How to use this book

This ID book contains tips for identifying a number of aquatic invasive species (AIS) that are considered high-risk to Minnesota waters, as well as some common native lookalike species.

As you look at identifying characteristics and descriptions in the pages that follow, bear in mind that colors and sizes can be variable. These are general guidelines, not definitive taxonomic identification characteristics. Whenever possible, we highlighted key or unusual characteristics about a species, but specimens can often look very similar. They may also sometimes be found outside of the suggested habitats. If you are in doubt as to whether you have found an AIS, be sure to submit a report to the DNR using EDDMapS or the Great Lakes Early Detection Network (GLEDN) app, or by contacting a DNR AIS Specialist.

You will notice two different styles of maps in this book: for native species, we use watershed maps to highlight where species are generally found. Again, this can vary — these maps are a guideline. For invasive species, we use county maps to provide more localized distribution information. Maps are current using available data as of February 2018.

For more information on this book and AIS research, please visit www.maisrc.umn.edu.
If you find an AIS

If you find an aquatic invasive species occurrence, follow these steps:

1. **Use EDDMapS to submit the report.**
   
   You can do this using the GLEDN app on your mobile device or on the EDDMapS website at www.eddmaps.org/Midwest. You should include:
   
   • The date and time you made the observation.
   • The species you believe you have found.
   • The location you made the observation. Be specific.
   • Photographs of the specimens.

2. **Take photos of the AIS.**
   
   You should take multiple photos, including:
   
   • Photos of the entire plant or animal (or as much as can clearly be captured in the frame).
   • Close-ups of identifying features (such as leaves, fins, shape, colors, etc.).
   • A photo that has an object in it for scale (such as a coin or a ruler).
   • One photo of the general area where the AIS was found.

3. **Collect a sample of the AIS.**
   
   • For animals such as invertebrates and fish, collect the entire animal.
   • For smaller animals such as zebra mussels or spiny waterflea, you may want to include a few animals.
   • For plants, you want to include as much of the plant as you reasonably can. Try to collect portions of the stem with leaves attached, any flowering structures if present, reproductive parts such as flowers or fruits, and organs such as tubers, turions, roots and rhizomes.
   • Place the collected sample in a sealed container, something as simple as a Ziploc bag will do. If you have a large animal, like a carp, put it on ice in a cooler. You may also choose to wrap the plant or animal in a damp paper towel or newspaper prior to putting it into its container.
   • Put a piece of paper with the location the sample was collected, the date of collection, and your name and contact information on it in the container with your sample. Be sure to write in pencil so that it doesn't bleed or run when wet.

4. **Contact your local AIS specialist.**
   
   • Inform them that you have a sample of a suspected AIS and ask for further direction on what they would like you to do with it.
   • The contact information for AIS Specialists is on the DNR's website: www.dnr.state.mn.us/invasives/ais/contacts.html

5. If you are using the GLEDN app, be sure to upload your report from the queue.

The DNR is responsible for confirming and communicating new AIS occurrences. Do not make public announcements of AIS findings.

If you are interested in learning more about AIS identification and citizen science, consider becoming an AIS Detector. Visit www.aisdetectors.org for more information.
Acknowledgements

The contents of this book have been reviewed for scientific accuracy by researchers and experts from the Minnesota Aquatic Invasive Species Research Center and the Minnesota Department of Natural Resources, including:

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Chris Taylor, Illinois Natural History Survey  
Mike Verhoeven, Minnesota Aquatic Invasive Species Research Center
## Quick reference guide

### Eurasian watermilfoil

<table>
<thead>
<tr>
<th>Leaves alternate</th>
<th>Eurasian watermilfoil</th>
<th>Northern watermilfoil</th>
<th>Hybrid watermilfoil</th>
<th>Coontail</th>
<th>Water marigold</th>
<th>White water crowfoot</th>
<th>Bladderworts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Bladders present on leaves</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Leaves whorled</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Leaflets on a central axis</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves with &lt;12 leaflets (4-11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves with ≥12 leaflets (12-20)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Hydrilla

<table>
<thead>
<tr>
<th></th>
<th>Hydrilla</th>
<th>Brazilian waterweed</th>
<th>Elodea (waterweed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 3 leaves in a whorl</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>≥ 3 leaves in a whorl</td>
<td>x (usually 5)</td>
<td>x (usually 4)</td>
<td></td>
</tr>
<tr>
<td>Showy white flowers</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Serrated leaf margins</td>
<td></td>
<td>x</td>
<td>x (under magnification)</td>
</tr>
<tr>
<td>Produces tubers and turions</td>
<td></td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

### Starry stonewort

<table>
<thead>
<tr>
<th></th>
<th>Starry stonewort</th>
<th>Chara spp.</th>
<th>Nitella spp.</th>
<th>Sago pondweed</th>
<th>Water stargrass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate, flat leaves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Branching needle-like leaves</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Whorled branchlets, like stem</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strong odor</td>
<td></td>
<td></td>
<td>Some species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rough stems</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Forked branchlets</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Forked tips symmetrical</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Stays rigid out of water</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Star-shaped bulbils</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Introduction to aquatic plants

Leaf arrangement:

- Alternate
- Opposite
- Whorled

Leaf type:

- Simple (undivided)
- Compound (divided into leaflets)

Leaf margins:

