A Species Action Plan for the Harlequin Darter *Etheostoma histrio*

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HARLEQUIN DARTER ACTION PLAN TEAM

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EXECUTIVE SUMMARY

The Florida Fish and Wildlife Conservation Commission (FWC) developed this plan as a component of Florida's Imperiled Species Management Plan (FWC 2016). In 2017, the FWC convened a biological review group (BRG) to reassess the status of the harlequin darter (*Etheostoma histrio*) by using criteria specified in Rule 68A-27.001, Florida Administrative Code (F.A.C.). The Biological Status Review report determined that the harlequin darter does not meet state listing criteria. Based on results from recent research in population demographics, FWC staff recommended the harlequin darter be removed from the Florida Endangered and Threatened Species List as a Species of Special Concern based on the BRG's findings. The goal of this plan is to maintain or improve the conservation status of the harlequin darter so that the species will not again need to be listed on the Florida Endangered and Threatened Species List.

The BRG identified habitat degradation reducing the water quality, habitat fragmentation resulting in loss of genetic fitness of the Florida population and the physical loss of habitat resulting from dredging and excessive removal of large woody debris as the most likely threats to harlequin darters. These risks are substantially addressed by existing programs within the FWC as well as other state agencies, such as the Florida Department of Environmental Protection and the Northwest Florida Water Management District. Programs covering water quality, deadhead logging, and general fish population monitoring within the Escambia River watershed are in place and adequately funded.

The actions outlined in this plan are designed to support progress towards the objectives: 1) take appropriate actions to collect valid population demographic information on the harlequin darter to determine population abundance and trend data for this species in Florida waters, and 2) maintain adequate required habitat (large woody debris) within the Escambia watershed, both within the waterways itself as well as the riparian zone document. Actions are organized into the following sections: Habitat Conservation and Management, Population Management, Monitoring and Research, Rule and Permitting Intent, Law Enforcement, Incentives and Influencing, Education and Outreach, and Coordination with Other Entities.

Successful management of the harlequin darter through the implementation of this plan requires the cooperation of local, state, and federal governmental agencies; non-governmental organizations; business and industrial interests; universities and researchers; and the public. The FWC developed this plan in collaboration with stakeholders, and its successful implementation requires cooperation and coordination with other agencies, organizations, private interests, and individuals.

This plan details the actions necessary to maintain the conservation status of the harlequin darter. A summary of this plan is included in Florida's Imperiled Species Management Plan (FWC 2016), in satisfaction of the management plan requirements in Rule 68A-27, Florida Administrative Code, Rules Relating to Endangered or Threatened Species. Florida's ISMP addresses comprehensive management needs for Florida's imperiled species and includes an implementation plan; regulatory framework; relevant policies; anticipated economic, ecological, and social impacts; projected costs of implementation; and a revision schedule. Achieving the objectives of the ISMP depends heavily on stakeholder input and partner support.

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GLOSSARY OF TERMS AND ACRONYMS

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-27.001, Florida Administrative Code (F.A.C.), 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. 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 Chapter 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 or 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

FDACS: Florida Department of Agriculture and Consumer Services

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.

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

GFC: Florida Game and Fresh Water Fish Commission, predecessor to the FWC.

GIS: Geographic Information System

GPS: Global Positioning System

ISMP: Florida's Imperiled Species Management Plan

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.

LTM: Long-term monitoring

MFL: Minimum flows and levels, the minimum water flows and/or levels adopted by the District Governing Board as 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

INTRODUCTION

Biological Background

The harlequin darter is classified within the phylum Chordata, class Actinopterygii, order Perciformes, and family Percidae. Originally classified *Etheostoma (Ulocentra*) *histrio* (Gilbert 1887), the harlequin darter specific sub-generic classification has been under debate for some time. Steinberg et al. (2000) recognized the species as a member of the sub-genus *Etheostoma*, lending to the current taxonomic classification as *Etheostoma (Etheostoma) histrio*. The etymology of "*histrio*" is in reference to the spots and stripes about the head and their similarity to a mask, as worn by a harlequin (or a comic character).

Life History

The life history of harlequin darters is poorly understood. They are small benthic fish, cryptic in nature, and attain a maximum size of about 7 cm (2.7 in). They are easily distinguishable from other darters within their range by the presence of 2 large, dark brown or green spots on the caudal fin base, a tear drop-shaped spot below the eye, 6 to 7 dorsal saddles, and 7 to11 dark brown mid-lateral blotches (Boschung and Mayden 2004, Page and Burr 2011). Both females and non-reproductive males tend to be yellow to green dorsally. During breeding season, males are emerald green with brown and black mottling and may have a red distal dorsal band (Mettee et al. 1996).

It is presumed that harlequin darter spawning begins in February or March (Gilbert and Yerger 1992). Although little is known regarding spawning site selection, it has been hypothesized that sexually mature individuals move to deeper water of large streams and rivers to attach eggs to woody debris (Kuhajda and Warren 1989, Bass et al. 2004). Fecundity was estimated as 456 eggs/mature female (Kuhajda and Warren 1989). Sexual maturity is reached at 1 year, while maximum age is around 4 years (Kuhajda and Warren 1989, Boschung and Mayden 2004).

Harlequin darters are found in a variety of habitats, but typically the species occurs in medium to large streams with variable stream currents, and substratum categories ranging from mud to bedrock (Boshcung and Mayden 2004). Surveys conducted in Illinois found harlequin darters exclusively on woody debris (root wads, logs and brush) that were secured in substrate and had an established invertebrate population (Henry et al. 2009). Regardless of habitat type, the species is always associated with detritus (Boschung and Mayden 2004). Harlequin darter diet consists almost exclusively of larval insects, such as midges and black fly, caddis fly, and may fly larvae.

Geographic Range and Distribution

Harlequin Darters are widely distributed in the lower Mississippi basin, predominantly below the fall line. Occasionally the species is distributed above the fall line (Ohio, Arkansas, Embarras, and Green rivers) (Kuehne and Barbour 1983). Specifically, Harlequin Darters range from Illinois, Indiana, and Kentucky, south to the Escambia River and west to Texas (Burr et al. 1996, Burskey and Simon 2008, Kuhajda and Warren 1989, Boschung and Mayden 2004, Etnier and Starnes 1993, Page 1983, Hubbs and Pigg 1972). In Florida, Harlequin Darters are only known from the Escambia River (Escambia/Santa Rosa counties). The species was first collected from Florida by Yerger and Suttkus (1962), and additional records were sporadic for the species from 1962 to 2009 (36 collections). However, from 2010 to 2017 an additional 139 collection

locations were discovered (FWC Long-term Monitoring Database 2017, unpublished data). Harlequin Darters are found in both the mainstem Escambia River and its tributaries; Big Escambia, Little Escambia, Pine Barren, Canoe, and Mitchell creeks (Figure 3). Collection records from the mainstem range from the Escambia River at the Florida/Alabama state line, south to the White River section of the Escambia (17.5 km ESE of Milton Florida) (FWC Long-term Monitoring Database 2016, unpublished data).

