sure all of your students are dressed appropriately for the weather.

Procedures:

Divide the class into teams of two with one team walking the high tide and the other team walking the low tide zone. Walk a zig zag path between the high and low tide lines. You can also walk the low tide line out and the high tide line back if you need to.

When recording data use tally marks in groups of five, then total when finished. For large groups of organisms, count ten then use that benchmark to estimate the rest. If you are not sure of the identity if an organism - don't record it. If you encounter a dead or stranded animal, make a note of its location and leave it alone.

Walk your designated zone recording your data on the data sheets. Take pictures of organisms and unusual sites for documentation. Pick up trash along the way and take it to a local dumpster. Return your completed data sheets to the Center for Coastal Studies.

Wrap-Up:

When you return to the classroom go over your data as a group. Do the graphing activity to compare low and high tide zone findings. Discuss human impact issues that may have come up on your stretch of the beach. Do the Design and Inquiry activity as a class to explore one issue or have the teams of students develop their own inquiries based on issues they have identified.

Extensions:

Keep some of your more interesting trash finds and hold an art contest back in the classroom. Challenge the students to come up with the most creative display of beach debris art.

Collecting GLOBE Data

Objective:

To explore the beach and become familiar with the plants and animals in the marine intertidal habitat while collecting some basic observational data. Specifically to answer the question: What is the density of common marine invertebrates on ocean coasts worldwide?

Concept:

This data will create a baseline for densities of common invertebrates on coastal shores worldwide. The data will allow us to monitor the health of coastal ecosystems by providing us with data to track changes in densities of these common organisms over time and across multiple sites.

You Will Need:

- Density Quadrats
  (*see instructions at end of lesson*)
- Frequency Quadrat (at least 1)
- Timer or watch (for timed counts)
- Data sheets
- Clipboard
- Pen (with waterproof ink) or pencil
- Tide chart
- GPS and camera (optional)

What to Do:

Overview of activity: Students will estimate the densities of certain broad categories of animals, common on many coastal shores worldwide. They will estimate the density, or frequency of common invertebrates in areas in the intertidal where they determine each invertebrate is common. There is a choice of sampling mode and species to count depending on which the class decides is best at their site.

The choices for sampling modes are to estimate

1) ***density using quadrats*** 25x25 cm and estimating a maximum density (the average of 3 quadrats with the most you can find), and average density (the average of 3 quadrats tossed randomly in the same general area), or

2) ***frequency*** (presence or absence of species in a 50x50 cm quadrat divided into 25 equal sized squares, tossed 3 times), or

3) ***timed counts*** (number counted in 10 minutes of counting). The choices of species are snails, limpets or chitons, barnacles, a bivalve (mussels, oysters, clams or scallops), an echinoderm (seastars, sea urchins or sea cucumbers), or crab.

On sandy shores, you can also count holes/ casings/casts on the sand. Each school chooses four categories to count.

Procedures:

Consult a tide chart or calendar to determine a day and time for your visit when there will be a low tide at the site. Prior to your trip, divide the class into pairs of students.

Plan to arrive before low tide so that you have time to explore the lowest tide levels while they are out of the water.

On the day of your first trip discuss with your students the characteristics of your site, particularly the area where you are sampling:
What is the substrate mostly?
Rock, cobble/boulder, sandy, muddy
What is the exposure to the open ocean?
Open coast, protected bay, semi-protected.
What general name would you give your site from the following (choose one, best)?

Collecting GLOBE Data continued...

Sandy bay, mudflat, rocky shore, cobble beach, sandy beach, estuary, sand with some rocks, rock with some sand

Explore your site and choose the animals that you will count. It is strongly encouraged that you complete a Discovery Hike first to familiarize you and your students with the beach site and allow you to make a list of the most common animals at your site. Plan to count five of the categories.

For each animal you are going to count, decide on what seems to be the best mode of sampling (maximum and average density, frequency sampling, or timed counts). As a class, first, spend 10 minutes trying out a sampling mode. If it doesn't work well (takes too long to count, or animals are too rare for a quadrat count, or too numerous), switch to a different sampling mode.

Assign each predetermined pair of students a single category of animal to count either using a quadrat, or a timed count

Once each team has a designated category and measurement technique (quadrats or timed counts) assigned, send them to their particular area where the category is known to be common.

