1350/1351/1352

Points of View: A Controversy in Conservation Biology

Editor's Note.—The following three papers constitute an essay by C. K. Dodd, Jr. and R. A. Seigel followed by two replies to the essay by, respectively, R. L. Burke and H. K. Reinert.

Herpetologica, 47(3), 1991, 336–350
© 1991 by The Herpetologists' League, Inc.

RELOCATION, REPATRIATION, AND TRANSLOCATION OF AMPHIBIANS AND REPTILES: ARE THEY CONSERVATION STRATEGIES THAT WORK?

C. Kenneth Dodd, Jr.[1] and Richard A. Seigel[2]

[1]*National Ecology Research Center, U.S. Fish and Wildlife Service, 412 N.E. 16th Avenue, Room 250, Gainesville, FL 32601, USA*
[2]*Department of Biological Sciences, Southeastern Louisiana University, Box 814, Hammond, LA 70402, USA*

Abstract: Conservation strategies involving relocations, repatriations, and translocations (RRT) have been carried out, are underway, or are advocated for a number of endangered and threatened amphibians and reptiles. However, recent reviews of RRT projects involving birds and mammals suggest that the success rate is low and that the factors that lead to endangerment operate to impede effective RRT results. In this paper, we review available information on RRT projects involving amphibians and reptiles, examine the motives for advocating RRT strategies, and recommend biological and management criteria that should be considered prior to undertaking RRT projects. Most RRT projects involving amphibians and reptiles have not demonstrated success as conservation techniques and should not be advocated as if they are acceptable management and mitigation practices. We urge caution in accepting claims of success and urge colleagues to publish detailed methods and results of past and ongoing RRT projects.

Key words: Amphibians; Reptiles; Repatriation; Relocation; Translocation; Conservation; Management

The concept of re-establishing populations of endangered or threatened species in areas where they have been extirpated has become extremely popular in recent years. For example, Griffith et al. (1989) reported that approximately 700 translocations or repatriations occurred each year, mainly in the United States and Canada. Variously termed "reintroductions", "translocations", and "repatriations", such programs have the laudable goal of reducing the probability of extinction by increasing the number of viable populations or increasing the number of individuals in small populations (Campbell, 1980; Scott and Carpenter, 1987). Repatriations into natural habitats are frequently combined with captive-breeding programs at zoological parks (Scott and Carpenter, 1987) and may spark wide public interest.

Despite the increasing popularity of repatriation programs as a conservation technique, serious questions have arisen about the theory behind such programs and their effectiveness (British Herpetological Society, 1983; Campbell, 1980; Conant, 1988; Griffith et al., 1989; Mlot, 1989; Scott and Carpenter, 1987; Tasse, 1989). In a comprehensive review of the success of repatriation and translocation programs for birds and mammals, Griffith et al. (1989) found an overall project success rate f 44%. They noted that success rates were pparently dependent on a variety of ecological factors, including the quality of the habitat where the release occurred, whether the individuals released were wild or captive-bred, and the feeding habits of adults.

There has been considerable recent interest in the conservation of reptiles and mphibians despite the fact that they lack he broad public appeal of birds and mammals. In the United States, Puerto Rico, and the U.S. Virgin Islands, 11 species of amphibians and 29 species of reptiles are currently on the federal list of Endangered and Threatened Wildlife and Plants, with many other species protected by state and territorial regulations. Frequently, management, conservation, and recovery plans or endangered or threatened reptiles and mphibians involve repatriation, relocaion, or translocation (hereafter referred to as RRT) programs. Such programs often become highly visible and intertwined with local political concerns. For example, relocation programs for the gopher tortoise (*Gopherus polyphemus*) have been used as mitigation allowing development of uplands habitats throughout Florida. Given he extremely limited resources (both in ime and money) available for conservation programs for reptiles and amphibians, a detailed understanding of the effectiveness of repatriations or translocations is essential (Scott and Carpenter, 1987). However, we are unaware of any critical review of the success of repatriation or translocation programs for amphibians and reptiles. In this paper, we provide such a review.

Definitions

A wide variety of terms have been used to refer to programs where animals are released into areas where they have become extirpated or rare (British Herpetological Society, 1983; Conant, 1988; Griffith et al., 1989; Mlot, 1989; Scott and Carpenter, 1987; Tasse, 1989). For the urposes of this paper, we define the rease of individuals of a species into an area ormally or currently occupied by that species as a repatriation, whereas releases of individuals into geographic areas not historically occupied by that species are termed translocations. Relocation involves moving an animal or population of animals away from an area where they are immediately threatened (e.g., by development) to an area where they would be less prone to habitat loss; ideally, relocated animals should be moved to habitats where they historically occurred, but this is not always the case.

There is considerable confusion in the literature concerning what the term "success" means in the context of repatriation or translocation programs. Because the goal of any conservation program is the establishment (or enhancement) of a viable, self-sustaining population, we follow Griffith et al. (1989) in defining a repatriation, relocation, or translocation as successful only if evidence is presented that a self-sustaining population has been established. Hence, the presence of some breeding individuals does not, in our opinion, constitute evidence for success unless it can be shown that the population is at least stable. Because many endangered reptiles and amphibians have long life spans (e.g., sea turtles, tortoises), determining the success of a given release may be difficult and time-consuming. Nonetheless, we suggest that the burden of proof is on the investigator to show that a self-sustaining population exists before declaring success; to do otherwise would be to imply that the probability for extinction has been lowered for that species, when, in fact, this may not be true.

Our review is based on published references in the open literature, unpublished references (often in the form of reports to various resource management agencies), and personal communications solicited from colleagues. We recognize that we may have missed RRT programs whose results remain unpublished.

Discussion of RRT Programs

We documented RRT programs that had been carried out for 25 species of amphibians and reptiles (Table 1). We consider the RRT programs for *Chelonia mydas* separately, but combine RRT programs

TABLE 1.—Tabulation of actual and planned RRT projects involving amphibians and reptiles. U = unknown, E = eggs, L = larvae, J = juveniles, H = hatchlings, A = adults, N = not successful, C = casual observations. Reasons for relocation failure as follows: 1 = unknown, 2 = unsuitable habitat, 3 = unsuitable developmental conditions, 4 = human predation, 5 = animals moved away from release site, 6 = mongoose predation, 7 = poor release design.

