Upper Carson Slough Aquatic Habitat Enhancement and Restoration: Rogers and Longstreet Springs and Outflow Restoration Ash Meadows National Wildlife Refuge

National Fish Passage Program Funding
Status Report: June 2014

Erin Bradshaw Settevendemio, Ecological Restoration Specialist

Background

Ash Meadows National Wildlife Refuge (Ash Meadows) was established in 1984 and consists of almost 24,000 acres of alkaline desert and Ramsar Wetlands of International Importance. As the last remaining true oasis in the Mojave Desert, Ash Meadows contains over 50 seeps and springs supporting 26 endemic plant and animal species. Of those endemic species, 12 are Federally-listed under the Endangered Species Act, including four fish, one aquatic invertebrate, and seven plant species. Prior to its establishment, Ash Meadows experienced wide-spread anthropogenic impacts by agriculture and introduced species. The U.S. Fish and Wildlife Service (USFWS) is currently involved in extensive ecosystem-level restoration to recover threatened and endangered species endemic to Ash Meadows. The Ash Meadows NWR Recovery Plan (Sada 1990) states, “Introduced non-native aquatic animals and exotic terrestrial plants are currently the greatest threats to endemic species survival in Ash Meadows. Springs need to be protected and outflows restored to historic channels to enable free movement of listed fish between springs.”

Fairbanks and Soda Springs, the northern springs to feeding into the UCS, were restored in 2009-2011. Rogers and Longstreet Springs were the main springs contributing from the eastern side of the Slough, and the last major portion of UCS restoration (while other springs exists, such as Cold Spring and Five Springs, they are comparatively low-flow; Figure 1). Large-scale anthropogenic impacts altered the hydrological and geological function of the Upper Carson Slough (UCS) in the early 1960’s. Prior to landscape modification, the UCS exhibited a “dynamic interaction between sand dunes, water, vegetation, and sediment” that resulted in diverse and beneficial habitat for native aquatic species (Gradient, LLC 2013). The construction of Mud Lake Dam, ditches, and berms altered the natural flow of surface water over the landscape, through which a 385-square mile watershed drains (Baldino 2010; Figure 2). Longstreet Spring pool was excavated to support the extensive irrigation system, increasing the pool size from 9 to 18 m (30 to 60 feet) in diameter (approximately). This action created a shallow shelf along the perimeter and drastically changed the natural shape of the spring, providing favorable habitat for aquatic invasive species. Peat mining further transformed the UCS by eliminating natural wetlands and resulted in barren agriculture fields (Deacon and Williams 1991). These actions substantially reduced the quality and quantity of beneficial habitat for native flora and fauna species, and supported the colonization of aquatic invasive species (AIS). For example, invasive emergent macrophytes such as cattail *Typha latifolia* and *Phragmites* have overgrown much of the Upper Carson Slough. This habitat structure limits sunlight penetration to the water surface, reduces water flow, and creates widespread marshes. Cattail and *Phragmites* marshes support populations of invasive animal species such as red swamp crayfish *Procambarus clarkii,* Western mosquitofish *Gambusia affinis*, and bullfrog *Rana catesbeiana,* and dramatically reduces habitation by native fishes (Scoppettone 2012).

Historically, Ash Meadows Amargosa pupfish *Cyprinodon nevadensis mionectes* and Ash Meadows speckled dace *Rhinichthys osculus nevadensis* inhabited all springs of the UCS.   By the 1950's, speckled dace were extirpated from the UCS due to environmental modification and degradation (Baldino 2010).   Prior to restoration efforts, pupfish were found in limited numbers in the outflow streams of Fairbanks, Rogers, and Longstreet Springs and in high numbers in spring pools (Scoppettone 2011, 2012). Fairbanks and Soda Springs were the first systems in the UCS to undergo restored channel alignment in 2009-2011. A total of 118 speckled dace were translocated from Jackrabbit and Bradford 1 Springs to the restored Fairbanks Spring system in 2010 for species reintroduction (Baldino 2010). In a post-restoration survey of Fairbanks Spring in fall 2010 – spring 2011, Scoppettone (2012) found pupfish throughout the Fairbanks Spring outflow and an enhanced speckled dace population. The same study by Scoppettone (2012) also evaluated relative abundance and distribution of native fishes in Rogers and Longstreet Spring systems (unrestored). Very low numbers of pupfish were captured in the unrestored spring outflow channels.

