Eelgrass as Teacher by Nikki Wright

With a respectful hush, students squat on the sand or sit on logs on the warm beach, listening intently to Trish speaking about the way her indigenous Coast Salish community harvested herring roe in Deep Bay, B.C., Canada when she was ten. You can hear a fir needle drop in the forest behind her as she recollects her memories of watching the shoreward migrating herring , so thick, she says, they were "like little bits of shining glass in the Bay." The families would collect the roe from cedar boughs placed in the bay and store it in long storage bins, where she would race past and swipe some to eat before Grandmother would find her out.

Herring roe on eelgrass shoots

These high school students were in a very special site, a Gulf Island on the British Columbia coast, learning first hand the traditional stories of Native peoples harvesting and storing the riches of the sea. During their time on this beach, they would explore eelgrass beds, which are also used for herring spawn sites, in the interface between ocean and land. They found myriad critters crawling and scurrying between the blades. This exploration of the mysteries of sea life so close to the shore would lead them further down the road of revelation and possibly to a lifetime of marine discoveries.

Shortly after I had listened to Trish on that extraordinary beach, I accompanied a grade four class on a beach within the boundaries of Victoria on Vancouver Island. With small class groups alongside me, I walked gingerly in gumboots in an eelgrass community at low tide. Once again, I had a glimpse into these wondrous undersea gardens, watching the small kelp crabs and juvenile seastars creep along the emerald green blades, and witnessed small flounder gliding under the sand. A whole world opened up before us. This is the magic of eelgrass in quiet bays and coves and estuaries.

SeaChange Marine Conservation Society, a community conservation group on Vancouver Island in British Columbia presents these kinds of opportunities in the spring, summer and fall each year to schools at all levels. Many times, eelgrass (*Zostera marina* –one of the two native species of eelgrass on the BC coast*)* is a gateway of learning during our time on the shore and in the estuary. This is the story of my experience with eelgrass as a teacher. The following are suggestions for exploring a seagrass community for Grades 1-6.

Eelgrass meadow

When I first started marine naturalist work in Victoria, Canada, I was a SCUBA diver diving for sea creatures and demonstrating their behaviour to elementary and middle students. Most of these young people were more familiar with facts about coral reefs and sharks across the world than with the sea cucumbers, Great Blue Herons and pipefish of their local marine world. This introduction to local sea animals was a first step, but unsatisfying to me as a marine educator. I wanted to teach ecology. I needed to find ways for young people to fall in love with the intricacies of an easily accessible natural system (Capra, 2005). I believed, and do so even more strongly today, that children learn best from the natural world when they are actively engaged in it (Krapfel, 1999). Eelgrass has afforded those opportunities through classroom, field and community activities. Students will observe ecological connections. The underwater blades offer viewing windows into complex food webs close to shore (Phillips, 1994). Students can extend their understanding of ecological relationships by investigating land use activities affecting these food webs. Teachers can help students understand the importance of citizen science in protecting shores with maps of the boundaries of eelgrass meadows made by their students.

The Biological Diversity within Eelgrass Meadows

Eelgrass is a simple enough looking plant, but it has great importance to living systems, both human and non-human. It evolved from fresh water and migrated to the ocean in relatively recent geological time. Eelgrass shoots act like crab grass or strawberry plants in that they grow most successfully by rhizomes, or underground roots. One plant in a large meadow can be the parent of thousands of shoots, as they clone in muddy sandy substrates in shallow protected bays and estuaries in most temperate marine areas of the world. The intricate weaving of the underwater blades afford shelter for salmon from the hungry foraging of Bald Eagles, and the minute algae on the blades feed the small crustaceans called copepods that swim near the muddy bottom which in turn feed the outcoming salmon fry from freshwater streams. The plants are so popular with salmon that eelgrass meadows have been compared to salmon highways in the Pacific Northwest.

Juvenile seastar in eelgrass

The high biological diversity available in eelgrass systems provides food for a diversity of organisms in several ways. In the Trent River delta on Vancouver Island, for example, 124 species of birds have been identified and includes over 38,000 individuals. Forty eight per cent were observed using the intertidal eelgrass (*Z. japonica*) of the delta for feeding, foraging or preening at some time during the year (Harrison and Dunn, 2004).