Species	Location	Stage	Success	Reproduction	Follow-up	Reference
RRT projects completed or in progress						
Amphibians						
Salamanders						
Plethodontidae						
Plethodon idahoensis	Montana	A?	U(2, 7)		U	Anon (1990)
Salamandridae						
Triturus vittatus	USSR	J	U	Y	Y	Goncharov et al. (1989)
Frogs						
Bufonidae						
Bufo calamita	England	L, U	N(1)		U	Beebee (1983); Corbett (1989)
Peltophryne lemur	Puerto Rico	J, A	U		C	Miller (1985); Paine and Duval (1985); Paine et al. (1989); Paine (personal communication)
Pelobatidae						
Pelobates syriacus	USSR	L, J	U	Y	Y	Goncharov et al. (1989)
Reptiles						
Turtles						
Cheloniidae						
Caretta caretta	Virginia	E	N(1, 3)	N	C	Dodd (1988*a*)
Chelonia mydas	Caribbean	H	N(1)	N	N	Carr (1984); Dodd (1982); Huff (1989); Parsons (1962)
	Florida	H	U	U	C	
Lepidochelys kempi	Texas	E	U	N	Y	Caillouet and Landry (1989)
Chelydridae						
Macroclemys temmincki	Georgia	H	U	U	U	Pritchard (1989)
Testudinidae						
Geochelone elephantopus	Galapagos Is.	J	U	Y	U	MacFarland et al. (1974); Bacon and Reynolds (1982); Snell (personal communication)
G. gigantea	Seychelles	A	U(4)	Y	Y	Stoddart et al. (1982); Samour et al. (1987); Spratt (1989)
Gopherus polyphemus	Southeast USA	A	U(1, 2, 4, 5)	Y	Y, N, U	Bard (1989); Burke (1987, 1989*a*,*b*); Diemer (1986, 1987, 1989); Dietlein and Smith (1979); Doonan (1986); FGFWFC (1989); Fucigna and Nickerson (1989); Godley (1989); Layne (1989); Lohoefener and Lohmeier (1986); Stout et al. (1989)
Xerobates agassizi	California	A	N(1, 5)		Y, C	Berry (1986); Cook (1983); Cook et al. (1978); St. Amant [illegible] Hoover (1980); [illegible] (1979)

Xerobates agassizi	California	A	N(1, 5)		Y, C	Stout et al. (1989) Berry (1986); Cook (1983); Cook et al. (1978); St. Amant and Hoover (1980). Weber et al (1979)

Lizards						
Cordylidae						
Cordylus giganteus	South Africa	U	U		U	Jacobsen et al. (1990)
Iguanidae						
Conolophus subcristatus	Galapagos Is.	U	U	Y	U	Snell (personal communication)
Cyclura pinguis	Br. Virgin Is.	U	U		U	Lazell (1989)
Lacertidae						
Lacerta agilis	England	A	Y, N, U(1, 2)	Y	Y	Corbett (1988); Spellerberg (1988); Spellerberg and House (1982)
Teiidae						
Ameiva polops	US Virgin Is.	A	N(6)	N	C	Dodd (1978)
Snakes						
Colubridae						
Drymarchon corais	Southeast US	A, J	U(1)		U	Smith (1987); Speake et al. (1987)
Crocodiles						
Crocodylidae						
Alligator mississippiensis	Arkansas	U	Y	Y	C?	Joanen and McNeese (1990)
Crocodylus niloticus	Nigeria	A	U		N	Morgan-Davies (1980)
C. palustris	India	J	Y		Y?	Choudhury and Bustard (1982)
C. porosus	India	H	Y		Y	Choudhury and Chowdhury (1986)
Gavialidae						
Gavialis gangeticus	India	J, H	Y	Y	Y	deVos (1984); Choudhury and Chowdhury (1986); Rao (1990)
Planned or proposed RRT projects						
Amphibians						
Plethodontidae						
Batrachoseps aridus	California					USFWS (1982)
Bufonidae						
Bufo hemiophrys	Wyoming					USFWS (1990*a*)
Discoglossidae						
Alytes muletensis	Mallorca					Tonge (personal communication)
Reptiles						
Scincidae						
Leiolopisma telfairi	Round Is.					Bloxam (1982); Tonge (personal communication)
Teiidae						
Cnemidophorus vanzoi	St. Lucia					Tonge (personal communication)

for other species. Of these RRT projects, five (19%) were classified as successful, six (23%) were unsuccessful, and 15 (58%) could not be classified although in six instances reproduction occurred. Thus, the success rate for RRT programs for reptiles and amphibians is considerably lower than for birds and mammals (44%: Griffith et al., 1989). Moreover, the success rate for reptiles and amphibians varied phylogenetically; of the five successful programs, four involved crocodilians. If projects were considered individually rather than by species, especially for all gopher tortoise RRT's, the success rate would be lowered considerably. Although reproduction may have occurred, no RRT program has yet established a self-sustaining population of snakes, turtles, frogs, or salamanders.

We recognize that some of the cases marked as "unknown" could eventually prove to be successful, such as projects involving the Aldabra and Galapagos tortoises and Galapagos land iguana. We also note that some of the cases currently listed as successful are based on limited follow-up data, and long-term studies could show that initial optimism was premature. There are few published accounts dealing with the rationale, methodology, results, and criteria for success of conservation-related repatriation, relocation, or translocation projects (but see Stubbs, 1989).

Examples of RRT Projects

In the following section, we summarize data on several representative RRT activities. While space limitations preclude a detailed summary of each actual or proposed RRT project listed in Table 1, a summary can be obtained by contacting the authors.

Bufo houstonensis.—Conservation efforts for the Houston toad have involved extensive data collection on both natural populations and the husbandry of toads in captivity. The project was begun in 1978 by the Houston Zoo to identify remaining populations and to either supplement existing populations or to start new populations in protected areas using wild adults, naturally deposited eggs, or captive-reared juveniles and adults. Ten sites at Attwater Prairie Chicken National Wildlife Refuge (APCNWR) were chosen in 1982 for [illegible] introduction, and tadpoles or juveniles were observed 6 wk after the 1982 and 1[illegible] releases. Detailed descriptions of husbandry, sites, release methods and numbers, and monitoring are contained in unpublished reports to the U.S. Fish and Wildlife Service (Quinn, 1980, 1981; Quinn and Ferguson, 1983; Quinn et al., 1984). However, despite careful laboratory and field techniques and the introduction of 0.5 million individuals since 1982 (adults, juveniles, recent metamorphs, tadpoles), not even a new population of the Houston toad has been successfully established at APCNWR (H. Quinn, personal communication).

Lepidochelys kempi.—From 1978 through 1988, freshly deposited Kemp's ridley eggs (1000–3000/yr) were transported from Rancho Nuevo, Mexico, to Texas in an attempt to establish a new nesting colony on protected Texas beach Eggs were incubated in sand at Padre Island and hatchlings were allowed to enter the water at Padre Island National Seashore to allow for possible imprinting on environmental cues. Hatchlings were then shipped to a National Marine Fisheries Service rearing facility at Galveston for head-starting. More than 17,000 hatchlings were imprinted at Padre Island, and >12,000 turtles have been released after head-starting. Details of the project, including rationale and objectives, methodology of transport, rearing, and release, numbers of turtles involved, and mortality and disease, have been outlined in a popular book (Phillips, 1989) and discussed by many papers in a symposium volume edited by Caillouet et al. (1989). The Padre Island phase of the Kemp's ridley project was terminated after the 1988 season.