Recently, FWC staff conducted a species directed study on the harlequin darter within Big Escambia and Pine Barren creeks. By using multi-census mark-recapture methods and visual survey techniques, the population of harlequin darters was estimated at greater than 10,000 individuals from just these 2 creeks, which represent only 2.4% of the Escambia River watershed area (Harriger and Knight 2017, FWC unpublished data). This newly gathered information suggests that harlequin darters are much more abundant than previously thought, however it does not inform the long-term trends in population status.

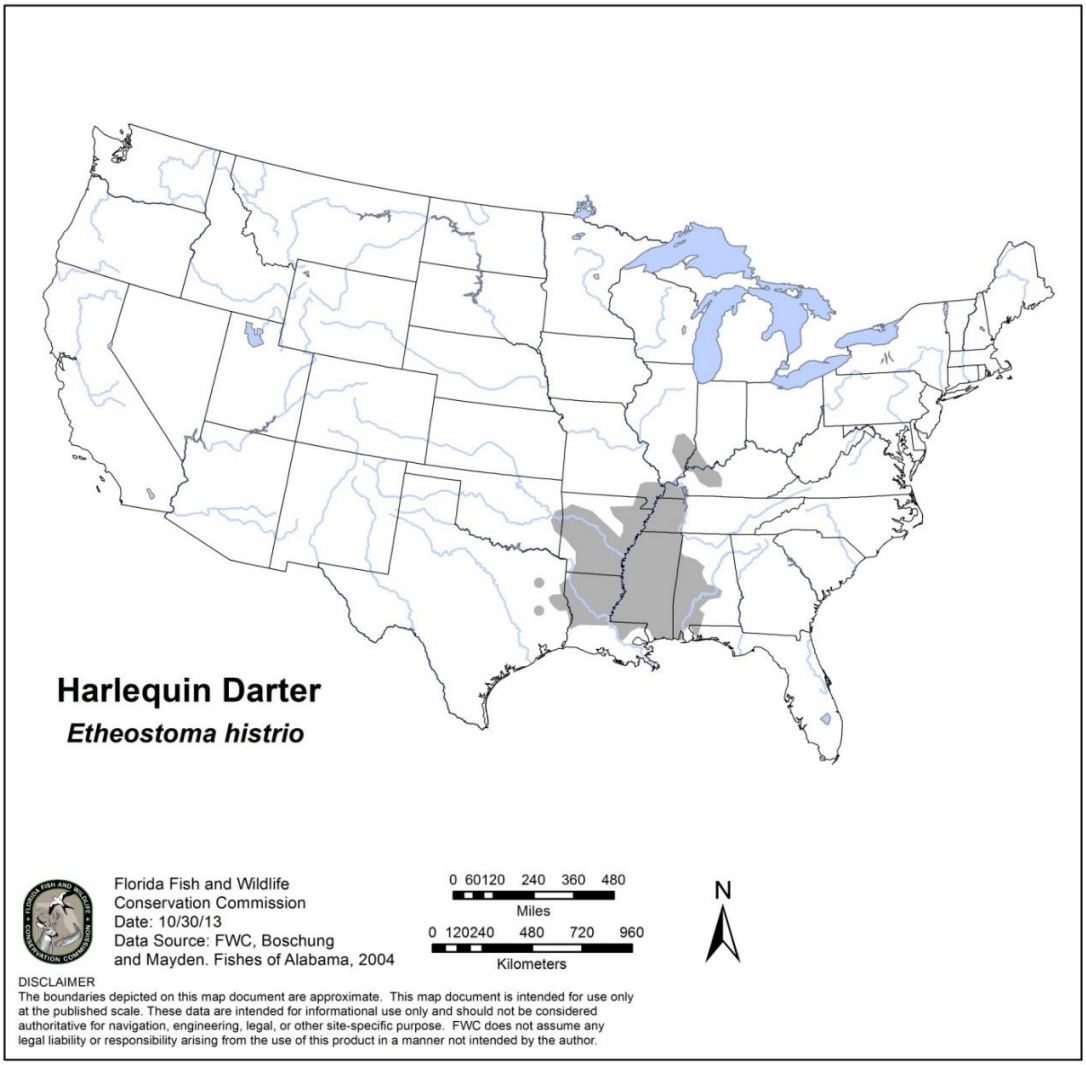

Figure 1. Range-wide distribution of the harlequin darter (*Etheostoma histrio*) in the United States.

