KEARNEY'S BLUE STAR (*Amsonia kearneyana*)
Final
RECOVERY IMPLEMENTATION STRATEGY
January 2021

Amsonia kearneyana –Photo credit Bill Radke, U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service
Southwest Region (Region 2)
Albuquerque, New Mexico

This Recovery Implementation Strategy (RIS) supplements the Kearney's Blue Star (*Amsonia kearneyana*) Recovery Plan, First Revision (Recovery Plan, U.S. Fish and Wildlife Service ([USFWS] 2021a) and describes in greater detail how the site-specific, prioritized actions outlined in the Recovery Plan will be implemented, and estimates the time and costs to complete recovery. The RIS may be revised at any time during the recovery process, whenever experience and information gained call for a change in approach, therefore maximizing flexibility of recovery implementation. As used here, "actions" are broad measures that clearly describe what needs to be done to accomplish the goal of long-term viability. "Activities" are the detailed, on-the-ground tactical steps needed to implement the higher-level recovery actions.

Prioritized recovery actions from the Recovery Plan and their associated activities are listed in the implementation table below (Table 1). Priority 1 actions and activities are defined as those that must be taken to prevent extinction or to prevent the subspecies from declining irreversibly in the foreseeable future. Priority 2 actions and activities are those that must be taken to prevent a significant decline in population size or habitat quality or some other significant negative impact. Priority 3 actions and activities are all other measures that are necessary to provide for full recovery of the subspecies. The assignment of priorities does not imply that some actions and activities are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented. Please refer to the Recovery Plan for a clear association among recovery actions, activities, and the factors (threats) affecting the survival of Kearney's blue star (USFWS 2021a; Table 6, p 42).

The implementation schedule is intended to assist the Service and other stakeholders in planning and implementing activities to carry out the recovery actions in the revised Recovery Plan. The Implementation Schedule includes activity numbers; activity descriptions; activity duration; responsible parties; and estimated costs. It is a guide for planning and meeting the objectives discussed in this strategy. The Implementation Schedule estimates costs for carrying out the first 5 years of recovery activities and the total estimated cost to implement activities through year 2059, the approximate date to reach the goal of recovery. Actual expenditures by agencies and other partners are contingent upon appropriations and other budgetary constraints.

While the Endangered Species Act of 1973 (ESA), as amended (54 FR 2131), 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 tasks. The identification of agencies and other stakeholders within the Implementation Schedule does not constitute any additional legal responsibilities beyond existing authorities (e.g., ESA).

LITERATURE CITATIONS AND AVAILABILITY

Literature citation should read as follows:

U.S. Fish and Wildlife Service. 2021. Kearney's Blue Star (*Amsonia kearneyana*) Final Recovery Implementation Strategy. Southwest Region, Tucson, Arizona, USA.

U.S. Fish and Wildlife Service. 2021a. Kearney's Blue Star (*Amsonia kearneyana*) Final Recovery Plan, First Revision. Southwest Region, Tucson, Arizona, USA.

An electronic copy of this draft RIS and Recovery Plan will be made available at: https://www.fws.gov/southwest/es/arizona/Kearney.htm

and

https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=7485

Key to acronyms used in the Implementation Schedule

Acronym	Institution
APTPL	All public, tribal, and private landowners (ASLD, BLM, BANWR, TON, private)
ASDM	Arizona Sonoran Desert Museum
ASLD	State of AZ
AZESFO	Arizona Ecological Services Field Office
BANWR	Buenos Aires National Wildlife Refuge
BLM	Bureau of Land Management
DBG	Desert Botanical Garden
BP	U.S. Border Patrol
TON	Tohono O'odham Nation
UNIV	University
USBP	U.S. Border Patrol

Table 1. Implementation Schedule for Kearney's Blue Star (*Amsonia kearneyana*) Recovery

Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
1	**Recovery Action 1: Census *A. kearneyana* Subsites**		Every 3 - 5 years over 40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 348,000	–	–	–	–	–	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years.
	1.1	Census plants at Upper Brown Canyon – Upper Slope, BLM	Every 3 - 5 years over 40 years	Same	NA	$ 2,907	–	–	$ 2,907	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the BLM, with technical assistance from the FWS if needed. Alternatively, plants could be censused by other permitted researchers.									
	1.2	Census plants at Upper Brown Canyon – Middle Slope, BLM	Every 3 - 5 years over 40 years	Same	NA	–	$ 2,907	–	–	$ 2,907	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the BLM, with technical assistance from the FWS if needed. Alternatively, plants could be censused by other permitted researchers.									
	1.3	Census plants at Upper Brown Canyon – Lower Slope, BLM	Every 3 - 5 years over 40 years	Same	NA	–	–	$ 2,907	–	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the BLM, with technical assistance from the FWS if needed. Alternatively, plants could be censused by other permitted researchers.									
	1.4	Census plants at Jaguar Canyon, BLM	Every 3 - 5 years over 40 years	Same	NA	$ 2,907	–	–	$ 2,907	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the BLM, with technical assistance from the FWS if needed. Alternatively, plants could be censused by other permitted researchers.									
	1.5	Census plants at South Canyon, TON	Every 3 - 5 years over 40 years	Same	NA	–	$ 2,907	–	–	$ 2,907	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the TON, with technical assistance from the FWS if needed. Alternatively, plants could be censused by the FWS or other permitted researcher if permission is granted by the TON.									
	1.6	Census plants at Sycamore Canyon, TON	Every 3 - 5 years over 40 years	Same	NA	$ 2,907	–	–	$ 2,907	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the TON, with technical assistance from the FWS if needed. Alternatively, plants could be censused by the FWS or other permitted if permission is granted by the TON.									
	1.7	Census plants at Baboquivari Canyon, TON	Every 3 - 5 years over 40 years	Same	NA	–	$ 2,907	–	–	$ 2,907	Surveys may take 1-5 days per Subsite.

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		Plants could be censused by the TON, with technical assistance from the FWS if needed. Alternatively, plants could be censused by the FWS or other permitted if permission is granted by the TON.									
	1.8	Census plants at Thomas Canyon, AZ	Every 3 - 5 years over 40 years	AZ, AZESFO, BANWR	NA	–	–	$ 2,907	–	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by the State of AZ with technical assistance from the FWS if needed. Alternatively, plants could be censused by the FWS or other permitted if permission is granted by the State of AZ.									
	1.9	Census plants at Lower Brown Canyon Introduction, BANWR	Every 3 - 5 years over 40 years	BANWR, AZESFO	NA	$ 2,907	–	–	$ 2,907	–	Surveys may take 1-5 days per Subsite.
		Plants could be censused by BANWR with technical assistance from AZESFO if needed. Alternatively, plants could be censused by other permitted researchers.									
1	**Recovery Action 2: Monitor *A. kearneyana* individuals and their habitat (e.g., quality)**		Every 3 - 5 years over 40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 348,000	–	–	–	–	–	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years.
	2.1	Establish monitoring plots	Same	Same	NA	$ 40,000	–	–	–	–	This includes the cost of establishing and collecting demographic data on plots in 4 subsites
		Monitoring plots at Upper Brown Canyon - Lower Slope and Lower Brown Canyon Introduction would likely be established first due to ease of accessibility. If feasible, plots at Jaguar Canyon and South Canyon should be established as well. Demographic data should be collected during this monitoring.									
	2.2	Monitor plots	Same	Same	NA	–	–	–	$ 23,158	–	
		Within plots, *A. kearneyana* individuals, pollinators, and habitat quality should be monitored.									
2	**Recovery Action 3: Survey for new *A. kearneyana* individuals and Subsites**		Every 3 - 5 years over 40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 388,000	–	–	–	–	–	This action will be implemented every 3-5 years over 40 years. Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs include those incurred by other parties conducting surveys (8 surveys at $5k/survey).
	3.1	Survey for new individuals within existing Subsites	Same	Same	NA	$ 14,586	-	-	$ 14,586	-	
		Survey for new individuals within existing Subsites. New individuals may be from recruitment events or missed during previous survey efforts.									

