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CONSERVATION TRIAGE OF SONORAN MUD TURTLES (*KINOSTERNON SONORIENSE*)

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***Abstract.*—Conservation triage is a strategy that promotes allocation of resources to species with at least moderate probabilities of long-term recovery. In contrast, legislation like the Endangered Species Act mandates that conservation resources are dedicated to listed species even if recovery probability is low. Conservation triage has not been embraced by funding agencies, and efforts to protect unlisted species must rely on private funding and volunteer effort. The Sonoran Mud Turtle (*Kinosternon sonoriense*) is a good candidate for conservation triage because it remains relatively common yet faces addressable threats such as habitat degradation. Populations often occur at impoundments that are experiencing siltation or dam failures. Even though Sonoran Mud Turtles are not threatened or endangered, they may already be conservation reliant, and many populations could decline unless impoundments are restored. Our efforts to obtain funding for impoundment restoration failed, so we initiated restoration projects at three impoundments in the Coronado National Forest, New Mexico and Arizona, using our own resources. During 2012, we removed about 328 m^3 of silt from three impoundments and repaired one leaking dam. As a result, two of the restored impoundments increased in water volume and hydroperiod, capture rates of turtles increased at one impoundment, and the third impoundment completely silted in again within two months. We expect little change in funding patterns or conservation priorities but remain committed to habitat restoration in our study area. We hope our efforts help convince others to make similar investments aimed at the important goal of keeping common species common.**

Key Words.—habitat restoration; siltation; Coronado National Forest

INTRODUCTION

Extinctions associated with human activities have far surpassed background extinction rates, and the cost of reversing this trend is well beyond current investment in conservation (Bottrill et al. 2008). The International Union for Conservation of Nature (IUCN), the Endangered Species Act (ESA), and various state versions of the ESA all dictate that conservation resources be allocated primarily to endangered or threatened species, those in imminent danger of extinction or likely to become endangered in the near future (Neel et al. 2012). Moreover, many threatened or endangered species have become conservation reliant and are likely never to be delisted, but instead will require active management for the foreseeable future (Scott et al. 2005, 2010). Consequently, even though theory suggests that hundreds or thousands of individuals may be needed for successful conservation of a species (Neel et al. 2012), conservation resources are often directed toward species reduced to a few small populations that have relatively low probabilities of recovery (Neel et al. 2012). As a result, conservation is often an acute struggle to prevent extinction (Shaffer and Stein 2000), with efforts waged down to the last individual (Rhodin et al. 2011).

Conservation triage is a strategy that promotes allocation of resources to threatened species with at least moderate probabilities of long-term recovery and assigns a lower priority to critically endangered species with little chance of avoiding extinction (Hobbs and Kristjanson 2003). If conservation measures begin before widespread population collapse, minimal and inexpensive efforts can be sufficient to maintain viable populations that are less prone to extirpation from stochastic processes (Bottrill et al. 2008). Allocation of funding for turtle conservation continues to be primarily for endangered species, indicating that conservation triage has not been embraced by turtle conservation organizations. For example, the Turtle Conservation Fund funded $536,000 in proposals for turtle conservation during 2002–2010, with low priority given to species not assigned a Threatened category (Vulnerable, Endangered, Critically Endangered) on the IUCN Red List (Turtle Conservation Fund 2002; Rhodin et al. 2011). Focusing on endangered turtles is certainly understandable given that turtles are among the most imperiled vertebrate clades, with approximately half of all species assigned to a Threatened category (Rhodin et al. 2011). Nevertheless, by not addressing manageable threats to unlisted species we are increasing the

likelihood that some will eventually join those ranked as threatened.

