Interstate Commission on the Potomac River Basin – Water Ways: Stream Ecology and Monitoring
https://www.potomacriver.org/water_ways

Teacher notes are provided.
Great resource for benthic macroinvertebrate life cycles and habits: *A guide to Common Freshwater Invertebrates of North America*, J. Reese Voshell, Jr.

My appreciation goes to Dan Boward and the Maryland Biological Stream Survey and Dan Boward for the quality education and resources they have provided me and the public through their personal efforts and on-line resources.

Likely, your students already have seen this slide.

To determine the condition of riverine ecosystems, scientists and citizen scientists evaluate three aspects of stream ecosystems: the physical aspects of the stream, including the instream and riparian habitat, stream chemical properties, and aquatic species, particularly fish and benthic macroinvertebrates.

The most telling aspect is the diversity and abundance of fish and benthic macroinvertebrates living in the stream, because this reflects the ongoing, long-term condition of the system. Ask if your students have any thoughts on why this might be.

Seguimiento con marcroinvertebrados bentónicos

- Ejemplos: larvas de insectos, escarabajos, cangrejos de río, mejillones, caracoles, gusanos, sanguijuelas.
- Términos referidos al hábitat y las características
  - Bentónico: que habitan en el fondo de los cursos de agua (fondo del lecho, hojas, raíces).
  - Macro: visible sin un microscopio.
  - Invertebrado: carente de columna vertebral.

Larva de mosca de las piedras
Orden: Plecópteros

Larva de la mosca de Dobson
Orden: Megalópteros
Familia: Coridálidos

Gusano acuático
Clase: Oligoquetos

The type of monitoring we will learn today involves collecting benthic macroinvertebrates from various habitats in a stream. This type of monitoring is called BIOMONITORING.

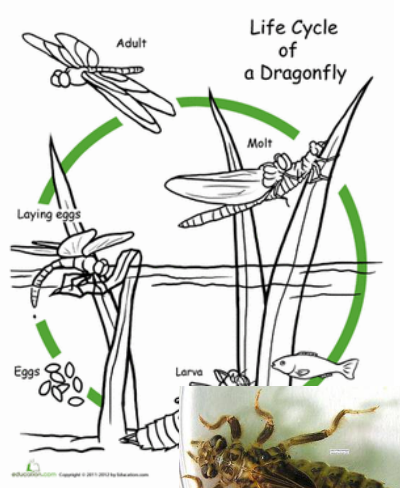
Just as we might guess from the name "benthic macroinvertebrates," these types of organisms live on or near the bottom of a stream , or more accurately, on the substrate of stream – which can be on and under a stream bed, on submerged logs and twigs, on roots hanging into a stream, or plants.

They are small, usually less that an inch long, but they are visible without a microscope, hence, the prefix macro.

Being an invertebrate means that they lack a backbone. Which also means they are cold blooded.

The majority of collected benthic macroinvertebrates are insects in their juvenile stage – larvae or nymphs, depending on whether they go through complete or incomplete metamorphosis, respectively. But when investigating streams, you also will collect crayfish, mussels, snails, worms, and leeches, and other organisms.

Muchos insectos inician la vida en los cursos de agua



Many insects start out their lives in the water. They go through different stages – metamorphosis – from eggs to larvae (or nymphs in incomplete metamorphosis) to adults when they emerge from the water to fly away and mate. For example, a dragonfly has a life span of more than a year, but very little of that life is spent as the adult dragonfly we recognize. There are three stages of the dragonfly life cycle, the egg, the nymph, and the adult dragonfly. Most of the life cycle of a dragonfly is lived out in the nymph stag - See more at: http://www.dragonfly-site.com/dragonfly-life-cycle.html#sthash.qvsvlpsG.dpuf

FOR YOUNG AUDIENCE:
When you were a baby you had the same body parts as your parents even though you were smaller. Insects are different. The female adult lays eggs on the water or on plants near the water. When the eggs hatch, a young dragonfly – a dragonfly nymph – comes out.
This is a young dragonfly. It looks a lot different that the adult, doesn't it? It doesn't have big wings, just the pads that will develop into wings. But it won't need wings until it leaves its underwater life. When it is big enough, it will climb on a rock or other surface, shed its old skin, and emerge as a mighty and beautiful dragonfly.

