

The Management of Amphibians, Reptiles and Small Mammals in North America: The Need for an Environmental Attitude Adjustment¹

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My objective is to provide an overview and perspective of the amphibians, reptiles, and small mammals of North America as a group that deserves more careful consideration from an environmental management and conservation standpoint. The justification of the need for and timeliness of a careful examination of amphibian, reptile, and small mammal assemblages is based on the premises stated below. One intent is to bring the problem into focus so that both scientists and managers can identify problem areas and conjoin in an effort that will result in the management of these animals in North America in a prudent and far-sighted manner.

I offer four premises to support the contention that amphibians, reptiles, and small mammals deserve special attention with regard to management considerations:

1. Amphibians, reptiles, and small mammals are a significant and important wildlife component of the fauna in most terrestrial and freshwater habitats in North America.

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Abstract.— Amphibians, reptiles, and small mammals need special consideration in environmental management and conservation because (1) they are significant biotic components in terrestrial and freshwater habitats; (2) research and management efforts have lagged behind those on other vertebrates; (3) a stronger understanding of their ecology and life history is needed to guide management decisions; and (4) their importance has not been promoted satisfactorily to develop the proper public attitude.

2. Research and management publication efforts as well as funding have lagged behind those of many of the more obvious faunal components (e.g., game species of large mammals, birds and fishes, and many insects, because of their importance as pests).
3. The direct empirical measurements of habitat requirements, species interactions, and life history patterns needed for proper management are often lacking for amphibians, reptiles, and small mammals.
4. An attitude that amphibians, reptiles, and small mammals should be of concern in environmental management decisions has not been satisfactorily instilled among some managers, the general public, and political officials.

Support for Premises

Premise 1—Amphibians, reptiles, and small mammals are a significant and important wildlife component in North American ecosystems.

One way for a taxonomic group or species assemblage to qualify as im-

portant to an environmental manager is to be identified as making a major contribution to biological complexity in terms of species diversity, trophic dynamics, and interactions within communities. Some groups clearly have the potential for overall community influence by virtue of abundance. Salamanders at Hubbard Brook were demonstrated to have a higher biomass than other vertebrate groups (Burton and Likens 1975). The capture of as many as 88,000 amphibians in one year (SREL Report 1980) and large numbers in most years (Pechmann et al. 1988) at a 1 ha temporary pond in South Carolina suggest that they dominate the higher trophic level in some habitats. Other studies support the postulation that amphibians are often the top predators in some aquatic systems (Taylor et al. in press). Freshwater turtles represent the majority of vertebrate biomass in many aquatic habitats (Congdon, Greene, and Gibbons 1986), and their potential significance as vectors for seeds and parasites among temporary aquatic habitats has been suggested (Congdon and Gibbons 1988). Box turtles (*Terrapene carolina*) have also been implicated as seed vectors (Braun and Brooks 1987). Small rodents are noted for their impact on plant communities under certain environmental conditions (Hayward and Phillipson 1979); desert granivores affect the density, biomass, and composition of annual plants (Brown et

al. 1986). These represent only a few of the available examples for amphibians, reptiles, and small mammals; however, many more studies are needed that document the role and importance of species in these groups in enhancing biological complexity.

Another way for a group to assume importance is for it to have a direct, measurable economic value or impact. Several examples can be given of the importance of amphibians, reptiles, and small mammals from the economic perspective, but their impact has been trivial in comparison to large game mammals or insect pests, and controls and regulations have been comparatively loose. The limited economic importance of most small terrestrial or semi-aquatic vertebrates is presumably one explanation for their being given minimal attention in many management schemes. A few species such as American alligators (Joanen and McNease 1987), bullfrogs (Shiffer 1987), and snapping turtles (Bushey, no date) are commercially important as human food items. Other species assume an economic value in the legal pet trade (Conant 1975) or as research animals sold by biological supply houses (Carolina Biological Supply 1987). Some venomous snakes, especially eastern (*Crotalus adamanteus*) and western (*C. atrox*) diamondback rattlesnakes, are an economic irony in that the venom is necessary to make antivenin (Parrish 1980). Of course, such species achieve some level of importance simply by being potentially injurious. Small mammals have been indicted in a variety of situations for negative economic impacts, such as prairie dog damage (Walker 1983), rabies in bats (Constantine 1970), and grain-eating by rodents (Rowe 1981).