For younger grade levels, it is fun to explore eelgrass meadows for juvenile creatures - small crabs, seastars, and flounder for example. Because the weaving of the eelgrass blades provides good hiding places from predators, the beds are resplendent with new life.

The matted rhizomes help capture sediment and decreases erosion (Phillips, 1984) which is important for shoreline homeowners. All these benefits of this underwater vegetation can be demonstrated to school children in their classroom and outside on their local beach or estuary. It takes little or lots of time, depending on how far and deeply you as an educator would like to extend the lessons. This article assumes that you have the opportunity to visit your local eelgrass more than once over the school year.

Matted rhizomes decrease shore erosion

I thought in 1993 I had found a simple way to teach ecological systems to children. Thirteen years later, after all the SCUBA dives, seining, kayaking, tide pooling, and mapping and restoring of eelgrass, I am still entranced with this nearshore plant that makes up underwater emerald forests.

Classroom Activities

A network of eelgrass conservationists along the entire coast of British Columbia maps eelgrass beds and locates potential restoration sites. Many of these individuals come into their local schools to help teachers with exploring the mysteries of eelgrass. They bring resource books with plenty of photographs, maps, stories, colouring books, overhead drawings and graphs of food webs found in eelgrass habitats, and eelgrass plants found along the beach. You can provide library books, web sites, stray eelgrass plants and help students explore ideas on how they would like to investigate their local eelgrass beds.

In preparation for the first field trip, students can formulate questions they wish to answer during their field trip, and discuss their hypotheses in small groups. For example, one group of fifth graders might formulate the following: "If young crabs use eelgrass for shelter, then they will be found in areas hidden from their predators." They then could create a data sheet with spaces to record how many and what kinds, sizes and locations of crabs they observe.

Students should be reminded that they are visiting the living rooms (or habitats, depending upon the age group) of intertidal animals and plants that are already stressed from exposure to the sun. Examples of good beach manners are:

- Turn rocks back gently after lifting them
- Fill in any holes when digging
- Wash hands in the tub of saltwater next to the touch tanks before touching animals and plants
- Handle animals and plants gently.
- Avoid walking on plants and animals
- Do not remove attached animals or plants.
- Leave the plants and animals in their natural homes (habitats).

It is important that students be comfortable and safe and be respectful for the life they will encounter on their field trip. Sunscreen, extra socks, drinking water, towels and gumboots or shoes that can get wet or muddy. They can add their own beach etiquette rules.

Field Trip Activities

Students identify sea animals using field guides

Students can become familiar with eelgrass ecology during a preliminary field trip lasting usually an hour and a half. Prior to the actually field trip, the class can be divided into three groups. We usually have three groups of ten students each.

The first beach station is the "Habitat Aquaria**".** We use two glass 33 gallon aquaria placed within a wooden frame and supported by two wooden supports. We fill the first aquarium with sand and "living rocks", drift eelgrass and crab and chitons, sea cucumbers, small seastars, sand dollars, clams and the like collected by SCUBA divers. We place rockier substrate in the second aquarium with drift kelp and other seaweeds, urchins, living rocks with tunicates and coral algae living on them, limpets, turban snails, and crabs to demonstrate what lives beyond the shallow eelgrass meadows. Simple rubber tubs can be substituted for glass aquaria. Laminated field guides are distributed so that the students can identify and observe animals on their own before they are told what is in the aquaria. Buckets and tubs surround the aquaria and are filled with seaweed and kelp to shade the animals that can be touched by the students under supervision. A hand washing tub full of saltwater ensures that sunscreen on the students' hands will not harm the animals in the touch tubs.

The second station can be a "Detective Game**"**. Using the field guides students are asked to find and observe, without collecting, animals that have hard shells, or live in a community, or plants that have knobs growing on their blades. They convene after 15 minutes or so to share their findings. Detective questions could be ones such as:

Find:

- Two different kinds of edges on seaweeds.
- Evidence of an animal having eaten something.
- Three seaweed leaves with different textures (smooth, prickly, etc.)
- Four different odors/smells.
- Five different sizes of barnacle.
- Six different kinds of birds on the shore or near-by
- Seven human activities on or near the shore.
- Remember eight different sounds and repeat them to the group
- Name nine different ways people are using the shore or waters near-by

" Kelp octopus"

The third station can be a "Making Art" display. On a large tarp, students at all grade levels enjoy as a group making a giant sea animal or an eelgrass or kelp underwater forest.