DRAGONFLY FACTS: Female dragonflies lay eggs in or near water, often on floating or emergent plants. When laying eggs, some species will submerge themselves completely in order to lay their eggs on a good surface. The eggs then hatch into naiads (nymphs). Most of a dragonfly's life is spent in the naiad form, beneath the water's surface, using extendable jaws to catch other invertebrates (often mosquito larvae) or even vertebrates such as tadpoles and fish.[5] They breathe through gills in their rectum, and can rapidly propel themselves by suddenly expelling water through the anus.[6]

The larval stage of large dragonflies may last as long as five years. In smaller species, this stage may last between two months and three years. When the naiad is ready to metamorphose into an adult, it climbs up a reed or other emergent plant. Exposure to air causes the naiad to begin breathing. The skin splits at a weak spot behind the head and the adult dragonfly crawls out of its larval skin, pumps up its wings, and flies off to feed on midges and flies. In flight the adult dragonfly can propel itself in six directions; upward, downward, forward, back, and side to side.[8] The adult stage of larger species of dragonfly can last as long as five or six months.

Benthic macroinvertebrates reflect *ongoing* stream conditions, as they spend months to years in the water. As such, they can serve as *indicators* of water quality.
Some organisms are pollution intolerant (or pollution-sensitive). These organisms require optimal conditions and cannot tolerate polluted conditions, such as low dissolved oxygen, high temperatures, or sedimentation.

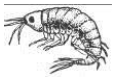
Scientists call pollution-sensitive species indicator species, because their presence indicates whether the stream is unpolluted; whereas their absence indicates that is has some level of pollution.

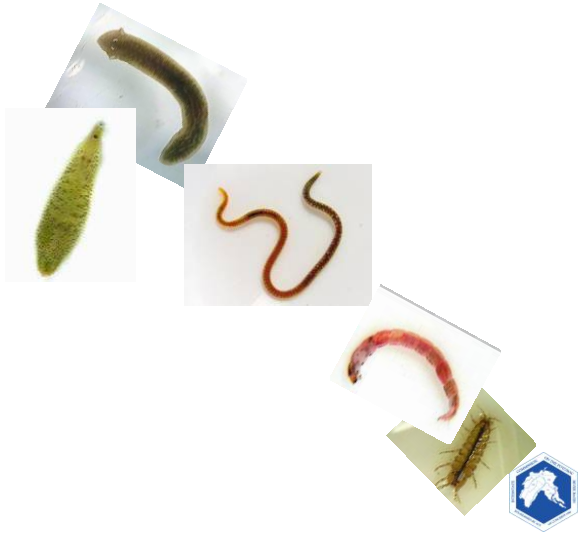
So we can tell much about the condition of a stream by collecting and keeping data on the amazing organisms living in it. The healthiest streams have *many benthic macroinvertebrates of many different species*, including those that can only live in unpolluted water. In other words, they have **high biodiversity and high abundance.**

Teachers can take time to see if students recognize any of these organisms.

Los cursos de agua contaminados tienen menos especies

Solo organismos que tienen tolerancia a la contaminación.





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Teachers, if you have preserved samples, you could have students practice ID, using the keys and data forms noted in the reference section.

This slide can be skipped, if desired.

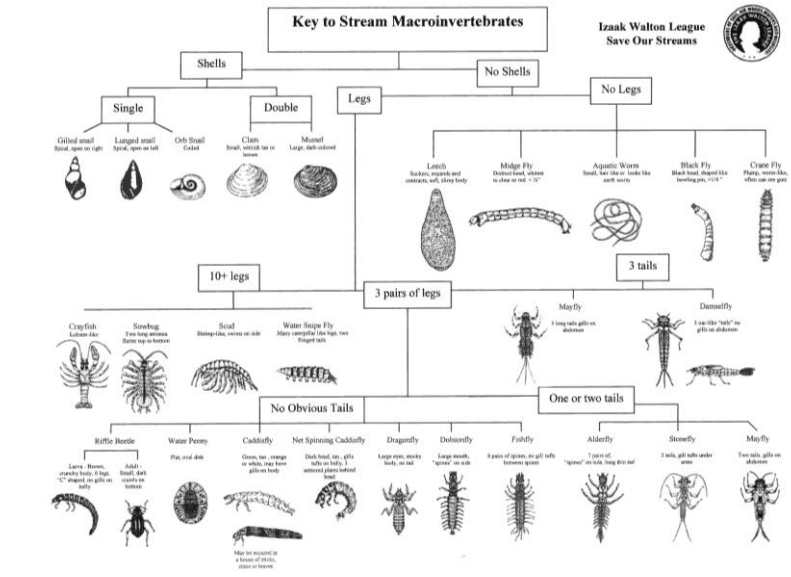
Scientists use scientific names, so that scientists around the world will have the same name for the same species. This is important, because common names can be different in different parts of the United States. You'll see that the common names for snails on the DNR and IWL keys are even different!