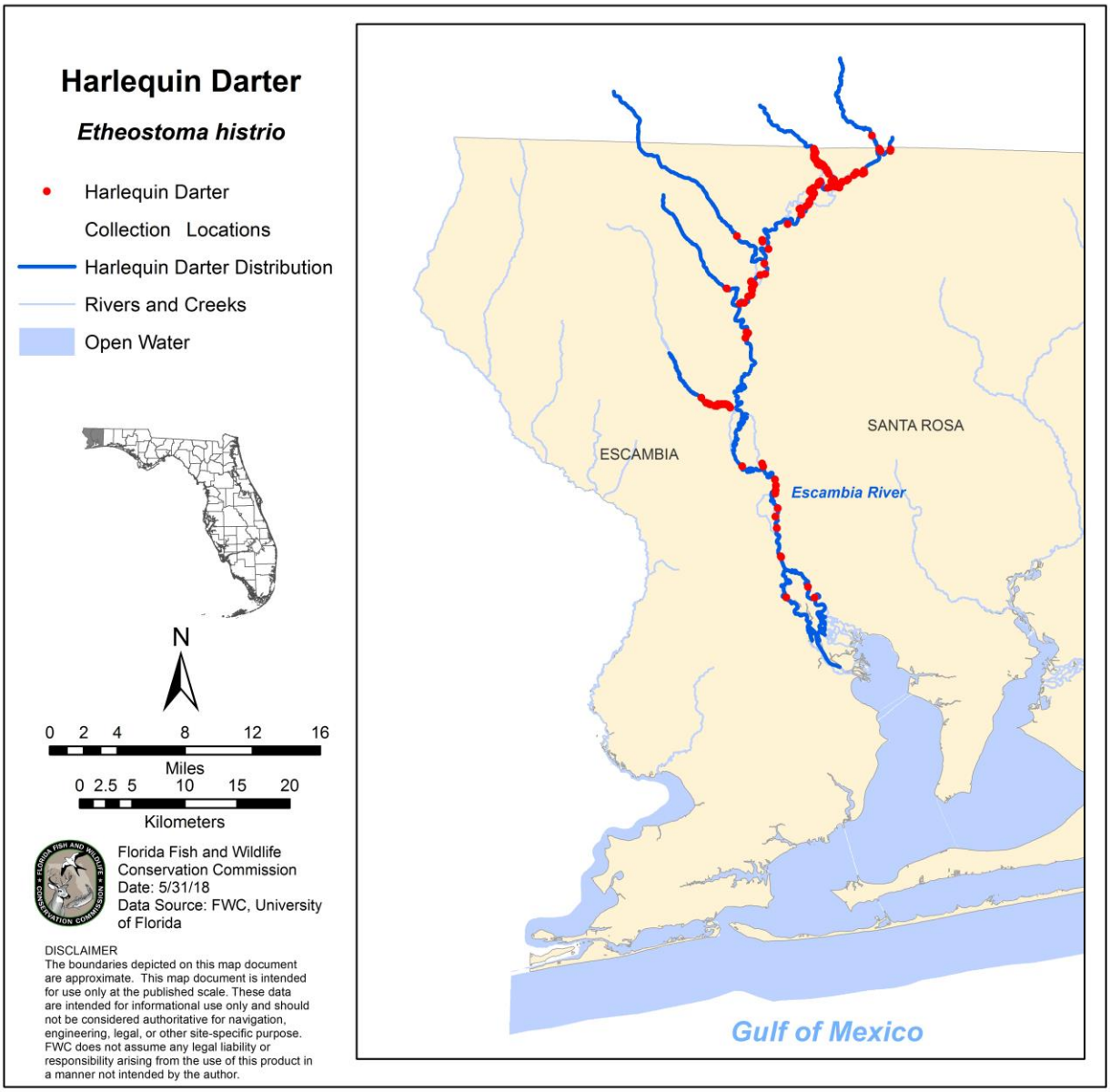

Figure 2. Distribution and range of the harlequin darter in Florida.

Conservation History

In 1977, the Florida Game and Fresh Water Fish Commission (GFC; predecessor to the FWC) listed the harlequin darter as a state-Threatened Species based on the belief that the species had a restricted range. In 1979, the harlequin darter was maintained as a listed species but reclassified to a Species of Special Concern.

No targeted conservation actions have been undertaken for the harlequin darter within the Escambia River in Florida. Limited conservation easements exist within the range of the species (Figure 3). Harlequin darters indirectly benefit from instream habitat protection resulting from land acquisitions, specifically by the Northwest Florida Water Management District (NWFWMD). Approximately 14,160 ha (35,500 ac) of floodplain, bottomland, and upland

forests were preserved from the State Road 90 Bridge crossing in Pensacola north to the State Road 4 Bridge crossing at Century (Florida Natural Areas Inventory 2011; Figure 3).

Harlequin darters residing in tributaries of the Escambia River have received little conservation attention, except for Big Escambia Creek. Nearly 8 km (5 mi) of stream length and 404 ha (1,000 ac) of wetlands were restored in the Big Escambia Creek Restoration Project. Currently no other stream systems within the range of the harlequin darter have received conservation attention or protection. In fact, the range of the harlequin darter doesn't include any designated Outstanding Florida Waters (Chapter 62-302.700, F.A.C.).

Figure 3. Distribution of the harlequin darter and associated conservation lands from the Escambia watershed.

Threats and Recommended Listing Status

Threats

The Florida harlequin darter population is restricted to a single watershed (Escambia), which makes the species susceptible to a catastrophic event within that watershed. Additional populations are available within the tributaries of the Escambia River, which could potentially re-populate a mainstem population if such an event were to occur. Harlequin darters occur in the Escambia River (Conecuh River in Alabama), but that population is partially fragmented from a source population north of Point A dam (Point A Reservoir, Andalusia, Alabama).

Habitat degradation is often considered the greatest threat to imperiled species (Wilcove et al. 1998). Certain land practices within the Escambia River watershed could negatively impact harlequin darter populations. Specifically, land use practices that result in both increased sediment and nutrient loads in the streambed, alterations in the hydrologic regime, destruction of habitat, and changes in shoreline morphology are the primary stressors affecting imperiled aquatic taxa (Richter et al. 1997). Excessive sediment loads and high turbidity may decrease reproductive success of harlequin darters by reducing visual contact between spawning individuals and preventing eggs from attaching to hard substrates (Steinberg et al. 2000). In addition, harlequin darters are always associated with some form of detritus (sticks, logs, leaves, roots), and presumably forage and attach their eggs to this instream material (Etnier and Starnes 1993, Boschung and Mayden 2004, Henry et al. 2009). Therefore, excessive snag removal within the Escambia River and tributaries could potentially negatively impact spawning success as well as fitness due to loss of foraging grounds (Bass et al. 2004, Henry et al. 2009).

Habitat fragmentation resulting from human-induced activities also poses a potential threat to harlequin darters by preventing movement of harlequin darters between groups that may become isolated. Fragmentation due to impounding of lotic waters may result in loss of genetic fitness for harlequin darters in Florida (Frankham 1996, Boschung and Mayden 2004). It was previously believed that the harlequin darter was found only within restricted sections of the Escambia River and its tributaries in Florida. Historically, knowledge about the species was very low, and FWC collections prior to 2010 were an inadequate representation of the actual population size and distribution. This was due to difficulties associated with collecting the species by using conventional sampling methods. With the increase in effort associated with standardized long-term monitoring (LTM) program within its range coupled with directed sampling efforts, harlequin darters are now known to have a much greater distribution throughout the Escambia watershed (Harriger and Knight 2017).

Recommended listing status

Florida's ISMP identifies the need to re-assess all remaining Species of Special Concern by 2017. When the FWC evaluated the harlequin darter in 2010, information on population size was lacking. Additional literature reviews and studies have since been conducted. In 2017, a biological review group (BRG) of experts on the harlequin darter was subsequently convened to assess the biological status of the species using criteria specified in Rule 68A-27.001, F.A.C., and following the protocols in 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 in the final BSR report. Based on this biological assessment, the BRG concluded that the harlequin darter does not meet any listing criteria. Based on literature review and the BRG findings, FWC staff recommended the harlequin darter not be listed as Threatened on the Florida Endangered and Threatened Species List, and that it no longer be listed as a Species of Special Concern. No information was received from the public during the information request period.

CONSERVATION GOAL AND OBJECTIVES

Goal

Conservation status of the harlequin darter is maintained or improved so that the species will not again need to be listed on the Florida Endangered and Threatened Species List.

Objectives

I. Take appropriate actions to collect valid population demographic information on the harlequin darter to determine population abundance and trend data for this species in Florida waters.

Rationale

The BRG concluded that the harlequin darter does not meet any listing criteria (FWC 2017). However, recently completed species-directed sampling concluded that there are more than 10,000 mature individuals in just a small fraction of the watershed. This information supports the determination that the harlequin darter does not meet criteria for state-listing. However, more population demographic data is needed to properly monitor this species and aid in the conservation of it within Florida. FWC staff have recently developed a method to predict darter abundance stream-wide in wadable streams. To date, this has only been applied to 2 of the 5 tributaries that harlequin darters inhabit in Florida. Reliable methods for quantifying harlequin darter abundance in the mainstem are still lacking, and a practical and efficient method of determining abundance in non-wadable waterways (i.e., mainstem Escambia River) will require more research to develop a quantitatively valid index of abundance. Once a quantitative measure of abundance is available, a population trend assessment may be feasible.

II. Maintain adequate required habitat (large woody debris) within the Escambia watershed, both within the waterways itself as well as the riparian zone.

