

# Chapter H2: Evaluation of Impingement and Entrainment in the Inland Region

## H2-1 I&E SPECIES AND SPECIES GROUPS EVALUATED

Table H2-1 provides a list of species and associated species groups that were evaluated in EPA’s analysis of impingement and entrainment (I&E) in the Inland region.

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**Table H2-1: Species Groups Evaluated by EPA**

Species Group	Species	Recreational	Commercial	Forage
Alewife	Alewife			X
American shad	American shad	X		
Bigmouth buffalo	Bigmouth buffalo	X		
	Smallmouth buffalo	X		
Black bullhead	Black bullhead	X		
Black crappie	Black crappie	X		
Blueback herring	Alosa herring			X
	Blueback herring			X
Bluegill	Bluegill	X		
Bluntnose minnow	Bluntnose minnow			X
	Central stoneroller			X
	Chub			X
	Creek chub			X
	Fathead minnow			X
	Silver chub			X
	Silverjaw minnow			X
	Stoneroller			X
Brown bullhead	Brown bullhead	X		
	Stonecat	X		
	Yellow bullhead	X		

Table H2-1: Species Groups Evaluated by EPA				
Species Group	Species	Recreational	Commercial	Forage
Carp	Common carp			X
	Goldfish			X
Channel catfish	Blue catfish	X		
	Channel catfish	X		
	Flathead catfish	X		
	White catfish	X		
Crappie	White crappie	X		
Darter species	Etheostoma darter	X		
	Fantail darter	X		
	River darter	X		
	Tessellated darter	X		
Emerald shiner	Bigeye shiner			X
	Common shiner			X
	Emerald shiner			X
	Golden shiner			X
	Mimic shiner			X
	River shiner			X
	Rosyface shiner			X
	Sand shiner			X
	Spotfin shiner			X
	Spottail shiner			X
Freshwater drum	Freshwater drum	X		
Gizzard shad	Gizzard shad			X
	Threadfin shad			X
Golden redhorse	Golden redhorse	X		
	Redhorse	X		
	River redhorse	X		
	Shorthead redhorse	X		
	Silver redhorse	X		
Logperch	Logperch	X		
Muskellunge	Grass pickerel	X		
	Muskellunge	X		
	Northern pike	X		
Other (forage)	American eel			X
	Chestnut lamprey			X
	Goldeye			X
	Longnose gar			X
	Mooneye			X
	Silver lamprey			X

<b>Species Group</b>	<b>Species</b>	<b>Recreational</b>	<b>Commercial</b>	<b>Forage</b>
Other (recreational)	Banded sculpin			X
	Coho salmon	X		
	Rainbow trout	X		
	Troutperch	X		
Paddlefish	Paddlefish	X		
Rainbow smelt	Rainbow smelt	X		
River carpsucker	River carpsucker	X		
Sauger	Sauger	X		
Skipjack herring	Skipjack herring			X
Smallmouth bass Spotted sucker	Largemouth bass	X		
	Red bass	X		
	Smallmouth bass	X		
	Spotted bass	X		
	Spotted sucker	X		
Striped bass	Striped bass	X		
Striped killifish	Eastern banded killifish	X		
Sucker species	Carpion sucker	X		
	Carpsucker buffalo	X		
	Catostomidae sucker	X		
	Highfin carpsucker	X		
	Northern hog sucker	X		
	Quillback	X		
	White sucker	X		
Sunfish	Centrarchidae sunfish	X		
	Green sunfish	X		
	Hybrid sunfish	X		
	Lepomis sunfish	X		
	Longear sunfish	X		
	Pumpkinseed	X		
	Redear sunfish	X		
	Rock bass	X		
	Warmouth	X		
Walleye	Walleye	X		
White bass	White bass	X		
White perch	White perch	X		
Yellow perch	Yellow perch	X		

Life histories of the species with the highest losses are summarized in the following section. The life history data used in EPA's analysis and associated data sources are provided in Appendix H1 of this report.

## H2-2 LIFE HISTORIES OF PRIMARY SPECIES IMPINGED AND ENTRAINED IN THE INLAND REGION

The life history characteristics of the primary species impinged and entrained at Ohio River CWIS are summarized in the following sections. The species described are those with the highest I&E rates at the facilities examined.

### Emerald shiner (*Notropis atherinoides*)

Emerald shiner is a member of the family Cyprinidae. It is found in large open lakes and rivers from Canada south throughout the Mississippi Valley to the Gulf Coast in Alabama (Scott and Crossman, 1973). Emerald shiner prefer clear waters in the mid- to upper sections of the water column, and are most often found in deep, slow moving rivers (Trautman, 1981). Because of its small size, emerald shiner is an important forage fish for many species.

Spawning occurs from July to August in Lake Erie (Scott and Crossman, 1973). Females lay anywhere from 870 to 8,700 eggs (Campbell and MacCrimmon, 1970), which hatch within approximately 24 hours (Scott and Crossman, 1973). Young-of-year remain in large schools in inshore waters until the fall, when they move into deeper waters to overwinter (Scott and Crossman, 1973). Young-of-year average 5.1 to 7.6 cm (2 to 3 in) in length (Scott and Crossman, 1973).