Another measure of importance of some species or groups is the intangible aesthetic value that some people place on them. Many species assume an undeniable importance to many people and may ultimately ac-

Table 1.—Publications on different taxonomic groups in major North American journals in general ecology and wildlife ecology. Issues from 1983-1988 were selected at random until 200 titles were chosen. Assignment to taxonomic categories was based on the appearance of study organism names in the titles. Not all papers used in tabulation were based on North American fauna. The definition of small mammals is that used in this Symposium.

JOURNAL (total)	A	R	S	L	F	B	I
(218) AMN	9	12	43	14	43	18	61
(201) ECOL	10	22	28	10	24	50	58
(213) CJZ	8	9	36	39	34	53	34
(614) Total	27	42	107	63	101	121	153
%	4	7	17	10	16	20	25
(139) HSI*	1	4	4	13	50	67	—
(204) JWM	0	2	6	103	—	93	—
(343) Total	1	6	110	126	50	160	—
%	<1	2	3	37	15	47	—

General Ecology
A = Amphibians AMN = American Midland Naturalist
R = Reptiles ECOL = Ecology
S = Small mammals CJZ = Canadian Journal of Zoology

Wildlife Ecology
F = Fishes HSI = U.S. Fish and Wildlife Service Habitat
B = Birds Suitability Index Models
I = Insects JWM = Journal of Wildlife Management

*Only 139 titles were available.

quire protected status. Legal protection of "the species" often provides protection to certain habitats. This circle of protection is a factor that can work to great advantage for those persons interested in preservation—the species is protected because it is important (aesthetic) and becomes even more important (legal) because it is protected and results in preservation of the habitat. For example, the legal status offered the desert tortoise (*Xerobates agassizi*; Luckenbach 1982) and the Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*; USDI 1980) in California or the American crocodile (*Crocodylus acutus*; Kushlan and Mazzotti 1986) in Florida serves to provide some level of environmental protection for the entire community where they occur. The protection given the black footed ferret has resulted in protection of its prey. The World Wildlife

Fund recognizes this effect in its conservation programs by designating "flagship" species such as great apes or monkeys, for which funds are more easily raised, in order to protect entire communities or ecosystems.

Premise 2—Ecological research on herpetofauna and small mammals has lagged behind that of other animal groups.

Support for the contention that the level of ecological research on amphibians, reptiles, and small mammals is lower than that of certain other animal groups can be given in several ways. These include annual publications on particular groups (table 1) and the proportion of funded grants that fall into each category (table 2).

The reasons for the lower levels of publication and funding in research on amphibians, reptiles, and small mammals are varied and in part conjectural. One seemingly obvious reason is that most species in these groups have low profile in health, hunting, agricultural, or other economic issues and therefore receive minimal attention from some quarters. The comparatively low level of attention given to small, non-game terrestrial and semi-aquatic vertebrates by certain sectors of society is reflected in lower overall funding and subsequently in fewer general publications.

Research funding is inequitable because of the emphasis on species that have important economic status; thus, the life history and ecology of even moderately abundant herpetofaunal or small mammal species are seldom understood at a level that would permit prudent management. Even those with potential economic importance receive less emphasis than many birds, large mammals, and fish. As an example, the American alligator represents a reptile species of vital concern from a manage-

ment standpoint, yet the number of publications that focus on the life history, ecology, behavior, and genetics of the species is limited (see Brisbin et al. 1985) compared to the hundreds on large mammal game species such as white-tailed deer (Halls 1984; Johns and Smith 1985).

Premise 3—The basic ecological and life history information necessary to make thoughtful environmental management decisions is often absent for many of the amphibians, reptiles, and small mammals in a community.

As indicated above, the research effort directed toward amphibians, reptiles, and small mammals by ecologists appears to be below that for other vertebrate groups. Although difficult to measure, it would also be expected that the fundamental data bases necessary for thoughtful management decisions would exist in lower proportions for herpetofaunal and small mammal species. One reason is that, compared to many large mammals, birds, and

fishes, certain aspects of field studies on many of the amphibians, reptiles, and small mammals are sometimes perceived as being more difficult because of factors such as small body or population sizes, fossorial or cryptic habits, patchy distribution, and unpredictable seasonality. Consequently, fewer papers are likely to be published in general ecology journals that expect quantitative ecological and life history research results rather than ones that are descriptive and qualitative. An exception to this may be manipulative field experiments in which small rodents have been used in almost half of the studies involving vertebrates.