The objective of this project was to "return [Rogers and Longstreet Springs] flows to their approximate historic location while promoting the recovery of hydrologic processes and connectivity and improving ecological integrity and function" (Gradient, LLC 2013)." Stream channel realignment and ditch/berm removal will promote natural surface and ground water flow, sediment deposition, nutrient cycling, and hydrological/biological connectivity throughout the system. These channels will connect with Fairbanks Spring and further expand beneficial habitat for Ash Meadows Amargosa pupfish and Ash Meadows speckled dace. This will also promote genetic exchange among native fish populations in the northern springs and improve genetic fitness (Martin 2013).

In preparation for this project, an eradication project targeting sailfin molly *Poecilia latipinna* was conducted in the Longstreet Spring system via rotenone in February 2011. Over 2,100 Ash Meadows Amargosa pupfish were trapped and relocated prior to chemical treatment.

In March 2013, fish salvage was conducted in expectation of project commencement. Approximately 3,119 Ash Meadows Amargosa pupfish were removed from Longstreet Spring outflow and pool, and an additional 102 pupfish removed from Rogers Spring outflow. No sailfin mollies were captured during fish salvage events. Efforts were ceased on 25 March 2013 in response to EA comments.

All actions were reviewed and approved by the Ash Meadows Recovery Implementation Team (AMRIT). Representatives from the Nevada Department of Wildlife (NDOW); U.S. Fish and Wildlife Service, Southern Nevada Field Office, (FWS-ES); U.S. Fish and Wildlife Service, Desert National Wildlife Refuge Complex Office and Ash Meadows National Wildlife Refuge (FWS-Refuges); U.S Geological Survey (USGS), Desert Research Institute (DRI); and Southern Oregon University (SOU). Gradient, LLC was contracted to design and construct the restored Rogers and Longstreet Springs outflow channels.

Design considerations

Pool size reduction and channel realignments were designed based on a number of resources, including LiDAR, GIS, topographic surveys, field surveys, historical descriptions, and historical aerial imagery (year 1948; Gradient, LLC 2013). Current aquatic invasive species populations and invasive vegetation were also considered in channel design. The Ash Meadows Recovery Implementation Team (AMRIT) was consulted in the approach and goals of Rogers and Longstreet Springs restoration.

Stream channel alignments were selected to keep the steepest gradient possible while also avoiding areas already containing invasive vegetation. Maintaining open, flowing channel restricts emergent vegetation overgrowth and minimizes suitable habitat for aquatic invasive species. However, to keep with natural topography, it was necessary to route lower reaches of both Rogers and Longstreet Springs systems through dense stands of cattail and *Phragmites*.

The excavation of Longstreet Spring pool for agricultural purposes resulted in a larger pool surface area and shallow shelf along the periphery. Enlarged surface area and residence time promoted heat loss from the pool and thus a reduction in temperature through the stream outflow. The shallow shelf around the spring pool encouraged invasive cattail encroachment and provides ideal habitat for aquatic invasive species. Longstreet Spring has a similar discharge rate to Kings Pool, another spring which underwent a size reduction. Kings Pool has successfully prevented the colonization of cattail stands and saw a substantial reduction in aquatic invasive animal species. Similar to methods at Kings Pool, large boulders of locally-derived caliche were placed along the shallow shelf and filled with cobbles and gravel in interstitial spaces. This helps prevent cattail growth, limits invasive animal species habitat, and provides ideal substrate for algae growth and pupfish habitat.

Progress to date

Restoration activities began in December 2013 and were completed in April 2014. In order to minimize native fish loss, extensive fish salvage efforts were conducted by Ash Meadows NWR staff, Nevada Conservation Corps (NCC) crew members, and volunteers prior to dewatering or major disturbance. Fish salvage was conducted in five phases in close coordination with Rob Andress (Gradient, LLC; Figure 3). Initially, water flow was only partially diverted (30-70%) to allow time for fish trapping and relocation. Water was fully diverted following the completion of fish salvage efforts. A total of 2,925 Ash Meadows Amargosa pupfish and 91 Ash Meadows speckled dace were captured and relocated during fish salvage events at Rogers Spring. At Longstreet Spring, 1,910 pupfish and 15 speckled dace were salvaged from the outflow channels prior to full diversion, and 6,011 pupfish salvaged from the spring pool prior to springhead alteration (Figure 4). In total, almost 5,000 crayfish, 6,900 mosquitofish, and 900 tadpoles were removed from the restoration areas.