Specific Sampling Instructions:

Activity 1, Density Quadrats (25x25 Quadrat): Find an area where the category of animal is very common. Intentionally choose three sites where you find the most individuals in a quadrat and count the number in 3 different quadrats (maximum counts). Then, in the same general area, toss the quadrat over your shoulder so that it lands at random but within the area where that animal occurs. Count all of the individuals in that category that occur in the quadrat where it lands. Repeat this process three times. Include any animal that is present in your quadrat, even if it is only part-way in the quadrat.

Activity 2, Frequency Quadrats (50 cm x 50 cm quadrats, divided into 25 squares). Toss the quadrat 10 times at random in an area where that species is common. Count presence or absence in each of the 25 squares of the quadrat. You will have a maximum of 25. For example, you might find that the animal occurs in 10 of the 25 squares. This would be a frequency of 10/25 = .40 for that quadrat. If an individual is partway in the square, include it as "present" if it is more than halfway.

Activity 3, Timed Counters. If you are doing timed counts as a group, a student or the teacher can be assigned to give the signal for starting and stopping the counts. For timed counts, count only one category at time. Groups doing timed counts will need to search in a limited area where the category of animal is known to occur. For example, if you are searching for seastars, go to where you know that seastars occur, then start your 10 minutes of counting.

Sampling:

Have students collect their data on the corresponding *Rocky Shore Monitoring data sheets.* If you are doing timed counts as a group, a student or the teacher can be designated to give the signal for starting and stopping the counts.

Collecting GLOBE Data continued...

Optional: Photograph or videotape the site facing in all four compass directions (4 photos). This way you can keep track of major changes in the site over time. Also, note visual landmarks, make a sketch map, and take a GPS reading. Record the common name of the beach. This information will help you or another class to return to the same beach on future sampling times.

Follow-Up

Pool the data from all groups and calculate the average for each type of sampling (average maxima, and average for density counts), average frequency for frequency counts, and average per 10 minutes counting for 10 minute counts. Record the number of values (called "N") that went into each average. For example, if 10 groups counted 3 quadrats each of chitons in density quadrats, that would be 10 x 3 = 30 values that went into that average. Enter the category of animal, scientific name if known, sampling mode, averages and N values for each category of animal on the teacher worksheet and eventually on the GLOBE server.

Background information

Random sampling can yield data with very low or no numbers, and can produce unreliable data when the habitat being sampled is highly heterogeneous, and where many species have clumped and/or very sparse distributions over the landscape. This is especially true for rocky shore habitats where tidal elevation can change dramatically over a short distance and where many microhabitats exist from tide pools to rock crevices. For this reason, we ask you to actively choose areas in the intertidal zone where the organism you are interested in is very common, for example, the barnacle "zone". Within that zone, you then randomly throw quadrats and count the number of animals in each quadrat.

GLOBE is unusual in that it is a database that collects data with procedures that are general enough to be applied across habitats and species ranges. For this reason, we ask schools to count categories of organisms, rather than particular species. You might want to keep track of which species are dominant in the quadrat and timed counts for each category for your own interest at your site. Schools along the same coastline may be counting the same species and can compare their numbers over time. To compare your data with that of schools across the world, you will have to consider them in higher taxonomic categories, such as snails, bivalves, or barnacles. This allows us to ask questions of the GLOBE data such as "How are snails, limpets or bivalves doing worldwide?" "Are bivalves declining in densities, perhaps indicating poor water conditions since they are filter feeders?" "Are snails declining worldwide, perhaps due to a drop in their food supply – algae – due to higher than average water temperatures?"

Instructions for making quadrats:

Density Quadrats: Using pvc tubing and elbow joints, cut tubing so that the inside dimensions of your square measure 25 cm x 25 cm. You will need one quadrat for each pair of sampling students.

Frequency Quadrats: Using pvc tubing and elbow joints, cut tubing so that the inside dimensions of your square measure 50 cm x 50 cm. Divide your quadrat into 25 equal sized squares marked with string. You will need one quadrat for each pair of sampling students.

Collecting GLOBE Data continued.

Seaweed Reproductive Protocol

Objective:

To classify and count the reproductive phenological phases of receptacles on selected seaweed species.

Students will be able to:

- ♦ Identify reproductive stages of seaweed plants
- ♦ Graph the relative abundance of the reproductive stages
- ♦ Compare when reproductive stages occr in different places
- ♦ Explore relationships between reproductive stages and climate factors

A GLOBE protocol has been developed but had not yet been incorporated into the GLOBE Teacher Manual at the time this curriculum packet was finalized in March, 2004.

