SPINELESS: PORTRAITS OF MARINE INVERTEBRATES: Photographs by Susan Middleton

At the Whatcom Museum
September 18, 2016–December 31, 2016

WHATCOM MUSEUM

Guide for Educators

What we imagine may be very beautiful, but nothing replaces reality.

Yves Saint Laurent

Susan Middleton; Pacific Giant Octopus (juvenile), 2014.

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Washington State Learning Standards

Susan Middleton, *Star Creature*

The Arts (grades 4-5)

1.1 Understands and applies art concepts and vocabulary.
1.2 Develops art skills and techniques.
1.3 Understands and able to apply different art genres and styles of various artists, cultures, and periods of time.
2.3 Applies a responding process. Engages with works of art through group discussion. Describes visual works of art, analyzes how works of art are created, interprets content of a work of art based on visual cues, and evaluates the strength of a work utilizing appropriate vocabulary and visual evidence.
4.2 Demonstrates and analyzes connections between the arts and other subjects.
4.3 Understands how the arts impact and reflect real life choices.
4.4 Understands how the arts reflect and influence cultures/civilizations throughout the ages.
4.5 Understands how knowledge of art and art skills are used in the workplace, including careers in the arts.

Science (grades 4-5)

4-LS1-1 Understands that plants and animals have internal and external structures that function to support survival, growth, and reproduction.
4-LS1-2 Uses a model to describe that animals receive different types of information through their senses. Understands there are different ways that animals process and respond to information.
SL.4.5 Adds audio recordings or visual displays to presentations to enhance the development of main ideas or themes.

Communication

1.1 Uses listening, observation skills, and strategies to focus attention and interpret information.

Literacy

CCSS.ELA-Literacy.W.5.2 Writes informative/explanatory texts to examine a topic and convey ideas and information clearly.

Exhibition Overview

Spineless features fifty spellbinding photographs of marine invertebrates from the waters around the San Juan Islands by acclaimed San Francisco-based photographer Susan Middleton. These astoundingly detailed photographs provide a window to the mysterious and surprising world of marine invertebrates, which represent 98 percent of the known animal species in the ocean.

Susan Middleton, Stubby Squid, 2014.

This body of work is the cumulative effort of seven years photographing and cataloging marine invertebrates while working as a Whitely Fellow at the University of Washington Marine Labs. The traveling exhibition celebrates Middleton's recent *book Spineless: Portraits of Marine Invertebrates, the Backbone of Life*, 2014, Abrams and Chronicle Books.

About the Artist

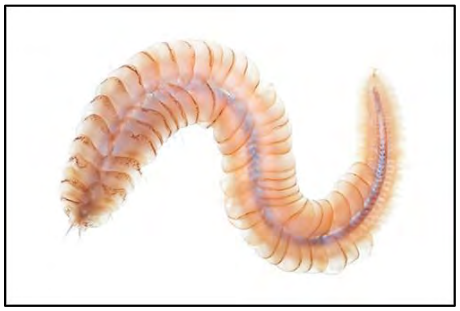
Susan Middleton is an acclaimed photographer, author, and lecturer who specializes in portraiture of rare and endangered animals, plants, sites, and cultures. Middleton is the recipient of a Guggenheim fellowship in 2009. For many years, she was Chair of the Department of Photography at the California Academy of Sciences in San Francisco, where she currently serves as research associate. Her photographs have been exhibited worldwide in fine art and natural history contexts and are represented in the permanent collections of the National Academy of Sciences and the National Gallery of Art in Washington, DC.

Susan Middleton, Courtesy of San Juan Museum of Art.

Invertebrates: The Backbone of Life

Invertebrates, animals without spines, comprise more than 98 percent of all animal life, out-numbering all other forms of life on Earth. The vast majority of marine creatures are invertebrates. As some of Earth's most elusive animals, marine invertebrates are a treasure trove of nature's most exotic and varied creatures. They are considered the backbone of all animal life on earth, and carry with them the same DNA that has been passed on to all animals living today, including human beings.