Emerald shiner move in schools and prefer clear waters over sand or gravel (Froese and Pauly, 2000). They surface at dusk to feed on microcrustaceans, midge larvae, zooplankton, and algae (Campbell and MacCrimmon, 1970). During the day, they descend to deeper waters.

Emerald shiner are sexually mature by age 2, though some larger individuals may mature at age 1 (Campbell and MacCrimmon, 1970). Most do not live beyond 3 years of age (Fuchs, 1967). Adults typically range in size from 6.4 to 8.4 cm (2.5 to 3.3 in) (Trautman, 1981). Populations may fluctuate dramatically from year to year (Trautman, 1981).

 <p style="text-align: center;"><b>EMERALD SHINER</b> (<i>Notropis atherinoides</i>)</p>	<p><b>Food Sources:</b> Microcrustaceans, midge larvae, zooplankton, algae.<sup>d</sup></p> <p><b>Prey for:</b> Gulls, terns, mergansers, cormorants, smallmouth bass, yellow perch, and others.<sup>d</sup></p>
<p><b>Family:</b> Cyprinidae.</p> <p><b>Common names:</b> Emerald shiner.</p> <p><b>Similar species:</b> Silver shiner, rosyface shiner.<sup>a</sup></p> <p><b>Geographic range:</b> From Canada south throughout the Mississippi valley to the gulf coast in Alabama.<sup>b,c</sup></p> <p><b>Habitat:</b> Large open lakes and rivers.<sup>b</sup></p> <p><b>Lifespan:</b> Emerald shiner live to 3 years of age.<sup>a,d</sup></p> <p><b>Fecundity:</b> Mature by age 2, although some may mature at age 1. Females can lay approximately 870 to 8,700 eggs.<sup>c</sup></p>	<p><b>Life Stage Information</b></p> <p><b>Eggs:</b> demersal</p> <ul style="list-style-type: none"> <li>▶ Eggs hatch in less than 24 hours.<sup>d</sup></li> </ul> <p><b>Larvae:</b> pelagic</p> <ul style="list-style-type: none"> <li>▶ Individuals from different year classes can have varying body proportions and fin length, as can individuals from different localities.<sup>a</sup></li> </ul> <p><b>Adults</b></p> <ul style="list-style-type: none"> <li>▶ Typically range in size from 6.4 to 8.4 cm (2.5 to 3.3 in).<sup>a</sup></li> </ul>
<p><sup>a</sup> Trautman, 1981.  <sup>b</sup> Froese and Pauly, 2000.  <sup>c</sup> Campbell and MacCrimmon, 1970.  <sup>d</sup> Scott and Crossman, 1973.            Fish graphic courtesy of New York Sportfishing and Aquatic Resources Educational Program, 2001.</p>	

## Freshwater drum (*Aplodinotus grunniens*)

Freshwater drum is a member of the drum family, Sciaenidae. Possibly exhibiting the greatest latitudinal range of any North American freshwater species, its distribution ranges north from Manitoba, Canada, south to Guatemala, and throughout the Mississippi River drainage basin (Scott and Crossman, 1973). Freshwater drum is not a favored food item of either humans or other fish (Edsall, 1967; Trautman, 1981; Bur, 1982).

Based on studies in Lake Erie, the spawning season peaks in July (Daiber, 1953), although spent females have been found as late as September (Scott and Crossman, 1973). Females in Lake Erie produce from 43,000 to 508,000 eggs (Daiber, 1953). The eggs are buoyant, floating at the surface of the water (Daiber, 1953; Scott and Crossman, 1973). This unique quality may be one explanation for the freshwater drum's exceptional distribution (Scott and Crossman, 1973). Yolk-sac larvae are buoyant as well, floating inverted at the surface of the water with the posterior end of the yolk sac and tail touching the surface (Swedberg and Walburg, 1970).

Larvae develop rapidly over the course of their first year. Maturity appears to be reached earlier among freshwater drum females from the Mississippi River than females from Lake Erie. Daiber (1953) found Lake Erie females begin maturing at age 5, and 46 percent reach maturity by age 6. Lake Erie males begin maturing at age 4, and by age 5, 79 percent had reached maturity.

Freshwater drum in western Lake Erie were found to live an average of 4 years, although the oldest male was 8 years of age, and the oldest female was 14 years (Edsall, 1967). Adults tend to be between 30 to 76 cm (12 to 30 in) long. The largest reported freshwater drum from the Ohio River was between 88.9 and 99.1 cm (35 and 39 in) long (Trautman, 1981).

