Conservation Assessment for the Eastern Sand Darter, *Ammocrypta pellucida*

by

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EXECUTIVE SUMMARY

1. The Eastern Sand Darter (*Ammocrypta pellucida*) belongs to the family Percidae. The genus *Ammocrypta* is one of the least studied of the four recognized North American darter genera; the genus is characterized by having a thing, elongate body and a translucent quality to their flesh that is most evident in living individuals.

2. The largest specimen of *Ammocrypta pellucida* is 70 mm standard length.

3. Breeding males may be distinguished from females by the yellow coloration over the entire body, breeding tubercles on pelvic fin rays, dark pigmentation on the pelvic fin membranes, and a longer anal fin. Subtle differences may occur in the genital papillae, with males having a smaller papillae that never comes into contact with the base of the anal fin spine.

4. Although spawning has not been observed in the wild, researchers estimate the spawning season to range from May to mid-August based on the mature ovarian condition of females and the presence of tubercles on males. Water temperatures during the spawning season were between 14.4 and 24.4 C.

5. *Ammocrypta pellucida* were found to spawn in a tank from 7 April to 10 June. Females are thought to spawn multiple times over a season.

6. Males may become sexually mature during their first year. Mature testes were found in males between May and early September.

7. Females become sexually mature at one plus years, the smallest female observed with ova was 36.3 mm SL. Mature ova were apparent between May and August. Females produce between 30-170 mature ova with an average of 71.

8. Two different studies have reported conflicting information on the sex ratio for this species. One study reported a one to one sex ratio throughout the year while another found males outnumbered females (23 males to 4 females) in the habitat sampled.

9. Spawning in the laboratory occurred both day and night at water temperatures of 20.5-23 C. Males would pursue a female around the tank. Once the female was ready to spawn,

she would move to the appropriate substrate. The male then mounted the female and both would vibrate to bury their tails in the substrate. The eggs were deposited singly in the substrate. Sneaker males were observed to move beside the spawning pair and vibrate.

10. Eggs were found in soft sand substrate. The eggs were slightly adhesive, translucent and spherical and were buried singly in the sand based on an aquarium observation. Mean egg diameter was 1.4 mm. No parental care occurs after spawning

11. A maximum life span of 2-plus years was estimated using scale annuli, with none reaching a third year. Similar growth rates were found for both males and females. At the end of the first year individuals attain an average standard length of 34-41 mm and 45-53 mm at the end of the second year.

12. Chironomid larvae comprise a majority of the diet of *A. pellucida*, accounting for an average of 94% of the total number of organisms consumed.

13. Due to the patchy distribution of their habitat, *A. pellucida* are often found congregated in shallow sandy areas of the stream.

14. *Ammocrypta pellucida* exhibits a burying behavior in the sand substrates that it inhabits. Although the ultimate reason for the burying is unknown, researchers have suggested that it is a station holding technique in spring rains and winter runoff and may also help the fish escape high temperature during summer.

15. *Ammocrypta pellucida* are often found in medium to large rivers with moderate current and sand or sand-gravel substrate. Microhabitat variables that described a significant component of the distribution included substrate, depth and water velocity. Presence of sand substrate alone accounted for 46% of the variance with shallow depths (less than 33 cm) and water velocities between 10-20 cm/sec also providing significant indicators.

16. In the United States, populations of *A. pellucida* are known from Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Vermont, and West Virginia. Additional populations are known in Canada from the provinces of Ontario and Quebec.

17. Significant declines have been documented for *A. pellucida* throughout its range. Range declines are thought to be primarily related to habitat loss due to siltation in the streams and rivers the species occupies. Various land use practices have been identified as contributing to habitat loss, but combinations of other factors (e.g., urban sprawl and pollution) almost certainly have played a role in range decline.

18. Populations of *A. pellucida* are considered currently stable throughout the species range.

19. Populations have not been documented from the Shawnee National Forest, Illinois, but are known from one stream (East Fork White River) in the Hoosier National Forest, Indiana, and three streams (Federal Creek, Symmes Creek and Little Muskingum River) in Wayne National Forest, Ohio.

20. Much of the land surrounding *A. pellucida* habitat is owned by private entities.

21. Research should focus on gathering in-stream life history data including information on spawning behavior, egg deposition sites, recruitment, and survivorship. These traits are critical when considering translocation studies or in monitoring and maintaining high quality habitat for *A. pellucida*.

NOMENCLATURE AND TAXONOMY

Ammocrypta pellucida (Eastern Sand Darter) belongs to the class Actinopterygii (ray-finned fishes), order Perciformes, and family Percidae. The genus *Ammocrypta*, or sand darters, includes six species that are generally characterized by their elongate and translucent bodies (Williams 1975). *Ammocrypta* has been presumed most similar to *Crystallaria* (Crystal Darter); the latter genus was historically considered a subgenus of *Ammocrypta* (Williams 1975). Recognition of two "sand" darter genera (*Ammocrypta* and *Crystallaria*), based on several studies (e.g., Simons 1991, Simon et al. 1992, Near et al. 2000) now appears to be stable. Both genera are recognized in the most recent list of common and scientific names of fishes in North America (Nelson et al. 2004). The two genera are recognized as distinct based on a variety of characters including the presence of a frenum, presence of four large dark saddles, a longer anal fin (12-16 rays), a longer soft dorsal fin (12-16 rays), and a higher number of pored lateral line scales in *Crystallaria* when compared to *Ammocrypta* (Page 1983, Pflieger 1997).

