

**Recovery Implementation Strategy**  
**for**  
**Yellowcheek Darter (*Etheostoma moorei*)**



**Photo courtesy of: J.R. Shute, Conservation Fisheries, Inc.**

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and

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This Recovery Implementation Strategy describes the activities to implement the recovery actions identified in the Recovery Plan for the Yellowcheek Darter (*Etheostoma moorei*) (Service 2018). The strategy provides a narrative and the implementation schedule for the Yellowcheek Darter recovery activities. The implementation schedule estimates the cost for implementing recovery activities for removal from the List of Endangered and Threatened Wildlife (delisting). Additionally, this strategy document restates the criteria for determining when the Yellowcheek Darter should be considered for delisting. A Species Biological Report, which provides information on the species' biology and status and a brief discussion of factors limiting its populations, is available at <http://www.fws.gov/arkansas-es>. The Recovery Implementation Strategy and Species Biological Report will be updated separately on a routine basis.

### **Recovery Strategy**

The primary strategy for recovery of yellowcheek darter is to conserve the range of genetic and morphological diversity of the species across its historical range; fully quantify population demographics and status within each of the four forks; improve population size and viability within each fork; reduce threats (Factors A, D, and E) having the greatest adverse effect on the species within each river; emphasize voluntary soil and water stewardship practices by citizens living and working within the upper Little Red River watershed; and use captive propagation to prevent local extirpation within forks where recruitment failure is occurring.

Yellowcheek Darter recovery will require an increased understanding of the status of the species throughout its range; developing information on life history, ecology, mortality, and habitat requirements; improving our understanding of some poorly understood threat factors potentially affecting the species; and using that information to implement management actions to promote recovery. Local landowners will be encouraged to participate in voluntary stewardship programs like the programmatic Safe Harbor Agreement for Yellowcheek Darter. Local, state and federal entities will be engaged to ensure existing water quality standards are adequate to promote species recovery and that best management practices to achieve those standards are systematically implemented.

Conservation and recovery of the species will require human intervention for the foreseeable future. It is known that human activities, population numbers, and associated adverse effects will change within watersheds, particularly those associated with activities like natural gas development. Therefore, it is essential to characterize and monitor aquatic habitats on a watershed scale, and respond to changing conditions rapidly, whether through negotiation and partnerships to alleviate threats, or through husbandry and augmentation and/or reintroduction of populations in appropriate areas. This approach will require monitoring extant populations of the Yellowcheek Darter and characterizing current habitat conditions in each watershed.

### **Recovery Goal**

The goal of the Yellowcheek Darter Recovery Plan is to ensure the long-term viability of the species in the wild to the point that it can be delisted from the *Federal List of Endangered and Threatened Wildlife*.

## Recovery Criteria

For the Yellowcheek Darter to be considered as recovered, the following criteria must be met:

- (1) water quality and quantity in the (1) Middle, (2) South and (3) either Archey or Devils Forks<sup>1</sup>, as defined by the best available science (to be refined by recovery actions), supports the long-term survival of Yellowcheek Darter in its natural environment (based on Safe Harbor enrollment and private landowner conservation efforts) (addresses Factors A, D, and E);
- (2) streams where the Yellowcheek Darter occurs contain geomorphically stable channels with relatively silt-free, moderate to strong velocity riffles with gravel cobble and boulder substrates that support adequate macroinvertebrate prey items, as defined by reference stream conditions in the Boston Mountain ecoregion (addresses Factors A, D, and E);
- (3) healthy, self-sustaining (evident by multiple age classes of individuals, including naturally recruited juveniles, and recruitment rates exceeding mortality rates) natural populations of Yellowcheek Darters, as defined by the best available science (to be refined by recovery actions), are maintained in three of four tributaries (Middle, South, and either Archey or Devils Forks) at stable or increasing levels during a 30-year period (trend based on surveys conducted every three years via standard protocol and incorporating species recovery period from extreme droughts) (addresses Factors A and E); and
- (4) a captive propagation, augmentation and reintroduction plan has been established, and a contingency plan is in place to ensure the survival of the species should a catastrophic event affect portions of a wild population (addresses Factor E).
- (5) The measures mentioned above have been realized and demonstrated effective via monitoring efforts (addresses Factors A, D, and E);
- (6) Commitments are in place to maintain conservation measures and recovered status (addresses Factor A).