Beach seining is exciting

Beach seining in a protected bay or estuary is another way to acquaint students to the eelgrass community but it is crucial this be done in a very sensitive manner, as juvenile marine animals such as salmon fry and young flounders cannot tolerate exposure out of water or touch. When done under the careful supervision of an experienced leader, however, students are thrilled with the diversity of the collection from seining after they have helped haul the net shoreward. The specimens can be collected carefully and kept in cool seawater tubs for a short duration for observation by all.

Beach specimen press on the beach

Beach specimen presses can be done easily with moist heavy paper and cardboard between the paper. Students collect drift (unattached) eelgrass, seaweeds and flat pieces of kelp and design patterns onto the heavy moist water. The sheets are then placed between two wooden boards and tied together with a belt. The collection should be placed in an area that is well ventilated in the classroom. In just a few days, the students can open the press and discover their dried creations. Cards, posters and other art work can then be taken home or displayed.

Extension of Field Activities

Students mapping on the shore

A second field trip can be designed for mapping a local eelgrass bed during the springtime on a very low tide (less than 2 metres in B.C.). The methodology for mapping can be practiced in the classroom. Before that however, it is essential that students know why this particular habitat is important to map. After they have become familiar with its ecology during their preliminary field trip, students can interview community members, including fishermen, First Nations members and old time residents on what they remember of eelgrass in the local waters. This information can then be brought back to collate into maps.

On southeast Vancouver Island, one of the eelgrass mapping coordinators consulted with First Nation Elders and old time fishermen to find out where the eelgrass "used to be" in a large estuary. She brought that information to a classroom of 5-6th graders, and asked them to map the areas on nine baseline maps. The class then combined the maps to compare where the meadows were historically sited and where they grow presently. They discovered that a large area was impacted by log storage activities, but they also discovered that local community restoration efforts were underway to bring back the meadows where the log leases were no longer used.

Mapping can be as simple as following the upper boundary of an eelgrass bed and noting on a cadastral map where the bed begins and ends. Or students may want to map the upper boundary using a GPS unit and then measure the density of the bed using a transect line and quadrats. The scientific protocol that has been accepted in British Columbia for mapping eelgrass can be found on the Seagrass Conservation Working Group web site (Seagrass Conservation Working Group web site, 2002).

Eelgrass demonstration quadrat

To show students how to measure eelgrass shoots within a meadow, you might try using a demonstration eelgrass grid, which takes little time to make. I suggest you find mesh material (we use the plastic mesh used to protect SCUBA tanks) with small (approximately ¼ inch) spaces to thread green ribbon in dense patterns. Provide a quadrat (see below) and a ruler so that students can practice measuring the width and length of the blades. Thicker ribbon can be used to represent reproductive flowering plants.

It is important that they know before they map on the beach that reproductive shoots are ephemeral. If flowering shoots are not noted while mapping, the class might return the following year and observe that the bed they measured is less dense, and conclude that it has been damaged. *Zostera marina* is a perennial plant (*Z. japonica* is most often annual), but densities can vary from year to year because of the timing of reproduction and the fact that they shed their leaves up to seven times in one year (Durance, 2002). If the class decides to monitor one bed over several growing seasons, these are important factors for accounting for different shoot densities over time.

Considering the world wide extent of seagrasses is estimated at 44 million acres, but that much of the extent has not been mapped, (Green & Short, 2003) there is a lot of mapping of eelgrass to be done everywhere! It is not difficult for students at all levels to inventory local seagrass beds whether they be *Zostera marina* or *Z. japonica* or another species of seagrass in your area of the world.