This data collection activity will be relevant to Alaskan rocky shores - *Fucus distichus*, a ubiquituous mid-intertidal zone seaweed on Alaskan shorelines, is the is one of the selected seaweed species for this study. The Teacher Guide will include descriptions of the reproductive stages tof *Fucu*s o be observed, along with illustrations of each stage. Measurements consist of counting plants within a plot, noting the reproductive stage of each plant, and counting receptacles.

This protocol will require four visits to a site (once a month for four consecutive months begining in the spring) during the lowest tide of the month.

The protocol will be posted on the GLOBE Web site http://www.globe.gov

POST TRIP ACTIVITIES

Entering Data into a Database

Analyzing Data

Objective:

Students will create a graph to illustrate their findings following their coastal monitoring field trip. Students will choose a graph that best represents their data.

Concept:

Students can gain a better understanding of the information they have gathered and the results of their monitoring by making a visual representation of the information.

You Will Need:

- ♦Large chart paper or black board
- ♦Data summary sheets
- ♦Graphing examples Worksheet
- ♦Colored opens or pencils

What to Do:

Timed Counts:

The best way to illustrate your findings after conducting timed counts is to make either a vertical bar graph or a pie chart that shows the number of organisms counted. A pie chart can also show the percentages of organisms found in the area and can help students to visualize the diversity of animals on your beach. Have students work in groups or pairs to compile the information you have collected. For example, all students who counted "sea stars" should work together to compile their data. Groups can do individual graphs showing species breakdown as well. As a class, draw a large graph on the board and have a representative from each group come up and chart their findings. Discuss the results as a class.

Some questions to ask might be:

What animal group is most abundant on our beach?

What tidal zone is that animal group found at?

Why do you think this group is found here?

Why do you think there are so many (so few) of a certain organism?

What factors do you think contribute to the abundance (or lack of abundance) of certain organisms on our beach?

CoastWalk Survey:

Once back in the classroom compile information collected either in small groups or as a class. Choose a graphing technique that will best represent your data and work as a class to illustrate your findings. If you have participated in a previous CoastWalk include doing a comparison graph that might show trends that can lead to class discussions about cause and effect.

GLOBE monitoring:

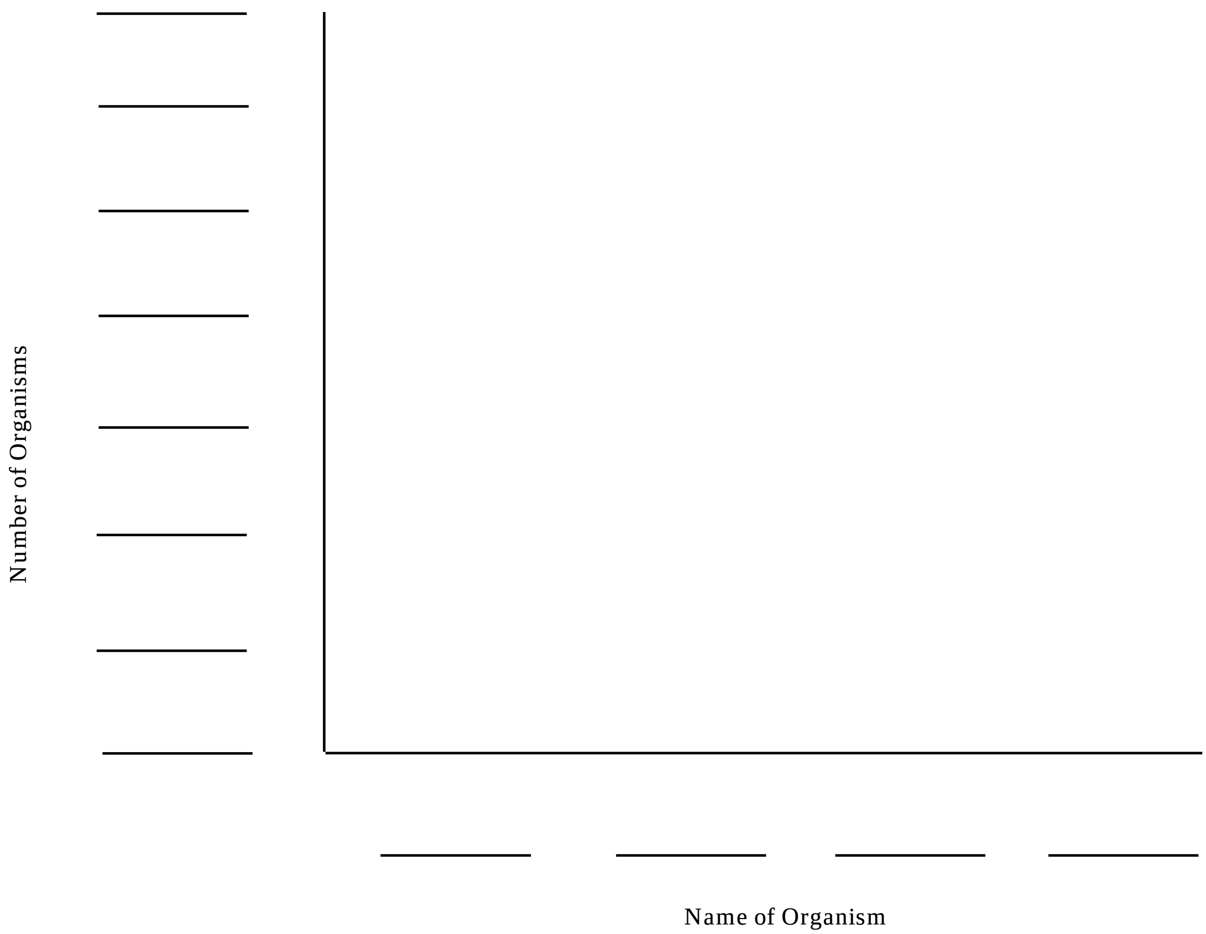
Once back in the classroom, have groups of students compile their data and choose the best graphing method to illustrate their findings. A bar graph or pie chart would work well for this information. A scatter plot works well for the frequency data.

