

Vermont Freshwater Mussel Survey

A Participant's Guide



Project Overview

Sponsors

The Vermont Freshwater Mussel Atlas of Life Project is sponsored by the Vermont Center for Ecostudies (VCE)

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The Vermont Freshwater Mussel Atlas aims to help document the abundance and distribution of native freshwater mussels across Vermont. The first step in developing effective conservation strategies for freshwater mussels is to know where populations exist. Without this basic information, conservation planning and action cannot be achieved.

Field work will rely heavily on volunteers, for whom this manual has been prepared. Participants need little experience to join the survey—only an interest in aquatic species and riparian habitats. Freshwater mussels are a prominent indicator species and are extremely sensitive to changing freshwater conditions in Vermont. They are one of the most endangered groups of animals on Earth. Nearly three-quarters of the 297 native mussel species in North America are imperiled and 35 species are thought to have gone extinct in the last century (Bogan 1996). The little data that exists on mussel species distribution is sparse and from a variety of sources. Information about where freshwater mussels reside or do not reside will help biologists to better assess the threats they face, and develop informed conservation action. With this in mind, the Vermont Center for Ecostudies (VCE) is launching the Vermont Freshwater Mussel Survey in 2017.

The project's major objectives are to:

- Publish maps and data about the historic and present distribution of Vermont freshwater mussels on the internet.
- Obtain a baseline of freshwater mussel distribution at the beginning of this century for comparison in the to historic and future observations .
- Assess the conservation status and needs of Vermont mussel species and river corridors.
- Identify habitats of statewide and regional importance for additional survey.
- Educate and involve more people in the discovery and protection of Vermont's natural heritage.

The survey will make essential data available to landowners, land-use planners, policy-makers, municipalities, and other individuals or organizations making conservation and management decisions. Our results will allow direct comparisons among states, with scientific and conservation implications extending throughout the Northeast. This project offers the opportunity for individuals, either professional or amateur, to make a significant contribution to the greater understanding of Vermont's natural heritage.

What are freshwater mussels?

The native freshwater mussels found in Vermont are members of the Unionidae family, and are also known as bivalves. This name comes from the two valves, or shells, that protect these animals. The majority of bivalve molluscs live in salt water, but they also live in brackish and fresh water. Freshwater mussels are filter feeders, feeding on detritus or plankton. They have shells made out of carbonate, a calcium-rich material, and these shells are coated in periostracum, a material that gives shells color. The interior of these shells is coated in a material called nacre, a glossy, iridescent material from which freshwater pearls form.

Mussels reproduce by creating tiny larval mussels called glochidia. Glochidia attach to the fins of gills or fish, and many adult mussels have developed tactics to ensure successful attachment. These glochidia grow into juvenile mussels that release from their host fish and burrow into sediment, remaining there for most of their lives. New England freshwater mussels can grow to be 30-40 years old. Most individuals rarely move more than a few hundred yards in a lifetime, but when they do, it's by using their foot, a muscular appendage.

Threats to Freshwater Mussels

- Habitat loss and fragmentation
- Human disturbance
- Drought
- Dams, which may cause changes in water temperature, quality, sediment levels, nutrient cycles, and migration.
- Anthropogenic restoration including rip rap, culverts, and road crossings
- Pollution, including waste effluent, excess nutrients, acid precipitation, and pesticides
- Invasive species like zebra mussels and Asian clams.
- Climate change
- Alteration of vegetation

Where do freshwater mussels live?

Freshwater mussels live in the streams, rivers and lakes of Vermont. They often prefer flowing water and different species thrive in a variety of substrates, including mud, clay, sand, and gravel. Freshwater mussels are usually sparse in areas of rivers dominated by bedrock and boulder substrates. Many species especially like slow flowing water, the downstream ends of pools, protected channels, and the outside of river bends.

While some species have a broad geographic range, like the Eastern *Elliptio*, many species are limited to specific substrate and water flow conditions. Areas populated with freshwater mussels often have shell fragments washed up onto the shoreline, and these shell fragments play a central role in this survey.

Why do mussels matter?

Mussels are crucial to water quality and aquatic food webs. They help filter nutrients out of the water and increase oxygen exchange throughout their habitat. Animals that feed on freshwater mussels include river otter, racoons, muskrats, and skunks, as well as a multitude of fish and bird species. Mussel shells also provide important biomass in aquatic systems, and act as a surface for macroinvertebrates and algae to attach.