- Entire
- Serrate
- Undulate

Leaflet

Central axis

Node

Leaf

Stem

Midvein

Whorled leaf

Node
Eurasian watermilfoil
*Myriophyllum spicatum*

**KEYS TO ID**
- Feathery looking with four leaves per whorl
- Leaves have central axis with 12 – 20 leaflet pairs
- Can grow up to 10 feet long
- Produces pink and white flowers on spike above surface
- Leaves become limp when taken out of water

**LOOKS SIMILAR TO**
- Northern watermilfoil (native)
- Coontail (native)
- Bladderworts (native)
- White water crowfoot (native)
- Water marigold (native)

**WHERE TO LOOK**
- In lakes, ponds, and slow-moving areas of rivers or streams
- Grows best in depths of 3 – 15 feet

**CURRENTLY FOUND**

Note: Eurasian watermilfoil is known to hybridize with northern watermilfoil.

Hybrid watermilfoil is also considered invasive and should be reported.

Four leaves per whorl with 12 – 20 leaflet pairs per leaf
KEYS TO ID
• Four leaves per whorl
• Each leaf has between 4 – 11 leaflet pairs
• Leaves have a central axis and are rigid when taken out of water

LOOKS SIMILAR TO
• Eurasian watermilfoil (invasive)
• Coontail (native)
• Bladderworts (native)
• Water marigold (native)
• White water crowfoot (native)
• Minnesota has six native milfoil species; this is the most common

WHERE TO LOOK
• In depths of up to 20 feet

CURRENTLY FOUND
NATIVE
Northern watermilfoil
Myriophyllum sibiricum

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf

Northern watermilfoil
Myriophyllum sibiricum

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf

Four leaves per whorl
with 4 – 11 leaflet pairs per leaf
KEYS TO ID
- Leaves have no central axis and are branching
- Can grow up to six feet long
- Often free-floating

LOOKS SIMILAR TO
- Eurasian watermilfoil (invasive)
- Water marigold (native)
- Northern watermilfoil (native)
- Bladderworts (native)
- White water crowfoot (native)

WHERE TO LOOK
- In water up to 20 feet deep
- Upper leaves may reach surface and form dense patches
- Can become highly abundant and form “oil slicks” when it dies back

CURRENTLY FOUND

Coontail
*Ceratophyllum demersum*
NATIVE Bladderworts
Utricularia spp.

KEYS TO ID
• Thin leaves branching and zig-zagging can give a “fractal” appearance
• Leaves are highly dissected and have no central axis
• Has bladders, some of which may be filled with invertebrate victims of these carnivorous plants
• Has snapdragon-like flowers

LOOKS SIMILAR TO
• Eurasian watermilfoil (invasive)
• Northern watermilfoil (native)
• Coontail (native)
• Water marigold (native)
• White water crowfoot (native)
• Minnesota has eight bladderwort species

WHERE TO LOOK
• Usually found in shallow waters
• Can be either free-floating or buried in the sediment

CURRENTLY FOUND

Branching
White water crowfoot

Ranunculus aquatilis

KEYS TO ID

• Grows in mats on the water’s surface
• Alternating leaves are highly dissected
• Produces flowers with yellow centers and five white petals
• Often has modified leaves at surface

LOOKS SIMILAR TO

• Eurasian watermilfoil (invasive)
• Water marigold (native)
• Northern watermilfoil (native)
• Bladderworts (native)
• Coontail (native)

WHERE TO LOOK

• In ponds, slow-moving streams, and marshes
• Can grow up to 1 to 6 inches above water’s surface

CURRENTLY FOUND

Branching leaves
KEYS TO ID
• Opposite to whorled, highly dissected leaves that are variable along stems
• Leaves do not have a central axis
• Produces yellow buttercup flowers with more than five petals in mid- to late-summer
• Has two simple emergent leaves under the flower that are serrated

LOOKS SIMILAR TO
• Eurasian watermilfoil (invasive)
• Coontail (native)
• Northern watermilfoil (native)
• Bladderworts (native)
• White water crowfoot (native)

WHERE TO LOOK
• In water up to 12 feet deep
• Flowers are above water

CURRENTLY FOUND
Water marigold
Bidens beckii (formerly Megalodonta beckii)
KEYS TO ID
• Submersed plant that grows into thick mats
• Leaves are bright green with a midvein down the center and are between $\frac{1}{4}$ and $\frac{3}{4}$ inches long
• Leaves directly attached to stem (stalkless) in whorls of 3 – 10; often 5
• Ascending stems can grow up to 30 feet long
• Tubers or turions may be present
• Leaves have sharply toothed serrated edges that may require a hand lens to see

LOOKS SIMILAR TO
• *Elodea* (native)
• Brazilian waterweed (invasive)

WHERE TO LOOK
• Streams, lakes, and ponds
• In shallow or deep waters
• May invade deep waters where native plants can't grow
• Has not been found in Minnesota

CURRENTLY FOUND

*Hydrilla verticillata*
Three leaves per whorl

Common waterweed
Elodea canadensis

KEYS TO ID
• Whorls of 3 oval-shaped leaves; whorls of 4 may occur
• Can grow up to three feet tall
• Leaves have smooth edges and are between ¼ and ⅔ inches long
• Small white flowers visible above water in the summer

LOOKS SIMILAR TO
• Hydrilla (invasive)
• Brazilian waterweed (invasive)
• Minnesota has three native Elodea species

