Chapter 7.

Fish Community Descriptions

Ohio – Great Lakes Basins Fish: Coldwater Community

Community Indicators: brook trout (*Salvelinus fontinalis*) mottled sculpin (*Cottus bairdii*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*)

Species of Conservation Concern: none

Habitat: This headwater stream community ($\overline{X}$ = 10.8 mi^2 watershed area) occurs in high gradients ($\overline{X}$ = 2.1%) flowing from ridges at relatively high elevations ($\overline{X}$ = 510 m). Water temperatures are the coldest among the fish communities. The Coldwater Community indicates headwater streams with brook trout and sculpin and slightly larger streams with brook or brown trout only. Some locations will also have rainbow trout. The community is less common in urbanized streams than in watersheds with natural landcover.

These small headwater streams tend to have fewer disturbances than larger waters flowing through valleys. High amounts of forested area appear to be associated with the catchments that support this community ($\overline{X}$ = 89.9% of the upstream watershed). These systems often flow from sandstone or shale ridges and have a unique water chemistry signature with few dissolved ions and low buffering capacity. Streams have low alkalinity ($\overline{X}$ = 26 mg/l) and conductivity ($\overline{X}$ = 182 µS/cm) values, and water temperatures are cold. These streams may be acidic at the headwaters; pH is lower than that found with other community types ($\overline{X}$ = 6.7).

Prediction analyses with the Coldwater Community found that high elevation streams, geology, and landcover were the most important variables in determining the locations of this community type. A low number of stream links and a low proportion of row-crop landcover in the local watershed were also strong predictors of the community distribution. Additionally, rather high elevations and large deposits of sandstone geology were highly associated with the habitats of this community type.

Stream Quality Rating: High

Community Rarity: No

Threats: Streams in Pennsylvania may be acidic from two major pollution sources: abandoned mine drainage (AMD) and acid deposition. Coal mining often occurs near Coldwater Community habitats and may contribute acidic and metal-laden discharges to these streams. Pollutants in the form of acid precipitation can fall on headwater stream watersheds and leach away the natural buffering capacity of soils. This can result in the reduction of stream pH to levels stressfully low to aquatic organisms.

Strongest Indicators of Community Type

Brook trout (*Salvelinus fontinalis*)

Photo Source: http://www.cnr.vt.edu/efish/

Mottled sculpin (*Cottus bairdii*)

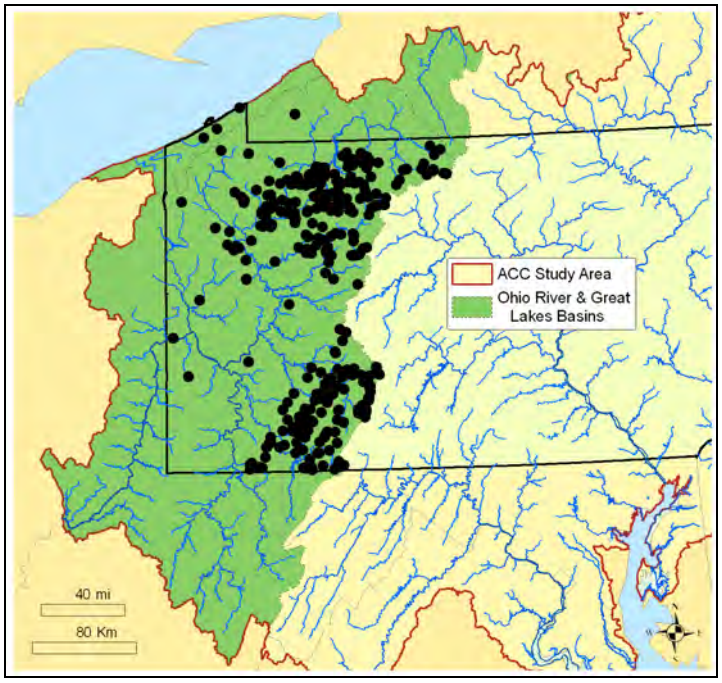
Photo Source: http://www.clemson.edu

Although trout fisheries are valued as a recreational resource, trout streams in Pennsylvania have been greatly altered since the transplantation of brown trout from Europe and rainbow trout from western North America. Habitats for native brook trout have been restricted by competition with non-native trout species.

Conservation Recommendations: Streams in these watersheds may have wild, reproducing populations of brook and brown trout and may be a fisheries resource. Because cold headwater streams often occur in terrain unsuitable for human development, they are not usually subject to the same types of water pollution issues as valley streams. However, addressing water pollution from AMD and acid deposition are critical for headwater streams. Where populations of native brook trout occur, care should be taken to avoid introductions of non-native trout species.

Ohio – Great Lakes Basins Fish: Coldwater Community

Known Locations:



Example Habitats:

Small, high gradient streams with forested watersheds are typical of the Coldwater Community habitat.

Photo source: PHNP

Ohio – Great Lakes Basins Fish: Coolwater Stream Community

Community Indicators: blacknose dace *(Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), brown trout (*Salmo trutta*, stocked), white sucker (*Catostomus commersoni*), redside dace (*Clinostomus elongatus*), longnose dace (*Rhinichthys cataractae*), fathead minnow (*Pimephales promelas*), pearl dace (*Margariscus margarita*)

Species of Conservation Concern: none

Habitat: This community type occurs in small to medium-sized streams ($\bar{x}$ = 70.9 mi^2) at moderate to high elevations ($\bar{x}$ = 393 m). Streams are generally faster ($\bar{x}$ = 1.0% gradient) than warmwater streams and have intermediate temperature between warm and cold streams. Water quality profiles for these streams show relatively high alkalinity ($\bar{x}$ = 65 mg/l) and conductivity ($\bar{x}$ = 348 µS/cm) compared to other fish communities. Values of pH are typically neutral ($\bar{x}$ = 7.2).

Fish in the Coolwater Stream Community are habitat generalists and generally pollution tolerant. This community type may represent small, coolwater streams that occur in agricultural landscapes ($\bar{x}$ = 24% agricultural land in watershed). This community also occurs in watersheds where urbanization may be altering water quality.

Predictive modeling of community stream types reveals that both local and total upstream land cover types are strongly related to the habitat of this community type. Specifically, high amounts of total pasture, low amounts of open water (lakes or large rivers) and low proportions of urban land were all shown to be important factors shaping these habitats.

Stream Quality Rating: Low

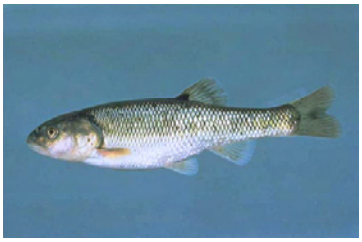
Community Rarity: No

Threats: This community occurs downstream of headwaters that are not usually protected from human alterations. A number of pollution types are found in watersheds where this community occurs. Abandoned mine drainage (AMD) is common in watersheds containing the Ohio Coolwater Community, suggesting that this community can tolerate some poor water quality conditions.