Scientists have classified the animal kingdom into thirty-four groups called *phyla*, or taxonomic categories. Of these thirty-four *phyla*, only one, the *phylum Chordata* contains all vertebrates, including humans. The remaining thirty-three are invertebrates, and almost half of those are marine invertebrates. The waters of the Puget Sound ecosystem is home to over 3,000 invertebrates, with new discoveries made every day.



Susan Middleton, Giant Fleshy Scaleworm, 2014.

Which Sea Animals are Marine Invertebrates?

The population of marine invertebrates is extremely varied and stunning to behold. The octopus, crab, coral, jellyfish, sea star, clam, shrimp, and sponge are familiar invertebrates.

Marine invertebrates are found in the following six *phyla*:

- **Porifera** (sponges)
- **Cnidaria** (includes hydra, corals, sea anemones, and jellyfish)
- **Platyhelminthes** (flatworms)
- **Anthropoda** (includes crabs, shrimp, copepods, barnacles, lobsters)
- **Mollusca** (includes monoplacophores, chitons, snails, slugs, clams, oysters, nautilus, octopus, and squid)
- **Echinodermata** (includes sea stars, sand dollars, sea urchins, and sea cucumbers)
- **Annelida** (segmented worms, polychaetes, and leeches)

When Artists and Scientists Team Up

The work of Susan Middleton and the University of Washington Friday Harbor Marine Biology Laboratories provides a perfect example of how scientists and artists team up to share ideas and learn from one another for the benefit of both disciplines.

Susan Middleton photographing a Widehand Hermit Crab at Friday Harbor Marine Laboratories. Photograph by Mary Piller.

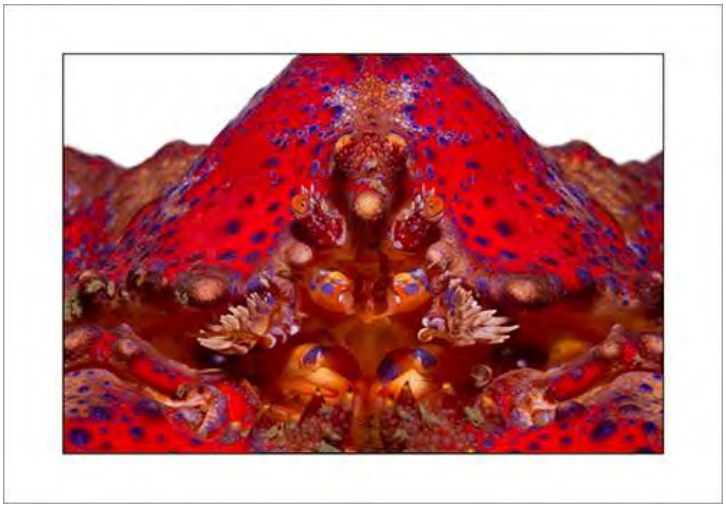
Middleton spent seven summers at University of Washington Marine Laboratories on San Juan Island. There, she worked with several marine biologists who collected and studied live specimens. They explored near shore habitats, finding burrowing marine worms in the mudflats, chitons attached to rocks in the inter-tidal zone, and creatures attracted to light projected in the water from a dock at night.

Working closely with marine biologists in a laboratory setting allows Middleton direct access to live specimens and to marine biology experts when questions arise or mysteries surface. The Friday Harbor Marine Lab has tools and equipment not found in an artist's studio.

Middleton's goal is to make a portrait photograph of each invertebrate. She begins by safely isolating the invertebrate in the temporary portrait studio Middleton calls a "photarium"—an aquarium or glass tray with near-perfect conditions that mimic each animals' natural habitat. She waits and watches, sometimes for hours, as the animal relaxes and begins to move and explore. She aims to capture the exceptional shapes, patterns, textures, and colors of each remarkable creature, as well as the behavioral and expressive qualities that make the animal unique.

Scientist, Adam Summers, also photographs invertebrates at the Friday Harbor Marine Biology Lab. His process and goals are different from Middleton's. Summers applies special dyes and enzymes to the specimens. The chemicals allow him to better examine each specimen's system, structure, and function, allowing him to document how the animal moves, eats, and breathes.