 <p><b>FRESHWATER DRUM</b> (<i>Aplodinotus grunniens</i>)</p>	<p><b>Food Sources:</b>            Juveniles: Cladocerans (plankton), copepods, dipterans.<sup>d</sup>            Adults: Dipterans, cladocerans,<sup>d</sup> darters, emerald shiner.<sup>e</sup></p> <p><b>Prey for:</b>            ▶ Very few species.</p> <p><b>Life Stage Information</b></p>
<p><b>Family:</b> Sciaenidae.</p> <p><b>Common names:</b> Freshwater drum, white perch, sheepshead.<sup>a</sup></p> <p><b>Similar species:</b> White bass, carpsuckers.<sup>a</sup></p> <p><b>Geographic range:</b> From Manitoba, Canada, south to Guatemala. They can be found throughout the Mississippi River drainage basin.</p> <p><b>Habitat:</b> Bottoms of medium to large sized rivers and lakes.<sup>b</sup></p> <p><b>Lifespan:</b> The average freshwater drum lives 4 years, although individuals up to 14 years have been reported.<sup>c</sup></p> <p><b>Fecundity:</b> Females in Lake Erie produced from 43,000 to 508,000 eggs.<sup>e</sup></p>	<p><b>Eggs: Pelagic</b>            ▶ The buoyant eggs float at the surface of the water, possibly accounting for the species' high distribution.<sup>e</sup></p> <p><b>Larvae:</b>            ▶ Prolarvae float inverted at the surface of the water with the posterior end of the yolk sac and their tail touching the surface.<sup>f</sup></p> <p><b>Adults:</b>            ▶ The species owes its name to the audible "drumming" sound that it is often heard emitting during summer months.<sup>e</sup>            ▶ Tend to be between 30 to 76 cm (12 to 30 in) long.<sup>a</sup></p>
<p><sup>a</sup> Trautman, 1981.  <sup>b</sup> Froese and Pauly, 2001.  <sup>c</sup> Edsall, 1967.  <sup>d</sup> Bur, 1982.  <sup>e</sup> Scott and Crossman, 1973.  <sup>f</sup> Swedberg and Walburg, 1970.            Fish graphic courtesy of New York Sportfishing and Aquatic Resources Educational Program, 2001.</p>	

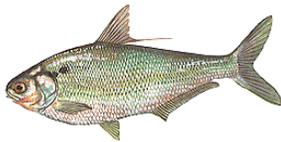
## Gizzard shad (*Dorosoma cepedianum*)

Gizzard shad is a member of the family Clupeidae. Its distribution is widespread throughout the eastern United States and into southern Canada, with occurrences from the St. Lawrence River south to eastern Mexico (Miller, 1960; Scott and Crossman, 1973). Gizzard shad are found in a range of salinities from freshwater inland rivers to brackish estuaries and marine waters along the Atlantic Coast of the United States (Miller, 1960; Carlander, 1969). Gizzard shad often occur in schools (Miller, 1960). Young-of-year are considered an important forage fish (Miller, 1960), though their rapid growth rate limits the duration of their susceptibility to many predators (Bodola, 1966). Gizzard shad occur in all of the impoundment pools of the Ohio River and account for nearly half of the fish sampled in Ohio River surveys (Hunter Environmental Services Inc., 1989).

Spawning occurs from late winter or early spring to late summer, depending on temperature. Spawning has been observed in early June to July in Lake Erie (Bodola, 1966), and in May elsewhere in Ohio (Miller, 1960). The spawning period generally lasts two weeks (Miller, 1960). Males and females release sperm and eggs while swimming in schools near the surface of the water. Eggs sink slowly toward the bottom or drift with the current, and adhere to any surface they encounter (Miller, 1960). Females produce an average of 378,990 eggs annually (Bodola, 1960), which average 0.75 mm (0.03 in) in diameter (Wallus et al., 1990).

Hatching time may be anywhere from 36 hours to one week, depending on temperature (Bodola, 1966). Young shad may remain in upstream natal waters if conditions permit (Miller, 1960). By age 2 all gizzard shad are sexually mature, though some may mature as early as age 1 (Bodola, 1966). Unlike many other fish, fecundity in gizzard shad declines with age (Electric Power Research Institute, 1987).

Gizzard shad generally live up to 5 to 7 years, but individuals up to 10 years have been reported in southern locations (Miller, 1960; Scott and Crossman, 1973). Mass mortalities due to extreme temperature changes have been documented in several locations during winter months (Williamson and Nelson, 1985).



**GIZZARD SHAD**  
(*Dorosoma cepedianum*)

**Family:** Clupeidae (herrings).

**Common names:** Gizzard shad.

**Similar species:** Threadfin shad.<sup>a</sup>

**Geographic range:** Eastern North America from the St. Lawrence River to Mexico.<sup>b,c</sup>

**Habitat:** Inhabits inland lakes, ponds, rivers, and reservoirs to brackish estuaries and ocean waters.<sup>b,c</sup>

**Lifespan:** Gizzard shad generally live 5 to 7 years, but have been reported at ages of up to 10 years.<sup>b</sup>

**Fecundity:** Maturity is reached at ages 2 to 3, females may produce between 59,480 and 378,990 eggs.<sup>b</sup>

**Food Sources:** Larvae consume protozoans, zooplankton, and small crustaceans.<sup>c</sup> Adults are mainly herbivorous, feeding on plants, phytoplankton, and algae. They are one of the few species able to feed solely on plant material.<sup>b</sup>

**Prey for:** Walleye, white bass, largemouth bass, crappie; among others (immature shad only).<sup>b</sup>

### Life Stage Information

#### *Eggs: Demersal*

- ▶ During spawning, eggs are released near the surface and sink toward the bottom, adhering to any surface they touch.