Strongest Indicators of Community Type

Blacknose dace (*Rhinichthys atratulus*)

Photo Source: http://www.ohiodnr.com/dnap



Creek chub (*Semotilus atromaculatus*)

Photo Source: http://www.cnr.vt.edu/efish/

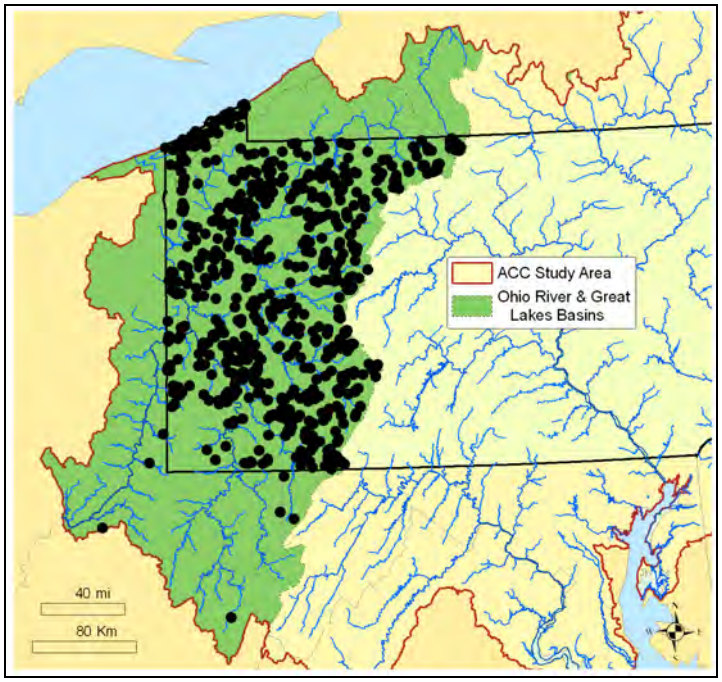
This community occurs in streams impaired by agricultural runoff and municipal discharges in urban areas. Stream temperature may be warmer than natural temperatures because protective vegetation on stream banks has been removed.

Conservation Recommendations: The habitat for the Coolwater Stream Community represents an important transition between cold headwater streams and warm larger streams. This habitat is distinct among other habitat types and should be protected and restored.

Where this community occurs, restoration of stream temperature, habitat, and water quality to natural conditions is recommended. Management of storm water runoff and riparian vegetation restoration are critical to improvement of stream habitat conditions. Treating AMD will reduce stream acidity and toxic metal concentrations. Where stocking of non-native fish is occurring in the same areas as the Ohio Coolwater Community, native fish are being displaced. Return of the fish assemblages to native species is recommended.

Ohio – Great Lakes Basins Fish: Coolwater Stream Community

Known Locations:



Example Habitats:

Valley streams with moderate gradients are typical of Coolwater Stream Community habitats. Fast, rocky-bottom sections alternate with slower pool habitats.

Photo source: PNHP

Ohio – Great Lakes Basins Fish: Warmwater Community

Community Indicators: greenside darter (*Etheostoma blennioides*), northern hogsucker (*Hypentelium nigricans*), river chub (*Nocomis micropogon*), bluntnose minnow (*Pimephales notatus*), central stoneroller (*Campostoma anomalum*), rainbow darter (*Etheostoma caeruleum*), rosyface shiner (*Notropis rubellus*), banded darter (*Etheostoma zonale*), smallmouth bass (*Micropterus dolomieu*), common shiner (*Luxilus cornutus*), rock bass (*Amploplites rupestris*), johnny darter (*Etheostoma nigrum*), fantail darter (*Etheostoma flabellare*), variegate darter (*Etheostoma variatum*), logperch (*Percina caprodes*), stonecat (*Noturus flavus*), silver shiner (*Notropis photogenis*), blackside darter (*Percina maculata*), striped shiner (*Luxilus chrysocephalus*), golden redhorse (*Moxostoma erythrurum*), sand shiner (*Notropis stramineus*), mimic shiner (*Notropis volucellus*), pumpkinseed (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), spotfin shiner (*Cyprinella spiloptera*)

Species of Conservation Concern: None

Habitat: The Warmwater Community usually occurs in medium to large watersheds ($\overline{X}$ = 91 mi^2). Habitats include Allegheny Plateau streams that occur at relatively high elevations ($\overline{X}$ = 340 m) and streams with lower than 1% gradient. Agricultural land ($\overline{X}$ = 29% of watershed) is prevalent in these watersheds.

Streams have intermediate alkalinity ($\overline{X}$ = 79 mg/l) and conductivity ($\overline{X}$ = 375 µS/cm) values and slightly basic pH values ($\overline{X}$ = 7.4) relative to the waters that other communities inhabit. Warm water temperatures are also characteristic of this community group. Consequently, thermal tolerances of fish in this community are higher than those fish found in cold- and coolwater communities. Habitats of indicator taxa represent a range of conditions, but this community is generally found in small to medium-sized warmwater systems with little silt and turbidity. On a watershed scale, this community appears to be associated with watershed position, land use (especially commercial/industrial and agricultural land uses), geology (namely sandstone and shale) and the number of stream links.

Stream Quality Rating: Medium

Community Rarity: No

Threats: Water and habitat quality may be influenced by non-point source pollution where this community occurs. Runoff from poorly managed agricultural areas can threaten this community, as these watersheds are usually associated with large amount of agricultural land. A number of potential point sources from municipal, industrial, and mining sources may occur in valley streams with this community type, including abandoned mine drainage (AMD).

Strongest Indicators of Community Type

Greenside darter (*Etheostoma blennioides*)

Photo Source: http://www.ohiodnr.com/dnap

Northern hogsucker (*Hypentelium nigricans*)

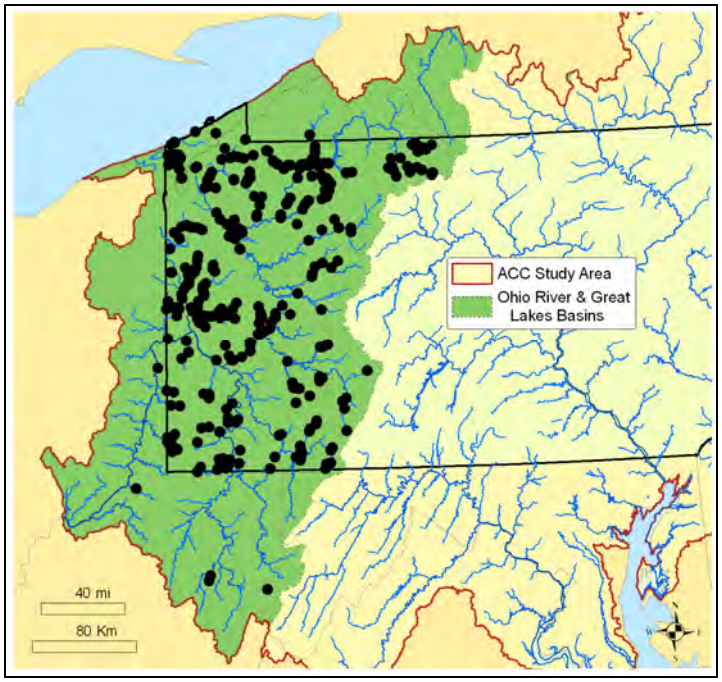
Photo Source: http://www.cnr.vt.edu/efish/

Conservation Recommendations: This community is a high conservation priority since quality warmwater streams are uncommon. The fish in this community type are not especially rare individually, but this group represents habitats in need of protection.