Recovery actions and activities listed below are expected to reduce or remove the threats (listing factors) identified in the *Species Biological Report for Yellowcheek Darter* and discussed in greater detail in the listing determination (76 FR 48722) and the designation of critical habitat (77 FR 63604). These actions are described in more detail in the Narrative Outline section that follows. These recovery actions are linked to Listing Factors A, D, and E and will serve to

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<sup>1</sup> Middle and South Forks support the largest Yellowcheek Darter populations; Archey Fork due to its hydrologic connectivity with South Fork provides additional protection from catastrophic events in the South Fork, and Devils Fork populations may be genetically dissimilar to manage as a separate unit pending ongoing research (see Species Biological Report).

measure progress in removing threats to the species. Overutilization (Factor B) is not a threat to the Yellowcheek Darter.

There is no direct evidence at this time that disease or predation is substantially affecting the continued survival of Yellowcheek Darter. However, increasing population sizes and ranges will reduce vulnerability of the Yellowcheek Darter to threats of predation from natural or introduced predators and bolster genetic fitness that will protect against disease. This is addressed under Factor A and E. Recovery activities and the listing factor(s) they address are shown in Table 1.

**Table 1.** Yellowcheek Darter recovery activities and links to listing factor(s). Check mark (✓) indicates listing factor(s) addressed by each recovery activity. Listing factors include (A) destruction, modification, or curtailment of habitat or range, (B) overutilization, (C) disease and predation, (D) inadequacy of existing regulatory mechanisms, and (E) other natural or manmade factors.

Recovery Activity	Listing Factor					
	A	B	C	D	E	
1.1	✓	Threat factor analyzed, not a known threat	Threat factor analyzed, not a known threat			
1.2	✓					
1.3	✓				✓	
1.4	✓				✓	✓
1.51	✓				✓	
1.52	✓				✓	
1.53	✓				✓	
1.54	✓				✓	
2.1	✓				✓	
2.2	✓				✓	
2.3	✓					
3.0	✓					
4.1	✓					
4.2	✓					

Recovery Activity	Listing Factor				
	A	B	C	D	E
4.3	✓				
4.4	✓				
4.5	✓				
5.0	✓				✓

### Recovery Actions Narrative with Stepped-down Activities

**1.0 Aid in recovery of the Yellowcheek Darter by protecting the habitat integrity and quality of stream reaches that currently support or could support the Yellowcheek Darters.** Stemming the decline and loss of aquatic habitats throughout the known range of the Yellowcheek Darter is essential for recovery of the species. Stream reaches known to be occupied by endangered or threatened aquatic species are generally protected by provisions of the Endangered Species Act from federally funded or permitted actions that could adversely modify supporting habitats or jeopardize the continued existence of the animal. Non-federal activities on private lands that comprise the bulk of Yellowcheek darter habitat require proactive efforts by the Service and natural resource managers to work cooperatively with private landowners to achieve recovery objectives.

**1.1 Protect the upper Little Red River watershed and four major headwater tributaries of the Little Red River (Middle, South, Archey and Devils forks) and identify additional stream reaches that could be restored to support the species.** Landowners and other watershed inhabitants may feel threatened by the presence of listed aquatic species adjacent to their lands, and be reluctant to participate in watershed stewardship planning or action. In such cases, informal Memoranda of Understanding, or other innovative avenues may be considered to assure and guarantee private land uses within watersheds. Some stream reaches within the historical range of the Yellowcheek Darter may be, or may become suitable for reintroduction of the species. Many of these areas include stream reaches upstream of designated Critical Habitat and/or areas adversely affected by current detrimental land use practices. Providing a higher degree of consideration for such areas will maintain and protect options essential for the successful management of isolated populations within a fragmented ecosystem. Regulatory agencies and non-federal land owners should thoroughly consider and apply creative alternatives to habitat modification, waste disposal, and other adverse effects to streams within the historical ranges of the species, even if they have been extirpated. The key to successful recovery planning that minimizes adverse effects to both listed species and stakeholders is vigilant monitoring and management of remaining aquatic

habitats through informed participation by all stakeholders.

