January–March 2006
Vol. 23 No. 1
pages 1–56

Endangered Species UPDATE

Science, Policy & Emerging Issues

School of Natural Resources and Environment

THE UNIVERSITY OF MICHIGAN

Contributors

A. R. Dar is Doctoral Scholar in the Centre of Plant Taxonomy (COPT), Department of Botany, University of Kashmir.

Dr. G. H. Dar is Profesor & Incharge of the KUBG and the Centre of Plant Taxonomy (COPT), Department of Botany, University of Kashmir.

Andrew C. Miller was Chief of the Aquatic Ecology & Invasive Species Branch at the U.S. Army Engineer R&D Center (ERDC), a research facility for the U.S. Army Corps of Engineers located in Vicksburg, Mississippi. Since the early 1980s he has conducted field and laboratory studies on the ecology and distribution of mussels, techniques for protecting and improving aquatic habitats, and impacts of water resource developments in lotic systems in the central United States. He is now retired from the ERDC and can be reached at amberstarglass01@earthlink.net.

Fred Nelson is a MBA/MS candidate at the University of Michigan School of Natural Resources and the Environment, and the Erb Institute for Global Sustainable Enterprise. He spent seven years working in northern Tanzania on natural resource management at the local level. His interests are biodiversity and species conservation and the ways in which enterprise, incentives, and resource rights can be used locally and through policy formulation to drive sustainable natural resource management.

Barry S. Payne is an aquatic ecologist at the ERDC. He has conducted numerous field and laboratory studies on the physiological ecology of native and nonnative freshwater mussels in relation to predicting and evaluating effects of water resource projects in medium to large rivers. He is the leader of a research team that focuses on freshwater invertebrate studies for the Aquatic Ecology & Invasive Species Branch at ERDC.

Dr. Zafar Reshi is Reader in the Department of Botany, University of Kashmir.

Ariana Rickard is a M.S. candidate in the Resource Ecology and Management program at the School of Natural Resources at the University of Michigan in Ann Arbor and is currently studying wetlands restoration and amphibian reintroduction programs.

Edythe Sonntag is presently working on her PhD at Michigan State University in the Department of Fisheries and Wildlife. Her research area is amphibian conservation locally and regionally while mainly focusing on the Blanchard's cricket frog decline in Michigan. She can be contacted at sonntage@msu.edu

Endangered Species UPDATE

Science, Policy & Emerging Issues

A forum for information exchange on endangered species issues
January-March 2006 Vol. 23 No. 1

Subscription Information: The Endangered Species UPDATE is published four times per year by the School of Natural Resources and Environment at The University of Michigan. Annual rates are: $78 institution, $33 individual, $25 student/senior, and $20 electronic. Add $5 for postage outside the US, and send check or money order (payable to The University of Michigan) to:

Endangered Species UPDATE
School of Natural Resources and Environment
The University of Michigan
440 Church Street
Ann Arbor, MI 48109-1041
(734) 763-3243; fax (734) 936-2195
E-mail: esupdate@umich.edu
http://www.umich.edu/~esupdate

Cover: Photo of adult Blanchard's cricket frog courtesy of Ariana Rickard.

The Endangered Species UPDATE was made possible in part by Chevron Corporation and the U.S. Fish and Wildlife Service Division of Endangered Species.

Assessment of Translocations of Blanchard's Cricket Frog (*Acris crepitans blanchardi)* in Southeast Michigan

Ariana Rickard

School of Natural Resources and Environment
University of Michigan
Ann Arbor
440 Church Street
Ann Arbor, MI 48109

Abstract

An entire population of Blanchard's cricket frogs (Acris crepitans blanchardi) threatened by construction, was translocated to three restored wetlands within the historic range of the species in the summer of 2004 and 2005. Working with the National Amphibian Conservation Center at the Detroit Zoo, state natural agencies and the developer, we moved about 1060 Blanchard's cricket frogs, a Michigan Species of Special Concern, from Lakewood Farms before housing construction began. This case study represents the first effort to track the effectiveness of translocations as a method of conserving cricket frogs in Michigan. I collected data on population structure and breeding success of the translocated populations of cricket frogs. I monitored nearby wild populations of cricket frogs to get baseline comparison data for the translocated frogs. Data on population size and breeding success were used to develop recommendations on amphibian translocation. Although initial breeding attempts were observed at all three release sites, and over 240 juvenile cricket frogs were seen at one of the translocation sites in August 2005, all translocated populations had declined rapidly by October 2005. The translocations apparently did not result in viable, self-sustaining populations of Blanchard's cricket frogs at any of the release sites. I recommend that no more cricket frog translocations occur until the causes of the decline is known and effectively removed at release sites. Conservation dollars and research should focus on habitat preservation and determining the causes of declining numbers of cricket frogs in the Midwest.

Resumen

Una población entera de Acris crepitans blanchardi amenazada por el desarrollo fue trasladada a tres pantanos restaurados en el área histórica de las especies durante los veranos del 2004 y 2005. Trabajando con el centro nacional de conservacion de amfibios en el Zoológico de Detroit, agencias de naturaleza estatales y el desarrollador, nosostros mudamos 1,060 ranas Acris crepitans blanchardi, una especie de Michigan de atención especial, de Lakewood Farms antes que la construcción de casas comenzara. Este estudio representa el primer esfuerzo de monitorear la eficacia de los traslados como un método de conservación para estas ranas en Michigan. Se recolectó data sobre la estructura poblacional, éxito reproductivo de las poblaciones trasladadas de estas ranas. Tambien se llevaron a cabo conteos de las poblaciones silvestres cercanas de esta rana para tener una comparación de base con las ranas trasladadas. Datos del tamaño de la población, y éxito reproductivo fueron usados para desarrollar recomendaciones de traslado de amfibios. A pesar que se observaron intentos iniciales de reproducción y se observaron mas de 240 juveniles en las áreas de traslado en agosto del 2005, para octubre del 2005 todas las poblaciones trasladadas habían disminuido rápidamente. Los traslados aparentemente no resultaron en poblaciones viables auto-sustentables de la rana Blanchard en ninguna de las áreas de traslado. Recomiendo que no se hagan mas traslados de la rana Blanchard hasta que las causas de la disminución se conozcan y se remuevan de manera efectiva de las áreas de traslado. El dinero e investigación para conservación debe enfocarse en la preservación de hábitat y la determinación de las causas de la disminución del número de ranas en el medio-oeste de los EE.UU.

Introduction

Since the late 1980s, there has been a global decline in population sizes and geographical ranges of a number of amphibians (Blaustein and Wake 1990). Possible causes for amphibian declines include habitat destruction and alteration, introduction of nonnative predators, pathogens, competitors, overexploitation, pesticides, pollution, acid rain, global warming, and UV radiation (Blaustein and Wake 1990). The root causes of many declines are unknown. The Blanchard's cricket frog was listed as a Species of Special Concern in Michigan in 1986 (Lee 1998). Surveys conducted in 1997 found 47 extant sites, so the species is too numerous to meet the state's criteria for threatened status (Lee 1998). In an attempt to increase the number of extant populations of cricket frogs in southeast Michigan, the National Amphibian Conservation Center initiated a translocation project to try to establish a self-sustaining population of cricket frogs in a restored wetland at the Detroit Zoo.

Usefulness of translocations as a management tool

Habitat loss appears to be the most significant factor contributing to amphibian declines (Wake 1991). Preserving critical habitat for threatened and endangered species is probably the best method for conserving species. Habitat preservation is not an option, however, when wildlife regulations do not mandate protection of habitat and when these laws are not properly enforced. One proposed method for mitigating habitat destruction is translocation, which is defined as the "intentional release of animals to the wild in an attempt to establish, reestablish, or augment a population and may consist of more than one release." (Griffith et al. 1989). Translocations are often promoted as tools for conserving amphibians, yet there is no consensus–and few data on the effectiveness of translocations as an amphibian conservation strategy (Marsh and Trenham 2001; Seigel and Dodd 2002). There are no generally accepted or widely used criteria for assessing the success or failure of translocations (Fischer and Lindenmayer 2000). Some measures that might be used to assess translocation success include population growth, and evidence of successful breeding (Towns & Ferreira 2001).

Here I report on a translocation that was used as a last resort to try to save a population of cricket frogs by introducing individuals into other wetlands before their breeding pond was destroyed to construct condominiums and houses. On May 18, 2004, I visited sites in Ypsilanti, Michigan (Washtenaw County), where cricket frogs had been previously reported (Lehtinen 2002). I heard cricket frogs calling in three distinct areas. One location, Lakewood Farms, seemed to host the largest population of cricket frogs in the area. The developer of Lakewood Farms had plans to build condominiums and single-family homes on the property, and intended to fill in the cricket frog breeding ponds for the entrance driveway into the complex. After negotiations with the developer, the Detroit Zoo, working together with the Michigan Department of Environmental Quality (DEQ), arranged to remove the frogs from the property before development began.

Goals and questions

My main objective for this study was to determine the effectiveness of translocation as a management tool to conserve populations of the Blanchard's cricket frog. I hypothesized that populations of cricket frogs in their native wetlands will have greater breeding success than populations of cricket frogs that were recently translocated into created or restored wetlands. I attempted to assess the success of this *ad hoc* translocation by surveying natural and release sites.

Methods

Study areas

All study sites were located in southeast Michigan. They were divided into two groups: potential donor populations and translocation recipient sites. Only two large populations of Blanchard's cricket frogs remain in southeast Michigan (Lehtinen 2002). I surveyed these two sites, Ford Lake in Ypsilanti (hereafter referred to as city park wetland), and Ives Road Fen in Tecumseh (hereafter referred to as Nature Conservancy site), for consideration as donor populations. After meetings of Detroit Zoo and Michigan Department of Natural Resources scientists, three sites were selected as translocation recipient sites: (1) Port Huron State Game Area, Avoca (hereafter referred to as release site 1); (2) National Amphibian Conservation Center, Detroit Zoo, Royal Oak (release site 2); and (3) St. John's Wildlife Marsh Area, New Baltimore (release site 3); (Figure 1).

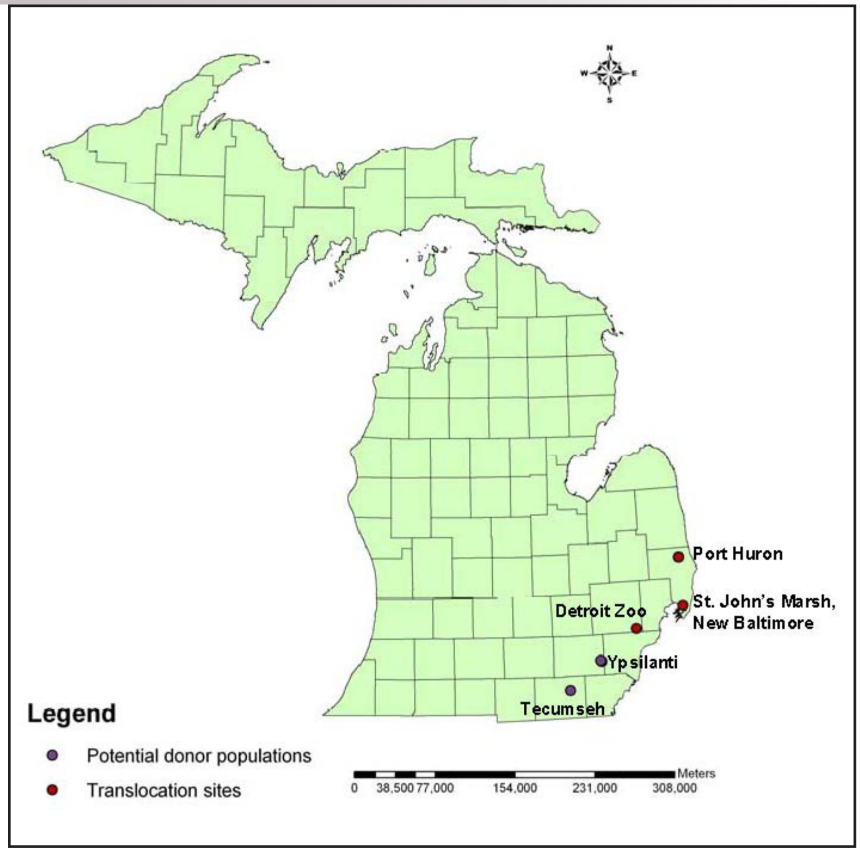


Figure 1. Location of donor and release sites.

Release site 1 is a marsh complex. Formerly farmland; it was transformed into wetlands in 2003 as mitigation for the construction of a Meijers store in Marysville. Release site 2, a wetland adjacent to the National Amphibian Conservation Center (NACC) at the Detroit Zoo, was created in early 2000. A highway and suburbs border the zoo, therefore no natural areas provide upland habitat or migration corridors for the cricket frogs. Release site 3 extends over 2400 acres and has been intensively managed by the Michigan Department of Natural Resources for over 13 years. The Nature Conservancy site consists of two abandoned gravel pits. Large stands of *Phragmites* encircle these shallow groundwater-fed ponds, which contain no fish and are prone to drying out or freezing. The city park wetland is only about one acre in size; it is bordered by Ford Lake Park and residential development. Emergent vegetation covers most of the pool and shoreline vegetation circles the pond.

Survey Methods

I surveyed all study areas for cricket frogs from May 2004 to September 2005. I conducted three types of surveys: visual encounter, photographic "mark-recapture," and calling surveys. These surveys lasted between 2-4 hrs per site. I started each survey at a different location, and alternated walking clockwise and counterclockwise. I used a modified version of a visual encounter survey during day visits to locate and count frogs (Crump and Scott 1994). I walked along the shoreline of the ponds in each study site and counted cricket frogs observed within 1 m of transect path.

Translocation

Due to planned construction at the Lakewood Farms site in summer 2005, volunteers and staff from the Detroit Zoo removed 1060 cricket frogs in the fall of 2004 and early summer of 2005, and relocated the frogs to the translocation recipient sites. All three-release sites received juveniles in fall 2004, while only release site 2 received tadpoles. In summer 2005, we captured 57 adults (31 males, 22 females, and four unknown) and released them at the site with the most comparable cricket frog habitat (Release Site 1).

Analysis

Translocations are generally regarded as successful when a viable self-sustaining population is established (Johnson 1990). To assess the success of these translocations, I compared population size and breeding success of founder frogs to frogs found at source and other natural sites.

Results

The initial population surveys in 2004 and 2005 indicated that some released frogs survived at the release sites, but few animals were found in a fall 2005 survey. The first and second translocations apparently did not result in self-sustaining, viable populations at any of the release sites.

Release sites

Twenty-three days after the initial release of juvenile cricket frogs on September 14, 2004, I encountered an average of 8.5% (SD = 4.6) of the frogs at all three release sites (Table 1). Calling surveys and visual encounter surveys in May and August 2005 indicated that few individuals survived from the translocation of 2004; eight surveys resulted in only two frogs, which were heard calling at the release site 2. The 2005 translocation of adults was more successful, as these animals produced large numbers of juvenile cricket frogs seen during visual encounter surveys in 2005 (Table 2). Adults released at release site 1 in spring 2005 survived long enough to breed, and juvenile numbers at release site 1 were comparable to the natural sites from late July until early September 2005. The population, however, appeared to decline drastically in late September and early October, as few cricket frogs were found at the site by mid-October.

Table 1. Results of visual encounter survey of release sites, Oct. 7, 2004

Site	Number of frogs released in August and Sept. 2004	Number of juvenile frogs encountered during VES	Encounter rate
Release site 1	189 juveniles	26	14%
Release site 2	347 juveniles and 102 tadpoles	20	6%
Release site 3	195 juveniles	12	6%

Natural Sites

I surveyed natural populations to provide baseline comparison data for translocated populations. I encountered between 52 to 351 juveniles, with an average of 183.2 juveniles (SD = 124.6, Table 2) at the Nature Conservancy site and between 43 to 96 juveniles in 2005, with an average of 69.5 juveniles (SD = 37.5) at the City park wetland (Table 2).

Comparison of translocation and natural sites

To assess the breeding success of translocated frogs, I compared juvenile cricket frog numbers from release site 1 to counts of juvenile cricket frogs from the natural sites. Surveys of translocation sites and natural sites were compared if they occurred within 7 days of each other (Table 2). The juvenile cricket frog number at the city park wetland was usually lower than the number seen at the other two sites; this is probably due to the smaller size of the city park wetland, which has a shoreline distance of 214m, while release site 1 and the Nature Conservancy site have shoreline distances of 762m and 703m, respectively.

Combining the counts from the two ponds at the Nature Conservancy site provides a fairer comparison between the Nature Conservancy site and release site 1 surveys, as the shoreline distance,

Date	Release site 1	Nature Conservancy pond A	Nature Conservancy pond B	City park wetland
7/3 – 8/3	66	NSC*	52	NSC*
8/17 – 8/23	238	71	128	43
8/26 – 9/2	171	101	143	96
9/7 – 9/11	216	225	126	NSC
10/13 – 10/14	8	35	35	NSC

Table 2. Juvenile cricket frog numbers in 2005
*NSC = no survey conducted

and thus, total area of suitable habitat, are then similar in size. For most of the season, release site 1 juvenile cricket frog numbers were similar to those seen at the Nature Conservancy site. The population of juvenile cricket frogs appeared to decrease rapidly at release site 1 at the beginning of fall 2005, however. On October 14, 2005, only 8 juvenile cricket frogs were seen at release site 1, while a survey conducted the day before at the Nature Conservancy site recorded 70 cricket frogs.

Discussion

The goal of any translocation project is the establishment of a self-sustaining, viable population (Dodd and Seigel 1991). Translocation programs can be assessed at various points to determine progress (i.e., the establishment of translocated animals at release sites) (Tasse 1989). In this project, initial surveys at the three release sites in fall 2004 indicated some establishment of juvenile cricket frogs in their new habitat after the 2004 translocation of adults, juveniles, and tadpoles (Table 1). But by the following spring, no cricket frogs were seen or heard at any release site. The results of the repeated surveys at the release sites indicate that the 2004 translocations failed to establish breeding, self-sustaining populations at the translocation sites.

Initially, the 2005 translocations of adult cricket frogs to release site 1 seemed more successful: adults were seen during early summer surveys and these adults reproduced, as indicated by the high number of juveniles found later in the summer (Table 2). Juvenile recruitment numbers at release site 1 were comparable to the number of juveniles seen at the Nature Conservancy site for most of the summer and fall, until mid-October, when release site 1 numbers dropped well below those at the Nature Conservancy site. While release site 1 should be surveyed again in spring 2006 to determine if any of the juvenile cricket frogs survived, it seems unlikely that our project succeeded in establishing viable, self-sustaining populations of cricket frogs at any of the release sites.