Approximately 5,140 meters (1,558 feet) of new stream channel was excavated [Rogers Spring = 1,830 meters (6,004 feet); Longstreet Spring = 2,035 meters (6,676 feet); lower combined channel = 1,275 meters (4,183 feet)] (Figure 5). The Longstreet Spring pool was reduced in size by approximately 50-60% to better resemble the size and shape of the spring prior to anthropogenic alteration (Figure 6). Additionally, the Longstreet Spring flume was removed for increased native fish passage between the spring pool and outflow (Figure 7). Following the completion of work on the spring pool and the removal of the flume, pupfish were sighted entering the pool and exhibiting breeding behavior along newly-placed caliche boulders (Figure 8). Speckled dace were also seen entering the pool by Rob Andress.

Concrete fish barrier structures with removable flashboard systems were installed approximately 600 meters (2,000 feet) downstream from Rogers Spring source and 900 meters (3,000 feet) downstream from Longstreet Spring source pool (Figure 9). The concrete barriers are structured as a 3.63-meter (12-foot) long box culvert with an open top. The barrier is placed in-line with stream flow which will pass over a locking and tamper-proof flash board fish barrier, creating a vertical water surface drop of 0-1 m (0-3 feet). This temporary or removable structure allows for future invasive species treatments or invasion prevention, but also allows for free passage of endemic fishes when boards are removed for connectivity throughout all systems. A concrete channel large enough to carry full flow from Longstreet Spring was also installed approximately 30 meters (100 feet) downstream from the spring pool for water quality monitoring (Figure 10).

Unfortunately, a gravid sailfin molly was captured approximately 0.9 km (0.56 mi) from Longstreet Spring pool in March 2014. As stated previously, Longstreet Spring underwent rotenone application targeting sailfin mollies in spring 2011, and this species had not been sighted or captured since the project (Weissenfluh 2012). Darrick Weissenfluh (Ash Meadows Conservation Facility Manager) Sharon McKelvey (Refuge Manager) and Rob Andress (Gradient, LLC) were immediately notified. Temperature readings indicated that current conditions would be suitable for sailfin molly reproduction in this area. Due to the sailfin molly discovery and the amount of effort already conducted in fish salvage (2,554 trap-hours), it was decided that water flow be fully diverted to the new channel immediately. A block net was placed below Zone 2A to prevent downward movement of sailfin molly during draining. The following day, eight more individuals were captured in Zone 2B while water remained, and fish salvage continued until the area was dry. Plates were installed on the new Rogers and Longstreet Springs fish barriers to prevent potential upstream movement of sailfin mollies through the new stream channels. Plates will remain in place until appropriate monitoring is conducted and confidence that no sailfin mollies remain in the system is attained.

Approximately 17,000 meters (56,000 feet) of berms and ditches were removed to promote the natural movement of overland and subsurface water flow throughout the Upper Carson Slough (Figure 11). Berms or ditches with substantial native plant growth (i.e., mesquite *Prosopis* spp., leatherleaf ash *Fraxinus velutina,* saltbush *Atriplex* spp.) were only partially removed if it would not significantly inhibit water movement during high flow events. A low water crossing was also constructed to maintain the accessibility of the east-west two-track road crossing Rogers Spring, just below the fish barrier (Figure 5; Figure 12). The road will not be decommissioned for the purposes of wildfire access and a future recreational trail system throughout the UCS.

Ash Meadows NWR staff, along with NCC crews planted transplanted native saltgrass *Distichlis spicata* along the upper portions of Longstreet (445 m) and Rogers (168 m) Springs channels to prevent colonization of invasive weeds (Figure 13). Watering of native plants and manual weeding or herbicide treatment is on-going. This is particularly necessary for the Longstreet Spring channel, which is now directed through a barren agricultural field and likely contains a substantial invasive weed seed bank. Revegetation of the lower portions of the channels is unnecessary due to the minimal disturbance footprint (Figure 14).

Future work

Follow-up monitoring and weed treatment of both restoration areas will be necessary for the next 1-3 years. Control of terrestrial and emergent aquatic weeds via manual and chemical methods is on-going in order to allow recently planted native vegetation time to establish and spread. Manual irrigation of plants is also performed on a weekly basis. Possible seed spreading or seed slurry application with locally-collected, native plant seed may be conducted this fall.