The actual or apparent rarity or unpredictability of occurrence of many amphibian, reptile, and small mammal species makes it difficult or impossible for the research ecologist to gather useful data without a funding base that is accepting of the uncertainty of whether data will actually be forthcoming in a particular year. The environmental manager in turn cannot incorporate such species into a management plan, and thus their perceived importance is diminished. The unpredictability of occurrence of some species can be demonstrated with amphibians and reptiles on the Savannah River Plant (SRP) in South Carolina. In spite of more than a quarter of a century of field studies and the capture of more than half a million reptiles and amphibians across all available habitats, species previously unreported from the SRP continue to be discovered (Gibbons and Semlitsch 1988; Young 1988). Or, some species have gone for intervals as long as one decade (e.g., pickerel frog, *Rana palustris*) or two (e.g., glossy water snake, *Regina rigida*) between sightings (Gibbons and Semlitsch 1988). Clearly, developing a basic ecological field study on such species in a region is not feasible under typical funding situations.

Resolutions to the problem of garnering information about rare species include intensifying survey efforts in

Table 2.—Number of grant proposals funded by selected U.S. granting agencies on particular groups of animals.

	A	R	S	L	F	B	I
NSF (1987)	1	3	4	2	11	7	24
Sigma Xi (March 1987)	4	8	9	7	9	24	10
National Geographic (1988)	0	3	2	28	8	15	14
World Wildlife Fund (1987-1988)	0	15	0	49	0	14	1
Total	5	29	15	86	28	60	49
%	2	11	6	32	10	22	18

A=Amphibians
R=Reptiles
S=Small mammals
L=Large mammals
F=Fishes
B=Birds
I=Insects

geographic regions of interest by supporting long-term research programs that can ultimately reveal the presence of rare or fossorial species. Once a species is identified to be present in a habitat, the decision should be made on whether an ecological research effort is warranted.

Long-term studies may be necessary to reveal certain life history traits, even about common species, because of the inherent variability in some life history features that can result from natural environmental variation (Semlitsch et al. 1988). Such studies may be essential to identify the extent of variability due to annual weather patterns and climatic variation (Semlitsch 1985; Pechmann et al. 1988). Long-term research programs may be needed because some species are long-lived, or in the case of many, because the potential longevity is great but unknown (Gibbons 1987).

For many species that have economic value (e.g., snapping turtle, *Chelydra serpentina*; Congdon et al. 1987), the impact of harvesting has not been properly assessed. Because of the limited baseline ecological and life history data for most species, a priority goal should be the establishment of a moratorium on the wholesale removal of all native species of amphibians, reptiles, and small mammals until it can be verified that regional populations can sustain the removal rate. State permits should be required of, and possession limits should be set for, all commercial collectors for all species of amphibians, reptiles, and small mammals.

Today's emphasis should be on protection of each species until convincing evidence is supplied that harvesting has no long-term impact, rather than placing the burden on herpetologists and mammalogists to demonstrate population irreversibility before harvesting is discontinued. The negative consequences of the latter, and current, approach (i.e., demonstrating the impact of removal while harvesting is in progress) is

that some populations will be reduced to the point of no recovery before the necessary evidence can be collected. Each species should be protected until proven harvestable. The appropriate basic research should be conducted by scientists with no economic or emotional investment in the outcome. Research support should be provided by state or federal agencies and by special interest groups that have no influence over the final management decisions. The ideal approach is that scientists would gather the facts and that environmental managers would interpret them in the context of harvesting quotas. The development and use of predation (Holling 1966) or harvest (Ricker 1975) models may be effective approaches for addressing the issue of human predation (i.e., harvestability by man).

One area that deserves attention in strengthening the study of small terrestrial or semi-aquatic vertebrates is the use of innovative techniques to address physiological, ecological, and behavioral questions under natural conditions. Non-destructive field sampling techniques are critical in the study of both rare and endangered species but are also important for preserving the integrity of any study population. These include techniques for capture, field identification of individuals, non-disruptive handling or observation, recapture, and the acquisition of non-destructive physiological, genetic, behavioral, and life history data. Some examples include radiography (Gibbons and Greene 1978) or sonography for determination of clutch sizes, blood sampling for genetic and hormonal analyses (Scribner et al. 1986), and cyclopropane for measuring lipid levels (Peterson 1988). A broader use of such techniques in field studies could strengthen the foundation of ecological and life history understanding that is necessary for environmental management.