WHERE TO LOOK
• In water up to 10 feet deep
• Near stream inlets
• May be free-floating

CURRENTLY FOUND
INVASIVE
Brazilian waterweed
*Egeria densa*

KEYS TO ID
- Leaves in whorls of 4 to 6
- Leaves are between $\frac{3}{8}$ and 1.5 inches long
- Small white flowers with 3 petals may be visible
- Can form dense mats that look bushy
- Serrated leaf margins may be visible under magnification

LOOKS SIMILAR TO
- *Elodea* (native)
- *Hydrilla* (invasive)

WHERE TO LOOK
- Submersed; can be free-floating or rooted
- Commonly used in home aquaria
- No established populations in Minnesota
KEYS TO ID
- Long, smooth branchlets are attached in whorls of 5 – 8 and branch asymmetrically at tips
- Stems are smooth
- Small, star-shaped bulbils form on clear threads at base of plant and may be found above or below the sediment surface
- Small, orange spheres called antheridia may be visible, these are male reproductive structures
- Branchlets typically several inches long, longer than Chara or Nitella
- Can fill water column and form surface mats

LOOKS SIMILAR TO
- Native Chara (native)
- Native Nitella (native)
- Sago pondweed (native)
- Water stargrass (native)

WHERE TO LOOK
- In shallow, still water and near accesses

CURRENTLY FOUND

Actual size of bulbils
Below: orange antheridia
NATIVE

Muskgrasses
*Chara* spp.

**KEYS TO ID**

- Stems are typically rough and crunchy
- Thin branchlets form whorls around thin stems
- Branchlets are not forked at tips
- May produce bulbils, but not star-shaped
- May have musky odor

**LOOKS SIMILAR TO**

- Starry stonewort (invasive)
- *Native Nitella* (native)
- Sago pondweed (native)
- Water stargrass (native)
- Minnesota has nine *Chara* species

**WHERE TO LOOK**

- Fully submerged
- Along lake bottoms forming patches called meadows

**CURRENTLY FOUND**

[Map showing distribution in Minnesota]
Stoneworts
Nitella spp.

KEYS TO ID
- Stems are smooth
- Branchlets fork into two or three tips at end
- Unlike starry stonewort, forked tips are of equal length
- Typical branchlets are around an inch in length; much shorter than starry stonewort
- Becomes limp when out of water

LOOKS SIMILAR TO
- Starry stonewort (invasive)
- Native Chara (native)
- Sago pondweed (native)
- Water stargrass (native)

WHERE TO LOOK
- Often in deeper zones of lake
- At depths up to 30 feet

CURRENTLY FOUND
- Branchlets; smooth stems
**KEYS TO ID**
- Has narrow, stiff leaves alternating off the slender stem
- The base of leaves are tightly attached to stem for about 1/4 of an inch before coming off the stem
- Produces clusters of egg-shaped fruits
- Leaves are very fine and almost look like pine needles
- Grows up to three feet tall

**LOOKS SIMILAR TO**
- Starry stonewort (invasive)
- Native *Chara* (native)
- Native *Nitella* (native)
- Water stargrass (native)

**WHERE TO LOOK**
- Usually in shallow waters up to six feet
- Entirely submersed in water

**CURRENTLY FOUND**

*Stuckenia pectinata*
**NATIVE**

**Water stargrass**

*Heteranthera dubia*

**KEYS TO ID**

- Small yellow flowers visible above water in mid- to late-summer
- Leaves lack a visible midvein
- Slender and branching stems with alternating leaves
- Leaves are narrow and flat
- May create dense mats

**LOOKS SIMILAR TO**

- Starry stonewort (invasive)
- Native *Chara* (native)
- Sago pondweed (native)
- Native *Nitella* (native)

**WHERE TO LOOK**

- Mostly in shallow waters and near stream banks
- On sandy or muddy bottoms

**CURRENTLY FOUND**

[Map of Minnesota showing the distribution of Water stargrass]
**Invasive**

**Curly-leaf pondweed**
*Potamogeton crispus*

**Keys to ID**
- Thin, submerged leaves have distinct “teeth” and wavy edges
- Produces turions that look like small, greenish-brown pinecones
- Generally the first pondweed to come up in the spring; dies back in midsummer
- Leaves do not clasp around stem where they connect

**Looks similar to**
- Clasping-leaf pondweed (native)

**Where to look**
- Lakes, rivers, and streams in waters up to 15 feet deep

**Currently found**

![Map of Minnesota showing Curly-leaf pondweed distribution](image)

*Teeth on edges*  *Turions*
KEYS TO ID
• Leaves alternate along the stem
• Leaves are wide and wavy, but don’t have “teeth” like curly-leaf pondweed
• Leaves clasp around stem

LOOKS SIMILAR TO
• Curly-leaf pondweed (invasive)
• Also called Richardson’s pondweed

WHERE TO LOOK
• Fully submersed
• In water up to 12 feet

CURRENTLY FOUND
### Rusty crayfish

<table>
<thead>
<tr>
<th>Feature</th>
<th>Rusty crayfish</th>
<th>Clearwater crayfish</th>
<th>Calico crayfish</th>
<th>Virile crayfish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red spot on carapace</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black band on pincers</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dark v-shaped mark on abdomen</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Notched gap in pincers</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Orange tip on pincers</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Blue tint &amp; white bumps on claws</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Oval gap when pincers closed</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Zebra and quagga mussels