Table 1. Implementation Schedule for Kearney's Blue Star (*Amsonia kearneyana*) Recovery

Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
	3.2	Survey for new individuals outside of known Subsites	Same	Same	NA	–	$ 14,586	–	–	$ 14,586	
		Additional *A. kearneyana* surveys in Arizona and Mexico are needed to determine distribution and status across the entire range. It is possible that the use of drones, scent detection dogs, or other innovative methods may assist in this endeavor, given landowner permissions are attained.									
1	**Recovery Action 4: Augment the number of *A. kearneyana* individuals at existing Subsites**		Periodically	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 390,600	–	–	–	–	–	This action will be implemented periodically over 40 years. Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs are included for 2 people (e.g., botanical garden staff) at a GS-11 rate ($315 per day) for 10 days to develop introduction guidelines. Reevaluation of guidelines (at the same rate) will occur once after initial guidelines are developed. Additional costs include those incurred by other parties conducting seed collection, grow out, outplanting, and monitoring (3 establishment events at $20k/event which include 3 GS-11s for 15 days plus growout costs).
	4.1	Augment the number of *A. kearneyana* individuals at existing Subsites	Same	Same	NA	$ 78,120	–	$ 78,120	–	$ 78,120	Costs are explained above

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Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
		Developing guidelines for augmenting *A. kearneyana* at existing Subsites will be important to the success of this action. Augmentation would first require the identification of the best Subsites (e.g., highest habitat quality, best protections, most accessible) and microhabitat (e.g., north facing slopes, presence of shade trees) into which *A. kearneyana* will be introduced. Secondly, techniques learned in the ex situ conservation program would be employed in establishing plants. Introduced plants should be managed and monitored the same as natural ones. When developing guidelines, the following should be taken into consideration. Introductions are increasingly important in conservation, however, they have variable success (Godefroid et al. 2011, pp. 673 and 678) and it is common that survival is low. Creating a self-sustaining introduced population may take decades to achieve and requires long-term monitoring and land management to sustain the habitat (Machinski and Albrecht 2017, p. 391). Studies have shown ways to increase success of introductions, including larger initial outplanting population size, as smaller populations are generally less capable of adapting to novel environments (Godefroid et al. 2011, pp. 679; Machinski and Albrecht 2017; p. 393). However, with rare plant introductions, the limiting factors of seed availability, low germination rates, remote locations, and lack of funding and personnel can make larger outplanting operations difficult (Godefroid et al. 2011, p. 679). While success is often low and the cost high (Godefroid et al. 2011, p 674), for highly imperiled species like *A. kearneyana*, introductions are often necessary for long-term viability in the wild.									
2		**Recovery Action 5: Establish new *A. kearneyana* Subsites**	Periodically	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 390,600	–	–	–	–	–	This action will be implemented periodically over 40 years. Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs are included for 2 people (e.g., botanical garden staff) at a GS-11 rate ($315 per day) for 10 days to develop introduction guidelines. Reevaluation of guidelines (at the same rate) will occur once after initial guidelines are developed. Additional costs include those incurred by other parties conducting seed collection, grow out, outplanting, and monitoring (3 establishment events at $20k/event which include 3 GS-11s for 15 days plus growout costs).
	5.1	Establish new *A. kearneyana* Subsites	Same	Same	NA	–	$ 78,120	–	$ 78,120	–	See comment above.
		Developing guidelines for establishing new *A. kearneyana* Subsites will be important to the success of this action. Establishment would first require the identification of the best habitat (e.g., lowest cover of nonnative plants, best protections, most accessible) and microhabitat (e.g., north facing slopes, presence of shade trees) into which *A. kearneyana* will be introduced. Secondly, techniques learned in the ex situ conservation program would be employed in establishing plants. Introduced plants should be managed and monitored the same as natural ones.									

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Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
2	**Recovery Action 6: Acquire *A. kearneyana* habitat within existing and new Subsites and protect *A. kearneyana* Subsites**		Periodically	APTPL, TON	$1,782,650	–	–	–	–	–	See explanation of cost below.
	6.1	Acquire *A. kearneyana* habitat within existing and new Subsites	Same	Same	NA	$ -	$ -	$ 120,500	$ 10,000	$230,500	Cost estimate based on purchase of 500 acres at $2k/acre ($1 million); plus 1/4 FTE ($20.5k) for 3 years to complete real estate transactions as real estate is available for purchase; plus administrative and management cost of newly acquired land at $10k/year for 37 years
		Where *A. kearneyana* habitat in existing and new Subsites requires greater protection, the need for acquisition should be explored and, if needed, acquisition by a conservation agency or organization pursued. Management of acquired sites could be by FWS, BLM, or other agency or not for profit organization.									
	6.2	Protect *A. kearneyana* Subsites	Same	Same	NA	$ 8,700	$ 8,700	$ 11,850	$ 8,700	$ 8,700	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs included for 5 people (e.g. Tribal Council) at a GS-11 rate for 2 days.
		Where *A. kearneyana* habitat in existing and new Subsites requires greater protection, mechanisms for protection (e.g., conservation easements, agreements, management plans) should be explored, pursued, and implemented.									
2	**Recovery Action 7: Establish and maintain *A. kearneyana* seeds and plants in botanical institutions**		40 years	ASDM, DBG, AZESFO, UNIV	$ 100,000	–	–	–	–	–	The cost estimate includes botanical garden and seed storage facility fees for 40 years.
	7.1	Establish and maintain *A. kearneyana* seeds and plants in botanical institutions	Same	Same	NA	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	

