

**A Species Action Plan for the  
Crystal Darter  
*Crystallaria asprella***

**Final Draft  
November 1, 2013**



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**EXECUTIVE SUMMARY**

The Florida Fish and Wildlife Conservation Commission (FWC) developed this plan in response to directive for staff to evaluate all species on the Florida Endangered and Threatened Species List. The biological review group for the crystal darter (*Crystallaria asprella*) assessed the status of the species using criteria specified in [Rule 68A-27.001, Florida Administrative Code \(F.A.C.\)](#). The [Biological Status Review](#) determined that the crystal darter met 2 listing criteria, and FWC staff recommended listing the crystal darter as Threatened on the Florida Endangered and Threatened Species List.

The goal of this plan is to improve the conservation status of the crystal darter to the point that the species is secure within its historical range. This plan outlines conservation objectives that will allow the FWC to maintain or increase the crystal darter population and area of occupancy. Actions outlined in this plan include the collection of valid population demographic information for crystal darters, so that the status of the species can be reviewed based on sound scientific results. Compiling existing knowledge on crystal darter distribution, habitat use, and threats will ensure minimization of impacts to crystal darter populations until proposed actions are completed and the species' status is re-evaluated.

This plan focuses on habitat conservation, population management, and research actions because current information on the population status of the crystal darter in Florida does not exist. Since a population status assessment has never been conducted for the crystal darter, current population size must be obtained to accurately determine its conservation status. This plan establishes strategies and actions that act as a framework to determine these measurable objectives.

This plan details the actions necessary to improve the conservation status of the crystal darter. A summary of this plan will be included in the Imperiled Species Management Plan (ISMP), in satisfaction of the management plan requirements in Chapter 68A-27, F.A.C., Rules Relating to Endangered or Threatened Species. The ISMP will address comprehensive management needs for 60 of Florida's imperiled species and will include an implementation plan; rule recommendations; permitting standards and exempt activities; anticipated economic, ecological, and social impacts; projected costs of implementation and identification of funding sources; and a revision schedule. The imperiled species management planning process relies heavily on stakeholder input and partner support. This level of involvement and support is also critical to the successful implementation of the ISMP. Any significant changes to this plan will be made with the continued involvement of stakeholders.

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**GLOSSARY OF TERMS AND ACRONYMS**

**Area of Occupancy:** The area within its extent of occurrence (see Extent of Occurrence), which is occupied by a taxon, excluding cases of vagrancy. This reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats (as defined by the International Union for Conservation of Nature [IUCN]).

**BMPs:** Best Management Practices. Generally, BMPs represent methods, measures or practices that are developed, selected, or approved by various agencies to protect, enhance, and preserve natural resources including wildlife habitat. They include, but are not limited to, engineering, conservation, and management practices for mining, agriculture, silviculture, and other land uses, that are designed to conserve water quality and quantity, soil, and associated nutrients, and to simultaneously control nonpoint and point-source pollution and other impacts to natural resources including aquatic and terrestrial wildlife habitat.

**BRG:** Biological review group, a group of taxa experts convened to assess the biological status of taxa using criteria specified in Rule 68A-27, Florida Administrative Code, and following the protocols in the Guidelines for Application of the IUCN Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1).

**BSR:** Biological status review report, the summary of the biological review group's findings. Includes a Florida Fish and Wildlife Conservation Commission (FWC) staff recommendation on whether or not the species status meets the listing criteria in Rule 68A-27.001, Florida Administrative Code. These criteria, based on IUCN criteria and IUCN guidelines, are used to help decide if a species should be added or removed from the Florida Endangered and Threatened Species List. In addition, FWC staff may provide within the report a biologically justified opinion that differs from the criteria-based finding.

**DEP:** Florida Department of Environmental Protection

**DOACS:** Florida Department of Agriculture and Consumer Sciences

**Extent of Occurrence:** The geographic area encompassing all observations of individuals of a species, including intervening areas of unoccupied habitat. Synonymous with range. See also Area of Occupancy (as defined by IUCN).

**F.A.C.:** Florida Administrative Code. The Department of State's Administrative Code, Register and Laws Section is the filing point for rules promulgated by state regulatory agencies. Agency rulemaking is governed by Chapter 120, Florida Statutes, the Administrative Procedures Act. Rules are published in the Florida Administrative Code.

**FNAI:** Florida Natural Areas Inventory

**FWC:** The Florida Fish and Wildlife Conservation Commission, the state agency constitutionally mandated to protect and manage Florida's native wildlife species.

**FWCG:** The Florida Wildlife Conservation Guide

**GPS:** Global Positioning System

**HCP:** Habitat Conservation Plan

**ISMP:** Imperiled Species Management Plan

**Incidental Take:** As defined in Rule 68A-27.001(5), F.A.C. Any taking otherwise prohibited, if such taking is incidental to, and not the purpose of the carrying out of an otherwise lawful activity.

**IUCN:** International Union for Conservation of Nature, a professional global conservation network.

**IUCN Red List (IUCN Red List of Threatened Species):** An objective, global approach for evaluating the conservation status of plant and animal species, the goals of which are to: Identify and document those species most in need of conservation attention if global extinction rates are to be reduced; and provide a global index of the state of change of biodiversity.

**Integrated Water Resource Monitoring Network.** The Integrated Water Resource Monitoring Network Program is a multi-level or "tiered" monitoring program designed to answer questions about Florida's water quality at differing scales. The program is supported by several DEP water quality monitoring groups in Tallahassee and in regional (district) offices. In general, Tier I addresses statewide and regional (within Florida) questions, Tier II focuses on basin-specific to waterbody-specific questions, while Tier III answers site-specific questions.

**LAP:** Landowner Assistance Program, a federal cost-share program administered in Florida by the FWC.

**MFL:** Minimum Flows and Levels, the minimum water flows and/or levels adopted by the District Governing Board necessary to prevent significant harm to the water resources or ecology of an area resulting from permitted water withdrawals. MFLs define how often and for how long high, average, and low water levels and/or flows should occur to prevent significant harm. When use of water resources alters the water levels below the defined MFLs, significant ecological harm can occur.

**NWFWMD:** Northwest Florida Water Management District

**Take:** As defined in Rule 68A-27.001(4), F.A.C. "To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct."

## GLOSSARY OF TERMS AND ACRONYMS

**USFWS:** United States Fish and Wildlife Service, the federal agency mandated to protect and manage the nation's wildlife and freshwater fish resources.

**Wildlife Conservation Actions:** This term includes the activities designed to restore, maintain, or enhance fish and wildlife populations or their requisite habitat. This term also includes those provisions that avoid or minimize the chance for incidental take of listed species of wildlife when conducting activities specifically designed for land or water use objectives other than wildlife.

**WMD:** Water Management District

## INTRODUCTION

### Biological Background

This plan is for the crystal darter (*Crystallaria asprella*). The crystal darter was formerly placed within the genus *Ammocrypta* until Simons (1991) determined it to be distinct from other darters and assigned this species to its own monotypic genus. Welsh and Wood (2008) described a second species of *Crystallaria*, *C. cincotta*, from the Cumberland, Elk, Green, and Muskingum river drainages of the Ohio River basin. This plan is intended to conserve and improve crystal darter populations to the point that the species is secure both within Florida and throughout its historical range.

### *Life History*

Crystal darters are relatively large, slender fish with a maximum length of 13 cm (5.1 in). They are differentiated from similar species by the presence of 4 brown saddles and a forked caudal fin (Boschung and Mayden 2004). Overall, the crystal darter is mostly translucent with mottling between the saddles and midlateral dark brown, oblong blotches (Page 1983). During breeding season, males develop tubercles on their anal fins, and their anal and soft dorsal fins become enlarged (George et al. 1996).

Spawning occurs late winter to early spring for crystal darters throughout their range. George et al. (1996) found crystal darters spawning from January to mid-April in the Saline River in Arkansas. They also found that the young grow quickly and are sexually mature before age 1, suggesting that crystal darters are able to spawn in the season after their hatch (George et al. 1996). In the Tallapoosa River in Alabama, crystal darters move to shallower water for spawning when water temperatures reach 12°C (54°F). Males fertilize eggs while the female is partially buried in the substrate, and the straw-colored, adhesive eggs attach to small substrate particles (Simon et al. 1992). In the Tombigbee River, Alabama, crystal darters were found in spawning condition from mid-March to mid-April when the water temperature was 15°C (59°F) (Boschung and Mayden 2004).