Rationale

The status of the harlequin darter in Florida is difficult to determine due to cryptic nature and complex instream habitats inhabited that make the species difficult to collect. The BSR notes that harlequin darters are strongly associated with woody debris, and recent research found that sites that had more woody debris had higher abundances of harlequin darters (FWC 2017). Research also showed that harlequin darters are not evenly distributed throughout the watershed, and that presence seems to be driven largely by the availability of embedded, stable woody debris, colonized by invertebrates (Henry et al. 2009, Harriger and Knight 2017). While currently there is no reliable method to directly determine the abundance of harlequin darters in the mainstem of the Escambia, it is possible to monitor large embedded woody debris using side scan sonar, and use this as a surrogate for harlequin darter abundance. FWC's long-term monitoring program has recently had increased success in collecting harlequin darters (236 individuals collected from 2010 to 2017) from mainstem Escambia River while conducting non-directed species sampling (FWC Long-term Monitoring Database 2017, unpublished data). Data collected during ongoing LTM can confirm continued presence of harlequin darters and increase confidence in associating overall population health with the availability of adequate amounts of large woody debris.

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.

The best available information suggests the harlequin darter is more widely distributed throughout the Escambia watershed (both in the mainstem and tributaries) than documented when the GFC listed the species in 1977. However, there is a need to evaluate the available information and act to enhance our knowledge of the overall population status, trends, and habitat associations for the species. All near-term actions are based on the need to collect this information.

Habitat Conservation and Management

The harlequin darter has a narrow geographic range within Florida, restricted to the Escambia watershed (mainstem and larger tributaries). These populations are vulnerable to natural or anthropogenic catastrophes that can cause permanent extirpation. Therefore, the physical habitat and water quality and/or quantity within the Escambia watershed should be maintained and managed to prevent irreversible harm to the population.

Ten Escambia sub-watersheds were identified as priority watersheds for harlequin darters based on locations of historical and current collection data (Figure 4). Protecting the integrity of both instream and riparian habitats within each of these watersheds will be important for the long-term survival of harlequin 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) maintain instream habitats within the Escambia watershed by minimizing removal of woody structures, and 3) minimize impacts to riparian vegetative buffers along streamside zones within both the Escambia River proper and tributaries harboring harlequin darter populations.

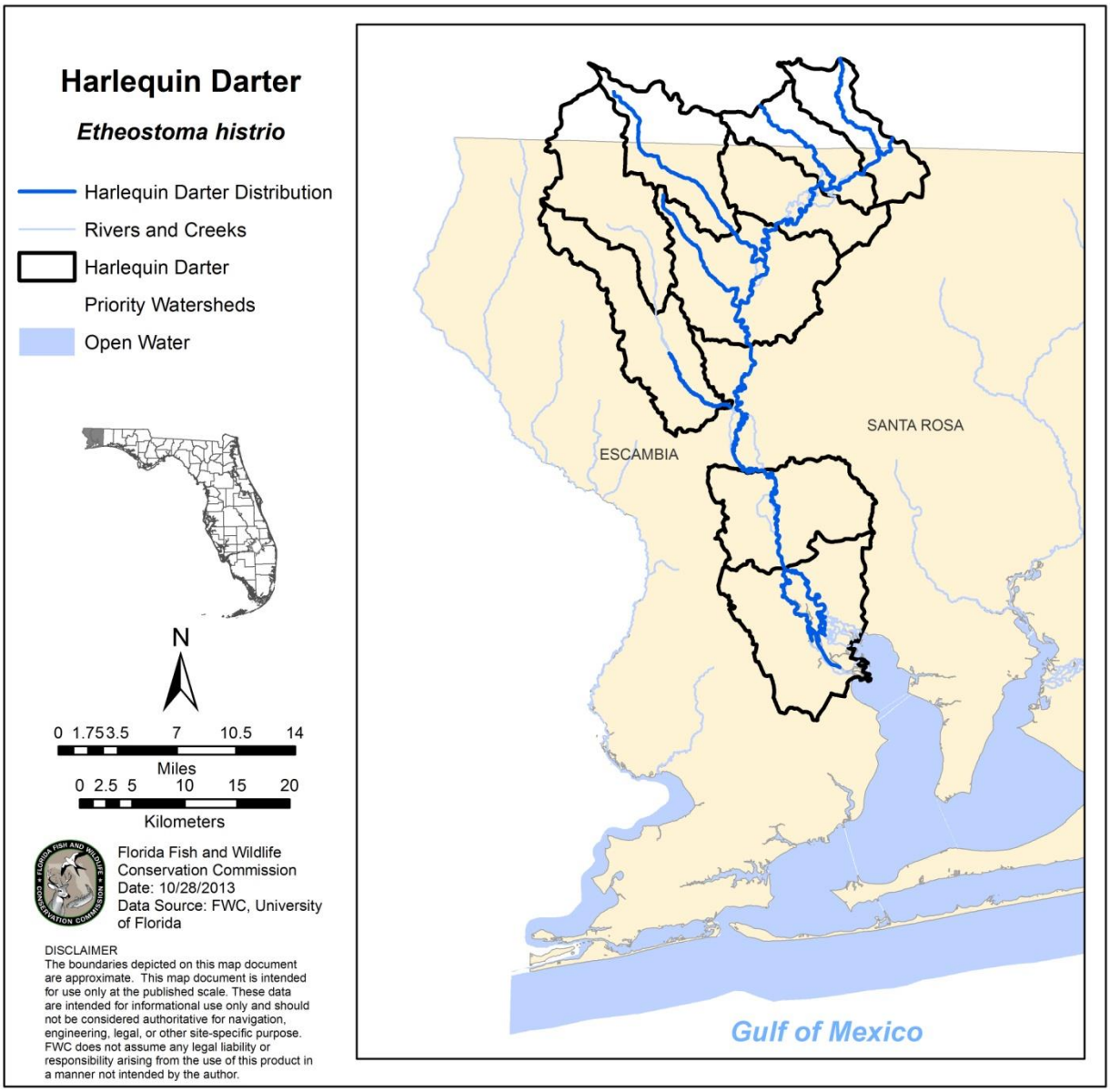

Figure 4. Priority sub-watersheds for the harlequin darter within the Escambia River watershed, Florida.

Action 1 Identify stream and river reaches that support harlequin darter populations. Provide locations and harlequin darter habitat requirements to regulatory agencies.

Action 2 Identify additional locations for water quality monitoring within the harlequin 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 United States Environmental Protection Agency, United States Army Corps of Engineers, Florida Department of Environmental Protection (DEP), and the NWFWMD 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 are 2 status monitoring sites located within or close to priority and historic harlequin darter sub-watersheds. These monitoring sites are in the Escambia River drainage (Escambia River Hwy 4 Bridge–Site 305758087140401; Escambia River at Hwy 184 Bridge–Site 304014087160101).

FWC recommends establishing additional water quality monitoring stations within the Escambia watershed. Since current monitoring stations are primarily associated with mainstem river segments, additional water quality stations in tributaries (near known harlequin darter locations) will provide data allowing patterns and trends of smaller-order tributaries to be compared against high-order river segments. Additional sites where sampling would be beneficial for monitoring harlequin darter populations include Big Escambia, Little Escambia, Pine Barren, Canoe, and Mitchell creeks (Figure 2).