Gopherus polyphemus.—The most numerous and extensive relocations and translocations of any amphibian or reptile species involve the gopher tortoise in the southeastern United States. Although thousands of animals have been moved from one area to another, particularly within Florida, in efforts to mitigate development or mining of the tortoise's remaining habitat, few details are available and these relate to only a few projects (Bard, 1989; Burke, 1987, 1989*b*; Diemer, 1986, 1987, 1989; Doonan, 1986; Fucigna and Nickerson, 1989; Stout et al., 1989). Additional animals have been released into populations from which they did not originate after use in tortoise races (e.g., Dietlein and Smith, 1979), although this practice now has ceased. Other efforts have sought to establish populations in areas that may be outside the historic range (e.g., in the Fall Line Hills of Alabama), in isolated locations at the limits of the species' range (e.g., in Tangipahoa Parish, Louisiana), or in reclaimed phosphate mines (Godley, 1989).

Diemer (1989) reviewed relocations of gopher tortoises that occurred in Florida prior to 1987. Details were provided on nine additional relocations at a 1987 symposium sponsored by the Florida Game and Fresh Water Fish Commission (Burke, 1989*b*; Fucigna and Nickerson, 1989; Godley, 1989; Layne, 1989; Stout et al., 1989). Four studies followed tortoises 2 yr or less. Each of the four short-term relocations involved moving a group of tortoises from one or more sites to one or more different sites. Generally about 50% of relocated tortoises remained within 0.5 km 1 yr after release.

Additional details are available from two studies reported at the 1987 symposium. Burke (1987, 1989*b*) reported that 35 of 85 relocated tortoises in south Florida remained 2 yr after relocation, an "apparently stable population". Although his study was of short duration, Burke (1989*b*) concluded that tortoises could be relocated "fairly successfully" and that his work did not support social factors as influencing success rate. In a central Florida relocation (Bard, 1989; Doonan, 1986), two of 12 radio-tagged tortoises could be accounted for after 41 mo while only three of 30 non radio-tagged animals were ever recaptured after release. Seven relocated tortoises were recaptured on 11 occasions compared with 144 captures of resident tortoises on 188 occasions.

Until 1990, moving tortoises from one area to another was accepted as a conflict mitigation measure, especially for Developments of Regional Impact (DRI's), by the State of Florida, particularly in the rapidly growing central and southern regions of the state. Between 75 and 100 relocations, involving thousands of tortoises, have occurred or been authorized (D. Wood and J. Diemer, personal communication). Details concerning these relocations are unknown.

Lacerta agilis.—After a severe fire on a nature reserve in 1976, surviving sand lizards were collected. In 1978, they were moved to an outdoor vivarium. In 1981, the vivarium held a breeding colony, the purpose of which was to furnish animals for eventual reintroduction to the burned area (Spellerberg and House, 1982). Lizards were released in 1981 and recolonized the burned area. By 1988, the heathland community had recovered and sand lizards were again prevalent (Spellerberg, 1988). Details concerning follow-up sampling or lizard numbers were not presented. Other relocations and translocations of this species have occurred throughout southeastern England (primarily Dorset), and more recently in northwestern areas, for at least 20 yr. However, little information appears in the literature concerning specific details. Four populations from releases 17 yr ago continue to survive: one survives after 13 yr, two survive after 5 yr, and only two have disappeared because of fire (Corbett, 1988). A population in the Inner Hebrides continues to survive 14 yr after establishment although this area is outside the known distribution and climatic requirements for the species (Corbett, 1988).

Crocodilians in India.—Relocation efforts in India have been summarized by de Vos (1984) and Choudhury and Chowdhury (1986), including discussions of objectives, criteria for relocation, problems, and the need for monitoring the release. However, specific data on individual reintroductions and the long-term status of introduced animals is unavailable.

More than 1000 muggers (*Crocodylus palustris*) have been reintroduced in 22 locations as of 1986. As of 1986, 1022 saltwater crocodiles (*C. porosus*) had been reintroduced in India in five locations

(Choudhury and Chowdhury, 1986). Reintroduction of both species is thought to be successful.

The reintroduction of gharials (*Gavialis gangeticus*) to areas where they had been eliminated or severely reduced is touted as a major conservation achievement in India. As of 1986, 1456 gharials had been released in eight locations (Choudhury and Chowdhury, 1986). Specific details are available only for the reintroduction at the National Chambal Sanctuary where monitoring has been conducted since 1975 (Rao, 1990). In 1988, 50 nests at 15 sites were reported, and the nesting population was estimated at 50 animals (Rao, 1990). A total of 1287 captive-raised gharial have been released in the Chambal River, and the total population estimate based on 1987–1988 surveys was 804.

Why Is Moving Animals So Popular?

Because the success rate of RRT movements for conservation-related purposes is not very high, the reasons for advocating such efforts as conservation strategies should be examined. We suggest the following reasons may help to explain the advocacy of RRT movements as conservation practices, and we recommend a change in attitudes concerning these practices.

Good publicity.—Moving animals from one area to another for what promoters describe as conservation-related purposes, particularly popular species such as sea turtles and tortoises, creates favorable media attention and publicity. Media attention in turn can be used to increase the public's awareness of problems facing the species and perhaps generate funding for other less public activities such as land acquisition and basic research. However, the "30-second spot" or short newspaper story may create a false positive image for the non-involved public, affected individuals (e.g., land developers or home owners), advocacy groups, and even land managers and agency administrators. The result is a belief that such movements are a proven conservation strategy that benefits the individual animal and species. Critical examinations of relocation results and consequences are rarely part of media coverage. From a cynical point of view, positive public perception of the success of human-mediated animal movements may be desirable if alternatives are difficult to undertake or costly (see Political concerns below).

Some relocations are successful.—There have been successful conservation related RRT movements involving amphibians and reptiles (Table 1), for example, among crocodilians and for the sand lizard in Britain. Although there is not much information in the published literature, crocodilian biologists have exchanged unpublished information on relocation and reintroduction techniques through correspondence and attendance at the meetings of the Crocodile Specialist Group of the International Union for the Conservation of Nature and Natural Resources. Likewise, conservation groups in England are closely situated to exchange information on sand lizard relocations. Exchange of information has undoubtedly facilitated the success of these efforts.

Perceived successes.—Perceived successes result from inadequate information presented to the general public, inappropriate extrapolation of results from one study to other taxa, and premature reports of success.