The lack of life history information for crystal darters is due to difficulties collecting and studying them in their habitats. Crystal darters are found in deep, swift raceways in large creeks and large rivers (Page 1983). They are typically found at depths greater than 1 m (3.3 ft) and current velocities greater than 46 cm/sec (1.5 ft/sec) (George et al. 1996). Crystal darters are associated with clean gravel, and cobble and sand are often present as well (George et al. 1996). Presence of aquatic vegetation, detritus, silt, and mud is uncommon in habitats used by crystal darters (Boschung and Mayden 2004). The crystal darter diet consists mostly of microcrustaceans, including larval midges and mayflies (Forbes 1880, Hatch 1997). Crystal darters have been observed buried in sandy substrate with only their eyes exposed, presumably in wait for prey (Miller and Robinson 1973).

### *Geographic Range and Distribution*

Crystal darters were historically distributed within the Mississippi River basin from Wisconsin and Minnesota east to Ohio, west to Oklahoma, and south to Louisiana and Florida (Page 1983, Boschung and Mayden 2004). The species also occurs in Gulf slope drainages such as the Escambia and Conecuh, Pearl, and Mobile river drainages (Page and Burr 1991). In Alabama, crystal darter distribution is primarily limited to larger rivers within the Mobile and Conecuh

(Escambia) river drainages (Grandmaison et al. 2003). Crystal darter records are sparse from the Conecuh (Escambia) River in Alabama to south of the Point A Reservoir (Andalusia, Alabama). Crystal darters were collected in 1981 (4.3 km [2.7 mi] south of Brewton, Alabama) and in 1985 (0.6 km [0.4 mi] north of the Florida state line). Popp (2005) reported only 1 collection record of the species during a 20-year study (1982 to 2002) from the Conecuh River (Escambia County, Alabama).

In Florida, crystal darters are only known to occur in the Escambia River ([Figure 1](#)). The species was first collected in Florida in 1972 (Gilbert 1992). Additional specimens were collected by Yerger and Beecher (1975) and Beecher et al. (1977). Biologists with FWC collected 5 individuals from the same location during 2003 and 2004 (Bass et al. 2004). Crystal darters were most recently collected in 2009 (a single individual) and 2011 (2 individuals) from the Escambia River (Strickland et al. 2010, J. Knight, Florida Fish and Wildlife Conservation Commission [FWC], unpublished data).

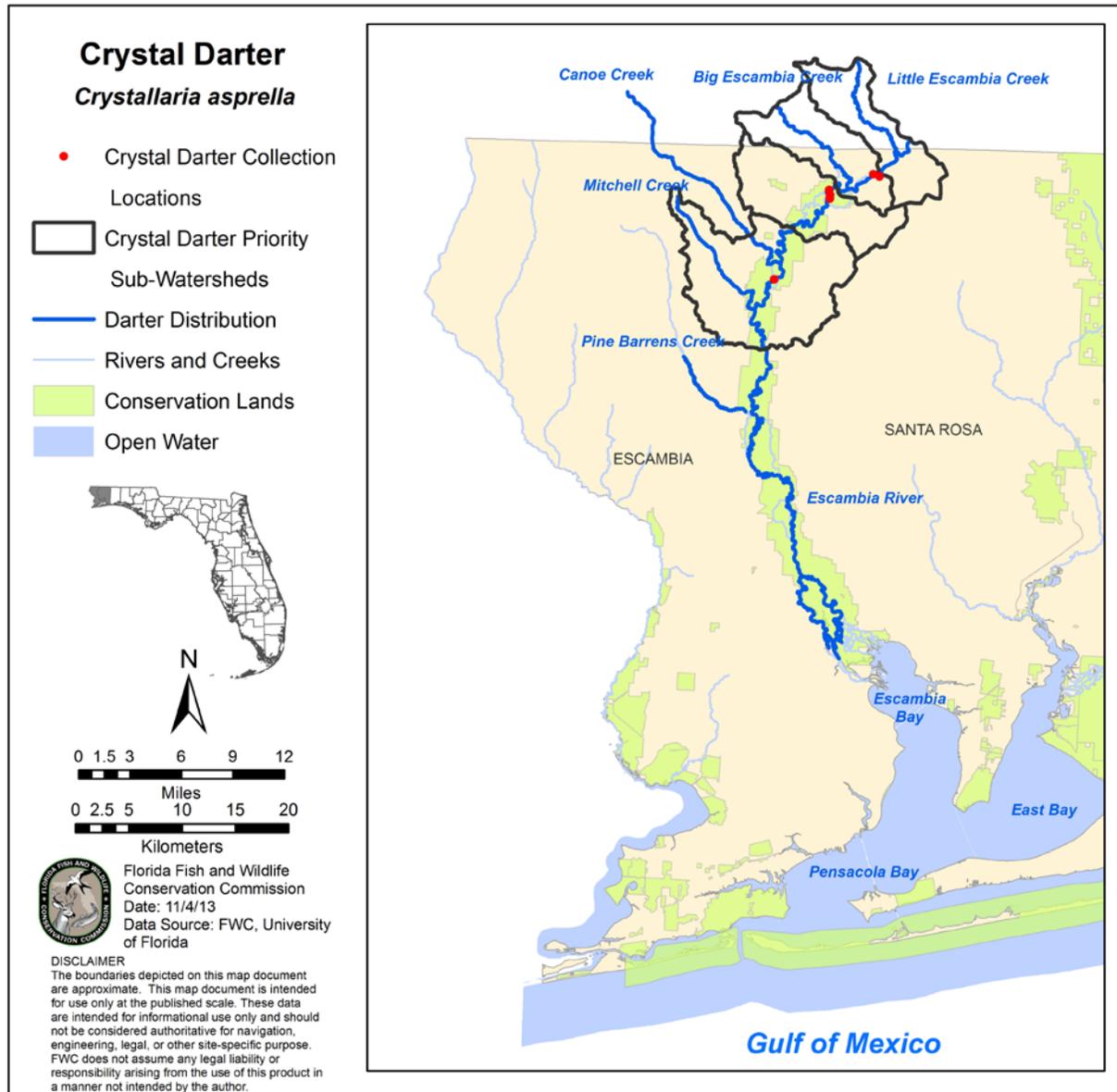


Figure 1. Distribution, range, priority watersheds, and conservation lands associated with known crystal darter (*Crystallaria asprella*) locations in Florida.

### Conservation History

In 1977, the crystal darter was listed as Threatened by the Florida Game and Fresh Water Fish Commission (predecessor to the FWC). While the crystal darter has been protected as a listed species for nearly 35 years, there have been few specific conservation actions directed toward protecting this species within the Escambia River. Limited conservation easements exist within the range of the species (Figure 1). Crystal darter populations have indirectly benefited from instream habitat protection. The mainstem Escambia River is designated as critical habitat for the Gulf of Mexico sturgeon (*Acipenser oxyrinchus desotoi*) and several listed mussels (Federal Register 2003, 2012). Land acquisitions, specifically by the Northwest Florida Water

Management District (NFWMD) have also recently occurred throughout a portion of its range. Approximately 143.6 km<sup>2</sup> (55.5 mi<sup>2</sup>) of floodplain, bottomland, and upland forests were preserved from the State Route 90 bridge crossing in Pensacola, north to the State Route 4 bridge crossing in Century, Florida (Florida Natural Areas Inventory [FNAI] 2011). Additionally, crystal darter populations most likely benefit from the restoration of Big Escambia Creek (an Escambia River tributary), where nearly 8 km (5 mi) of stream length and 4 km<sup>2</sup> (4.5 mi<sup>2</sup>) of wetlands were restored (U.S. Fish and Wildlife Service [USFWS] 2005). While crystal darters most likely do not occur in this tributary, restoration and subsequent stabilization of stream banks of this large tributary likely reduced non-point source pollution (e.g., sedimentation) that may affect this population. In 2003, the USFWS produced a report assessing the status of the species range wide (Grandmaison et al. 2003). While the species occurs in 16 states, that report indicated that crystal darters were protected as a Species of Concern, Threatened, or Endangered species in 11 of those states (69%).