The Sonoran Mud Turtle, *Kinosternon sonoriense*, is a good candidate for conservation triage because they remain relatively common within their geographic range (van Loben Sels et al. 1997; Hall and Steidl 2007; Stanila 2009) yet face addressable threats. Locally, Sonoran Mud Turtles are listed as Apparently Secure in Arizona and Vulnerable in New Mexico (NatureServe. 2013. Available from http://www.natureserve.org/explorer [Accessed 6 January 2014]). Globally, based in part on documentation of populations in intermittent aquatic habitats formerly thought uninhabitable (van Loben Sels et al. 1997; Stone 2001; Hall and Steidl 2007; Hensley et al. 2010), the status of Sonoran Mud Turtles has recently been changed from Vulnerable (a Threatened category) to Near Threatened on the IUCN Red List, indicating the species is less imperiled than previously thought (IUCN 2013. Available from http://www.iucnredlist.org [Accessed 6 January 2014]). However, several factors indicate the Sonoran Mud Turtle is a conservation concern: (1) a small geographic range within arid portions of southwestern New Mexico, southern Arizona, and northern Mexico (Iverson 1992); (2) numerous recent droughts that are predicted to increase in severity and frequency by climate models (Seager 2007; Seager and Vecchi 2010); (3) predation by exotic species such as Virile Crayfish, *Orconectes virilis* (Hensley et al. 2010) and American Bullfrogs, *Lithobates catesbeianus* (Akins and Jones 2010); and (4) habitat degradation caused by siltation and dam failures at intermittent impoundments (e.g., stock tanks and Civilian Conservation Corps dams). Because threats are unlikely to diminish without active management into the foreseeable future, it is likely that Sonoran Mud Turtles are already conservation reliant. Habitat degradation is one threat that can be addressed with cost-effective measures, such as building erosion control structures, repairing dams, and removing silt from impoundments, which should increase the probability of long-term viability of populations throughout the range of the species.

Throughout the American Southwest humans have modified aquatic habitats to support livestock ranching. For example, five of the eight natural springs in our Peloncillo Mountain study area were capped during the past century with the water diverted to watering troughs or holding tanks that are of little or no value to wildlife (Stanila 2009). During the same period 15 impoundments were constructed using rock or earthen dams across canyon beds, creating aquatic habitats with extended hydroperiods in areas where aquatic habitats had been ephemeral (Stanila 2009). These impoundments have been part of the core areas (Semlitsch and Jensen 2001) of Sonoran Mud Turtles for almost a century and currently harbor the largest concentrations of individuals in the Peloncillo (Stanila 2009) and Chiricahua Mountains (van Loben Sels et al. 1997). However, reduced and sporadic maintenance has resulted in dam failures, and sedimentation has reduced water volume and hydroperiod of many impoundments. Because Sonoran Mud Turtles are desiccation tolerant (Wygoda and Chmura 1990; Peterson and Stone 2000; Ligon and Stone 2003) and have the capacity for long-distance movements across terrestrial habitat (Stone 2001; Hall and Steidl 2007; Hensley et al. 2010), it is likely they would colonize newly constructed or restored impoundments.

All of our study sites were within the Coronado National Forest, and ultimately restoration and maintenance of aquatic habitats is part of the United States Forest Service (USFS) mission. We approached the USFS for assistance in restoring aquatic habitats in our study area, but because they were understaffed, underfunded, and faced with more pressing challenges, they were unable to act. Likewise, grant proposals to outside funding agencies for aquatic habitat restoration were not funded. We decided to restore three impoundments ourselves, using private funding and volunteer labor. This paper describes our restoration efforts and the effects during the first year on water levels and turtle trapping success.

BLACKWATER HOLE

Blackwater Canyon is approximately 3.75 km long with an elevational gradient of about 50 m, located in the Clanton Draw drainage of the Peloncillo Mountains. Water levels in Blackwater Canyon are highly variable (Stone 2001; Ligon and Stone 2003). Blackwater Hole is an intermittent impoundment created by a concrete dam (3 m high and 15 m wide) located 0.75 km from the headwaters of Blackwater Canyon. During 1994–2012, Blackwater Hole was full of water during at least 13 y, completely dry during at least seven y, and reduced to a puddle $\leq$10 m^2 during three other years. In 1994, Blackwater Hole was about 25 m long and 15 m wide with an approximate surface area of 375 m^2 and a maximum depth of 2.5 m. In July 2006, a major flood washed in about 200 m^3 of silt into Blackwater Hole that had little effect on the surface area but reduced the standing water volume by about half. In May 2008, a small hole developed in the steel cleanout plate at the base of the dam, completely draining the surface water of Blackwater Hole in approximately one mo. The tank filled again in July 2008, continued to lose water during August 2008, and was dry from May-August 2009. The hole in the cleanout plate was temporarily patched in May 2009 and the impoundment held water for much of 2010–2011. However, by August 2011 several other holes had formed in the cleanout plate and Blackwater

Figure 1. Blackwater Hole restoration: Top, Blackwater Hole in May 2012, before silt removal; Middle, Blackwater Hole in May 2012 after silt removal; Bottom, Blackwater Hole in August 2013, about one year after refilling with water (Photographed by Paul A. Stone).