<table>
<thead>
<tr>
<th>Feature</th>
<th>Zebra mussels</th>
<th>Quagga mussels</th>
<th>Native mussels</th>
<th>Asian clam</th>
<th>Snails</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults attach to hard surfaces</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Two shells</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Symmetric shape</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Ridges on shell</td>
<td></td>
<td>Some species</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Spiral-shaped shell</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Striped pattern</td>
<td>Zig-zags</td>
<td>Rings</td>
<td>Some species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flattened ventral edge</td>
<td>x</td>
<td></td>
<td>Some species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curved line where shells meet</td>
<td></td>
<td>x</td>
<td>Some species</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coloration lightens toward hinge</td>
<td></td>
<td>x</td>
<td>Some species</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Spiny waterflea

<table>
<thead>
<tr>
<th>Feature</th>
<th>Spiny waterflea</th>
<th>Fishhook waterflea</th>
<th>Other zooplankton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long, spine-like tail</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbs on tail</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Black eyespot(s)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Egg sac (on females)</td>
<td>Round, bulbous</td>
<td></td>
<td>Long, pointed</td>
</tr>
<tr>
<td>Hook at end of tail</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Can clump on angling gear</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
Introduction to invertebrates

Crayfish
- Two pincers form a claw
- Antennae
- Carapace
- Abdomen
- Tail

Mussels and clams
- Hinge
- Ventral edge

Snails
- Operculum
KEYS TO ID
• All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
• Red spots on the sides of carapace
• Small black bands at the tip of each pincer on claws
• When claws close, there is an oval-shaped gap
• Can grow up to 5 inches long

LOOKS SIMILAR TO
• Red swamp crayfish (invasive)
• Northern clearwater crayfish (native)
• Calico crayfish (native)
• Virile crayfish (native)
• Young or smaller specimens can often be difficult to tell apart

WHERE TO LOOK
• Often found in shallow water up to three feet deep
• On a wide variety of bottom types

CURRENTLY FOUND

Oval-shaped gap and black bands
KEYS TO ID

- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- Can grow up to 5 inches
- Red bumps on claws
- Black wedge-shaped stripe on top of abdomen

LOOKS SIMILAR TO

- Rusty crayfish (invasive)
- Northern clearwater crayfish (native)
- Calico crayfish (native)
- Virile crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

WHERE TO LOOK

- All types of freshwater
- Burrowed into bottoms of lakes, rivers, and ponds

CURRENTLY FOUND

Red swamp crayfish
Procambarus clarkii
KEYS TO ID
- All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
- No red spot on side of carapace
- Claws are similar to rusty crayfish with black band at the tip
- Dark wedge-shaped marking down abdomen
- Can grow up to 4.5 inches

LOOKS SIMILAR TO
- Rusty crayfish (invasive)
- Red swamp crayfish (invasive)
- Calico crayfish (native)
- Virile crayfish (native)
- Young or smaller specimens can often be difficult to tell apart

WHERE TO LOOK
- In clear, rocky streams and rocky lake shores

CURRENTLY FOUND
Northern clearwater crayfish
Orconectes propinquus

NATIVE
KEYS TO ID
• All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
• No red spot on carapace
• Distinctive notch in the pincers of their claws
• Can grow up to 3.5 inches

LOOKS SIMILAR TO
• Rusty crayfish (invasive)
• Red swamp crayfish (invasive)
• Virile crayfish (native)
• Northern clearwater crayfish (native)
• Young or smaller specimens can often be difficult to tell apart

WHERE TO LOOK
• In shallow waters under plants for cover
• Will burrow in muddy bottoms of ponds

CURRENTLY FOUND
Calico crayfish
Orconectes immunis
KEYS TO ID
• All crayfish resemble miniature lobsters with long antennae, a pair of claws, and eight legs
• No red spot on side of carapace
• Narrow claws with no black band
• Claws may have a blue tint with small white bumps
• Can grow up to 5 inches

LOOKS SIMILAR TO
• Rusty crayfish (invasive)
• Red swamp crayfish (invasive)
• Calico crayfish (native)
• Northern clearwater crayfish (native)
• Young or smaller specimens can often be difficult to tell apart

WHERE TO LOOK
• In a wide variety of habitats
• Under stones in lakes, streams, and wetlands
• Not found in swift-moving waters

CURRENTLY FOUND
Virile crayfish
Orconectes virilis
NATIVE
2 – 6
KEYS TO ID
• Stripes are generally in zigzag pattern
• Pattern is variable; some may lack striping altogether and can be solid tan or brown
• Have a flat edge and won’t topple over when set on it
• Shells form straight line when closed
• Range from 1/5 of an inch to 2 inches

LOOKS SIMILAR TO
• Quagga mussels (invasive)
• Asian clam (invasive)
• Chinese mystery snail (invasive)
• Native snails (native)
• Native mussels (native)

WHERE TO LOOK
• Often found attached to submerged objects (such as boats and docks as well as plants and rocks)
• May leave behind byssal threads when removed
• Newly settled mussels are usually in shallow areas; adults are common in depths of 10 to 20 feet

CURRENTLY FOUND
Zebra mussels
*Dreissena polymorpha*

INVASIVE
**KEYS TO ID**

- Stripes are in rings
- Wide range of coloration – some may appear to have almost no striping
- Will topple over when placed on ventral edge
- Shells form S-shape when closed
- Range from $\frac{1}{8}$ of an inch to 2 inches