DESCRIPTION OF SPECIES

The following description was taken from Williams (1975) and Page (1983). *Ammocrypta pellucida* is described as having 62-84 lateral scales, 1-7 scales above the lateral line and 2-10 scales below lateral line, 7-12 dorsal spines, 8-12 dorsal rays, 12-16 pectoral rays; 1 anal spine, 7-11 anal rays and 42-45 vertebrae. *Ammocrypta pellucida* lacks an opercular spine and a serrated posterior margin on the preopercle. There are typically 10 (9-11) preoperculomandibular pores and a row of horizontally oriented blotches along the side of the body. The lateral line is complete. Cheeks and opercles moderately to well scaled, nape partially scaled, and belly unscaled. Body elongate with depth going into standard length 7-10

(typically 8-9) times . Head moderate, going 4 to 5 times into standard length. Mouth horizontal and small. Largest specimen 70 mm standard length (Page 1983).

Coloration

Sand darters are in general characterized by the translucent nature of their flesh. In fact the specific epithet *pellucida*, derived from the Latin *pellucidus*, means "to shine through". Trautman (1981) provided the following description:

> "Dorsal half of head and body a pellucid-white with a yellowish cast. Ventral half of head and body white or silvery. A series of 12-16 small, olive spots along dorsal ridge; these become rows of paired spots along the base of the dorsal fins, with one row on each side of fin. Series of 9-14 oblong, dusky-olive spots along lateral line; these posteriorly tending to become confluent; in some specimens a suffused band of yellow is present along the lateral line. Webbing of fins transparent; some have a yellowish tinge."

Coloration in young *A. pellucida* is typically more silvery, with little or none of the yellowish coloration found in adults (Trautman 1981). Breeding males tend to exhibit yellow coloration over the entire body and may develop breeding tubercles on pelvic fins rays (Williams 1975, Trautman 1981, Page 1983).

Geographic Variation

Although some meristic variation can be seen in *A. pellucida*, the variation does not follow discernible geographic boundaries (Williams 1975). Interestingly, there is considerable individual variation in squamation on the cheek and opercle from completely scaled to almost

naked. No subspecies have been recognized by any modern researchers. Williams (1975) examined museum material from across the entire range of the species concluding that *A. pellucida* consisted of a single, albeit variable, species.

LIFE HISTORY

Reproduction

Sexual dimorphism

Breeding males tend to exhibit yellow coloration over the entire body and may develop breeding tubercles on pelvic fin rays (Trautman 1981, Page 1983). When breeding tubercles are present they are typically restricted to fin rays 1 to 3 and are located on the basal half to two-thirds of the segmented portion of the ray. Tubercles are associated with the articulation between two segments (Williams 1975). Males exhibit dark pigmentation on the pelvic fin membranes (Williams 1975, Johnston 1989). Sexual dimorphism is also found in the anal fin, with males having a longer fin than females (Spreitzer 1979). Subtle differences may occur in the genital papillae, with males having a smaller papillae that never comes into contact with the base of the anal fin spine. In females the enlarged papillae becomes more elongate and may touch the base of the anal fin spine (Spreitzer 1979).

Reproductive cycles

Ovarian development first begins in December in Ohio females that are one plus years old (Spreitzer 1979). Mature ova are apparent beginning in May and ending in August (Spreitzer 1979). The smallest Ohio female with ova was 36.3 mm SL. Young females (greater than 30 mm SL) did not possess mature ova until June (Spreitzer 1979). Although egg diameter was not significantly correlated to female size, there was a significant relationship between female size

and fecundity (Spreitzer 1979). Number of mature ova ranged from 30-170 with an average of 71. Males in Ohio populations exhibited mature testes between May and early September. Males are able to spawn their first year (Spreitzer 1979).

The spawning season in Ohio ranged from May to mid-August (based on peak ovarian condition) when water temperatures were between 14.4 and 24.4 C (Spreitzer 1979). In Vermont, Facey (1998) estimated spawning began in mid June based on presence of gravid females in the Winooski River. Spawning has not been observed in the field, however fish were found to spawn in aquarium studies from 7 April to 10 June (Johnston 1989). Females are thought to spawn multiple times over a season (Johnson 1989).

Sex ratio

Spreitzer (1979) found a one to one sex ratio for *A. pellucida* in Ohio throughout the year. Johnston (1989) found that males outnumbered females (23 males to 4 females) in the habitat she sampled and suggested males were congregated in the area or that males outnumber females in the population.

Spawning behavior

Spawning behavior has not been observed in the wild for this species and only one published report has been made based on captive spawning. Johnston (1989) found spawning in the laboratory occurred both day and night at water temperatures of 20.5-23 C. Males would pursue a female around the tank. Once the female was ready to spawn, she would move to the appropriate substrate. The male then mounted the female and both would vibrate to bury their tails in the substrate. The eggs were deposited singly in the substrate (Johnston 1989). Johnston

(1989) suggested the position of the breeding tubercles on the pelvic rays helped the male clasp and stimulate the female. Sneaker males were observed to move beside the spawning pair and vibrate (Johnston 1989).