Basic mussel morphology

Beak or Umbo- the raised and rounded area on each shell. Shells grow outward from the beak in a concentric pattern known as **growth lines**. The inside of the beak is known as the **beak cavity**.

Rays- lines that shoot out from the beak, perpendicular to growth lines. The color of shells is provided by the **periostracum**.

Valve-another word for the shell of a freshwater mussel. The valves can be **compressed, normal, or inflated**.

Hinge- elastic-like ligament along the dorsal surface of a mussel . The beak sometimes expands past the hinge line, or is sunken below it.

Teeth- small structures known as teeth interlock and help hold shells together. These features vary species to species:

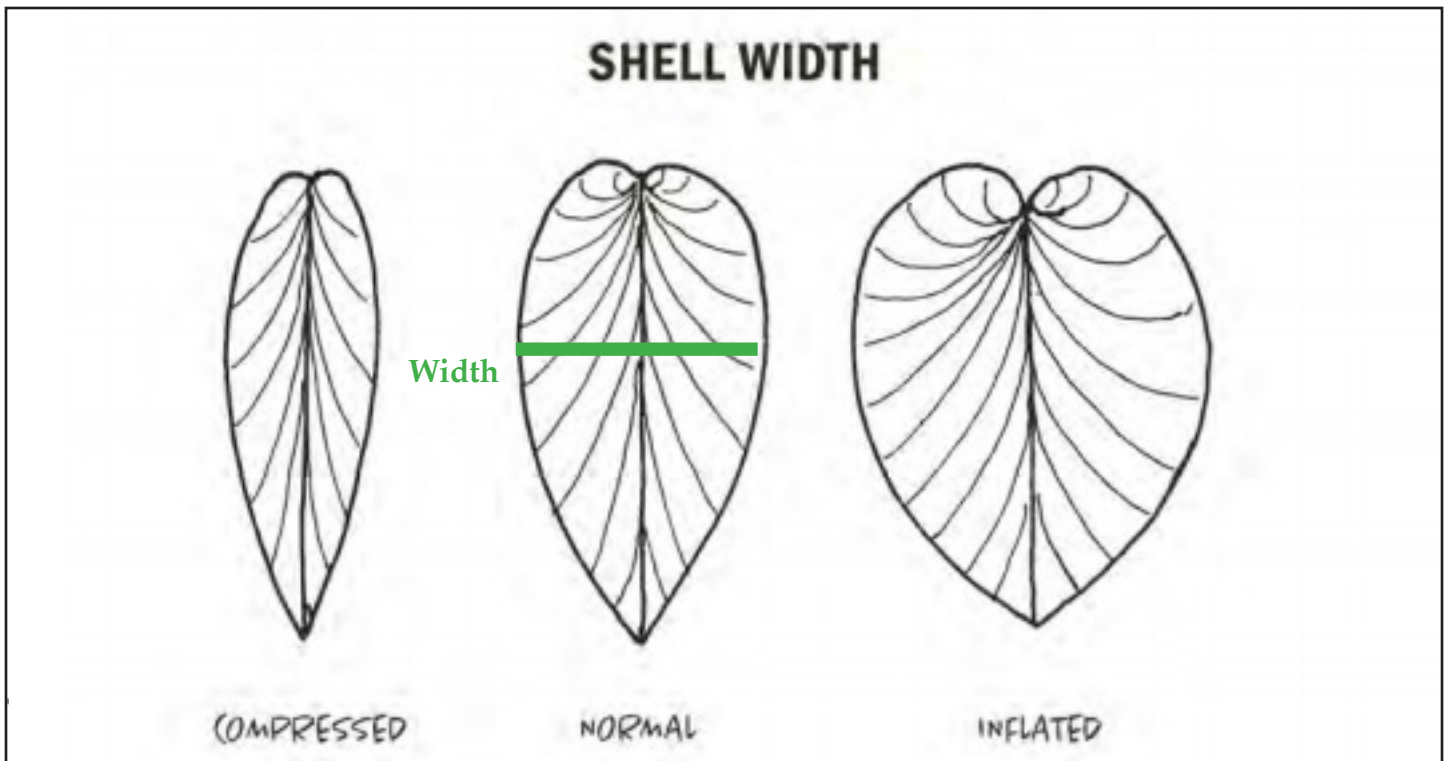
Lateral teeth- long narrow teeth near the hinge