### **Threats and Recommended Listing Status**

The crystal darter was listed as a Threatened in 1977 because the species has a significant vulnerability to habitat modification, environmental alteration, human disturbance, and human exploitation. Specific threats to crystal darters include the destruction and degradation of critical habitats as a result of impoundments, channelization, dredging, and sedimentation (Grandmaison et al. 2003). The crystal darter in Florida represents a disjunctive population that is isolated from any potential source population capable of contributing to persistence of the species. In Florida, the crystal darter has only been collected from gravel bar habitats restricted to approximately 25 km (15.5 mi) of the upper Escambia River (J. Knight, unpublished data). Within this reach, the species has only been collected at 5 locations ([Figure 1](#)). The sporadic occurrence of this habitat, even in unaltered rivers, suggests that historically these fishes were not distributed continuously throughout their range (Wood and Raley 2001).

The genetic structure of Florida's crystal darter population is also currently unknown. Crystal darter populations are highly divergent from one another (Wood and Raley 2000). The Conecuh River (in Alabama) population is likely limited in numbers and may not represent an adequate population size to repopulate the Escambia River if a catastrophic event were to eliminate the species from Florida. In addition, crystal darters are fragmented from any potential source population north of Andalusia, Alabama, due to the presence of Point A Dam (Point A Reservoir). Small population sizes and inhibited gene flow between crystal darter populations (caused by habitat fragmentation) may increase the likelihood of local extinction (Grandmaison et al. 2003). Similarly, the random loss of adaptive genes through genetic drift may limit the ability of crystal darters to respond to changes in their environment (Grandmaison et al. 2003).

Non-native and invasive species may also pose a threat to crystal darters (Grandmaison et al. 2003). Non-native flathead catfish (*Pylodictis olivaris*) may also negatively impact crystal darters in the Escambia River, but the extent of that impact is unknown. Actions to manage flathead catfish most likely will not eradicate the species; therefore, specific actions to manage flathead catfish are not proposed in this plan.

In 2010, FWC directed staff to evaluate the status of all species listed as Threatened or Species of Special Concern that had not undergone a status review in the past decade. To address this charge, staff conducted a literature review and solicited information from the public on the status

of the crystal darter. The FWC convened a biological review group (BRG) of experts on the crystal darter to assess the biological status of the species using criteria specified in Chapter 68A-27.001, Florida Administrative Code (F.A.C.). This rule includes a requirement for BRGs to follow the Guidelines for Application of the International Union for Conservation of Nature (IUCN) Red List Criteria at Regional Levels (Version 3.0) and Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1). FWC staff developed an initial draft Biological Status Review report (BSR), which included the BRG's findings and a preliminary listing recommendation from staff. The draft was sent out for peer review, and the reviewers' input was incorporated into a [final BSR report](#).

Based on this biological assessment, the BRG concluded that the crystal darter met 2 listing criteria. No information was received from the public during the information request period. After considering the available data, staff reviewed the BRG finding and the recommendations in the Guidelines for Using the IUCN Red List Categories and Criteria (Version 8.1). Biologists with FWC recommended that the crystal darter be retained as a Threatened species.

The BRG found the crystal darter met the following criteria for listing as Threatened:  
Criterion D, population is very small or restricted:

- D(1) – Crystal darter populations were assumed to be less than 1,000 mature individuals.
- D(2) – The species is assumed to also have a highly restricted area of occupancy (less than 20 km<sup>2</sup> [7.72 mi<sup>2</sup>]) and less than 5 known locations.

Given this rarity, the BRG concluded that crystal darters are highly susceptible to the effects of human activities or stochastic (random) events within a short time period in an uncertain future. Additionally, the BRG found that there was not enough information available on crystal darter populations to address the other criteria used to evaluate population trends and whether there had been a reduction in population size or geographic range.

## CONSERVATION GOALS AND OBJECTIVES

### Goal

The conservation status of the crystal darter is improved to the point that the species is secure within its historical range.

### Conservation Objectives

I. Maintain or increase the population of the crystal darter.

#### *Rationale*

This objective addresses Criterion D(1) of the [BSR](#) findings. The [BSR](#) estimated the population size of crystal darters to be fewer than 1,000 mature individuals, based on recent collections (6 individuals collected within the last 10 years). It is currently unknown whether these records are reflective of the actual population size or represent a low probability of detection (typical of cryptic and benthic fishes). Therefore, alternative sampling techniques need to be evaluated for crystal darters from the Escambia River, Florida, to determine whether a population estimate is feasible for the species.

II. Maintain or increase the extent of occurrence and area of occupancy of the crystal darter.

#### *Rationale*

This objective addresses criterion D(2) of the BSR findings. Crystal darters inhabit an approximately 25 km (15.5 mi) reach of the Escambia River from the Florida-Alabama border southward. The [BSR](#) considered this reach as 1 location. In order to maintain suitable habitat for the species (clean, gravel substrate), efforts are needed to reduce sedimentation within the area of occupancy. Specifically, a watershed-based approach is needed to reduce sediment inputs into the Escambia River proper by minimizing poor land-use practices within riparian zones (from both mainstream and tributaries), stabilizing stream banks, preventing alterations to the stream bed, and preventing any stream flow modification (e.g., impoundments). Such an approach would require interstate and interagency partnerships since much of the Escambia watershed occurs in Alabama. The crystal darter area of occupancy within the Escambia River should be continually monitored and the efficacies of current sampling methods need to be evaluated.

## CONSERVATION ACTIONS

The following sections describe the conservation actions that will make the greatest contribution toward achieving the conservation objectives. Actions are grouped by category (e.g., Habitat Conservation and Management, Population Management). The Conservation Action Table ([Table 1](#)) provides information on action priority, urgency, potential funding sources, likely effectiveness, identified partners, and leads for implementation.

### Habitat Conservation and Management

Maintenance and improvement of crystal darter habitat within the Escambia watershed is needed to maintain or increase crystal darter area of occupancy. The crystal darter has a narrow geographic range within Florida, distributed within a 25-km (15.5-mi) reach of the Escambia River from the Florida – Alabama border southward. This single population is highly vulnerable to natural or anthropogenic impacts that could cause permanent extirpation. Therefore, the physical habitat (instream and riparian), water quality, and water quantity within the Escambia watershed should be maintained and managed to increase the area of occupancy and prevent irreversible harm to crystal darters in the Escambia River.

Four Escambia sub-watersheds were identified as priority sub-watersheds for crystal darters based on locations of historical and current collection data ([Figure 1](#)). Protecting the integrity of both instream and riparian habitats within each of these watersheds will be important for the long-term survival of crystal darters. Therefore, the focus of the Habitat Conservation and Management actions is to: 1) maintain standards for water quality and quantity critical to the persistence of the species, 2) identify suitable instream habitat within the Escambia River to protect and maintain populations, and 3) minimize impacts to streamside riparian zones along the upper Escambia River to reduce sedimentation and protect instream habitats. The following actions will require coordination, collaboration, and cooperation of local, state, and federal agencies to achieve the actions summarized below.

**Action 1** Establish additional locations for water quality monitoring within the crystal darter priority sub-watersheds.

There are several regulatory agencies in Florida, from local to federal levels of government, which collaborate to maintain quality aquatic habitats. The U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, Florida Department of Environmental Protection (DEP), and NFWMD monitor and regulate water quality and quantity to maintain healthy conditions for aquatic plants, fish, and wildlife. For example, DEP created a “multi-tiered” Integrated Water Resource Monitoring Network Program designed to answer questions about Florida’s water quality at differing scales. Currently there is only 1 status-monitoring site located within a priority crystal darter sub-watershed. The monitoring site is located in the Escambia River drainage (Escambia River Highway 4 Bridge - U.S. Geological Survey site 305758087140401).