These data can be used in conjunction with habitat-use information (discussed in Monitoring and Research) to create minimum flows and level (MFL) rules. Establishing MFLs is a state legislature requirement under Chapter 373.042(2), Florida Statutes. MFLs identify a range of water flows and/or levels above which water might be permitted for consumptive use. Consumptive 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 NWFWMD has not initiated development of MFLs within the Escambia watershed.

These data, coupled with habitat information collected (discussed in Monitoring and Research), can also be used to predict new locations of occupancy. If new locations are discovered, the habitat conservation and management actions described above will be implemented for new locations.

Action 3 Minimize removal of instream habitats such as large, woody structures within the Escambia watershed.

While numerous aspects of the harlequin darter's life history are unknown, the unifying characteristic of its habitat is use of detritus (Etnier and Starnes 1993, Boschung and Mayden 2004, Henry et al. 2009). In Florida, harlequin darters are exclusively collected from locations that contain some form of woody material (Harriger and Knight 2017). The species is occasionally encountered on gravel and sand bars only when embedded woody material is present (Hubbs and Pigg 1972; J. Knight, unpublished data). Therefore, it is critical to minimize the removal of woody material from stream channels within the Escambia watershed. DEP manages deadhead logging permitting in all Florida rivers, restricting authorized snag removal to only those trees that were previously felled by the lumber industry. DEP permits no removal of deadfall or stormfall trees, since this constitutes natural habitat for darters, turtles, alligators, sportfish, birds, and other species. Furthermore, DEP coordinates with FWC and U.S. Fish and Wildlife Service to ensure that deadhead logging will not impact protected mussels, Gulf sturgeon (*Acipenser oxyrinchus desotoi*), or other listed species. There are presently very few deadhead logging permits issued for the Escambia River.

Removal of large woody debris from stream channels can have direct and indirect effects on harlequin darter populations. Given that the harlequin darter's preferred habitat is woody material, excessive removal would most likely negatively affect populations. Furthermore, excessive debris removal may cause numerous indirect effects on harlequin darter populations by reducing habitat heterogeneity (Angermeier and Karr 1984); channel stability (Bilby and Likens 1980); refugia from predation (Angermeier and Karr 1984); and, presumably, available spawning habitat (Bass et al. 2004). Therefore, FWC staff recommends developing materials that define conservations measures needed to maintain instream habitats that are critical to harlequin darter populations for land managers within the Escambia watershed.

Action 4 Minimize impacts to riparian vegetative buffers along streamside zones where harlequin darters are known to occur.

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, thereby increasing water quality. They also provide nutrients, vegetative cover, and detritus to riverine systems.

Most riparian zones along the mainstem Escambia River (where the harlequin darter occurs) are under public lands conservation, and as previously mentioned, some areas have been restored as part of the Big Escambia Creek Restoration Project completed in 2005. However, most of the remaining tributary riparian zones within the Escambia watershed are not adequately protected

Protection of tributary riparian zones will require coordination between federal state and local regulatory agencies. Most unprotected riparian zones along Escambia River tributaries are privately owned, so the agencies will need to discuss best management practices (BMPs) with stakeholders. In many cases, it will be important to discuss appropriate riparian zone widths with landowners, and how improvements (if needed) can be made to riparian zones. FWC staff recommends a 100-ft (30.5-m) minimum riparian zone be maintained along the mainstem of rivers that contain harlequin darters. For all other streams (where endangered species are not present), we recommend a 50-ft (15.2-m) minimum riparian zone.

Agencies may also need to reinforce the value of following BMPs to maintain the health of the Escambia River watershed to stakeholders. The Florida Department of Agriculture and Consumer Services (FDACS) developed BMPs designed to protect water quality by reducing inputs of sediments, nutrients, logging debris, and chemicals for silviculture and other agricultural practices (FDACS 2011). These BMPs are set in Rule 5I-6, F.A.C., and are regulated by the Florida Forest Service Hydrology Section.

Action 5 Use standardized techniques to create habitat maps depicting large woody debris using combination of side-scan sonar and digital processing techniques to monitor habitat availability over time.

Recently, FWC has added side-scan sonar habitat mapping to the LTM sampling protocol. These maps are planned to be generated between 2-3 times over a 10-year period for those areas

monitored by LTM. These maps can be further processed to identify, and quantify amount of large woody debris available within the mainstem portion of the Escambia River.

Population Management

Given that basic population dynamics and density estimates for the harlequin darter are currently only available for a very small portion of this species range in Florida, the following actions are intended to provide stakeholders with guidance on how to determine the current distribution and abundance of the species within the Escambia watershed. Specifically, FWC will provide guidance on sampling design and techniques needed to collect harlequin darters from the Escambia watershed. Distribution of the species can then be updated using new data collected during sampling.

Action 6 Develop or refine species-specific sampling protocols needed to collect harlequin darters from both the mainstem Escambia River or find suitable surrogate for monitoring trends in abundance over time (i.e. changes in available large woody debris over time using side scan sonar).

Action 7 Use species-specific sampling protocols to develop population abundance estimate of harlequin darters in all wadable habitats occupied.

FWC monitors sport fish populations and fish communities from the Escambia River proper and Big Escambia Creek (Strickland et al. 2011). Harlequin darters are typically collected at 2 or 3 new locations per year from both waterbodies. Since this monitoring program uses a community-based sampling approach, additional species-directed techniques were developed to estimate abundance in non-monitored (wadable) tributaries. Currently, abundance estimates are only available for 2 of the tributaries occupied by harlequin darters. Using the validated technique of extrapolating harlequin darter abundance based on amount of woody debris present, it will be possible to create a more robust population estimate of this species in the tributaries (Harriger and Knight 2017). Once this is determined, repeated sampling can allow for population trend analysis in the future (Harriger and Knight 2017).

Monitoring and Research

The BRG identified a lack of data on harlequin darter population size and population trends as significant limiting factors in determining the long-term viability of this species in Florida. Peer reviewers concurred with those concerns. To address concerns and data gaps identified by the BRG, specific actions were identified for research and monitoring in order to achieve the conservation goal and objectives. Specifically, research is needed 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 harlequin darter population trends in Florida.

Effective monitoring and research of harlequin 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). Therefore, FWC recommends a multi-scale sampling design to determine the harlequin darter population trend in Florida. 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 in order to characterize site specific (micro-habitat) changes in occupancy. This approach provides a greater understanding to researchers of how both instream (e.g., sediment size, velocity) and landscape (e.g., geology, gradient) attributes influence harlequin darter population dynamics. Additionally, site-specific sampling is needed to determine persistence, stability, and probability of detection, and to characterize site occupancy on a finer spatial (micro-habitat) scale. This multi-scale approach will facilitate inferences about population status and trends on both temporal and spatial scales.

Since the FWC monitors fish communities from the Escambia River and Big Escambia Creek, information collected can be used to update harlequin darter distribution from a portion of its range. Harlequin darters are typically collected at 2 to 3 new sample locations per year, and all of this information is entered into FWC's databases. Therefore, harlequin darter distribution is updated annually but only from a portion of the known range. FWC staff recommends the following actions to update harlequin darter distribution throughout its range and re-evaluate area of occupancy in each priority sub-watershed.

Action 8 Follow FWC's standardized sampling protocol to update presence/absence information and identify new collection locations of harlequin darters from non-wadeable (monitored) sections of the Escambia watershed.