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Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
2	**Recovery Action 8: Conduct research relating to *A. kearneyana* biology, ecology, threats, management, etc.**		Periodically over 40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 508,000	–	–	–	–	–	This action will be implemented periodically over 40 years. Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs are explained in activities below.
	8.1	Conduct basic biological and ecological research on *A. kearneyana*	Same	Same	NA	–	$ 15,233	$ 15,233	$ 15,233	–	Additional costs include those incurred by other parties conducting research (1, 3 year study at $30k).
		Basic *A. kearneyana* biology studies are needed. For example, what is the lifespan of *A. kearneyana*? Are flowers self-compatible, obligate outcrossers, or facultative (e.g. greenhouse studies to see if selfing produces viable seed)? Also, a map the daily production of nectar, the receptivity of stigmatic surfaces, and the dehiscence of anthers, would be useful in determining pollinator effectiveness. How do populations of known pollinators vary across habitat types and conditions in the Site?									
	8.2	Conduct research to examine genetics and population structure of *A. kearneyana*	3	Same	NA	–	–	–	–	$ 25,233	Additional costs include those incurred by other parties conducting research (1, 3 year study at $60k).
		Studies of *A. kearneyana* genetics within and between Subsites are needed to determine the functioning and structure of populations, the level of genetic diversity, if inbreeding depression is occurring, and how frequently sexual vs. vegetative reproduction is required to maintain or improve genetic diversity. How do Sites and Subsites relate to populations and population boundaries.									
	8.3	Conduct research on threats to *A. kearneyana*, including drought and climate change, nonnative plant species, and fire regime alteration	Periodically over 40 years	Same	NA	–	–	$ 20,000	–	–	Additional costs include those incurred by other parties conducting research (2 studies at $20k/study).
		Studies on the effects to *A. kearneyana* from nonnative plant competition, livestock use of habitat, shade and nurse tree reduction, and fire frequency and severity shifts are necessary to better understand how these impact *A. kearneyana* germination, growth, and reproduction. For example, how does regular low severity fire vs. irregular high severity fire impact the species? Does the loss of shade trees to fire and drought impact moisture, humidity, and *A. kearneyana* germination and survival?									

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	8.4	Conduct research to determine the best management practices for habitat and pollinator health	Periodically over 40 years	Same	NA	–	$ 5,000	$ 5,000	$ 5,000	–	Additional costs include those incurred by other parties conducting research (1, 3 year study at $15k/study).
		Research is needed to determine the best management practices for *A. kearneyana* habitat and pollinator health.									
	8.5	Conduct research on the best methods for *A. kearneyana* introduction	3 years	Same	NA	$ 5,000	$ 5,000	$ 5,000	–	–	Additional costs include those incurred by other parties conducting research (1, 3 year study at $15k/study).
		Studies of the best methods for *A. kearneyana* introduction are needed to create new viable populations. For example, what is the best introduction location for this species? Can plants be grown in the field with direct seeding under protective wire mesh? How can seed germination be improved when seed availability must coincide with wet years for germination and initial seedling survival?									
1	**Recovery Action 9: Monitor threats to *A. kearneyana***		40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 348,000	–	–	–	–	–	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years.
	9.1	Monitor threats *A. kearneyana* at Subsites, including drought and climate change, nonnative plant species, and fire regime alteration	Same	Same	NA	$ 8,700	$ 8,700	$ 8,700	$ 8,700	$ 8,700	
		As research is conducted to better understand threats to *A. kearneyana* (see Activity 8.3), monitoring of each of the principal threats to the species should be conducted. Monitoring may need to occur at different times of the year depending on the specific threat being monitored.									
2	**Recovery Action 10: Reduce threats to *A. kearneyana* and manage habitat quality**		40 years	APTPL, ASDM, BP, DBG, AZESFO, TON, UNIV	$ 511,800	$ 12,600	$ 3,150	$ 3,150	$ 3,150	$ 3,150	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs are explained below.
	10.1	Reduce threats to *A. kearneyana*	Same	Same	NA	$ 4,350	$ 4,350	$ 4,350	$ 4,350	$ 4,350	
		Reduce threats identified in Recovery Action 8 and monitored in Recovery Action 9. Efforts to reduce threats will focus on those that most adversely impact *A. kearneyana.*									