FWC recommends establishing additional water quality monitoring stations within the Escambia watershed. Since the only monitoring station within the known range of the species is located on the mainstem Escambia river, additional water quality stations in tributaries (in the vicinity of known crystal darter locations) will be beneficial in identifying sources of non-point source pollution (e.g., sedimentation), which may impact crystal darter habitats. Potential sites for

additional water quality monitoring include: Big Escambia, Little Escambia, Mill, Pritchett Mill, Canoe, and Mitchell creeks.

**Action 2** Identify crystal darter habitat requirements and define conservation measures needed to mitigate impacts to these habitats.

**Action 3** Identify additional potentially suitable instream habitat for the crystal darter within priority sub-watersheds.

Crystal darter habitat is best described as deep raceways with clean sand and gravel substratum and strong current velocities (Page 1983, Boschung and Mayden 2004). The species is often collected in water as deep as 180 cm (6 ft) and current velocities as great as 90 cm/sec (35 in/sec) (George et al. 1996, Hatch 1997). Given the difficulty of sampling in these habitats with conventional fisheries gear and the lack of knowledge about their location, research is needed to identify where these habitats are within the Escambia River and how they can be sampled effectively. Advanced sonar technology may provide a useful tool for identifying where these habitats are located. Developing and refining a map of the instream channel of the Escambia River would enable managers to monitor persistence and stability of this critical habitat. A habitat map would also provide a baseline for conducting an analysis of trends in crystal darter habitat over time. Additionally, this map could guide sampling efforts needed to determine crystal darter population status (see [Monitoring and Research](#)).

**Action 4** Coordinate with federal, state, and local regulatory agencies to develop Minimum Flows and Levels (MFLs) for the Escambia River.

The maintenance of clean sand and gravel habitats for crystal darters is needed for persistence of populations in Florida, given that the species both spawns and resides in these habitats. If maintenance (and potentially enhancement) of these habitats is conducted in concert with pollution control and abatement programs, persistence of these populations is feasible (Grandmaison et al. 2003). Therefore, it is critical to minimize sedimentation impacts to gravel and sand raceway habitats within stream channels in the Escambia watershed. The FWC currently coordinates with the DEP and the USFWS to ensure that sedimentation will not impede critical habitats for protected freshwater mussels and Gulf Sturgeon. Several protected mussel species live in habitats similar to those of crystal darters, and Gulf sturgeon most likely spawn on these gravel habitats (Heise et al. 2004, Williams et al. 2008). Developing materials that define conservation actions for land managers within the Escambia watershed is needed to maintain instream habitats that are critical to crystal darter populations.

Habitat information collected to determine population trends (see [Monitoring and Research](#)) can be used to develop MFL rules. Establishing MFLs is a state legislature requirement under [Subsection 373.042\(2\), Florida Statutes](#). MFLs identify a range of water flows and levels above which water might be permitted for consumption. Consumptive water use permits allow the holder to withdraw a large but specified amount of water, either from the ground, a canal, a lake, or a river. The water can be used for a public water supply; to irrigate crops, nursery plants, or golf courses; or for industrial processes. Individual homeowners do not need consumptive water

use permits. To date, the NFWFMD has not initiated development of MFLs within the Escambia watershed.

**Action 5** Determine conservation measures needed to minimize impacts to riparian zones along the Escambia River where crystal darters are known to occur.

**Action 6** Identify land use for crystal darter priority watersheds and coordinate with landowners on the use of water quality best management practices (BMPs) or other conservation measures to alleviate threats to populations

While it is critical to protect instream habitat, it is equally important to maintain the riparian zones to reduce sedimentation inputs to the Escambia River. Natural functioning riparian zones are essential for healthy, productive riverine ecosystems. These zones include terrestrial habitat from the water's edge to the edge of the floodplain. Functional riparian zones reduce siltation and pollution, increasing water quality. They also provide nutrients, vegetative cover, and detritus to riverine systems. Protecting riparian zones should reduce sedimentation in the Escambia River and help maintain clean gravel habitat for crystal darters.

A portion of riparian zones along the mainstem Escambia River, where the crystal darter occurs, are under public lands conservation. However, most of the Escambia tributaries and mainstem river riparian zones (north of the State Route 4 Bridge) do not receive the same protection. The majority of unprotected riparian zones along Escambia River tributaries are privately owned. Protection of tributary riparian zones will require coordination between federal, state, and local regulatory agencies with landowners to propose the utilization of wildlife conservation measures to minimize impacts to riparian zones along the Escambia River and its tributaries. Biologists with FWC recommend a 30-m (100-ft) minimum riparian zone be maintained along the mainstem of rivers that contain crystal darters. For all other streams (where endangered species are not present), a 15-m (50-ft) minimum riparian zone is recommended.

Agencies may also need to reinforce the value of instituting conservation measures like water quality BMPs to stakeholders to maintain the health of the Escambia River watershed. The Florida Department of Agriculture and Consumer Services (DOACS) developed BMPs, under [Rule 5I-6, F.A.C.](#), which are designed to protect water quality by reducing inputs of sediments, nutrients, logging debris, and chemicals for silviculture and other agricultural practices (DOACS 2011).

### **Population Management**

Conserving crystal darter genetic diversity requires a thorough understanding of existing levels of genetic diversity, both within and among populations. This information can be valuable for determining whether propagation, translocation, or stocking is appropriate for crystal darters in Florida. Data are needed to compare the Florida crystal darter population to other populations in the event it is determined that translocation is needed to augment Florida populations. Specifically, genetic studies can determine the level of divergence between Florida's crystal darter populations and other populations throughout its range. Actions that address these research areas are described in Monitoring and Research ([Actions 15](#), [16](#), [17](#), and [18](#)).

### **Monitoring and Research**

The BRG recommended maintaining the crystal darter as Threatened based on 2 criteria: a small population size and a restricted area of occupancy. The BRG also indicated that there was not enough available information to determine whether the crystal darter population had been reduced in size or range and was unable to determine population trends. Therefore, data are needed to determine crystal darter distribution, population size, and population trends in the Escambia River. This information is needed to understand how to maintain and increase the crystal darter population size and area of occupancy in the Escambia River.

To address these data gaps, specific actions were identified for research and monitoring to achieve the conservation goal and objectives. Specifically, research is needed in Florida to explore alternative methods for determining population size, detection probability, and site-level occupancy, all of which would facilitate a greater understanding of variation in crystal darter population size and geographic range. Instream habitat should be monitored, and research on propagation and population augmentation techniques will be needed if such action is necessary for crystal darters.

Effective monitoring and research of crystal darter populations requires a multi-scale approach. Fish habitat relationships can vary depending on scale, from microhabitat conditions to stream channel units to watershed-level characteristics (Fausch et al. 2002). These scales form a hierarchy; factors affecting local conditions are the result of processes occurring at a larger scale (Rahal and Jackson 2007). A multi-scale sampling design is recommended to determine crystal darter population trends. Specifically, a watershed sampling design would be sufficient in updating distribution information and characterizing area of occupancy on a coarse scale (IUCN 2010). Meanwhile, site-specific sampling is recommended for characterizing changes in occupancy in microhabitats. This approach provides researchers with a greater understanding of how instream attributes (e.g., sediment size, velocity) and landscape attributes (e.g., geology, gradient) influence the population dynamics of crystal darters. Site-specific sampling is also needed to determine persistence, stability, and probability of detection, and to characterize site occupancy on a smaller (microhabitat) scale. This multi-scale approach will facilitate inferences about population status and trends on both temporal and spatial scales.

#### *Area of Occupancy*

Since the FWC monitors fish communities from the Escambia River, information collected can be used to update crystal darter distribution from a portion of its range. Crystal darters were collected at 2 new sample locations in the last 5 years, and all of this information is entered into FWC's databases. Different sampling techniques, such as use of a trawl rather than electrofishing, may be more effective in sampling crystal darters (Herzog et al. 2009). The following actions are recommended to update crystal darter distribution throughout its range and re-evaluate area of occupancy within the Escambia watershed.

**Action 7** Follow FWC's standardized sampling protocol to update presence and absence information and identify new collection locations.