Release site 1 is (155 km) north of the Nature Conservancy site, and it is possible that cricket frogs in release site 1 shifted to hibernation earlier than Nature Conservancy cricket frogs, due to the temperature difference between the sites. The timing and weather conditions varied between the two survey dates; the Nature Conservancy survey occurred on a warmer day and later in the afternoon than the release site 1 survey. Nonetheless, it is unlikely that latitudinal and temperature differences among the sites account for the disparity in juvenile cricket frog numbers. The timing of the population reduction at both sites is comparable to the timing of population contractions for other cricket frog populations and suggests that the main contributor to the decreased survival of cricket frogs at release site 1 is predation, not winter conditions. Cricket frogs are most vulnerable to predation in the late summer and fall after metamorphosis (Gray and Brown 2005, and I did observe an adult green frog eating a juvenile cricket frog at release site 1).

Port Huron translocation site

The Blanchard's cricket frog translocation in the context of other amphibian translocations

Previous reviews have found low success rates for translocations and particularly low rates for amphibian translocation programs. Griffith et al. (1989) estimated that nearly 700 bird and mammal translocations occur each year; the overall success rate of these projects is 44%. A review of 120 re-introduction papers found a success rate of 26%, while the outcome of 47% of the projects was unknown at the time of publication (Fischer and Lindenmayer 2000). Fischer and Lindenmayer (2000) emphasized that the re-introduction success rate they found was probably an over-estimate, since authors are more likely to publish their results if their project is a success. Dodd and Seigel (1991) examined 25 relocations, repatriations, and translocations (RRT) programs for amphibians and reptiles and found that only five (19%) were considered successful. None of the amphibian RRTs (n = 5) could be definitively classified as successful (Dodd and Seigel 1991).

Although Dodd and Seigel's earlier review in 1991 noted few successful amphibian translocation projects, a number of later projects (and one project they might have overlooked) achieved the goal of a self-sustaining populations for relatively common species: gray tree frogs (*Hyla versicolor)*, spring peepers (*Pseudacris crucifer*), spotted salamanders (*Ambystoma maculatum*), wood frogs (*Rana sylvatica*), common toads (*Bufo bufo*), and common frogs (*Rana temporaria)* (Cook 1989; Sexton et al. 1998; Cooke and Oldham 1995).

Only one translocation project involving a rare or threatened species (the natterjack toad, *Bufo calamita*), resulted in the establishment of several self-sustaining populations (Denton et al. 1997). The translocation of another threatened species, Hamilton's frog (*Leiopelma hamiltoni*) yielded a survival rate of 58.33% for adult frogs; however, breeding at the new site was not confirmed at the time of publication (Brown 1994). Other threatened species translocations have not been monitored long enough to determine success; these include the Wyoming toad and the Puerto Rican crested toad (AZA 1998; Johnson 1990). A translocation project involving the boreal toad (*Bufo boreas*), an endangered species in Colorado, failed; no tadpoles or adults were seen at the release sites during intensive monitoring surveys (Muths et al. 2001). Lastly, short distance translocations of mountain yellow-legged frogs (*Rana muscosa)* resulted in loss of body mass of displaced frogs (Matthews 2003). Matthews concluded that moving frogs may be stressful, and animals may lose valuable foraging or breeding time looking for their home site.

Various factors affect the likelihood of success for translocation projects: for example, type of animal released (wild vs. captive-bred, game vs. sensitive taxa), causes of decline, number of animals released, and location of release sites within the species range (Griffith et al. 1989). Translocations were more likely to succeed when the source population was wild rather than captive-bred (Griffith et al. 1989; Fischer and Lindenmayer 2000). All the cricket frogs released in our project were wild, although the animals from 2004 were held in captivity for varying lengths of time, ranging from a few days to six weeks. The time spent in quarantine and travel between sites might have heightened the stress levels of animals and increased possible disease transmission; both of these factors might have lowered the likelihood of success for our translocation experiment.

Translocations that involved native game species have a higher success rate than those that move sensitive species like the Blanchard's cricket frog: Griffith et al (1989) report an 86% success rate for these species compared to 46% for threatened, endangered, or sensitive species. In addition, if the original causes of decline are known and addressed, translocations are more likely to succeed (Fischer and Lindenmayer 2000). Unfortunately, because the reasons for the decline for cricket frogs in the Midwest are unknown, it is unlikely that any original cause of decline was removed at the release sites.

Translocations also tend to be more successful when a large number of animals (n > 100) are released (Fischer and Lindenmayer 2000). In this case, our translocation followed best practices: all our release sites received more than 190 cricket frogs in 2004, and, while only 57 adult cricket frogs were released in 2005, these cricket frogs bred and produced over 200 juvenile cricket frogs.

Translocations into the core of a species' historical range are more successful than those on the periphery or outside historical ranges (Griffith et al. 1989). Our release sites were on the northern extent of the range of Blanchard's cricket frog, which might have contributed to the low success rate of our project (Lehtinen 2002). Thus, our cricket frog translocation met only two of the five factors observed to increase the likelihood of success for translocation projects.

No consensus exists in the literature on the suitability of amphibians for translocations. Marsh and Trenham (2001) asserted that amphibians are well suited for translocations, since most amphibians lack parental care, and are thus good candidates for egg and larval translocations. They suggest that translocations may be "indispensable tools" for conserving amphibians in landscapes with multiple breeding ponds and may be necessary to promote regional population persistence when ponds are isolated. These statements contrast with the findings of published translocation studies that the effectiveness of amphibian translocations is unclear, many attempts have failed, and those that have succeeded usually involve non-threatened species (Seigel and Dodd 2002; Muths et al. 2001; Dodd 2005; Matthews 1993).

While some amphibians may be candidates for translocations and captive-breeding programs, most threatened species are not, due to life history traits such as low reproductive output, short life spans, and low natural population numbers or density (Dodd 2005). Translocation projects can also harm conservation efforts by siphoning off funds that could be used for habitat preservation or other research (Dodd 2005). Lastly, animals used in translocations can transmit pathogens and para-

Volunteers came from various organizations to help and learn more about local ecology.

sites to other release animals or resident animals of the same species, leading to unknown consequences for the translocated individuals, resident animals and the release ecosystem (Cunningham 1996). Dodd (2005) suggests that translocations should only be considered as a last resort for amphibians and Reinert (1991) argues that translocations should only be considered if other options, such as protecting extant populations and improving habitat, are not available, but Burke (1991) maintains that translocations should be considered in any species recovery program.

Motives for translocations

If translocations are considered risky, experimental techniques, why are they promoted as solutions to the problem of declining wildlife populations? Reasons commonly cited for the use of translocations include favorable press attention, public education, conservation potential, and mitigation of human-animal conflicts (Fischer and Lindenmayer 2000; Dodd and Seigel 1991). The main rationale for our translocation project was the impending destruction of a cricket frog breeding pond.

Translocation projects, particularly those that involve the "rescue" of animals from doomed sites to safer locations, can attract considerable favorable publicity (Fischer and Lindenmayer 2000). Articles about our cricket frog translocation project appeared in three local newspapers: the *Ann Arbor News*, the *Livonia Observer & Eccentric*, and the *Oakland Press*. All the newspaper articles praised the Detroit Zoo for the cricket frog "rescue" and included information about the status of cricket frogs in Michigan. Publicity about translocation projects can educate the public about threats to declining species and might generate funding for other conservation activities, such as research and land preservation (Dodd and Seigel 1991).

If press articles gloss over the difficulties of succeeding in translocations, they give a false impression of the ability of translocations to conserve wildlife species. Developers can argue that it is okay to destroy critical habitat as long as the threatened animals are moved to new locations. One Department of Environmental Quality official praised the developer of the cricket frog breeding pond, saying that the developer deserved a "pat on the back" for coming up with a solution (Kuban 2004). I tried to emphasize to the reporters who wrote about our project that we would need to monitor the release sites before we can claim success for the rescue effort, but only the *Ann Arbor News* included a quote stating that there was no guarantee of success for the translocation proj-

Lakewood Farms before and after construction.

ect. That same article implied that the cricket frogs would be safe in their new homes, where "the only danger is hungry bull frogs, not bulldozers" (Rueter 2004). Post-relocation results are rarely reported in the media (Dodd and Seigel 1991) and, because our translocation results were not reported in any articles, most readers probably assumed that the animals survived and thrived in the release sites. This assumption might damage efforts to preserve habitat, because translocations seem to solve the conflict between habitat destruction and threatened species protection.

Another motive for conducting a translocation is public education. Involving community members as volunteers in the relocation effort can cultivate interest in conservation issues and activities (Dodd and Seigel 1991). Many volunteers from diverse backgrounds assisted with our translocation; most had no previous training or experience with amphibians. Participants in the relocation project might have learned more about local amphibian species and the threats facing them in our own backyards.

Translocations are used to try to conserve threatened species. Our translocation project was an attempt to establish more cricket frog populations in southeast Michigan, because cricket frogs are declining or nearly extirpated (Lehtinen 2002). Translocation efforts might ultimately hinder preservation projects, however, by diverting funds that could be better used for other conservation purposes, and increasing the risk of disease transmission (Dodd 2005; Cunningham 1996). A preferable method to conserve threatened species is early identification of populations or habitats threatened by development (Griffith et al. 1989). In our case, we only discovered that the cricket frog breeding pond was threatened with development a few months before construction began, limiting options for protecting the property.

Translocations are often promoted as a win-win solution to human-animal conflicts. Developers are allowed to destroy habitat for sensitive species as long as they grant permission to conservation officials to move the animals before construction begins. Participants in relocation attempts are happy that they are "saving" the animals from bulldozers. As Edythe Sonntag, the Detroit Zoo keeper in charge of our relocation effort, told the *Ann Arbor News*: "It's a good feeling to know they're not going to be rolled over by a bulldozer" (Rueter 2004). Moving animals away from certain death seems to be a humane solution to habitat destruction (Dodd and Seigel 1991). But, there is no guarantee that the animals will survive at the new site, so the question of *when* the animals die becomes more important than *if* they die (Dodd and Seigel 1991). Although the cricket frogs we moved did not die immediately from bulldozers, it appears that we simply delayed their deaths.

One of the main threats to cricket frogs is widespread ignorance and apathy about its conservation status among state and federal government agencies (Gray and Brown 2005). The unsupportive responses of some local and state government agencies to our requests for assistance with protecting the cricket frog population reveals a lack of political will for protecting threatened nongame species. This problem is prevalent throughout the range of the cricket frog, and could be contributing to its decline. For example, one solution proposed to save the cricket frog breeding pond was to reroute the entrance driveway to the condo complex around the pond. The local roads commission would not allow this, however, because a local statute mandates that entrance driveways should come straight off of the nearest major intersection and not be displaced to the side of the intersection.

Recommendations for future translocation projects and research on Blanchard's cricket frog declines

Given the mixed results of amphibian translocation projects and the low success rates of threatened amphibian relocation programs, it is not surprising that our cricket frog translocation did not succeed in establishing viable, self-sustaining populations at the release sites. Amphibian translocations should only be attempted if no other management options are available. Protecting the species and its critical habitat is usually the best way to conserve threatened animal and plant species (Reinert 1991). We attempted translocations with cricket frogs because we were not able to stop development of the cricket frog breeding site.

Despite our failure to establish additional populations of cricket frogs, our experience provides lessons on improving the success rate of future translocations. First, the timing of translocations and life stage released affected survival rates at release sites. Juveniles released late in the fall did not survive very long (Table 1), whereas adults released early in the breeding season were able to establish breeding territories and breed successfully before dying or migrating away from the wetland. Dodd and Seigel (1991) cite 50-500 as the minimum number of individuals that should be released to sustain a viable breeding population. Releasing 57 adults at release site 1 appeared to result in successful breeding: high juvenile recruitment was observed later that summer (Table 2). Lastly, a plan and process for assessment needs to be put in place before starting a translocation project. Long-term intensive monitoring, such as shoreline and calling surveys, should be used to evaluate the progress of the project and determine what factors might influence the success or failure of the project. Project managers should select specific criteria to assess their project and try to publish the results, even if they are not successful (Fischer and Lindenmayer 2000).

The causes of the population declines of Blanchard's cricket frog are unknown: thus, advocating more translocations seems to be promoting a solution to a problem that has not been identified (i.e., why cricket frogs are declining). The best way to protect cricket frogs in Michigan at present is to preserve their habitat and provide more legal protection to the species. The Michigan Department of Natural Resources is considering upgrading the status of the Blanchard's cricket frog to threatened in 2006 (Lee, personal communication). This additional protection might prevent more cricket frog breeding ponds from being destroyed for subdivisions and urban sprawl.

Habitat destruction is still the greatest threat to the survival of most amphibian species (Dodd 2005). Translocations will not solve the problem of additional habitat loss for cricket frogs and research dollars should be directed at the causes of decline and other, more effective management options. Empirical evidence demonstrates that the initial cause of decline must be removed for a successful translocation (Fischer and Lindenmayer 2000). Otherwise, animals might be placed in unsuitable habitats where they will still be affected by the factors that caused their original decline (Dodd 2005). We will not succeed in conserving cricket frogs until we know more about their ecology and the causes of their decline.

Literature Cited

AZA (American Zoo and Aquarium Association). 1998. Wyoming toad and 98 fact sheet. http://www.aza.org/programs/ssp/ssp.cfm

Blaustein, A., D.B. Wake. 1990. Declining Amphibian Populations: A Global Phenomenon? Trends in Ecology and Evolution 5:203-204.

Brown, D. 1994. Transfer of Hamilton's frog, *Leiopelma hamiltoni*, to a newly created habitat on Stephen's Island, New Zealand. New Zealand Journal of Zoology 21: 425-430.

Burke, R.L. 1991. Relocations, Repatriations, and

Translocations of Amphibians and Reptiles: Taking a Broader View. Herpetologica 47:350-357.

Cook, R.P. 1989. And the voice of the grey tree frog was heard again in the land... Park Science 9:6-7.

Cooke, A.S., R.S. Oldham. 1995. Establishment of populations of the common frog, *Rana temporaria*, and common toad, *Bufo bufo*, in a newly created reserve following translocation. Herpetological Journal 5: 173-180.

Crump, M.L., N.J. Scott, Fr. 1994. Visual Encounter Surveys. Pages 84-92 In W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editor. Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians, Smithsonian Institution Press, Washington and London.

Cunningham, A.A. 1996. Disease risks of wildlife translocations. Conservation Biology 10:349-353.

Denton, J.S., S.P. Hitchings, T.J.C. Beebee, and A. Gent. 1997. A recovery program for the natterjack toad (*Bufo calamita*) in Britain. Conservation Biology 11: 1329-1338.

Dodd, C.K. Jr. 2005. Population Manipulations. Pages 265-270 *In* M.L. Lannoo, editor. Amphibian Declines: The Conservation Status of United States Species, University of California Press, Berkeley.

Dodd, C.K. Jr., R.A. Seigel. 1991. Relocation, Repatriation, and Translocation of Amphibians and Reptiles: Are They Conservation Strategies That Work? Herpetologica 47:336-350.

Fischer, J., D.B. Lindenmayer. 2000. An assessment of the published results of animal relocations. Biological Conservation 96:1-11.

Gray, R.H., L.E. Brown. 2005. Decline of Northern Cricket Frogs (*Acris crepitans)*. Pages 47-54 In M.L. Lannoo, editor. Amphibian Declines: The Conservation Status of United States Species, University of California Press, Berkeley.

Griffith, B., Scott, J.M. Carpenter, J.W., Reed, C. 1989. Translocations as a species conservation tool: status and strategy. Science 245:477-480.

Johnson, R.R. November 1990. Release and Translocation Strategies for the Puerto Rican Crested Toad, *Peltophryne lemur*. Endangered Species UPDATE 8:54-57.

Kuban, K. August 29, 2004. "Rescue effort saves tiny frogs from doomed wetland." Livonia Observer & Eccentric. Pg. A8

Lee, Y.M. 1998. Final report on Blanchard's cricket frog (*Acris crepitans blanchardi*) surveys in southern Michigan.

Lehtinen, R.M. 2002. A historical study of the distribution of Blanchard's Cricket Frog (*Acris crepitans blanchardi*) in southeastern Michigan. Herpetological Review 33:194-197.

Marsh, D.M., P.C. Trenham. February 2001. Metapopulation dynamics and amphibian conservation. Conservation Biology 15:40-49.

Matthews, K.R. 2003. Response of Mountain Yellow-Legged Frogs, *Rana muscosa*, to Short Distance Translocation. Journal of Herpetology 37 (3):621-626.

Muths, E., T.L. Johnson, P.S. Corn. 2001. Experimental repatriation of boreal toad (*Bufo boreas)* eggs, metamorphs, and adults in Rocky Mountain National Park. Southwestern Naturalist 46: 106-113.

Reinert, H.K. 1991. Translocation as a Conservation Strategy for Amphibians and Reptiles: Some Comments, Concerns, and Observations. Herpetologica 47:357-363.

Rueter, A. September 2, 2004. "Zoo extends safety net to tiny, and rare, frogs: Rescuers step in before condominium construction begins." Ann Arbor News, pg. E1 and E2.

Seigel, R.A. and J.C.K. Dodd. 2002. Translocations of Amphibians: Proven Management Method or Experimental Technique? Conservation Biology 16:552-554.

Sexton, O.J., C.A. Phillips, T.J. Bergman, E.B. Wattenberg, and R.E. Preston. 1998. Abandon Not Hope: Status of Repatriated Populations of Spotted Salamanders and Wood Frogs at the Tyson Research Center, St. Louis County, Missouri. Pages 340-344 In M. L. Lannoo, editor. Status and Conservation of Midwestern Amphibians, University of Iowa Press, Iowa City.

Tasse, J. 1989. Translocation as a strategy for preserving endangered species. Endangered Species UPDATE 6:6-6.

Towns, D.R., S.M. Ferreira. 2001. Conservation of New Zealand lizards (Lacertilia: Scincidae) by translocation of small populations. Biological Conservation 98:211-222.

Wake D.B. 1991. Declining Amphibian Populations. Science 253:860-860.