Nest sites, nesting behavior

No discernible nests are built by *A. pellucida*. Egg deposition sites in aquaria occurred in soft sand substrate (Johnston 1989). Eggs were slightly adhesive, translucent and spherical and were buried singly in the sand (Johnston 1989). Mean egg diameter of water-hardened eggs was 1.4 mm. No parental care occured after spawning (Simon 1992).

Larval behavior

Ammocrypta pellucida young hatched at 5.5 mm total length (Simon et al. 1992). The yolk sac has heavy pigmentation and yolk sac absorption was almost complete at 7.4 mm (Simon et al. 1992).

General Life History

Growth and Longevity

Using scale annuli, Spreitzer (1979) estimated a maximum life span of 2-plus years, with none attaining a third year. Both males and females have similar growth rates, attaining an average standard length of 34-41 mm at the end of the first year and 45-53 mm at the end of the second year (Spreitzer 1979). Facey (1998) also concluded *A. pellucida* lived 2-plus years based on length frequency histograms from rivers in Pennsylvania.

Feeding and Food

Spreitzer (1979) found chironomid larvae to comprise a majority of the diet of *A. pellucida*, accounting for an average of 94% of the total number of organisms consumed. Similar observations were also made by Forbes (1880) and Forbes and Richardon (1920) in Illinois and Turner (1921) in Ohio. Other taxa consumed by *A. pellcudia* included oligochaete annelids, cladocerans, dipteran larvae, ephemeropteran nymphs, trichopteran larvae, plecopteran nymphs, copepods, ostracods, terrestrial mites and terrestrial insects (Spreitzer 1979). Most of these items were taken in very small numbers and only oligochaetes (6.67% of the contents in June) and cladocerans (19% of the contents in November) accounted for more than 4% of the gut contents (Spreitzer 1979).

Seasonal variation in feeding occurred with continuous feeding from February through August, a decline from September to November and no food found in the guts during December (Spreitzer 1979). Peak feeding intensity occurred in July and August. Food consumption occurs primarily during the day and Spreitzer (1979) suggested this indicates *A. pellucida* is a sight-feeder. Spreitzer (1979) concluded *A. pellucida* consumes their prey whole since items in the foregut were intact. He also used slow motion video in the laboratory to examine feeding behavior. Spreitzer (1979) found *A. pellucida* to expand the orobranchial chamber and create a negative pressure that drew the prey into the mouth. They typically struck their prey from five to ten millimeters away.

Ecology

Species associations

Ammocrypta pellucida are typically found in aggregations due to the patchy nature of their habitat (sand substrate) (Daniels 1993). Daniels (1993) found a correlation between abundance of *A. pellucida* and *Pimephales notatus* (Bluntnose Minnow*), Semotilus corporalis* (Fallfish), and *Etheostoma olmstedi* (Tessellated Darter) at a site. However only abundance of *E. olmstedi* was significantly positively correlated with abundance of *Ammocrypta pellucida* within a seine haul. Throughout its range the Eastern Sand Darter has been found in association with over 25 species that occupy, at least seasonally, similar sandy habitats.

Behavior

Burying behavior, although not unique to *Ammocrypta*, is a well-documented behavior in this genus. Several hypotheses have been put forward to explain the burying behavior of *A. pellucida* including response to a predator (Jordan and Copeland 1877), increased foraging efficiency (Trautman 1981), and to conserve energy during high velocity (Williams 1975). Daniels (1989) was the first to experimentally test these three hypotheses and found that *A. pellucida* was most likely to bury in the sand when turbulence was increased in the experimental chambers. He suggested *A. pellucida* uses the burying technique primarily to maintain station during high spring runoff and summer rains. Daniels (1989) also suggested the burying behavior may be elicited during low water periods of late summer and early fall. Temperatures 2 cm below the sand was 10 C below that of the sand surface, providing the darter with a potential refuge from the increased temperatures (Daniels 1989). Simon (1991) conducted similar tests to those of Daniels (1989) and concluded the burying behavior to be a resting response since the average burial time was 8.6 hours. Neither author found a burying response to a predator or the introduction of prey. Increased velocity alone did not appear to elicit a response; instead increased turbulence was the important factor.

Welsh and Perry (1998) conducted field studies on the microhabitat use of *A. pellucida*. They found that when a diver in the stream approached a sand darter, the darters would bury into the substrate. The variation between this study and previous studies discussed above may be due to laboratory vs. *in-situ* observations.

Dispersal/Migration

No data have been collected on site fidelity in *A. pellucida*.

Obligate Associations

No obligate associations are known for *A. pellucida*.

HABITAT

Ammocrypta pellucida are typically found in moderate current of medium to large rivers with a sand or sand-gravel substrate (Williams 1975). Microhabitat variables including substrate, depth and water velocity were found to account for a substantial degree of variation in abundance (Daniels 1993). Presence of sand substrate alone accounted for 46% of the variance with shallow depths (less than 33 cm) and water velocities between 10-20 cm/sec also providing significant indicators (Daniels 1993). Daniels (1993) argued however that sand was the primary indicator and suggested water depth and velocity may have been an artifact of the location of the sand beds during their sampling period. Other studies have found sand darters in fairly deep water (Scott and Crossman 1979) and in higher velocity systems, indicating a tolerance for a variety of habitat conditions as long as the sand beds are present. In field collections, Daniels (1993) and Facey (1998) found *A. pellucida* were typically found on the depositional bank of the channel, directly downstream of a bend.