**LOOKS SIMILAR TO**

- Zebra mussels (invasive)
- Chinese mystery snail (invasive)
- Asian clam (invasive)
- Native mussels (native)
- Native snails (native)

**WHERE TO LOOK**

- Often found attached to submerged objects (such as boats and docks as well as plants and rocks)
- May leave behind byssal threads when removed
- May inhabit softer substrates (such as silt) and deeper water than zebra mussels

**CURRENTLY FOUND**

Quagga mussels
*Dreissena rostriformis* “bugensis”
INVASIVE

Asian clam

Corbicula fluminea

KEYS TO ID

• Bivalve that ranges from light to dark in color
• Symmetric shape; rounder than zebra mussels
• Shells have rigid concentric rings
• Can grow up to 2 inches

LOOKS SIMILAR TO

• Zebra mussels (invasive)
• Quagga mussels (invasive)
• Chinese mystery snail (invasive)
• Native snails (native)
• Native mussels (native)

WHERE TO LOOK

• In soft substrates like sand or mud

CURRENTLY FOUND

Asian clam

Corbicula fluminea

INVASIVE

2 – 9
Freshwater mussels
Family Unionidae

KEYS TO ID
• Have two shells (bivalves) with an asymmetrical shell shape
• Grow significantly larger than zebra mussels, quagga mussels, and Asian clam
• 48 different species live in Minnesota
• Often called clams

LOOKS SIMILAR TO
• Zebra mussels (invasive)
• Chinese mystery snail (invasive)
• Asian clam (invasive)
• Quagga mussels (invasive)
• Native snails (native)
• Collectively called “unionids”

WHERE TO LOOK
• Embedded in the bottom of lakes and rivers throughout Minnesota

CURRENTLY FOUND

Top: Native mussel on its own.
Bottom: Native mussel being smothered by zebra mussels. The uncovered part of this mussel was buried in the river bottom.
KEYS TO ID

• Grow up to 2 inches long
• Light to dark brown
• Have an operculum ("trapdoor") covering opening which is missing when dead

LOOKS SIMILAR TO

• Zebra mussels (invasive)
• Quagga mussels (invasive)
• Asian clam (invasive)
• Native mussels (native)
• Native snails (native)

WHERE TO LOOK

• In lakes and slow-moving rivers

CURRENTLY FOUND

Chinese mystery snail
* Cipangopaludina chinensis

Operculum

Operculum
NATIVE Snails

KEYS TO ID
• Single shell with spirals
• Generally under 2 to 3 inches

LOOKS SIMILAR TO
• Zebra mussels (invasive)
• Quagga mussels (invasive)
• Chinese mystery snail (invasive)
• Asian clam (invasive)
• Native mussels (native)

WHERE TO LOOK
• Most aquatic habitats (from woodland pools to streams, rivers, wetlands, ponds, and lakes) throughout the state

CURRENTLY FOUND

Pond snail

Ramshorn snail

Limpet snail
Limpet snails are native to Minnesota but do not have the typical spiraled shell, and can be found attached to other animals or objects — often leading to confusion with zebra or quagga mussels.
Spiny waterflea
*Bythotrephes longimanus*

**KEYS TO ID**
- Range from $\frac{1}{4}$ to $\frac{5}{8}$ of an inch
- Have long, spiny tails with 1 – 4 pairs of barbs
- Have distinctive black eyespots
- Females may have bulbous brood chamber on back
- Most abundant during late summer and autumn

**LOOKS SIMILAR TO**
- Fishhook waterflea (invasive)
- *Leptodora* (native)
- *Chaoborus* (native)

**WHERE TO LOOK**
- Most often found on fishing line or other equipment in clumps that resemble a gelatinous blob
- Usually found in deep lakes but can establish in shallow lakes and rivers
- Suspended in water column

**CURRENTLY FOUND**

*Spiny waterflea with three pairs of barbs*

*Brood chamber holding early development eggs*
**KEYS TO ID**
- Range from about ¼ to ½ inch
- Have long tail with up to three pairs of barbs and a characteristic “hook” near the end
- Have distinctive eyespot
- Females may have pointed brood chamber on back

**LOOKS SIMILAR TO**
- Spiny waterflea (invasive)
- Leptodora (native)
- Chaoborus (native)

**WHERE TO LOOK**
- Clogged on nets or other fishing gear
- Brackish and freshwater lakes
- Has not been found in Minnesota

**CURRENTLY FOUND**

Fishhook waterflea (top)
Spiny waterflea (bottom)
KEYS TO ID
• No long, spine-like tail
• *Leptodora* grow up to 0.8 inches long with two antennae and one eye
• *Chaoborus* have two small eyes at the front of their bodies, lack spines on their tail, and also lack long antennae
• Both are almost entirely transparent

LOOKS SIMILAR TO
• Spiny waterflea (invasive)
• Fishhook waterflea (invasive)

WHERE TO LOOK
• Collected on fishing line
• Very widespread throughout Minnesota

CURRENTLY FOUND

*NATIVE* Predatory zooplankton
*Leptodora sp.* and larval *Chaoborus sp.*
# Quick reference guide
## Bighead and silver carp

