Rarity as a criterion for endangerment in Florida's fauna

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It has been argued that the initial rarity of an animal species may be a good indicator of subsequent vulnerability. The usefulness of this argument in the conservation of endangered species has been investigated by the authors, who have compared the apparent vulnerability of certain rare animals with their actual status. The two approaches agreed substantially, but some striking differences occurred. Some rare species seem more prone to extinction than is officially recognized, and their status should be reviewed. Other species are not particularly rare, but are threatened for other biological and economic reasons. Knowledge of rarity is a good starting point, but this sould be followed by a detailed examination of other relevant factors to discern genuine risk.

Consideration of life history characteristics and extinctions of birds from land-bridge islands and fragmented forests (Terborgh, 1974; Terborgh and Winter, 1980) has led to the inference that the single best indicator of vulnerability is the initial rarity of the animal. The former paper considered certain life history characteristics to be unstable: specialization at high trophic levels; being the largest member of a feeding guild; having weak dispersing and colonizing ability; being endemic; nesting colonially; and migrating. The latter paper found that most of these traits caused animals to be rare, which in turn was believed to predispose them to extinction. The manifestation of initial rarity is that an animal is either very limited in distribution, or widespread but quite uncommon locally.

How useful is this essentially theoretical perspective in the pragmatic business of listing and recovering endangered species? To test this question, we compared apparent vulnerability with management-agency designations across a sample fauna: the reptiles, amphibians and mammals of Florida. This is an exemplary test fauna because of an optimal combination of features. Firstly, the extremely rapid growth of Florida's human population raises the scale of endangerment of native biota and does so according to a settlement pattern independent of species' biology. Secondly, the survival status of the fauna is unusually well documented because an active community of natural-resource scholars is supported by government and academia. Thirdly, the fauna is relatively well known taxonomically, even to the subspecies level. And finally, the fauna shows an extremely high degree of endemism—the outcome of elaborate adaptive radiations promoted by Florida's unique history and geography. The State consists of a long peninsula, bordered by barrier islands, and attenuates in a long archipelago, all extending along a gradient from a warm-temperate, continental climate to a subtropical, maritime one. Other areas of the world have an equally interesting geography or more diverse faunas, but few combine this with the urgency of rapid habitat loss and the judgment possible with strong bases of taxonomic and ecological knowledge.

Legal status/rating rarity

The survival status of Florida vertebrates believed to be in danger of exinction has been formally designated by both Federal and State governments. Our comparisons are with these designations (Florida Game and Fresh Water Fish

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Commission, 1985; US Fish and Wildlife Service, 1985). The USFWS list is widely recognized and tends to change slowly because of complicated listing processes. The FGFWFC list is less well known but better reflects local conditions. Both agencies define 'endangered' as being in immediate danger of extinction or extirpation, and 'threatened' as being acutely vulnerable or declining in number or range and very likely to become endangered. USFWS recognizes candidates for listing as 'under review.' In contrast, FGFWFC acts quickly to make official listings, and species not qualifying under the primary definitions are designated 'species of special concern' when a lesser problem exists, for example: (1) significant vulnerability that may lead to threatened status, (2) possibly threatened but confirmation needed, (3) a keystone species, the decline of which would affect other species, or (4) insufficiently recovered from historical population depletion.

To evaluate vulnerability according to initial rarity, it was necessary to organize Terborgh's factors into a hierarchy of qualitative criteria, emphasizing the most important. We summarized the primary indications of rarity as limited distribution, low local density, and large body size. We awarded an animal one point for each of these characteristics it possesses, or two if the condition is extreme. Additionally, we compiled other sensitive factors under a fourth category, but did not award any points for them. Details of point awarding varied by taxon; for other applications, criteria may need to be modified to accomodate various geographic units. Some examples follow. Initial screening of reptile and amphibian species was by geographic range. Any not principally Floridian (with 50 per cent or more of their entire range within the State) were removed from the list. Of the remainder, 'rare' species had ranges of 10–25 per cent of the State, and 'exceedingly rare' species occurred in less than 10 per cent of the State. The absolute numbers are important only when results from this ranking system are to be compared with those of another system. Relative densities were estimated from our field experience, supplemented by other specialists as needed. 'Large body size' was designated for species that are exceptionally large for their taxon—for example, the largest 20 per cent of snake species. The largest species in each higher taxon and any other exceptionally large forms, such as marine turtles, were awarded two points.