**Action 8** Evaluate and implement new sampling protocols needed to update the distribution of crystal darters.

**Action 9** Integrate information collected from [Actions 7](#) and [8](#) to determine crystal darter area of occupancy within the Escambia River and update distribution of crystal darters.

Crystal darter locations are entered in FWC's databases when collected using existing standardized fish community sampling protocols, and area of occupancy is updated. Catch rates are extremely low, so no meaningful population trend analysis is feasible. Course-scale habitat information is also recorded during standardized sampling and entered into databases, although additional habitat information is still needed on a microhabitat scale. From all available data, biologists with FWC created a baseline map of crystal darter current distribution and historical distribution ([Figure 1](#)). These data were used to identify where additional monitoring and research are needed. The FWC also identified a preliminary set of priority sub-watersheds based on current and historical crystal darter locations ([Figure 1](#)).

*Population Estimate, Detection Probability, and Site Occupancy*

Once suitable techniques are identified for collecting crystal darters from the Escambia River, an estimate of crystal darter population size may be possible. However, research is still needed to determine which techniques are most effective at detecting and collecting crystal darters. [Actions 10 through 12](#) are necessary to determine the minimum population size of crystal darters from the Escambia River.

**Action 10** Evaluate and implement a sampling design to determine population estimates of crystal darters from the Escambia River.

**Action 11** Annually re-sample crystal darter populations using the methods and techniques in ([Actions 8](#) and [10](#)) to determine whether crystal darter population trends can be determined.

Information collected during a crystal darter population estimate can be used to inform the number of sampling locations needed to determine probability of detection. Additional sampling will be necessary to determine temporal variation in probability of detection and to achieve an acceptable level of precision in estimates (Mackenzie and Royle 2005, Albanese et al. 2011). Detection probability and a site (microhabitat) occupancy estimate would enable researchers to determine whether changes in the number of crystal darter observations (or collections) over time represents an actual population trend or simply a decline in capture efficiency on a watershed-scale (Mackenzie and Royle 2005, Albanese et al. 2011, Hagler et al. 2011). Additionally, if a precise population estimate cannot be achieved (i.e., variation around the estimate is excessively large), then probability of detection can be used to determine site occupancy (e.g., proportion of area occupied), which has been used as a surrogate for abundance (Bailey et al. 2004, Mackenzie et al. 2006, Royle and Dorazio 2008).

**Action 12** Re-sample recent crystal darter collection locations used to estimate population size. Analyze data to evaluate variability in probability of detection and determine the number of sample sites needed to determine probability of detection.

**Action 13** Collect and analyze instream and landscape-level habitat information to determine the effect of these parameters on variability in detection.

**Action 14** Incorporate information collected during [Action 12](#) to determine site-level occupancy.

Site (or microhabitat) occupancy has been used as an index to determine population status of aquatic species when actual population dynamic studies are not feasible (i.e., for rare, cryptic, and difficult to collect species) (Bailey et al. 2004, Royle and Dorazio 2008). Such a design may be needed to accurately characterize the current status of this species. Occupancy models are also capable of relating spatial patterns to environmental variables, facilitating the ability to potentially relate probability of detection to both instream habitat and landscape attributes (Mackenzie et al. 2006, Albanese et al. 2011, Anderson et al. 2012). Additionally, historical information can be used in conjunction with site-specific population sampling to ascertain population trend information (Hagler et al. 2011).

Environmental and physical habitat information associated with locations occupied and unoccupied by crystal darters must be collected to develop habitat suitability criteria and improve the accuracy of the occupancy models produced. The watershed should be inventoried for both instream (e.g., sediment size, velocity) and landscape (e.g., geology, gradient) habitat characteristics to create geographical information system data layers for crystal darters, so that geographic-spatial software may be used to identify new areas of potential occupancy.

**Action 15** Collect and analyze tissue samples from crystal darters to describe the genetic characteristics of populations or subpopulations.

**Action 16** Compare genetic structure of Florida crystal darters to other populations within the Escambia–Conecuh watershed and adjacent watersheds to determine if translocation or supplementation of crystal darter populations is feasible or needed.

*Propagation, Translocation and Reintroduction*

Translocation and supplementation (reintroductions) of imperiled species are common methods used to augment small or declining populations. If the crystal darter numbers in the Escambia River remain low after identification, elimination, or improvement (e.g., flow, sedimentation) of factors leading to their decline, then translocation and supplementation may be viable options to increase the crystal darter population size.

The translocation, propagation, and reintroduction of crystal darters have not been conducted in Florida. Translocation may be a more cost-effective strategy for augmenting crystal darter populations than propagation, although information is needed to compare the genetic composition of Florida crystal darters to any potential source stock. It is currently unknown whether the Conecuh River (Alabama reach of the Escambia River) harbors a sufficient source population that could be used to supplement Florida crystal darter populations. Popp (2005) indicated that only 1 crystal darter was collected from the Conecuh River over a 20-year period of sampling. Given the apparent rarity of this species in Alabama, there may be a need to investigate supplementing crystal darter populations with sources outside of the Escambia–Conecuh watershed.

**Action 17** If translocation is necessary, identify a suitable source population of crystal darters to augment the Florida population.

**Action 18** If translocation is not feasible and propagation is determined necessary for reintroduction, then develop, evaluate, and implement techniques to propagate crystal darters in a hatchery.

If translocation and propagation are determined to be necessary, then coordination with other state and federal agencies will be necessary to identify a suitable source population and efficiently and effectively transporting individuals to a state hatchery. Post-introduction monitoring of stocked populations may also be needed (Williams et al. 1988).

Reintroduction of translocated or propagated fishes generally involves establishing juvenile or adult individuals into historically occupied stream reaches where the species no longer occurs or where habitat may not be accessible to natural immigration or recruitment from existing populations. Additionally, supplemental stocking on existing populations, or introduction to stream reaches not previously known to support crystal darters (but have favorable habitat), may also be an option. Reintroduction of aquatic organisms into historical habitats is recommended only if the mechanisms which led to extirpation have been identified, eliminated, or improved (Williams et al. 1988). Some benefits of reintroductions are reestablishment of populations, genetic refugia, and reducing the potential of extinction due to unforeseen events.

Regardless of whether introductions are accomplished by transplanting wild individuals or by stocking captive-raised individuals, some guiding genetic principles are: 1) maintain the current level of genetic variability, 2) avoid management actions that may lead to increased inbreeding or outbreeding, 3) maximize the effective population size of managed populations, and 4) perform a risk-benefit analysis for any proposed stocking.

### **Rule and Permitting Intent**

#### *Existing Regulations and Intent of Future Regulations*

The recommendation is to retain the crystal darter as a Threatened species [Rule 68A-27.004, F.A.C.](#) As a Threatened species, the crystal darter is protected under Rule 68A-27, F.A.C. Permit requirements for intentional take and incidental take as currently defined in Rule 68A-27, F.A.C., are applicable to the crystal darter. The following actions are recommended to be required of any entity seeking incidental take permits of crystal darters.

**Action 19** Require that intentional take permits contain comprehensive site-specific collection data, including negative capture data, sampling staff, sampling protocol, environmental data (habitat and water quality characteristics) and associated fish communities.

**Action 20** Require that the FWC Regional Fisheries Administrator consult with the FWC Fish Taxa Coordinator prior to issuing intentional take permits and send the collection information described in Action 19 to the FWC Fish Taxa Coordinator following collection events.

These modifications to intentional take permits requirements are needed to further refine knowledge of habitat use on multiple scales, and update the distribution and trends of crystal darter populations. This information can also be used by researchers to supplement information collected during Monitoring and Research. The intent is to limit direct or intentional take until

there is a better understanding of the population status, trends, habitat needs, and potential impacts from activities that might cause incidental take. Restrictions and requirements on intentional take are precautionary but are needed to facilitate coordination of specimen collections and to reduce information gaps associated with the species

#### *Permitting Structure*

As outlined in [Rule 68A-27, F.A.C.](#), permits may be issued for take of Threatened species if those permits are not detrimental to the survival potential of the species. The FWC currently issues permits for scientific collecting or possession of listed species for educational and research purposes. Currently, scientific collecting permits contain standard and species-specific conditions, such as including reporting unintended mortality, for the collection of species, specimen disposition, collection data, and copies of all publications that result from surveys. To compile additional data regarding crystal darter habitat needs, abundance, and distribution, requirements identified in action 13 should be added to all scientific collection permits requiring notification to FWC when crystal darters are collected in the Escambia watershed. These requirements would allow the FWC to gather additional data on crystal darter range and habitat preferences.