Action 9 Evaluate and implement new sampling protocols needed to update the distribution data of harlequin darters from small, wadeable (non-monitored) tributaries.

Action 10 Incorporate information collected by Actions 6, 7, 8 and 9 into databases in order to update harlequin darter distribution and range-wide area of occupancy.

Current FWC monitoring protocols collect harlequin darters annually (Strickland et al. 2011). Harlequin darter distribution is entered in FWC's databases and area of occupancy can be updated annually, within a portion of the species' range. However, catch rates are low, which means no meaningful population trend analysis is feasible. FWC staff created a baseline map of harlequin darter current and historical distribution (Figure 1), compiled from all available data. These data were used to identify where additional monitoring and research is needed. FWC also identified a preliminary set of priority sub-watersheds based on current and historical harlequin darter locations (Figure 4). Now that a suitable technique has been identified for collecting harlequin darters from tributaries of the Escambia watershed, an estimate of harlequin darter population size from selected tributaries is possible. However, research is still needed to determine which techniques are most effective at detecting and collecting harlequin darters from mainstem habitats. Therefore, FWC recommends the following actions to determine the minimum population size of harlequin darters from the Escambia watershed.

Action 11 Conduct sampling needed to establish population estimates of harlequin darters from selected tributaries and range wide.

A formal population estimate is likely to be feasible only within a portion of the known harlequin darter range (wadeable streams). Population estimates from non-wadeable sections of the Escambia River are not feasible due to naturally occurring high levels of dissolved organic carbon, which limits visibility and detection in habitats where harlequin darters typically occur (e.g., deep, moderate flow habitats with woody debris) in the river. Therefore, any harlequin darter population estimate generated as a result of Action 11 should be considered the minimum population size.

Several studies have demonstrated that visual survey sampling techniques (i.e., snorkeling) are an effective alternative to conventional fisheries gears (e.g., seines, electrofishing gear) used to characterize fish population demographic information in clear streams (Jordan et al. 2006, Albanese et al. 2011). Tributaries to the Escambia River where harlequin darters occur have naturally low levels of dissolved organic carbon. Therefore, visual survey techniques have been used successfully to estimate population demographic information from a portion of these waterbodies. The specific sampling approach (and analysis) has been developed by FWC and evaluated. A multiple-pass removal design has been frequently used to estimate population size (Angermeier and Smoger 1995, Simonson and Lyons 1995, Peterson et al. 2004). This approach increases the level of precision in the population estimates (Widmer et al. 2010). However, these estimates tend to be biased when abundance and/or capture efficiency is low, or when variability in capture efficiency among repeated sampling passes is high (Peterson et al. 2004). Capture (or mark–recapture) methods have also been used to estimate population size (Otis et al. 1978, Peterson and Cederholm 1984, Hankin and Reeves 1988, Rosenberger and Dunham 2005). FWC evaluated of both techniques and found that a multi-census mark-recapture methods and visual surveys using snorkeling gear were more than sufficient to estimate site abundance of harlequin darters in in tributaries of the Escambia River (Harriger and Knight 2017).

Information collected during a harlequin darter population estimate can also be used to inform the number of sampling locations needed to determine probability of detection. However, 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, potentially, site (micro-habitat) occupancy estimate would enable researchers to determine whether changes in the number of harlequin darter observations (or collections) over time represent 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 an acceptably 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). Therefore, FWC recommends the following actions to determine detection probability, and an estimate of site (microhabitat) occupancy.

Action 12 Resample (quarterly) recent harlequin darter collection locations used to estimate population size. Analyze data to evaluate variability in probability of detection and determine the number of sample sites and sampling events needed to determine probability of detection from wadeable (non-monitored) habitats.

Action 13 Resample (quarterly) recent harlequin darter locations from monitored habitats (i.e., (Escambia River and Big Escambia Creek) to determine probability of detection. Analyze data to evaluate variability in probability of detection and determine the number of sample sites and sampling events needed to determine probability of detection from these habitats.

Action 14 Integrate information collected from previous actions to determine harlequin darter area of occupancy within the Escambia watershed and update distribution of harlequin darters. 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., rare, cryptic, and/or difficult to collect species) (Bailey et al. 2004, Royle and Dorazio 2008). Such a design may be needed to accurately characterize the 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. 2007, Anderson et al. 2012).

Environmental and physical habitat information associated with locations occupied and unoccupied by harlequin darters is needed to improve the accuracy of the occupancy models. Additionally, there is need to inventory the Escambia watershed for these same environmental and physical habitat characteristics to compare use verses availability, which can be used to determine whether harlequin darters are selecting any particular instream or landscape level habitat feature (Johnson 1980). Information collected from these actions can be used to create a multi-scale predictive model to predict harlequin darter distribution in Florida. Specifically, Geographic Information System (GIS) data layers for harlequin darters can be used to identify new areas of potential occupancy. This information, combined with information collected from previous actions, will be valuable for evaluating harlequin darter population trends.

Rule and Permitting Intent

During previous listing as a Species of Special Concern, the harlequin darter was afforded protections against take. However, no specific harvest restrictions (e.g., bag limits, size limits, or harvest seasons) other than regulations that apply to all freshwater fisheries species (gear restrictions, etc.) exist for species that are not on the Florida Endangered and Threatened Species List. Additionally, a Freshwater Collection Permit is not automatically required for harlequin darter collection for scientific, educational, or exhibition purposes.

Currently, transportation and selling of harlequin darters is not of concern, so rule language does not need to include these components. Land-management activities intended to enhance natural communities may lead to incidental take of harlequin darters, but should be exempt from “take” permitting when following the guidance in Habitat Conservation and Management. Because the best current information indicates that this species, though restricted to the Escambia watershed, occurs throughout the watershed (Figure 1), the intent is to limit direct or intentional take and use non-regulatory methods to minimize incidental take until there is a better understanding of the population status, trends, habitat needs, and potential impacts from activities that might cause incidental take.

Permitting structure

No new protections are proposed for the harlequin darter. Once removed from the Florida Endangered and Threatened Species List, it will be protected from take under the general classification for nongame fish as defined by Rule 68A-1.004 (46), F.A.C. Collection (taking) of nongame fish is controlled by rules of Chapter 68A-23, F.A.C., which specify devices and methods that may be used to take nongame fish by persons that possess a valid freshwater fishing license. There is no documented importance of harlequin darters to recreational anglers, although they may be taken as incidental catch during bait-collection activities, in rare circumstances. Rule 68A-23.003, F.A.C., governs persons fishing under a commercial fishing license. Currently, there are no known commercial fishing operations that take significant numbers of harlequin darters. There are no known recreational or commercial uses of the harlequin darters.

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, incidental captures of harlequin darters should be reported by any study intended to collect crystal darters (*Crystallaria asprella),* which may be collected from similar habitats.

Law Enforcement

There is no additional law enforcement involvement proposed, outside of that normally afforded to nongame fish species under Chapter 68A-23, F.A.C.

Incentives and Influencing

There are no actions currently recommended for incentives and influencing specific to the harlequin darter.