Follow the directions for Timed Counts graphing. If you have participated in a previous GLOBE coastal monitoring field trips, compare your data to past data collected using either a line graph or

Analyzing Data

Graphing Examples

Bar Graph



Glossary

Abiotic factors: physical parameters, such as temperature, pH, salinity, humidity, etc.

Abundance: number, or amount, of organisms that you can count.

Adaptation: the gradual changing of structure, form or behavior of a plant or animal to increase its chances of survival and reproduction.

Alga (AL-guh) [plural algae(AL-jee)]: a photosynthetic, plant-like protist.

Arthropod: An invertebrate with a jointed body case.

Bilateral symmetry: a type of symmetry in which the body can be divided, down the midline, into two equal halves.

Biota (by-OT-a): species of all the plants and animals occurring within a certain area or region.

Biodiversity: The variation in life on Earth reflected at all levels from various ecosystems and species to the genetic variation within a species.

Blade: The leaflike part of many seaweeds.

Carnivore: an animal feeding on the flesh of other animals.

Cnidarian (Nigh-dare-ee-in): An invertebrate with a digestive cavity that has only one opening.

Community: a group of plants and animals living in the same area and depending on one another for survival.

Competition: occurs when a number of organisms of the same or of different species compete for common resources that are in short supply, such as food, space, or mates.

Density: number of individuals in relation to the space in which they occur.

Desiccation: when a plant or animal is exposed to the sun or wind and is unable to maintain needed moisture, and dries out.

Detritus: small particles of dead plant and animal matter.

Distribution: where the organisms live in an area, e.g., high intertidal vs. low intertidal, or over their whole range.

Dynamics: in population ecology refers to the study of the reasons for changes in population size.

Echinoderm: (EE-kine-o-derm): An invertebrate with an internal skeleton and fivefold symmetry.

Ecology: the study of how organisms interact with the physical (nonliving) and biological (living) parts of their environment.

Ecosystem (EE-koh-sis-tum): biotic community and its abiotic environment.

Endo-: a prefix referring to something that is internal

Exoskeleton: an external skeleton, as in crustaceans and other arthropods.

Filter Feeder: an animal equipped with hairs, tentacles, sieves, or other devices for straining plankton and minute particles of detritus from he water (e.g., clams, oysters, mussels, tube worms, and barnacles).

Food web: interconnected feeding relationship of who eats whom in an ecosystem, starting with autotrophs - algae and plants - and ending with the carnivores.