Intentional take permits of fish are issued from FWC regional offices by the Regional Fisheries Administrator. Intentional take permits must be carefully reviewed by both Division of Freshwater Fisheries Management staff and the Fish Taxa Coordinator to ensure current populations of crystal darters remain sustainable. If it is determined that the intentional take of crystal darters will not cause irreversible harm to current populations, then the capture information contained from collection efforts may be used to further our understanding of the distribution and trends within known populations, identify both re-colonized historical locations and new locations, and refine our understanding of habitat associations.

#### *Coordination across Actions and with Other Species*

Additional actions within this plan require data that can be collected concurrent with sampling outlined above. For any other studies, collecting fishes from the Escambia River, incidental captures of this species should also be reported. For example, any study intended to collect harlequin darters (*Etheostoma histrio*), which may be collected from similar habitats, incidental captures of crystal darters should be reported.

#### **Law Enforcement**

There are no specific actions proposed for crystal darters with respect to law enforcement at this time.

#### **Incentives and Influencing**

County growth management plans and land development regulations provide an avenue by which the FWC can inform and influence land and water uses that are relevant to the conservation of crystal darters ([Actions 1 through 6](#)). This plan identifies areas known to harbor crystal darters and identifies the threats to crystal darters. The FWC offers conservation planning services to local governments during growth management plan development as well as during consideration of plan amendments and associated development proposals.

**Action 21** Develop outreach and education programs to inform stakeholders about the conservation of crystal darters and associated threats.

Information can be provided to local governments regarding species management plans, permitting options, technical assistance, and incentive programs available to applicants, developers, landowners, and the general public. Conservation actions can be developed to address the habitat needs of crystal darters and be provided to local governments for incorporation into their local land development regulations.

#### *Incentive Programs*

The FWC currently takes advantage of several programs that promote conservation by providing technical and financial assistance to private landowners. The FWC has established partnerships with other state and federal agencies to administer the Forest Stewardship Program, Wildlife Habitat Incentives Program, Wetlands Reserve Program, Environmental Quality Incentives Program, Partners for Fish and Wildlife Program, and the Cooperative Conservation Blueprint. These programs are voluntary, and some may provide financial incentives for wildlife conservation and habitat management on private lands. Florida also provides tax incentives including property tax exemptions for landowners who put a perpetual conservation easement on their lands. These incentives would allow any landowner to receive a break from property taxes for excluding additional development on their property. Additional incentives may include exemption from permits for activities that enhance wildlife activities such as mowing, roller-chopping, and tree stand thinning, as long as they are not a precursor to development.

The FWC's Landowner Assistance Program (LAP) advances species conservation objectives through public-private conservation partnerships. These partnerships range from individual landowner conservation plans to multi-landowner conservation cooperatives organized to address species or habitat threats at a larger landscape level. Where possible, FWC's LAP efforts are focused on areas where public conservation investments occur in an effort to further those efforts. Voluntary partnerships established with other state and federal conservation agencies to administer landowner assistance programs such as the Forest Stewardship Program, Wildlife Habitat Incentives Program, Wetlands Reserve Program, Environmental Quality Incentives Program, and Partners for Fish and Wildlife Program may offer financial assistance to landowners implementing conservation plans (see [Incentives and Influencing](#)).

**Action 22** Investigate the development of a watershed-based Habitat Conservation Plan (HCP) for multiple aquatic species in the basins containing crystal darters.

The HCP concept was originally developed as a required piece of the application for a federal incidental take permit. As defined in the Endangered Species Act, incidental take permits authorize the take of listed species incidental to a lawful activity. The intent of the HCP is to make sure the effects of issuing a take permit are adequately minimized or mitigated. While it may not be practical to develop individual HCPs for many of the state-listed fish species, the FWC is investigating the potential for the development of a "watershed-based HCP" for multiple aquatic species that are both state and federally listed in the basins containing crystal darters.

**Action 23** Develop a conservation banking program for species identified on Florida’s Endangered and Threatened Species List.

Conservation banking is another program for private landowners interested in habitat conservation. Conservation banking for listed species is comparable to mitigation banking in that lands are permanently protected and can be used to offset adverse impacts to wildlife resources from development. These banks offer private landowners the opportunity to preserve, enhance, restore, and establish habitat for specified wildlife resources. In exchange for permanently preserving and managing the land, an administrative agency allots “credits” that may then be sold by the bank to developers or applicants to mitigate future development projects. With 63 state-listed species and ever-increasing development pressures, conservation banking in Florida may provide a viable alternative to development by offering financial incentives to preserve private property.

*Wildlife Conservation Measures*

Approximately 65% of Florida is in some form of agricultural land use. Florida’s fish and wildlife, including many of the state-listed species, occur on agricultural lands. FWC is currently working with the DOACS and landowners engaged in agriculture to identify agricultural activities that are currently being conducted in a manner that provides a reasonable assurance that take of listed species or habitat will be avoided or minimized.

Use of wildlife conservation measures could preserve or enhance additional habitat or avoid take of crystal darters by identifying such things as the preferred timing of clearing and construction, methods of clearing and re-vegetating, preferred locations and methods of stormwater management, preservation of on-site ecosystem features, preferred location of open, green-space conservation areas, inclusion of development and density buffers, or inclusion of conservation easements over conservation areas. Incentives for incorporating wildlife conservation actions into development proposals could include expedited permitting, reduced permitting fees, local or state recognition, tax incentives, or density bonuses.

**Education and Outreach**

**Action 24** Develop outreach material for FWC Law Enforcement, DEP, NFWFMD, local governments, federal agencies, and the public to identify and implement conservation actions that minimize water quality impacts from unpaved roads, agriculture and silviculture, riparian zone management, and development within the upper Escambia watershed.

Education and outreach are important components of managing imperiled aquatic species. Citizens who are well-informed on the merits of species and the habitat that supports them can help to secure those species’ continued survival. Formal and informal settings can serve as opportunities to inform Floridians about imperiled species.

Outreach topics for crystal darters include:

- Indicators of habitat condition, water quality, and water quantity
- How to reduce impacts to the instream and landscape habitat
- Specific needs for continued survival
- Unique characteristics and benefits to the ecology of a region

A unified and comprehensive approach to education and outreach will serve to inform the public regarding the means and needs to protect crystal darters.

### **Coordination with Other Entities**

The FWC is a review agency for several regulatory and planning programs that affect potential crystal darter habitat. These programs can fill data gaps regarding species range and habitat associations. Some regulated activities require that surveys for crystal darters be conducted at sites where they are likely to occur. The FWC can provide survey methodologies regarding crystal darter presence or absence on site. Scientific collection permits would be required for the surveys and would contain information and conditions as identified in [Rule and Permitting Intent](#).

**Action 25** Use existing programs to fill data gaps for and reduce potential impacts to crystal darters on private lands.

**Action 26** Coordinate with universities, research institutes, non-governmental organizations, and other agencies to achieve actions relating to [Habitat Conservation and Management](#) and [Monitoring and Research](#), creating an approach for determining population status and for education and outreach efforts.

To meet the actions identified in the [Habitat Conservation and Management](#) and [Monitoring and Research](#), the FWC will work with public landowners, non-governmental organizations, and educational entities that manage conservation lands that can assist in data-collection efforts, or have particular expertise required by the actions. Many public and private land managers initiate monitoring efforts designed to identify species lists for the lands they manage. As such, coordination with land managers could result in the collection of occurrence information and crystal darters collected during other fish surveys.

**Action 27** Communicate and coordinate with local and state regulatory agencies, water management districts (WMDs), and stakeholders to propose cooperative measures addressing habitat requirements and locations of specific threats to crystal darters and to propose measures to abate, alleviate, or mitigate the identified threats to habitats needed for crystal darter populations.