It is sufficient for citizen scientists to identify organisms to their order or family level. There are many different types (species) of organisms with each order or family.

It also is sufficient for citizen scientists to use common names.

We are *Homo sapiens*.....
Class: Mammalia
Order: Primates
Family: Hominidae
Genus: Homo
Species: H. sapiens
Subspecies: H. s. sapiens

Cuadro de identificación general



Se puede obtener a través del programa Explore and Restore Maryland Streams

Dichotomous keys, such as this, are commonly used to identify many different things – plants, trees, fish. This one is designed to help us identify the types of benthic macroinvertebrates that we collect.

Go through this key with the students. Each student or pair or students should have a copy of the key.

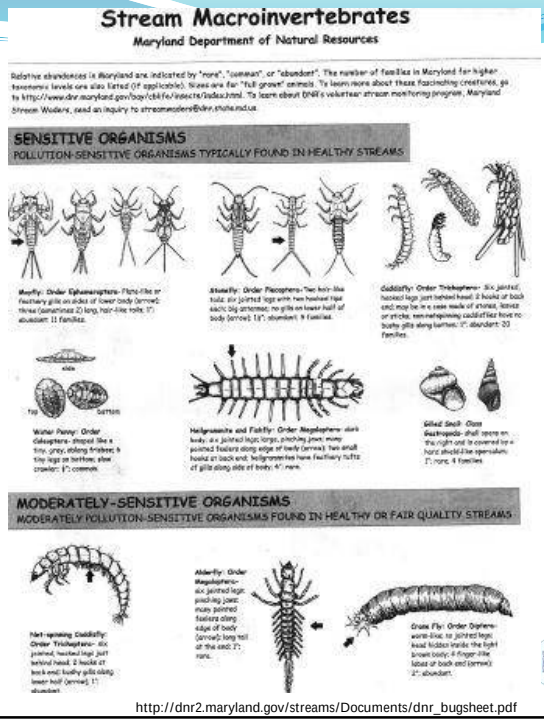
Three orders of insect larvae are the most important in determining the stream condition. These INDICATOR organisms belong to three orders –

- the Mayflies in the Order Ephemeroptera;
- Stonefly in the order Plecoptera,
- and Caddisflies in the order Trichoptera.

If you are in a stream with an abundance of EPTs (as they are known for short), it is likely the stream conditions are good for aquatic life.

Cuadro para aprender sobre la tolerancia a la contaminación de los especímenes

¿Dónde se encuentran las moscas de mayo, las moscas de las piedras y las friganeas en este cuadro?



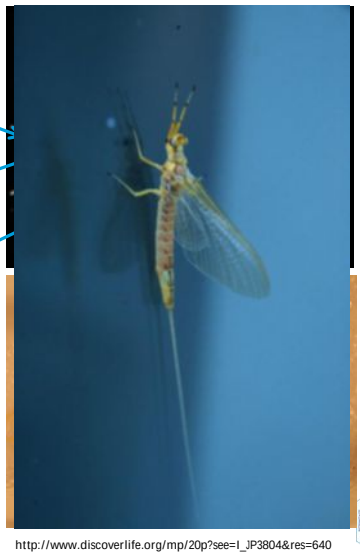
http://dnr2.maryland.gov/streams/Documents/dnr_bugsheet.pdf

The Maryland Department of Natural Resources gives this chart to citizen scientists to learn of the different levels of pollution tolerance of species.

Go over this chart with students. Have them read the headings or have one pick out an organism, and have the others find its tolerance.