DISTRIBUTION AND ABUNDANCE

Range-wide Distribution (Figure 1)

Illinois- State threatened. Historically known only from the Embarras, Little Wabash, Wabash, and Vermilion rivers (Smith 1979). Surveys conducted since 1980 have documented a substantial decline in the number of extant populations in Illinois. No specimens have been collected in the Wabash and Little Wabash rivers since 1940 and 1950, respectively (INHS Fish Collection Database, UMMZ Fish Collection Database) and only two localities along the Vermilion River have been documented since 1979, compared to more than 6 prior to 1979 (Smith 1979, INHS Fish Collection Database). The presence of *A. pellucida* along the Embarras River has remained more consistent over time (INHS Fish Collection Database).

Indiana- State species of special concern. Historically collected in the Black, Driftwood, Eel, Flat Rock, Ohio, Maumee, Salamonie, St. Joseph, St. Mary's, Tippecanoe, Wabash, East Fork White, and White rivers and 14 Mile, Big, Big Pine, Big Walnut, Black, Coal, Fall, Lewis, Raccoon, and Wildcat creeks (Simon 1993, Grandmaison et al. 2004). Additional populations have been documented in the Big Blue, Muscatatuck, Vermillion, Whitewater and Wabash rivers and Clifty, Deer, Graham, Mill, Plummer, Richland, Salt, Sand and Sugar creeks (Grandmaison et al. 2004). Although multiple streams are known to contain populations of this species in the state, there has been a reduction in the number of sites along many of the larger systems (Simon 1993). In addition, no extant populations are documented from Black, Big Pine, and Fall creeks. Several other water

bodies including the Black, Salamonie and Ohio rivers have not been sampled in recent years and current status of these populations is unknown (Gransmaison et al. 2004).

Kentucky- Currently no state status. Historically reported in the Cumberland, Green, Red, Rolling Fork, Kentucky, Licking, Little Sandy, Little Barren, and Rough rivers; Big Muddy, Straight, and Triplett creeks (Burr and Warren 1986, Dolloff et al. 2001, Cicerello 2003, Eisenhour, pers. comm). Specimens have not been taken in the Green River system since 1965 despite extensive sampling by multiple researchers (Cicerello 2003). Recent collections from many of the historic sites indicates a degree of stability in Kentucky populations (Cicerello 2003).

Michigan- State threatened. Historically reported from the Little Raisin, Huron, Pine, Black, Belle, and St. Joseph rivers, Davis Creek, Big Gallagher and Strawberry lakes, and Lake St. Clair (Grandmaison et al. 2004). *Ammocrypta pellucida* are thought to be extirpated form the River Raisin drainage based on surveys conducted in 1978 (Smith et al. 1981, Dodge 1998) and have not been recently observed in the St. Joseph River (Shultz et al. 1982). An assessment of the Huron River (Hay-Chmielewski et al. 1995) indicated an increase in the range of sand darters between 1928 and 1977. Populations within the Huron River appear to be stable (Grandmaison et al 2004). Recent sampling in Davis Creek produced specimens from the historic site but no specimens from the headwaters of Davis Creek (Grandmaison et al. 2004). Thomas and Haas (1997) reported 18 individuals from trawl tows on Lake St. Clair in 1996. Recent collections have also been made from the Pine and Black rivers (Grandmaison et al. 2004). A recent atlas of

Michigan fishes shows the range of *A. pellucida* as described here, and as based on over 174,000 geo-referenced collections from the state (Bailey et al. 2004).

New York- State threatened. Historic populations have been sampled from the Little Salmon, Mettawee, St. Regis/Deer, Grasse, and Poultney rivers, Cattaraugus and Cazenovia creeks, and Lake Erie (Kraft et al. 2003, Grandmaison et al. 2004). Recent surveys of the Cattaraugus and Cazenovia creeks indicate extirpation of *A. pellucida* from these streams. Overall, *A. pellucida* appear to be increasing their range in New York possibly due to water quality and habitat improvement in streams and/or increased temperatures (Grandmaison et al. 2004).

Ohio- State species of special concern. No known extirpations have occurred in Ohio streams and rivers although a range decline within some systems was reported by Trautman (1981). Populations of *A. pellucida* in Ohio are thought to be currently stable (Grandmaison et al. 2004). Water bodies known to contain populations of *A. pellucida* include: Black River, Lake Erie, Big Darby Creek, Salt Creek, Muskingum River, Grand River; Federal Creek (Barnes 1979); Great and Little Miami rivers (Harrington 1999); Ohio, Little Muskingum, Hocking, Kokosing, Licking, Mahoning, Walhonding, and Scioto rivers, and Doughty, Killbuck, Wakatomika, Bear, and Symmes creeks (Grandmaison et al. 2004).