Foot: in molluscs, the organ used for crawling, digging, and some other functions.

Frond: the blade-like or leaflike expansion of seaweeds in which the functions of a stem and leaf are not distinguished.

Holdfast: a structure anchoring seaweeds to rocks and other hard surfaces.

Intertidal: the area between the high tide mark and the low tide mark on a seashore.

Kelp: large, brown seaweeds with strong holdfasts.

Limiting Factors: influences on an organism's ability to maintain its population (e.g., food, water, shelter, space, temperature, light, salinity, oxygen, type of bottom; as well as predators, competition, pollution and overharvesting).

Glossary

Mantle: in molluscs, an outer sheet of tissue that secretes the shell and also encloses the cavity within which the true gills (if present) are located.

Mollusc: A soft-bodied invertebrate that is often protected by a hard shell.

Monitor: to study an area in a way that gathers data relating to changes (or lack of changes) over time, i.e., changes in species abundance, composition, distribution, etc.

Muscular Foot: the wide, flat-ended or wedge-shaped muscle used for crawling or digging (found on snails, limpets, chitons, abalones and clams).

Nematocyst: in cnidarians, a stinging capsule.

Niche (NICH): the role played by an organism on a community; its requirements for food and shelter, special behaviors, as well as its function (e.g., predator, decomposer, scavenger, and how it performs that function).

Phylum (FYE-lum) (plural phyla): a taxonomic category within Kingdoms; e.g. sponges, arthropods, echinoderms within animals, phyla are divided into classes.

Population: group of individuals of a single species.

Quadrat: not a recognized word in Webster's Dictionary but a word ecologists have been using for years. Refers to a grid (of pvc pipe usually) you place in an area to count organisms.

Radial symmetry: a type of symmetry in which the structures of the body are arranged around a central point, so that the animal can be divided into several equal parts (as in jellyfishes, sea stars and sea urchins).

Radula: a rasping, tonguelike structure used for scraping food from rocks and sometimes for boring holes through shells.

Random: chosen with no specific pattern, haphazard.

Sample: when you go into the field and collect data you are "sampling."

Sessile: attached to an object or fixed in place (e.g., barnacles), in contrast with sedentary (rarely moves) and motile (moves from place to place).

Species (SPEE-seez): a particular kind of organism, its members having similar anatomical characteristics and the ability to interbreed.

Stability: absence of fluctuations in populations, the ability to withstand perturbations without large changes in composition.

Stipe: the stem-like part of many seaweeds.

Stratified: a sampling pattern where you have some level of separation between plots, e.g., the mid and low intertidal zone are considered separately and you sample randomly within each area, or when you are sampling only flat surfaces and not pool.

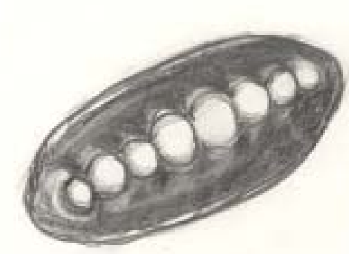
Tidal height: the height of the tide on the shore above or below a fixed level, can be measured with a stadia rod and eyepiece.

Tidepool: a pool of sea water isolated in the rocky intertidal when the tide goes out; also tide pool.

Transect: a line across an area to be sampled, marked by a tape measure (you bring the tape in the field with you each time and don't leave it in the field); it is good to put permanent markers at the ends of the line so when you bring in the tape measure out each time, you can easily find your transect line over time.

Tube feet: special attachment appendages for movement and for collecting food: as in sea stars, urchins and cucumbers.

Zonation: an arrangement of plants and animals in horizontal levels on the shore.



Black Leather Chiton

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Life in a Massachusetts Tide Pool: www.old.umassd.edu/Public/People/Kamaral/thesis/tidepools.html

PBS: Life at the Edge of the Sea: and Shape of Life. www.pbs.org/wnet/nature/edgeofsea

Marine Biodiversity Pages: www.oceanlink.island.net/oinfo/biodiversity

LiMPETS: http://limpets.noaa.gov

BRIDGE: Ocean Science Teacher Resource Center: www.vims.edu/bridge/

Woods Hole Sea Education Association: www.seaedu/k12LessonPlans/k12pgmtop.htm

Bamfield Marine Station: www.oceanlink.island.net

Science Standards with Integrative Marine Science at UCLA: www.msc.ucla.edu/sswims/marinelinks2.htm