On many shores of southern British Columbia, both eelgrass species grow close to each other. We are having fun creating useful and easily memorized limericks to help us decipher the difference between the two species, as on some shores they look remarkably similar. One example of a “limerick in process” is:

Marina, like green onions,
it's sheaths they do tear,
While *japonica*, like celery,
it's sheaths pry open, to bare. (Sanford, 2006)

Students can make up their own rhymes and songs to identify species of eelgrass that they then can pass on to the next class for the following year.

Eelgrass meadows are naturally highly dynamic systems, often changing from year to year or from season to season, reflecting changes in the environment (Den Hartog, 1971) At one school, fourth graders are monitoring both species (*Z. marina* and *Z. japonica*) growing adjacent to each other over several years, to note competition or changes between the two. They pass on the monitoring data onto the next class before the next mapping expedition during the following spring.

What is needed

One quarter metre and one metre square quadrats can be easily made from aluminum or plastic pipe. These frames are set upon a 60 m transect line (polypropylene rope is easiest to use) at metre points randomly selected. The transect rope can have tape tied securely at one metre marks with the designated metre number marked on each tape. On the way to the site, students can call out numbers from 1-30, a recorder can write them on a data sheet (see illustration). Other equipment

Community mappers using a quadrat along a transect needed is GPS units or compass (for triangulation for site location), data sheets and pencils attached to clipboards, field trip supplies (sun screen, drinking water, first aid kit, snacks and hats), and binoculars. Make sure students are wearing gumboots or shoes or sandals that can withstand some saltwater.

Date: *January 15, 2006*			Location: *Sidney Beach*	
# of zones: *3*			Zone #: *2*	
Length of transect: *60 m*			# of quadrats sampled: *30*	
Direction of transect: *East to West*			Size of quadrat: *.25 m2*	
Quadrat #	**# of shoots**	**# of reproductive shoots**	**Shoot length (cm)**	**Shoot width (cm)**
1	*60*	*5*	*25*	*.25*
2	*45*	*2*	*22*	*.21*
3	*53*	*0*	*15*	*.23*
4	*19*	*8*	*14*	*.24*
5 ⇓	*6*	*0*	*12*	*.25*
30	*75*	*14*	*24*	*.23*
Total:	X # of shoots	X # of shoots		
Mean Density (total/# of quadrats):	Total # of shoots divided by total # quadrats			

Eelgrass Mapping Field Data Sheet (Durance, 2002)

Methodology

To ensure success, visit the site yourself before the field trip so that you have a clear idea how to direct the students. Since eelgrass shoots tend to grow at different lengths and widths according to where they are located in the intertidal zone, it is important to place the 60 m transect line parallel to shore well within the range of the zone you may want to select beforehand.

For example, this could be a description of the bed before you:

> *Zone 1* is a narrow band 8 metres wide, located in the low intertidal and shallow subtidal. The zone is characterized by a sparse population of short eelgrass (length 25 cm, density 32 shoots/m2). Zone 1 blends into *Zone 2*, at a slightly lower elevation. The bed in Zone 2 is 50 metres in width. The majority of the bed is located in Zone 2.

During your preliminary visit, you may have decided to have the students map only one zone with their 60 m transect. By the end of the exercise, they might feel more confident to map more of an area at a later date. The pressure of the incoming tide dictates how much time is available to map one zone. It is best to arrive with your class at the site about an hour before the tide begins to recede. During this time, the students could identify the zones of eelgrass on the beach. You may have already visited the site at low tide, so you can help direct the discussion.

For a class of 30, you may want to organize students into groups of three: In each group, one student is the recorder, one the counter of shoots, and one measures one shoot in the right hand corner of the quadrat for width and length. Each group will have one third of the 30 numbers they randomly selected before they arrived on the beach. The recorder in each group makes sure the numbers are located accurately so there are 30 sets of measurements by the end of the mapping exercise. When the tide has returned, the data sheets are collected and returned to the classroom. Over time students will notice changes in the density and width of the eelgrass bed they mapped and will have lively discussions as to why that is.