Since warmwater streams mainly occur in valleys downstream of human influences, they are often subject to pollution from non-point sources such as agriculture and urban runoff. Stormwater management, restoration of riparian buffer zones and exclusion of livestock from streams are some mitigation techniques for non-point source pollution. AMD continues to be problematic in many warmwater streams in the Ohio River Basin. The effects of AMD and other ants can be minimized by treatment systems which will improve water quality conditions.

Ohio – Great Lakes Basins Fish: Warmwater Community

Known Locations:



Example Habitats:

The Warmwater Community is found in warmwater streams in good condition with adequate riparian vegetation. Rocky and sandy-bottom substrates provide habitat for fish and other stream organisms.

Photo source: PNHP

Ohio – Great Lakes Basins Fish: Large River Community

Community Indicators: channel catfish (*Ictalurus punctatus*), sauger (*Sander canadensis*), common carp (*Cyprinus carpio*), gizzard shad (*Dorosoma cepedianum)*, freshwater drum (*Aplodinotus grunniens*), walleye (*Stizostedion vitreus)*, white bass (*Morone chrysops)*, shorthead redhorse (*Moxostoma macrolepidotum*), spotted bass (*Micropterus punctulatus*), silver redhorse (*Moxostoma anisurum),* quillback carpsucker (*Carpiodes cyprinus*), emerald shiner (*Notropis atherinoides)*, flathead catfish (*Pylodictis olivaris*), black crappie (*Pomoxis nigromaculatus*), smallmouth buffalo (*Ictiobus bubalus*), river redhorse (*Moxostoma carinatum*), mooneye (*Hiodon tergisus*)

Species of Conservation Concern: mooneye (S2?/G5), smallmouth buffalo (S2/G5), longnose gar S2S3/G5), river redhorse (S3/G4), channel darter (S1S2/G4)

Habitat: The Large River Community occurs in the largest streams and rivers ($\overline{X}$ = 7,024 mi^2 watershed area) in our study area. Habitats are mainly the Monongahela, Allegheny, Youghiogheny, and Ohio Rivers at moderate elevations ($\overline{X}$ = 232 m) with relatively low gradient (< 1%). Water temperatures in these habitats are the warmest of all fish communities. Dissolved ions in the large rivers result in alkaline waters ($\overline{X}_{pH}$ = 7.4, $\overline{X}_{Alkalinity}$ = 55.7 mg/l) with high conductivity values ($\overline{X}$ = 480.2 µS/cm).

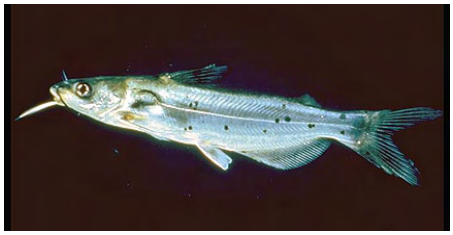
The preferred habitats of fish in the Large River Community generally exist in rivers, including impounded sections. Large rivers offer varied habitats including shallow shorelines, deep channels and slow or non-flowing impoundments behind dams. The fish species richness in Ohio River Basin streams has been augmented by the addition of stocked or introduced game fish, many of which can displace native fishes.

Landcover and geology appear to be important watershed variables influencing the distribution of this community type. Urban development in the riparian zone and little pastureland cover in the local watershed were the strongest predictors of habitat for the large river community, likely due to the close proximity of urban centers to large rivers in western Pennsylvania. Dam storage capacity and proportion of upstream shale geology were also related to the occurrence of this community.

Stream Quality Rating: Medium

Community Rarity: Yes

Strongest Indicators of Community Type



Channel catfish (*Ictalurus punctatus*)

Photo Source: http://www.cnr.vt.edu/efish/

Sauger (*Sander canadensis*)

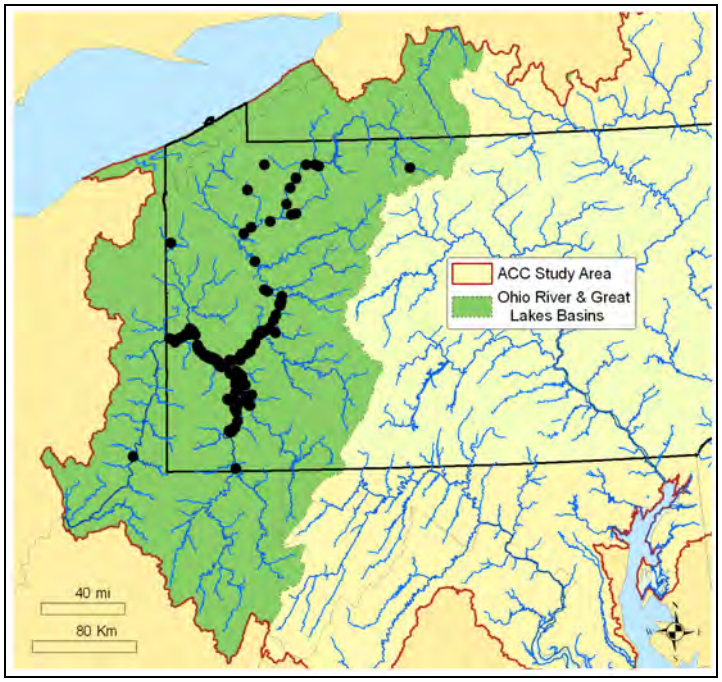
Image Source: http://sites.state.pa.us/PA_Exec/Fish_Boat

Threats: The water quality of large rivers in the Ohio River Basin has vastly improved in recent decades. However, detriments to water quality and habitat conditions remain. Non-point source pollution contributes excess nutrients, sediments, and pesticide runoff to river systems. Additional threats from stormwater runoff and municipal discharges are concentrated around urbanized areas. Tributaries can contribute pollution from abandoned mine drainage (AMD), urban runoff and agricultural non-point source pollution to large rivers. Additionally, a number of dams occur in the Ohio River and its tributaries. Dams interrupt the continuity of flowing waters, altering flow patterns and sediment transport regimes. The movement of fishes is restricted by dams, which may segregate populations. These augmentations in hydrology can damage riverine habitats disrupt river functions.

Conservation Recommendations: Reducing pollution in the upper Ohio River watershed would improve water quality in its lower sections. Reducing point source discharges and stormwater runoff to these large rivers will improve water and habitat quality. Additionally, minimizing habitat destruction from sand and gravel dredging and other disturbances will improve habitat condition. Managers of large river habitats and dam operators should coordinate efforts to maintain the habitats of large river fish.