Características que identifican la mosca de mayo

- Tres colas con forma de filamento (a veces dos)
- Branquias de forma laminar o con mechones plumosos en los costados del abdomen (parte inferior del cuerpo)
- Almohadillas para las alas en el tórax



http://www.discoverlife.org/mp/20p?see=I_JP3804&res=640

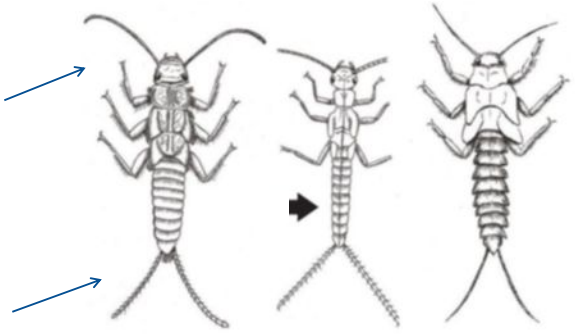
You can take out your stream Macroinvertebrate sheet from the MD DNR to look at while I show you these slides. You can see that it has descriptions about the insect larvae.

As shown earlier, one of the most pollution-sensitive species is in the mayfly order – known as Ephemeroptera. Most mayflies need cool, well oxygenated water, unpolluted water.

An easy way to remember the name is that most mayflies have 3 tails, and the word may has 3 letters.

The explanation behind their common name is that many species emerge from the water as adults in May. The explanation for the scientific name is their BRIEF ADULT STAGE of about 24 hours or less, much shorter than adult stages for other insects. A species will crawl out of the water enmasse, shed their skins, becoming full adults. last a day. Most species only an adult about 24 hours. Adults do not feed, as they have no mouthparts. Their purpose is to mate and reproduce.

Organismos sensibles a la contaminación



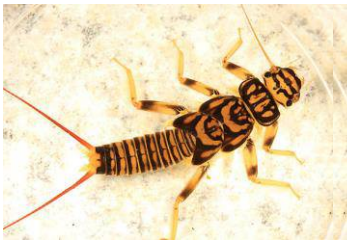


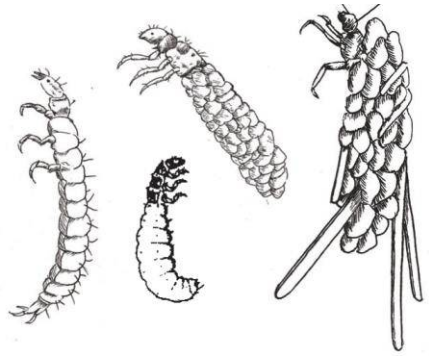
Photo: http://bugguide.net/images

Stonefly: Order Plecoptera-Two hair-like tails; six jointed legs with two hooked tips each; big antennae; no gills on lower half of body (arrow); 1½"; abundant; 9 families.

Find this on both the key and the tolerance chart.

The greatest diversity of stoneflies is sound in small, cool streams, where the water temperature remains cool and dissolved oxygen remains near saturation. Such streams are usually shaded. They prefer boulders, cobble, pebbles, and pieces of water-soaked wood, and decaying leaf packs snagged within swift currents.

Organismos sensibles a la contaminación

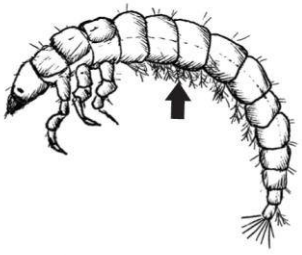


Caddisfly: Order Trichoptera- Six jointed, hooked legs just behind head; 2 hooks at back end; may be in a case made of stones, leaves or sticks; non-netspinning caddisflies have no bushy gills along bottom; 1"; abundant; 20 families.

Find this on the keys.

These are different caddisfly species larvae that use their sild threads to glue small bits of leaves, twigs, or rocks together to form a case that shelters them from predators and camoflages them from prey..

Organismos de sensibilidad moderada a la contaminación



Net-spinning Caddisfly: Order Trichoptera- six jointed, hooked legs just behind head; 2 hooks at back end; bushy gills along lower half (arrow); 1"; abundant.

Photo: http://gfp.sd.gov/wildlife/critters/insects-invertebrates/caddisflies.aspx

Find this on the keys.

Caddisfly larvae can spin silken threads, similar to spiders. The net-spinners attach themselves to objects in the stream, so they don't get carried downstream by the current. They also construct nets to catch their food (algae, small invertebrates and detritus). Different types of caddisflies spin different mesh sizes and shapes based on which type of food they are targeting.