GLOBE: www.globe.gov
EVOS/GEM: www.evostc.state.ak.us/gem/
National Science Standards: www.nas.edu

Science Standards

Monitoring Activity	AK State Content Standards A: 12	A: 14	A: 15	B: 1	B: 2	B: 3	B: 4	B: 6	C: 2	C: 3	C: 4	C: 5	D: 1	D: 3		National Science Standards: A	C	E	F
Pre-Trip Activities																			
Classification Game	*					*			*				*			*	*	*	
Fab-Four	*	*		*	*	*	*	*								*	*		
Know Your Seaweed		*		*	*	*										*	*		
Counting Beads and Bobbles			*	*					*							*			
Sampling for the "e" Organism			*	*					*							*		*	
Practicing Protocols			*	*					*							*		*	
Beach Trip Etiquette			*					*											*
Designing an Inquiry	*	*	*	*	*	*	*	*	*	*	*		*	*		*	*	*	*
Field Activities																			
Selecting and Mapping a Site				*	*			*								*		*	*
Discovery Hike	*	*	*	*	*						*		*			*	*	*	*
Coastwalk Survey	*	*	*	*	*				*	*	*		*			*	*	*	*
Collecting GLOBE Data	*	*	*	*	*	*			*				*			*	*	*	*
Post-Trip Activities																			
Analyzing Data	*	*		*			*		*			*		*			*	*	*

Alaska Content Standards Addressed:

Content Standard A: A Student should understand scientific facts, concepts, principles and theories.

A12 distinguish the patterns of similarity and differences in the living world in order to understand the diversity of life and understand the theories that describe the importance of diversity for species and ecosystems (Diversity)

A14 understand the interdependence between living things and their environments; and understand that a small change in a portion of an environment may affect the entire environment (Interdependence)

A15 use science to understand and describe the local environment (Local Knowledge)

Content Standard B: A student should possess and understand the skills of scientific inquiry.

B1 use the processes of science;

B2 design and conduct scientific investigations using appropriate instruments

B3 understand that scientific inquiry often involves different ways of thinking, curiosity, and the exploration of multiple paths

B4 understand that personal integrity, skepticism, openness to new ideas, creativity, collaborative effort, and logical reasoning are ll aspects of scientific inquiry

B6 employ strict adherence to safety procedures in conducting scientific investigations

Science Standards continued...

Alaska Content Standards Addressed:

Content Standard C: A student should understand the nature and history of science.

C2 understand that scientific knowledge is validated by repeated specific experiments that conclude in similar results
C3 understand that society, culture, history and environment affect the development of scientific knowledge
C4 understand that some personal and societal beliefs accept nonscientific methods for validating knowledge
C5 understand that sharing scientific discoveries is important to influencing individuals and society and in advancing scientific knowledge

Content Standard D: A student should be able to apply scientific knowledge and skills to make reasoned decisions about the use of science and scientific innovations.

D1 apply scientific knowledge and skills to understand issues and everyday events
D3 recommend solutions to everyday problems by applying scientific knowledge and skills

National Science Standards Addressed:

Content Standards, Grades 5-12:

A. Science as Inquiry
* Abilities necessary to do scientific inquiry (5-12)
* Understanding about scientific inquiry (5-12)

C. Life Science
* The characteristics of organisms (K-4)
* Structure and function in living systems (5-8)
* Reproduction and heredity (5-8)
* Regulation and behavior (5-8)
* Populations and ecosystems (5-8)
* Diversity and adaptations of organisms (5-8)
* Biological evolution (9-12)
* Interdependence of organisms (9-12)
* Behavior of organisms (9-12)

E. Science and Technology
* Understanding about science and technology (K-8)
* Understandings about science and technology (5-12)
* Abilities of technological design (5-12)

F. Science in Personal and Social Perspectives
* Populations, resources and environments (5-8)
* Science and technology in society (5-8)
* Personal health (5-8)
* Natural hazards (5-8)
* Personal community Health (9-12)
* Population growth (9-12)
* Natural resources (9-12)
* Environmental quality (9-12)
* Natural and human-induced hazards (9-12)
* Science and technology in local, national and global challenges (9-12)

Trash & Pollution

Please note presence:

- ☐ Aluminum
- ☐ Bouys
- ☐ Garbage Dumps (Please note location on your zone map)
  - ☐ Private
  - ☐ Industrial
- ☐ Glass
- ☐ Metal
- ☐ Plastics
- ☐ Styrofoam
- ☐ Visqeen
- ☐ Fishing Gear (please describe)
- ☐ Vehicle/Boat Part(please describe)

Please note the location of large accumlations or large objects that reqire removal on your map.