Due to the sailfin molly discovery during fish salvage events, regular monitoring via snorkel surveys and trapping is on-going at Longstreet Spring. A snorkel survey performed on 15 May 2014 from the fish barrier to the spring pool yielded no sailfin molly sightings. Sailfin mollies also were not sighted during a snorkel survey of Longstreet Spring pool on 6 June 2014. On 12 June 2014, several traps were deployed below Rogers and Longstreet Springs fish barriers for sailfin molly monitoring. No sailfin mollies were found, however both pupfish and dace were captured (Rogers Spring: 31 pupfish and 13 dace; Longstreet Spring: 5 pupfish and 35 dace).

In conjunction with sailfin molly monitoring, regular trapping of the spring pool will also allow a further reduction in bullfrog tadpoles. Over 800 tadpoles were captured and removed during fish salvage of the spring pool from December 2013 to February 2014, demonstrating an evident need for bullfrog/tadpole control in this system. A modified hoop net designed to remain erect in non-flowing water was also deployed in the spring pool in late May 2014. Five adult bullfrogs have been removed to date. Hopefully, the reduction in cattail growth due and regular trapping will significantly reduce the bullfrog and tadpole population at this spring.

Summary

- 1,830 meters (6,004 feet) of new stream channel constructed for Rogers Spring outflow.
- 2,035 meters (6,676 feet) of new stream channel excavated for Longstreet Spring outflow.
- 1,275 meters (4,183 feet) constructed for the combined flow of Rogers and Longstreet Springs.
- Removable fish barriers installed along both, Rogers and Longstreet Springs outflows.
- Over 100 Ash Meadows speckled dace captured during fish salvage events indicates reproduction and dispersal from the Fairbanks Spring system.
- Longstreet Spring pool reduced in size by 50% with a reduction in preferred habitat of aquatic invasive species.
- Removal of Longstreet Spring flume increases connectivity and genetic exchange among native fish populations.
- Completion of Rogers and Longstreet Springs, in combination with Fairbanks Spring restoration, increased habitat for the Ash Meadows speckled dace from 0.95 km (0.59 mi) to a total of 11.70 km (7.27 miles). Speckled dace have already been found throughout the Upper Carson Slough system, following reintroduction to Fairbanks Spring in April 2010.

References

Baldino, C. R., 2010. Restoration of the Upper Carson Slough, phase I/II: aquatic habitat restoration and improved fish passage at Fairbanks and Soda Springs, Ash Meadows National Wildlife Refuge, Amargosa Valley, NV, U.S. Fish and Wildlife Service.

Deacon, J.E. and C.D. Williams, 1991. Ash Meadows and the Legacy of the Devils Hole Pupfish in W.L. Minckley and J.E. Deacon (eds.) Battle Against Extinction - Native Fish Management in the American West. The University of Arizona Press. p.69-87

Gradient, LLC, 2013. Upper Carson Slough aquatic habitat enhancement and restoration: Rogers and Longstreet Springs and outflow restoration, Ash Meadows National Wildlife Refuge, Amargosa Valley, NV, U.S. Fish and Wildlife Service.

Martin, A. 2013. Genetic management plant for the Ash Meadows pupfish *Cyprinodon nevadensis mionectes*, Ash Meadows National Wildlife Refuge, U.S. Fish and Wildlife Service.

Sada, D.W., 1990. Recovery plan for the endangered and threatened species of Ash Meadows, Nevada, Reno, NV, U.S. Fish and Wildlife Service.

Scoppettone, G.G., P. Rissler, D. M. Johnson, and M. E. Hereford, 2011. Relative abundance and distribution of fishes and crayfish at Ash Meadows National Wildlife Refuge, Nye County, Nevada, 2007-08, U.S. Geological Survey Open-File Report 2011-1017, 56 p.

Scoppettone, G.G., D. M. Johnson, and M. E. Hereford, P. Rissler, M. Fabes, A. Salgado, and S. Shea, 2012. Relative abundance and distribution of fishes and crayfish at Ash Meadows National Wildlife Refuge, Nye County, Nevada, 2010-11, U.S. Geological Survey Open-File Report 2012-1141, 52 p.

Weissenfluh, D. 2012. Eradication of the Sailfin Molly (*Poecilia latipinna*) from the Longstreet Spring System, Ash Meadows National Wildlife Refuge, Nevada. U.S. Fish and Wildlife Service, Department of the Interior.