Acknowledgements

Thanks to Emily Silverman and Bobbi Low for helpful comments on this manuscript. Thanks to Kevin Zippel for initiating the translocation project and bringing me on board. To Michael Lannoo, thanks for sharing your knowledge of cricket frogs and reviewing my research proposal. Thanks to Edi Sonntag for managing the cricket frog translocation, helping me out in the field, and providing data. We would not have been able to move the cricket frogs from Lakewood Farms before construction began without the assistance of James Sallee from the Michigan Department of Environmental Quality. I really appreciate Mr. Sallee taking our concerns seriously and negotiating with the developers to allow our translocation to occur. Thanks to Doug Pearsall of the Nature Conservancy and Ernie Kafcas at the Michigan Department of Natural Resources for access to research sites. This project would not have occurred without financial support from the Doris Duke Charitable Foundation, the Marshall Weinberg Fellowship, and Rackham Discretionary Funding. Lastly, thanks to all the volunteers who assisted with the translocation.

In response to: Assessment of translocations of Blanchard's cricket frog (Acris crepitans blanchardi) in southeast Michigan

Edythe Sonntag

Michigan State University Department of Fisheries and Wildlife, and Detroit Zoological Institute National Amphibian Conservation Center

Abstract

As one of the researchers involved in the project referenced in Ariana Rickard's article, *Assessment of translocations of Blanchard's cricket frogs* (Acris crepitans blanchardi*) in southeast Michigan* (this issue), I have a different interpretation of the results and accomplishments of the emergency translocation of cricket frogs from the Lakewood Farm construction site. Rickard's interpretation of this program as a failure may eventually prove to be accurate, but is, at best, premature. Long-term monitoring is required before an accurate assessment of the success or failure of an established, self-sustaining population at the translocation sites can be completed. Though I agree with many basic principles presented in Rickard's article, translocation should not be eliminated as a possible conservation tool for this and other species until long term and more complete monitoring data are available. The inevitable destruction of habitat in this case required the translocation of parts of the endangered local population of Blanchard's cricket frogs to occur sooner than expected. Since a full feasibility study was not possible given the immediace of the situation, decisions were based on the best life history data available. Even if the population translocations that were attempted were complete failures (which remains to be determined), these failures will provide valuable information on which to base future plans for translocation when extensive planning can be done with more adequate time.

Resumen

Como uno de los investigadores involucrados en el proyecto al que hace referencia el articulo de Ms. Richard; Evaluación de los traslados de la rana Acris crepitans blanchardi en el sureste de Michigan (este volumen), tengo una interpretación diferente de los resultados y logros de este traslado de emergencia de ranas Blanchard del lugar de construcción en Lakewood Farms. La interpretación de Ms. Rickard de este programa como un fracaso puede ser correcta eventualmente, pero es prematura. Se necesita monitoreo a largo plazo antes que se pueda completar una evaluacion correcta de éxito o fracaso en el establecimiento de una población auto-sustentable en las áreas de traslado. Aunque estoy de acuerdo con muchos de los principios básicos presentados en su artículo, el traslado de poblaciones no se debe eliminar como una posible herramienta de conservación para ésta y otras especies hasta que los datos de monitoreos mas completos y a largo plazo estén disponibles.

History And Background Of The Program

This research project was initiated as a feasibility study for potential translocation activities with translocation experiments planned only after habitat choice and population dynamics of the species was better understood in extant, local populations. Rickard was studying the dynamics of the extant southeast Michigan populations while I was performing habitat characteristic comparisons among potential translocation sites and extant populations in southeast Michigan and Ohio. Our intent was to make fully educated and responsible decisions prior to any translocation activity being initiated.

At a symposium in September 2003 at the USGS/National Park Service facilities at Indiana Dunes National Lakeshore, amphibian experts discussed and established working theories to explain the decline of the species across the northeastern extent of the cricket frog's range. Likely causes identified included habitat loss, fragmentation, toxins/pollutants, disease, and invasive species. Habitat fragmentation may be the leading cause because it is widespread throughout the region and presents landscape barriers too extensive for this species to traverse. Translocation was considered as a potential population management and conservation tool to overcome habitat fragmentation through establishment of more populations that could assist with genetic mixing of isolated populations and return the species to its former range. This emergency translocation afforded us an opportunity to explore this theory further.

Cricket frogs are an annual species with breeding occurring in the early summer, adult dispersal and/or death occurring shortly after breeding, and metamorphs hibernating through the winter and breeding the next year. Late summer and winter metamorph survival determines the size of the next year's breeding population. Stochastic events can cause a severe decline or the complete elimination of a small population in a single year. In an undisturbed landscape, metapopulation dynamics allow the reestablishment of small populations eliminated by such stochastic events through immigration from source to sink populations. With connective corridors, it is possible for this species to utilize ideal as well as sub-prime habitat, avoid dense predator areas, and maintain genetic diversity through subpopulation mixing. Unfortunately, migratory corridors have too often been eliminated in urbanized environments and reestablishment of these migratory corridors is not feasible. Thus, reestablishment of the population connection may only be possible through the use of translocation to create new populations of cricket frogs in their historic range.

Currently, this species is listed only as a Species of Special Concern in Michigan and therefore receives little legal protection. This listing indicates the need to closely monitor the species but does not provide the habitat protection that comes with threatened and endangered species status. Without legal protection, destruction of the Ypsilanti Lakewood Farms population habitat was unstoppable, resulting in the need to either translocate the population and/or to mitigate for expected losses on site. An emergency translocation was initiated with the support of the Detroit Zoological Institute, the Michigan Department of Natural Resources (MDNR) and the Michigan Department of Environmental Quality (MDEQ). In addition, the developer agreed to redesign the mitigation wetland (changing the shoreline structure and vegetation and excluding fish) to provide "in kind" replacement of the cricket frog habitat lost. Although unlikely to replace all of the habitat lost and though time is required to develop habitat structure and function and overcome threats such as invasive species, this mitigated area may support more cricket frogs than the original planned mitigation. The "in kind" mitigation also presented an opportunity to test the theories of cricket frog habitat choice and migratory behavior while identifying potential barriers to establishing populations in restored and mitigated wetlands. An extensive monitoring plan for the mitigation site began April 2006 even though planting had not been completed. Because mitigation on site would only be completed after the destruction of the current habitat, the translocation was initiated to remove animals that faced elimination due to construction activities.

The release sites for the translocated animals in this program were based on habitat available including consideration of shoreline slope, plant communities present, and water chemistry. Since comparisons were already being made with extant population habitat to use an area on the Detroit Zoo's property for a future translocation (should the area prove to be appropriate), the decision was made to conduct a translocation on the Zoo's property based on the preliminary site data and the belief that a population could utilize surrounding natural areas within the 125 acres of the Zoo's property. The Port Huron and St. John's Marsh sites were both selected as they were restored and managed by MDNR game areas, surrounded by light residential, agricultural, and natural areas. These sites appeared to offer appropriate habitat in the form of restored, fishless, prairie wetland complexes but more time to further assess the suitability of these sites would have certainly been desirable. Additional sites were identified as future, potential translocation sites but full assessments will be completed before any new translocations are attempted.

The Potential For Translocation As Science

As mentioned by Rickard, in the review of amphibian translocation by Dodd and Seigel (1991), the authors took a critical view on translocation as a conservation measure and as science. Some of their concerns included the low success rate from documented accounts of translocations, the potential impact on the practice of habitat protection, the lack of long-term monitoring, and the ambiguity of the terms "success" and "failure" in reference to a translocation program. This article is seriously out dated having been published in 1991 and conclusions were based on lack of reproductive activity in released populations at that time, that no population at that time was self-sustaining, and therefore, in their opinion, were not successes. They also noted that the perception of success, lack of published failed projects, public support, and self interest tended to perpetuate the belief that translocation was (is) a viable practice that saves species (Dodd and Seigel 1991).

Burke (1991) and Trenham and Marsh (1991) replied to this paper in the same issue of *Herpetologica*, taking a slightly less critical stance on translocation for conservation. Burke pointed out that Dodd and Seigel failed to consider invasive species, which could be viewed as successful translocations. Trenham and Marsh supported translocation as a means to help amphibians overcome landscape barriers and distance between populations. In 2002, Seigel and Dodd published another paper taking a slightly less critical stance regarding translocation but retained their statement that translocation has not been proven science using scientifically objective data but concluding that much more research is needed (Seigel and Dodd 2002).

I agree with aspects of each of these papers. Translocation can be a viable option for the conservation of species when properly and responsibly researched and when decisions are made that are in the best interest of the animals and not politically motivated. The process of understanding the habitat and other needs of a species is crucial in its conservation even if translocations are not considered to be a viable option. Translocations must be programs performed as *scientific experiments* that consider all components of the habitat and ethology of a species. The papers referenced above, more than anything, indicate the need for better science in translocations. All these papers also agree that the lack of publishing of failed attempts and the lack of long-term monitoring are critical needs for advancing the scientific understanding of the value of translocation programs.

Rickard notes in her article that there is no generally accepted and widely used criteria for assessing success or failure in translocation. This is a difficult parameter to identify in a translocation given the variable life histories of translocated species. However, the World Conservation Union (IUCN) has put forth guidelines for the translocation of living organisms that have taken into consideration many of the variables that may affect the outcome of a translocation (IUCN 2000). These guidelines have been referenced in recent translocations attempts, however, some of the earlier programs did not take such detailed considerations into mind when moving animals. Using such guidelines in the planning of a translocation, and interpreting the resulting data, may offer more consistent interpretations and easier direct comparability between programs.

Based on the life history of the Blanchard's cricket frog, extensive reading, and research into translocations and reintroductions in amphibians and other species, an appropriate monitoring protocol for this species should include a series of milestone events that would give indications of a successful translocation. These milestones include, initial survival and first year breeding of released animals, survival of first year offspring to breeding age and to the following breeding season, successful breeding of first year offspring with an increase in population size, and continued population growth to a level comparable to a similar "natural" population. As the sites are monitored closely, it will be possible to identify where the program is encountering difficulties

Table1. Successful amphibian translocation programs. S=success, U=unknown, F= failure, and I=invasive

Species	Common Name	Result	Authors
Alytes muletensis	Mallorcan Midwife Toad	S, U	Bloxam, et al. (1995), Dodd, et al. (1991), Seigel, et al. (2002), Zippel (2005)
Ambystoma tigrinum	Tiger Salamander	S	Burke (1991)
Bufo baxteri	Wyoming Toad	S, F	Dodd, et al. (1991), Seigel, et al. (2002)
Bufo calamita	Natterjack Toad	S, F	Beebee (1996), Banks, et al. (1988), Burke (1991), Dodd, et al. (1991)
Bufo lemur	Puerto Rican Crested Toad	S, U	Bloxam, et al. (1995), Dodd, et al. (1991), pers. com.
Bufo marinus	Marine Toad	S, I	Beebee (1996), Burke (1991),
Chirixalus romeri	Romer's Tree Frog	S	Dudgeon and Law 1999 in Zippel (2005)
Dendrobates auratus	Green and Black Dart Frog	S, I	Burke (1991)
Desmognathus quadramaculatus	Black-bellied Salamander	S	Burke (1991)
Hyla arborea	European Treefrog	S, U	Zvirgzds (1995, 1998) in Zippel (2005)
Litoria raniformis	Green and Gold Frog	S, U	Tyler 1978 in Zippel (2005)
Nectrus maculosus	Mudpuppy	S	Burke (1991)
Rana catesbeiana	Bullfrog	S, I	Burke (1991), Hirai (2004)
Rana dalmatina	Agile Frog	S, U	Gibson and Freeman 1997 in Zippel (2005)
Rana Tarahumarae	Tarahumara Frog	S,U	Sredl et al. 2004 in Zippel (2005)
Xenopus laevis	African Clawed Frog	S, I	Burke (1991)

and where alterations in the reintroduction plans are or will be necessary. Even with initial indications of breeding, only over a span of 5-10 years will we be able to make definitive statements regarding the success or failure for this or other translocated cricket frog populations. The science of translocation is a learning process at this time. No one claims to know exactly how to perform a successful translocation, nor would it be possible to set such a universal protocol even based on taxonomic order or family. The translocation of cricket frogs will provide valuable information on life history and ways to better conserve this species.

Rickard also mentions that there is debate as to whether animals should only be released into the center of their historic range or if they can succeed at the periphery. Translocations at the periphery may be less successful due to more drastic and long-term habitat changes, climatic changes, or elimination of habitat. If the reasons for past extinctions are successfully identified, exact location within the range of the species may not be of concern as long as those factors have been mitigated. Historic ranges should be used as a guideline for potential translocation recipient sites, but studies of all potential sites should be done to ensure that the necessary components of the habitat are present for the species. For southeast Michigan, the core areas of the range of the cricket frog are highly urbanized and altered. With habitat loss and fragmentation playing a significant role in the decline in this species, the more peripheral areas of the historic range offer better habitat, lower human densities, and more connectivity to other habitats.

Restoration and reclamation of agricultural land and expansion of natural areas have created or restored areas of habitat that were once lost. It is possible to utilize these areas for translocation. Though it is not the original habitat, and alterations have impacted the sites, a site situated on a protected and expansive natural area in the periphery of the range is preferential to a remnant in the core of the historic range.

There are examples of amphibian translocation that have been successful completely outside the historic range of the species. *Litoria raniformis* is a species that was once common in Australia but has experienced significant declines in its native range. An introduced population in New Zealand has been established and is thriving (Zippel 2005). Similarly, Nevada supports a population of *Ambystoma tigrinum* that has become well established as an exotic species while the species is endangered, threatened or vulnerable in a large portion of its historic range. These established populations are ideal case studies to determine what characteristics of the habitat are valuable to each species and what is necessary to protect extant populations and increase the success of translocations as a conservation tool when necessary.

All translocations do not succeed, however, if these practices are monitored and documented, the success rate will increase as we learn. As with any branch of science, initial attempts are often not successful, but they are valuable. Table 1 contains examples of monitored and documented successful amphibian translocation programs that are in the literature. A good portion of the disagreement in the result of each of these programs is related to the date when the paper was published. For example, both *Bufo baxteri* and *Bufo lemur* have recently shown breeding and population growth sufficient to indicate success that were not evident when the programs were in their early stage.

Translocations are intended to be used as a conservation measure to increase population size, distribute animals into multiple populations, and assure the long-term survival of the species. Some species, however, are moved for reasons other than conservation and can have impacts on the recipient site biota. *Bufo marinus, Rana catesbeiana, Xenopus laevis* and *Dendrobates aruatus* have all successfully established new populations when moved by humans, even on different continents. These species have life history characteristics that allow them to utilize non-native habitat and resources, sometimes to the exclusion of the native species. Though the ecological impacts that have resulted are negative, the study of these invasions as unintentional translocations that succeeded exceptionally well may give indications of ways to better apply translocation in management of recovery programs for threatened and endangered species.

Rickard states that the translocation of *Bufo calamita* is the only successful establishment of a threatened species. Interestingly, early accounts in the literature indicated the failure of this program. The aforementioned *Bufo baxteri, Bufo lemur, Litoria raniformis,* and *Ambystoma tigrium* translocations, as well as *Chirixalus romeri,* and *Alytes muletensis* are examples of successful establishment of threatened and endangered species using translocation. *C. romeri* declined to an estimated 1300 animals before initiation of a captive breeding and reintroduction program that resulted in the establishment at seven of the eight release sites. *A. muletensis* was believed to be extinct when relict populations were discovered. A mixture of wild-caught and captive bred animals, was translocated in 1989 and subsequent monitoring has identified young and tadpoles every year since (Zippel 2005).

These data indicate that the translocation of amphibians as a conservation tool can be successful and help to assure the long-term existence of a species. Anthropogenic impacts have altered the ecosystem and landscape to the extent that habitat protection and limitations on future developments cannot be expected to reverse the degradation of habitat and the loss of populations. Though I support all efforts to preserve natural areas and habitat first and foremost, there are situations when it is not possible. This translocation was initiated as an attempt to save animals that would have been destroyed by construction activity, however that is not why the investigation that identified the problem was initiated in the first place. Landscape barriers that have formed due to human activity and urban sprawl cannot be traversed by small species like the cricket frogs. The remaining populations in southeast Michigan are isolated from each other and face future impacts of loss of genetic variation due to inbreeding, stochastic events, and potential disease events that could eliminate the population completely. In this case, and many similar cases where isolation and fragmentation leave scattered populations, translocation may be the only way assure the existence of this species in Michigan.

Interpretations Of The Cricket Frog Translocation Results

I would first like to present a few observations and clarifications with regards to the information presented in Rickard's article. First, in her results she states that animals were heard calling at site 2 in the spring of 2005 but in the discussion states that no cricket frogs were heard or seen in any of the release sites that spring. Based on call surveys done by myself and the staff at the Detroit Zoo, cricket frogs were heard calling at the Port Huron Site (site 1) and the Detroit Zoo Site (site 2). Though these numbers were small, they gave indication that there were appropriate hibernacula at both sites 1 and 2, and that the animals were able to locate these hibernacula between their release and the onset of winter.

Second, in her abstract, Rickard

states that initial breeding attempts were observed at all three release sites. This species does not breed in the late summer and adults disperse or die after breeding in the early to mid summer. Animals were released between August 24 and October 8, 2004 with site 1 and St. John's Marsh (site 3) receiving animals only on September 14, 2004, which is well past the breeding season. In addition, in 2004 only 12 animals that were released were identified as adults (based on size only), 11 of which were released at site 2 and one released at site 3. No adult size animals were released to site 1. The remainder of animals were juveniles and tadpoles and not sexually mature. Though it is possible that these breeding attempts were observed in late summer and the translocation of the animals to new territories stimulated a change in adult behavior, that would only account for this statement being made for sites 2 and 3. However, if these animals maintained their natural breeding cycle, that would require them being seen at all three sites in the spring of 2005 which she previously stated did not occur.

Third, as stated above, there were animals that survived and were calling at site 1 in the spring of 2005 prior to the release of an additional 57 animals. Though animals released in 2005 were marked to indicate year of release, the actual parentage of the offspring at the site cannot be assumed to be from the 2005 release animals. Therefore, it is possible that the few animals that survived the winter were able to produce young. More accurate indications of over-winter survival and breeding will be evident during the spring and summer of 2006 and subsequent year surveys.