Pennsylvania- State endangered. Historically reported from the Monongahela and Youghiogheny rivers (Evermann and Bollman 1886) but is known recently only from

French and Muddy creeks and Lake Erie (Cooper 1983, Grandmaison et al. 2004). Populations in the Monongahela and Youghiogheny are thought to be extirpated (Grandmaison et al. 2004). Few data are available on changes in abundance but a range decline of approximately 50% was reported in Grandmaison et al. (2004).

Vermont- State threatened. Known historically only from the Lamoille River, however no data are available on historical abundance for the Lamoille population (Facey 1998). More recent collections have documented *A. pellucida* in the Lamoille, Missisquoi, Poultney, and Winooski rivers (Facey 1998). Facey (1998) considered populations to be stable and well established and notes they were collected in practically all suitable habitats sampled. Overall, *A. pellucida* appear to be increasing their range in Vermont possibly due to water quality and habitat improvement in streams and/or increased temperatures (Grandmaison et al. 2004).

West Virginia- No state status. Little Kanawha, Lower Kanawha, Monongahela, Mud, and Ohio rivers, Middle Island and Twelvepole creeks. Exhibits a patchy distribution in West Virginia but is locally abundant in Middle Island Creek and Little Kanawha River (Stauffer et al. 1995).

State and National Forest Distribution

Within the range of the Shawnee, Hoosier and Wayne National Forests, the species has been found only in the Hoosier and Wayne National Forests. The distribution of *A. pellucida* in Illinois is well north of the proclamation boundary of the Shawnee National Forest and Illinois

historical records for fish distribution give no indication that the present absence of *A. pellucida* in the Shawnee National Forest is due to a range reduction.

In the Wayne National Forest, Barnes (1979) documented *A. pellucida* in Federal Creek just upstream of the confluence with Hocking River in Athens County. *Ammocrypta pellucida* were found in a pool with low to no flow areas over sand substrate. Ewing (pers. comm.) found additional populations in the Little Muskingum River and Symmes Creek within the National Forest boundary.

In the Hoosier National Forest, *A. pellucida* is known only from the White River system (Seegert 1987). Seegert (1987) intensively sampled the mainstem of the White and the East Fork White River for *Ammocrypta*. Although his sampling occurred southwest of the Hoosier boundary, he found *A. pellucida* at 8 different localities (Figure 2). Recent sampling within the Hoosier National Forest has not yielded new localities for *A. pellucida*.

RANGE WIDE STATUS

Ammocrypta pellucida is listed as a species of special concern, threatened, or endangered at the state level throughout most of its range. Numerous publications document the dramatic decline in *A. pellucida* abundance since the turn of the century. Throughout its total known range populations tend to be currently stable (see specific state information above).

POPULATION BIOLOGY AND VIABILITY

Most data available for *A. pellucida* pertains to the presence/absence of the species at a particular site. No studies have attempted to determine population level dynamics over time. There is also a high degree of variability in sampling gear employed by researchers making

comparison among sites/states difficult. In many cases, reports of distribution are not from targeted sampling for *A. pellucida* but rather general fish community surveys.

POTENTIAL THREATS

Present or Threatened Risks to Habitat

Siltation

One of the primary documented threats to the habitat of *A. pellucida* is siltation. The close habitat association with sandy areas of streams and rivers makes this species extremely vulnerable to habitat loss. Trautman (1981) described the continual decline in suitable habitat for *A. pellucida* from 1925-1980 in Ohio. The decline in numbers was directly related to the size and abundance of sandy habitats in streams. The close habitat association between *A. pellucida* and presence of sand was also noted statistically by Daniels (1993).

Throughout the range of *A. pellucida,* numerous factors have accounted for an increase in siltation over the past century. Sedimentation along stream and river banks is considered one of the greatest threats to this species. Agricultural practices that result in removal of riparian buffers along stream corridors results in significant input of sedimentation into the streams. Also soil erosion from vast expanses of cropland can compound the effect. Several state web sites document land use patterns along streams occupied by *A. pellucida*. Many of the drainage basins for these streams are dominated by cropland, which may represent up to 50-80% of the land use (see http://www.dnr.state.il.us/orep/c2000/assessments for Illinois). Other practices such as channelization and impoundments may increase siltation in the stream bed.

Agricultural and industrial pollution

Nothing is known concerning the susceptibility of *A. pellucida* to agricultural and industrial pollution.

Over-utilization

The Eastern Sand Darter has no commercial value, but live specimens may be collected for the aquarium trade (Walsh et al. 2003). While somewhat difficult to fully gauge the impact of scientific collecting or live collecting for the aquarium trade on population densities of *A. pellucida*, we doubt that any populations have been extirpated from over-collecting. Commercial bait dealers could potentially alter suitable habitats or impact densities unintentionally.