Ohio – Great Lakes Basins Fish: Large River Community

Known Locations:



Example Habitats:

Wide, deep channel habitats are common in the larger rivers of the Ohio River Basin, and are characteristic of the areas where the Large River Community is found.

Photo source: PNHP

Atlantic Basin Fish: Coldwater Community

Community Indicators: brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*)

Species of Conservation Concern: none

Habitat: This headwater stream community occurs in small streams ($\overline{X}$ = 17.6 mi^2 watershed area) at high elevations ($\overline{X}$ = 383 m) and high gradients ($\overline{X}$ = 2.5%). Water temperatures are the coldest among all fish communities. The Atlantic Coldwater Community represents small, swift streams with brook trout and slightly larger streams with both brook and brown trout or brown trout only.

The small streams that support the Atlantic Coldwater Community tend to have fewer disturbances than larger waters flowing through valleys. These systems often flow from sandstone or shale ridges and have a unique water chemistry signature with few dissolved cations and low buffering capacity. Streams have low alkalinity ($\overline{X}$ = 27 mg/l) and conductivity ($\overline{X}$ = 140 µS/cm). Water temperatures are generally cold and pH is usually lower than that of other community types ($\overline{X}$ = 6.7).

Predictive habitat modeling showed that large amounts of forest cover ($\overline{X}$ = 89.4%), little agriculture ($\overline{X}$ = 8.2%) and little open water area ($\overline{X}$ = 0.2%) in the watershed appeared to be the most important factors in shaping habitat for the Coldwater Community. The amounts of bedrock sandstone and shale geology in the watershed were also important habitat attributes. In addition, low amounts of urbanization and few road stream crossings in the watershed were all positively associated with the occurrence of this community.

Stream Quality Rating: High

Community Rarity: No

Threats: Streams in Pennsylvania may be acidic from two major pollution sources: abandoned mine drainage (AMD) and acid deposition. Coal mining often occurs in watersheds containing the Coldwater Community and may contribute acidic and metal-laden discharges to these streams. Pollutants in the form of acid precipitation can fall on headwater stream watersheds and leach away the natural buffering capacity of soils, reducing stream pH to levels stressfully low for aquatic organisms.

Conservation Recommendations: Streams in these watersheds may have wild-reproducing populations of brook and brown trout and may be a fishery resource. Because cold, headwater streams often occur in terrain unsuitable for most types of human developments, they are not usually subject to the same types of water pollution issues as valley streams. Streams like this should be preserved as a unique resource for the region.

Strongest Indicators of Community Type

Brook trout (*Salvelinus fontinalis*)

Photo Source: http://www.cnr.vt.edu/efish

Brown trout (*Salmo trutta*)

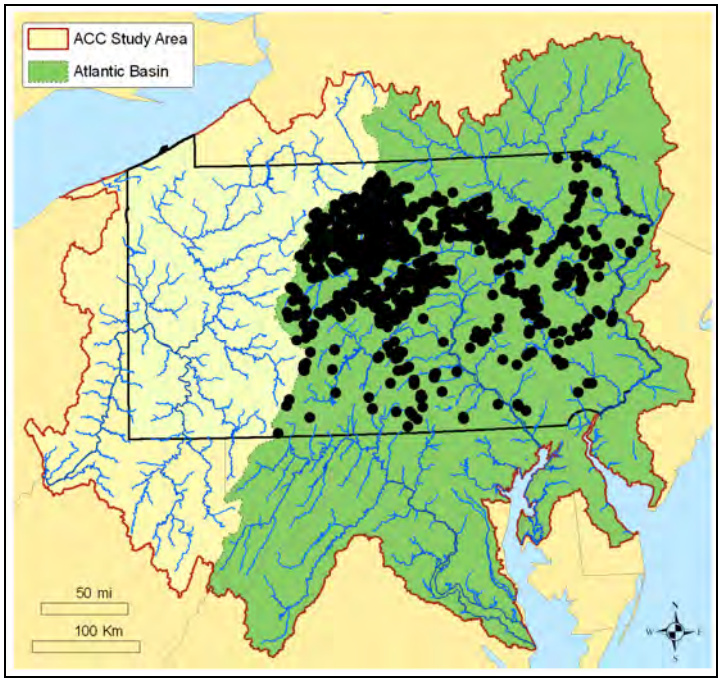
Photo Source: http://www.cnr.vt.edu/efish

Addressing water pollution from AMD and acid deposition are critical for headwater, coldwater streams. Adequate treatment of AMD can reduce the acidity and concentrations of toxic metals in the discharge that enters streams. Liming watersheds and/or streams is one option for minimizing the effects of acid deposition or AMD. In lieu of liming activities, mitigated wetlands may offer a more cost-effective way to treat AMD.

Trout streams in Pennsylvania are highly valued by fisherman, but have been greatly altered by the transplantation of brown trout from Europe and rainbow trout from western North America. Where populations of native brook trout occur, care should be taken to avoid introductions of non-native trout species. These introduces species can out-compete native fishes for vital habitat and food resources.

Atlantic Basin Fish: Coldwater Community

Known Locations:



Example Habitats:

Small, high-gradient streams with forested watersheds are typical of the Coldwater Community habitat.

Photo source: PHNP

Atlantic Basin Fish: Coolwater Community 1

Community Indicators: slimy sculpin (*Cottus cognatus*), brown trout (*Salmo trutta*, stocked), fathead minnow (*Pimephales promelas*), pearl dace (*Margariscus margarita*)

Species of Conservation Concern: none

Habitat: This community generally occurs in high gradient ($\overline{X}$ = 2.0%), mid-reach streams ($\overline{X}$ = 54 mi^2 watershed area) potentially in high elevations ($\overline{X}$ = 367 m). Habitats may be disturbed by human influences.

Water chemistry is similar to the warmwater community types with relatively high alkalinity ($\overline{X}$ = 54 mg/l) and conductivity ($\overline{X}$ = 225 µS/cm); pH ($\overline{X}$ = 7.0) values are neutral. Water temperatures are cooler than the norm for warmwater streams, but not as low as coldwater streams. Agricultural land cover is a large proportion ($\overline{X}$ = 19.0%) of the watershed and urbanized land cover averages about 3.0% in these catchments.

The fish that indicate this community type prefer cool waters with rocky substrates, likely occurring in transitional areas between cold- and warmwater streams. The Coolwater Community 1 may represent streams with put-and-take trout fisheries or cool streams with seasonally warm temperatures. Fish in this community type may tolerate acidic conditions, low dissolved oxygen, suspended sediments or other water quality impairments.

Predictive modeling of stream habitats suggested that community distribution is related strongly to stream gradient and land use type. Low proportions of total emergent wetland in the local and upstream watersheds, high amounts of mixed (hardwood and deciduous) forests in the local watershed, and high stream gradients best predicted the locations of the Coolwater Community 1. Since this community occurs in the uplands, there are few riparian and floodplain wetlands. Agricultural area in the watershed was not a strong predictor of the community habitat, but large amounts of watershed forest cover was.