Figures

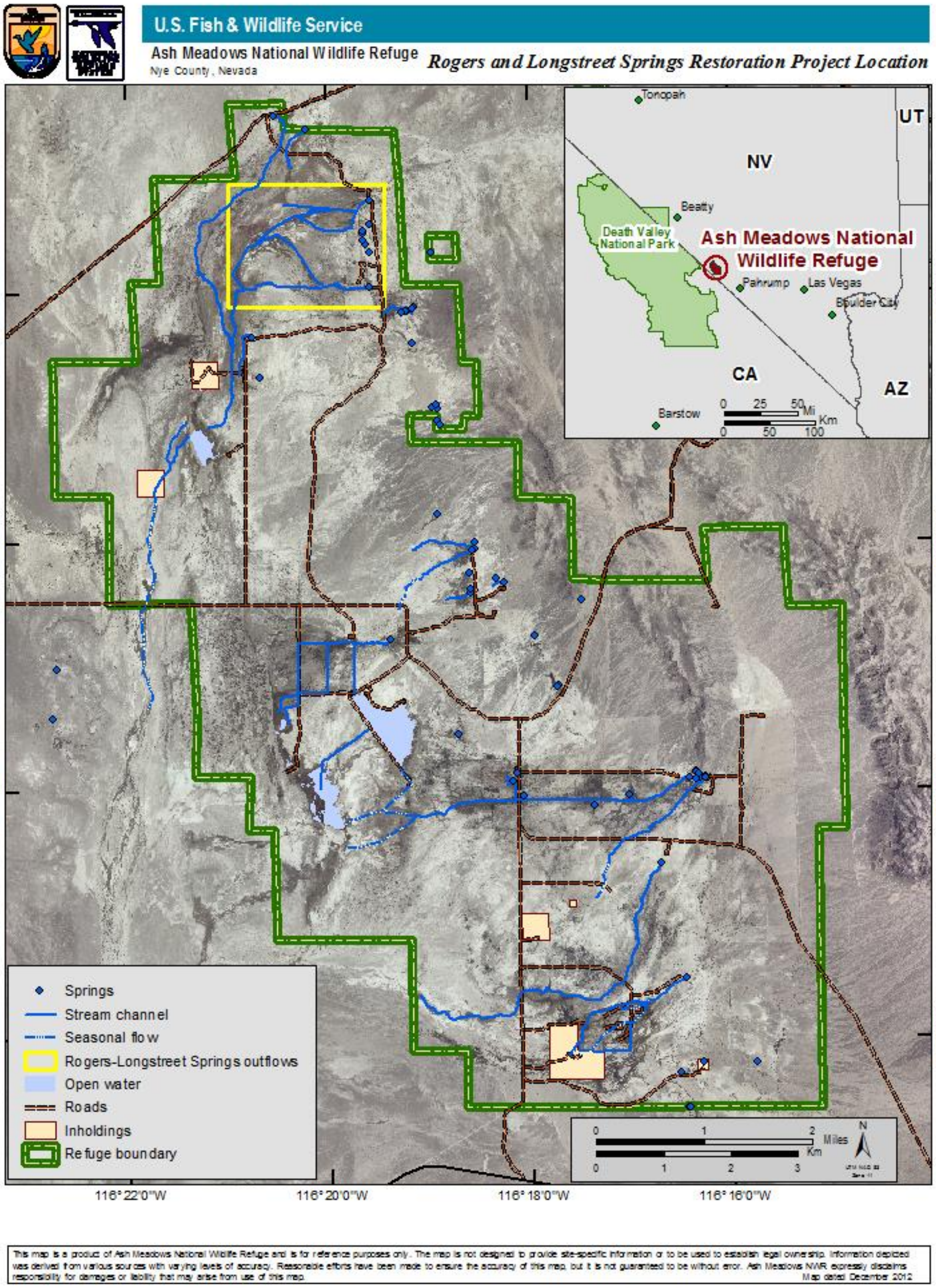

Figure 1. Location of the Rogers and Longstreet Springs project area, Ash Meadows National Wildlife Refuge, NV.