Pseudocardinal teeth- tooth-like structures located below the beak

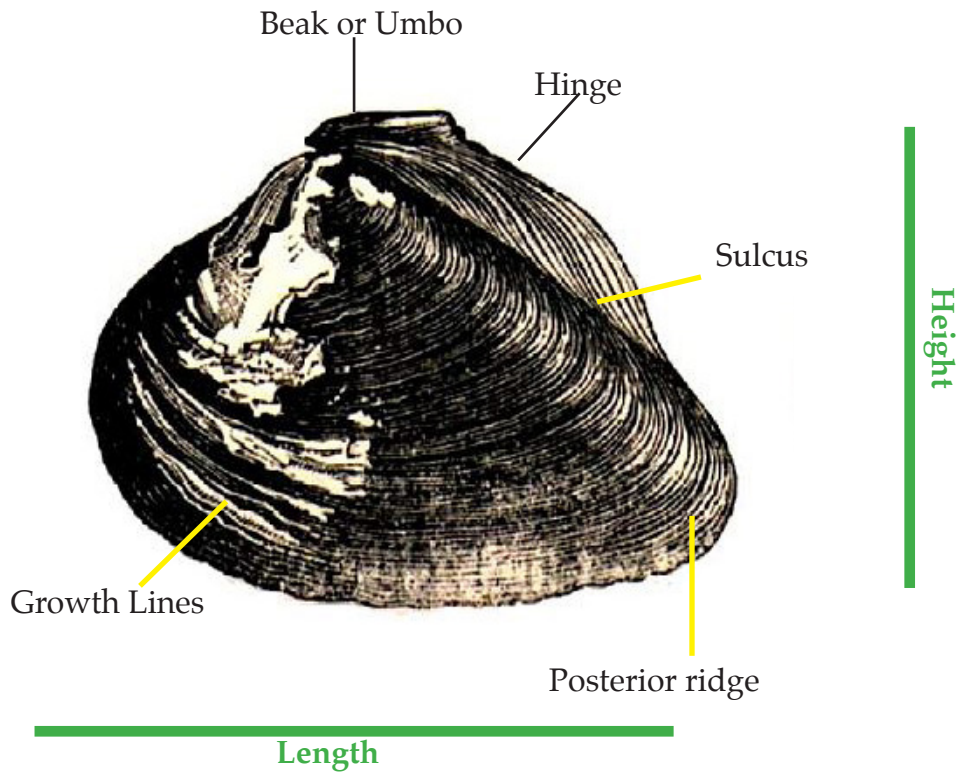
Posterior end- this portion of a mussel usually protrudes from stream bottom

Sulcus- depression in the shell that runs from the beak to the ventral edge

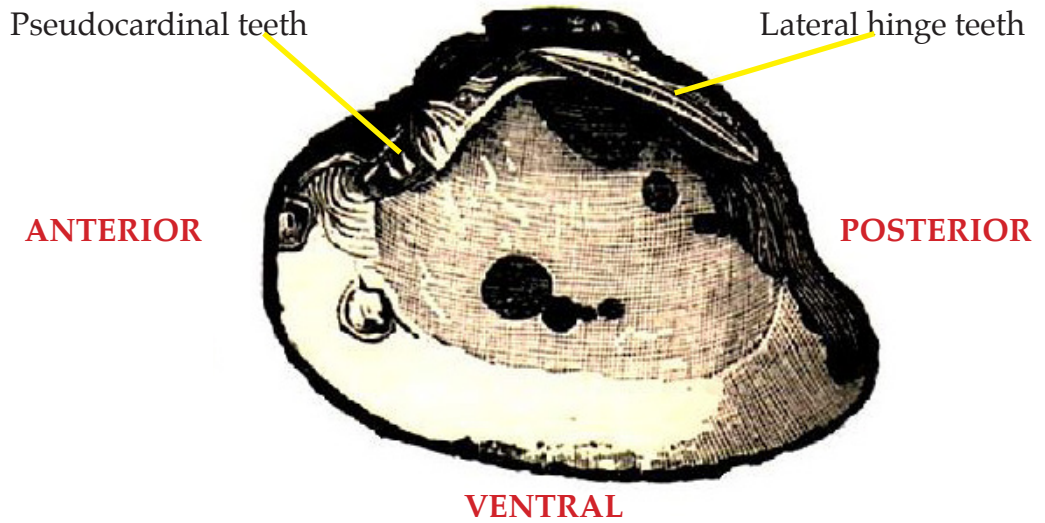
Nacre- smooth and sometimes pearly internal surface of shells