Education and Outreach

Education and outreach are important components of managing imperiled aquatic species. Citizens who are well-informed regarding the merits of an imperiled species and the habitat that supports such species can make better decisions and can support sound conservation measures to secure those species' continued survival. Both formal and informal settings can serve as opportunities to inform Floridians about imperiled species.

Action 15 Coordinate with, and develop outreach material for, DEP, NWFWMD, local governments, federal agencies, and the public to identify and recommend implementation of conservation measures that minimize water quality impacts from unpaved roads, agriculture/silviculture, riparian zone management, and development within the Escambia watershed.

Action 16 Coordinate with these agencies, and develop material for land managers within the Escambia watershed to define conservations measures needed to protect and maintain instream habitats that are critical to harlequin darter populations.

Aspects regarding harlequin darters that need to be presented include:

- Indicators of habitat condition, water quality, and water quantity;
- Specific needs for continued survival;

- Unique characteristics and benefits to the ecology of a region; and
- Potential to provide medical breakthroughs, even if unforeseen today.

A unified and comprehensive approach to education and outreach will serve to inform the public regarding the means and needs to protect harlequin darters. A 2-tiered approach is needed to minimize impacts to harlequin darter populations. First, conservation measures are needed to minimize degradation of water quality resulting from anthropogenic land disturbances, by establishing water quality standards important to harlequin darter populations. The standards may be achieved by ensuring proper riparian zone management minimizes impacts of unpaved roads, agricultural/silvicultural practices, and development within the Escambia Watershed. Second, material is needed to identify, protect, and maintain instream habitats critical to harlequin darter populations. Specifically, material is needed to maintain and mitigate removal of large wood debris from the Escambia River and its tributaries.

Coordination with Other Entities

Action 17 Use existing programs to fill data gaps for, and reduce potential impacts to, harlequin darters (on private lands).

The FWC is a state review agency for several regulatory programs that affect potential harlequin darter habitat. These programs can be used to fill data gaps regarding species range and habitat associations. The FWC currently provides review and comments on the impacts of regulated activities on fish and wildlife, including impacts to harlequin darters and their habitat, such as commenting on deadhead logging permits issues by DEP.

Action 18 Coordinate with universities, research institutes, non-governmental organizations, and other agencies to achieve actions relating to habitat conservation and management, creating an approach for determining population status and for education and outreach efforts.

In order to meet the actions identified in Habitat Conservation and Monitoring and Monitoring and Research, FWC will need to work with public landowners, non-governmental organizations, and educational entities that manage conservation lands, can assist in data-collection efforts, or have particular expertise required by the actions. Further, many public and private land managers initiate monitoring efforts designed to identify species lists for the lands they manage.

Action 19 Communicate and coordinate with local and state regulatory agencies, water management districts, and stakeholders to propose cooperative actions addressing issues related to habitat requirements and locations of specific threats to harlequin darters and to propose cooperative actions to alleviate identified threats.

Action 20 Coordinate with partners and landowners on proposed conservation measures that should be utilized to alleviate threats to the area, extent, and quality of habitat occupied by the harlequin darter.

If needed, the FWC will develop criteria for preserving harlequin darter habitat on lands or waters slated for development. Types of criteria might include:

- Minimum acreages required to support sustainable populations of harlequin darters.
- Buffer distances around harlequin darter habitat to avoid degradation.
- Activities that cause permanent disturbance to the habitat of harlequin darters.
- Compatible land uses in or near harlequin darter habitat.
- Guidelines for habitat purchase and/or contribution to a fund for use in purchasing and managing lands for harlequin darter conservation.

Development of such criteria could form the basis of a permitting program or habitat acquisition program in the future. As additional information on harlequin darters is collected, coordination between FWC and local governments, other state agencies (i.e., DEP, FDACS, Florida Forest Service, Florida Department of Transportation, and NWFWMD), and federal agencies will be important in developing habitat acquisition and management guidelines. Funding sources for these programs will also need to be identified or developed. Sources may include Florida Forever program, conservation mitigation banks, or wetland mitigation banks for purchase and management of listed species habitat, including 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 the 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 FWC can streamline FWC's review process. This improvement can be implemented by FWC in coordination with the local government by adding 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/absence of harlequin darters. Requiring necessary listed species permits prior to issuing clearing or building permits, or by notifying FWC staff that harlequin darters or its habitat have been identified onsite, should expedite FWC's review and approval of permits required under FWC regulations.

Land development is governed by a variety of federal, state, and local government growth management and permitting processes or requirements. Some of the processes may include Joint Coastal Permits, Environmental Resource Permits, Sector Plans, Developments of Regional Impacts, Master Planned Unit Developments, and Mitigation Banking Permits. Most state and water management district 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, FWC can help determine presence/absence and help address avoidance, minimization, and/or mitigation prior to the permitting process. An Interagency Review Team would also provide FWC the opportunity to participate in large-scale local government planning efforts, would be able to coordinate with other permitting agencies to reduce redundancy in recommended conditions, and would be able to 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 harlequin darters.

Through development of a simple survey protocol (Action 5) for determining presence/absence of harlequin darters, or through knowledge of known locations (see Monitoring and Research), FWC can assist local governments and the regulatory agencies in protecting habitat for harlequin darters. If the presence of harlequin darters is determined, FWC can help the applicant avoid incidental take permitting by providing conservation measures (e.g., appropriate site design) 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.

Table 1. Harlequin darter conservation action table.

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

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
1	5	1	Identify stream and river reaches that support harlequin darter populations. Provide locations and harlequin darter habitat requirements to regulatory agencies	Habitat Conservation & Mgmt	ONGOING	FWRI, DFFM, HSC	TNC, FFS, DEP, NWFWMD	Medium- will benefit the species by further refining distribution	Highly feasible.	No, population status and distribution appear to be stable
1	2	2	Identify additional locations for water quality monitoring within the harlequin darter priority sub-watersheds.	Habitat Conservation & Mgmt	NEW	FWRI	TNC, FFS, DEP, NWFWMD	Medium - Monitoring water quality may be a key element to aid in determining stability	Feasible but may take some initial research to gather information for providing this guidance.	No,the majority of the range is protected and unlikely to be impacted by WQ changes, the exceptions being tributaries
2	1	3	Minimize removal of instream habitats such as large, woody structures within the Escambia watershed	Habitat Conservation & Mgmt	EXPANDED	FWRI, DFFM, HSC	TNC, FFS, DEP, NWFWMD	Medium to high- maintaining instream suitable habiitat is the key to persistance of the species	Feasible	Yes, maintaining habitat is critical the species persistance
2	1	4	Minimize impacts to riparian vegetative buffers along streamside zones where harlequin darters are known to occur.	Habitat Conservation & Mgmt	NEW	FWRI, HSC	TNC, FFS, DEP, NWFWMD, research institutions	Medium to high- maintaining riparian zones is key to preserving habitat	Feasible depending on which agencies are willing to work on this by partners	No, improved riparian buffers would only be applicale to tributaries, since the majority of the mainsteam is already maintained
1	3	5	Use standardized techniques to create habitat maps depicting large woody debris using combination of side-scan sonar and digital processing techniques to monitor habitat availability over time	Habitat Conservation & Mgmt	EXPANDED	FWRI	Research institutions	moderate to high. Quantifying available habitat will establish a baseline to assess trends	Highly feasible.	Yes; baseline is needed for future trend analysis
1	5	6	Develop or refine species-specific sampling protocols needed to collect harlequin darters from both the mainstem Escambia River or find suitable surrogate for monitoring trends in abundance over time (i.e. changes in available large woody debris over time using side scan sonar).	Population Mgmt	EXPANDED	DFFM	Research institutes and/or Universities	Moderate, developing an index to determine status and trends would be benefical for areas difficult to sample	feasible	No, not critical to long term survival of the species
1	4	7	Use species-specific sampling protocols to develop population abundance estimate of harlequin darters in all wadable habitats occupied.	Population Mgmt	EXPANDED	FWRI	Research institutes and/or Universities	Moderate- Abundnace is known from 2 of the 5 tributaries	feasible	No, existing sampling is not critical to persistance