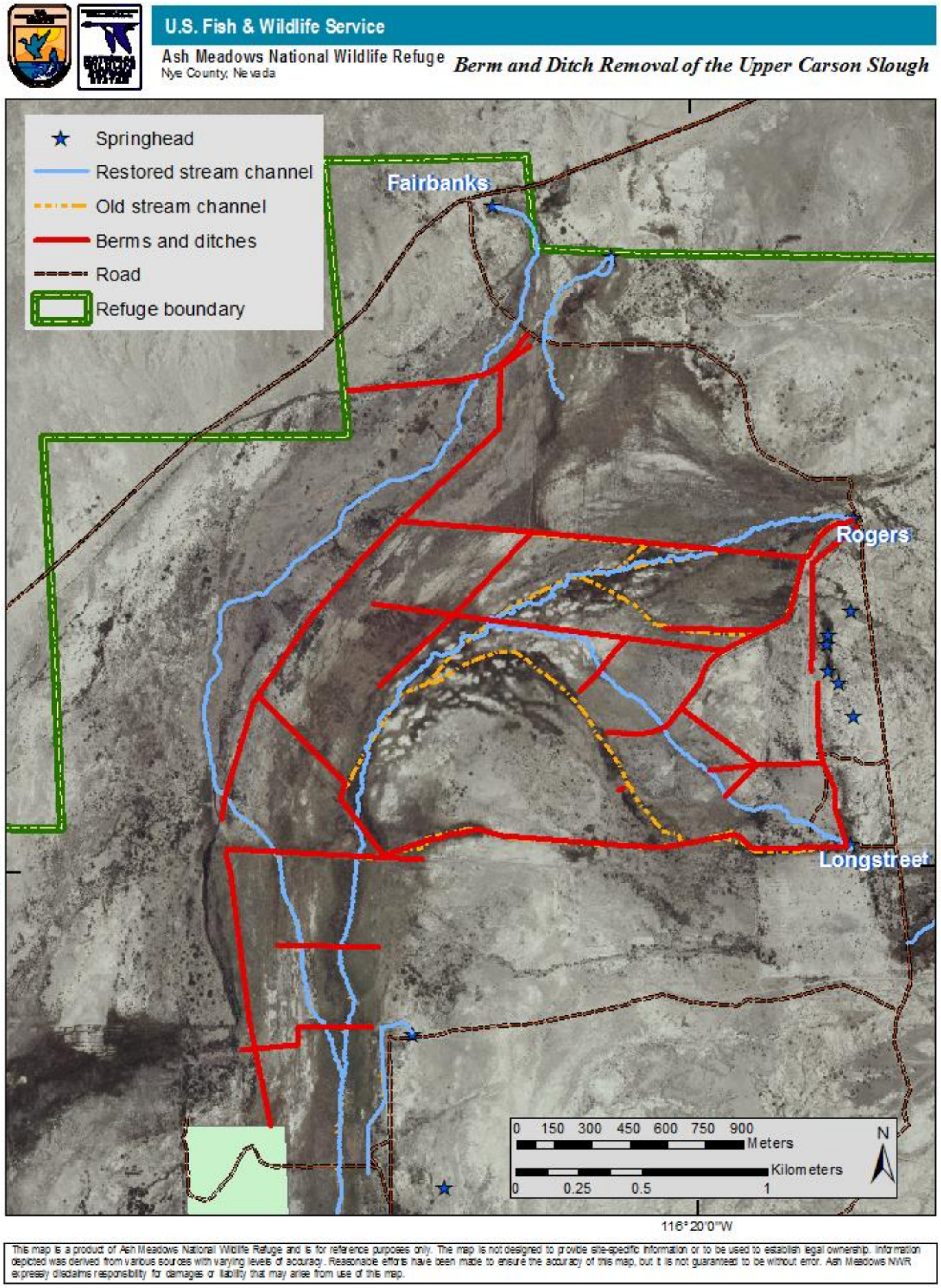

Figure 2. Locations of removed berms and ditches throughout the Upper Carson Slough, Ash Meadows National Wildlife Refuge, NV.