Stream Quality Rating: Low

Community Rarity: No

Threats: This community occurs downstream of headwaters and exists in streams not usually protected from human influences. The most common insults to water quality in Coolwater Community 1 watersheds are abandoned mine drainage (AMD) and non-point source pollution from poorly managed agricultural areas. AMD contributes metal-laden waters that are very low in pH to streams and can increase the acidity of stream waters to levels unhealthy for aquatic organisms.

Strongest Indicators of Community Type

Slimy sculpin (*Cottus cognatus*)

Photo Source: www.nj.gov/dep

Fathead minnow (*Pimephales promelas*)

Photo Source: http://www.cnr.vt.edu/efish

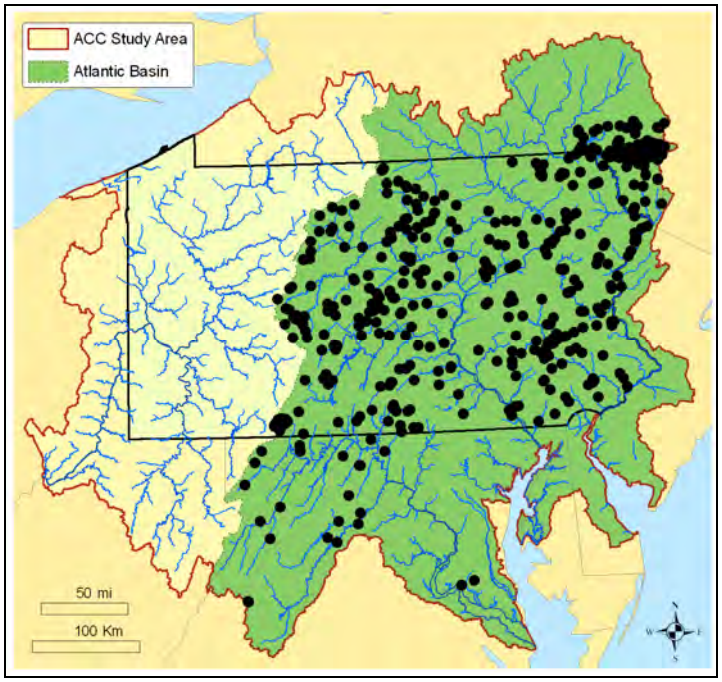
Removal of stream bank vegetation contributes to poor water quality and habitat condition by allowing excess levels of sediments and nutrients to enter streams, especially in agricultural areas. As a result of these impairments, water temperatures may be warmer than usual in these streams.

Conservation Recommendations: The habitat for the Coolwater Community 1 represents an important transition between cold headwater streams and warm, larger streams; the habitat is distinct among other habitat types and should be protected and restored.

Restoration of stream habitat and water quality to a natural condition is recommended. Management of storm water runoff and riparian vegetation restoration are critical to improvement of in-stream habitat. Excess nutrient runoff and sedimentation impair some locations where this community occurs. Where stocking of non-native fish is happening, native fish can be displaced. Restoration of the fish community to native species is recommended.

Atlantic Basin Fish: Coolwater Community 1

Known Locations:



Example Habitats:

Medium-sized streams like Marsh Creek (left) and the faster flowing Wilson Creek (right) are examples of streams characterized by the Coolwater Community 1.

Photo source: PNHP

Atlantic Basin Fish: Coolwater Community 2

Community Indicators: blacknose dace (*Rhinichthys atratulus*), white sucker (*Catostomus commersoni*), golden shiner (*Notemigonus crysoleucas*)

Species of Conservation Concern: none

Habitat: This community type is similar to Atlantic Basin Coolwater Community 1 since it occurs in small to medium size streams ($\bar{x}$ = 46 mi^2) at moderate to relatively high elevation ($\bar{x}$ = 243 m) and gradient ($\bar{x}$ = 1.0%). Streams are faster than warmwater streams and are intermediate in temperature between warm and cold streams. Water quality profiles show relatively high values of alkalinity ($\bar{x}$ = 55.6 mg/l) and conductivity ($\bar{x}$ = 213 µS/cm) compared to other community groups. pH values are typically neutral ($\bar{x}$ = 7.2).

Fish found in this community type are habitat generalists and generally pollution tolerant. There are a comparatively small number of fish species associated with the Atlantic Coolwater Community 2. This community type may represent small coolwater streams that are more degraded, perhaps by urbanization or agricultural non-point source pollution in the watershed, than those that support the Atlantic Basin Coolwater Community 1 type. Proportionately high amounts of urban land cover ($\bar{x}$ = 4.6% watershed area) and agriculture ($\bar{x}$ = 26.1%) indicate more potential pollution sources.

A predictive modeling analysis confirmed that large amounts of disturbance in urban settings, particularly from commercial and industrial sources, were associated with this community type. Positive relationships with emergent and total wetland landcover types in the local watershed suggest that the community occurs in valleys where riparian and floodplain wetlands are common.

Stream Quality Rating: Low

Community Rarity: No

Threats: Poorly managed agricultural practices are the most pressing threat to the Atlantic Coolwater Community 2. Excess siltation and nutrients contributed from crop fields and livestock grazing lead to degraded stream conditions. In some locations, urban runoff also leads to poor habitat and water quality. Point sources from industry and municipal sources, like sewage treatment plants, may also occur in watersheds supporting this community.

Strongest Indicators of Community Type

Blacknose dace (*Rhinichthys atratulus*)

Photo Source: http://www.ohiodnr.com/dnap

White sucker (*Catostomus commersoni*)

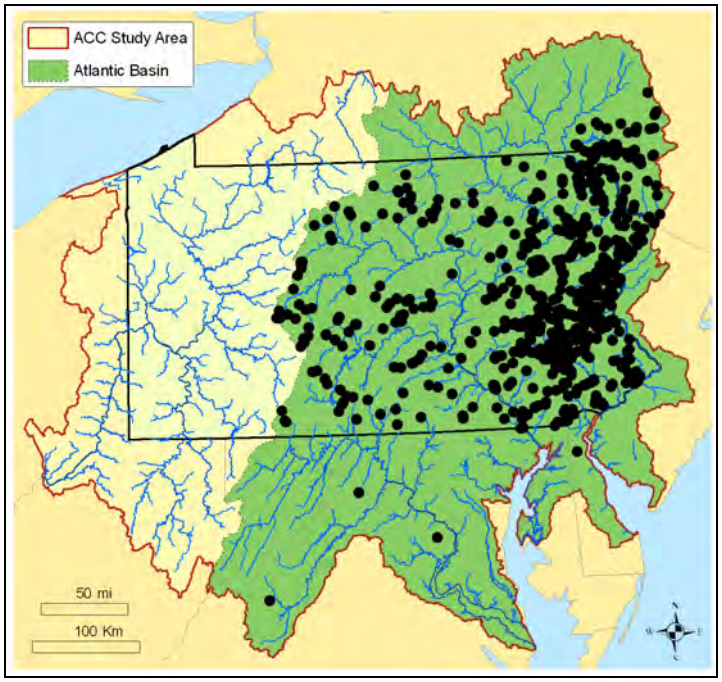
Photo Source: www.nj.gov/dep

Conservation Recommendations: This community is indicative of stream habitats resembling those of Atlantic Coolwater Community 1, but water quality and habitat condition are likely inferior. The occurrence of Atlantic Coolwater Community 2 should signify poor stream conditions that should be restored, potentially to support Atlantic Basin Coolwater Community 1.