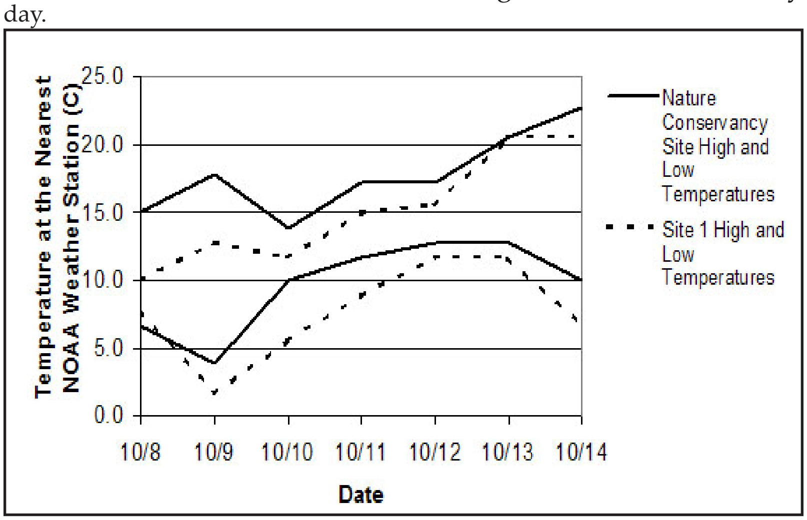
The analysis of this program has been presented based on a single year's data and under the assumptions that an established population and a newly released population would show identical population trends in the first year. The trends of the data presented in Table 2 of Rickard's article indicate a significant decline in all surveyed sites between the September and October surveys, not just at site 1. However, without data from multiple years and including surrounding wetlands, actual population trends cannot be identified. The only information that is definitive from these data is that some animals released at site 1 survived and bred. The number of pairs that bred, genetic variability within the population, survival rates, and population trends require significantly more data to make any conclusions but need to be analyzed as this project continues.

Rickard's table 2 also assumes animals remained in the wetland where they were released. Site 1 and site 3 are both surrounded by large natural areas containing a variety of wetland features that could be utilized by the cricket frogs for migration, hibernation or breeding. The migratory abilities of this animal are unclear and surrounding areas were not surveyed to determine if they were being colonized. In addition, the Nature Conservancy site is situated in a sparsely vegetated gravel pit with little to no cover for migrating animals while site 1 and 3 are surrounded by tall prairie grasses which afford a degree of protection from desiccation and predation during movements. The grassy areas of site 1 and 3 also support burrowing crayfish at significant distances from the edges of the wetlands while the Nature Conservancy site crayfish burrows appear to be concentrated near the wetland shoreline. Crayfish burrows are considered to be utilized as hibernacula by cricket frogs. It is possible that animals were dispersing and not seen at the shoreline at the time of the survey.

Rickard also suggested that the reason for the 2005 decline in site 1 was most likely predation. All sites contained similar biotic assemblies of amphibians, birds and reptiles and were known to contain green frogs. The consumption rate of cricket frog metamorphs by green frogs at site 1 should be similar to that at the Nature Conservancy site unless there is a significant difference in the size of the green frog population, and no evidence of that was presented. Therefore, the impact of green frogs cannot be assessed objectively based on data presented. Without established, quantitative differences between predator assemblages at each of the release sites and the extant population site, cause and effect cannot be attributed to predation differences.

Rickard dismisses the potential for differences in animal activity levels and visibility being related to air and water temperatures, as well as location. Though temperature cannot be confirmed to be impacting these populations at the time of survey, it is noteworthy that the Nature Conservancy Site was consistently warmer for the week prior to surveying (figure 1) and that this trend continued back to the beginning of the month of October. Also, in the month of October up to the survey date, site 1 only experienced four sunny or partly sunny days while the Nature Conservancy Site experienced eight. This species is known to bask and prefer warm temperatures. With lower temperatures and less basking opportunities, the frogs would be less likely to be on the shoreline and easily visible. Therefore, the differences between sites could be behavioral due to climatic conditions.

Figure 1. Comparison of high and low temperatures at Site 1 and the Nature Conservancy Site for the week prior to the last survey day.



Conclusion

Translocations are a viable conservation tool to overcome landscape barriers, maintain genetic diversity in isolated populations, utilize restored habitat, and protect biodiversity. Emergency translocations should only be used when other options such as habitat protection and improving habitat adjacent to threatened populations are not feasible. The fragmented landscapes that have been created through anthropogenic activities often leaves few options to translocations in urbanized and degraded areas. Species such as the Blanchard's cricket frog can benefit regionally from the establishment of more populations in their former range. The translocations of this study will result in a better understanding of the life history of this species and will offer insights into ways in which future translocation experiments should be performed. Performing this study before the species declines to critically low levels will minimize the impact of translocation attempts on the remaining populations.

Translocation must be treated as a science, not just the movement of animals from point A to point B. Proper planning and responsible decisions are required, taking into consideration the natural history of the species, habitat use and availability, the impacts of the donor population, the impacts on the recipient site, and the possibility of disease transmission as well as a long term commitment to the management and monitoring of the population that becomes established. The lack of previously published and monitored translocation leaves today's ecologists only a minimal framework for designing a program. The lessons learned from successes and failures will better prepare the next scientist and increase success rates. No branch of science or conservation technique proves perfect when first tried. The expectation of near perfection in translocation is unrealistic, especially in a natural system with a myriad of potential influencing factors. It is the responsibility of all involved in a translocation to share what was learned to increase the probability of success in future projects.

Human-animal conflicts are common in urbanized and developing areas. In most circumstances, little or nothing is done in an attempt to save the animals prior to construction. Historically, it has been assumed that the animals will move and find new habitat. When construction is performed where there are connected natural areas, some animals may be able to move. However, this is not the case in a majority of the urbanized areas. In some cases, natural areas are preserved and maintained as habitat for the animals. These scattered stands are often completely isolated from other habitat and other populations. The result is a collection of physically and genetically isolated populations that face genetic homogenization and are unable to sustain the impacts of stochastic events. Though I believe we should protect all possible natural areas, regardless of location or size, we must also consider the context of these areas and the need for management of the populations within these areas before deeming them to be ecological saviors. Translocation gives us a tool to manage these isolated populations as well as a tool to establish new populations and avoid an "all eggs in one basket" scenario.

The general public tends to view translocation as a catch-all answer for threatened populations. This project received a significant amount of press coverage and continues to generate interest for speaking engagements. This continued interest has given me the opportunity to explain the situation around our translocation project and focus on the point of habitat protection first and foremost. Unfortunately, as state and federal laws stand, there are often no legal means of stopping a construction project. If our project was able to spur residents into action and encourage their involvement in protecting their environment, then something has been gained and the likelihood of future emergency translocations being needed decreased.

I agree with Rickard that there is a need for greater legal habitat and species protection. At this site, the redirection of the entrance road may have allowed for preservation of the site assuming the rest of the development and changes in the surrounding area did not cause significant degradation. However, we had no legal recourse to change the road design plans based on the status of the species (Species of Special Concern) and wetland protection laws. The concession of redesigning the mitigation site was a measure suggested by the MDEQ based on "in-kind" replacement rules, but if the contractors refused, I am not aware of any legal recourse to make them change the design. This project was not initiated to assist the contractors but to make at least an attempt to save some animals. No one claims that translocation will solve the problem of additional habitat loss for cricket frogs. It is, however, a tool that may allow some reversal of population losses while attempts to preserve the remaining natural populations are underway.

My research on this species is continuing and the MDNR is supporting a portion of this research. Michigan Natural Features Inventory representatives have been working with the MDNR to up-list the Blanchard's cricket frog to Threatened. With this higher level of protection, more habitat conservation will be possible in the future. With a more educated public, more legislation that protects natural areas is also possible.

There are many unknowns with regards to the natural history and causes for declines in the Blanchard's cricket frog in Michigan and throughout its range. Multiple researchers in the region are working to better understand these factors. This translocation project may fail but the data to date does not prove failure. It indicates declines that may result in failure or may be related to natural fluctuations, sampling error, or climatic conditions. Long term monitoring, comparisons between extant and release sites, will increase the chance of future project success. Even if this project does not succeed in establishing a new population of cricket frogs, it will be a valuable learning experience.

Literature Cited

Burke, R.L. 1991. Relocations, Repatriations, and Translocations of Amphibians and Reptiles: Taking a Broader View. Herpetologica 47:350-357.

Dodd, C.K. Jr., R.A. Seigel. 1991. Relocation, Repatriation, and Translocation of Amphibians and Reptiles: Are They Conservation Strategies That Work? Herpetologica 47:336-350.

IUCN Species Survival. *IUCN/SSC Guidelines for Reintroductions* [cited 1/8/2004]. Available from http://www.iucn.org/themes/scc/pubs/policy/reinte.htm

Seigel, R.A. and J.C.K. Dodd. 2002. Translocations of Amphibians: Proven Management Method or Experimental Technique? Conservation Biology 16:552-554.

Zippel, K. Amphibian Web: Information on amphibian biology and conservation. 2005. Berkeley, California: AmphibiaWeb. [cited 2/14/2006]. Available from http://amphibiaweb.org

The Fat Threeridge (*Amblema neislerii*), the Surprisingly Common Endangered Mussel in the Apalachicola River, Florida

Andrew C. Miller[1,2]
Barry S. Payne[1,3]

[1]Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS 39180-6199

[2]millera3@wes.army.mil

[3]payneb@wes.army.mil

Abstract

Native freshwater mussels (Family: *Unionidae*) are the most 'endangered' organisms in North America; in January 2006 the U.S. Fish and Wildlife Service listed 70 species as threatened or endangered. Although some species are widely distributed throughout the central and eastern United States, many others are localized and found only in certain watersheds. For example, the fat threeridge mussel, *Amblema neislerii* (Lea, 1858), is now restricted to the Apalachicola River, Florida. Although results of surveys conducted during the 20th century suggest that this species was always rare in the river, our findings indicate that in moderately depositional areas near shore, *A. neislerii* is common-to-abundant and exhibits good evidence of recent recruitment. In 6 surveys between 1996 and 2003, divers and waders searched for mussels at approximately 100 sites in the 171-km-long river. Over 4,500 live mussels were collected and 19 species were identified. *Amblema neislerii* dominated the bivalve fauna at moderately depositional sites where it constituted approximately 36% of the fauna. Evidence of recent recruitment (live individuals less than 30 mm total shell length) was evident at many sites. This article examines the status of *A. neislerii* in the Apalachicola River based on a literature review and recent surveys.

Resumen

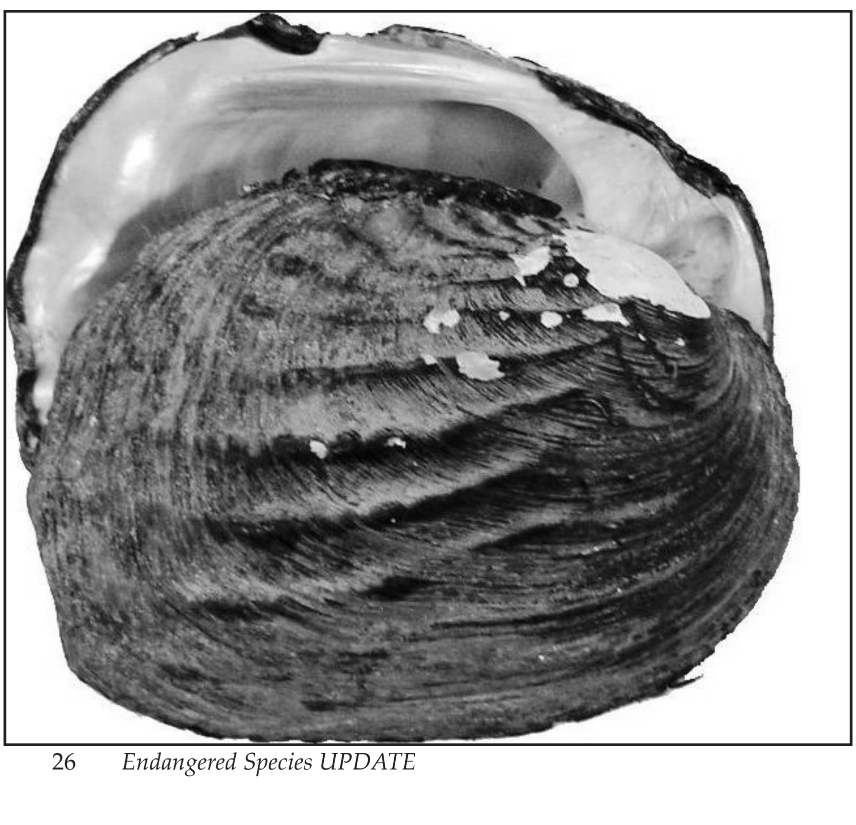
Mejillones nativos de agua fresca son los organismos mas amenazados en América del Norte; en enero del 2006 el Servicio de Pesca y Vida Silvestre de EE.UU. listó 70 especies como amenazadas o en peligro. A pesar de que algunas especies están ampliamente distribuidas por todo el centro y la parte este de los EE.UU., muchas otras están localizadas y se encuentran solo en ciertos acuíferos. Por ejemplo, el mejillón Amblema neislerii (Lea, 1858) está ahora restricto al Río Apalachicola, Florida. Aunque los resultados de conteos realizados durante el siglo 20 sugieren que esta especie siempre fue rara en el río nuestros resultados indican que en áreas cerca de la orilla de deposición moderada, A.neislerii es de común a abundante y hay buena evidencia de reclutamiento reciente. En 6 conteos de 1996 a 2003, buzos y vadeadores buscaron mejillones en aproximadamente 100 lugares en el estrecho de 171 km del río. Más de 4,500 mejillones vivos fueron recolectados y se identificaron 19 especies. Amblema neislerii domina la fauna bi-valvular en lugares de deposición moderada, donde formaba parte del 36% de la fauna. Evidencia de reclutamiento reciente (individuos vivos de menos de 30mm de largo de concha) estaba presente en muchos de los lugares. Este artículo examina el estatus de A.neislerii en el Río Apalachicola basado en una revisión de la literatura y conteos recientes.

Introduction

The Apalachicola River provides habitat for an endemic freshwater mussel (family: Unionidae) the fat threeridge, *Amblema neislerii* (Lea, 1858), which was listed as endangered on 15 April 1998. The decision to list this and 6 other mussel species in the Southeast was partially based on results of a status survey conducted at 324 sites in the Apalachicola-Chattahoochee-Flint (ACF) river basin and 77 sites along the Ochlockonee River Systems, southeast Alabama, southwest Georgia, and north Florida (Federal Register 63(50): 12664-12687). Jayne Brim Box and James D. Williams conducted the status survey in 1991-93 using scuba and snorkeling, and by handpicking in shallow water. These and other studies (Butler 1993) were synthesized for the Technical/Agency Draft Recovery Plan (Butler and Alam 1999) and for the Final Recovery Plan (Butler et al. 2003).

As of January 2006 the total number of federally listed threatened and endangered species was 1,272, which included 527 animals and 745 plants (US Fish and Wildlife Service 2006). When compared with charismatic species such as mammals and birds, concern has been expressed by some that invertebrates have been largely overlooked by the Endangered Species Act (ESA) (Kellert 1993; Opler 1987; Bean 1993; Murphy 1991; Hughes et al. 2000; Black et al. 2001). Regardless, of the 297 mussel species in the United States (Williams et al. 1993), 62 are endangered and 8 are threatened; therefore 24% have federal protection. Considering this comparatively high percentage, one could conclude that either native mussels are in serious trouble (Stansbery 1970; Fuller 1974; Master 1990; Bogan 1993; Seddon et al. 1998; Hayes 1998; Williams et al. 1993; Neves 1999; and Strayer et al. 2004) or they benefit from strong advocates (Yaffee 1982). Most likely, it is a combination of both.

Figure 1. The fat threeridge, *Amblema neislerii.*



Between 1996 and 2003 six mussel surveys were conducted in the Apalachicola River for the U.S. Army Engineer District, Mobile. These studies were designed to obtain information on distribution and abundance of federally listed mussels to avoid impacts of dredged material disposal. During this period nearly 211 hours were expended searching at approximately 100 sites in the 171-km-long river. As a result of these surveys and a critical review of previous papers on *A. neislerii*, it became apparent that this species is more common in the Apalachicola River than results of previous surveys would suggest. The purpose of this paper is to discuss survey results and the status of *A. neislerii* in the Apalachicola River. The other federally-listed mussel in the Apalachicola River is the purple bank climber, *Elliptoideus sloatianus* (Lea, 1840), listed as threatened on 15 April 1998.

Study Area

The Apalachicola River, formed by the confluence of the Flint and Chattahoochee Rivers, originates at Navigation Mile (NM) 106.3, just south of Lake

Seminole in the tailwater of Jim Woodruff Lock and Dam. This 171-km river is the largest in Florida with a mean annual flow of 690 m^3/sec (Light et al. 1998). The Apalachicola-Chattahoochee-Flint (ACF) River Basin, in Georgia and northeastern Florida, drains approximately 210,448 hectares. The river enters the Apalachicola Bay at Apalachicola, Florida.

Jim Woodruff Dam is located at Navigation Mile 106.3 on the Apalachicola River and forms the Lake Seminole impoundment. Jim Woodruff Dam and Lake Seminole are operated as a run-of-the-river reservoir with the capability for only limited water storage. The tailwaters below Jim Woodruff Dam on the Apalachicola River are free-flowing and unobstructed, but can be affected by upstream reservoir operations and releases. The USACE allows basin outflows from Jim Woodruff Dam to approximately equal inflows from the upstream reservoirs in the basin except when upstream reservoirs are refilling. However, to avoid having discharge fall below 141.6 cms (minimum flow) during low flow periods, flows can be augmented by releases from Jim Woodruff Dam and/or other upstream reservoirs along the Chattahoochee River.

In 1875 the USACE was authorized to maintain a navigation channel in the Apalachicola River (U.S. Army Engineer District, Mobile 1987). In the early 20th century sediments were dredged from the main channel, oxbows, tributaries, and sloughs and placed on the floodplain within natural riverbanks. In the 1980s nearly 150 disposal areas were permitted throughout the river, although in any single year relatively few are used. Dredging was restricted to the main channel and material was only placed at specifically designated disposal areas primarily along shore in within-bank disposal sites. Although maintained for commercial navigation, commercial river traffic on the Apalachicola River in recent years has been light and has consisted mainly of recreational vessels. A number of factors have led to an unreliable navigation channel and the observed reduction in commercial navigation on the river, including recurrent drought conditions, dredged material capacity shortfalls, increasing restrictions on dredged material disposal, and funding limitations. The continued use of within-bank disposal areas has remained controversial within the State of Florida. However, mussel surveys have been conducted at all proposed within-bank disposal sites prior to their use in order to avoid impacts to threatened and endangered mussels or their habitat.