Summers embraces the artistic and poetic aspect of science, noting that biologists and artists both "spend a lot of time naming and organizing things" to better understand them. For his photography exhibition titled, *Cleared: the Art of Science,* Summers asked poet Sierra Nelson to write a descriptive poem for each photograph. The poems, he feels, "help people better understand the science behind the biology."



Susan Middleton, Puget Sound King Crab.

"All life is one and yet every single life is unique."
—William S. Merwin

Trouble Down Below

From the simple sponge to the complex octopus, marine invertebrates are crucial to maintaining a healthy ecosystem. As the foundation of a variety of food chains, they affect life in the oceans and outside the oceans.

Middleton and others researching Earth's seas and fresh water habitats are concerned about the quality of these environments. The ocean's delicate balance in which marine invertebrates thrive is increasingly disturbed by local and global pressures, both man-made and natural phenomena.

Threats to marine invertebrates include:

- Overfishing: Taking wildlife from the sea at rates too high for species to be able to replace themselves is highly disruptive to the food chain.
- Climate change: Warming waters, variations in sea level, ocean acidification, melting icecaps, and changes in the ocean's current systems all affect ocean wildlife.
- Acidification of ocean waters: Carbon dioxide emissions from fossil fuel-powered machines are released into Earth's atmosphere, and about half is absorbed over time by the oceans. When carbon dioxide dissolves in the ocean, carbonic acid is formed, leading to higher acidity. The elevated acidity inhibits the ability of marine animals, including many plankton organisms, to create shells, disrupting life within the very foundation of the ocean's food web.
- Marine habitat degradation and pollution: Coastal areas including estuaries, swamps, marshes, and wetlands serve as breeding grounds, or nurseries, for nearly all marine species. Inland dams decrease nutrient-rich runoff, cut off fish migration routes, curb freshwater flow, and increase the salinity of coastal waters.

- Dredging of wetlands: Urban, industrial, and agricultural development lessens the essential habitat of many species that is crucial for their survival.
- Tourism: Millions of boaters, snorkelers, and scuba divers are brought into direct contact with fragile ecosystems, often causing damage and destruction.
- Marine industry: Container ships and tankers, as well as oil spills damage, take an irreversible toll on marine habitats.
- Invasive species: Non-native species introduced to an ecosystem can cause environmental harm.

What Can We Do to Safeguard Marine Habitat

Susan Middleton has devoted years of her life to studying and photographing these spectacular animals that live mostly hidden from view. By calling attention to the beauty and diversity of species, her work benefits both art and science. Through her photographs and research, Middleton hopes to encourage appreciation for these exquisite creatures and the role they play in the world's ecosystem.

Ongoing efforts to safeguard ocean habitats include the creation of gigantic marine sanctuaries where development is curtailed and fishing is prohibited. Laws banning the dumping of sewage and chemicals into the ocean and policies that foster better stewardship of wetlands are having positive effects. But scientists agree that drastic measures will be needed to avert the ocean crises being created by climate change.

All life on Earth is connected to the ocean and its inhabitants. To find out how you can protect this vital ecosystem visit the following websites:
http://ocean.nationalgeographic.com/ocean/take-action/10-things-you-can-do-to-save-the-ocean/

http://ocean.nationalissues-overfishing/

http://ocean.nationalgeographic.com/ocean/critical-issues-marine-habitat-destruction

Regional Field Trips to See Invertebrates

Marine Life Center, Bellingham, WA. http://www.marinelifecenter.org/
Aquatic displays and hands-on touch tank with local marine flora and fauna.

Padilla Bay National Estuarian Reserve, Mount Vernon, WA. http://www.padillabay.gov/
Group tours, teacher resources, kid's page, adult and children's classes.

Vancouver Aquarium:
https://www.vanaqua.org/learn/aquafacts/invertebrates/marine-invertebrates

Arts-Infused Classroom Extensions

The Art and Science of Observational Drawing

Observational drawing is an important tool for artists and scientists. Drawing from life:

- Forces us to really look at a subject and notice many details we might ordinarily miss.
- Increases perceptual skills and eye-hand coordination.
- Enhances memory about the subject or experience.
- Often leads to further investigation.

Observing and Drawing Shells

Shells are the outer skeletons of invertebrates. A tough outer shell provides protection for crabs, mussels, oysters, snails, and other invertebrates.