Restoration of stream temperature may be particularly important to improving the habitats for this community type. Restoring or establishing natural vegetation in riparian zones and restoration of in-stream habitats will return more natural conditions where the Atlantic Coolwater Community 2 occurs. Mitigating runoff from crops and livestock pastures will reduce sedimentation and nutrient loading. Upgrades or enhancements in treatment systems for hazardous effluents from industrial and municipal point sources can vastly improve water quality.

Atlantic Basin Fish: Coolwater Community 2

Known Locations:



Example Habitats:

Atlantic Coolwater Community 2 is found in a variety of habitats in medium-sized streams and small rivers. Habitat-generalist fish can tolerate slow and silty streams.

Photo source: PNHP

Atlantic Basin Fish: Warmwater Community 1

Community Indicators: central stoneroller (*Campostoma anomalum*), northern hogsucker (*Hypentelium nigricans*), river chub (*Nocomis micropogon*), longnose dace (*Rhinichthys cataractae*), cutlips minnow (*Exoglossum maxilingua*), mottled sculpin (*Cottus bairdii*), margined madtom (*Noturus insignis*), creek chub (*Semotilus atromaculatus*), rosyface shiner (*Notropis rubellus*), fantail darter (*Etheostoma fabellare*), greenside darter (*Etheostoma blenniodes*)

Species of Conservation Concern: none

Habitat: The Warmwater Community 1 occurs in small to medium size watersheds ($\overline{x}$ = 128 mi^2 watershed area) at moderate elevation ($\overline{x}$ = 255 m) and low gradient ($\overline{x}$ < 1%).

Streams have moderate alkalinity ($\overline{x}$ = 50 mg/l) and conductivity ($\overline{x}$ = 175 µS/cm) relative to other groups, and nearly neutral pH values ($\overline{x}$ = 7.2). Warm water temperatures are also characteristic of these habitats; consequently, thermal tolerances of fish in this community group are higher than those of fish from the cold and cool-water communities. Habitat preferences of indicator taxa suggest this community occurs in warmwater streams with moderate to high currents and little silt.

Community prediction analysis demonstrated that local and upstream watershed landcover as well as position in the watershed were important variables for community distribution. Elevation, high number of upstream first order streams and high number of stream links suggest that communities occurred below headwater streams. High amounts of pasture ($\overline{x}$ = 22.1% of the watershed), row-crop agriculture ($\overline{x}$ = 5.2%) and non-row crop agriculture ($\overline{x}$ = 22.2%) were also related to community distribution.

Stream Quality Rating: Medium

Community Rarity: No

Threats: Water quality and habitat may be influenced by non-point source pollution where the Warmwater Community 1 exists. Poorly managed agricultural land is likely the most prominent threat to the habitat of this community. In most locations where this community occurs, about one-third of the watershed is in agricultural practices. Nutrient enrichment and excess sedimentation of streams from mismanaged agricultural practices impair many streams in watersheds with this community type. Low pH and dissolved and precipitated metals from abandoned mine drainage (AMD) influence some warmwater watersheds in the Anthracite coal region in eastern Pennsylvania.

Strongest Indicators of Community Type

Central stoneroller
(*Campostoma anomalum*)

Photo Source: http://www.ohiodnr.com/dnap

Northern hogsucker
(*Hypentelium nigricans*)

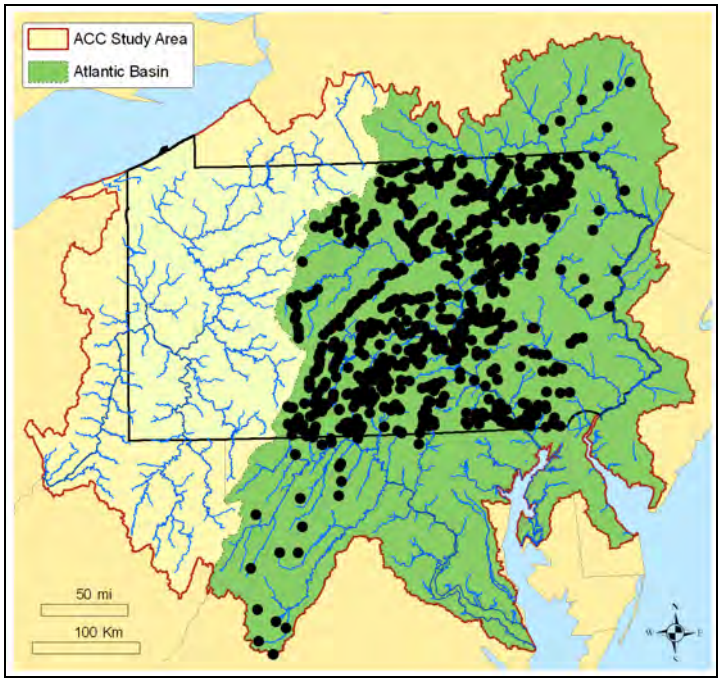
Photo Source: http://www.ohiodnr.com/dnap

Conservation Recommendations: This community is a high conservation priority. Warmwater streams in good condition are not common in the region. The fish associates of this community type are not especially rare individually, but this community represents habitats in need of protection and restoration.

Since warmwater streams mainly occur in valleys downstream of human influences, they are often subject to pollution from non-point sources such as AMD, agricultural runoff and urban pollutants. Adequate remediation of AMD helps to alleviate its effects. Storm water management, restoration of riparian buffer zones, and exclusion of livestock from streams are some mitigation techniques for non-point source pollution.

Atlantic Basin Fish: Warmwater Community 1

Known Locations:



Example Habitats:

Medium-sized streams without many groundwater inputs are typical of Warmwater Community 1 streams. Stream sequences of pools (slow-moving habitats), riffles (swift current habitats), and runs (intermediate current habitats) provide a variety of habitats and support warmwater fish communities.