Synthesizing Classroom Studies with Field Experiences

The classroom activities and field trips can be integrated across curricula. Students can photograph their art displays on the beach tarp and combine them with the pressed plant specimens to include on a wall mural in the classroom. They can write stories about the eelgrass animals they observed on the beach and combine facts about the creatures' biology with fiction about their lives in the meadow. They can use math to calculate Leaf Area Index (mean eelgrass leaf length and width determined from sampling one eelgrass shoot in each of 30 quadrats) for determining the productivity of an eelgrass bed, and research the history and geography while they find local stories about the locations and uses of this seagrass, including Indigenous traditions.

The following table illustrates how lessons can focus on science processes (Gough & Griffiths, 1994)

Observing	**Inferring**	**Classifying**	**Predicting**	**Communicating**	**Quantifying**	**Interpreting Data**
Research	Hypothesis Activity	Eelgrass demo grid	Hypothesis Activity	Beach Manners	Eelgrass demo grid	
Habitat Aquarium	Touch tubs	Habitat Aquarium/Touch tubs	Beach seining	Hypothesis Activity	Detective Game	Beach seining
Detective Game	Inquiries with organisms	Mapping/Monitoring	Mapping	Art Display on the Beach	Mapping	Mapping
Beach seining		Detective Game	Monitoring	Mapping	Monitoring	Monitoring
		Beach seining		Beach press		

Eelgrass restoration in Tod Inlet on Vancouver Island

Eelgrass Restoration

It has been estimated that approximately 222,000 acres of seagrasses worldwide have been lost in the last decade (1990-2000) (Green & Short, 2003) because of development, forestry and agricultural practices, dredging and hardening of shorelines (construction of cement seawalls), to name a few.

Students at all grade levels can participate in restoration of eelgrass as part of a community effort to restore damaged fish habitat. Since 2000, in Tod Inlet on southeastern Vancouver Island, community members of all ages have completed five eelgrass transplants under the guidance of a local conservation group, a scientific advisor in partnership with provincial and federal agencies. Over the past four years, community conservation groups in 22 communities on the 27,000 km coast have involved students and families on mapping and restoration projects. This level of involvement can start simply with one person committed to a plant in one place, with equipment such as gumboots, an inexpensive tub showing students eelgrass critters, rope and a square of aluminum and pencil and paper.

Maps as Community Connectors

It has been estimated that as much as 80% of the pollution load in the ocean originates from land based activities (NPA, 2007). After researching its history and constructing maps, students might conclude that their local eelgrass meadows are not as dense or as extensive as they were, even as recently as 10-20 years ago. The maps they have created can be used to influence decisions affecting the shoreline, such as the construction of cement seawalls or the creation of riparian set backs to offset the erosion effects of seasonal storm events. Students' maps can be displayed at a local council meeting, at festivals, in brochures and in presentations to other schools or community associations.

On the BC coast, we are making eelgrass a household term, because these maps created by people of all ages have heightened awareness of the importance of this crucial underwater plant community and have been included in regional atlases, official community plans and shellfish aquaculture plans and First Nations treaty negotiations. Knowing that their data collection has far reaching influence, even fourth graders will take special care for accuracy.

Further Explorations

As students become more familiar with their local eelgrass meadows, teachers might want to facilitate discussions with their students about why eelgrass habitats are so important on the global scale. Students could establish research teams around such issues as the role of seagrasses in global respiration (amount of carbon and oxygen released and absorbed into the atmosphere), the impact of eelgrass habitat losses with decreasing world fisheries resources, the role of seagrasses and mangroves in conserving shores during extreme weather events, and the connections between land use activities and nearshore environments and about their own responsibility in caring for eelgrass habitats.. They might conduct their research through interviews with scientists within the community as well as by using the Internet. As their understanding increases from the local to the global, they can take their information to other classes within their school, and demonstrate their findings through a multi-media event or by taking another class to the beach at low tide to demonstrate their knowledge. The beach then becomes a laboratory to learn about biology, zoology, ecological patterns and ultimately about the responsibility of humanely living in the global biotic community. We as educators can help our students face environmental challenges by encouraging them to take the time to observe, reflect, ask questions and find answers within their community. Eelgrass meadows offer one way into that window of inquiry.

Eelgrass mapping in a community in British Columbia

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For more information about the educational, conservation and restoration activities of the author's organization: www.seachangesociety.com