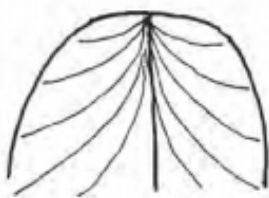
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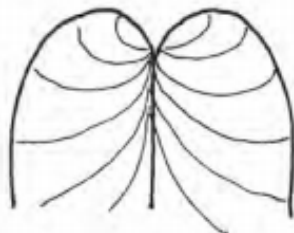
DORSAL



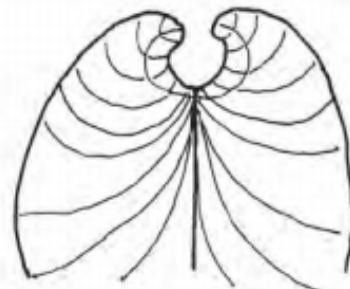
BEAK MORPHOLOGY



BEAKS NOT ABOVE HINGE LINE



BEAKS ABOVE HINGE LINE



BEAKS ELEVATED AND HOOKED

Vermont freshwater mussel species

Scientific Name	Common Name	State Ranking
<i>Pyganodon cataracta</i>	Eastern Floater	S4
<i>Strophitus undulatus</i>	Creeper	S3
<i>Pyganodon grandis</i>	Giant Floater	S2S3
<i>Potamilus alatus</i>	Pink Heelsplitter	S2
<i>Ligumia recta</i>	Black Sandshell	S1
<i>Leptodea fragilis</i>	Fragile Papershell	S2
<i>Lasmigona costata</i>	Fluted-shell	S2
<i>Lasmigona compressa</i>	Creek Heelsplitter	S2
<i>Lampsilis radiata</i>	Eastern Lampmussel	S5
<i>Lampsilis ovata</i>	Pocketbook	S2
<i>Elliptio complanata</i>	Eastern Elliptio	S5
<i>Anodontoides ferussacianus</i>	Cylindrical Papershell	S1S2
<i>Anodonta implicata</i>	Alewife Floater	S1
<i>Alasmidonta varicosa</i>	Brook Floater	S1
<i>Alasmidonta undulata</i>	Triangle Floater	S3
<i>Alasmidonta marginata</i>	Elktoe	S1
<i>Alasmidonta heterodon</i>	Dwarf Wedgemussel	S1
<i>Margaritafera margaritafera</i>	Eastern Pearlshell	S2

Vermont Fish and Wildlife, Native Freshwater Mussels of Vermont, March 2017

Survey instructions

Instructions follow for participation in the Vermont Freshwater Mussel Survey. Before beginning any work, please read this manual carefully, and take note of safety precautions. Do not handle living specimens or remove them from substrate. Do not dig for or move live mussels.

There are two options for contributing to the survey.

Option 1: Designated Site Survey: This option involves your choosing one or more specific sites to survey once between July 15 through September 15 and requires four steps:

1. Choosing a survey site(s) along a river, stream, or lake.
2. Visiting your site(s), filling out a short data form and photographing mussel shells.
3. Creating an iNaturalist profile and account if you do not have one and joining the Vermont Freshwater Mussel Survey project.
4. Submitting your data to Vermont Freshwater Mussel Survey through iNaturalist, including photographs and corresponding data.

Option 2: Casual Survey: This option encourages casual data submission. Rather than choosing a specific site to monitor ahead of time, the Casual Survey allows you to report mussel presence on an incidental basis—while at a swimming hole, canoeing a lake or fishing.

This option still requires three steps:

1. Photographing mussel shells found and noting surroundings.
2. Creating an iNaturalist profile and account if you do not have one.
3. Submitting your data to VCE through iNaturalist, including photographs and corresponding questions if possible.