¿Nosotros qué somos? ¿Cuán sensibles somos?

Larva de libélula
Orden de los Odonatos

Caballitos del diablo
Orden de los Odonatos

What are these?

Dragonflies and damselfies. Both the nymphs and the adults are great predators. They are the only creatures with extendable lower lips. The lip has a hinge in the middle that allows it to bend. To feed, a larva rapidly shoots the lower lip out and captures its prey – often a mosquito or fly. If too big, the sharp, pointed mouthparts can tear apart its prey. Having such a dexterous mouth, enables the dragonfly and damselfly to use all 6 legs, and keep their grasps on the substrate while feeding. (suborder Zygoptera).

Último bichito por ahora

- ¿Qué soy?
- ¿Cuál es mi nivel de tolerancia?

Spiracles on the end are openings to this cranefly larvae's breathing system.

Some are common in leaf packs. These shredders and detritivores help break down the leaves that fall from trees (and other plant and animal waste), making the energy and nutrients contained in the leaves available to other aquatic organisms.

Parte 3: Hábitats de los macroinvertebrados bénticos dentro de los cursos de agua

Hábitat principal para muchos: los rápidos

Una amplia variedad de macroinvertebrados bentónicos se encuentra en los rápidos porque:

- El agua turbulenta capta más oxígeno.
- Las rocas ofrecen escondrijos y recodos para que los organismos se oculten y se adhieran.

Background Photo: Audubon Naturalist Society, Green Kids Resources

Many aquatic organisms prefer riffle areas — the parts of streams where there are rocks, cobble, or gravel. The water moves faster and breaks over the rocks in these areas, causing more oxygen to be in the water.
The insect larvae with gills need plenty of oxygen, and they can get it in these spots. They also can use the rocks to hide from predators or to lurk for prey. Some burrow into the soil; others perch on the cobble. The great diversity of habitats in these areas supports a diversity of species.
Additionally, because the water flows over these shallower areas more quickly, it removes sediments from the substrate. Consequently, there is less likelihood of sand and grit harming or clogging the delicate gills of insects.

This presentation can only provide generalizations on the feeding and habitat preferences of benthic macroinvertebrates. For more information, see A Guide to Common Freshwater Invertebrates of North America, J. Reese Voshell, Jr.

Hojas y madera mojada

Algunos organismos viven y se ocultan en su fuente de alimento, hojas y madera en descomposición.

Los predadores, como las larvas de libélulas, buscan su presa en ese tipo de lugares.

Submerged logs and wet decaying clumps of leaves (leaf packs) support macroinvertebrates that eat decaying leaves and wood or algae and plant and animal debris on the leaves and wood. Basically, they live on their food source, as the leaves also can make good hiding places. Some have mouth parts that enable them to shred plant material to smaller pieces; others have mouth parts that enable them to scrape algae from the surfaces of logs and rocks.

"Marañas" de raíces

- Las raíces bajo el agua pueden estar cubiertas de algas y pequeñas partículas de plantas y desechos.
- Proporcionan alimento a los organismos que se alimentan en las superficies y las rastrillan.
- Naturalmente, los predadores también se encuentran en las raíces.

Plantas acuáticas

Los organismos, como los caracoles, comen las algas de las plantas o las propias plantas.

Algunos macroinvertebrados bentónicos ponen huevos en el pasto.

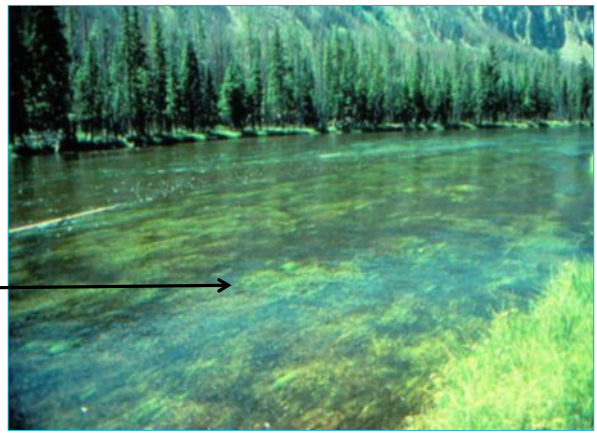


Photo: D. Boward, MBSS, MD DNR

Parte 4: Procedimientos de muestreo

- Recoge 20 muestras de un pie en una extensión de 100 metros utilizando una red tipo D.
- Recoge un porcentaje relativo del mejor hábitat.
- Desplázate contra la corriente.