Some individuals and organizations (e.g., Tasse, 1989) have advocated RRT movements as a conservation strategy based on limited success in a few species: for example, the Arabian oryx repatriation or the rock wallaby translocation from Australia to Hawaii. We believe such advocacy is naive and ill-informed. If two species have similar biological requirements and evolutionary history, extrapolation of the results from one taxon to the other may be initially justified. However, we do not recommend the automatic acceptance of positive results on one species as a substitute for critical experimentation and long-term monitoring of the related species. The recent publication of critical examinations of movement-related management of a wide variety of birds and mammals should serve as a caution for even within-taxon extrapolation of results (Conant, 1988; Griffith et al., 1989).

Of greater concern to us, however, is the premature claim of "success" by researchers involved with RRT movements. For instance, we fail to understand how a 50–60% desertion rate by gopher tortoises relocated in south Florida, surrounded by urban development and monitored for only 2 yr or less, can be heralded as a success and proof that relocation works (Burke, 1989*b*). Such claims give credence to the perception that RRT movements are proven management strategies that can be used to mitigate questions of habitat loss. In turn, this perception undermines efforts to protect existing habitat and appears to provide an easy way out of difficult land use questions. Until long-term studies have demonstrated otherwise, human-mediated movements of amphibians and reptiles should not be taken as proven conservation strategies, but only as experimental strategies designed to fit specific needs. Researchers should temper their claims of success with a recognition of the need for long-term evaluation. If they do not, editors should.

Lack of information on failures.—We suspect one of the most likely reasons human-mediated movements of animals for conservation purposes are continually proposed is the lack of information on what has been attempted in the past. Information on criteria for RRT movements, techniques, and results are very difficult to obtain for most studies, even those claimed as "successes". Data on negative results are virtually impossible to find. Perhaps the reasons for failure of most RRT movements are unknown. However, we consider it essential that both positive and negative results be made available in accessible sources if mistakes are to be avoided in the future.

Political concerns.—Relocation has been advocated in areas where rapid development is occurring, particularly involving tortoises in south and central Florida. Moving animals rather than killing them during construction would seem to be a humane way of dealing with problems related to habitat loss. However, most relocated or translocated animals move off the relocation or translocation site, and long-term studies have yet to demonstrate the effectiveness of these techniques. *When* the animals die becomes more important than *if* they die. In addition, commensals and other less glamorous members of the threatened community often are not considered. Rather than creating within-habitat protected areas or dealing with the larger issues of habitat protection in rapidly growing areas, relocation allows an expedient answer to a crisis demanding immediate attention. As such, relocation and translocation efforts have become the "cost of doing business" rather than well thought out strategies for effective conservation.

Humane considerations.—Concern for the fate of individual animals has sparked interest in moving them from harm's way. Concern is shown generally for the larger and more charismatic or benign reptiles, particularly tortoises, although humane reasons are sometimes used as a justification for relocating crocodilians or smaller species. Relocating animals for humane considerations can be used to foster interest in nature and involve individuals, especially young persons and the elderly, in active participation in conservation issues and activities. However, animals relocated for humane reasons should be released in accordance with the same scientific principles that guide other relocations and translocations.

Self-interest.—We have received reports that a few consultants have promoted relocation not as a measure to mitigate habitat-related conflicts, but because they want to make a large profit from the relocation. Rumors exist of consultants charging clients exorbitant fees for relocations of tortoises in south Florida (G. Dalrymple, personal communication). While we believe that most consultants operate within professional and ethical guidelines, reasons for relocating amphibians and reptiles should not be based solely on the profit to be made from the relocation. Consultants should ensure that scientific principles guide the relocation and that provisions for the long-term survival of the relocated animals are in place prior to relocation.

Recommendations

In addition to the recommendations we have made in the preceding text, the topics discussed below should be addressed prior to advocating or undertaking RRT projects for conservation purposes. Lack of clearly defined objectives, methodology, measures of success, and provisions for long-term follow-up studies is an indication of a project likely to fail. In addition, we cannot over-emphasize the need to publish the results of RRT experiments in appropriate journals. The methodology and results of both successful and unsuccessful RRT experiments need to be presented in detail to ensure that future efforts benefit from past experience. Unfortunately, it is our experience that seemingly obvious questions often are not asked during the planning stages of RRT projects.

Know Causes of Decline

A sound recovery plan for any species should start with a detailed understanding of what caused the species to become endangered or threatened. Consequently, RRT programs should only be attempted if (a) the causes of the original decline are reasonably well understood, and (b) those problems have been eliminated. In several cases, an understanding of why the species became endangered or threatened was not apparent (e.g., *Bufo houstonensis*, *Peltophryne lemur*) or was ignored (e.g., *Ameiva polops*), and these RRT programs have not been successful.

Know Biological Constraints

Although intuitively obvious, the need for RRT projects to operate within the biological constraints imposed by the species must be re-emphasized. Several projects have failed, at least in part, because of lack of attention to the biological requirements of the species (Beebee, 1983; Berry, 1986; Dodd, 1988*a*). Biological constraints to conservation are those factors that set the limits within which human-mediated actions can be taken: i.e., they comprise the animal's life history requirements. These include habitat, demographic, and biophysical components. Various authors have discussed the need to consider the biological and habitat requirements of herpetofaunal species in specific RRT projects (e.g., Bloxam, 1982; Berry, 1986; Diemer, 1989).

Habitat constraints.—We refer to habitat constraints as the physical characteristics, both macro and micro, that influence a species' presence. These include sufficient space for feeding, reproduction, cover, and social interaction of all life stages; space to allow for a population sufficiently large so that environmental fluctuation and demographic stochasticity do not lead to extinction (Soulé, 1983); food of proper nutrient content and availability, especially for herbivores; habitats free from adverse disturbance, especially from that related to human activity, roads, and predation or modification by introduced, feral, or domestic animals (especially dogs, cats, mongooses, pigs, and cattle); habitats designed to minimize "edge effects"; habitats without unnaturally large concentrations of natural predators, such as raccoons and ravens; and habitats free of toxic pollutants. Appropriate habitats should be available for all phases of the life cycle.

In addition to the size and disturbance factors above, the proper habitat must be available in sufficient quality. Factors to be considered include vegetative structure (e.g., important for gopher tortoises and many lizards), friable soils (for digging species), moisture requirements and access, access to dispersal agents (e.g., offshore currents for sea turtles), and access to symbionts (e.g., bacteria to aid gut fermentation in herbivorous species).

For wide ranging species, corridors for dispersal or migration (Harris, 1988; Harris and Gallagher, 1989) should be factored into the selection of RRT sites. Active management should be planned for RRT release sites (Griffith et al., 1989), but we caution that single species management may have detrimental effects on other sensitive species and should generally be avoided.