<table>
<thead>
<tr>
<th></th>
<th>Bighead carp</th>
<th>Silver carp</th>
<th>Gizzard shad</th>
<th>Mooneye</th>
<th>Shiners</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
<td>Gray with dark patches; silvery white underside</td>
<td>Silver; sometimes with a green hue</td>
<td>Silver-white</td>
<td>Silver</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>Eye location</strong></td>
<td>Center below midline</td>
<td>Center below midline</td>
<td>Center above midline</td>
<td>Center above midline</td>
<td>Center above midline</td>
</tr>
<tr>
<td><strong>Keel</strong></td>
<td>Short</td>
<td>Long</td>
<td>Long</td>
<td>Short</td>
<td></td>
</tr>
<tr>
<td><strong>Shoulder spot</strong></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teeth</strong></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Long final ray of dorsal fin</strong></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Round goby

<table>
<thead>
<tr>
<th></th>
<th>Round goby</th>
<th>Tubenose goby</th>
<th>Sculpins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
<td>Mottled browns, blacks, grays, and olives — white or cream underside</td>
<td>Mottled brown on light brown, olive, or tan — white or cream underside</td>
<td>Variable brown markings</td>
</tr>
<tr>
<td><strong>Black spot on first dorsal fin</strong></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Separated 1st and 2nd dorsal fins</strong></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><strong>Fused pelvic fins</strong></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

## Ruffe

<table>
<thead>
<tr>
<th></th>
<th>Ruffe</th>
<th>Walleye</th>
<th>Yellow perch</th>
<th>Sauger</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
<td>Tans, grays, olive, and silvers with irregular dark blotches; white-cream</td>
<td>Brown/olive with mottling, white-cream underside</td>
<td>Brownish-green with dark vertical bars, white-cream underside</td>
<td>Brown/gray with mottling, white-cream underside</td>
</tr>
<tr>
<td><strong>Mouth extends past front of eye</strong></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>White tip at base of caudal fin</strong></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fused 1st and 2nd dorsal fins</strong></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Introduction to fish

Fish characteristics

- **Mouth**
- **Eye**
- **Dorsal fin**
- **Adipose fin**
- **Caudal (tail) fin**
- **Anal fin**
- **Pelvic fin (paired)**
- **Pectoral fins (paired)**
- **Keel**

Variations in fins

- Two connected dorsal fins
- Two separate dorsal fins
- Fin rays

Keel
**KEYS TO ID**
- Dark gray with black blotches on back and sides
- Eyes point downward; center of the eye is even with or below the midline
- No teeth in upper or lower jaw
- Short keel between pelvic and anal fins
- Average size of Bighead carp caught in Minnesota is nearly 40 inches; early life stage could be confused with minnows

**LOOKS SIMILAR TO**
- Silver carp (invasive)
- Gizzard shad (native)
- Mooneye (native)
- Emerald shiner (native)

**WHERE TO LOOK**
- Prefer turbulent, nutrient-rich rivers
- Need flowing water to reproduce; will use backwaters and slow areas other times of the year
- No known established populations in Minnesota; individuals have been caught intermittently

**CURRENTLY FOUND**

![Map showing currently found areas of Bighead carp](image)
KEYS TO ID

- Silver in color; can be greenish on back
- Eyes point downward
- Center of the eye is even with or below the midline
- No teeth in upper or lower jaw
- Long keel that extends in front and behind pelvic fins
- Average size of Silver carp caught in Minnesota is nearly 33 inches; early life stage could be confused with minnows

LOOKS SIMILAR TO

- Bighead carp (invasive)
- Gizzard shad (native)
- Mooneye (native)
- Emerald shiner (native)

WHERE TO LOOK

- Can jump up to ten feet in the air
- Prefer turbulent, nutrient-rich rivers; can tolerate a wide range of temperatures
- Need flowing water to reproduce; will use backwaters and slow areas other times of the year
- No known established populations in Minnesota; individuals have been caught intermittently

CURRENTLY FOUND
NATIVE

Gizzard shad
Dorosoma cepedianum

KEYS TO ID
• Silver to white with a distinguishing shoulder spot
• Last ray on dorsal fin much longer than the others
• Upper edge of the eye located above the tip of the upper lip
• No teeth in upper or lower jaw
• Generally grow about 8 – 12 inches

LOOKS SIMILAR TO
• Bighead carp (invasive)
• Silver carp (invasive)
• Mooneye (native)
• Emerald shiner (native)

WHERE TO LOOK
• Prefer shallow waters with soft, muddy bottoms
• Also found in slow-moving areas of rivers

CURRENTLY FOUND

[Map of Minnesota showing areas where Gizzard shad are found]
Mooneye
(Hiodon tergisus)

KEYS TO ID
- Silver in color
- Keel extends from anal to pelvic fin
- Upper edge of the eye is located above the tip of the upper jaw
- Has teeth on both jaws and roof of mouth
- Grow up to 15 inches long

LOOKS SIMILAR TO
- Bighead carp (invasive)
- Silver carp (invasive)
- Gizzard shad (native)
- Emerald shiner (native)

WHERE TO LOOK
- Prefer large, clear lakes and rivers

CURRENTLY FOUND

3 – 5
NATIVE  Emerald shiner
Notropis atherinoides

KEYS TO ID
• Emerald-silver color on its sides
• Upper edge of the eye is located above the tip of the upper jaw
• No teeth on upper or lower jaw
• Generally grow about 3 – 4 inches