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1	3	8	Follow FWC's standardized sampling protocol (LTM) to update presence/absence information and identify new collection locations of harlequin darters from non-wadeable (monitored) sections of the Escambia watershed	Monitoring & Research	ONGOING	FWRI	N/A	Moderate, such information will be beneficial to future trend analysis	highly feasible	No, existing sampling is not critical to survival.
1	5	9	Evaluate and implement new sampling protocols needed to update the distribution data of harlequin darters from small, wadeable (non-monitored) tributaries.	Monitoring & Research	EXPANDED	FWRI	Research Institutions and/or Universities	Moderate, any additional information about the population would be beneficial	feasible, but needs funding source.	No, not critical to long term survival of the species
1	3	10	Incorporate information collected by Actions 6, 7, 8 and 9 into databases in order to update harlequin darter distribution and range-wide area of occupancy.	Monitoring & Research	EXPANDED	FWRI	Research universities	Moderate- analysis could be used as a trend index	High feasibility. But needs funding source	No. But could become urgent in the future if a trend analysis is needed
1	3	11	Conduct sampling needed to establish population estimates of harlequin darters from selected tributaries and range wide.	Monitoring & Research	EXPANDED	FWRI	Research universities	Moderate- if needed my managers	Unknown feasibility, given species cryptic nature	No, not critical to the persistance of the species
1	5	12	Resample (quarterly) recent harlequin darter collection locations used to estimate population size. Analyze data to evaluate variability in probability of detection and determine the number of sample sites and sampling events needed to determine probability of detection from wadeable (non-monitored) habitats..	Monitoring & Research	NEW	FWRI, DFFM	Research universities	High - needed to ascertain trend analysis	Feasible. But need to identify funding	No- unless determined critical by management
1	5	13	Resample (quarterly) recent harlequin darter locations from monitored habitats (i.e., (Escambia River and Big Escambia Creek) to determine probability of detection. Analyze data to evaluate variability in probability of detection and determine the number of sample sites and sampling events needed to determine probability of detection from these habitats.	Monitoring & Research	NEW	FWRI	Research universities	moderate -if management agencies determinethis type of analysis is needed	Feasible. But need to identify funding	No, unless determined critical by management
1	3	14	Integrate information collected from previous actions to determine harlequin darter area of occupancy within the Escambia watershed and update distribution of harlequin darters.	Monitoring & Research	NEW	FWRI, DFFM	Research universities	High - needed for trend analysis	Feasible. But need to identify funding source.	No, unless determined critical by management

Table 1. Harlequin darter conservation action table.

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
1	2	15	Coordinate with, and develop outreach material for, DEP, NWFWMD, local governments, federal agencies, and the public to identify and recommend implementation of conservation measures that minimize water quality impacts from unpaved roads, agriculture/silviculture, riparian zone management, and development within the Escambia watershed.	Education & Outreach	NEW	FWRI	TNC, FFS, DEP, NWFWMD	High - FWC alone will not be able to conduct all aspects of the SAP, so participation of other agencies to gather data and implement conservation strategies will be critical to the success of this SAP.	Feasible- But need to identify funding source	No, unless determined critical by management
2	1	16	Coordinate with these agencies, and develop material for land managers within the Escambia watershed in order to define conservations measures needed to protect and maintain instream habitats that are critical to harlequin darter populations.	Education & Outreach	NEW	FWRI	TNC, FFS, DEP, NWFWMD	moderate. Much of the watershed is currently protected, except for tributaries	Feasible, given the data is collected	No, but additiona land use protection willl only benefit the species
2	1	17	Use existing programs to fill data gaps for, and reduce potential impacts to, harlequin darters (on private lands).	Coordination with Other Entities	EXPANDED	DFFM, AHRES	none	High - protection of habitat is a key factor in maintaing the specie	Feasible	No, but additional land use protection willl only benefit the species
2	3	18	Coordinate with universities, research institutes, non-governmental organizations, and other agencies to achieve actions relating to habitat conservation and management, creating an approach for determining population status and for education and outreach efforts.	Coordination with Other Entities	NEW	DFFM, FWRI	none	Moderate- if management determines necessary	Feasible	No, but additional land use protection willl only benefit the species
1	3	19	Communicate and coordinate with local and state regulatory agencies, water management districts, and stakeholders to propose cooperative actions addressing issues related to habitat requirements and locations of specific threats to harlequin darters and to propose cooperative actions to alleviate identified threats.	Coordination with Other Entities	NEW	FWRI, HSC	DEP, TNC, NWFWMD, FFS	High - regulatory agencies are required	Feasible contingent on staff flexibility and funding availability for habitat conservation, education, and outreach	No, but additional conservation measures will only benefit the species long term

Table 1. Harlequin darter conservation action table.

Objective(s) Addressed	Team Assigned Priority Level	Action Number	Action	Conservation Action Category	Status	Implementation leads: FWC divisions or sections	External partners	Likely Effectiveness	Feasibility	Urgency: Is the action immediately critical to the species' survival?
2	2	20	Coordinate with partners and landowners on proposed conservation measures that should be utilized to alleviate threats to the area, extent, and quality of habitat occupied by the harlequin darter.	Coordination with Other Entities	NEW	FWRI, HSC	DEP, TNC, NWFWMD, FFS	High - FWC alone will not be able to conduct all aspects of the SAP, so participation of other agencies to gather data and implement conservation strategies will be critical to the success of this SAP.	Highly feasible, contingent on regulatory agencies' interest and cooperation.	No, but additional conservation measures will only benefit the species long term

Acronyms used in this table:

AHRES: FWC's Aquatic Habitat Restoration and Enhancement Section
DEP: Florida Department of Environmental Protection
DFFM: FWC's Division of Freshwater Fisheries
FFS: Florida Forest Service
FWC: Florida Fish and Wildlife Conservation Commission
FWRI: Fish and Wildlife Research Institute, the research branch of the Florida Fish and Wildlife Conservation Commission
HSC: FWC's Division of Habitat and Species Conservation
HSC: Habitat and Species Conservation, a Division of the Florida Fish and Wildlife Conservation Commission
NWFWMD: Northwest Florida Water Management District
TNC: The Nature Conservancy

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