Rápidos

- Coloca la boca de la red de modo que embolse la corriente aguas abajo y los organismos.
- Coloca la red con firmeza en el lecho contra la corriente en la zona donde tomarás las muestras (de modo que el agua corra hacia la red).
- Junta y frota la superficie de cantos rodados grandes (> 3 cm).

Revolver el rápido

- Pon tus pies frente a la red (a no más de 2 pies)
- *Revuelve la zona 5 a 8 cm debajo de la superficie arrastrando los pies.*

Photo: Maryland Biological Stream Survey

Recoger hojas mojadas

- Toma muestras de grupos de hojas mojadas en el río, no de hojas frescas.
- Cantidad moderada que cabe en un puño = una muestra.
- Se puede clasificar los organismos en el balde o dejarlos a un lado para hacerlo después.

Photos: Maryland Biological Stream Survey

Raspado de residuos de madera

- Toma muestras de madera mojada y estable, no de ramas que estén flotando.
- Es mejor tomar las muestras en zonas donde corra el agua (y no en zonas de agua estancada).
- Coloca la red tipo D contra la corriente y frota la madera con la mano cubierta con un guante, un cepillo o la red para que atrapes organismos.

Peinado de raíces

- Coloca la red tipo D contra la corriente frente a la maraña de raíces.
- Peina las raíces con la mano.
- O da golpes rápidos con la red y haz un barrido del agua para atrapar los bichitos.

Photo: Maryland Biological Stream Survey

¡Manos a la obra!

Photo: Izaac Walton League of America

Recursos para muestras de macroinvertebrados bentónicos

DOCENTES DE ENSEÑANZA SECUNDARIA:

Programa Explore and Restore Maryland Streams, *Biological Assessment of Stream Health* del Departamento de Recursos Naturales de Maryland.

Para obtener formularios para realizar estudios biológicos y de otro tipo:

- Hoja global del estudiante de datos para todas las actividades relativas a cursos de agua.
- Hoja global del estudiante de datos costeros (para cursos de agua en la planicie costera de la provincia geográfica)

Macroinvertebrados de los cursos de agua del programa Maryland Stream Waders clasificado por niveles de tolerancia, CLAVE

Mapa del estado de los cursos de agua de Maryland:

- Consulta los datos recabados en un curso de agua cerca de tu escuela empleando los mapas interactivos y los cuadros con los resultados.

Guías de macroinvertebrados:

- *A Guide To Common Freshwater Invertebrates* of North America, J. Reese Voshell, Jr.
  - Abarca hábitos de vida y anatomía básica y tiene ilustraciones a color.
- *Guide to Aquatic Insects & Crustaceans*, Izaak Walton League of America.
  - Incluye clave dicotómica, descripciones de grupos funcionales (métodos de alimentación de distintos macroinvertebrados bénticos).

Recursos para muestras de macroinvertebrados bentónicos

DOCENTES DE PREESCOLAR HASTA NIVEL INTERMEDIO DE ENSEÑANZA SECUNDARIA:

- El Instituto Cacapon plantea un método interactivo denominado *Potomac Highland Watershed School* con juegos para aprender sobre la identificación y recolección de macroinvertebrados bentónicos. (http://cacaponinstitute.org/e_classroom.htm)
- Programa GreenKids de la organización Audobon Naturalist Society: planificaciones completas de clases y presentaciones para 4.º y 5.º grado, que abarcan el hábitat de los cursos de agua, los procedimientos de seguimiento y el equipamiento. Consultar las planificaciones de las clases sobre cursos de agua de GreenKids (http://ansbookshop.org/index.php/nature-programs/schools-teachers/greenkids-school-partnerships#lessons)
- Programa Creek Freak de la organización Izaac Walton League of America : lecciones completas dirigidas a estudiantes y docentes de 5.º y 8.º grado para prácticas de investigaciones exhaustivas de los ecosistemas de los cursos de agua.

ENCUENTRA MÁS RECURSOS EN NUESTRO SITIO WEB: *Comisión Interestatal para la Cuenca del Río Potomac, https://www.potomacriver.org*