Image: Drawing seashells with watercolor pencils from www.whatdowedoallday.com.

Tools and materials: Journals and/or drawing paper, pencils, colored pencils, Conté crayon, blending tools, erasers, and a collection of shells.

Warm-up exercise: Each student, or student team, selects a shell from a box of shells and observes it for two minutes. Shells are returned to the box and shuffled. Students find their "own" shell, based on their observations. Ask students to write or share what they learned about this observational exercise and have them research the animal that lives in that type of shell.

Observational Drawing:

1. Students practice drawing a variety of lines, textures, and tones, to become acquainted with their media (pencil, pastel, Conté crayon).

2. Students make quick sketches of several shells. Encourage students to look and sketch shells from a variety of angles, studying shapes, proportions, and surface texture. Ask them to make notations on the drawing about color, pattern, size, and weight.

3. Demonstrate contour drawing and reinforce the importance of keeping your eyes on the object or subject as you draw, so that your brain won't take shortcuts and skip over visual details.

Illustration: Using a pencil to judge proportion and angles.

4. Show students how to judge proportion and angles by holding a pencil at arm's length between their eye and the shell they are drawing.

5. Once students have had time to practice, have them select a shell and make a final drawing using a pencil, Conté crayon, or pastels on toned paper.

Reflection and self-assessment:
Have students share what they learned from the process of drawing from observation. Consider the skills needed to draw from observation. With cameras and scanners available, why might some scientists prefer to draw directly from their subjects? Have the young artists reflect on the work of their peers by noting use of line, texture, values, tone, shading, and proportion in each other's drawings.

Marine Invertebrate Model Making

Tide pool models, from growing with science blog. Blog.growingwithscience.com.

Research: Gather photographs of various marine invertebrates. Identify each animal and classify it into a major *phyla*. If possible, plan a field trip to a nearby aquarium or estuary (see resources section). Write up descriptions and make sketches, identifying body parts and describing how the animal engages in essential life activities. How does it see? How does it move? How does it find and eat food? How does it dispose of waste? How does it avoid predators and other threats? How does it reproduce? In what habitat is the invertebrate typically found?

Modeling: When research is completed, have students create a model of an invertebrate using modeling materials (Crayola Model Magic® works well), toothpicks, chenille stems, fabric, and clay tools. Toothpicks can be pushed into the clay to simulate spines while chenille stems make great legs for some animals. Let the models dry and before painting them.

Display: Have students make a tide pool habitat diorama with cardboard, paint, rocks, paper, and other items. Display the sculpted invertebrates in the diorama. Have students share their sketches and research.

Reflection and self-assessment: Have students create a (PowerPoint/slide) presentation for the group that includes a photograph of the invertebrate, a picture of their model, and a descriptive exhibit label. Share the slide show with other classes.

Visual Thinking Exercise

Select a portrait photograph from the *Spineless* exhibition. Divide the class into teams and give each team a formal art term (use the glossary of art terms or the list below).

Teams spend 5 - 10 minutes discussing the art term as it applies to the photograph. Teams take turns sharing their findings with the class.

Susan Middleton, Giant Pacific Octopus (juvenile).

Looking at Art

Use art and design elements and principles to describe a photograph.

- Make an inventory of the textures, colors, shapes, lines, and values you see in the artwork.
- What is the focal point of the image and why?
- How do your eyes move through the composition?

Invertebrate Poetry

When Susan Middleton is observing and photographing invertebrates, she envisions the world from the animal's perspective. Have students select an image from *Spineless* and research the marine invertebrate. Ask students to create a poem from the point of view of the animal. Have them tell about their life in the sea. What do you see, hear, smell, taste, think, and feel? What do you eat? How do you get your food? How do you keep safe from your enemies? Do you live alone or with other sea animals?