Most dredged material disposal areas are now located on erosional point bars, typically at a bend in the river so high flow redistributes sediments downriver. As is the case with all rivers, downriver of the erosional point bar is a zone of moderate sediment deposition. Concerning sediment deposition, the term 'moderate' is used to indicate that during low flow fine-grained sediments

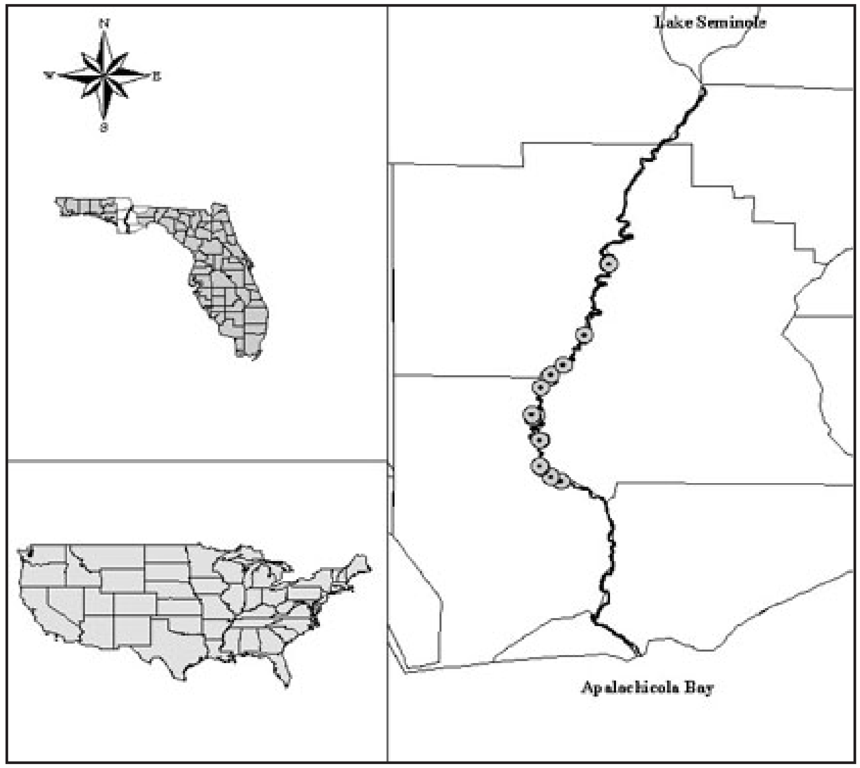


Figure 2. Sites surveyed for *A. neislerii*, Apalachicola River, Florida, November, 2003.

or silts will be deposited and gradually increase in depth. Moderately depositional areas are firm but muddy and will support benthic invertebrates such as mussels, snails, worms (oligochaeta) and dipterans (chironomidae). A period of high-velocity water will scour sediments and remove most of the smaller, short-lived fauna, although the site usually recolonizes quickly. Depending on conditions, these moderately depositional areas could scour several times a year, or simply maintain a dynamic equilibrium between erosion and deposition which is not detrimental to the fauna. Many shoals in large rivers such as the Ohio, Tennessee, and upper Mississippi that support dense and diverse mussel assemblages meet these latter criteria

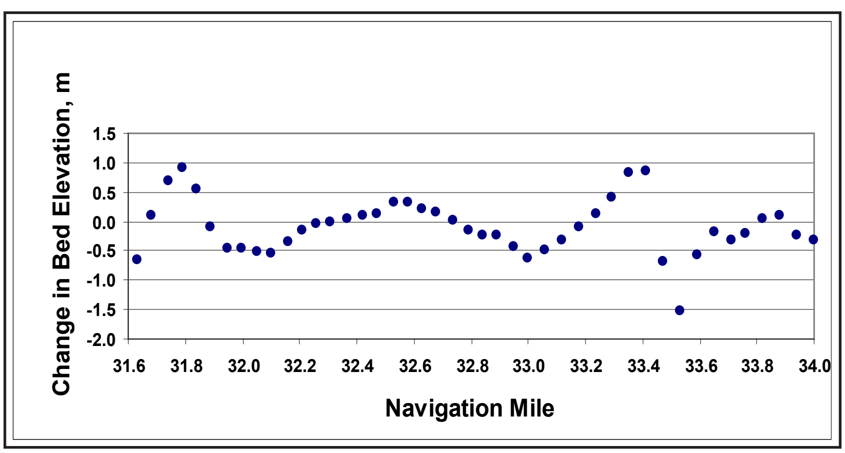
Methods

Mussels were collected by 2-4 waders in shallow water and by 2 divers in water deeper than 1 m. Searches were timed and usually lasted 15-20 minutes. Collecting was done tactilely since underwater visibility was poor. Divers were equipped with a pneumofathometer to record water depth and were tethered to the boat with a 100-m line. All live mussels were taken to the boat or a station onshore and counted, identified, and returned to a location unlikely to be disturbed by future maintenance. Demographic data were obtained at a single site by collecting total substratum quantitative samples using a 0.25-m^2 quadrat (Miller and Payne 1993). Mussel taxonomy is consistent with Williams et al. (1993).

The major objective during most study years was to assess presence/absence of threatened and endangered mussels in areas likely to be affected by dredged material disposal operations. In 1996, 1997, 1999, and 2002 these surveys were conducted immediately up- and downriver of 57 disposal areas. In 2001 searches were conducted immediately up- and downriver of 34 sloughs scheduled for maintenance dredging for ecosystem restoration. All sites were chosen by USACE and state environmental resource agency personnel and included both high quality benthic habitats as well as erosional zones not inhabited by live mussels or other benthic organisms.

A second objective was to analyze *A. neislerii* size demography, and abundance with respect to water depth at sites where this species was known to be common to abundant. These investigations were initiated to obtain a more complete understanding of this species in the Apalachicola River during low flow conditions. Population structure and evidence of recent recruitment were examined in 1999 by collecting quantitative total substratum samples using a 0.25-m2 quadrat. Total shell length of each live *A. neislerii* was measured with digital calipers, and then it was returned to the river unharmed. These samples were taken from a moderately depositional area along the right descending bank of the Chipola Cutoff immediately downriver of the point where it exits the Apalachicola River at NM 41.7. As part of this objective, the distribution of *A. neislerii* with respect to water depth was investigated in November 2003 at 11 moderately depositional sites between NM 30.0 and 73.3. Transects perpendicular to shore were established that ran from shallow (0.6 m) to deep (2.7 m) water. At 0.3-m depth increments along

Figure 3. Results of the HEC-2 SED model, which depict depositional and erosional reaches of the Apalachicola River (indicated by positive and negative changes in bed load, respectively) and identify suitable habitat for mussels and *A. neislerii*. The vertical lines indicate downriver (lower Navigation Miles) and upriver reaches of Disposal Areas 32A and 33A. Mussels were typically found in slightly depositional reaches immediately downriver of the disposal areas.



each transect 2 divers searched for mussels for 15 minutes. A total of 100 timed searches were conducted. Gauge height and discharge at the nearest gauge near Blountstown, Florida (NM 78) was 1.11 m, 266.7 cms (18 Nov 03); 1.27 m, 291.7 cms (19 Nov 03); and 1.50 m 325.6 cms (20 Nov 03).

Results

Data from the first objective, to search for endangered species at sites likely to be affected by dredged material disposal, are summarized in Table 1. More than 4,200 live mussels were collected at approximately 100 sites in the Apalachicola River. *A. neislerii* constituted 10% of the fauna and ranked 4th of 19 species. The most abundant species at these sites was *Lampsilis teres* (Rafinesque, 1820), which constituted 35.2% of the fauna. This species is usually common in sandy substratum in rivers, streams, and lakes throughout the Midwest (Cummings and Mayer 1992). Overall Collection per Unit Effort (CPUE; mussels collected per person hour) for all mussels was 21.9 and for *A. neislerii* was 2.2. As noted above, these sites included some where *A. neislerii* was common to abundant and others where virtually no benthic organisms were found.

It became apparent that freshwater mussels, including *A. neislerii*, were most abundant in moderately depositional areas often located 1-2 km or less downriver of point bars. Output from the CH3D-SED model (Raphelt and Alexander 2001) identifies areas of moderate sediment deposition downriver of point bars and disposal areas (Figure 3). A different impression of the relative abundance of *A. neislerii* emerges when collecting was restricted to moderately depositional sites (Objective 2). At 11 depositional sites (8 separate locations) *A. neislerii* ranked 1 of 12 and constituted 35.8% of the fauna. Average CPUE was 37.9 for all mussels and 13.6 for *A. neislerii*. CPUE ranged from 0.5 to 20.2 for *A. neislerii* and from 6.3 to 55.9 for total mussels on transects located perpendicular to shore (Figure 4). Total shell length varied from 30 to 90 mm with 12% less than 40 mm total shell length. Mussels were most abundant at a depth of 1.2 m. Mussels were virtually absent at water depths less than 1.2 m likely because of predation and aerial exposure. At depths greater than 2.7 m flow became erosional and few live mussels were found.

To investigate *A. neislerii* population demography, total substratum quantitative samples were taken at a moderately depositional site along the Chipola Cutoff where it connects with the Apalachicola River (approximate NM 41.7). CPUE for all mussels was 145, and A. neislerii was collected at the rate of nearly 90 per hour and constituted slightly more than 61% of the molluscan fauna. Total shell length ranged from 12.8 to 63.7 mm with good evidence of recent

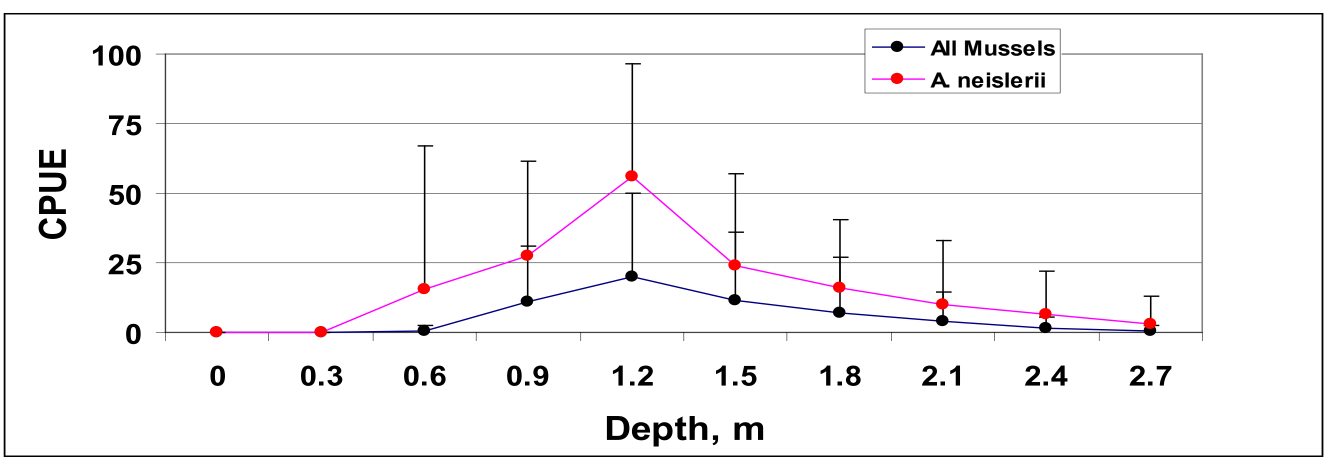


Figure 4. CPUE of *Amblema neislerii* and total mussels at 11 depositional sites in the Apalachicola River, Florida, 2003.

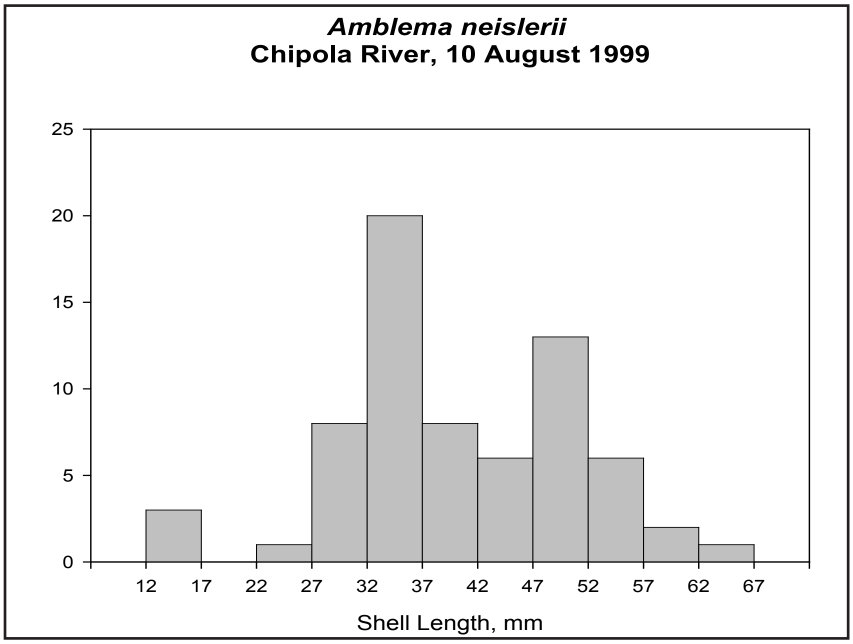


Figure 5. Length-frequency histogram for *A. neislerii*, mouth of Chipola River, 10 August 1999.

recruitment (Figure 5). We can only quantify the presence of small mussels, however, when total substratum samples were obtained. Mean density of A. neislerii was 27.2 individuals/m2, and mean density for all mussels was 34.8 individuals/m2.

Discussion

The first published reference to *A. neislerii* in the ACF basin was by Hyning (1925) who considered this species to be 'rare.' He made this statement after receiving an unreported number of *A. neislerii* from the Chipola River that were given to him by a fisherman. Later van der Schalie (1940) summarized early mussel studies in the mainstem Chipola River and tributaries. He reported that *A. neislerii* was not found in tributaries but was collected at 2 sites in the Chipola River where it constituted 1.49 % of the unionid fauna. Clench and Turner (1956) reported that *A. neislerii* was rare in the watershed, although when present it could be locally abundant. They considered it to be extinct in the upper Flint River where it had not been taken since the latter part of the previous century, although they did find some specimens in the lower Flint, Apalachicola, and Chipola Rivers. They reported that *A. neislerii* was 'amazingly abundant' in a natural impoundment in the lower Chipola River (referred to as Dead Lake) where 10-15 *Crenodonta* (=*Amblema*) *neislerii* could be found in "every square meter" along a 200-meter reach.

In a survey conducted for the Office of Endangered Species, Heard (1975) collected mussels at 150 locations in the Gulf and Southeastern States; 3 were in the Apalachicola and 4 were in the Chipola River. He collected live *A. neislerii* only in the lower Chipola River (Dead Lake). Heard (1975) reported no live *A. neislerii* in the Apalachicola River although he did find shells at 1 of 3 sites. He provided no information on sampling methods, intensity, or locations.

Richardson and Yokley (1996) collected mussels in the lower Apalachicola River using quantitative (6-0.25-m2 quadrats and total substratum removal) samples at each of 3 sites where adult *A. neislerii* or *E. sloatianus* had been found by previous investigators. *Amblema neislerii* was found at 1 of 3 sites (NM 21.8) where it constituted 25% of the assemblage. Three live organisms were smaller than 50 mm total shell length. Richardson and Yokley (1996) concluded that appropriate search methods (total substratum removal) would likely yield additional evidence of recent recruitment for *A. neislerii* in the Apalachicola River.

In 1991-92, Brim Box and Williams (2000) surveyed 324 sites in the ACF River Basin. They identified 33 species from a collection of 5,757 live individuals and 2,988 shells. Most sites were in the Chattahoochee and Flint Rivers upriver of Jim Woodruff Lock and Dam. In the Apalachicola River, Brim Box and Williams (2000) collected 32 live *A. neislerii* at 7 sites.

Early studies (Hyning 1925, van der Schalie 1940, Clench and Turner 1956, Heard 1975) give an impression that *A. neislerii* is rare in the ACF basin, but

Species	% Abundance	% Occurrence	CPUE, hr
A. neislerii	35.8	47	13.57
G. rotundata	32.36	55	12.26
L. teres	10.67	28	4.04
E. icterina	8.26	21	3.13
Q. infucata	4.13	14	1.57
E. complanata	2.75	7	1.04
P. grandis	2.75	9	1.04
M. nervosa	1.03	4	0.39
U. peggyae	0.86	4	0.33
T. paulus	0.69	4	0.26
E. crassidens	0.34	2	0.13
V. lienosa	0.34	2	0.13
Total collections	**100**		
Total individuals	**581**		
Total species	**12**		
Time, hr	**15.3**		
CPUE, Catch per person hour	**37.9**		

Table 1. Summary of timed searches for mussels at disposal areas, slough mouths, or banks requiring maintenance in the Apalachicola River, Florida (1996, 1997, 1999, 2001, and 2002).

it is difficult to critically evaluate their results without knowing details of the surveys. It is also true that this species would accurately be described as common-to-abundant in the Apalachicola River but uncommon in the ACF Basin as a whole. Richardson and Yokley (1996) collected just 6 quantitative samples at a site in the Apalachicola River where they knew *A. neislerii* was present and reached conclusions similar to ours but different from previous workers. Over 200 hours were spent searching at approximately 100 sites in the Apalachicola River. Over 4,800 live mussels were processed and more than 600 live *A. neislerii* were collected. This is far more than any previous surveys, even those upon which the decision to list *A. neislerii* as endangered was based.

Amblema neislerii survives best in slightly depositional, low-flow reaches of medium-to-large sized rivers, and is less common in small streams. Therefore it was probably never common in the smaller Flint or Chipola Rivers. It is endemic to the ACF basin because it has been isolated from the Mississippi drainage by marine conditions to the south and physiography to the east, north, and west. It was concluded that *A. neislerii* is common to abundant at moderately depositional sites in the Apalachicola River. If earlier workers had access to powerboats and divers and conducted intensive and extensive surveys, they would likely have concluded that this species was common in the Apalachicola River and uncommon in smaller tributaries. An alternative hypothesis seems unlikely. It is difficult to believe that *A. neislerii* was previously uncommon in the Apalachicola River and that its abundance has greatly increased during the last 30 years.

These studies were initiated as-

Table 2. Summary of results from timed searches at multiple depths (0.3 – 2 m) at 11 locations along the mainstem Apalachicola River, November 2003.