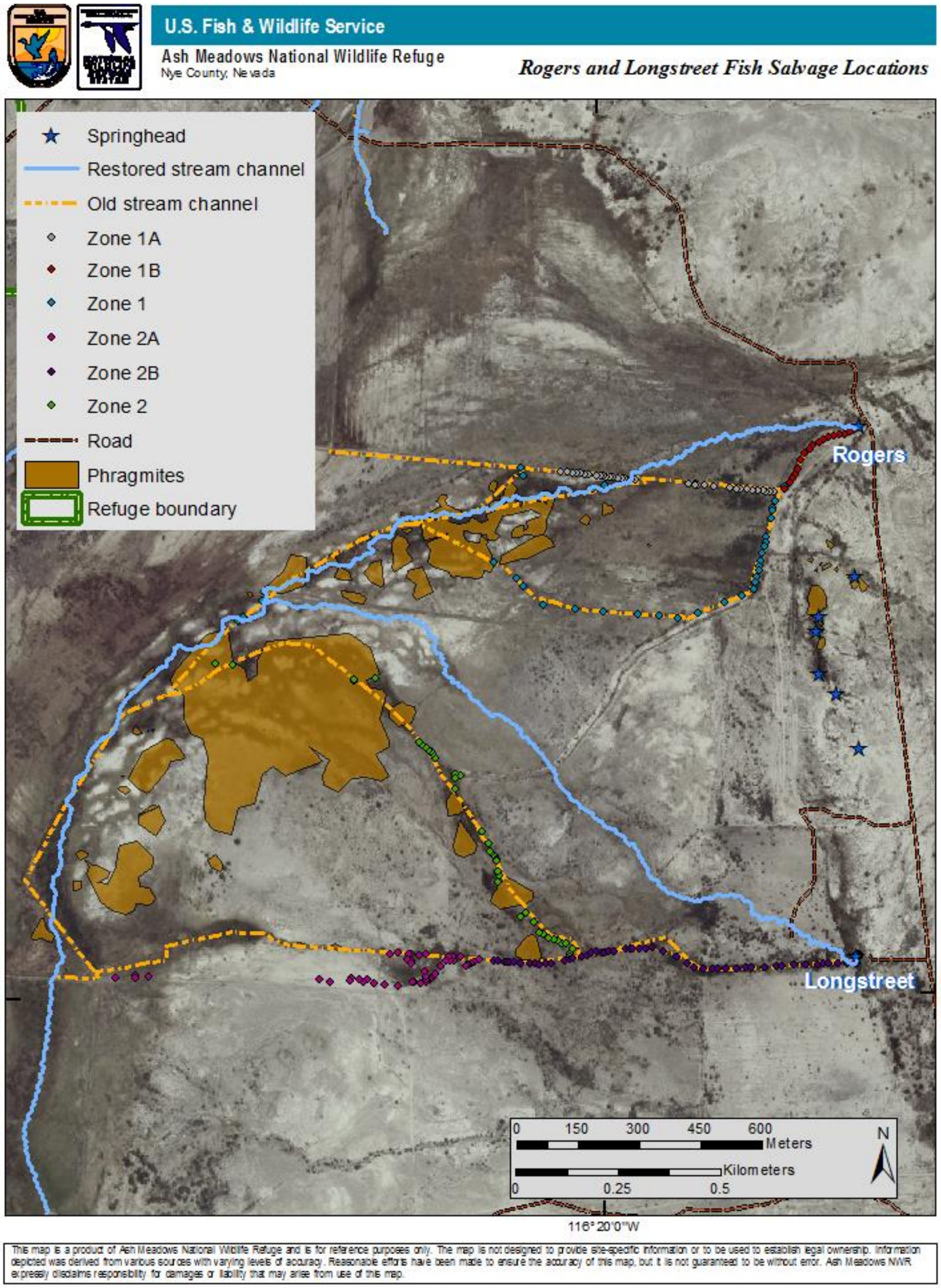

Figure 3. Trapping locations for fish salvage during restoration events at Rogers and Longstreet Springs, Ash Meadows National Wildlife Refuge, NV.

Figure 4. Fish salvage efforts conducted by Great Basin Institute contractors (left and upper right) and Nevada Conservation Corps crew members (lower left), Ash Meadows National Wildlife Refuge, NV.