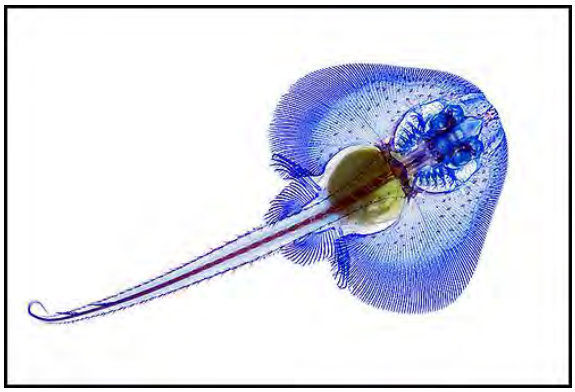


Image: Adam Summers, *Little Skate*, photograph.

Summers photographs invertebrates after applying special dyes and enzymes to the specimens. The chemicals allow him to better examine the system, structure and function of each specimen.

Little Skate
Leucoraja erinacea

Littlest of little skates, just barely hatched!
You can still see the remnants
of my yellow egg sac.

And my tail's a little longer
than my whole body
(I'll grow into it more eventually).

And the tiny whiplash at my very tail-tip
(that inside my egg case I used to thrash)
I'll keep for just a few days more.

In warmer days, I'll move toward shore:
Summer Skate you might call me.

Check me out! Already sensing
with ampullae of Lorenzini!

~ Sierra Nelson.

Poem: Sierra Nelson, *Little Skate.*

Poet, teacher, performer, collaborator, and armchair aquanaut, Sierra Nelson wrote the poem below to be exhibited alongside the photograph of a *Little Skate* taken by biologist Adam Summers for his exhibition, *Cleared: The Art of Science.*

Glossary of Art Terms

Portrait: A painting, photograph, sculpture, or other artistic representation of a person in which the face and its expression is predominant. The intent is to capture the likeness, personality, and even the mood of the person.

Photograph: the process or art of producing images of objects on sensitized surfaces by the chemical action of light or other forms of radiant energy, such as x-rays, gamma rays, or cosmic rays.

Observational Drawing: Drawing while looking at a subject; drawing what is presented to the eye.

Line: Lines are a path created by a point moving in space. Lines describe a shape, suggest movement, and organize an artwork into a structured whole. Lines are defined by type (angular or curved), direction (horizontal or vertical), and quality (thick or thin). They lead your eye around a composition and communicate by type and direction.

Shape: A two or more dimensional area that stands out from the space next to or around it, due to a defined or implied boundary, often because of differences in value, color, or texture.

Form: A three-dimensional object. Form can be measured for height, width, and depth. It can be defined by the presence of shadows on surfaces or faces of an object. Forms are often divided into two types: geometric (man-made) and natural (organic form).

Modeling: The process of producing sculpted form with some plastic material, such as clay.

Texture: The way a surface feels or appears to feel.

Tone: The light and dark values used to render a realistic object or create an abstract composition.

Density: The visual weight of an object, which may be described as transparent/opaque, thick/thin, or liquid/solid

Scale/proportion: The size of parts relative to one another.

Movement: Movement is created in a work of art by directing the viewer's eye to various areas of a composition with color, line, shape and other visual tools.

Value: The lightness or darkness of tone or shading.

Glossary of Natural Science Terms

Classification: The process of dividing objects into related groups.

Invertebrate: An animal without a backbone.

Biodiversity: The variety of life on earth, between all species of plants, animals and micro-organisms and the ecosystems within which they live and interact.

Ecosystem: A system that includes all living organisms in an area and its physical environment functioning as a unit.

Plankton: Small animals and plants that float or drift in seas and lakes.

Phylum: A major category in the classification of living organisms.

Habitat: The place where an organism or a biological population normally occurs.

Porifera: The invertebrate phylum of sponges.

Cnidaria: The invertebrate phylum including hydra, corals, sea anemones, and jellyfish.

Platyhelminthes: The invertebrate phylum of flatworms.

Arthropoda: The invertebrate phylum including horseshoe crabs, ticks, mites, scorpions, spiders, water fleas, copepods, barnacles, lobsters, shrimp, millipeds, centipedes, and insects.

Mollusca: The invertebrate phylum of mollusks, including chitons, snails, slugs, clams, oysters, nautilus, octopus, and squid.

Echinodermata: The invertebrate phylum including sea stars, sand dollars, sea urchins, and sea cucumbers.

Annelida: The invertebrate phylum of segmented worms, including earthworms, polychaetes, and leeches.

Sources & Resources

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