- 1.2 Implement the Safe Harbor Agreement for the Yellowcheek Darter to help reach full recovery potential of the species.** This voluntary agreement will help in recovery of the species while providing landowners with confidence their land use practices will not violate the Endangered Species Act.
- 1.3 Minimize in-stream adverse effects resulting from activities conducted or permits issued by regulatory authorities by implementing best management practices or considering alternatives (where appropriate).** Habitat modifications that may have sizeable adverse effects on the Yellowcheek Darter have been either constructed or authorized by federal and/or state regulatory agencies. Such modifications in the future for flood control, hydropower, water supply, natural gas development and extraction, transportation infrastructure improvements, etc., must be fully considered for need and alternatives. Practical alternatives such as purchasing riparian easements, implementing BMPs and other conservation practices, protection of headwater habitats, etc., should be used where and when appropriate. All construction activities permitted or conducted by federal, state, county, or other local regulatory authorities within the historical range of the Yellowcheek Darter should effectively implement BMPs and other conservation practices for surface water pollutants (e.g. chemical contaminants, nutrients and sediment) and water use.
- 1.4 Work with state and federal authorities to ensure water quality standards and classifications provide for species survival and recovery.** In streams of the upper Little Red River basin, water quality degradation is suspected in the decline of the species. Boston Mountain streams that support the Yellowcheek Darter are typically characterized by adequate water quality. However, increasing activity within the watersheds related to resource extraction, urban development, and other human-related activities is reason for concern regarding the recovery potential of the Yellowcheek Darter. Protection of water quality into the future will require adherence to current standards and regulations. In some cases, changes to the standards and criteria for characteristics such as turbidity and nutrients may be necessary. State water quality classifications, permit review processes, and other important water quality actions should be revised where appropriate studies have identified and quantified inadequacies.
- 1.5 Promote and support a watershed management approach to water quality and quantity.** A watershed management approach synchronizes water quality and quantity monitoring, inspections, and permitting within a defined watershed. It has the potential of integrating imperiled species habitat concerns with all other water quality and quantity issues, including economic and human health, within the defined watershed. This approach allows a greater degree of public awareness about, and involvement with, local water quality and quantity issues and decisions.

- 1.51 Encourage and assist municipalities to address sanitary wastewater treatment plant effluents within affected watersheds.** Sanitary wastewater treatment plant effluents are a contributor to stream eutrophication, particularly in the vicinity of more urban areas of the upper Little Red River watershed (e.g., Middle, South, and Archey forks near the cities of Clinton, Shirley and Leslie). Some wastewater treatment plants may need to be upgraded as necessary to protect aquatic resources. Residual chlorine and certain other wastewater components resulting from disinfectant procedures are toxic to aquatic organisms. Alternative disinfectant techniques (e.g., treatment with ultraviolet radiation, ozone, etc.) are available and should be encouraged for use by city officials and planners in addition to implementation of an unused medication disposal program.
- 1.52 Encourage compliance with current water quality discharge limitations and regulations.** Current state and federal enforcement programs should ensure consistent compliance with conditions and discharge limitations. Regulated industrial effluents, sewage treatment plant effluents, other permitted discharges, and storm water runoff should be monitored with sufficient frequency to encourage compliance with water quality standards. Unpermitted discharges should be identified and brought into compliance. Increased public involvement and attention to watershed conditions may provide opportunities for community based monitoring.
- 1.53 Encourage effective sediment control for land use activities.** Uncontrolled sedimentation due to temporary and permanent ground disturbing activities (e.g., construction sites, unpaved roads, agricultural and silvicultural activities) contribute to river and stream degradation. Excess sediments may smother stream bottom habitats and/or result in erosion and other channel changes. Such activities should be encouraged to use and maintain effective sediment control techniques and dispose of excess sediments such that these materials will not eventually reach surface waters.
- 1.54 Encourage water conservation to maintain ecologically adequate stream flows to support the Yellowcheek Darter.** Water withdrawal from streams for natural gas extraction, irrigation and other uses adversely affects streams in the upper Little Red River, particularly during low flow periods. Surface water demands for domestic, industrial, and irrigation purposes will likely continue to increase. Naturally occurring droughts are projected to be more intense by mid-century (<https://statesummaries.ncics.org/ar>) further reducing available instream flow for Yellowcheek Darter. Identifying and adopting ecologically adequate stream flows will protect aquatic resources and communities, encourage consideration of alternative technology, and reduce future conflicts. Determining instream flow needs for Yellowcheek Darter will be important to its recovery.