#### *Larvae: Pelagic*

- ▶ Larvae serve as forage to many species.
- ▶ After hatching, larvae travel in schools for the first few months.

#### *Adults*

- ▶ May grow as large as 52.1 cm (20.5 in).<sup>a</sup>
- ▶ May be considered a nuisance species because of sporadic mass winter die-offs.<sup>c</sup>

<sup>a</sup> Trautman, 1981.

<sup>b</sup> Miller, 1960.

<sup>c</sup> Scott and Crossman, 1973.

Fish graphic from Iowa Department of Natural Resources, 2001.

## Sauger (*Stizostedion canadense*)

Sauger is a member of the perch family, Percidae. Its distribution extends from the St. Lawrence River system south to northern Louisiana and throughout the Mississippi drainage. Sauger is primarily limited to freshwater systems and only occasionally found in brackish water (Scott and Crossman, 1973; Carlander, 1997). It is a close relative of the walleye, and the two species were once thought to be a single species, with the darker colored sauger mistaken for the male of the species (Trautman, 1981). Once plentiful in western Lake Erie, sauger have declined over the last 100 years. Commercial fishing of sauger in Lake Erie was banned in 1968. While abundance in the Ohio River was never as high as in Lake Erie, it has remained more stable over the years (Trautman, 1981).

Spawning in early April has been documented in Tennessee and in Lake Erie (Carlander, 1997). Males arrive at the spawning grounds before the females. Estimates of female fecundity range from 9,000 to 96,000 eggs per female (Scott and Crossman, 1973). Sauger are able to hybridize with walleye, producing what are locally known as “saugeyes” (Carlander, 1997).

Females broadcast their sticky eggs, which harden and become semibuoyant and nonadhesive. Eggs are 1.44 to 1.86 mm (0.06 to 0.07 in) in diameter. Hatching takes place anywhere from 25 to 29 days at temperatures of 4.4 to 12.8 °C (40 to 55 °F (Scott and Crossman, 1973). Yolk-sac larvae are 4.5 to 6.2 mm (0.18 to 0.24 in) long after hatching (Scott and Crossman, 1973), and in Ohio, young-of-year are 7.6 to 15.2 cm (2.6 to 6.0 in) by October (Trautman, 1981).

Male sauger typically mature at age 2, and females have been documented to mature anywhere from age 2 to 8 (Scott and Crossman, 1973; Carlander, 1997). In the Ohio River region, sauger generally do not live more than 8 years (Carlander, 1997). Adult male sauger in the Ohio River usually obtain average lengths of 23 cm (9 in), and females obtain lengths of 25.4 to 40.6 cm (10 to 16 in) (Trautman, 1981). The Ohio State record for sauger is 62.2 cm (24.5 in) (Ohio Department of Natural Resources, 2001).

 <p style="text-align: center;"><b>SAUGER</b> (<i>Stizostedion canadense</i>)</p>	<p><b>Food Source:</b> Juveniles feed on cladocerans, chironomids, fish fry.<sup>e</sup> Adults are sight predators, feeding mainly on gizzard shad and emerald shiner; other prey include freshwater drum, channel catfish, mimic shiner.<sup>f</sup></p> <p><b>Prey for:</b> Other sauger, northern pike, walleye, and yellow perch.<sup>e</sup></p>
<p><b>Family:</b> Percidae (perches)</p> <p><b>Common names:</b> Sauger, Jack salmon.<sup>a</sup></p> <p><b>Similar species:</b> Walleye, blue pike.<sup>b</sup></p> <p><b>Geographic range:</b> St. Lawrence River system south to northern Louisiana throughout the Mississippi drainage.<sup>c</sup></p> <p><b>Habitat:</b> Inhabits sand and gravel runs, and sandy or muddy pools of rivers. Occasionally found in lakes and impoundments.<sup>d</sup></p> <p><b>Lifespan:</b> Up to 8 years in the Ohio River region.<sup>e</sup></p> <p><b>Fecundity:</b> Females produce anywhere from 9,000 to 96,000 eggs.<sup>c</sup></p>	<p><b>Life Stage Information</b></p> <p><b>Eggs: Demersal</b></p> <ul style="list-style-type: none"> <li>▶ Eggs sink to the bottom after hardening, falling between rocks and gravel.<sup>c</sup></li> <li>▶ Eggs may take 25 to 29 days to hatch.</li> </ul> <p><b>Larvae: Pelagic</b></p> <ul style="list-style-type: none"> <li>▶ Yolk-sac larvae are 4.5 to 6.2 mm (0.18 to 0.24 in) long after hatching.<sup>c</sup></li> </ul> <p><b>Adults</b></p> <ul style="list-style-type: none"> <li>▶ Can hybridize with walleye (hybrids are known as saugeyes).<sup>e</sup></li> <li>▶ Males in the Ohio River average 23 cm (9 in), females are 25.4 to 40.6 cm (10 to 16 in).<sup>b</sup></li> </ul>
<p><sup>a</sup> Ohio Department of Natural Resources, 2001.  <sup>b</sup> Trautman, 1981.  <sup>c</sup> Scott and Crossman, 1973.  <sup>d</sup> Froese and Pauly, 2001.  <sup>e</sup> Carlander, 1997.  <sup>f</sup> Wahl, D.H. and L.A. Nielsen, 1985.  Fish graphic courtesy of New York Sportfishing and Aquatic Resources Educational Program, 2001.</p>	

## White bass (*Morone chrysops*)

White bass is a member of the temperate bass family, Percichthyidae. It ranges from the St. Lawrence River south through the Mississippi valley to the Gulf of Mexico, though the species is most abundant in the Lake Erie drainage (Van Oosten, 1942). Although white bass is native to the Ohio River, populations were introduced to several of the river's impoundments following dam construction (Trautman, 1981).