LOOKS SIMILAR TO
• Bighead carp (invasive)
• Silver carp (invasive)
• Mooneye (native)
• Gizzard shad (native)

WHERE TO LOOK
• Tend to shoal in large groups near surface of the water at dusk to feed

CURRENTLY FOUND
3 – 6
KEYS TO ID
• Young gobies are solid gray; older fish are light gray with dark blotches
• Fused pelvic fin – which no native fish have – can resemble a suction cup
• First and second dorsal fins are separate
• Prominent black spot on first dorsal fin
• Has fine scales on body
• Usually less than 6 inches

LOOKS SIMILAR TO
• Tubenose goby (invasive)
• Native Sculpins including mottled, slimy, spoonhead, and deepwater (native)

WHERE TO LOOK
• Lakes and slow-moving rivers
• Areas with vegetation cover and rocky bottoms
• Found in Lake Superior but not yet in inland lakes

CURRENTLY FOUND

INVASIVE
Round goby
Neogobius melanostomus

Above: Fused pelvic fin
Below: Dark spot on dorsal fin
Tubenose goby
Proterorhinus marmoratus

INVASIVE

KEYS TO ID
• Has fused pelvic fins, which no native fish have
• Does not have black spot on dorsal fin
• First and second dorsal fins are separate
• Nostril extends beyond lower lip
• Has fine scales on body and grows to about 4 inches

LOOKS SIMILAR TO
• Round goby (invasive)
• Native Sculpins including mottled, slimy, spoonhead, and deepwater (native)

WHERE TO LOOK
• In slow-moving, shallow water less than 15 feet with lots of plant cover
• Found in Lake Superior but not in inland lakes

CURRENTLY FOUND

Note nostril extending beyond bottom lip and lack of black spot on dorsal fin.
NATIVE
Sculpins
*Cottus spp.*

**KEYS TO ID**
- Vary from light tan to dark brown with mottled blotches
- Fused first and second dorsal fin
- Scaleless body
- Have two separated pelvic fins
- Grow between 4.5 and 6 inches long

**LOOKS SIMILAR TO**
- Round goby (invasive)
- Tubenose goby (invasive)
- Includes mottled, slimy, spoonhead, and deepwater sculpins

**WHERE TO LOOK**
- Usually found in rocky areas
- Sometimes found in headwaters of creeks or small rivers

**CURRENTLY FOUND**

*Underside of a Slimy sculpin with separated pelvic fins (right)*

*Lateral view of a Mottled sculpin showing coloring (below)*
INVASIVE

Ruffe

Gymnocephalus cernuus

KEYS TO ID

• Olive- to gold-brown on its back with yellow-white underside
• Fused dorsal fins with dark spots
• Small, downturned mouth that does not expand past the the front of the eye
• Sharp spines on gill cover
• Generally less than 6 inches long

LOOKS SIMILAR TO

• Walleye (native)
• Sauger (native)
• Yellow perch (native)

WHERE TO LOOK

• Prefer cooler waters
• Often in deep, offshore areas
• Lakes, reservoirs, and slow-moving rivers
• Found in Lake Superior but not in inland lakes

CURRENTLY FOUND
NATIVE
Walleye
*Sander vitreus*

**KEYS TO ID**
- Golden-brown to yellow in color; dorsal fin has dark blotches
- Separated first and second dorsal fins
- White spot on tip of tail
- Mouth extends past the eye
- Eyes point outward
- Grows larger than ruffe

**LOOKS SIMILAR TO**
- Ruffe (invasive)
- Sauger (native)
- Yellow perch (native)

**WHERE TO LOOK**
- In the shelter of aquatic vegetation

**CURRENTLY FOUND**
*Walleye (Sander vitreus)*

*Native*
NATIVE
Sauger
*Sander canadensis*

**KEYS TO ID**
- Sandy to dark brown with 3 – 4 dark patches along back and sides
- Dorsal fins are separated and have rows of dark spots
- Mouth extends past the eye
- Grows larger than ruffe

**LOOKS SIMILAR TO**
- Ruffe (invasive)
- Yellow perch (native)
- Walleye (native)

**CURRENTLY FOUND**
- 3 – 12

**WHERE TO LOOK**
- Likely to be found in deep pools
- Areas of high turbidity, low stream velocity, and deep water
Yellow perch

Perca flavescens

**KEYS TO ID**
- Green on top with 6 to 9 stripes down yellow sides
- Separated dorsal fins
- No distinct spots
- Grows larger than ruffe