**2.0 Promote voluntary stewardship as a practical and economical means of reducing nonpoint source pollution from private land use.** BMPs can be effective and practical actions identified to prevent or reduce nonpoint source pollution from specific land use activities. For example, agricultural BMPs are designed to reduce sediments, animal wastes, fertilizers, and pesticides in storm water runoff (Benthrop 2008). Silviculture BMPs include actions to minimize sediments, nutrients, organics, other chemicals and stream canopy removal (AFC 2002). Natural gas development BMPs have been created specifically to address such activities in the Fayetteville Shale region of Arkansas (Service 2009; Service 2007a). BMPs are developed by state and industry planning partnerships with public participation, and can be effective when they are properly implemented and adequately maintained. BMPs, however, are not always fully implemented or maintained. Industry groups and organizations, and state resource agencies should continue to promote and improve BMPs when necessary as a non-regulatory approach to aquatic habitat management.

**2.1 Work with state and private partners to promote land and water stewardship awareness within the historical range of the species.** Local offices of state and federal agencies and private organizations can become a primary source of encouragement and information for imperiled species and aquatic ecosystem management. For example, local offices (e.g., Water Conservation Districts, Natural Resources Conservation Service, State Forestry Commission, private industry groups, environmental groups, etc.) can identify watersheds with listed species within their areas; inform local landowners of listed species presence, needs, and special management concerns; recommend appropriate BMPs; and alleviate landowner concerns. In some watersheds, standard BMPs may need to be adjusted according to stream size, soil conditions, and land use intensity. Private industry groups can work with local landowners to customize BMPs where needed to address watershed problems and practices.

**2.2 Encourage the development and implementation of adequate Streamside Management Zones (SMZs) along all streams within the historical range of the Yellowcheek Darter.** Properly designed SMZs, acting as filter strips, can buffer the effects of deleterious land use activities on water and stream bottom habitat quality. SMZs protect public and private property from erosion, and reduce downstream sedimentation in aquatic systems. SMZs can also reduce nutrient levels in tributary streams which will help control eutrophication in reservoirs. Some farmlands adjacent to streams and rivers may qualify for SMZ assistance through the U.S. Department of Agriculture's Farm Bill Program. SMZs are widely recognized as cost effective habitat management practices. For example, the American Forest and Paper Association's Sustainable Forestry Initiative requires its members to meet or exceed existing SMZ state standards. SMZs are also effective in controlling urban and suburban storm water runoff.

**2.3 Develop outreach materials and implement programs to help educate the public on the need for and benefits of ecosystem management, and to involve them in**

**watershed stewardship to protect this listed fish.** Only an informed and proactive public can bring about ecosystem stabilization and rehabilitation. Successful species and habitat management and recovery will require public involvement, monitoring, and commitment of resources. Educational materials and programs should describe the concept and need for ecosystem management, its long-term economic and environmental advantages, and public and individual stewardship opportunities.

**3.0 Develop a spill prevention and management plan for the upper Little Red River watershed.** A plan to avoid catastrophic spills of pollutants and/or contaminants within streams of the upper Little Red Watershed should be developed and implemented. Chemicals used in the hydraulic fracturing process for natural gas extraction and other potentially detrimental chemicals are routinely transported across streams supporting the Yellowcheek Darter. Appropriate plans of action for responding to potentially catastrophic spills are essential to aid municipalities in mitigating contamination of drinking water and other environmental resources. An effective method to determine travel times for contaminants in Arkansas streams has been researched by the United States Geologic Survey (Funkhouser and Barks 2004). Additionally, such spill response plans can help natural resource managers respond accordingly in order to minimize the effects of toxic spills on narrowly endemic species like the Yellowcheek Darter. Methodology for evaluating the effectiveness of this plan should be developed. The effectiveness of this plan should be monitored and evaluated regularly and, as necessary, modified as new information and/or hazardous materials information becomes available.