Disease or Predation

Some natural predation almost certainly occurs on the eggs and larvae of *A. pellucida* and there is no known reason why adults would not be eaten by piscivorous fishes. The impact of predation on this species is simply not known with certainty. Exotic species introduced into Lake Erie could pose a threat to *A. pellucida*, but this is speculative. Spreitzer (1979) found digenetic trematodes (*Uvulifer ambloplites*) encysted on the body of an individual *A. pellucida* which might be an intermediate host for the Ramshorn Snail (*Helisoma* sp.); the life cycle of this species is completed once the darter is consumed by the Belted Kingfisher (*Megaceryle alcyon*). Spreitzer (1979) further documented that 80% of the *A. pellucida* he examined were infected by a proteocephalan cestode (*Proteocephalus ambloplites*) which encysts the coelom and internal organs. Eleven of 119 specimens had a nematode in their intestine, apparently passed to the darter through a copepod that is eaten by the species. As with most fishes in the eastern United States, *A. pellucida* is occasionally infected with the parasitic copepod *Lernaea cyprinacea*

(Anchor Worm). Despite the parasite loads in some individuals (and populations) there is no evidence that stream populations are declining from such burdens.

Inadequacy of Existing Regulatory Mechanisms

Much of the habitat occupied by *A. pellucida* lies outside the governance of state or federal agencies. One of the primary barriers associated with determining regulatory mechanisms that would benefit *A. pellucida* lies in the lack of available data on the susceptibility of the species to alterations in stream habitat and water quality. The only documented threat is an increase in siltation. However, there are documented cases where suitable habitat appears to be available within the range of the species but where populations were not recorded. In the Wayne National Forest, Barnes (1979) found suitable habitat in all streams sampled and suggested lack of *A. pellucida* at many sites was a result of acid mine drainage.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT/MANAGEMENT ACTIVITIES

Illinois- Only a few state and no federal lands are found along the Embarras, Little Wabash, and Vermilion rivers in Illinois (Smith 1979). All three streams are located primarily in privately owned cropland habitats. Data collected by the state of Illinois (http://dnr.state.il.us/orep/ctap/sumrepo.chahp3/chap3t.htm) indicates dramatic reduction in forest cover along the Embarras and Little Vermilion (a reduction of 40-80%) over the past 50 years.

Indiana- Both state and federal properties are located on lands adjacent to *A. pellucida* habitat. Tippecanoe River State Park is on the Tippecanoe River; Shades State Park, Atterbury Fish and Wildlife Area, and Turkey Run State Park are located along Sugar

Creek; Williams Dam fishing area, Hindonstan Falls fishing area, Martin State Forest and the Hoosier National Forest are all located along the East Fork White River; and Muscatatuck National Wildlife Refuge is located along the Vernon Fork Muscatatuck River (Grandmaison et al. 2004). No current management activities are underway in Indiana for *A. pellucida* (Grandmaison et al. 2004)

Kentucky- Many populations are located in streams along privately owned lands; however, the Daniel Boone National Forest is located along the middle and south fork of the Red River. The Nature Conservancy owns land along the Green River as well as Mammoth Cave National Park. Management activities re underway in Kentucky along the Licking River below Cave Run Dam to protect riparian habitat.

Michigan- The Huron River populations are protected to some degree by the presence of the Island Lake Recreation Area, which is part of the Michigan Natural Rivers Program (Grandmaison 2004). The Michigan Natural Rivers Program provides habitat protection for this portion of the river (Grandmaison et al. 2004).

New York- Populations of *A. pellucida* in New York are primarily bordered by private land (Grandmaison 2004). No current management activities are occurring for *A. pellucida*.

Ohio- Three streams within the boundary of the Wayne National Forest have documented populations of *A. pellucida*. Federal Creek was first documented by Barnes (1983) and recent sampling has revealed populations in Symmes Creek and Little Muskingum River.

No current conservation activities are occurring relevant to *A. pellucida* (Grandmaison et al. 2004)

Pennsylvania- Populations of *A. pellucida* in Pennsylvania are primarily bordered by private land (Grandmaison et al. 2004). No management activities are occurring for *A. pellucida*; however, streambank stabilization along French Creek watershed may reduce siltation (Grandmaison et al. 2004).

Vermont- A portion of stream adjacent to the *A. pellucida* population in the Lamoille River is controlled by a state wildlife management area. The Nature Conservancy owns land along the Poultney River.

West Virginia- Populations of *A. pellucida* in West Virginia are primarily bordered by private land (Grandmaison et al. 2004).

RESEARCH AND MONITORING

Existing Surveys, Monitoring, and Research

Surveys are being conducted in both the Hoosier and Wayne National Forests to document additional populations of *A. pellucida* and assess the current status of the species. We are not aware of additional surveys/monitoring specifically targeting *A. pellucida* throughout its range, except that the recent State/Tribal Wildlife program will help provide funds for monitoring populations in some states (e.g., Kentucky).

Research Priorities

There is a need for additional documentation of the distribution and population status of *A. pellucida* throughout its range. Aquatic biologists are uncertain about the responses of the species to human alteration of stream habitat. More research aimed at experimental studies of siltation and turbidity on the species in artificial stream treatments might be useful.

Habitat protection and restoration will allow for more long-term success of conservation of freshwater organisms including the Eastern Sand Darter. Keeping potential spawning areas (i.e., sand and gravel raceways) clean from sediment is likely to allow for population persistence if conducted along with pollution control and abatement within the species range. In Illinois, for example, there are tax incentives for those engaged in agricultural activities to control sedimentation by maintaining historical buffer zones along stream edges. However, the cost of restoring already degraded streams is high and so management and research priorities should be directed to high quality habitats that are already supporting reasonable densities of *A. pellucida*.