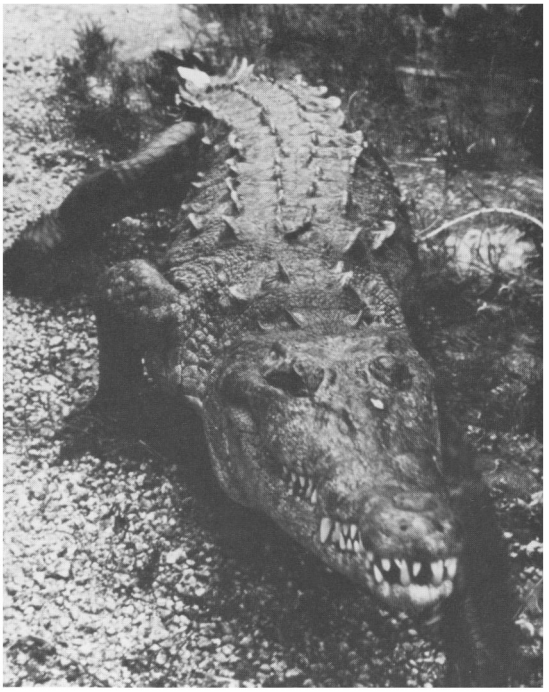
To summarize these ratings in a way roughly comparable to the conventional endangered and threatened designations, we assigned animals with four or more points to an 'extremely vulnerable' category. Those with three points were considered 'very vulnerable', and those with two points plus some other sensitive factors were considered 'moderately vulnerable'. Animals not thus rated but legally listed were placed in a miscellaneous category termed 'possibly vulnerable'. The tabular details upon which this summary is based are available from the authors by request. All native species and subspecies were considered. Taxonomy followed Conant (1975) for reptiles and amphibians and Hall (1981) for mammals, except where newer information was available.

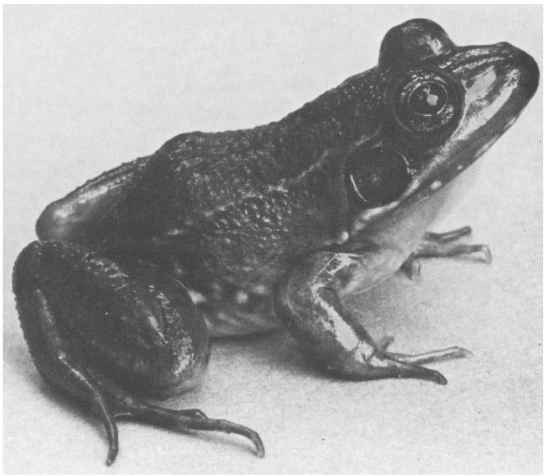
The comparisons

Comparisons of vulnerability ratings with legal listings (Tables 1 and 2) showed general concordance. Most of the animals ranked as extremely or very vulnerable are listed as endangered or threatened. However, two subsets deviated from this pattern, appearing as mismatches of our vulnerability ratings from the legal listings. One included vulnerable animals that are not officially considered endangered or threatened. A few, like the South Florida rainbow snake, were rated as extremely vulnerable; most appeared in the very or moderately vulnerable categories. At least some of these animals are genuinely at risk—the pallid beach mouse was reported as apparently extinct (Humphrey and Barbour, 1981) before it was listed by either FGFWFC or USFWS. In contrast, some other animals were rated as less vulnerable than their legal status would suggest. We were unable to reduce the scale of these discordances by tinkering with our definitions of vulnerability. Examples such as the Perdido Key and Choctawatchee beach mice are in fact highly endangered, so this trend apparently shows inadequacy in some vulnerability ratings.