A direct contribution to environmental managers could be achieved

by attempts to verify the several amphibian, reptile, and small mammal Habitat Suitability Index models of the U.S. Fish and Wildlife Department. The concept has the potential value of providing an initial quantitative approach that gives a tangible product. However, to be of greatest value, the HSI models must be evaluated and modified as appropriate. It is perhaps noteworthy that the HSI models prepared for amphibians (1), reptiles (4), and small mammals (4) collectively represent only 6% of the 139 that have been completed on vertebrates (table 1). For these to become an effective tool in management of herpetofauna and small mammals, more herpetologists and mammalogists need to volunteer to develop HSI models for these groups.

A distinction must be made between (1) problem oriented applied research on specific systems that relies on qualitative assessments or indirect measurements of variables with minimal inference power and (2) basic research that is founded on quantitative or direct measurements of variables, has a conceptual or theoretical base or orientation, and can be strongly inferential through general field or laboratory experiments. The latter approach will be necessary if environmental managers are to have a reliable data base that is founded on broad applicability, levels of predictability, and clear directions for future research.

Premise 4—The attitude of most people in North America toward most amphibians, reptiles, and small mammals is either negative or neutral, in part because efforts to develop an attitude change have been insufficient or ineffective.

Although documentation is difficult, it would appear that in North America we are far from a suitable acceptance level toward these groups of

organisms. People still try to run over snakes on highways, have little awareness that many conspicuous predators rely on small mammals for their basic diets, and give no thought to how many small vertebrates will be eliminated by the draining of a swamp or damming of a stream. I think the situation is an embarrassing one for the scientists and general public of a nation that espouses education and knowledge.

Evidence that a more positive attitude and less environmental leniency has developed over the last several years is the recent federal listings of snakes (e.g., indigo snake, *Drymarchon corias*; San Francisco garter snake, *Thamnophis sirtalis tetrataenia*) and small rodents (e.g., Utah prairie dog, *Cynomys parvidens*; salt marsh harvest mouse, *Reithrodontomys raviventris*; Key Largo cotton mouse, *Peromyscus gossypinus allapaticola*) as protected species. However, many of the listings involving amphibians, reptiles, and small mammals have been hard fought ones against public and political opinions that such species hardly deserve such concessions. The failed efforts at protection far outnumber the successful ones. The attitude that these animals are unimportant is pervasive throughout the general public, politicians, and even some environmental managers. The basic responsibility for eliminating ignorance and effecting the proper environmental attitude adjustment must start with the scientist.

It is my firm opinion that many scientists have lost sight of who their patrons are (for most of us, the U.S. taxpayers) and of their responsibility to communicate findings to all levels of society. This communication process entails a level of cooperation and an educational spirit that allows each individual to contribute in the most effective manner. However, we must all accept and work toward the common goals of establishing a thorough and general foundation of ecological information for amphibians, reptiles, and small mammals and of being

generous in the distribution of the findings in a form palatable to and usable by the intended audience.

Conclusions

An environmental attitude adjustment model must be developed and promoted that considers where we want to end up, who we must educate and influence, and what we must know and do to achieve the goal of education in a convincing manner. The desired end point is a nationwide attitude among scientists, managers, politicians, and the public that amphibians, reptiles, and small mammals are critical wildlife components. Each species population and community must be identified as having an intrinsic value in maintaining the integrity of the natural ecosystems of North America.

Scientists have a responsibility for collecting extensive and intensive information on the life history patterns and habitat requirements of native amphibians, reptiles, and small mammals. The required data must be collected in a rigorous experimental manner that promotes an understanding of these species and communities through strong inferences and syntheses.

Politicians have a responsibility to assure that the approval of a government project is as contingent on environmental consequences as on budgetary considerations. Our attitude must graduate to become one of acceptance of a proposed project only after environmental impact determinations have led to an objective decision that the gain from the project warrants the loss to the environment.

Managers have a responsibility for promoting basic research, for applying the findings to habitat management, and for having the patience to wait for the completion of long-term studies as required. In situations where removal of animals or elimination of habitat is an issue, the burden of proof should be borne by the har-

vester or developer, and not by the scientist or manager. The status of a species should be determined before the decision to proceed is made, certainly not after harvesting begins or during the physical development of a project. This assessment should be made and evaluated before the project is approved. Each species should be protected until proven harvestable.

Both scientists and managers have a responsibility to inform the public and political arena that the protection and ecological understanding of inconspicuous and non-game species are vital to proper ecosystem management and to the preservation and maintenance of North America's natural heritage.

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