Translocation should certainly be considered before a species becomes critically imperiled. There is general agreement (Minckley 1995) that translocations occur within the historic range of a species because ecological interactions within its natural distribution are likely to have fewer negative consequences than would introductions to a new environment. Potential transplant sites should be afforded some degree of protection from habitat degradation, contain sufficient natural resources (e.g., food, space) to support self-sustaining populations, and be large enough to sustain the range of natural variability needed to maintain local and regional diversity (Moyle and Sato 1991).

Other considerations in translocation studies include the genetic composition of the introduced stock, especially so that genetic variation is maintained within and between populations, and the potential for introduction of diseases or parasites. Post-introduction

monitoring should be implemented to determine survivorship, recruitment, and population persistence. There are case studies of darter translocations, two of which have been considered imperiled by the federal government: Snail Darter [*Percina tanasi*] (Hickman and Fitz 1978) and the Duskytail Darter [*Etheostoma percnurum*] (Conservation Fisheries, Inc.). In a recent study of a non-endangered darter species (Fringed Darter, *Etheostoma crossopterum*) that was successfully translocated in southern Illinois, Poly (2003) stressed that the number of individuals released should be substantial, consist of multiple age classes, and that individuals be released into suitable habitat. Other factors to consider included sex ratio of inoculum, fecundity, and potential interactions with species in the new locale (Poly 2003). Poly's study showed that translocated Fringed Darters maintained normal breeding activity, that adults and juveniles were present in subsequent years following introduction, and that nest productivity had increased. Another important factor that Poly was able to demonstrate was that introduction of individuals prior to their natural breeding season was most effective in increasing the chances of finding a mate in the new habitat prior to dispersal. Similar steps could be taken to evaluate the potential for Eastern Sand Darter translocation if deemed necessary by Hoosier Forest personnel.

It cannot be stressed enough that baseline life history data are always necessary and useful in management strategies and in helping resource personnel understand critical stages in the lives of imperiled species. Basic observational and field research on spawning behavior, egg deposition sites, recruitment, survivorship, and other life history traits are clearly lacking for natural in-stream populations of *A. pellucida*. Streams maintaining large numbers of the species should be studied in detail, their habitat evaluated and quantified, and their sand darter populations studied in depth.

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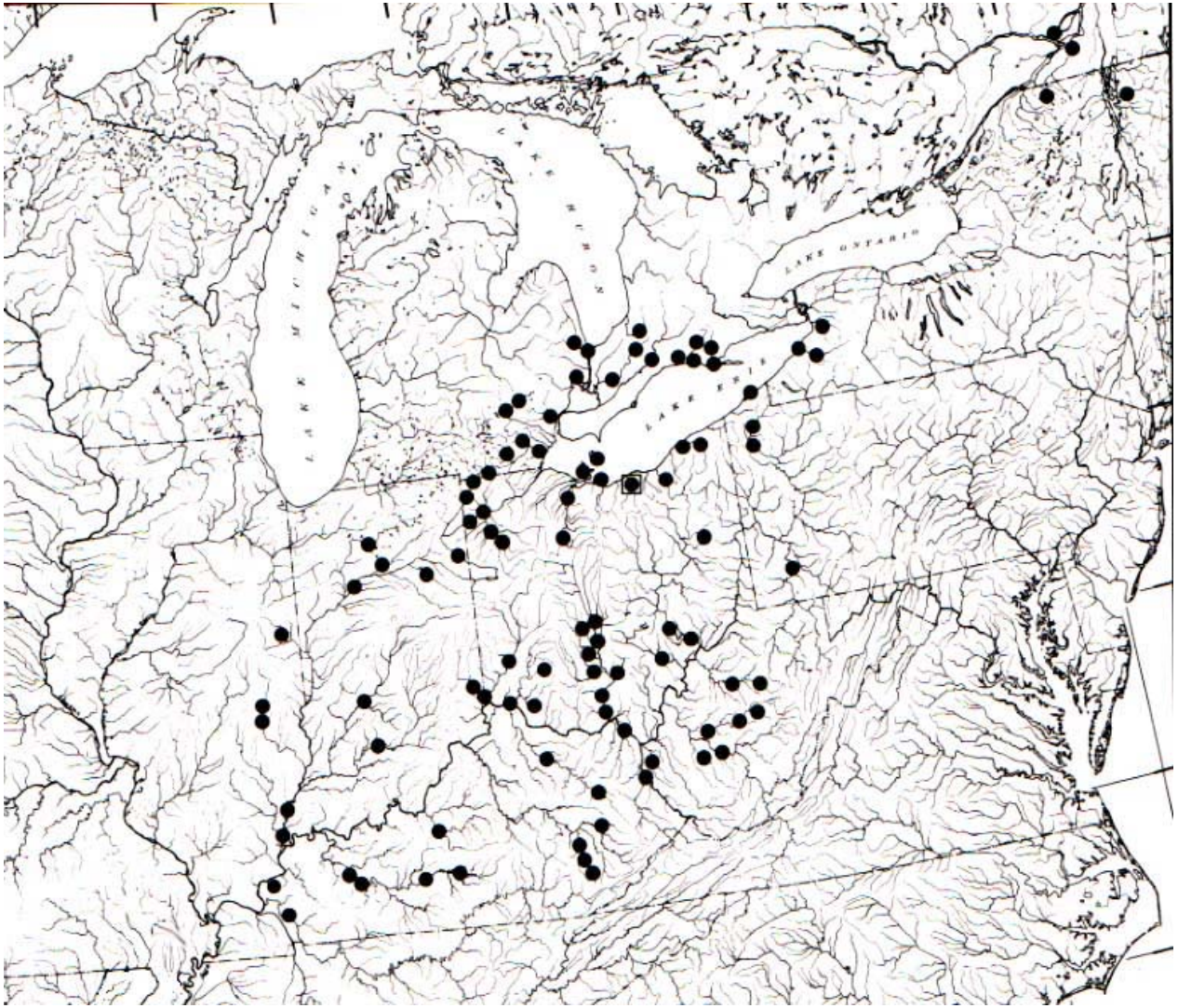