Table 1. Comparison of reptile and amphibian vulnerability with legal status

Degree of vulnerability (this study)	Legal status (FGFWFC)	Legal status (USFWS)
Category I—extremely vulnerable		
American crocodile, *Crocodylus acutus*	Endangered	Endangered
Barbour's map turtle, *Graptemys barbouri*	Special concern	Under review
Atlantic green turtle, *Chelonia m. mydas*	Endangered	Threatened
Atlantic hawksbill, *Eretmochelys i. imbricata*	Endangered	Endangered
Atlantic loggerhead, *Caretta c. caretta*	Threatened	Threatened
Atlantic ridley, *Lepidochelys kempi*	Endangered	Endangered
Atlantic leatherback, *Dermochelys c. coriacea*	Endangered	Endangered
South Florida rainbow snake, *Farancia erythrogramma seminola*	Not listed	Not listed
Short-tailed snake, *Stilsoma extenuatum*	Threatened	Under review
Rimrock crowned snake, *Tantilla oolitica*	Threatened	Under review
Florida bog frog, *Rana okaloosae*	Special concern	Not listed
Gulf Hammock dwarf siren, *Pseudobranchus striatus lustricolus*	Not listed	Under review
Category II—very vulnerable		
Key mud turtle, *Kinosternon bauri palmarum*	Endangered	Under review
Mangrove terrapin, *Malaclemys terrapin rhizophorarum*	Not listed	Not listed
Suwannee cooter, *Chrysemys concinna suwanniensis*	Special concern	Under review
Florida bark anole, *Anolis distichus floridanus*	Not listed	Not listed
Florida scrub lizard, *Sceloporus woodi*	Not listed	Under review
Florida Keys mole skink, *Eumeces egregius egregius*	Special concern	Under review
Cedar Key mole skink, *Eumeces egregius onocrepis*	Not listed	Not listed
Blue-tailed mole skink, *Eumeces egregius lividus*	Threatened	Under review
Sand skink, *Neoseps reynoldsi*	Threatened	Under review
Atlantic saltmarsh snake, *Nerodia fasciata taeniata*	Threatened	Threatened
Key ringneck snake, *Diadophis punctatus acricus*	Threatened	Under review
Brown-chinned racer, *Coluber constrictor helvigularis*	Not listed	Not listed
Everglades racer, *Coluber constrictor paludicola*	Not listed	Not listed
Eastern indigo snake, *Drymarchon c. corias*	Threatened	Threatened
Everglades rat snake, *Elaphe obsoleta rossalleni*	Not listed	Not listed
Key rat snake, *Elaphe obsoleta deckerti*	Not listed	Not listed
Gulf Hammock rat snake, *Elaphe obsoleta williamsi*	Not listed	Not listed
Striped newt, *Notophthalmus perstriatus*	Not listed	Not listed
Category III—moderately vulnerable		
Florida East Coast terrapin, *Malaclemys terrapin tequesta*	Not listed	Not listed
Ornate diamondback terrapin, *Malaclemys terrapin macrospilota*	Not listed	Not listed
Reef gecko, *Sphaerodactylus n. notatus*	Not listed	Not listed
Gulf saltmarsh snake, *Nerodia fasciata clarki*	Not listed	Not listed
Mangrove water snake, *Nerodia fasciata compressicauda*	Not listed	Not listed
Blue-striped garter snake, *Thamnophis sirtalis similis*	Not listed	Not listed
Blue-striped ribbon snake, *Thamnophis sauritus sauritis*	Not listed	Not listed
Florida pine snake, *Pituophis melanoleucas mugitis*	Special concern	Under review
Rosy rat snake, *Elaphe guttata rosacea*	Special concern	Not listed
Florida crowned snake, *Tantilla relicta neilli*	Not listed	Not listed
Peninsula crowned snake, *Tantilla r. relicta*	Not listed	Not listed
Costal dunes crowned snake, *Tantilla relicta pamlica*	Not listed	Not listed
Category IV—possibly vulnerable		
American alligator, *Alligator mississippiensis*	Threatened	Threatened
Alligator snapping turtle, *Macrochelys temmincki*	Special Concern	Under review
Gopher tortoise, *Gopherus polyphemus*	Special concern	Under review
Flatwoods salamander, *Ambystoma cingulatum*	Not listed	Under review
Florida gopher frog, *Rana areolata aesopus*	Special concern	Under review
Pine barrens tree frog, *Hyla andersoni*	Special concern	Under review





Above left: A small population of American crocodiles persists in southern Florida, but has not responded as well to protection as the American alligator *(Stephen R. Humphrey)*.
Above: The Key Largo cotton mouse is endemic to the largest patch of unprotected tropical hardwood forest in the US east of Hawaii *(Stephen R. Humphrey)*.
Below: The Florida bog frog is newly discovered and has an extremely limited distribution *(Barry W. Mansell)*.

Rare animals may or may not be in trouble

Absence of certain vulnerable animals from the official list shows that some may be more prone to extinction than is currently recognized. These taxa should be carefully scrutinized as candidates for listing. Some of the unlisted beach mouse subspecies may even be endangered.

Failure of our ratings to detect obvious endangerment of other taxa shows the importance of life history characteristics other than rarity, and of the realities of human use of natural resources. In many cases, the key factor is an extraordinary concentration of human settlement within the range of an animal. In the case of the grey bat, the concept of initial rarity simply does not apply. This species is very abundant where it occurs, but it bears young in uncommon sites (caves) with a narrow microclimatic requirement, and it does not tolerate intrusion of spelunkers or scientists in these sites.