**4.0 Conduct research to aid recovery efforts for the Yellowcheek Darter.** General aspects of the biology and ecology of the Yellowcheek Darter have been studied, but some data gaps persist. This information may provide insight into past declines, current status of the species, vulnerabilities in the life cycle, and management guidance for future recovery efforts. This information will also help natural resource managers better assess the effects of anthropogenic influences such as natural resource extraction, silviculture, infrastructure development, etc. on Yellowcheek Darter populations. All partners should be aware of research efforts and results, so that information can be immediately applied.

**4.1 Refine laboratory husbandry techniques for the species.** Develop and refine propagation techniques capable of producing Yellowcheek Darter progeny that can be maintained indefinitely in a laboratory environment. Such techniques could be used to maintain an ark population if necessary or to provide individuals for augmentation or reintroduction within the historical range of the species. Develop a captive propagation and drought contingency plan.

**4.2 Conduct research on larval drift dynamics.** Little is known about the larval life stage of the Yellowcheek Darter in wild populations. Larvae reared in the laboratory exhibit strong pelagic tendencies and are suspected to be displaced downstream of riffles where they hatch by stream currents. Better understanding of larval drift dynamics will inform resource managers about the species' use of available stream habitat.

**4.3 Conduct research on use of pool environments during zero discharge conditions.** Yellowcheek Darters are rarely collected in pool environments even when adjacent riffle areas they inhabit exhibit zero discharge conditions. More information is needed regarding the species' use of pool environments during drought conditions to better inform management decisions.

**4.4 Conduct research on Yellowcheek Darter genetics.** Genetic analysis has not been conducted for the Archey Fork population to compare to the other forks. This should be undertaken by obtaining a maximum of 20 non-lethal fin clips from specimens in each of the four forks, or through other procedures acceptable to the Service.

**4.5 Conduct research on the effects of climate change to Yellowcheek Darters.** The effects of climate change on Yellowcheek Darter recovery should be investigated to inform management and recovery decisions. The vulnerability of the species to drought may exacerbate potential adverse effects of climate change to the Yellowcheek Darter. High and low emission climate change models project warmer air temperatures by mid-century in Arkansas (<https://statesummaries.ncics.org/ar>). Warmer water temperature would be expected to accompany warmer air temperatures. Temperature tolerances should be determined for Yellowcheek Darter. As specified in Recovery Activity 1.54, determining instream flow needs for Yellowcheek Darter will be important to its recovery.

**5.0 Develop and implement a monitoring protocol for the Yellowcheek Darter.** Periodic surveys of occupied stream reaches, as well as those known to be historically occupied by the species, should be performed in a repeatable fashion. Yellowcheek Darter habitat and population sizes should be monitored to assess the efficacy of conservation measures implemented for recovery of the species. Surveys should be conducted range wide for the species every three years using a rigorous approach to model gear efficiency (e.g., Peterson and Paukert 2009) or detectability (e.g., Magoulick and Lynch 2015). Changes in distribution/abundance (losses and gains), habitat quality, etc. should be used to focus recovery efforts and adjust priorities as needed. Adequately fund stream gages within the watershed to monitor flow trends and stream drying.

### **Acknowledgments**

The U.S. Fish and Wildlife Service (Service) would like to thank the following individuals and their respective organizations for their dedicated efforts to protect this fish. These include, Ethan Inlander (The Nature Conservancy), Dr. Steve Lochmann (University of Arkansas at Pine Bluff), Dr. Dan Magoulick (U.S. Geological Survey Arkansas Cooperative Fish and Wildlife Research Unit), Jim Petersen (U.S. Geological Survey), Sherri Shoults (U.S. Fish and Wildlife Service, Greers Ferry National Fish Hatchery), Jason Throneberry (Arkansas Natural Heritage Commission) and Brian Wagner (Arkansas Game and Fish Commission). We would also like to thank Drs. Ron Johnson (Arkansas State University) and Joe Stoeckel (Arkansas Tech University) for their research efforts on the species and review of the recovery plan.