Species	% Abundance	% Occurrence	CPUE
Lampsilis teres	35.22	58.3	7.7
Glebula rotundata	23.81	46.9	5.2
Elliptio icterina	14.48	22.9	3.16
Amblema neislerii	10	22.9	2.19
Quincuncina infucata	2.76	22.9	0.6
Elliptio crassidens	1.64	16.7	0.36
Megalonaias nervosa	1.55	15.6	0.34
Elliptoideus sloatianus	1.69	9.4	0.37
Pyganodon grandis	1.31	19.8	0.29
Elliptio complanata	6.12	15.6	1.34
Toxolasma paulus	0.4	8.3	0.09
Utterbackia imbecillis	0.21	6.3	0.05
Villosa villosa	0.19	3.1	0.04
Pyganodon cataracta	0.16	3.1	0.04
Uniomerus caroliniana	0.12	3.1	0.03
Elliptio arctata	0.19	3.1	0.04
Utterbackia peggyae	0.07	2.1	0.02
Pyganodon heardi	0.05	2.1	0.01
Lampsilis claibornensis	0.05	2.1	0.01
Total locations	**96**		
Total individuals	**4,268**		
Total species	**19**		
Time, hr	**195.3**		
CPUE, Catch per person hour	**21.9**		

suming that *A. neislerii* was extremely uncommon and that intensive field searches would be needed to find live specimens. However, results of these field studies indicated that this species is not in imminent danger of becoming extirpated in the Apalachicola River; conversely, in appropriate habitat it is abundant and exhibits good evidence of recent recruitment. In the Apalachicola River, *A. neislerii* could even be used as an indicator of good quality moderately depositional mussel habitat. The ESA provided protection and raised awareness of abundance and distribution of *A. neislerii*. A similar situation was noted for the endangered bivalve *Potamilus capax* in the St. Francis basin, Arkansas (Miller and Payne 2005).

Depending on need, the USACE has dredged along the Apalachicola River and has typically placed the dredged material near shore. Dredging impacts, water levels, commercial uses of the river, and protection of endangered species is central to coordination among conservation groups, navigation interests, and the USACE. A complete understanding of the distribution and abundance of *A. neislerii* is therefore critical to managing the waterway.

Literature Cited

Bean, M. J. 1993. Invertebrates and the Endangered Species Act. Wings. 17(2):12-15.

Black, S. H., Shepard, M., and M. M. Allen. 2001. Endangered Invertebrates: The Case for Greater Attention to Invertebrate Conservation. Endangered Species Update 18(2):41-49.

Bogan, A. E. 1993. Freshwater bivalve extinctions (Mollusca: Unionidae): a search for causes. American Zoologist 33:599-609.

Brim Box, J., and J.D. Williams. 2000. Unionid mollusks of the Apalachicola Basin in Alabama, Florida, and Georgia. Bulletin of the Alabama Museum of Natural History No. 22. 143 pp.

Butler, R.S. 1993. Results of a status survey for 8 freshwater mussels (Bivalvia: Unionidae) endemic to eastern gulf slope drainages of the Apalachicolan Region of southeast Alabama, southwest Georgia, and north Florida. Status Report Prepared by U.S. Fish and Wildlife Service, Jacksonville, FL.

Butler, R.S., and S.K. Alam. 1999. Technical/Agency Draft Recovery Plan for endangered fat threeridge (*Amblema neislerii*), shinyrayed pocketbook (*Lampsilis subangulata*), Gulf moccasinshell (*Medionidus penicillatus*), Ochlockonee moccasinshell (*Medionidus simpsonianus*), oval pigtoe, and threatened Chipola slabshell (*Elliptio chipolaensis*), and purple bankclimber (*Elliptoideus sloatianus*). Prepared for Southeast Region, U.S. Fish and Wildlife Service, Atlanta, GA.

Butler, R.S., Ziewitz, J., Alam, S.K., and H.N. Blalock-Herod. 2003. Recovery Plan for endangered fat threeridge (*Amblema neislerii*), shinyrayed pocketbook (*Lampsilis subangulata*), Gulf moccasinshell (*Medionidus penicillatus*), Ochlockonee moccasinshell (*Medionidus simpsonianus*), oval pigtoe, and threatened

Chipola slabshell (*Elliptio chipolaensis*), and purple bankclimber (*Elliptoideus sloatianus*). Prepared for the U.S. Fish and Wildlife Service, Southeast Region, Atlanta, GA.

Clench, W.J., and R.D. Turner. 1956. Freshwater mollusks of Alabama, Georgia, and Florida from the Escambia to the Suwannee River. Bulletin of the Florida State Museum, Biological Sciences 1(3):97-349.

Cummings, K.S., and C.A. Mayer. 1992. Field Guide to Freshwater Mussels of the Midwest. Illinois Natural History Survey, Manual 5. 194 pp.

Fuller, S. L. H. 1974. Clams and Mussels (Mollusca: Bivalvia). Pages 215-273 in C. W. Hart, Jr., and S. L. H. Fuller, editors. Pollution Ecology of Freshwater Invertebrates. Academic Press. New York, NY.

Hayes, T. 1998. Conservation of Native Freshwater Mussels: An Overview. Endangered Species Update 15(6):108-110.

Heard, W.H. 1975. Determination of the endangered status of freshwater clams of the Gulf and Southeastern States. Terminal Report for the Office of Endangered Species, Bureau of Sport Fisheries & Wildlife, U.S. Department of Interior (Contract 14-16-000-8905).

Hughes, J. B., Daily, G. C., and P. Ehrlich. 2000. Conservation of Insect diversity: A habitat approach. Conservation Biology 14:1788-1797.

Hyning, V.T. 1925. *Amblema neisleri* (Sic) nest located. The Nautilus 38(3):105.

Kellert, S. R. 1993. Values and Perceptions of Invertebrates. Conservation Biology 7(4):845-855.

Light, H.M, Darst, M.R., and J.W. Grubbs. 1998. Aquatic Habitats in Relation to River Flow in the Apalachicola River Floodplain, Florida. U.S. Geological Survey Professional Paper 1594. ISBN 0-607-89269-2.

Master, L. 1990. The imperiled status of North American aquatic animals. Biodiversity Network News 3:1-2, 7-8.

Miller, A. C., and B. S. Payne. 1993. Qualitative versus quantitative sampling to evaluate population and community characteristics at a large-river mussel bed. The American Midland Naturalist 130:133-145.

Miller, A. C., and B. S. Payne. 2005. The curious case of the fat pocketbook mussel, *Potamilus capax*. Endangered Species Update 22(2):61-70.

Murphy, D. D. 1991. Invertebrate Conservation. Pages 181-198 in K. A. Kohm, editor. Balancing on the Brink of Extinction: the Endangered Species Act and Lessons for the Future. Island Press. Washington, D.C.

Neves, R. J. 1999. Conservation and commerce: management of freshwater mussel (Bivalvia: Unionidae) resources in the United States. Malacologia 41(2), 461-474.

Opler, P. A. 1987. Invertebrate surveys in North America are necessary. Wings 12: 8-10.

Raphelt, N. K. and M. P. Alexander. 2001. Multidimensional Models in Rivers and Streams. Coastal and Hydraulics Engineering Technical Note CHETN-VII-2, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Richardson, T.D., and P. Yokley, Jr. 1996. A note on sampling technique and evidence of recruitment in freshwater mussels (Unionidae). Archiv fur Hydrobiologie 137(1):135-140.

Seddon, M. B., Killeen, I. J., Bouchet, P., and A. E. Bogan. 1998. Developing a strategy for molluscan conservation in the next century. Journal of Conchology Special Publication No. 2(1998): 295-298.

Stansbery, D. H. 1970. Eastern freshwater mollusks: (I) the Mississippi and St. Lawrence River Systems. Malacologia 10(1), 9-22.

Strayer, D. L., Downing, J. A., hag, W. R., King, T. L., Layzer, J. B., Newton, T. J., and S. J. Nichols. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. BioScience 54(5): 429-439.

US Army Engineer District, Mobile. 1987. Apalachicola-Chattahoochee-Flint Waterway Navigation Maintenance Plan. Mobile, AL.

US Fish and Wildlife Service. 2006. http://ecos.fws.gov/tess_public/servlet/gov.doi.tess_public.servlets.TESSBoxscore?forma=print&type=current&sysdate=12/17/2005

van der Schalie. H. 1940. The naiad fauna of the Chipola River, in northwestern Florida. Lloydia 3(3):191-206.

Williams, J.D., Warren, M.L., Jr., Cummins, K.S., Harris, J L., and R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18(9):6-22.

Yaffee, S.L. 1982. Prohibitive Policy, Implementing the Federal Endangered Species Act. MIT Press, Cambridge, MA.

Acknowledgments

Studies were funded by the U.S. Army Engineer District, Mobile, Mobile, Alabama. The authors thank Will Green, Mark Farr, Naomi Van Tol, Donald R. Manning, and divrs from Tennessee Valley Authority and Mainstream Commercial Divers for field assistance. Joanne Brandt, U.S. Army Engineer District, Mobile provided financial and technical support for this project. The Chief of Engineers granted permission to publish this information.

Conservation of *Artemisia amygdalina* – A Critically Endangered Endemic Plant Species of Kashmir Himalaya

A. R. Dar[1,2]
G. H. Dar[1]
Zafar Reshi[1]

[1] Centre of Plant Taxonomy (COPT), University of Kashmir, Srinagar

[2] ardar4u@yahoo.coml

Abstract
Despite our reliance on plants for human well-being, a crisis point has been reached. Many of the world's rare plant species are edaphic endemic, whose unique soil requirements, habitats, and restricted distribution make them especially vulnerable to human activities. Artemisia amygdalina collected last in the Kashmir Himalaya, almost four decades ago, is a critically endangered endemic species, but has received little attention. Despite being a very important ethno-medicinal angiosperm species, due to many factors, it has now been restricted to small pockets of the Kashmir Himalaya. The present study attempts to collect, cultivate, restore, propagate, and reintroduce this useful species in it's known natural range. This study may prove vital to protect and conserve the germplasm of this species for future use, and at the same time serve as an impetus for its sustainable use. Our endeavour has been a grand success in conserving Artemisia amygdalina.

Resumen
A pesar de nuestra dependencia en las plantas para el bienestar humano, se ha llegado a un punto critico. Muchas de las especies raras de plantas son endémicas edáficas, cuyas características de suelo únicas, hábitats, y distribución restringida las hacen especialmente vulnerables a la actividad humana. Artemisia amygdalina recolectada hace casi cuatro décadas del Kashmir Himalaya, es una especie endémica en peligro de extinción crítico y ha recibido poca atención en los últimos años. A pesar de ser una especie de angioespermas etno-medicinales muy importante, ahora está restricta a pequeñas áreas del Kashmir Himalaya, debido a una agrupación de factores múltiples. Este estudio intenta recolectar, cultivar, restaurar, propagar, y reintroducir esta importante especie. Este estudio puede servir como una forma vital de proteger y conservar los germoplasmas de esta especie para uso futuro y a la misma vez servir como un ímpetus para su uso sustentable. El presente intento ha sido un gran éxito en la conservación de dicha especie.

Introduction

Plants are a vital part of the world's biological diversity and an essential resource for human well-being. In addition to crop plants that provide our basic food and fibre, many thousands of plants have great economic and cultural importance and potential to provide food, medicine, fuel, clothing, and shelter for vast numbers of people throughout the world. Plants also play a key role in maintaining the basic ecosystem functions and are essential for the survival of the world's animal life. Yet, despite our reliance on plants, a crisis point has been reached. Although much work remains to be carried out to evaluate the status of the world's plants, it is reported that between 60,000 to 100,000 plant species are threatened worldwide. Plants are endangered by a combination of factors: habitat loss and degradation, unsustainable agriculture and forestry practices, urbanization, pollution, land use changes, spread of invasive species, and climatic changes. Even by the most conservative estimates, the rate of species loss is shocking – 27,000 species disappear each year; 74 each day, and 3 every hour! (Gadagkar, 1996).

There is an implicit principle of human behaviour important to conservation: the more we know of an ecosystem, the less the chances of our destroying it. Despite the interest and efforts to collect and compile information on these species (e. g. CSIR [Council of Scientific and Industrial Research] 1989; Chaurasia and Singh 1996; Gaur 1999; Kala 2000; Dar & Naqshi 2001; Kala 2002a, 2002b, 2000c), it is because of the inaccessibility of the high-altitude areas in the Himalayas and the restricted distribution of threatened species, that a paucity of information exists on their distribution pattern, population status and indigenous use pattern. Habitat loss and degradation are believed to threaten 91% of the rare plants in the world (IUCN 2002). Many of the world's rare plant species are edaphic endemic, whose unique soil needs, habitats, and restricted distribution make them especially vulnerable to human activities (Hopper et al. 1990; Briggs and Leigh 1996, and Narendran and Cherian 2002).

***Artemisia amygdalina* Decne.**

Perennial herb, large, glabrous; rhizome solid, hard, woody, 2.5-3.5 cm in diameter, blackish-brown, almost straight–slightly curved; stem erect, 2-3 m in height, 0.5 – 1.5 cm in diameter, leafy, prominently grooved, bears dense, small, leafy branches and branchlets. Leaves simple, rather membranous, acuminate, glabrous and bright-green above, dull-white and pubescent below, serrate, 3-9 cm in length and 0.5 – 1.5 cm in breadth, sub sessile-sessile. The terminal, tapering portion of stem bears a number of flowering heads; flowering heads in terminal branched raceme, ovoid, 0.5-1.5 cm in length and 0.4 – 0.6cm in diameter; involucre bracts oblong, obtuse, glabrous with pappery margins; outer florets female, fertile; disc florets hermaphrodite, fertile, yellow, tubular. Population restricted to a small area in lower Jhelum Valley, flowering tops browsed by cattle.

Habitat

Occurs in sandy, relatively loose and moist soil along the foothills in almost open sub-alpine situations.

The concept of endemism in biology dates back to De Candolle (1820). The topic, however, has received little attention of researchers in the field of modern biology. Nonetheless, endemism is one of the most important and interesting subjects in plant geography, and is useful in indicating antiquity, isolation, and diversification of habitats (Polunin 1960). Endemism may be particularly useful in the recognition of different floristic regions and also in determining or expressing the degrees in which floras are peculiar. Now-a-days endemism is considered to signify unique biodiversity and is of great significance to phylogenetic biographers, conservation biologists and ecologists. Endemic taxa are useful for developing conservation priorities. Twenty eight major endemic centres of plants are recognized in India, among them are some areas in the Kashmir Himalaya. Various estimates have been given for endemics in Kashmir flora, however, as per the latest information (Dar and Nasreen 2003), 152 (ca. 8%) taxa are endemic to this region, which forms just about 3% of the total Indian angiosperm endemics. Nonetheless, the extent of endemism in Kashmir can be appreciated by considering the fact that this region constitutes only 0.48% of the total landmass of India, is geologically younger and, among adjoining regions, has the least area per endemic taxon. Artemisia amygdalina is one of the critically endangered endemic plant species of this region. This species was last collected from this region in 1971 by Gurcharan Singh. Since then no specimen has been collected. The populations of this species have been restricted now to specific pockets, and in fact during present study the species was located from only one sub-alpine, relatively isolated and less disturbed area in the Kashmir Himalaya. The endemic nature, ethnobotanical uses, threat status, and medicinal importance of other species of genus Artemisia explored in other parts of the world inclined us to address this species.

Materials and Methods

The Kashmir University Herbarium (KASH) was searched for the specimens of Artemisia amygdalina in order to obtain information regarding collection, localities, altitudes, and other details. Likewise the relevant literature about the floristics of this region was also perused for the same purpose. During the present study (2004-2005) various field survey trips were conducted throughout the sub-alpine and alpine habitats of the Kashmir Himalaya, to locate and collect the species. For collection purposes, polythene bags, shears, tags, specimen bottles, and field-note books were used. The specimens were expelled from the soil along with rhizome (whole plant). The specimens collected for planting purpose were put in polythene bags and brought as quickly as possible to the already selected land plot in the Kashmir University Botanical Garden (KUBG) and planted there. A few flowering specimens of the species were collected separately for the purpose of identification. The specimens collected for herbarium use were processed in the laboratory of the Centre of Plant Taxonomy (COPT). These specimens were subjected to standard methods of pressing, drying, etc. and latter identified. The identification was confirmed by matching our specimens with those deposited in KASH.

Field Survey and Collection

Various field survey trips were organized during the present study throughout the sub-alpine and alpine habitats of the Kashmir Himalaya. Most of the trips actually failed and we returned empty handed. During one survey trip we happened to see a patch of Artemisia amygdalina in a less-disturbed, low-inhabited, and far off area. A dense patch of population was located along the slopes of the area, interspersed with Pinus wallichiana and Picea smithiana trees at lower places, and a few Betula utilis tree-higher up. We collected about 25-30 accessions with long runner type rhizomes which were planted in the experimental plot at KUBG.

Standardization of Propagule

Almost all of the rhizomes sprouted nicely and produced many off-shoots. The rhizomes were hard, woody, and relatively resistant to water logging providing standard propagating propagule. Later, the field trials indicated that stem segments and young shoots are also capable of propagation and multiplication of this species.

Survival and acclimatization

The collected rhizomes planted in open sunlight flourished in the experimental plot which is now densely covered due to spreading of the plants. The 25-30 accessions which were collected and planted have now multiplied to form a considerable number of individuals. From a single piece of rhizome (which at the time of collection had only one off-shoot in natural habitat) 3-6 off-shoots have been produced in the experimental plot. These off-shoots grew vigorously in the plot and attained a height of 2-3 m, and even produced inflorescence in the very first year of establishment, which is actually a rarity as much of the plants energy is used simply to survive in it's natural habitat.. Such plants usually take 1-2 years to first get established and then share resources for reproduction, even then only some species produce flowers and seeds. The acclimatization, vigorous growth, propagation, reproduction, and seed production in the very first year is thrilling. On comparing growth of the species in its natural habitat and in the experimental plot, it was found that individuals attained greater height (2-3 m) and vigorous growth in experimental plot than in the natural habitat, where height was 1-2 m, and the growth normal.

Efforts for Propagation

With a healthy and established population of plant material present in the experimental plot, we attempted to enhance the propagation of the species at a larger level. Juvenile small leafy shoots were cut carefully from the main stem and transferred to an already designed experimental setup consisting of two sets of trial pots: one set containing only simple garden soil and the second containing soil and sand mixed in 1:1 ratio. The experiment was designed to promote rooting of the off-shoots. The juvenile off-shoots were planted in these trial pots and watered, some placed in the open and some placed in the shade of the plot as well as. in the open and shaded field beds. The entire experimental setup was kept under constant observation. After about 20-25 days, several planted off-shoots in each plot were dug out carefully and checked for rooting. It was found that in each case a few thin, long, bright-white roots had developed on the underground portion. Upon comparison, the individuals in the shaded trial pots and beds showed less pace of growth as compared to those in trial pots and beds kept in open sunlight. The leaves in shaded plants were dull-colored and their stem relatively weak as compared to open-planted off-shoots.The individuals in sandy soil trial depicted rapid root formation and healthy growth, while those in garden soil rooted slowly and showed rela-

Rooted juvenile twigs of *A. amygdalina* in open trial beds

Juvenile twigs of *A. amygdalina* for rooting in shaded trial pots

Flowering specimen of *A. amygdalina* in experimental plot at KUBG

tively slower growth. Similarly, experiments were performed to make stem cuttings root and actually pace the already started mass propagation.