Two conclusions show that knowledge of rarity is necessary, but not nearly sufficient, to evaluate the risk of extinction. Firstly, inherent rarity is an important initial consideration. Some vulnerable species have been overlooked because their rarity was not appreciated, and this error should

be remedied. Secondly, the log-normal distribution of the abundance of species (Preston, 1948; Fisher, 1952; Williams, 1953) ensures that most species are rare as a fact of life. While these rare species may be considered at risk in a statistical sense (Terborgh's point), only some are

Table 2. Comparison of mammal vulnerability with legal status

Degree of vulnerability (this study)	Legal status (FGFWFC)	Legal status (USFWS)
Category I—extremely vulnerable		
Sperm whale, *Physeter catodon*	Endangered	Endangered
Sei whale, *Balaenoptera borealis*	Endangered	Endangered
Fin-backed whale, *Balaenoptera physalus*	Endangered	Endangered
Hump-backed whale, *Megaptera novaeangliae*	Endangered	Endangered
Northern right whale, *Balaena glacialis*	Endangered	Endangered
Florida black bear, *Ursus americanus floridanus*	Threatened*	Under review
Florida panther, *Felis concolor coryi*	Endangered	Endangered
West Indian manatee, *Trichechus manatus latirostris*	Endangered	Endangered
Category II—very vulnerable		
Florida mastiff bat, *Eumops glaucinus floridanus*	Not listed	Under review
Big Cypress fox squirrel, *Sciurus niger avicennia*	Threatened	Under review
Goff's pocket gopher, *Geomys pinetis goffi*	Endangered†	Under review†
Silver rice rat, *Oryzomys argentatus*	Endangered	Under review
Key deer, *Odocoileus virginianus clavium*	Threatened	Endangered
Category III—moderately vulnerable		
Anastasia Island mole, *Scalopus aquaticus anastasae*	Not listed	Under review
Bass' eastern mole, *Scalopus aquaticus bassi*	Not listed	Under review
Small eastern mole, *Scalopus aquaticus parvus*	Not listed	Not listed
Gold Coast eastern mole, *Scalopus aquaticus porteri*	Not listed	Not listed
Indiana bat, *Myotis sodalis*	Endangered	Endangered
Grey bat, *Myotis grisescens*	Endangered	Endangered
Key marsh rabbit, *Sylvilagus palustris hefneri*	Not listed	Under review
Micco cottontail, *Sylvilagus floridanus ammophilus*	Not listed	Under review
Gold Coast cottontail, *Sylvilagus floridanus paulsoni*	Not listed	Not listed
Sherman's fox squirrel, *Sciurus niger shermani*	Special concern	Under review
Pine Island rice rat, *Oryzomys palustris planirostris*	Not listed	Under review
Sanibel Island rice rat, *Oryzomys palustris sanibeli*	Special concern	Under review
Choctawhatchee beach mouse, *Peromyscus polionotus allophrys*	Endangered	Endangered
Pallid beach mouse, *Peromyscus polionotus decoloratus*	Endangered†	Under review†
Santa Rosa Island beach mouse, *Peromyscus polionotus leucocephalus*	Not listed	Under review
Southeastern beach mouse, *Peromyscus polionotus niveiventris*	Not listed	Under review
Peninsular beach mouse, *Peromyscus polionotus peninsularis*	Not listed	Under review
Anastasia Island beach mouse, *Peromyscus polionotus phasma*	Not listed	Under review
Perdido Key beach mouse, *Peromyscus polionotus trissyllespis*	Endangered	Endangered
Key Largo cotton mouse, *Peromyscus gossypinus allapticola*	Endangered	Endangered
Chadwick cotton mouse, *Peromyscus gossypinus restrictus*	Special concern†	Under review†
Key Largo woodrat, *Neotoma floridana smalli*	Endangered	Endangered
Everglades mink, *Mustela vison evergladensis*	Threatened	Under review
Category IV—possibly vulnerable		
Homosassa shrew, *Sorex longirostris eionis*	Special concern	Under review
Sherman's short-tailed shrew, *Blarina carolinensis shermani*	Special concern	Under review
Eastern chipmunk, *Tamias striatus*	Special concern	Not listed
Florida mouse, *Peromyscus floridanus*	Special concern	Under review
Saltmarsh meadow vole, *Microtus pennsylvanicus dukecampbelli*	Special concern	Under review
Key Vaca raccoon, *Procyon lotor auspicatus*	Threatened	Under review

*Except in three areas where hunting is permitted. †Actual status is apparently extinct.

Choctawatchee beach mouse running for its life. There are two remnants of the original range: one is protected and the other is slated for development *(Stephen R. Humphrey)*.

actually threatened. Therefore, there is no substitute for the conventional subjective evaluation, in which all relevant factors are considered. For example, coastal islands in Florida both promote endemism and attract human settlement, but other types of habitat islands may do only the former.

So many biological and economic factors can affect a species's vulnerability that applying an exhaustive ranking system to all species is impractical. We recommend that an early step in considering priorities for the conservation of endangered species be the application of an easy-to-use, rarity-based filter such as ours to highlight species needing detailed attention. Then, those species should be subjected to a much more meticulous examination of life history and trends in habitat and population. No ranking system can be devised to be completely objective, because the choice and weighting of various factors is necessarily subjective (for example, Sparrowe and Wight, 1975). The best overall approach may be to compare the results from multiple screening techniques. Species repeatedly emerging as being in danger should be listed, and anomalous results should be examined critically.

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