Choosing a site:

Select a site on the shoreline of a river, stream, or lake. It can be a place you frequent or one you'd like to visit. Plan on surveying at least 3 stretches of the shoreline for at least 50 meters each. If you need guidance on site selection, each [species profile](http://val.vtecostudies.org/projects/vermont-freshwater-mussel-atlas/species/) (<http://val.vtecostudies.org/projects/vermont-freshwater-mussel-atlas/species/>) on the project page has geographical range information that may help direct your efforts. You can also reach out directly to Lyra Brennan at lbrennan@vtecostudies.org for further guidance on where to survey.

Before you survey:

- Pick a nice day - direct noon sunlight may be the easiest time to discern mussel shells on the shoreline or see them in the water. Heavy rain and high water conditions often cover shorelines.
- Get permission – contact the landowner before visiting any private property.
- Bring a small measuring tape or ruler, a hand lens, a camera to take photographs, a plain white sheet of paper to use as your photo backdrop, a printed data sheet, a GPS or smart phone to record coordinates, and shoes you don't mind getting muddy.
- Remember, freshwater mussels are extremely variable in coloration, shape, and size, both within and between species. No specimen is likely to exactly fit the description or picture. It's helpful for you to guess what a species is, even if you're not sure. Our experts will help make the final ID for each observation.

(continued on next page)

Safety Considerations:

- Never wade above knee level in unfamiliar water.
- Always tell someone where you are going and when you plan on arriving home
- VCE does not encourage swimming or searching for live specimens. If you happen to see shells from shore and can wade into shallow water safely, that is fine. This survey is specifically meant to be a shoreline survey for shells, not live specimens. There is no need to go in the water unless you are personally inclined to do so.
- Be cautious of areas where water levels change quickly due to dam releases or flooding. Use caution when you are uncertain about the stability of substrate; i.e. eroding banks and loose rocks.
- Do not cross a running river, brook, or lake. These surveys are designed to take place on one side of a body of water.

Survey Instructions

Upon Arrival to your site:

1. Fill out the first section of your data sheet: **Survey Location**
2. Take a photo that you think captures the character of your site. It's best if this photo includes both the water's edge and the surrounding vegetation.
3. Record your starting coordinates using a GPS or a smartphone. Coordinates can also be found by using Google Maps aerial retroactively; in this case, it is helpful to record a landmark like a large rock or a bridge that can be located on a map later.
4. Begin your survey

Surveying for shells:

Do not handle living specimens or remove them from substrate. Do not dig for or move live mussels!

1. Walk your site along the waters edge, examining the ground for fragments of shells. The search area should be about 3 meters out from the waters edge, or higher if you can discern a higher waterline.
2. Search by examining the ground for fragments of shells, look on the tops and sides of rocks, and underneath banks. Look for piles of shells or middens from otter and muskrat on river banks.
3. Once you locate a shell, give it a sample letter to differentiate it from your other specimens. (A, B, C...)
4. Photograph the shell using the tips listed in the next section, and label these photographs on your phone/camera.
5. Examine it for key traits such as shell shape, pseudocardinal teeth, lateral hinge teeth, and nacre color, and answer the corresponding questions on the next page. If you wish, you may attempt to ID the mussel to species.
6. Note the general environment in which the shell was found including substrate and water speed, and answer the corresponding questions on the next page.
7. Note the abundance of shells in the **shell abundance area** of your sample sheet.
8. Note anything else that stands out about your sample site including human overuse, rip rap, nearby dams, etc.

Photographing shells:

1. Only photograph shells that appear to be different than shells you have already photographed. There is no need to take pictures of every shell fragment at your site-- only those that are likely to be different species.
2. Place the shell on a flat surface on a blank, light-colored piece of paper. It may help to use a pencil and label each specimen (A, B, C) so that you do not confuse the photos before sending them and you can pair the correct notes with each photograph.
3. Lay a measuring tape out across the length axis of the mussel
4. Take a photograph of the exterior of the fragment, where the periostracum is.
5. Move the measuring tape so that it now measures the height of the mussel.
6. Flip the mussel and take a photograph of the interior, making sure any teeth are visible.
7. If possible, take a photograph of the end of the mussel to show the width, beak elevation, and inflation of the valves.
8. It is acceptable to take shells home with you to photograph or examine further.

Survey Location

Name of waterbody or river and town: _____

Access point: _____

Lat/Long Beginning of survey(s): _____

Lat/Long End of survey(s): _____

Estimated length of shoreline examined (m): _____

Shell Fragment Information

For each specimen photographed, choose from the following options; use the data table on page 10 if you find it helpful.