Spawning take place in May in Lake Erie and may extend into June, depending on temperatures. Spawning bouts can last from 5 to 10 days (Scott and Crossman, 1973). Adults typically spawn near the surface, and eggs are fertilized as they sink toward the bottom. Fecundity increases directly with size in females. The average female lays approximately 565,000 eggs. Eggs hatch within 46 hours at a water temperature of 15.6 °C (60 °F) (Scott and Crossman, 1973).

Larvae grow rapidly, and young white bass reach lengths of 13 to 16 cm (5.1 to 6.3 in) by the fall (Scott and Crossman, 1973). They feed on microscopic crustaceans, insect larvae, and small fish. As adults, the diet switches to fish. Yellow perch are an especially important prey species for white bass (Scott and Crossman, 1973).

Most white bass mature at age 3 (Van Oosten, 1942). Upon reaching sexual maturation, adults tend to form unisexual schools, traveling up to 11.1 km (6.9 mi) a day. Adults tend to occupy the upper portion of the water column, maintaining depths of 6 m or less (Scott and Crossman, 1973). On average, adults are between 25.4 to 35.6 cm (10 to 14 in) long (Ohio Department of Natural Resources, 2001). White bass rarely live beyond 7 years (Scott and Crossman, 1973).



**WHITE BASS**  
(*Morone chrysops*)

**Family:** Percichthyidae.

**Common names:** White bass, silver bass.

**Similar species:** White perch, striped bass.<sup>a</sup>

**Geographic range:** St. Lawrence River south through the Mississippi valley to the Gulf of Mexico, highly abundant in the Lake Erie drainage.<sup>b</sup>

**Habitat:** Occurs in lakes, ponds, and rivers.<sup>c</sup>

**Lifespan:** White bass may live up to 7 years.<sup>d</sup>

**Fecundity:** The average female lays approximately 565,000 eggs.<sup>b</sup>

**Food Source:** Juveniles consume microscopic crustaceans, insect larvae, and small fish.<sup>b</sup> Adults have been found to consume yellow perch, bluegill, white crappie,<sup>b</sup> and carp.<sup>b,d</sup>

**Prey for:** Other white bass.<sup>a</sup>

### Life Stage Information

**Eggs:** *Demersal*

- ▶ Eggs are approximately 0.8 mm (0.03 in) in diameter.<sup>b</sup>

**Larvae:** *Pelagic*

- ▶ White bass experience their maximum growth in their first year.<sup>b</sup>

**Adults:**

- ▶ Travel in schools, traveling up to 11.1 km (6.9 mi) a day.<sup>b</sup>
- ▶ Most mature at age 3.<sup>c</sup>
- ▶ Adults prefer clear waters with firm bottoms.<sup>a</sup>

<sup>a</sup> Trautman, 1981.

<sup>b</sup> Scott and Crossman, 1973.

<sup>c</sup> Froese and Pauly, 2000.

<sup>d</sup> Carlander, 1997.

<sup>e</sup> Van Oosten, 1942.

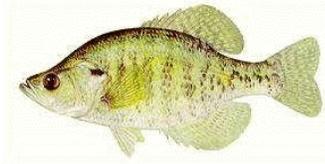
Fish graphic courtesy of New York Sportfishing and Aquatic Resources Educational Program, 2001.

## White crappie (*Pomoxis annularis*)

White crappie is a member of the Centrarchidae family and is found in the central United States from the Great Lakes to the Gulf of Mexico (Scott and Crossman, 1973). It occurs in freshwater pools, creeks, small to large rivers, and lakes and ponds over sand and mud bottoms. It is found most often in moderately turbid waters (Froese and Pauly, 2000). White crappie tend to school near submerged trees, brush, aquatic vegetation, and boulders (Edwards et al., 1982). Young white crappie feed primarily on zooplankton, and adults feed primarily on small fish, especially gizzard shad (Scott and Crossman, 1973).

White crappie reach sexual maturity between 2 and 3 years (Wang, 1986). Spawning begins in the spring when water temperatures are between 16 and 20 °C (60 and 68 °F). Males construct nests by fanning out a depression on the bottom near brush, rocks, and vegetation in water that is usually less than 1.5 m (4.9 ft) deep (Wang, 1986; Ohio Department of Natural Resources, 2001). Nests have been observed at average depths of 10 to 420 cm (0.3 to 13.8 ft) (Edwards et al., 1982). Females lay 5,000 to 30,000 eggs per season, but release only a few eggs at a time and often mate with multiple males (Scott and Crossman, 1973; Ohio Department of Natural Resources, 2001). Males guard their nests until the larvae can swim freely into adjacent plant beds (Wang, 1986).