Photo source: PHNP

Atlantic Basin Fish: Warmwater Community 2

Community Indicators: redbreast sunfish (*Lepomis auritus*), rock bass (*Ambloplites rupestris*), spotfin shiner (*Cyprinella spiloptera*), fallfish (*Semotilus corporalis*), smallmouth bass (*Micropterus dolomieu*), spottail shiner (*Notropis hudsonius*), common shiner (*Luxilus cornutus*), tessellated darter (*Etheostoma olmstedi*), pumpkinseed (*Lepomis gibbosus*), bluntnose minnow (*Pimephales notatus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), satinfin shiner (*Cyprinella analostana*), swallowtail shiner (*Notropis procne*), yellow bullhead (*Ameiurus natalis*), shield darter (*Percina peltata*), American eel (*Anguilla rostrata*), largemouth bass (*Micropterus salmoides*), common carp (*Cyprinus carpio*)

Species of Conservation Concern: none

Habitat: The Warmwater Community 2 is found in larger streams than the Atlantic Warmwater Community 1. Typical habitat occurs in low gradient ($\overline{X}$ = 1.1%), medium-to-large sized streams ($\overline{X}$ = 626 mi^2 watershed area) at low elevations ($\overline{X}$ = 96 m). Water chemistry values are generally moderate for alkalinity ($\overline{X}$ = 47 mg/l) and conductivity ($\overline{X}$ = 237 µS/cm). pH is neutral and water temperatures are usually warm.

Fish in this community type prefer pools in warm streams or ponds. Some indicator fish are tolerant of low dissolved oxygen levels or turbid waters. Many of these fish are habitat generalists. This group also includes game fish like smallmouth bass and bluegill, which were likely stocked in many locations and have potentially become naturalized.

Community distribution modeling showed that position in the watershed and both local and upstream landcover are strongly related to community locations. Low elevation, gradient, high numbers of upstream first order streams and high numbers of stream links were also good predictors of habitat. Amount of pastureland in the local and upstream ($\overline{X}$ = 25.6%) watersheds, amount of total wetlands ($\overline{X}$ = 0.9%), and wide, open stream channels were positively related to the streams containing the Warmwater Community 2.

Stream Quality Rating: Medium

Community Rarity: No

Threats: Similar to the Atlantic Basin Warmwater Community 1, non-point source pollution is a significant threat to the habitats of Warmwater Community 2. Large amounts of watershed agricultural land cover (~ 33%) typically occur with this community group. Nutrient enrichment and excess sedimentation of streams from mismanaged agricultural practices impair many streams in watersheds containing this community type.

Strongest Indicators of Community Type

Redbreast sunfish (*Lepomis auritus*)

Photo Source: http://www.ohiodnr.com/dnap

Rock bass (*Ambloplites rupestris*)

Photo source: www.nj.gov/dep

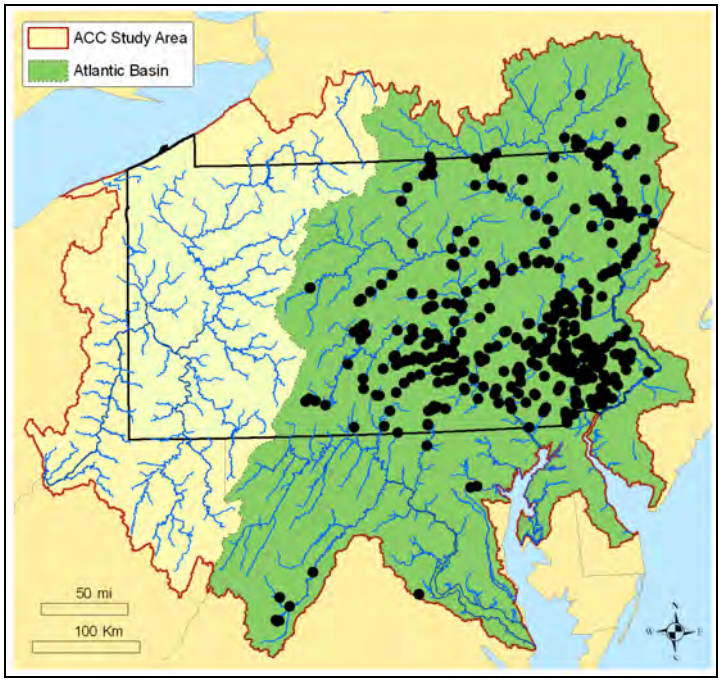
Some streams where this community is found are impaired from residential or municipal discharges. Urban runoff and sewer discharges can contain silt, high levels of nutrients, and other pollutants that damage fish habitats. River modifications through dams, channelization and bridge construction also threaten the habitats of aquatic communities.

Conservation Recommendations: This community is found downstream of many populated areas and exists in habitats that have been altered from their natural condition. Protection of the variety of habitats in small rivers is essential to maintaining a diverse fish community.

Management of combined sewer overflows, road runoff, and vegetated riparian areas will improve stream habitats in urban streams. Alternatively, the restoration of riparian buffers and exclusion of livestock from streams are techniques to control non-point source pollution in agricultural streams.

Atlantic Basin Fish: Warmwater Community 2

Known Locations:



Example Habitat:

In large streams and rivers with warm waters, the diverse Warmwater Community 2 is supported by a variety of habitats.

Photo source: PHNP

Atlantic Basin Fish: River and Impoundment Community

Community Indicators: walleye (*Stizostedion vitreus*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaulatus*), goldfish (*Carassius auratus*)

Species of Conservation Concern: None

Habitat: The River and Impoundment Community habitat is represented by relatively low gradient ($\bar{x}$ < 0.5%) large streams and rivers ($\bar{x}$ = 325 mi^2 watershed area) at low elevations ($\bar{x}$ = 203 m). Dam impoundments along rivers generate deep pools with soft stream bottoms to create this habitat.

Streams are characterized by warm waters ($\bar{x}$ = 18.6°C) with relatively high conductivity ($\bar{x}$ = 256 µS/cm) and alkalinity ($\bar{x}$ = 60 mg/l). pH values are slightly alkaline ($\bar{x}$ = 7.4).

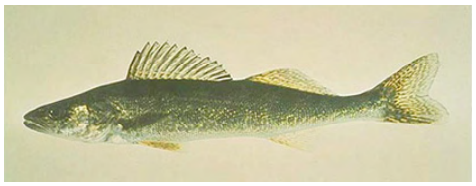
Landscape variables typically associated with large streams and rivers were the best predictors of habitat for the Atlantic River and Impoundment Community in distribution models. This community was highly related to amounts of pastureland ($\bar{x}$ = 16.6%), non row-crop agriculture ($\bar{x}$ = 16.7%), total agriculture ($\bar{x}$ = 21.0%), emergent wetlands ($\bar{x}$ = 0.2%), and the number of road-stream crossings in the watershed.

Stream Quality Rating: Medium

Community Rarity: No

Threats: Large streams and rivers are subject to many types of pollution. Tributaries to the mainstem of the lower Susquehanna River, Schuylkill River and Delaware River are impaired from a number of sources. These locations are where many examples of this community are found. Large rivers receive effluent from industrial discharges, sewage treatment plants and storm water runoff. The Schuylkill watershed receives polluted waters from abandoned mine drainage (AMD) resulting from coal mining practices in the watershed. Non-point source pollution from agriculture can contribute excessive silt and nutrients to rivers. Runoff from impervious surfaces in urban areas can carry road contaminants. Lastly, the presence of dams on the Susquehanna River fundamentally alters river habitat and changes natural flow patterns.