Toxic Pollution (Please note location.)

- ☐ Fuel
- ☐ Lubricating Oil
- ☐ Paint
- ☐ Batteries

Outfalls or Pipes (Please note location.)

Total Number________

Comments on Discharges (bad odors, foam, ect.)

____

____

No. of bags of trash collected _____

Comments

Please comment on the overall conditions of the beach and amount of garbage and pollution. If you've walked this beach in the past, how does it compare? Use an extra sheet of paper if needed.

CoastWalk
c/o Center for Alaskan Coastal Studies
PO Box 2225

CoastWalk Checklist

Zone Number:_________

Please mark the start and end of your walk on your map.

Date:_______ Time Started:_____Time Ended:____

Day's Lowest Tide:________feet at____________

Coastwalker's Name:________________________

Address:____________________________________

____

Phone:_____________________________________

Other Members of Group:_____________________

____

____

Weather Conditions

Air Temperature:____________________

☐ Overcast ☐ Partly Cloudy ☐ Clear

Wind Speed________ Wind Direction_____

Which vertical zone(s) did you walk?

☐ High ☐ Middle ☐ Low

Number of hours spent:____________

Miles of shoreline walked:_______

Total miles walked (include access and round-trip mileage):________________

CoastWalk Checklist

Wildlife (Actual Count)

Birds

Bald Eagles Adults____________
Immature_________
Nests____________

Sea Ducks:

Seabirds:

Shorebirds:

Loons:

Please note any unusual sightings.

Domestic Mammals

Cattle____
Horses____
Dogs____
Other____

Land Mammals

Moose: _______ Adults_____Calves
Black Bears__________________________________
Brown Bears__________________________________
Land/River Otter_____________________________
Red Squirrels__________________________________

Marine Mammals

Sea Otters____
Harbor Seals____
Harbor Porpoises____________________________________
Steller's Sea Lions__________________________________
Whales:
Belugas_______________________________________
Orcas_____________Humpback________________
Minke_____________Gray____________________
Unidentified Marine Mammal___________________________

Seaweeds

(Check if common or abundant along shoreline)

	Band	Attached	Washed
Up	☐	☐	☐
Green Seaweed	☐	☐	☐
Red Seaweed	☐	☐	☐
Rockweed	☐	☐	☐
Kelps (long brown seaweeds)	☐	☐	☐
Eelgrass (has roots)			

Beach Substrate

(If uniform on your stretch of beach)

☐Rocky ☐Pebbles ☐ Sand ☐ Mud

If not uniform throughout stretch, note on the map where there are large areas of uniform substrate.

Bluff and Cliff Erosion

Describe areas of active erosion and evidence of erosion

____
____
____

Human Activities (Actual Count)

	Signs of	Actual Observation
Walking		
Camping		
Partying		
Fire Pits		
Clamming		
Fishing		
Coaling		
Picnicking		
Horseback Riding		
Harvesting		

Vehicle Use

	Sets of Tracks	Actual Observation
Cars/ Trucks		
ATV's		
Bicycles		
Aircraft		

Structures on the Beach

Buildings________________________________
Docks________________________________
Driftwood Structures______________________
Riprapped Areas__________________________
Erosion Control Structures__________________
Abandoned Vehicles________________________

Archeological Sites

(Please note location on your zone map.)