D. ...graphic constraints.—Population ...istics of both the released animals ... animals already on-site, if any, ... be considered prior to undertaking RRT projects. Factors include knowledge ... both the age and size structure of af...ted animals, sex ratios, and social structure. Social structure must be considered ... terms of mating system, spacing and ...ment patterns, and cannibalism.

...ysical constraints.—As ecto... amphibians and reptiles have ther... ...uirements not common to endo...s. RRT projects should consider ...ecialized biophysical requirements, es...ecially to ensure the presence of undis...urbed basking sites. Amphibians and rep...les also need a proper environment for ...g development (temperature, moisture, ... exchange, waste excretion, pH, ion ... ...ration). For species with environ... ...x determination (ESD), sex ratios ... affected by the location of nest ... and season of deposition (e.g., Mro...ky et al., 1984; Mrosovsky and Pro...ncha, 1989; Vogt and Bull, 1984). ESD ...hus affects existing and future population ...ructure. Many reptiles have ESD (Deem...ng and Ferguson, 1988), especially those ...ted for RRT projects (crocodilians, ...).

...s habitat, demographic, and bio... ...l requirements of species are care... ...considered, RRT success will be ran...om and most likely to fail. We recommend that thorough knowledge of a ...ecies' life history requirements be a pre...equisite to the adoption of RRT strategies. The lack of information on the life histo... ...f amphibians and reptiles, especially ... ...ent geographic regions, emphasiz... ...ed for basic research.

Population Genetics and Social Structure

...onservation biologists have recently ...cused considerable attention on the con...pt of the minimum viable population ... Samson, 1983; Samson et al., 1985; ...ffer, 1981; Shaffer and Samson, 1985): ... number of breeding individuals in ...ation needed to avoid possible del... ...s effects of inbreeding and loss of genetic variability as the result of drift (Simberloff, 1988). Although the exact consequences of small population size remains unclear (Simberloff, 1988), a consideration of population genetic factors is considered to be essential to successful management (Frankel and Soulé, 1981; Lande, 1988).

The RRT programs that we reviewed, with the exception of the Puerto Rican crested toad project, did not give any consideration to population genetics when planning the repatriation or translocation. Even for *Peltophryne lemur*, studies on mitochondrial DNA began long after initial repatriation attempts. Although the exact numbers of individuals used in RRT programs often are not available, in several cases (e.g., many gopher tortoise programs), the number of individuals released is clearly much smaller that the 50–500 number frequently cited as the minimum necessary to sustain a viable breeding population (see Simberloff, 1988, for a review and critique of these numbers). In addition, because many newly-released individuals do not become part of the breeding population, the actual number of animals released may need to be much higher than the theoretical effective population size. If the planners of RRT programs rejected the idea of a minimum viable population size because of a sound theoretical argument, we would have little basis for criticism. However, to neglect the subject entirely suggests either ignorance of the consequences of small population size or wishful thinking that the project may "work out" despite the small number of individuals released.

In a similar manner, we suggest that more specific attention should be devoted to the social structure of the released group of animals based on specific information from natural populations. For example, if natural populations of a species have a characteristic sex ratio, then that sex ratio should be maintained among released animals because of its potential bearing on social interactions (e.g., dominance, hierarchies, harem formation, movements away from areas). Obviously, detailed information on the life history and population ecology of the managed species is required.

Disease Transmission

There are few studies on the effects of disease on natural populations of amphibians and reptiles. However, disease may be confined to localized populations and have serious consequences, at least on a short-term basis (e.g., Dodd, 1988*b*). Of more immediate concern is the potential for introducing disease to wild populations from either captive animals released into the wild or from moving diseased animals from one population to another.

For example, disease has proved catastrophic and led, in part, to federal protection for the desert tortoise in the western Mojave Desert (U.S. Fish and Wildlife Service, 1990*b*). The disease affects the upper respiratory tract, hence the name upper respiratory disease syndrome (URDS), and combined with nutritional problems and long-term environmental stress is nearly always fatal. Preliminary work suggests that the agent is a *Mycoplasma* (Jacobson and Gaskin, 1990) that is spread from individual to individual through direct contact. URDS is common in captive reptiles (Jacobson and Gaskin, 1990), and the locations of areas where the disease was first observed suggest that it may have been introduced to wild populations from released captives.

A similar URDS has been diagnosed in the population of *Gopherus polyphemus* on Sanibel Island, Florida, and more recently near Ft. Myers and along the Tamiami Trail. While it is premature to speculate whether the disease is identical with URDS in desert tortoises, preliminary data suggest that transmission is directly from one tortoise to another, and that the disease is highly contagious and often fatal (G. McLaughlin, personal communication). Captive tortoises are known to have been released on Sanibel Island, and it is possible that the disease was introduced by a released captive. The appearance of URDS in a wild population is cause for concern, because thousands of tortoises now are routinely relocated and translocated from one area to another within Florida.

Because of the threat of disease transmission, we recommend that health checks be adopted for animals scheduled to be relocated or translocated prior to actual movement, particularly for groups such as tortoises that are known to be susceptible to contagious diseases. Release of long-term captives should always be discouraged. Health checks should include clinical evaluation using hematologic diagnosis (Rosskopf and Woerpel, 1982) by a veterinarian familiar with herpetofaunal pathology. Keeping animals in a pen or "halfway house" may increase the opportunity to observe disease problems prior to release, but may expose animals to other problems including disruption of social behavior and vandalism. Individuals from an area with known disease problems, such as Sanibel Island, should never be moved to areas where they could infect wild populations.

Need for Long-term Monitoring

There is a critical lack of information on the long-term success or failure of herpetofaunal-related RRT projects even when monitoring has been incorporated into management and conservation programs. Except for the study of gopher tortoises by Layne (1989), Aldabra tortoises in the Seychelles (Table 1), and the monitoring of crocodilian repatriation project in India, details of reputed successes, such as with sand lizards in Great Britain, are lacking.

For the other studies that we reviewed, data are either unavailable or the projects have not been monitored long enough to evaluate success or failure. We are especially critical of claims of relocation "successes" involving long-lived species where monitoring occurred for a relatively short time. For example, Burke (1989*a*) claimed relocation had no effect on existing social structure of resident tortoises, and that tortoises could be successfully relocated (Burke, 1989*b*) despite data to the contrary on related species (Berry, 1986). He monitored relocated animals for only 2 yr at the end of which only 41% of the relocated tortoises remained on the release site. Monitoring a population of an animal for only 10% of the time it takes to reach sexual maturity hardly qualifies as enough time to measure long-term relocation "success." Likewise, we suggest that claims of success involving other tortoise relocations (e.g., Fucigna and Nickerson, 1989; Godley, 1989; Stout et al., 1989) are premature and tend to foster a false impression that relocation and translocation are proven management techniques.