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### **PART III: RECOVERY IMPLEMENTATION SCHEDULE**

Recovery plans are intended to assist the Service and other stakeholders in planning and implementing actions to recover and/or protect endangered and threatened species. The following Implementation Schedule indicates activity numbers; activity descriptions; activity duration; potential stakeholders and responsible agencies; and estimated costs. It is a guide for planning and meeting the objectives discussed in this strategy. The Implementation Schedule outlines recovery activities, their estimated costs for 30 years of this recovery program, and the total cost to reach the goal of delisting. Actual expenditures by agencies and other partners is contingent upon appropriations and other budgetary constraints. While the ESA assigns a strong leadership role to the Service for the recovery of listed species, it also recognizes the importance of other Federal agencies, States, and other stakeholders in the recovery process. The “Responsible Agency” column of the Implementation Schedule identifies partners who can make significant contributions to specific recovery activities. The identification of agencies and other stakeholders within the Implementation Schedule does not constitute any additional legal responsibilities beyond existing authorities (e.g., ESA, CWA, etc.).

#### **Key to acronyms used in the Implementation Schedule**

ADEQ	Arkansas Department of Environmental Quality
ANRC	Arkansas Natural Resources Commission
AGFC	Arkansas Game and Fish Commission
ARSC	Arkansas Rural Services Commission
FHWA	Federal Highway Administration
FWS	U.S. Fish and Wildlife Service
NGO	Non-governmental Organizations
NRCS	Natural Resources Conservation Service
TNC	The Nature Conservancy
UAF	The University of Arkansas – Fayetteville
UAPB	The University of Arkansas – Pine Bluff
UNIVERSITY	Post-secondary Educational Institution
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

#### **Definition of Action Durations**

Continual (C): A task that will be implemented on a routine basis once begun.

Ongoing (O): A task that is currently being implemented and will continue until no longer necessary.

Periodic (P): A task that recurs periodically, for example every five years, so long as the species is listed.

To Be Determined (TBD): A task duration is not known at this time or implementation of the task is dependent on the outcome of other recovery actions.

<b>YELLOWCHEEK DARTER IMPLEMENTATION SCHEDULE</b>				<b>COST ESTIMATES (\$)</b>							<b>Total Recovery Costs</b>	<b>Comments</b>
<b>Activity No.</b>	<b>Activity Description</b>	<b>Activity Duration</b>	<b>Responsible Parties</b>	<b>Year 1 – 5</b>	<b>Year 6 – 10</b>	<b>Year 11 – 15</b>	<b>Year 16 – 20</b>	<b>Year 21 – 25</b>	<b>Year 26 – 30</b>			
1.1	Protect the upper Little Red River watershed and four major headwater tributaries of the Little Red River (Middle, South, Archey and Devils forks) and identify additional stream reaches that could be restored to support the species	O	FWS, USACE, ANRC, ADEQ	431K	40K	431K	40K	40K	431K	1.4M	Main stem and tributary habitat assessments in Year 3, 15, and 25.	
1.2	Implement the Safe Harbor Agreement for the Yellowcheek Darter to help reach full recovery potential of the species.	25 YEARS	FWS, AGFC, NRCS, TNC	2.84M	2.84M	2.84M	2.84M	2.84M		14.2M	Costs based on enrollment (13 landowners / year) and implementation based on actual costs of first 5 years).	
1.3	Minimize in-stream adverse effects by implementing best management practices or considering alternatives	O	FWS, EPA, ADEQ, USACE, NRCS, ANRC	40K	30K	40K	30K	40K	30K	210K		

<b>YELLOWCHEEK DARTER IMPLEMENTATION SCHEDULE</b>				<b>COST ESTIMATES (\$)</b>						<b>Total Recovery Costs</b>	<b>Comments</b>
<b>Activity No.</b>	<b>Activity Description</b>	<b>Activity Duration</b>	<b>Responsible Parties</b>	<b>Year 1 – 5</b>	<b>Year 6 – 10</b>	<b>Year 11 – 15</b>	<b>Year 16 – 20</b>	<b>Year 21 – 25</b>	<b>Year 26 – 30</b>		
1.4	Work with state and federal authorities to ensure water quality standards and classifications provide for species survival and recovery	C	USGS, EPA, FWS, ADEQ	17K	34K	17K	34K	17K	34K	153K	Costs are based on triennial review of water quality standards. Data gaps for toxicity testing have not been identified and are not included herein.
1.51	Encourage and assist municipalities to address sanitary wastewater treatment plant effluents within affected watersheds	C	EPA, ADEQ			5M	5M	5M		15M	Costs to upgrade WWTP (3 facilities) to UV radiation or ozone based on 10 MGD facility.
1.52	Encourage compliance with current water quality discharge limitations and regulations	C	EPA, ADEQ	35K	35K	35K	35K	35K	35K	210K	
1.53	Encourage effective sediment	O	FWS, ADEQ,	2.1M	2.1M	2.1M	2.1M	2.1M	2.1M	12.6M	Costs based on improving 126