**LOOKS SIMILAR TO**
- Ruffe (invasive)
- Sauger (native)
- Walleye (native)

**WHERE TO LOOK**
- Abundant in lakes and backwaters of large rivers
- Prefer to be near vegetation

**CURRENTLY FOUND**
- Minnesota

---

Yellow perch (top)
Invasive ruffe (bottom)
Adipose fin: Located between the dorsal fin and caudal fin; have no spines or rays and are soft
Alternate leaves: Leaves are attached to the stem singly and on alternate sides
Anal fin: Located on the underside of a fish between the tail and pelvic fins, near the anus
Antheridia: Male reproductive structures that are small and orange to red on starry stonewort
Ascading stem: A stem growing upward
Axis: The main stem about which plant parts such as branches are arranged
Bivalve: An animal that has two shells that meet at a hinge
Branchlet: A small branch or a subdivision of a branch
Bulbil: Asexual reproductive structure found on some charophytes. Bulbils of starry stonewort are white and star-shaped
Byssal threads: A mass of strong, silky filaments which mussels use to attach to surfaces
Carapace: A hard shell on the backs of crayfish
Caudal fin: Also known as a tail fin, it is located at the end of the fish and propels and steers the fish
Dissected: Leaves that are deeply or repeatedly divided
Dorsal fin: Located on the top of a fish, it may be a single fin, with or without spines, or consist of two connected or unconnected parts — a sharp-spined part and a soft-rayed part
Fractal: When similar patterns recur at progressively smaller scales
Fry: Immature fish from the time they hatch to the time they become fingerlings
Gill cover: A flap of skin protecting a fish's gills
Hybridize: To produce hybrids; crossbreed
Invasive species: Species that are not native to a given ecosystem, and cause (or have high potential to cause) harm, whether economic, environmental, or harm to human health
Invertebrate: An animal that lacks a spine
Keel: A ridge on the belly of the fish which is present only in some species
Leaflet: A part or division of a compound leaf
Midvein: The vein in the center of a leaf
Mottled: Marked with spots or smears of color
Node: The place on the stem where a leaf or branch is attached (or has been attached)
Pectoral fins: Located on both sides of the fish near the gill; help with balance, steering, and controlling depth
Pelvic fins: Located on the bottom of the fish in front of the anal fin; help balance the fish and keep it level
Serrated: Having a saw-toothed edge or margin notched with toothlike projections
Shoal: When fish group together, for social purposes
Submersed/submerged: Submersed plants are usually found entirely underwater, but the flowers and fruits may rise above the water surface. They are rooted in the sediment and have underwater leaves
Substrate: The surface on which an organism lives, grows, or obtains its nourishment
Tubers: A short, thick stem that grows underground and can produce a new plant
Turbidity: A measure that provides an estimate of the cloudiness of water due to silt, organic and inorganic matter, plankton, and microscopic organisms
Turions: A vegetative bud that detaches from a parent plant and can produce new plants via asexual reproduction
Ventral edge: On a bivalve, the surface opposite the hinge
Water column: A conceptual column of water from lake surface to bottom sediments
Whorl: A ring of 3 or more similar structures radiating from a common point
PLANTS
Leaf arrangements: Cayte · Compound leaves: Evelyn Fitzgerald
Simple leaf: Benjamint444 · Leaf margins: Debivort
Whorled leaf with midvein: Christian Fischer
Eurasian watermilfoil flower and close-up: Paul Skawinski, UW-Extension Lakes
Bladderwort: Christa Rittberg
White water crowfoot: Trish Steel
Water marigold flower: Peter Dziuk
Hydrilla: Michael J. Grodowitz, U.S. Army Engineer Research and Development Center; Tim Krynak; J.M.Garg
Elodea stalk: Minnehaha Creek Watershed District
Brazilian waterweed: David Liu, Minnehaha Creek Watershed District; Lamiot; Lara Gudmundsdottir
Starry stonewort: Dave Hansen; Paul Skawinski, Aquatic Plants of the Upper Midwest
Native chara: Christian Fischer; Megan Weber
Native Nitella: Kristian Peters; Paul Skawinski, Aquatic Plants of the Upper Midwest
Sago pondweed fruit: Christian Fischer
Water staragrass: Paul Skawinski, Aquatic Plants of the Upper Midwest
Curly-leaf pondweed: Paul Skawinski, UW-Extension Lakes; Leslie J. Mehrhoff
Clasping leaf pondweed: Paul Skawinski, Aquatic Plants of the Upper Midwest

INVERTEBRATES
Rusty crayfish: Jeff Gunderson
Northern clearwater crayfish: Chris Taylor
Calico crayfish: Chris Taylor
Virile crayfish: Chris Taylor
Quagga mussels (in pile): Megan Weber
Freshwater mussels (in pile): U.S. Fish and Wildlife Service
Asian clam: Minnehaha Creek Watershed District; Böhringer Friedrich
Limpet snail: Alfredo Eloisa
Spiny waterflea: Donn Branstrator; Jeff Gunderson; Minnehaha Creek Watershed District
Fishhook waterflea: J. Liebig, NOAA GLERL; Mart Simm
Chaoborus: Piet Spaans
Leptodora: Great Lakes Environmental Research Laboratory

FISH
Illustrations of trout perch, sculpin, and ruffe: Joseph Tomelleri
Keel: John Lyons
Bighead carp: Asian Carp Regional Coordinating Committee
Juvenile silver carp: Michigan Sea Grant; Adult silver carp: Asian Carp Regional Coordinating Committee
Gizzard shad: Brian Gratwicke; Chad Thomas
Mooneye: Konrad Schmidt
Emerald shiner: Andrew Kornacki; Konrad Schmidt
Round goby: Peter van der Sluijs
Tubenose goby: John Lyons; Harka Ákos
Slimy sculpin: John Lyons
Ruffe: Tiit Hunt; USGS
Walleye in hand: John Lyons; Adult walleye: USFWS
Sauger: Konrad Schmidt
Yellow perch: USFWS; Yellow perch with ruffe: John Lyons

Photos not otherwise credited are (c) Christine Lee, Minnesota Aquatic Invasive Species Research Center