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Priority #	Activity #	Activity Narrative	Duration	Responsible Party	Total Estimated Cost	Cost Estimate by FY 2021	2022	2023	2024	2025	Comments
	10.2	Manage *A. kearneyana* habitat quality at Subsites	Same	Same	NA	$ 13,800	$ 4,350	$ 4,350	$ 4,350	$ 4,350	Additional cost of involvement of 3 partners for 10 days each at this rate to develop management plans. Plan revisions (at the same rate) will occur every 10 years (2030, 2040, and 2050).
		Develop and implement adaptive management plans that address: 1) potential and realized threats identified in Recovery Action 8 and monitored in Recovery Action 9; 2) concerns regarding habitat quality identified in Recovery Action 2; and 3) concerns regarding population trends identified in Recovery Actions 1 and 2. Among other activities, the management plan should explore the use of prescribed fire (i.e., reintroduction of more natural fire regimes) to restore habitat for *A. kearneyana* while recognizing there are risks to using fire until more is known about the plant's response to repeated fire and altered fire regimes on the landscape.									
	10.3	Enforce laws, regulations, and ordinances to protect *A. kearneyana*	Same	AZ, BANWR, BLM, TON, BP	NA	$3,150	$3,150	$3,150	$3,150	$3,150	Cost estimate based on 2 weeks per year at GS-11 rate
		Enforce laws, regulations, and ordinances to protect *A. kearneyana.* Coordination with law enforcement and regulators will be important to inform accomplish this activity.									
2	**Recovery Action 11: Conduct outreach, education, and coordination relating to *A. kearneyana* conservation and recovery**		40 years	APTPL, ASDM, DBG, AZESFO, TON, UNIV	$ 628,000	–	–	–	–	–	Cost estimate based on 1/10 FTE at GS-11 rate, plus equipment and supplies (e.g., vehicle use, laptops, GPS, cameras) ($5k) for 40 years. Additional costs include those incurred by other partners for outreach ($1k/year for 5 partners) and to meet once per year.
	11.1	Develop and maintain partnerships	Same	Same	NA	$ 3,925	$ 3,925	$ 3,925	$ 3,925	$ 3,925	
		Development and maintenance of a strong working alliance among management agencies, the Tohono O'odham Nation, research facilities, and the public is important to increase productivity and promote cooperation toward the conservation of *A. kearneyana*.									
	11.2	Conduct education and outreach on *A. kearneyana* conservation and recovery	Same	Same	NA	$ 3,925	$ 3,925	$ 3,925	$ 3,925	$ 3,925	
		Conducting education and outreach with various partners and the public on the status and conservation of *A. kearneyana* is important to the recovery of the species. For example, coordinating with U.S. Border Patrol is important to inform them of sensitive *A. kearneyana* habitat, so efforts can be focused on protecting the species and its habitat from illegal activity (e.g., trampling and fire starts). Similarly, coordinating with fire management agencies is important to prevent fuel breaks and fire lines from being created near *A. kearneyana* individuals.									

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	11.3	Secure funding for recovery implementation	Same	Same	NA	$ 3,925	$ 3,925	$ 3,925	$ 3,925	$ 3,925	
		Pursuing and securing funding to implement recovery activities for *A. kearneyana* is critical to the success of the recovery program and should be done by all partners.									
	11.4	Manage annual recovery program activities	Same	Same	NA	$ 3,925	$ 3,925	$ 3,925	$ 3,925	$ 3,925	
		Managing *A. kearneyana* recovery program activities is critical to the success of the recovery program and should be done by all partners.									
Total cost of recovery actions					**$5,743,650**	**$220,854**	**$179,281**	**$305,439**	**$210,348**	**$409,784**	