Crappie are very popular for sport fishing (Hansen 1951; Dames and Moore, 1977). Because white crappie are such a prolific species, they often become overcrowded. This can lead to depletion of their food supply and result in slower growth rates and smaller sizes (Carlander, 1969; Steiner, 2000).



**WHITE CRAPPIE**  
(*Pomoxis annularis*)

**Family:** Centrarchidae (sunfishes).<sup>a</sup>

**Common names:** White crappie, papermouth, specks.<sup>b</sup>

**Similar species:** Black crappie, rockbass.<sup>c</sup>

**Geographic range:** Central United States, including the Mississippi and Great Lakes basins to the Gulf Coast.<sup>c,d</sup>

**Habitat:** Prefers pools, backwaters of creek, rivers, lakes, and ponds over sand and mud bottoms. Often found in turbid water, and near aquatic vegetation.<sup>a</sup>

**Lifespan:** The highest reported age is 10 years.<sup>a</sup>

**Fecundity:** Mature at 2-3 years.<sup>d</sup> Females produce between 5,000 and 30,000 eggs.<sup>b</sup>

**Food Sources:** Larvae feed on algae, insects, and microcrustaceans; young feed primarily on zooplankton; and adults eat several different types of fish, including gizzard shad, perch, and small crappie.<sup>f</sup>

**Prey for:** Northern pike, muskellunge.<sup>a</sup>

### Life Stage Information

#### Eggs: Demersal

- ▶ Laid in nests and guarded by the male. Females often mate with several males in a single spawning season.<sup>d,e</sup>

#### Larvae:

- ▶ 1.22-1.98 mm (0.05 to 0.08 in) at hatching.<sup>d</sup>
- ▶ Remain in nest until they can swim freely.<sup>d</sup>

#### Adults: Demersal

- ▶ Average length: 15.4 to 30.5 cm (6-12 in).<sup>b</sup>
- ▶ Noted as an abundant species in the Ohio River in studies done in 1957-1959 and 1976-1978.<sup>c</sup>

<sup>a</sup> Froese and Pauly, 2000.

<sup>b</sup> Ohio Department of Natural Resources, 2001.

<sup>c</sup> Trautman, 1981.

<sup>d</sup> Wang, 1986.

<sup>e</sup> Dames and Moore, 1977.

<sup>f</sup> Carlander, 1969.

Fish graphic from North Dakota Game and Fish Department, 1986.

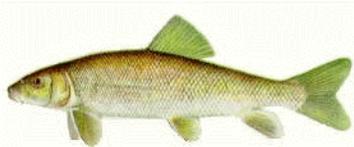
## White sucker (*Catostomus commersoni*)

The white sucker is a member of the Catostomidae family, and is found throughout most of Canada, and south to North Carolina and New Mexico in the United States (Froese and Pauly, 2000). It inhabits small and large streams, ponds, lakes, and reservoirs.

Male white suckers reach sexual maturity between ages 2 and 6, and females mature 1 to 2 years later (Twomey et al., 1984). White suckers typically run upstream in the spring to spawn. They spawn over shallow gravel substrate, usually in riffles or swift water, but they have been observed spawning in lakes (Carlander, 1969). Females may scatter 20,000 to 50,000 eggs with several males (Steiner, 2000). The eggs may drift downstream before sticking to the gravel (Steiner, 2000). After hatching, larvae remain in the safety of the gravel for up to 2 weeks before moving on.

Adults primarily inhabit pools and areas of slow to moderate velocity, but are tolerant of a wide range of conditions. White suckers move toward shore at dawn and dusk to feed. They are omnivorous bottom feeders, feeding on plants, zooplankton, insects, mollusks, and crustaceans (Steiner, 2000).

Since 1925, this species has been one of the six most abundant fishes in collections across Ohio (Trautman, 1981). It is a popular catch among anglers, and is especially easy to catch during spawning runs (Ohio Department of Natural Resources, 2001).



**WHITE SUCKER**  
(*Catostomus commersoni*)

**Family:** Catostomidae (suckers).

**Common names:** White sucker, common sucker, mullet.<sup>a</sup>

**Similar species:** Longnose sucker.<sup>b</sup>

**Geographic range:** Most of Canada, and south through North Carolina to New Mexico in the United States.<sup>a</sup>

**Habitat:** Small and large streams, ponds, lakes, and reservoirs. Adults primarily inhabit pools and areas of slow to moderate velocity, but are tolerant of a wide range of conditions. Prefer swift water and gravel bottoms for spawning.<sup>c,d</sup>

**Lifespan:** The average lifespan is 5-7 years.

**Fecundity:** Males mature between 2 and 6 years, females 1 to 2 years later.<sup>d</sup> Females produce 20,000 to 50,000 eggs.<sup>f</sup>

**Food Sources:** Fry feed on plankton and small invertebrates; bottom feeding commences upon reaching a length of 1.6 to 1.8 cm (0.6 to 0.7 in).<sup>a</sup> Adults are omnivorous, feeding on plants, zooplankton, insects, mollusks, and crustaceans.<sup>f</sup>

**Prey for:** Birds, fishes, lamprey, and mammals.<sup>a</sup>

### Life Stage Information

#### Eggs:

- ▶ Eggs are released over shallow gravel substrate.<sup>d</sup>

#### Larvae:

- ▶ Approximately 8 mm (0.3 in) upon hatching.<sup>e</sup>
- ▶ Remain in gravel substrate for up to 2 weeks.<sup>f</sup>

#### Adults: *Demersal*

- ▶ Maximum size is approximately 64 cm (25 in).<sup>a</sup>
- ▶ One of the six most abundant fishes in collections in Ohio since 1925.<sup>b</sup>

<sup>a</sup> Froese and Pauly, 2000.