Figure 1. Distribution of *Ammocrypta pellucida* in North America. Modified from Williams (1975).

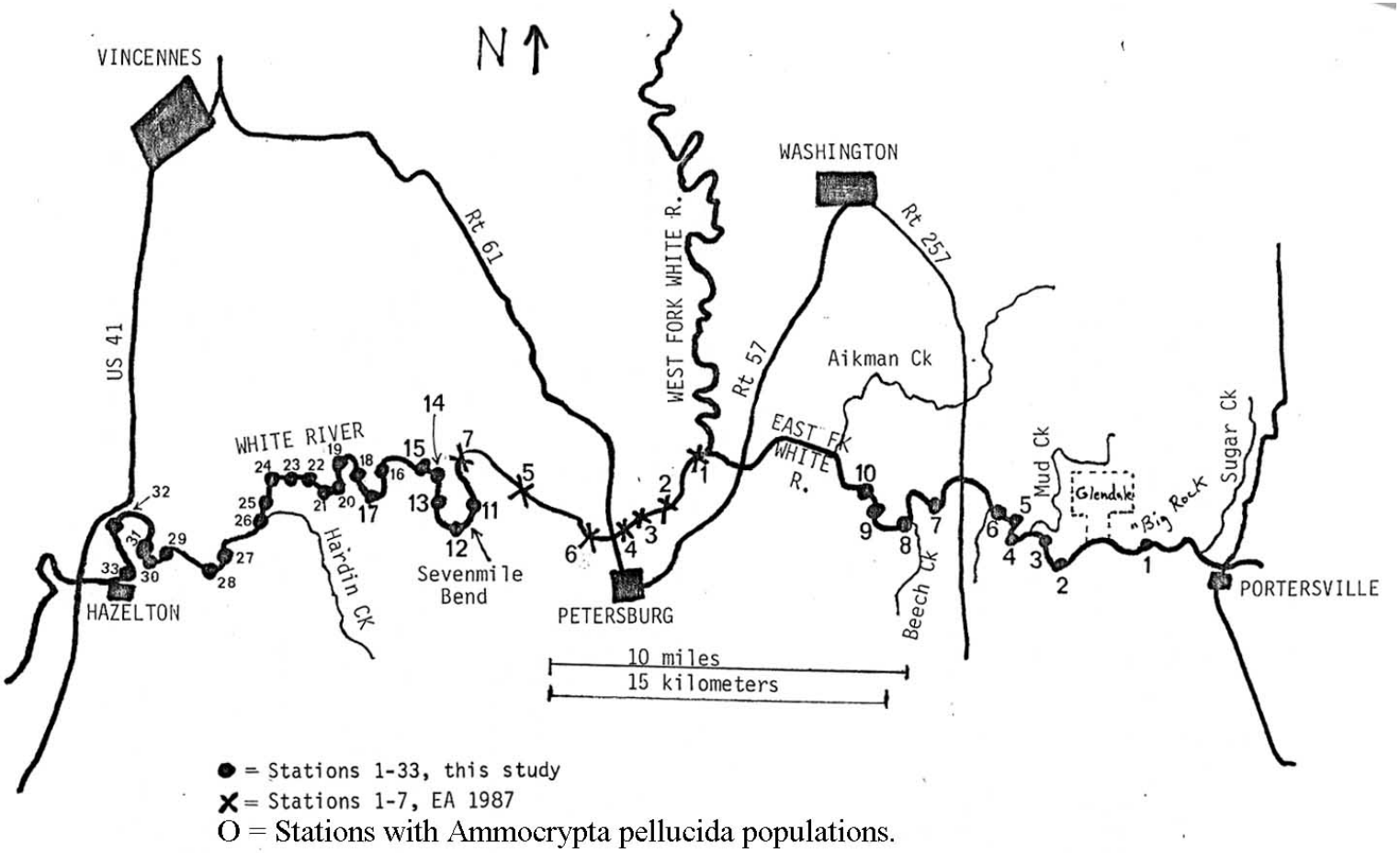

Figure 2. Sampling localities from a 1987 study of Ammocrypta in the White and East Fork White rivers. Ammocrypta pellucida populations were found at stations 2-8 in the East Fork White River and at stations 1, 5, 6, 7, and 10 on the mainstem of the White River. Modified from Seegert (1987).