Conservation actions are needed for preserving crystal darter habitat on lands or waters slated for development. These conservation actions might include:

- Minimum acreages required to support sustainable populations of crystal darters
- Buffer distances around crystal darter habitat to avoid degradation
- Activities that cause permanent disturbance to the habitat of crystal darters
- Compatible land uses in or near crystal darter habitat

- Guidelines for habitat purchase or contribution to a fund for use in purchasing and managing lands for crystal darter conservation

Development of non-regulatory conservation actions could form the basis of regulatory permitting guidelines and inform habitat acquisition programs in the future. As additional information on crystal darters is collected, coordination between FWC and local governments, other state agencies (i.e., DEP, DOACS, Florida Forest Service, Florida Department of Transportation, and NFWFMD), and federal agencies will be important in developing habitat acquisition and management guidelines. Funding sources for these programs may include the Florida Forever program, conservation mitigation banks, or wetland mitigation banks for purchase and management of listed species habitat (and public lands).

Local and municipal governments are required through their comprehensive plans to identify important state resources such as imperiled species and their habitats. Specific objectives, policies, and land use designations are required to address imperiled species and their habitats. These designations are implemented through land development regulations and ordinances. Because local governments use the land development regulations or ordinances to govern development and expansion under their jurisdiction, coordination with the FWC can streamline the review and approval process. The FWC offers conservation planning services to local governments during consideration of comprehensive plan amendments and associated development proposals. Improvements can be made in coordination with the FWC by having the local government add questions to their development applications asking for information on what listed species surveys have been conducted on the property, or by inspecting parcels for the presences and absence of crystal darters.

Land development is governed by a variety of federal, state, and local government growth management and permitting processes or requirements. Most state and WMD permits require consideration of potential impacts to listed species and their habitats. Local governments and other state or federal agencies often conduct site visits prior to clearing and development. These site visits occur early in the regulatory process, often well before permitting begins. By participating in site visits, project scoping meetings, and pre-application reviews as part of an interagency review team, the FWC can help determine presence and absence of crystal darters and address avoidance, minimization, and mitigation prior to the permitting process. An Interagency Review Team would also provide the FWC an opportunity to participate in large-scale local government planning efforts, coordinate with other permitting agencies to reduce redundancy in recommended conditions, and help large developments plan to avoid habitat impacts. These early meetings and coordination efforts would also give local governments and other agencies the opportunity to determine the presence or absence of crystal darters.

If the presence of crystal darters is determined, the FWC can help the applicant avoid incidental take permitting by providing conservation actions, or providing mitigation options (e.g., purchase of land or contribution to a trust fund for the conservation of this species). This may also provide an opportunity to make the applicant aware of any FWC incidental take permits or authorizations.

**Action 28** Maintain current records for crystal darter in the Florida Wildlife Conservation Guide (FWCG).

The [FWCG](#) is an online resource that facilitates effective land use planning, project design, and the management of natural communities, with a focus on wildlife conservation. Developed by the FWC in partnership with the USFWS and FNAI, the guide provides an easily accessible repository of wildlife life history, habitat management, and conservation options. The FWCG aims to provide a common platform of ecologically based wildlife information based on best-available scientific information. As a dynamic resource, it is maintained with current guidelines and recommendations for wildlife management and protection, and includes numerous links to relevant external sources of information. The FWCG will have the specific information related to the crystal darter and necessary conservation actions once they are developed ([Action 28](#)).

**Table 1. Crystal Darter (*Crystallaria asprella*) Conservation Action Table**

NOTE: An explanation of acronyms used is below the table.

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
1	3	1	Establish additional locations for water quality monitoring within the crystal darter priority sub-watersheds.	Habitat Conservation & Mgmt	NEW	YES	YES	\$0-25k	Existing budget OR Unknown	FWRI	TNC, FFS, DEP, NFWFMD	Moderate - maintaining water quality will benefit the species.	Feasible, but may require initial research to gather information for providing this guidance.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	1	2	Identify crystal darter habitat requirements and define conservation measures needed to mitigate impacts to these habitats.	Habitat Conservation & Mgmt	NEW	NO	YES	\$0-25k	Existing budget OR Unknown	FWRI, FFM, HSC	TNC, FFS, DEP, NFWFMD	Moderate- will benefit the species by increasing awareness.	Highly feasible.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	3	3	Identify additional potentially suitable instream habitat for the crystal darter within priority sub-watersheds.	Habitat Conservation & Mgmt	ONGOING	YES	YES	\$0-25k	Existing budget	FWRI	TNC, FFS, DEP, NFWFMD	High - will increase knowledge of habitat use/needs.	Feasible.	Yes, understanding the species' habitat needs is critical to the immediate survival of the species.
1	2	4	Coordinate with federal, state, and local regulatory agencies to develop Minimum Flows and Levels (MFL) for the Escambia River.	Habitat Conservation & Mgmt	NEW	YES	YES	\$0-25k	Existing budget OR Unknown	FWRI	TNC, FFS, DEP, NFWFMD	Moderate - maintaining water quantity will benefit the species.	Feasible but may require initial research to gather information for providing this guidance.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	3	5	Determine conservation measures needed to minimize impacts to riparian zones along the Escambia River where crystal darters are known to occur.	Habitat Conservation & Mgmt	NEW	YES	NO	\$0-25k	Existing budget OR Unknown OR Grant	FWRI, HSC	DOACS, TNC, FFS, DEP, NFWFMD, research institutions	Moderate- will benefit the species by protecting habitat.	Feasible depending on available partners.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	3	6	Identify land use for crystal darter priority watersheds and coordinate with landowners on the use of water quality best management practices (BMPs) or other conservation measures to alleviate threats to populations.	Habitat Conservation & Mgmt	EXPANDED	YES	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI, HSC	DOACS, TNC, FFS, DEP, NFWFMD, research institutions	High- identifying, protecting, and maintaining adequate land use in the Escambia is critical to the species	Feasible depending on available partners.	Yes, minimizing anthropogenic stressors to the species will protect critical habitat for the species.
1	4	7	Follow FWC's standardized sampling protocol to update presence and absence information and identify new collection locations.	Monitoring & Research	ONGOING	YES	YES	\$0-25k	Existing budget	FWRI	None	High -ongoing sampling is filling in data gaps.	Highly feasible.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	1	8	Evaluate and implement new sampling protocols needed to update the distribution of crystal darters.	Monitoring & Research	EXPANDED	YES	YES	\$0-25k	Existing budget	FWRI	Research Universities	Moderate - any additional information about the population would be beneficial.	Feasible, but requires additional sampling.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	3	9	Integrate information collected from Actions 7 and 8 to determine crystal darter area of occupancy within the Escambia River and update distribution of crystal darters.	Monitoring & Research	NEW	YES	YES	\$25-50k	Existing budget OR Unknown	FWRI	Research Universities	Moderate - any additional information about the population would be beneficial.	Uncertain; funding unknown.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	1	10	Evaluate and implement a sampling design to determine population estimates of crystal darters from the Escambia River.	Monitoring & Research	EXPANDED	YES	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI	Research Universities	Moderate - any additional information about the population would be beneficial.	Feasible, but requires additional sampling.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	3	11	Annually re-sample crystal darter populations using the methods and techniques in (Actions 8 and 10) to determine whether crystal darter population trends can be determined.	Monitoring & Research	NEW	YES	YES	\$0-25k	Existing budget OR Unknown	FWRI	Research Universities	Moderate - any additional information about the population would be beneficial.	Feasible, but requires additional sampling.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	2	12	Resample recent crystal darter collection locations used to estimate population size. Analyze data to evaluate variability in probability of detection and determine the number of sample sites needed to determine probability of detection.	Monitoring & Research	NEW	YES	YES	\$25-50k	Unknown	FWRI, FFM	Research Universities	High - trend analysis is needed.	Feasible, but need to identify funding.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
1	2	13	Collect and analyze instream and landscape-level habitat information to determine the effect of these parameters on variability in detection.	Monitoring & Research	NEW	YES	YES	\$25-50k	Unknown	FWRI	Research Universities	High- needed to identify threats to species	Feasible, but need to identify funding	Yes, minimizing anthropogenic stressors to the species will protect critical habitat for the species.
1	2	14	Incorporate information collected during Action 12 to determine site-level occupancy.	Monitoring & Research	NEW	YES	YES	\$0-25k	Existing budget OR Unknown	FWRI	Research Universities	High - need to analyze information.	Feasible, but need to identify funding.	No, sampling is not critical to the immediate survival of the species, but knowing the current status is necessary.
2	4	15	Collect and analyze tissue samples from crystal darters to describe the genetic characteristics of populations or subpopulations.	Monitoring & Research	NEW	YES	YES	\$25-50k	Unknown	FWRI	Research Universities	High - will provide important population genetics information.	Feasible.	No, tissue samples are not critical to the immediate survival of the species, but understanding the genetic interaction is necessary.