Reintroduction

With the success of the experiment, we now had enough material in hand to attempt reintroducing this species (in the form of various propagules) at different high altitude sites in the Kashmir Himalaya, with first reintroduction in protected sites (e,g. High Altitude Botanical Garden-Gulmarg, 2,500 m). The species is growing successfully in this site; it seems to indicate that this species will not have much trouble if transferred to natural habitat sites in the Kashmir Himalaya.

Apparent strategy of the plant

In the natural habitat of theArtemisia amygdalina, the population was observed minutely for a few months in the spring and summer seasons (2004-2005). Most of the individuals were without inflorescence, but the overall population density was higher and there appeared to be no signs of decline in the number of individuals. On further observation, it was found that the population is visited regularly by tribal people, who's cattle graze on the inflorescence of flowered individuals and no other part. The injury caused to the plant and its vital propogating parts, has continued over many years and may have led to the plant's inability to rely on propagation through seeds. To compensate, the plants have started investing more resources to their rhizomes and developed them as potential and effective means of propagation. Still propagation by seeds has not been stopped altogether, as it appears to have been kept as subsidiary means although most of the seeds produced through sexual reproduction have been found to be non viable. Perhaps the plant will stop allocating resources towards seed production if it finds that conditions are not improving.

Discussion

Artemisia amygdalina , last located in 1971, has altogether been neglected since then. This narrow endemic species may prove potentious for this region and to overall humanity as is evident from its ethno botanical importance and medicinal properties of the related species. Over the years many operational factors, such as low population size, habitat specificity, narrow distribution ranges, land-use disturbance, heavy livestock grazing, construction of dams and roads, fragmentation and degradation of populations, population bottle necks (Kala 1998, 2000; Weekly and Race 2001; Oostermeijer et al. 2003; Verger et al. 2003) have reduced the population of rare species, and A. amygdalina is no exception to this. The location and collection of this species from the Kashmir Himalaya proved like looking for needle in a heap of straw. Our most difficult, exertive, and troublesome field survey trips proved most often to be a mere failure. This may be evident that in the present study the said species was located from only one locality of the Kashmir Himalaya to date. The successful cultivation of the species in the experimental trial, resulted in standardizing methodology for mass level propagation of this species from its various organs vegetatively, which is very much unique to this species. This methodology is potentious, easy, economical, less sophisticated, adoptive and accommodative, time saving, and practical as compared to the usual modern methods (e.g. tissue culture) of propagation of RET species. It is implicative that indigenous knowledge system and traditional survival strategies should be adequately valued. The results achieved during the present study are of direct practical relevance in conservation and sustainable use of plant biodiversity of the Kashmir Himalaya. This will pave the way for the recovery, restoration and conservation of this and other economically important and critically endangered, narrow endemic angiosperms of Kashmir, thereby providing long-term backup collections for sustained use by the local populace.

Literature Cited

Briggs, J. D., and J. H. Leigh. 1996. Rare or Threatened Australian Plants. CSIRO, Collingwood. Victoria, Australia.

Chaurasia, O. P., and B. Singh. 1996. Cold desert Plants. Volumes I-IV. Field Research Laboratory, Defense Research and Development Organization, Leh, India.

Council of Scientific and Industrial Research (CSIR). 1989. The wealth of India: raw materials. Publications and Information Directorate, CSIR, New Delhi.

Dar, G. H. & Aman, N. 2003. Endemic angiosperms of Kashmir: assessment and conservation, Pp. 63 (abstract) in: National seminar on recent advances in plant science research, October 12-14, 2003, Department of Botany, University of Kashmir, Srinagar, India.

Dar, G. H. & A. R. Naqshi. 2001. Threatened flowering plants of the Kashmir Himalaya-A checklist. Oriental Science 6 (1): 23-53.

De Candolle, A.P. 1820. Essai elmentaire de geographique. In: Dictionaire de Sciences Naturelles. Vol. 18. Flevrault, Strasbourg and Paris.

Gadagkar, R. 1996. Biology in the 21st Century-back to stamp collection. Scampus 98:5.

Gaur, R. D. 1999. Flora of the district Garhwal northwest Himalaya (with ethno-botanical notes). Tran media, Srinagar Garhwal, India.

Hooper, S. D., S. Van Leeuwen, A. P. Brown, and S. J. Patrick. 1990. Western Australia's Endangered Flora. Department of Conservation and management, Perth. Western Australia, Australia.

IUCN (International Union for Conservation of Nature and Natural Resources). 2002. IUCN Red List of Threatened Species. IUCN, Gland. Switzerland.

Kala, C. P. 1998. Ecology and Conservation of alpine meadows in the Valley of Flowers National Park, Garhwal Himalaya. Ph. D. thesis. Forest Research Institute, Dehra-dun, India.

Kala, C. P. 2000. Status and Conservation of Rare and Endangered Medicinal Plants of Indian Trans-Himalaya. Biological Conservation 93: 371-379.

Kala, C. P. 2002a. Medicinal Plants of Indian Trans-Himalaya. Bishen Singh Mahendra Pal Singh. Dehra-Dun, India.

Kala, C. P. 2002b. Indigenous knowledge of Bhotiya tribal community on wool dying and its present status in the Garhwal Himalaya, India. Current Science 83: 814-817.

Kala, C. P. 2002c. Paradise under fire. Down to Earth 11: 46-48.

Naredran, T. C., and P. T. Cherian. 2002. On some misconceptions on conservation of insects. Zoosprint 17 (1): 687-688.

Oostermeijer, J. G. B., S. H. Lujiten, and J. C. M. den Nijs. 2003. Integrating demographic and genetic approaches in Plant Conservation. Biological Conservation 113: 389-398.

Polunin, N. 1960. Introduction to Plant Geography and Some Related Sciences. Longmans, London.

Vergeer, P. R. Rangelink, A. Copal, and N. J. Ouborg. 2003. The interacting effects of genetic variation, habitat quality and population size on performance of Succisa pratensis. Journal of Ecology 91: 18-26.

Weekly, C. W., and T. Race. 2001. The breeding system of Ziziphus Celata Judd and D. W. Hall (Rhamnaceae), a rare endemic plant of the Lake Wales Ridge, Florida, U. S. A: implications for recovery. Biological Conservation 100: 207-213.

Book Review

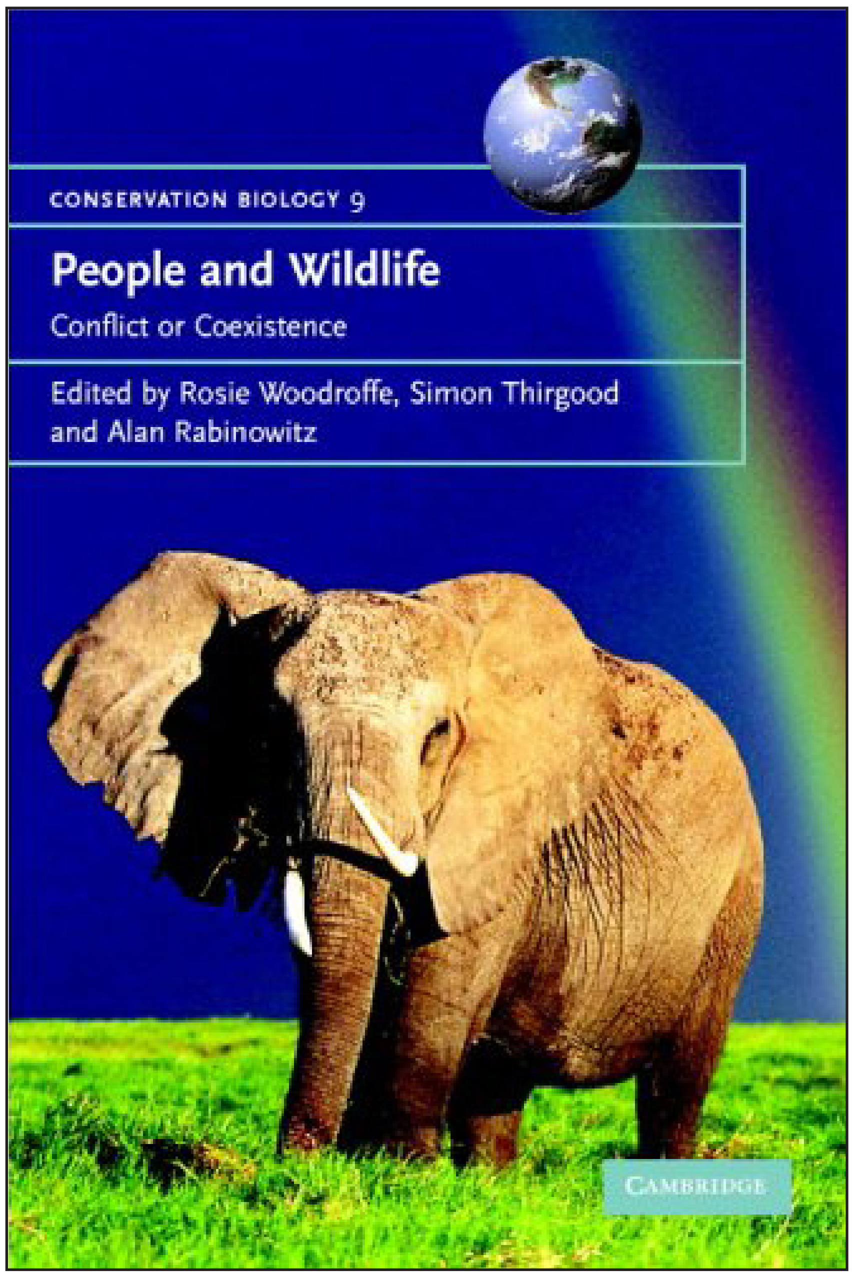
People and Wildlife: Conflict or Coexistence?

Edited by Rosie Woodroffe, Simon Thirgood, and Alan Rabinowitz. Cambridge University Press 2005

Fred Nelson

School of Natural Resources
and Environment, and the
Stephen M. Ross School of
Business
University of Michigan
Ann Arbor

fnelson@umich.edu



The essential challenge of modern natural resource conservation is how to find space on the planet for the 12-15 million species that live here in the face of increasing levels of resource consumption by a single species: humans. Although this competition for habitat and resources affects nearly all species, it is particularly pronounced for large animals, such as primary predators, that compete most directly with people and thus threaten human livelihoods. For centuries, the result of this conflict has been the displacement of wildlife and gradual extirpation of species populations. Lions, for example, ranged from southern Europe to India to the Cape of Good Hope two thousand years ago, but today survive mainly in the savannahs of east and southern Africa. The Caspian and Bali sub-species of tiger went extinct during the twentieth century, and in the continental United States wolves and grizzly bears were persecuted to nearly the same status.

Such a track record of interactions between people and wildlife can suggest that co-existence is impossible, ecologically and socially, and that the future will continue to see the gradual disappearance of more and more species. Famed photographer Peter Beard, in his classic depiction of East Africa's modern environmental apocalypse, *The End of the Game*, talks of "the shape of things to come: an elephant reaching for the last branch on a tree, a vestigial giraffe plodding out of the picture, its legs lost in mirage." More recently, David Quammen, in his renowned 2003 book on people and wild predators, *Monster of God*, concluded, "when I look into [the] future, I don't see any lions, tigers, or bears."

Is the future of wildlife conservation really this bleak? Is co-existence between people and wildlife a chimera? Is the overwhelming reality truly a zero-sum conflict battle which wildlife must inevitably lose? What conditions, strategies, and management systems best enable co-existence, and thus, conservation? This new volume, *People and Wildlife*, attempts to synthesize a wealth of global experiences and information to provide answers to these critical questions. Containing 24 chapters, nearly 500 pages, and a total of 65 contributing authors from a wide range of backgrounds and disciplines, this book is nothing if not a comprehensive treatment of the subject.

People and Wildlife combines overarching thematic discussions of key conflict areas- such as attacks on people, crop raiding, and livestock predation, with a rich set of geographically focused case studies from five continents. Two introductory chapters by the three co-authors provide a basic conceptual foundation by illustrating the two fundamental aspects of human-wildlife conflict. First, that people often cause wildlife extirpation or even extinction, such as by killing livestock predators; and second, that wildlife imposes substantial damage to people, particularly poor people in rural areas of the tropics, as a result of these same conflicts. This balanced introductory overview reflects the editors' pragmatic and honest treatment of the subject, and drives home the critical point that human-wildlife conflict must be considered from both ecological and socioeconomic viewpoints if it is to be understood and managed effectively.

Chapters 3 through 10 provide general overviews on different elements of human-wildlife conflict, including direct attacks by animals on people, crop destruction, lethal control of predators, and zoning as a mitigation strategy. Included here are three chapters that review some of the critical economic tools for wildlife management, including compensation schemes, ecotourism as a source of conservation incentives, and wildlife utilization. The latter subject is addressed by Nigel Leader-Williams and Jon Hutton, who provide a valuable overview, replete with local examples, of the potential and challenges of sustainable use management strategies for mitigating conflicts between people and wildlife. These three chapters help to illustrate how the line between co-existence and conflict is largely an economic one; animals, which continue to impose unacceptable livelihood costs on people, will not be tolerated and will disappear. The converse of that, however, is that wildlife which produces significant local economic benefits in excess of its costs is likely to be conserved and even promoted as a form of land use. As Leader-Williams and Hutton point out, this economic cost-benefit equation has driven wildlife recoveries on private lands throughout much of southern Africa over the past thirty years with the growth of profitably game ranching, tourism, and safari hunting industries.

The initial ten thematic chapters in *People and Wildlife* are all informative, thorough, and serve to build a holistic overview of the critical issues facing terrestrial human-wildlife conflict management around the globe. It is however, the thirteen case study chapters that ultimately provide the empirical richness and diversity of perspectives that makes this a valuable work. Alan Rabinowitz discusses conflicts between jaguars and livestock in Latin America, and recent efforts to collaborate actively with ranchers in Brazil's Pantanal. Ullas Karanth and Rajesh Gopal provide an ecological overview of human-tiger conflict and co-existence in India, while Dale Miquelle and colleagues discuss similar issues with respect to the Amur tiger in the Russian Far East. Elephants, perhaps the most notorious problem animal species in sub-Saharan Africa and consequently the subject of a vast array of mitigation measures, merit two chapters here. One, by Lisa Naughton-Treves and Adrian Treves examines the social context of conflicts between crop-raiding wildlife and local communities in Uganda adjacent to Kibale National Park.

In terms of a biological analysis of human-wildlife conflict, the standard-bearer is a chapter by Simon Thirgood and Steve Redpath, based on ten years of studying the interaction of hen harriers and red grouse on British moorlands used by private landowners for commercial grouse hunting. This study also illustrates the important point that in some instances the conflicts between local economic interests and predator conservation are not easily reconciled; the hen harriers do limit grouse populations, and the size of grouse populations is the critical management goal of the landowners. While many conservationists might call for stronger protections for the harriers in light of persecution from landholders, it is the profitability of grouse hunting which produces landholder incentives to maintain moorland as a form of land use, conserving biodiversity in the process. Thirgood and Redpath note that rather than enacting stricter harrier protections, conservation of these raptors may best be served by loosening restrictive laws and allowing active limitation of harrier numbers on grouse moorlands in order to encourage landholders to adopt more flexible conflict mitigation strategies.

If the fortunes of any species are cause for hope that co-existence between predators and people is feasible, albeit far from easy, it is those of the wolf in the United States during the past thirty years. Since the 1970's, wolves have expanded in the Midwest from their holdout in Minnesota to significant populations in both Wisconsin and Michigan. In the Northern Rockies, the reintroduction of wolves to Yellowstone National Park and Idaho in 1995-96 has played out as one of the most successful efforts in the country's recent conservation history. Writing from the perspectives of on-the-ground wolf managers, Ed Bangs and colleagues review the experiences of wolf-human conflict in the Northern Rockies following the reintroductions a decade ago. They emphasize the importance of culturally laden perceptions, values, and biases in determining attitudes towards wolves and in framing of conflicts. Since their return to the region, wolves have caused relatively little direct economic damage through livestock predation, particularly when compared to the impacts of other species such as coyotes, but nevertheless wolves remain a flashpoint of political controversy and conflict. The lesson, these authors suggest, is that conflict must be managed not only out on the range but within society's collective and individual minds, and mitigation must not only prevent negative economic impacts from wolves, but must respond to and be conscious of the political sensitivities and values of key stakeholders if the co-existence of people and large predators is to be sustainable.

Richard Reading and colleagues make a similar point about conservation's social and political dimensions in relation to the black-tailed prairie dog, which unlike the wolf continues to see its fortunes decline in the face of entrenched antipathy from the livestock ranching community. What defines conflicts in these cases is not necessarily ecological facts (there is little point in trying to persuade ranchers that prairie dogs do not degrade livestock forage if rancher culture is committed to the belief that they do) but in working collaboratively to recognize the different values and interests of different actors, and to work with them to develop acceptable management strategies.

Reflecting similar social and political sensibilities, David Western and John Waithaka, both formerly of the Kenya Wildlife Service, broaden the discussion further still by exploring the evolution of human-wildlife conflict, and policies to address it, over the past three decades in their country. They describe long-standing calls within policy-making circles to deal with these conflicts by devolving management of wildlife to the local level, so that rural communities and private landholders can best make decisions about how to manage wild animals which are destructive yet highly valued in terms of tourism and hunting enterprises. This approach has however been stymied by political obstacles, particularly a 1977 ban on all forms of hunting in Kenya which persists to this day. Without fixing these political and policy problems, there is little chance of solving human-wildlife conflict in a durable way.

All of these case study chapters contain compelling stand-alone material; assembled together as they are here, they comprise a complex and engaging mosaic of lessons and experiences. The co-editors attempt to synthesize the key points and principles from both thematic and case study chapters in a relatively brief conclusion that returns to the tensions over co-existence. They note that, despite the prevalence of human-wildlife conflict, and the fundamental challenges that these conflicts pose for wildlife in an increasingly crowded world, there is plenty of evidence that co-existence between people and large, predator wildlife species is indeed possible. Moreover, they remind us that if we are to have any hope for conservation, there is no alternative to co-existence of people and wildlife in the same landscapes. National parks or other protected areas that attempt to provide refugia for wildlife and keep people outside, while an invaluable part of any long-term conservation strategy, can never be sufficient to sustain wildlife populations, most of which exist outside parks or at least range far across their boundaries. Here, as ever, these authors are pragmatic and realistic, and eschew any of the polarized rhetoric that characterizes recent debate over the appropriate conservation roles of protected areas, on the one hand, and private or local community management, on the other.