Hole drained rapidly. In May 2012, when restoration work began, Blackwater Hole was dry (Fig. 1).

During 41 trips to Blackwater Canyon during 1994–2012 we captured 633 Sonoran Mud Turtles 1,798 times. The Sonoran Mud Turtle population in Blackwater Canyon is the largest and most intensively studied population in our 200 km^2 study area in the Peloncillo Mountains, New Mexico (Stone 2001; Stanila 2009; Stone et al. 2011). Restoring Blackwater Hole was therefore important to our long-term study and for enhancing the probability of long-term persistence of the species.

During 15–25 May 2012, we completed most of the restoration work at Blackwater Hole (Fig. 1). Over 2.5 d, a team of 15 volunteers used shovels, buckets, and wheelbarrows to remove approximately 53 m^3 of silt from the area adjacent to the upstream side of the dam. On the third day, we maneuvered a skid steer loader (hereafter Bobcat; Bobcat Company, West Fargo, North Dakota, USA) up a narrow foot trail to Blackwater Hole (approximately 3 km at about 1 km/h with a number of minor trail modifications). That afternoon we used the Bobcat to build an access ramp into the tank and over the next two d spent a total of five h removing an additional 35 m^3 of silt from Blackwater Hole. To prevent the 88 m^3 of removed silt from washing back into Blackwater Hole, we either placed it on the downstream side of the dam (ca. 15 m^3) or spread it in a depression about 20 m from the impoundment. We seeded both areas with native seed to stabilize the silt. We also removed the old plate (92 cm × 151 cm) from the dam and replaced it using thicker metal. To prolong the life of the new plate, we had it powder-coated and glued pond liner to the inside surface before attachment to the dam.

We have made four trips to the study area since the restoration of Blackwater Hole. Blackwater Hole was holding water on each occasion, with an average surface area (mean ± SD) of 500 ± 239.8 m^2. Trapping success of turtles in Blackwater Hole by August 2013 was similar to what it was before the plate started leaking.

CLANTON DRAW DAM

Clanton Draw Dam is in the Clanton Draw drainage, about 2.5 km straight-line distance (4.1 km of canyon bed) from Blackwater Hole. The concrete dam measures about 2 m high and 5 m long and originally created an impoundment about 10 x 5 m. Before 1994, the impoundment was persistent enough to be occupied by a small number of Chiricahua Leopard Frogs, *Lithobates chiricahuensis* (Charles Painter, pers. comm.). However, except for small pools immediately above and below the dam, the impoundment has been fully silted since at least 1994, and few mud turtles have been captured there during our study.

We sampled Clanton Draw on eight occasions during 1994–2012 and captured eight turtles within 0.1 km and 25 turtles within 1 km of the dam. Even though it was unclear that restoring such a small impoundment would create enough aquatic habitat to harbor a population of mud turtles, restoration would increase connectivity and persistence of aquatic habitats in the drainage, and that

should benefit mud turtles, given their propensity for terrestrial movements (Stone 2001; Hall and Steidl 2007; Hensley et al. 2010). We used the Bobcat to remove about 50 m^3 of sediment from behind the dam in five h. The sediment, which consisted mainly of heavy rock and gravel, was deposited on the downstream side of the dam and had all washed downstream by October 2012. We did not capture any turtles during four visits to the Clanton Draw Dam area after sediment removal. The restored impoundment held water on each occasion, with an average surface area of 95 ± 31.3 m^2.

JACK'S TANK

In 2009, Jack's Tank was added to five other study sites regularly sampled since 1990 for Sonoran Mud Turtles in the Chiricahua Mountains (van Loben Sels et al. 1997). The tank is approximately 30 m long and 10 m wide (300 m^2 surface area) when full and is approximately 4 m deep at the dam. The presence of a large pile of silt 30–40 m from the tank indicated it had previously been cleaned out, and in 2009 the majority of the tank was covered with standing water. We marked 56 individuals in 2009 but were unable to access the tank in 2010 and 2011 due to wildfires. Jack's Tank completely filled with silt and ash after the 2010 and 2011 wildfires.