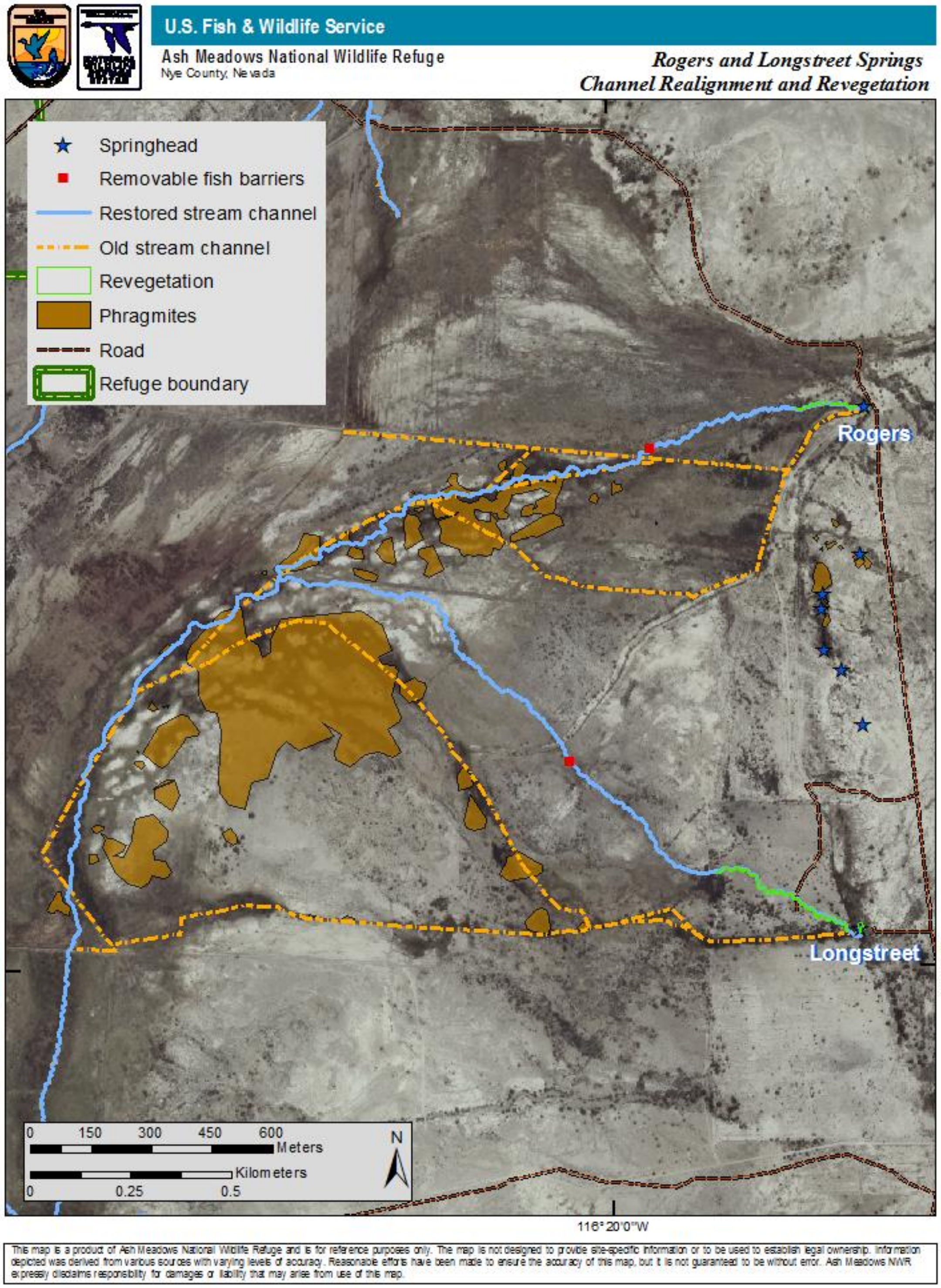

Figure 5. Restored channel realignment of Rogers and Longstreet Springs, Ash Meadows National Wildlife Refuge, NV.

Figure 6. Longstreet Spring pool before (upper) and after (lower) restoration. Note the reduction in size and shallow marginal area by placement of caliche boulders. Ash Meadows National Wildlife Refuge, NV.

Figure 7. Outlet to Longstreet Spring pool after removal of water monitoring flume allowing full fish passage ability for native fishes, Ash Meadows National Wildlife Refuge, NV.

Figure 8. Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*) congregation and breeding behavior in newly-restored Longstreet Spring pool, Ash Meadows National Wildlife Refuge, NV.

Figure 9. Fish barriers installed along restored stream channels in Rogers (upper) and Longstreet (middle) springs. Lower panel shows installation of removable plates and grate. Ash Meadows National Wildlife Refuge, NV.

Figure 10. Concrete structure installed for water monitoring, Longstreet Spring, Ash Meadows National Wildlife Refuge, NV.

Figure 11. Berm and ditch removal in the Upper Carson Slough, Ash Meadows National Wildlife Refuge, NV. Photo courtesy of Hal Fairfield, volunteer.

Figure 12. Low water crossing, Rogers Spring, Ash Meadows National Wildlife Refuge, NV.

Figure 13. Saltgrass (*Distichlis spicata*) planting along restored stream channels, Rogers and Longstreet Springs, Ash Meadows National Wildlife Refuge, NV. Photos courtesy of Abram DaSilva, Great Basin Institute.

Figure 14. Example of minimal disturbance along the lower channel, Rogers Spring, Ash Meadows National Wildlife Refuge, NV.