How many shell fragments were found within 3 meters of the specimen?

- None: 0-5
- Sparse 5-15
- Many: 15-25
- Abundant/Midden: 25+

What kind of substrate was the shell fragment found in?

- Sand
- Silt/Mud
- Gravel or Cobbles
- Bedrock

How many pseudocardinal teeth are visible?

- None
- One
- Two
- Unknown

How many lateral teeth are visible?

- None
- One
- Two
- Unknown

How fast is the water moving?

- Slow
- Moderate
- Fast
- High

Shell Fragment Information

Specimen	Substrate	Pseudo-cardinal Teeth	Lateral Hinge Teeth	Water Movement	Shell abundance	Species	Notes
A	<i>Sand/Cobble</i>	1	1	<i>Lake, slow</i>	<i>0-5, only a few small shell fragments nearby</i>	<i>Eastern elliption</i>	<i>Dense woody vegetation surrounding site</i>

Submitting Data

iNaturalist

If you do not have an iNaturalist account, please go to inaturalist.org to sign up and create one. Once you have joined iNaturalist, search for the [Vermont Freshwater Mussel Project](#) and join the project.

Uploading data

Create an observation and upload specimen photographs. For each specimen, answer the 5 corresponding questions on iNaturalist. These questions are not mandatory, but it is helpful to have additional information. Even photographs with no additional information are helpful. Photos should be labeled with a site and specimen name. i.e. " Little River State Park A"

Absence Data

If you visited a site and found no evidence of mussels, this is still **extremely important** information. Rather than submitting an observation, please login to iNaturalist and

- Click the envelope icon in the upper right hand of the iNaturalist homescreen
- Click "New Message" and message recipient Kent McFarland with the following information:
 - Lat/Long Beginning
 - Lat/Long Ending or Distance Walked
 - Specify that there were **No Mussels Found**
 - Send the message**

Sources and Helpful Links

ORGANIZATIONS AND AGENCIES

[Vermont Atlas of Life: Freshwater Mussel Atlas](http://val.vtcostudies.org/projects/vermont-freshwater-mussel-atlas/)

<http://val.vtcostudies.org/projects/vermont-freshwater-mussel-atlas/>

[Vermont Zebra Mussel Monitoring Program](http://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/monitoring/zebra-mussels)

<http://dec.vermont.gov/watershed/lakes-ponds/aquatic-invasives/monitoring/zebra-mussels>

[Vermont Fish & Wildlife Department](http://www.vtfishandwildlife.com/)

<http://www.vtfishandwildlife.com/>

[Vermont Department of Environmental Conservation](http://dec.vermont.gov/about-dec/a-z/water-topics)

<http://dec.vermont.gov/about-dec/a-z/water-topics>

[New Hampshire Fish & Game – Freshwater Mussels](http://www.wildlife.state.nh.us/nongame/mussels.html)

<http://www.wildlife.state.nh.us/nongame/mussels.html>

[Biodrawversity – Freshwater Mussels](http://www.biodrawversity.com/freshwater_mussels.htm)

http://www.biodrawversity.com/freshwater_mussels.htm

PUBLICATIONS

Nedeau, E.J. 2008. Freshwater Mussels and the Connecticut River Watershed. Connecticut River Watershed Council. Greenfield, MA. xvii + 132pp.

(Chap 1: [Biology and Ecology](http://biodrawversity.com/pubs/Chapter1.pdf), <http://biodrawversity.com/pubs/Chapter1.pdf>)

(Chap 2: [Habitat and Distribution](http://biodrawversity.com/pubs/Chapter2.pdf), <http://biodrawversity.com/pubs/Chapter2.pdf>)

(Chap 3: [Status and Threats](http://biodrawversity.com/pubs/Chapter3.pdf), <http://biodrawversity.com/pubs/Chapter3.pdf>)

(Chap 4: [Protect and Restore](http://biodrawversity.com/pubs/Chapter4.pdf), <http://biodrawversity.com/pubs/Chapter4.pdf>)

(Chap 5: [Species Profiles](http://biodrawversity.com/pubs/Chapter5.pdf), <http://biodrawversity.com/pubs/Chapter5.pdf>)