Rather, the authors make the only conclusion that seems plausible based on the diverse material in *People and Wildlife*, which is that effective conflict mitigation requires a range of flexible, locally adapted, and integrated strategies. This may involve zonation, lethal control of predators, sustainable utilization policies, devolution of ownership rights, collaborative stakeholder-based management processes, financial incentives such as landholder payments, or compensation for the loss of crops, livestock, or even human life. Many management systems will inevitably employ several of these strategies in combination, and through experimentation and adaptive management, the efficacy of different tactics can be determined over time. The authors emphasize the importance of this flexible and experimental approach, and reiterate that no 'silver bullet' conflict mitigation strategies exist. They also highlight the need for more and better quantitative analysis of the impacts of different strategies in order to help managers hone their strategies over time.

People and Wildlife is a rich and skillfully assembled collection which will be of value to a diverse audience, including natural resource management practitioners and managers, policy-makers, and conservation students and scholars. Many researchers will undoubtedly find topics of particular interest or applicability within one or two chapters, although for most practitioners I would strongly recommend reading all or most of the case studies in order to capitalize on the diverse perspectives and conclusions that emerge from them. It is, it should be said, a synthesis collection, and for those with extensive familiarity with global wildlife management issues there may be little novel here, save perhaps for a few case examples here and there. Nevertheless, *People and Wildlife* is a valuable addition to understanding contemporary wildlife management challenges in an integrated and practical manner. It will help a diverse range of local and international actors in the elusive but attainable search for co-existence between people and wildlife. The game is not over yet.

Literature Cited

Beard, P. 1988. *The End of the Game*. London: Thames and Hudson Ltd.

Quammen, D. 2003. Monster of God: The Maneating Predator in the Jungle of History and the Mind. New York: W.W. Norton & Company.

News From Zoos

Gentoo Chick Hatches at Newport Aquarium

The American Zoo and Aquarium (AZA) Association-accredited Newport Aquarium had reason to celebrate in December of 2005, with the rare hatching of a gentoo penguin chick. Like most penguins, gentoos are difficult to breed in captivity. Only 20 institutions worldwide exhibit the species and the Newport Aquarium was one of only five U.S. institutions to successfully breed gentoo penguins in 2005. As in the wild, the penguins are sensitive and require near perfect conditions to hatch. A successful birth shows that the aquarium has created an environment that will promote captive breeding of this rare animal.

Gentoo penguins are found in the wild on many islands near Antarctica and are currently classified by the IUCN as near threatened due to habitat loss, human disturbance, and pollution. Standing between 30 and 35 inches tall, the gentoo is also the fastest underwater swimming penguin, reaching speeds of up to 22 mph. The success of the movie March of the Penguins has heightened public interest in the species, and this chick is serving as a valuable conservation ambassador for her wild counterparts by allowing visitors to appreciate and value the species in a whole new way by actually seeing, smelling and hearing a real live penguin in Newport, Kentucky.

Pittsburgh Zoo Purchases Land for Future Elephant Breeding Center

The AZA-accredited Pittsburgh Zoo and PPG Aquarium is planning to construct an International Conservation Center that will serve as a breeding ground in North America for African elephants. The 724 acres of land for the breeding facility, previously used as a hunting preserve, were purchased for $2.2 million. There are plans for a large barn and exercise arena at the facility to hold the elephants in the winter months. Pittsburgh already owns one of three breeding African elephant bulls in the country; the new facility could hold up to five bulls and 20 elephants total. The ability to house additional bull elephants will be an encouraging step forward for captive breeding. About 174 African elephants currently live in North American institutions. Without an increase in captive breeding, experts estimate that in 40 years there will only be about 50 African elephants remaining in the US. Having zoo elephants serve to promote conservation for their wild counterparts is important, as populations in Africa have dropped from 1.3 million to about 400,000 since 1980. These factors have created an ideal niche for Pittsburgh's International Conservation Center.

The Zoo also intends to utilize the Center to expand its work in support of other endangered species, including cheetahs, black rhinoceros, African wild dogs, and Grevy's zebras. Breeding at the facility is expected to begin in approximately two years.

Seven Endangered Hawaiian Palila Released

Seven palila (Loxioides bailleui), critically endangered honeycreepers native to Hawaii, were recently released into the wild. They were raised at the Keauhou Bird Conservation Center and released into the Puu Mali Forest Reserve on Mauna Kea. Twenty-two palila have been released into the Mauna Kea Reserve since 2003. Both the Keauhou center and the Maui Bird Conservation Center were established in 1996 as part of the Hawaiian Endangered Bird Conservation Program (HEBCP), which is part of the AZA-accredited San Diego Zoo's department of Conservation and Research for Endangered Species (CRES).

The HEBCP is working to recover 22 endangered bird species in Hawaii. Other endemic Hawaiian species that are being propagated and managed in captivity at the two breeding centers, and which may soon become part of the release efforts, are the Maui parrotbill, the Hawaii 'akepa and creeper, the nene, and the 'alala.

SeaWorld Celebrates Birth of Sex-selected Dolphin

With the innovation of technologically advanced sperm-sorting processes, the Atlantic bottlenose dolphin is one of the first zoo animals to be bred for a specific sex. Through sex-selection technology pioneered by the company XY Inc., AZA-accredited SeaWorld San Diego was able to artificially inseminate one of their female dolphins with a previously sorted mixture of X chromosome sperm. In October of 2005, a baby female dolphin was born. While data are not conclusive that the sex selection process was solely responsible for the female calf, it points strongly to the possibility that sex-selection technology is right around the corner for some species managed in American zoos and aquariums.

Why sort animal sperm prior to artificial insemination instead of letting nature run its course? The answer lies in providing the most socially appropriate management for AZA zoo and aquarium species. For example, wild dolphins tend to form female pods, while adult males travel alone or in small groups of other adult males. This makes it easier for zoos and aquariums to house more females than males. The situation is similar with elephants, where females travel in matriarchal herds. Sex-selection techniques will make it possible to sustain larger, more viable populations of animals in social situations similar to those in the wild. SeaWorld's newest baby girl provides hope for the future success of sex-selection techniques for all captive species.

White-winged Guans Reintroduced to Chaparri Community Ecological Reserve, Peru

The white-winged guan is a critically endangered bird endemic to the arid valleys of northwest Peru. The species has been decimated by hunting and there are now less than 200 individuals left in the wild. Captive birds have been reintroduced to certain areas of Peru in an attempt to re-establish the guan population over the past few years. In 2003 and 2004, the American Zoo and Aquarium Association (AZA) Conservation Endowment Fund (CEF) supported a project to increase the population and enhance community outreach at the Chaparri Community Ecological Reserve. Rob Williams of Asociación Naymlap, Fernando Angulo Pratolongo of Asociación Cracidae Peru and George Wallace of the American Bird Conservancy coordinated the project, which has made several notable accomplishments since its inception.

One goal is to establish a population of 40 white-winged guans in the reserve by 2007. Reintroduction efforts since 2003 increased the population from 11 to at least 31 birds in the reserve. The project also aimed to have four breeding pairs by 2004-2005. During this time, six pairs made breeding attempts and produced 19 chicks so far. The community outreach component of the project was equally successful; project educators disseminated 5,000 leaflets, visited 20 local schools and held an educational event that was attended by 16 local teachers. The success of this project is encouraging for future reintroduction of the white-winged guan throughout Peru.

Wolverine Kit Born at Northwest Trek Wildlife Park

On Valentine's Day 2006, the AZA-accredited Northwest Trek Wildlife Park in Eatonville, WA bore witness to the uncommon captive birth of a wolverine kit. The kit was removed from the wolverine habitat immediately following the birth and cared for by keepers to give it the best possible chance for survival. The kit is snow white, a stark difference from the dark brown coats of its parents. Wolverines are uncommon in accredited zoos; only 10 North American institutions currently house the species. Other than Northwest Trek, only the Detroit Zoo has had a surviving litter of kits in the last two years.

The wolverine is a carnivorous mammal native to the northern areas of North America and Europe; it is categorized as vulnerable on the IUCN Red List. Since the beginning of its decline in the mid 1800s, the wolverine is now found only in scattered areas of the U.S. The main causes of the species' decline are trapping and habitat loss. Wolverines have 38 sharp teeth, non-retractable claws for attacking prey, and are frequently referred to as "devil bear" or "skunk bear." Despite their wicked reputation, wolverines obtain much of their food by consuming dead animals and therefore play an important role in ecosystems.

National Zoo Kiwi birth

A North Island brown kiwi chick hatched in our nation's capital this February after a long stay in an incubator at the AZA-accredited Smithsonian National Zoological Park. This is the first kiwi chick born at the zoo since 1975 and only the second to hatch in the zoo's 116-year history. The chick hatched with its eyes fully open, but despite its developed state will not begin foraging for its own food until one week after birth. Kiwis hatch with an internal yolk sack that is slowly absorbed for energy during this time. Of the five species of kiwi, the North Island brown is the only one listed as endangered by the IUCN and is only bred at four zoos (including the National Zoo) outside of New Zealand.

The kiwi is the nocturnal and flightless national symbol of New Zealand. Unlike most birds, it has poor vision and an extraordinary sense of smell. There are currently about 25,000 kiwis in the wild, but that number is decreasing at about 4-5% per year due to predation, introduced species, and habitat decline.

AZA Florida Facilities Aid in Manatee Rehabilitation

Hundreds of manatees are found injured or sick off the coast of the southern United States each year. The specific environmental conditions necessary for a manatee's survival in the wild often necessitate that injured and sick animals be rescued, rehabilitated, and hopefully released. Rescue and rehabilitation costs are estimated at about $20,000 per manatee, and even in the best conditions not all rescued animals survive. Human threats (including boat collisions, poaching, fishing bycatch, and pollution) are responsible for approximately 30% of all manatee deaths. Fortunately for the threatened manatees, several AZA-accredited institutions in Florida and Ohio participate in manatee research, rehabilitation, or release each year. The significant number of recent manatee releases by Florida institutions is a testament to these efforts.

Four manatees from AZA-accredited SeaWorld Orlando and one from AZA-accredited Lowry Park Zoo were released back into the wild in February. The five manatees were released at Blue Spring State Park, where a spring keeps the water above 70 degrees. Winter is often a good time to release manatees back to the wild, since cold temperatures help force the animals to seek the warm water they need to survive. Over 475 manatees have been released to date, making a significant contribution to the 3,100 manatees that currently reside in Florida waters.

Ellen Trout Zoo Welcomes Louisiana Pine Snake Eggs

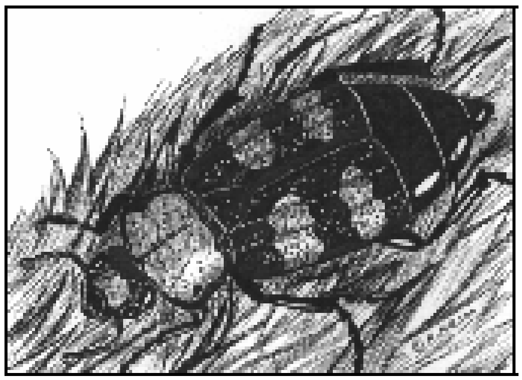
The Louisiana pine snake is one of the most endangered snakes in North America, and the AZA-accredited Ellen Trout Zoo in Lufkin, TX was recently rewarded with four eggs from their resident female Louisiana pine snake. The eggs were laid in February, each approximately four inches long and weighing between 75 and 80 grams. The pine snakes' eggs are relatively large, but this is a necessary adaptation because the species feeds exclusively on pocket gophers. The babies need to be 1.5 to 2 feet long upon hatching in order to eat the gophers. The Ellen Trout Zoo's eggs are currently sitting in glass jars in a temperature-controlled room on a mixture of water and vermiculite that mimics the ground they would be buried under in the wild. The eggs will remain here while they harden and hatch over the next two months.

In addition to captive breeding, a number of AZA institutions have conducted field projects to better understand the species. In 2003, the Memphis Zoo performed a census and analysis of pine snakes and Baird's pocket gophers to aid in improved management and conservation. Other projects include a Louisiana pine snake conservation workshop and the creation of a release program.

Louisiana pine snakes inhabit the longleaf pine forests of western Louisiana and eastern Texas. Their natural habitat also includes sandy soils that maintain an herbaceous vegetation layer through periodic burning. Their endangered status largely stems from a lack of burning in their native pine forests, leaving them with too little vegetation. Human disturbance on roads and trails is also a cause of decline.

FOCUS ON NATURE ®

Insight into the lives of animals



On a warm July night, a 1 ¼-inch, orange and shiny black **AMERICAN BURYING BEETLE** *(Nicrophorus americanus)* "smells", using his antennae, a mouse that has just died. He quickly emits a chemical to signal his mate who soon arrives to help bury the treasure before daybreak. Now working under several inches of soil beneath secluded grasslands, the pair prepares the carcass by removing the fur, rolling it into a tight ball and covering it with antibacterial secretions. The 10-30 newly-hatched larvae will feed on it for about a week while being cared for by both parents. Then, after only bones remain, the adults leave the subterranean chamber and fly away. Living only a year, they soon die. The fattened young disperse to pupate in nearby soil and emerge as carrion beetles a couple months later. *Artwork and text by Rochelle Mason* © 1999-2006 *www.Rmasonfinearts.com*

Call for Submissions

Our Mission Statement

With increased pressures on our world's plant and animal life, the success of endangered species recovery programs is more important than ever. The major downfalls faced by professionals involved in these programs, however, are based in miscommunication—scientists do not talk to policy makers and policy makers do not consult scientists. The Endangered Species UPDATE, an independently funded quarterly journal published by the University of Michigan's School of Natural Resources and Environment, recognizes the paralyzing power of poor communication. Now entering its 23rd year, the UPDATE's primary goal is to bridge the chasm between policy and science.

Call for Articles

The UPDATE is seeking articles ranging from feature articles to opinion articles to reports from the field regarding endangered species recovery and policy issues. We are currently accepting submissions for our July–September and October–December 2006 issues.

Interested authors may e-mail esupdate@umich.edu. Please see the instructions to authors or visit our website at www.umich.edu/~esupdate for more information.

Instructions to Authors

The Endangered Species UPDATE is committed to advancing science, policy, and interdisciplinary issues related to species conservation, with an emphasis on rare and declining species. The UPDATE is a forum for information exchange on species conservation, and includes a reprint of the U.S. Fish and Wildlife Service's Endangered Species Technical Bulletin, along with complementary articles relaying conservation efforts from outside the federal program.

The UPDATE welcomes articles related to species protection in a wide range of areas including, but not limited to:

-Research and management of rare and declining species;
-Theoretical approaches;
-Strategies for habitat protection and reserve design;
-Policy analyses and approaches to species conservation;
-Interdisciplinary issues;
-Emerging issues (e.g., wildlife disease ecology).

In addition, book reviews, editorial comments, and announcements of current events and publications are welcome.

Subscribers to the UPDATE are very knowledgeable about endangered species issues. The readership includes a broad range of professionals in both scientific and policy fields including corporations, zoos, and botanical gardens, university and private researchers. Articles should be written in a style that is readily understood but geared to a knowledgeable audience.

Acceptable Manuscripts

The Endangered Species UPDATE accepts several kinds of manuscripts:

1. Feature Article — on research, management activities and policy analyses for endangered species, theoretical approaches to species conservation, habitat protection, and interdisciplinary and emerging issues. Manuscripts should be approximately 3000 words (8 to 10 double spaced typed pages).

2. Opinion Article — concise and focused argument on a specific conservation issue; may be more speculative and less documented than a feature article. These are approximately 450-500 words (About 2 double spaced typed pages).

3. Technical Notes/Reports from the Field — ongoing research, application of conservation biology techniques, species conservation projects, etc., at the local, state, or national level. These are approximately 750 words (3 double spaced typed pages).

4. Species at Risk — profiles of rare and declining species, including the following information: taxonomy, distribution, physical characteristics, natural/life history, conservation status, and economic importance. These profiles are approximately 750-1500 words (3 to 6 double spaced typed pages).

5. Book Reviews — reviews should include such information as relevant context and audience, and analysis of content. Reviews are approximately 750-1250 words (3 to 5 double spaced typed pages). Please contact the editor before writing a book review.

6. Bulletin Board — submissions of news items that can be placed on the back page. These items can include meeting notices, book announcements, or legislative news, for example.

Manuscript Submissions and Specifications

Submit the manuscript to:
Editor, Endangered Species UPDATE
School of Natural Resources and Environment
University of Michigan
440 Church Street
Ann Arbor, MI 48109-1041

To submit your manuscript electronically, e-mail the manuscript as a Word file or rich formatted text (.rft) attachment to: esupdate@umich.edu.

Manuscripts should be typed, double-spaced, with ragged right margins to reduce the number of end of line hyphens. Print must be in upper- and lower-case letters and of typewriter quality. Metric measurements must be given unless English measurements are more appropriate, in which case metric equivalents must be given in parentheses. Statistical terms and other measures should conform to the Council of Biology Editors Style Manual. All pages should be numbered. Manuscripts must be in English.

Initial acceptance of a proposal or manuscript does not guarantee publication. After initial acceptance, authors and editors work closely on all revisions before a final proof is agreed upon.

Citations, Tables, Illustrations, and Photographs

Literature citations in the text should be as follows: (Buckley and Buckley 1980b; Pacey 1983). For abbreviations and details consult the Editor and recent issues of the Endangered Species UPDATE.

Illustrations and photographs may be submitted as electronic documents or as hard copies. If hard copies are submitted, the author's name and the figure number should be penciled on the back of every figure. Lettering should be uniform among figures. All illustrations and photos should be clear enough to be reduced 50 percent. Please note that the minimum acceptable resolution for all digital images is 300dpi.

Author credit instructions for each author of the article should accompany the manuscript.

Policy on Reviewing Proofs

Authors are asked to do the final copy editing of their articles. It is in the authors' power to save themselves and the journal the embarrassment of having to explain mistakes that could have been avoided.

Contents

Volume 23 No. 1 2006

School of Natural Resources and Environment
The University of Michigan
440 Church Street
Ann Arbor, MI 48109-1041