Long-term monitoring of marked individuals will be required to establish the success or failure of RRT projects. What constitutes "long-term" will depend on the life-history characteristics of the species. For instance, a long-term monitoring program might continue 10–15 yr for a toad, but extend >20 yr for tortoises. Such long-term monitoring will establish not only the presence of released individuals but also the success or failure of reproduction. Long-term monitoring will ensure that release sites can maintain their integrity rather than become susceptible themselves to destruction or encroachment from "edge-effects".

We recommend that RRT projects involving amphibians and reptiles should not be attempted unless provisions are made for a biologically-based, long-term monitoring program. Considerations such as duration of monitoring that are based on non-biological priorities should not eclipse the need for evaluation within the biological constraints of the species. RRT movements should be considered experimental unless long-term studies document the feasibility of the movement on the same or a related species. Periodical evaluation is important. We caution our colleagues to exercise restraint when evaluating the "success" of such movements based on short-term monitoring and data collection.

Summary

It is not our intention to belittle any of the biologists or RRT programs reviewed in this paper. We recognize that decision-making in conservation biology often is made by non-scientists or under crisis circumstances. Nonetheless, our review casts doubt on the effectiveness of RRT programs as a conservation strategy, at least for most species of amphibians and reptiles. Although RRT programs may work under certain circumstances, they should not be used unless all parties involved are prepared to make the necessary commitment for collecting baseline data, releasing animals under appropriate circumstances, providing for follow-up studies at periodic intervals, and publishing the methodology and results of the program regardless of whether the outcome is positive or negative. If such commitments cannot be made, other conservation strategies should be considered.

Acknowledgments.—We thank J. Diemer, R. Lohoefener, R. Martin, P. Moler, H. Quinn, R. Paine, R. Reynolds, H. Snell, I. J. Stout, S. Tonge, and D. Wood for information related to relocation activities. L. Close, D. Cundall, D. Formanowicz, Jr., R. Franz, R. Jaeger, and J. P. Ross provided thoughtful comments on the manuscript.

Literature Cited

(References we know to be non peer-reviewed are cited with an *.)

*Anonymous. 1990. Handled with care? Trop. Fish Hobbyist 38(10):96.

Bacon, J. P., and R. P. Reynolds. 1982. Current status of the Galapagos tortoise (*Geochelone elephantopus*) in Ecuador. AAZPA Ann. Proc. 1982: 414–423.

Bard, A. M. 1989. Resident and Relocated Tortoises: A Comparative Study in Central Florida, 1985–1989. M.S. Thesis, University of Central Florida, Orlando, Florida.

Beebee, T. J. C. 1983. The Natterjack Toad. Oxford University Press, Oxford.

Berry, K. H. 1986. Desert tortoise (*Gopherus agassizii*) relocation: Implications of social behavior and movements. Herpetologica 42:113–125.

Bloxam, Q. M. C. 1982. The feasibility of reintroduction of captive-bred Round Island skink *Leiolopisma telfairii* to Gunner's Quoin. Dodo, J. Jersey Wildl. Preserv. Trust 19:37–41.

British Herpetological Society. 1983. Herpetofauna translocations in Britain—A policy. Brit. J. Herpetol. 6:314–316.

Burke, R. L. 1987. An Experimental Relocation and Reintroduction of a Gopher Tortoise Population. M.S. Thesis, University of Florida, Gainesville, Florida.

———. 1989*a*. Effects of social structure on success of a gopher tortoise relocation in Palm Beach county, Florida. Gopher tortoise relocation symposium proceedings. Florida Nongame Wildl. Prog. Tech. Rep. 5:83.

———. 1989*b*. Florida gopher tortoise relocation: Overview and case study. Biol. Conserv. 48:295–309.

Caillouet, C. W., Jr., and A. M. Landry, Jr. (Eds.).

1989. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. Texas A&M University Sea Grant Program 89-105:1–260.

CAMPBELL, S. 1980. Is reintroduction a realistic goal? Pp. 263–269. *In* M. E. Soulé and B. A. Wilcox (Eds.), Conservation Biology. An Evolutionary-Ecological Perspective. Sinauer, Sunderland, Massachusetts.

CARR, A. F. 1984. So Excellent a Fishe, Rev. ed. Charles Scribner's Sons, New York.

CHOUDHURY, B. C., AND H. R. BUSTARD. 1982. Restocking mugger crocodile *Crocodylus palustris* (Lesson) in Andhra Pradesh: Evaluation of a pilot release. J. Bombay Nat. Hist. Soc. 79:275–289.

CHOUDHURY, B. C., AND S. CHOWDHURY. 1986. Lessons from crocodile reintroduction projects in India. Indian For. 112:881–890.

CONANT, S. 1988. Saving endangered species by translocation. BioScience 38:254–257.

COOK, J. C. 1983. Rehabilitation of the Desert Tortoise *Gopherus agassizi*. M.S. Thesis, California State Polytechnic University, Pomona, California.

COOK, J. C., A. E. WEBER, AND G. R. STEWART. 1978. Survival of captive tortoises released in California. Pp. 130–135. *In* M. Trotter (Ed.), Desert Tortoise Council, Proceedings of 1978 Symposium. Long Beach, California.

CORBETT, K. F. 1988. Conservation strategy for the sand lizard (*Lacerta agilis agilis*) in Britain. Mertensiella 1:101–109.

———. 1989. Conservation of European Reptiles & Amphibians. Christopher Helm, London.

DEEMING, D. C., AND M. W. J. FERGUSON. 1988. Environmental regulation of sex determination in reptiles. Phil. Trans. Roy. Soc. Lond. B 322:19–39.

DE VOS, A. 1984. Crocodile conservation in India. Biol. Conserv. 29:183–189.

DIEMER, J. E. 1986. The ecology and management of the gopher tortoise in the southeastern United States. Herpetologica 42:125–133.

———. 1987. Tortoise relocation in Florida: Solution or problem? Pp. 131–135. *In* M. W. Trotter (Ed.), Desert Tortoise Council, Proceedings of 1984 Symposium. Long Beach, California.

———. 1989. An overview of gopher tortoise relocation. Gopher tortoise relocation symposium proceedings. Florida Nongame Wildl. Prog. Tech. Rep. 5:1–6.

DIETLEIN, N. E., AND A. SMITH. 1979. Gopher tortoise races—What they mean to the tortoise. Pp. 181–185. *In* E. St. Amant (Ed.), Desert Tortoise Council, Proceedings of 1979 Symposium, Long Beach, California.

*DODD, C. K., JR. 1978. Island lizard in danger. Nat. Parks and Conserv. Mag. 52(8):10–11.

———. 1982. Nesting of the green turtle, *Chelonia mydas*, in Florida: Historic review and present trends. Brimleyana 7:39–54.