Strongest Indicators of Community Type



Walleye (*Stizostedion vitreus*)

Photo Source: http://www.cnr.vt.edu/efish

Yellow perch (*Perca flavescens*)

Photo source: www.nj.gov/dep

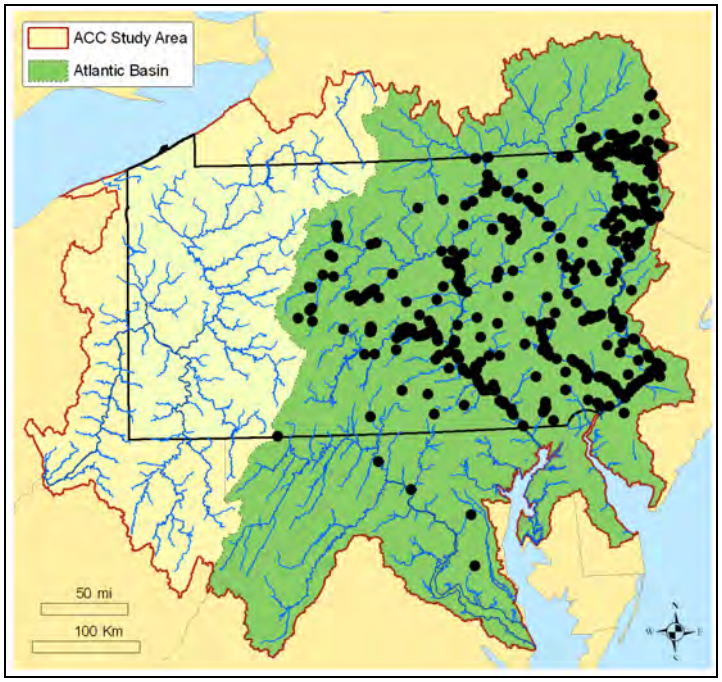
This community is primarily composed of fish that are not native to the Susquehanna or Delaware River watersheds. Walleye, black crappie, and goldfish are introduced species to the Atlantic Basins in eastern and central Pennsylvania. Many game fish, like walleye and yellow perch, have been introduced and may be actively stocked around Pennsylvania. Fish may have naturalized in many locations.

Conservation Recommendations: Large stream and river habitats in good condition are rare. Most large rivers have dams for flood control, navigational or recreation. Special consideration to dam removal should be made where possible because dams alter riverine functions like flow regime, habitat structure and connectivity. The damming of rivers has many ecological effects on aquatic species, including the disruption of migration and dispersal activities.

Although the potential sources of pollution to the river and impoundment community are many, remediation of these pollution problems is possible. Reducing pollution impacts from storm sewers, AMD, sewage treatment plants and industrial point sources can improve even the most severe water quality issues. Additionally, non-point source pollution from agricultural and urban areas should be addressed.

Atlantic Basin Fish: River and Impoundment Community

Known Locations:



Example Habitat:

Large rivers like the Susquehanna River (above) and impoundments Provide the habitats for the River and Impoundment Community.

Photo source: PNHP

Atlantic Basin Fish: Lower Delaware River Community

Other community members: white perch (*Morone americana*), channel catfish (*Ictalurus punctatus*), blueback herring (*Alosa aestivalis*), eastern silvery minnow (*Hybognathus regius*), white catfish (*Ameiurus catus*), striped bass (*Morone saxatilis*), gizzard shad (*Dorosoma cepedianum*), American shad (*Alosa sapidissima*), banded killifish (*Fundulus diaphanus*)

Species of Conservation Concern: None

Habitat: This community mainly occurs in the lower Delaware River ($\overline{x}$ = 7,200 mi^2 watershed area) and its tributaries at low elevation ($\overline{x}$ = 5 m) in the coastal plain where stream gradients are low ($\overline{x}$ < 0.5%).

The Delaware River provides a unique riverine habitat in Pennsylvania. One of the only large, free-flowing rivers in North America, it meets its estuary near Morrisville, PA and Trenton, NJ. Consequently, the Delaware River has a suite of fauna suited to its coastal environment. The Lower Delaware River Community represents coastal fish that spawn in the lower Delaware River and associated freshwater fish. Several fish like the white perch, blueback herring, striped bass and American shad migrate into the Delaware River for spawning. Other community fish, like the channel catfish, are common in larger rivers.

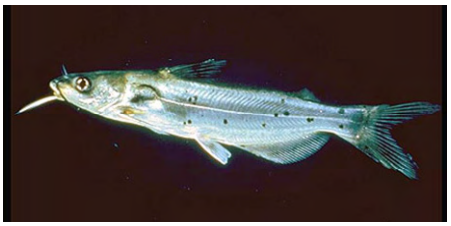
Predictions of community distribution were negatively associated with stream elevation and gradient. A large number of dams, point sources and road stream crossings in the upstream watershed were good predictors of habitat for the Lower Delaware River Community. Although the mainstem of the river is unimpounded, the number of accumulated dams in the upstream watershed on its tributaries is large. A number of riparian, local and total watershed landcover associates are related to the habitat for this community. Low proportions of riparian forest ($\overline{x}$ = 12.4%), relatively high amounts of upstream woody wetlands ($\overline{x}$ = 3.0%), and relatively high amounts of low intensity urban development ($\overline{x}$ = 4.9%) were among the strongest predictors of this community type.

Stream Quality Rating: Moderate to low

Strongest Indicators of Community Type

White perch (*Morone americana*)

Photo Source: http://www.cnr.vt.edu/efish



Channel catfish (*Ictalurus punctatus*)

Photo source: www.nj.gov/dep

Community Rarity: Yes

Threats: Because of dense human populations surrounding the lower Delaware River, it is subject to typical urban threats such as combined sewer overflows, runoff from residential areas, stormwater discharges and road runoff. In addition, the shipping and commercial industries on the river can contribute to habitat destruction and pollution from dredging and discharges or spills from boats and barges.

Conservation Recommendations: Current levels of low human disturbance in the upper Delaware watershed translate to good water quality as the river flows into its lower section. Minimizing point source effluence, stormwater runoff and combined sewer overflows will maintain water quality as the Delaware River flows out to its estuary.

Additionally, preventing major habitat destruction from dredging and other in-stream projects will allow fish species habitat to exist in a natural state.

Atlantic Lower Delaware River Community

Known Locations:

Example Habitat:

The lower Delaware River is one of the few un-impounded rivers in North America, and provides a home to the unique Lower Delaware River Community.

Photo source: PNHP

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http://sites.state.pa.us/PA_Exec/Fish_Boat. Pennsylvania Fish and Boat Commission.

http://www.clemson.edu. Clemson University, Clemson Experimental Forest.

http://www.cnr.vt.edu/efish. Dr. Lou Helfrich, Dr. Tammy Newcomb, Dr. Eric Hallerman, and Dr. Ken Stein. EFISH: The Virtual Aquarium; Department of Fisheries and Wildlife Sciences, Virginia Polytechnic Institute and State University.

http://www.ohiodnr.com/dnap. Ohio Department of Natural Resources, Division of Natural Areas and Preserves.

www.nj.gov/dep. New Jersey Deparment of Environmental Protection.