In May 2012, we used the Bobcat and a tractor to remove sediment from Jack's Tank. Based on approximately 4 min per bucket load for each piece of equipment, we removed about 190 m^3 of silt from the back of the tank, and this restored about one quarter of the original surface area of the tank. Removed silt was moved to the silt pile from the previous cleanout. Two people conducted the work due to safety concerns and work was halted on the second d when a load arm on the tractor cracked.

During searches of the area around the tank during breaks for water and food, we found 12 turtles in shallow forms in forested areas, in shaded niches along cliff faces, and one that had entered the excavated area of tank where shallow water accumulated. Unfortunately, the tank was completely re-filled with silt early in the Monsoon season (July 2012) when the first heavy storms occurred. A small ephemeral tank that may provide some refuge for turtles is located approximately 2 km from Jack's Tank.

DISCUSSION

Our habitat improvement projects required ca. $6,000 and 55 person days to complete. There were unexpected complications that increased the time and costs of the projects, including mechanical failures of the tractor, Bobcat, and the truck used to haul the Bobcat. Conservation funding for marginally threatened populations is unlikely to increase given the long-term resource commitments needed for conservation-reliant species that are already threatened or endangered. Therefore, privately funded conservation projects that rely on enthusiastic volunteer effort, like the one described here, could be a prerequisite for successful conservation triage. Fortunately, efforts to maintain marginally threatened populations should be less expensive and have a higher probability of success than projects involving more endangered populations. It may seem unreasonable to expect researchers to privately fund conservation efforts in their own study areas. However, we think the mud turtle population at Blackwater Canyon would have substantially declined without restoration of Blackwater Hole and the mud turtle population at Jack's Tank will also decline precipitously unless further restoration is undertaken. Because neither the USFS nor granting agencies were able to assist the proposed restoration, it became clear we faced two choices: let these populations collapse or restore the habitats ourselves. We found the former choice unacceptable. Only time will tell if our efforts will serve as cost-effective examples of habitat restoration that can be successful at preventing other species from becoming endangered.

Beginning in 1999, drought has prevailed throughout the southwestern United States in all but a few years (Seager 2007). In the future, climate models consistently predict long-term drought conditions due to climate change throughout the region (Seager and Vecchi 2010). Drought exacerbates current threats to Sonoran Mud Turtles associated with aquatic habitat deterioration and introduction of exotic species. A program that includes erosion control, maintenance of existing impoundments, and restoration of failing impoundments should be effective at helping maintain Sonoran Mud Turtle populations during an era of persistent drought.

There are other impoundments within the range of Sonoran Mud Turtles that need restoration, and hydroperiods of ephemeral pools could be increased by constructing small loose rock dams (trincheras) that slow rates of water flow and trap silt in upper areas of watersheds. Indeed, it is likely there will always be aquatic restoration projects in our study area, and that Sonoran Mud Turtle populations are reliant on successful completion of these projects. Although some projects will be successful and others will fail, we are committed to further restoration work on the aquatic habitats of Sonoran Mud Turtles. Currently, it appears that conservation triage is not a conservation priority, but we hope this paper stimulates discussion about the importance of keeping common species common and results in similar commitments to restoration efforts in other areas.

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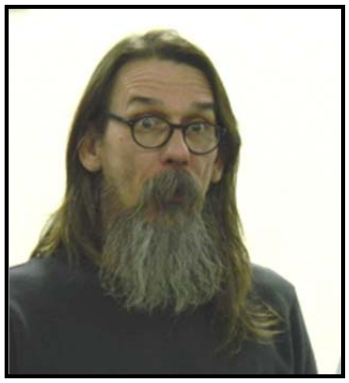

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CHELSEA SMITH is an undergraduate in the Biology Department at the University of Central Oklahoma. She will receive her Bachelor of Science in May of 2014. Chelsea engaged in undergraduate research throughout her undergraduate career under the advisement of Paul Stone. Her main focus has been on Sonoran Mud Turtle conservation through habitat rehabilitation. Chelsea intends to pursue a graduate degree in conservation or paleontology and museum studies. (Photograph by Kristen Bliss).