<sup>b</sup> Trautman, 1981.

<sup>c</sup> Ohio Department of Natural Resources, 2001.

<sup>d</sup> Twomey et al., 1984.

<sup>e</sup> Stewart, 1926.

<sup>f</sup> Steiner, 2000.

Fish graphic from North Dakota Game and Fish Department, 1986.

## H2-3 I&E DATA EVALUATED

Table H2-2 lists Inland facilities in scope of the Phase II rule and the facility I&E data evaluated by EPA to estimate current I&E rates for the region.

<b>Table H2-2: Inland Facilities In Scope of the Section 316(b) Phase II Rule and Facility I&amp;E Data Evaluated</b>		
<b>In Scope Facilities</b>	<b>I&amp;E Data?</b>	<b>Years of Data</b>
AES Somerset (NY)	No - extrapolated	
Ashtabula (OH)	No - extrapolated	
Avon Lake (OH)	No - extrapolated	
B C Cobb (MI)	No - extrapolated	
Bailly (IN)	No - extrapolated	
Bay Front (WI)	No - extrapolated	
Bay Shore (OH)	No - extrapolated	
Belle River (MI)	No - extrapolated	
C R Huntley (NY)	No - extrapolated	
Conners Creek (MI)	No - extrapolated	
Crawford (IL)	No - extrapolated	
Dan E Karn (MI)	No - extrapolated	
Davis-Besse (OH)	No - extrapolated	
Dean H Mitchell (IN)	No - extrapolated	
Donald C Cook Nuclear (MI)	Yes	1975-1982
Dunkirk (NY)	No - extrapolated	
Eastlake (OH)	No - extrapolated	
Edgewater (OH)	No - extrapolated	
Edgewater (WI)	No - extrapolated	
Fermi Nuclear (MI)	No - extrapolated	
Fisk (IL)	No - extrapolated	
Ginna (NY)	No - extrapolated	
Harbor Beach (MI)	No - extrapolated	
J B Sims (MI)	No - extrapolated	
J C Weadock (MI)	No - extrapolated	
J H Campbell (MI)	No - extrapolated	
J R Whiting (MI)	Yes	1978-1983, 1987, 1991
James A Fitzpatrick (NY)	No - extrapolated	
James De Young (MI)	No - extrapolated	
Kewaunee Nuclear (WI)	No - extrapolated	
Lake Shore (OH)	No - extrapolated	
M L Hibbard (MN)	No - extrapolated	
Manitowoc (WI)	No - extrapolated	
Marysville (MI)	No - extrapolated	
Michigan City (IN)	No - extrapolated	

<b>In Scope Facilities</b>	<b>I&amp;E Data?</b>	<b>Years of Data</b>
Midland Cogeneration Venture (MI)	No - extrapolated	
Mistersky (MI)	No - extrapolated	
Monroe (MI)	Yes	1974, 1975, 1982, 1985
Nine Mile Point Nuclear (NY)	No - extrapolated	
Oswego (NY)	No - extrapolated	
Palisades Nuclear (MI)	No - extrapolated	
Perry Nuclear (OH)	No - extrapolated	
Point Beach Nuclear (WI)	No - extrapolated	
Port Washington (WI)	No - extrapolated	
Presque Isle (MI)	No - extrapolated	
Pulliam (WI)	No - extrapolated	
River Rouge (MI)	No - extrapolated	
Rochester 7 (NY)	No - extrapolated	
Shiras (MI)	No - extrapolated	
South Oak Creek (WI)	No - extrapolated	
St Clair (MI)	No - extrapolated	
Trenton Channel (MI)	No - extrapolated	
Valley (WI)	No - extrapolated	
Waukegan (IL)	No - extrapolated	
Will County (IL)	No - extrapolated	
Wyandotte (MI)	No - extrapolated	

## H2-4 EPA'S ESTIMATE OF CURRENT I&E IN THE INLAND REGION EXPRESSED AS AGE 1 EQUIVALENTS, FOREGONE YIELD, AND PRODUCTION FOREGONE

Table H2-3 provides EPA's estimate of the annual age 1 equivalents, foregone fishery yield, and production foregone resulting from the impingement of aquatic species at facilities located in the Inland region. Table H2-4 displays this information for entrainment.