———. 1988*a*. A biological synopsis of the loggerhead sea turtle, *Caretta caretta* (Linnaeus, 1758). U.S. Fish and Wildlife Service, Biol. Rep. 88(14): 1–110.

———. 1988*b*. Disease and population declines in the flattened musk turtle *Sternotherus depres*[...] Am. Midl. Nat. 119:394–401.

DOONAN, T. J. 1986. A Demographic Study [...] Isolated Population of Gopher Tortoise, *Gopher[...] polyphemus*; and an Assessment of a Relocation Procedure for Tortoises. M.S. Thesis, University of Central Florida, Orlando, Florida.

FLORIDA GAME AND FRESH WATER FISH COMMISSION. 1989. Guidelines for gopher tortoise relocations. 1 February 1988. Gopher tortoise relocation symposium proceedings. Florida Nongame Wildl. Prog. Tech. Rep. 5:103–108.

FRANKEL, O. H., AND M. E. SOULÉ. 1981. Conservation and Evolution. Cambridge University [...] Cambridge.

FUCIGNA, T. E., JR., AND D. K. NICKERSON, JR. 19[...]. Relocations of two groups of gopher tortoises from Palm Beach County to Martin County, Florida. Gopher tortoise relocation symposium proceedings. Florida Nongame Wildl. Prog. Tech. Rep. 5:59–71.

GODLEY, J. S. 1989. Comparison of gopher tortoise populations relocated onto reclaimed phosphate-mined sites in Florida. Gopher tortoise relocation symposium proceedings. Florida Nongame Wil[...] Prog. Tech. Rep. 5:43–58.

GONCHAROV, B. F., O. I. SHUBRAVY, I. A. SERBIN[...] AND V. K. UTESHEV. 1989. The USSR program[...] for breeding amphibians, including rare and endangered species. Int. Zoo. Yb. 28:10–21.

GRIFFITH, B., J. M. SCOTT, J. W. CARPENTER, AND C. REED. 1989. Translocation as a species conservation tool: Status and strategy. Science 245:477–480.

HARRIS, L. D. 1988. Landscape linkages: The dispersal corridor approach to wildlife conservation. Trans. 53rd N. Am. Wildl. Nat. Res. Conf., p[...] 595–607.

HARRIS, L. D., AND P. B. GALLAGHER. 1989. N[...] initiatives for wildlife conservation. The need [...] movement corridors. Pp. 11–34. *In* G. Mackintosh (Ed.), In Defense of Wildlife: Preserving Communities and Corridors. Defenders of Wildlife. Washington, D.C.

HUFF, J. A. 1989. Florida (USA) terminates 'head-start' program. Mar. Turtle Newsl. 46:1–2.

JACOBSEN, N. H. G., R. E. NEWBERY, AND W. PETERSEN. 1990. On the ecology and conservation status of *Cordylus giganteus* A. Smith in the Transvaal. S. Afr. J. Zool. 25:61–66.

*JACOBSON, E. R., AND J. M. GASKIN. 1990. Clin[...]copathologic investigations on an upper respirator[...] disease of free-ranging desert tortoises, *Xerobates agassizii*. Rep. to U.S. Department of Interior, Bureau of Land Management, Riverside, California.

*JOANEN, T., AND L. MCNEASE. 1990. Classification and population status of the American alligator. Pp. 11–20. *In* Crocodiles. Proceedings of the 9th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of IUCN—The World Conservation Union, Vol. 2. IUCN Publ., n.s., Gland, Switzerland.

LANDE, R. 1988. Genetics and demography in biological conservation. Science 241:1455–1460.

LAYNE, J. N. 1989. Comparison of survival rates and movements of relocated and resident gopher tortoises in a south-central Florida population. Gopher tortoise relocation symposium proceedings. Florida Nongame Wildl. Prog. Tech. Rep. 5:73–79.

*LAZELL, J. D. 1989. Guana. A Natural History Guide. The Conservation Agency, Jamestown, Rhode Island.

LOHOEFENER, R., AND L. LOHMEIER. 1986. Experiments with gopher tortoise (*Gopherus polyphemus*) relocation in southern Mississippi. Herpetol. Rev. 17:37, 39–40.

MACFARLAND, C. G., J. VILLA, AND B. TORO. 1974. The Galapagos giant tortoises (*Geochelone elephantopus*). Part II. Conservation methods. Biol. Conserv. 6:198–212.

MILLER, T. J. 1985. Husbandry and breeding of the Puerto Rican toad (*Peltophryne lemur*) with comments on its natural history. Zoo Biol. 4:281–286.

MLOT, C. 1989. The science of saving endangered species. BioScience 39:68–70.

MORGAN-DAVIES, A. M. 1980. Translocating crocodiles. Oryx 15:371–373.

MROSOVSKY, N., AND J. PROVANCHA. 1989. Sex ratio of loggerhead sea turtles hatching on a Florida beach. Can. J. Zool. 67:2533–2539.

MROSOVSKY, N., S. R. HOPKINS-MURPHY, AND J. I. RICHARDSON. 1984. Sex ratio of sea turtles: Seasonal changes. Science 225:739–741.

*PAINE, F. L., AND J. J. DUVAL. 1985. The resurrected toad. Anim. Kingdom 88(5):33–38.

PAINE, F. L., J. D. MILLER, G. CRAWSHAW, B. JOHNSON, R. LACY, C. F. SMITH III, AND P. J. TOLSON. 1989. Status of the Puerto Rican crested toad *Peltophryne lemur*. Int. Zoo Yb. 28:53–58.

PARSONS, J. J. 1962. The Green Turtle and Man. University of Florida Press, Gainesville, Florida.

PHILLIPS, P. 1989. The Great Ridley Rescue. Mountain Press, Missoula, Montana.

PRITCHARD, P. C. H. 1989. The Alligator Snapping Turtle. Biology and Conservation. Milwaukee Public Museum, Milwaukee, Wisconsin.

*QUINN, H. 1980. Captive propagation/release program of the Houston toad, *Bufo houstonensis*. Final report. Unpubl. rep. to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

*———. 1981. Captive propagation/release program of the Houston toad, *Bufo houstonensis*. Final report. Unpubl. rep. to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

*QUINN, H., AND G. FERGUSON. 1983. Release program for captive-raised and wild-caught Houston toads, *Bufo houstonensis*. Progress report for work completed from February through June 1983. Unpubl. rep. to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

*QUINN, H., G. FERGUSON, AND A. N. BARRASS. 1984. Release program for captive-raised and wild-caught Houston toads *Bufo houstonensis*. Progress report for work completed through June 1984. Unpubl. rep. to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

*RAO, R. J. 1990. Recovered gharial population in the National Chambal Sanctuary. Pp. 122–143. *In* Crocodiles. Proceedings of the 9th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of IUCN—The World Conservation Union, Vol. 2. IUCN Publ., n.s., Gland, Switzerland.