<b>YELLOWCHEEK DARTER IMPLEMENTATION SCHEDULE</b>				<b>COST ESTIMATES (\$)</b>							
<b>Activity No.</b>	<b>Activity Description</b>	<b>Activity Duration</b>	<b>Responsible Parties</b>	<b>Year 1 – 5</b>	<b>Year 6 – 10</b>	<b>Year 11 – 15</b>	<b>Year 16 – 20</b>	<b>Year 21 – 25</b>	<b>Year 26 – 30</b>	<b>Total Recovery Costs</b>	<b>Comments</b>
	control for land use activities		AGFC, ANRC TNC ARSC								road segments with greatest impact to habitat
1.54	Encourage water conservation in order to maintain ecologically adequate stream flows	5 Years	FWS, AGFC, USGS, ANRC, UNIVERSITY	150K	70K					220K	
2.1	Work with state and private partners to promote land and water stewardship awareness	O	FWS, AGFC, NRCS, ANRC, NGO	15K	15K	15K	15K	15K	15K	90K	
2.2	Encourage the	O	FWS,	13K	13K	13K	13K	13K	13K	78K	Cost of

<b>YELLOWCHEEK DARTER IMPLEMENTATION SCHEDULE</b>				<b>COST ESTIMATES (\$)</b>							
<b>Activity No.</b>	<b>Activity Description</b>	<b>Activity Duration</b>	<b>Responsible Parties</b>	<b>Year 1 – 5</b>	<b>Year 6 – 10</b>	<b>Year 11 – 15</b>	<b>Year 16 – 20</b>	<b>Year 21 – 25</b>	<b>Year 26 – 30</b>	<b>Total Recovery Costs</b>	<b>Comments</b>
	development and implementation of adequate Streamside Management Zones (SMZs)		AGFC, NRCS								establishing forested riparian buffers in pasture adjacent to four forks of Little Red River
2.3	Develop outreach materials and implement programs to help educate the public on the need and benefits of ecosystem management, and to involve them in watershed stewardship to protect listed species	C	FWS, AGFC, NGO	25K	25K	25K	25K	25K	25K	150K	
3.0	Develop a spill prevention and management plan for the upper Little Red River watershed	C	FWS, AGFC, USGS, ADEQ, FHWA	50K						50K	
4.1	Refine laboratory	3 Years	FWS,UAPB	20K						20K	

<b>YELLOWCHEEK DARTER IMPLEMENTATION SCHEDULE</b>				<b>COST ESTIMATES (\$)</b>						<b>Total Recovery Costs</b>	<b>Comments</b>
<b>Activity No.</b>	<b>Activity Description</b>	<b>Activity Duration</b>	<b>Responsible Parties</b>	<b>Year 1 – 5</b>	<b>Year 6 – 10</b>	<b>Year 11 – 15</b>	<b>Year 16 – 20</b>	<b>Year 21 – 25</b>	<b>Year 26 – 30</b>		
	husbandry techniques for the species		, UAF								
4.2	Conduct research on larval drift dynamics	TBD	FWS, AGFC, UNIVERSITY	100K						100K	
4.3	Conduct research on use of pool environments during zero discharge conditions	5 Years	FWS, AGFC, UNIVERSITY	125K						125K	
4.4	Conduct research on Yellowcheek Darter genetics	2 Years	FWS, AGFC, UNIVERSITY	18K						18K	
4.5	Conduct research on the effects of climate change to Yellowcheek Darters	3 Years	FWS, USGS, UNIVERSITY	210K						210K	
5.0	Develop and implement a monitoring protocol for the Yellowcheek Darter	1 Year to Develop Plan; P	FWS, AGFC, UAPB, UAF	100K	75K	75K	75K	75K	75K	475K	

## APPENDIX 1

### List of Stakeholders (\* Invited Peer Reviewer)

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