**Table 1. Crystal Darter (*Crystallaria asprella*) Conservation Action Table**

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for Implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
2	4	16	Compare genetic structure of Florida crystal darters to other populations within the Escambia-Conecuh watershed and adjacent watersheds to determine if translocation or supplementation of crystal darter populations is feasible or needed.	Monitoring & Research	NEW	YES	YES	\$25-50k	Unknown	FWRI	Research Universities, USFWS, state agencies	Moderate - source populations need to be identified before genetics can be compared.	Feasible, but coordination between agencies in other states may be necessary.	No, tissue samples are not critical to the immediate survival of the species, but understanding the genetic interaction is necessary.
1	4	17	If translocation is necessary, identify a suitable source population of crystal darters to augment the Florida population.	Monitoring & Research	NEW	YES	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI	Research Universities	Moderate - any additional information about the population would be beneficial.	Unknown, suitable source population must be identified.	Unknown, may not be necessary.
1	4	18	If translocation is not feasible and propagation is determined necessary for reintroduction, then develop, evaluate, and implement techniques to propagate crystal darters in a hatchery.	Monitoring & Research	NEW	YES	YES	\$25-50k	Unknown	FWRI, FFM	Research Universities	Moderate - any additional information about the population would be beneficial.	Feasible, facilities exist for propagating crystal darters.	Unknown, may not be necessary.
1	3	19	Require that intentional take permits contain comprehensive site-specific collection data, including negative capture data, sampling staff, sampling protocol, environmental data (habitat and water quality characteristics) and associated fish communities.	Protections & Permitting	EXPANDED	YES	YES	\$0-25k	Existing budget	HSC, FFM, Permitting	None	High - provides beneficial information about the species and provides protection to the population.	Feasible.	Yes, will supplement data collected during research.
1	3	20	Require that the FWC Regional Fisheries Administrator consult with the FWC Fish Taxa Coordinator prior to issuing intentional take permits and send the collection information described in Action 19 to the FWC Fish Taxa Coordinator following collection events.	Protections & Permitting	EXPANDED	YES	YES	\$0-25k	Existing budget	Permitting, FFM	None	High - provides beneficial information about the species and provides protection to the population.	Feasible.	Yes, coordination and collaboration within divisions is critical
1	4	21	Develop outreach and education programs to inform stakeholders about the conservation of crystal darters and associated threats.	Incentives & Influencing	NEW	YES	YES	\$0-25k	Existing budget OR Unknown	FWC	FWC, NFWFMD, DEP, USFWS	Low.	Feasible.	No, outreach materials should not be critical to the immediate survival of the species.
2	4	22	Investigate the development of a watershed-based Habitat Conservation Plan (HCP) for multiple aquatic species in the basins containing crystal darters.	Incentives & Influencing	EXPANDED	NO	YES	\$0-25k	Existing budget	FWC	USFWS	Moderate - may provide additional protection to crystal darters.	Feasible.	Yes, the intent is to make sure the effects of issuing a take permit are adequately minimized and/or mitigated, which may be critical to the immediate survival of the species.
2	3	23	Develop a conservation banking program for species identified on Florida's Endangered and Threatened Species List.	Incentives & Influencing	ONGOING	NO	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI	USFWS	Moderate - land management is important to the conservation of the species.	Feasible.	Yes, water and land management activities may be critical to the immediate survival of the species.
1	4	24	Develop outreach material for FWC Law Enforcement, DEP, NFWFMD, local governments, federal agencies, and the public to identify and implement conservation actions that minimize water quality impacts from unpaved roads, agriculture and silviculture, riparian zone management, and development within the upper Escambia watershed.	Education and Outreach	EXPANDED	NO	YES	\$0-25k	Existing budget OR Unknown OR Grant	HSC, FFM	DEP, TNC, NFWFMD, FFS	Moderate - land management is important to the conservation of the species.	Feasible.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	5	25	Use existing programs to fill data gaps for and reduce potential impacts to crystal darters on private lands.	Coordination with Other Entities	ONGOING	YES	YES	\$0-25k	Existing budget	HSC, FFM, FWRI	Landowners	Moderate - will update gaps in knowledge.	Highly feasible.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.
1	4	26	Coordinate with universities, research institutes, non-governmental organizations, and other agencies to achieve actions relating to Habitat Conservation and Management and Monitoring and Research, creating an approach for determining population status and for education and outreach efforts.	Coordination with Other Entities	NEW	YES	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI, HSC	DEP, TNC, NFWFMD, FFS	High - regulatory agencies are required.	Feasible, but contingent on staff flexibility and funding, availability for habitat conservation, education, and outreach.	Yes, coordinating with partners to achieve actions will be critical to immediate survival of the species.
1	3	27	Communicate and coordinate with local and state regulatory agencies, water management districts (WMDs), and stakeholders to propose cooperative measures addressing habitat requirements and locations of specific threats to crystal darters and to propose measures to abate, alleviate, or mitigate the identified threats to habitats needed for crystal darter populations.	Coordination with Other Entities	NEW	YES	YES	\$0-25k	Existing budget OR Unknown OR Grant	FWRI, HSC	DEP, TNC, NFWFMD, FFS	High - FWC alone will not be able to conduct all aspects of the plan, so participation of other agencies to gather data and implement conservation strategies will be critical to the success of this plan.	Highly feasible- contingent on regulatory agencies' interest and cooperation.	Yes, water and land management rules and land management activities may be critical to the immediate survival of the species.

**Table 1. Crystal Darter (*Crystallaria asprella*) Conservation Action Table**

Objective(s) Addressed	Team Assigned Priority Level	Action Item Number	Action Items	Conservation Action Category	Ongoing, Expanded or New Effort?	Authority	Man Power	Estimated Cost To Implement	Funding Source(s)	Lead for implementation: FWC Program(s) and/or Section(s)	External partners	Likely Effectiveness	Feasibility	Urgent?
2	5	28	Maintain current records for crystal darter in the Florida Wildlife Conservation Guide (FWCG).	Coordination with Other Entities	ONGOING	YES	YES	\$0-25k	Existing budget	FWC	USFWS, FNAI	High - will provide an easily accessible repository of wildlife life history, habitat management, and conservation options.	Feasible.	No, maintaining current records is not critical to the immediate survival of the species, but it can facilitate effective land use planning, project design, and the management of the species.

**Acronyms used in this table:**

- BMP: Best Management Practices
- DEP: Florida Department of Environmental Protection
- DOACS: Florida Department of Agricultural and Consumer Services
- F.A.C.: Florida Administrative Code
- FFM: Freshwater Fisheries Management, a Division of the Florida Fish and Wildlife Conservation Commission
- FFS: Florida Forest Service
- FNAI: Florida Natural Areas Inventory
- FWC: Florida Fish and Wildlife Conservation Commission
- FWRI: Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
- HCP: Habitat Conservation Plan
- HSC: Habitat and Species Conservation, a Division of the Florida Fish and Wildlife Conservation Commission
- MFL: Minimum flows and levels
- NWFWMD: Northwest Florida Water Management District
- TNC: The Nature Conservancy
- USFWS: United States Fish and Wildlife Service
- WMD: Water Management District(s)

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