ROSSKOPF, W. J., AND R. W. WOERPEL. 1982. The use of hematologic testing in diagnostic medicine: An introduction. Chelonian Doc. Ctr. Newsl. 1:30–34.

SAMOUR, H. J., D. M. J. SPRATT, M. G. HART, B. SAVAGE, AND C. M. HAWKEY. 1987. A survey of the Aldabra giant tortoise population introduced on Curieuse Island, Seychelles. Biol. Conserv. 41:147–158.

SAMSON, F. B. 1983. Minimum viable populations—A review. Nat. Areas J. 3(3):15–23.

SAMSON, F. B., F. PEREZ-TREJO, H. SALWASSER, L. F. RUGGIERO, AND M. L. SHAFFER. 1985. On determining and managing minimum population size. Wildl. Soc. Bull. 13:425–433.

SCOTT, J. M., AND J. W. CARPENTER. 1987. Releases of captive-reared or translocated endangered birds: What do we need to know? Auk 104:544–545.

SHAFFER, M. L. 1981. Minimum population sizes for species conservation. BioScience 31:131–134.

SHAFFER, M. L., AND F. B. SAMSON. 1985. Population size and extinction: A note on determining critical population sizes. Am. Nat. 125:144–152.

SIMBERLOFF, D. 1988. The contribution of population and community biology to conservation biology. Ann. Rev. Ecol. Syst. 19:473–511.

SMITH, C. R. 1987. Ecology of Juvenile and Gravid Eastern Indigo Snakes in North Florida. M.S. Thesis, Auburn University, Auburn, Alabama.

SOULÉ, M. E. 1983. What do we really know about extinction? Pp. 111–124. *In* C. Schonewald-Cox, S. Chambers, B. MacBryde, and W. Thomas (Eds.), Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations. Benjamin/Cummings, Menlo Park, California.

SPEAKE, D., D. MCGLINCY, AND C. SMITH. 1987. Captive breeding and experimental reintroduction of the eastern indigo snake. Pp. 84–90. *In* R. R. Odom, K. A. Riddleberger, and J. C. Ozier (Eds.), Proceedings of the Third Southeastern Nongame and Endangered Wildlife Symposium. Georgia Department of Natural Resources, Athens, Georgia.

SPELLERBERG, I. F. 1988. Ecology and management of *Lacerta agilis* L. populations in England. Mertensiella 1:113–121.

SPELLERBERG, I. F., AND S. M. HOUSE. 1982. Relocation of the lizard *Lacerta agilis*: An exercise in conservation. Brit. J. Herpetol. 6:245–248.

SPRATT, D. M. J. 1989. Operation Curieuse: A conservation programme for the Aldabra giant tortoise *Geochelone gigantea* in the Republic of Seychelles. Int. Zoo Yb. 28:66–69.

*ST. AMANT, J., AND F. HOOVER. 1980. Progress report on the experimental rehabilitation of captive desert tortoises. Region 5 Information Bulletin 0003-4-1980, California Department of Fish and Game.

STODDART, D. S., D. COWX, C. PEET, AND J. R.

WILSON. 1982. Tortoises and tourists in the western Indian Ocean: The Curieuse experiment. Biol. Conserv. 24:67–80.
STOUT, I. J., T. J. DOONAN, R. E. ROBERTS, AND D. R. RICHARDSON. 1989. Comparisons of results of three gopher tortoise relocations in central and southeast Florida. Gopher tortoise relocation symposium proceedings. Florida Wildl. Prog. Tech. Rep. 5:15–42.
*STUBBS, D. (Compiler). 1989. Appendix 2. Policy statements. P. 41. *In* Tortoises and Freshwater Turtles. An Action Plan for Their Conservation. IUCN, Gland, Switzerland.
*TASSE, J. 1989. Translocation as a strategy for preserving endangered species. Endang. Sp. Update 6(11–12):6.
U.S. FISH AND WILDLIFE SERVICE. 1982. Desert Slender Salamander Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon.
———. 1990*a*. Wyoming Toad Recovery Plan. U.S. Fish and Wildlife Service, Denver, Colorado.
*———. 1990*b*. Determination of threatened status for the Mojave population of the desert tortoise. Fed. Reg. 55(63):12178–12191.
VOGT, R. C., AND J. J. BULL. 1984. Ecology of hatchling sex ratio in map turtles. Ecology 65:582–587.
WEBER, A. E., J. C. COOK, AND G. R. STEWART. 1979. A second report on survival in rehabilitated desert tortoises. Pp. 101–103. *In* E. St. Amant (Ed.), Desert Tortoise Council, Proceedings of 1979 Symposium. Long Beach, California.

Accepted: 3 December 1990
Associate Editor: David Cundall

Herpetologica, 47(3), 1991, 350–357
© 1991 by The Herpetologists' League, Inc.

RELOCATIONS, REPATRIATIONS, AND TRANSLOCATIONS OF AMPHIBIANS AND REPTILES: TAKING A BROADER VIEW

RUSSELL L. BURKE

Department of Biology and Museum of Zoology, University of Michigan, Ann Arbor, MI 48109 USA

THE review of "relocation, repatriation and translocation" (RRT's) of amphibians and reptiles by Dodd and Seigel (1991) provides a summary of the literature on the use of these techniques for conservation purposes. Their recommendations are generally sound, and apply not only to these conservation practices, but equally well to any of the myriad possible techniques used to help insure the preservation of a species. However, I believe that the evidence they use for support is weak, that their dissatisfaction with past efforts is only partially justified, and thus their conclusions extreme. Basically, the question that they attempt to answer is: given that conservation dollars are always limited, are RRT's cost effective and appropriate procedures for amphibian and reptile conservation programs? They find that these techniques have been successful in only a few cases, and thus they propose a rigid set of criteria to be addressed before any future attempts are begun. My comments on their work focus on two main points: whether amphibians and reptiles are generally poor candidates for RRT's, and how success should be determined.

REPTILES AND AMPHIBIANS AS RRT CANDIDATES

As Griffith et al. (1989) did for a much larger number of studies of birds and mammals, Dodd and Seigel reviewed RRT programs for 25 species of amphibians and reptiles and found that of the 11 projects that could be defined as successful or unsuccessful by their standards, five (45%) were successful. This is slightly higher than the success rate reported for 198 RRT's reviewed by Griffith et al. Even so, the use of this type of analysis is exceedingly crude, because it assumes that snakes, lizards, turtles, crocodilians, salamanders, and anurans have comparable potential for successful RRT. Certainly there is wide variation within each order as well as between them, and anyone considering an