INTERTIDAL BIODIVERSITY CHECKLIST

Names of CoastWalkers_____________________________________

Date_______________

Low Tide Zone

Sponges

- ❑ Breadcrumb Sponge
- ❑ Purple Sponge

Cnidarians

Anemones

- ❑ Burrowing Green Anemone
- ❑ Orange Colonial Anemone
- ❑ Frilled Anemone/Plumose Anemone
- ❑ Christmas Anemone

Sea Jellies

- ❑ Moon Jelly
- ❑ Many-ribbed hydromedusa
- ❑ Compass Jelly
- ❑ Lion's Mane Jelly

Worms

- ❑ Calcareous Tube Worm
- ❑ Spiral Tube Worm

Molluscs

Jingles

- ❑ Rock Jingle

Cephalopods

- ❑ Giant Pacific Octopus
- ❑ Stubby Squid

Scallops

- ❑ Pink Scallop

Nudibranchs

- ❑ Maned Nudibranch
- ❑ False Sea Lemon/False Lemon Peel
- ❑ Orange-tipped Nudibranch
- ❑ Spotted Nudibranch
- ❑ Opalescent Nudibranch
- ❑ Bushy-backed Nudibranch

Arthropods

Crabs

- ❑ Dungeness Crab
- ❑ Black-clawed Cancer Crab
- ❑ Decorator Crab
- ❑ Carapace Carb
- ❑ Red King crab
- ❑ Northern Kelp Crab
- ❑ Helmet Crab

Shrimp

- ❑ Broken-back shrimp
- ❑ Coonstripe Shrimp
- ❑ Sand Shrimp

Brachiopods

- ❑ Transverse Lampshell

Echinoderms

Sea stars

- ❑ Red-banded/Rainbow Star
- ❑ Morning Sun Star
- ❑ Stimpson's Sun Star
- ❑ Rose Star
- ❑ True Star/False Ochre Star/Mottled Star
- ❑ Blood Star

Brittle Stars

- ❑ Serpent Star
- ❑ Daisy Brittle Star

Sea Urchins

- ❑ Green Sea Urchin
- ❑ Red Sea Urchin

Sea Cucumber

- ❑ Silky Burrowing Cucumber
- ❑ Orange Cucumber/Red Cucumber
- ❑ Tar-spot Cucumber/Black Cucumber

Sand Dollars

- ❑ Green-spined Sand Dollar/Northern Sand Dollar

Chordates

Tunicates

- ❑ Colonial Tunicate/Sea Pork
- ❑ Sea Peach

INTERTIDAL BIODIVERSITY CHECKLIST

Names of CoastWalkers____ Date____________

Mid - High Tide Zone

Worms
- ❑ Giant Flatworm

Nemerteans
- ❑ Amphiporus/Two-spotted Ribbon Worm
- ❑ Red Ribbon Worm

Echiurans
- ❑ Fat Innkeeper/Alaskan Spoonworm

Sipunculids
- ❑ Peanut Worm

Molluscs

Mussels
- ❑ Horse Mussel
- ❑ Pacific Blue Mussel

Snails
- ❑ Hairy Triton
- ❑ Big-mouth Whelk
- ❑ Aleutian Moonsnail
- ❑ Ridged Neptune
- ❑ Channeled Dogwinkle
- ❑ Emarginate Dogwinkle
- ❑ Frilled Dogwinkle
- ❑ File Dogwinkle
- ❑ Sitka Periwinkle
- ❑ Helicina Margarite
- ❑ Puppet Margarite

Limpets
- ❑ Dunce Cap Limpet
- ❑ Plate Limpet

Clams
- ❑ Nuttall's Cockle
- ❑ Northwest Ugly Clam
- ❑ Arctic Rock Borer
- ❑ Baltic Macoma
- ❑ Stained Macoma
- ❑ Pacific Surf Clam
- ❑ Truncated Mya
- ❑ Steamer Clam/ Pacific Littleneck Clam
- ❑ Butter Clam

Chitons
- ❑ Gumboot Chiton
- ❑ Black Katy Chiton
- ❑ Brick Chiton
- ❑ Mossy Chiton
- ❑ Tiger Chiton
- ❑ Lined Chiton

Echinoderms

Sea stars
- ❑ Ochre Star
- ❑ Sunflower Star
- ❑ Leather Star
- ❑ Little Six-rayed Star

Arthropod

Barnacles
- ❑ Acorn Barnacle
- ❑ Thatched Acorn Barnacle
- ❑ Pelagic Gooseneck Barnacle

Amphipods
- ❑ Skeleton Shrimp
- ❑ Small Beach Hopper

Isopods
- ❑ Pillbug Isopod
- ❑ Rockweed Isopod

Crabs
- ❑ Red Hermit Crab
- ❑ Striped Hermit Crab

Annelids
- ❑ Mussel Worm/Clam Worm
- ❑ Northern Feather Duster Worm/Carpet Worm
- ❑ Cone Worm
- ❑ Scaleworm