<b>Species Group</b>	<b>Age 1 Equivalents (#s)</b>	<b>Yield (lbs)</b>	<b>Production Foregone</b>
American shad	96,989	23,736	51,667
Alewife	513,592	0	8,073
Bass ( <i>Micropterus</i> sp.)	64,569	2,611	5,426
Black crappie	10,921	1,821	457
Blueback herring	3,415,663	0	156,342
Bluegill	25,045	484	298
Bullheads	19,322	1,503	704

<b>Table H2-3: Current Annual Impingement in the Inland Region Expressed as Age 1 Equivalents, Foregone Fishery Yield, and Production Foregone</b>			
<b>Species Group</b>	<b>Age 1 Equivalents (#s)</b>	<b>Yield (lbs)</b>	<b>Production Foregone</b>
Carp minnow	141,981	0	36,676
Crappie	86,981	14,501	3,637
Darters	461	0	0
Freshwater catfish	797,219	165,061	70,836
Freshwater drum	1,094,178	260,737	104,058
Gizzard shad	58,399,773	0	2,111,658
Logperch	3,641	0	15
Other (forage)	62,803,622	0	6,778
Other (recreational)	3,741	727	480
Paddlefish	14,721	77,235	37,399
Pikes	50	190	29
Rainbow smelt	49	0	1
Redhorse	7,128	0	383
River carpsucker	7,192	0	747
Sauger	164,452	43,452	58,600
Shiners	51,283,780	0	85,826
Skipjack herring	103,190	0	18,483
Spotted sucker	577	0	142
Striped bass	293,950	407,991	82,512
Striped killifish	2,223	0	14
Suckers	54,729	0	9,641
Sunfish	1,527,419	1,102	2,578
Walleye	1,616	1,414	476
White bass	556,594	169,643	52,090
White perch	1,240,736	546	15,517
Yellow perch	9,467	126	103

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<b>Table H2-4: Current Annual Entrainment in the Inland Region Expressed as Age 1 Equivalents, Foregone Fishery Yield, and Production Foregone</b>			
<b>Species Group</b>	<b>Age 1 Equivalents (#s)</b>	<b>Yield (lbs)</b>	<b>Production Foregone</b>
Bass (Micropterus sp.)	2,519,031	101,867	439,407
Blueback herring	20,498	0	23,455
Bluegill	1,687	33	88
Bullheads	57,419	4,473	10,475
Carp minnow	89,771,852	0	22,697,892
Crappie	1,009,726	168,335	693,908

<b>Species Group</b>	<b>Age 1 Equivalents (#s)</b>	<b>Yield (lbs)</b>	<b>Production Foregone</b>
Darters	2,976,999	0	30,060
Freshwater catfish	595,138	123,221	173,303
Freshwater drum	423,876	101,008	270,007
Gizzard shad	3,959,229	0	737,286
Logperch	55,167	0	4,577
Other (forage)	6,318,596	0	65,193
Paddlefish	12,637	66,302	54,539
Redhorse	21,815	0	38,873
Sauger	3,454,069	912,651	5,112,177
Shiners	8,095,946	0	313,151
Skipjack herring	7,578	0	19,417
Suckers	54,117,525	0	87,608,444
Sunfish	12,309,725	8,884	135,994
Walleye	33,729	29,527	84,589
White bass	247,685	75,491	426,277
Yellow perch	248,681	3,313	143,785

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## H2-5 ASSUMPTIONS USED IN CALCULATING RECREATIONAL AND COMMERCIAL LOSSES

Unlike the other regions, all losses in the Inland region are assumed to be to recreational fisheries. Therefore, it was not necessary to partition losses between commercial and recreational fisheries. It was also not necessary to collect data on commercial value per pound for the Inland region.

Age-1 equivalent fish that are spared from I&E are not necessarily old enough or large enough to be attractive to anglers. It may take one or more years for these fish to reach a harvestable age. For this reason, EPA discounts recreational benefits so that the cost and benefits estimates will be comparable. Table H2-5 presents the multiplicative discounting factors used in discounting benefits assuming a 3 percent real discount rate and a 7 percent real discount rate. For details on how these factors are developed, see Chapter A14.

Species Group	Discount Factors for Entrainment		Discount Factors for Impingement	
	3% Discount Rate	7% Discount Rate	3% Discount Rate	7% Discount Rate
American shad	na	na	0.897	0.780
Bass ( <i>Micropterus</i> sp.)	0.926	0.839	0.953	0.897
Bluegill	0.899	0.783	0.925	0.838
Bullheads	0.904	0.795	0.925	0.839
Crappie	0.901	0.789	0.928	0.845
Freshwater catfish	0.938	0.866	0.966	0.926
Freshwater drum	0.871	0.734	0.897	0.785
Other (recreational)	na	na	0.950	0.889
Paddlefish	0.897	0.782	0.924	0.837
Pikes	na	na	0.696	0.439
Rainbow smelt	na	na	0.931	0.851
Sauger	0.905	0.799	0.932	0.855
Striped bass	na	na	0.879	0.749
Sunfish	0.908	0.803	0.936	0.859
Walleye	0.890	0.770	0.917	0.823
White bass	0.919	0.826	0.947	0.883
White perch	na	na	0.904	0.796
Yellow perch	0.899	0.783	0.925	0.838
Other (forage)	0.919	0.829	0.919	0.829