WETLAND FUNCTIONS AND VALUES: THE STATE OF OUR UNDERSTANDING
NOVEMBER AMERICAN WATER RESOURCES ASSOCIATION 1978

IMPORTANCE OF WETLANDS TO ENDANGERED AND THREATENED SPECIES

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ABSTRACT: The importance of wetland habitats to certain endangered and threatened plants and animals of the United States is reviewed and examples of endangered and threatened reptiles, amphibians, fishes, and birds dependent on wetlands are discussed. The role of the American alligator in shaping some wetland habitats is greater than its commercial value. The status of wetland habitats in desert areas of the southwestern United States is examined and Ash Meadows, Nevada, is used as an example to illustrate the precarious nature of these habitats. On a National basis, the percentage of endangered and threatened species dependent on wetlands is presented by major taxonomic groups. Without increased protection of wetland habitats, many of our endangered and threatened species may disappear before the end of the century.
(KEY TERMS: alligator; amphibians; birds; conservation; desert wetlands; endangered and threatened species; fishes; mammals; plants; reptiles; wetlands.)

INTRODUCTION

Of all our natural heritage, America's wetlands are among the most vulnerable and most threatened habitats. Wetland ecosystems of the United States have been the target of physical alteration, usually drainage, for many decades and more recently pollution has become a serious problem. Only in recent years have efforts been made to protect remaining wetlands and to inform private, commercial, and government interests of their value and significance. In many cases, endangered and threatened species have been benefactors of the efforts.

If one examines a map of the wetlands of the United States (Shaw and Fredine, 1971), it becomes apparent that these areas represent a small fraction of our total land area. Wetland ecosystems and their associated transitional communities, however, harbor an unusually large percentage of unique plants and animals. In the past, wetland habitats and their associated endangered, threatened, and unique plants and wildlife have been given little or no value by land developers and public officials. Unfortunately, this led to the wholesale destruction of many of our prime wetland habitats and their associated flora and fauna. In recent years, increased research effort has resulted in a better understanding of the structure and function of wetlands and has contributed to their protection. Increased environmental awareness of the general public in the past decade has been instrumental in pointing out the aesthetic value of these unique and biologically rich areas.

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To illustrate the importance of wetlands to endangered and threatened species several examples are examined. The examples were selected to cover species and geographic areas which were not primary topics of discussion elsewhere in this symposium. We have restricted our discussion to species protected or being considered for protection under provisions of the Endangered Species Act of 1973 (16 USC 1531-1543). Definition of the terms endangered and threatened as we use them are included in the Act.

WETLANDS AND CROCODILIANS

The American alligator, *Alligator mississippiensis,* is the best known reptile considered either endangered or threatened within the United States and its territories. It has been feared, praised, and exploited since man first came to the southeast. Early naturalists, such as Bartram (1791), presented startling and unbelievable stories concerning the species and its behavioral patterns. Despite its suspected major role in wetlands ecosystems of the south, surprisingly little scientific work has been published on it and then often with conflicting results (McIlhenny, 1935; Neill, 1971). The importance of the alligator as a top predator, modifier of its environment, and behaviorally sophisticated species is recognized universally by the scientific community (Craighead, 1968; Garrick and Lang, 1977).

Hunting, poaching, and habitat degradation at one time seriously reduced the number of alligators throughout the species' range and led to its inclusion as endangered under provisions of the Endangered Species Conservation Act of 1966 (Laycock, 1972). Valentine, *et al.* (1972), estimated that illegal poaching probably equaled the legal take on the Sabine National Wildlife Refuge in Louisiana. This would amount to almost 7500 illegally harvested alligators. Strict Federal protection, coupled with strong state laws pioneered by Louisiana and Florida, enabled alligator populations to recover dramatically in many parts of the species' former range. For example, the alligator population in Louisiana increased from an estimated 26,000 in 1957 to over 300,000 presently (Duffy, 1963; Joanen, pers. comm.). Because of this, the alligator has been reclassified twice to reflect its improved status (Greenwalt, 1975, 1977). The improving status of the alligator is good news from both an ecological as well as an esthetic or commercial point of view.

The ecological role of the alligator in shaping plant communities is especially important in southern Florida wetlands, and particularly in the Everglades (Craighead, 1968; Carr, 1973). In this area, the alligator builds "gator holes" by pulling plants loose and dragging them to the sides of a natural depression in limestone bedrock, and then pushing and carrying marl and organic muck to the sides of the depression. In this way, the alligator creates a pool with a raised perimeter above the surrounding wetland area. Often the areas form "islands" which provide the only high ground for many acres of sawgrass prairie. Trees, such as willow, red bay, pop-ash, maple, bottonbush, myrtle, and other small species, become established and then provide cover, breeding sites, and food for insects and birds. The islands provide high ground which can be used by turtles and snakes on which to lay eggs. Mammals such as rabbits, otters, and raccoons use the islands for cover and as areas for feeding. Thus, a unique community of plants and animals can make use of the by-product of the alligator's building activities. Continued maintenance by the resident alligator, perhaps consisting of nothing more than its everyday movements

(Kushlan, 1974), prevents natural invasion by aquatic plants such as coontail *(Myriophyllum* sp.), bladderwort *(Utricularia* sp.), pondweeds *(Potamogeton* spp.), and "flags" *(Thalia geniculata).*

The primary purpose of gator holes is to provide the alligator with sufficient water to sustain itself during periods of drought, generally from November to April. As the surrounding fresh waters recede, the hole becomes a refuge for many aquatic species, thus resulting in concentrations of fish (as many as 23 species), crustaceans, and protozoa. The number of organisms inhabiting a gator hole can be phenomenal; Kushlan (1972) found densities of 1,600 fish and prawns per square meter in a gator hole in Big Cypress Swamp. The high concentration of potential food is preyed upon by predatory species of mammals, birds, and reptiles which congregate along the adjacent perimeter of vegetation and bank. Scraps and feces of predators, in turn, fulfill nutrient requirements of species lower on the food chain. When spring rains return, the organisms trapped in gator holes repopulate the surrounding area, often with a spectacular burst of energy.

The concentration of organisms in a small area can be vital to breeding cycles of piscivorous birds, such as some Ciconiiformes (Carr, 1973; Kushlan, 1972). One example is that of the wood ibis *(Mycteria americana)* in which reproduction is timed to coincide with maximum concentration of fish in gator holes. Successful rearing of young requires vast numbers of small fishes which the parents obtain by moving their beaks back and forth in shallow water until contact is made with the prey. This method of feeding will work only if the prey are concentrated in a restricted area since the fishes are small and mobile and could easily otherwise escape. By rearing their young during the dry season, when the fish are collected in gator holes, selection has ensured that adequate prey will be available to satisfy the energy requirements of the young ibis. In abnormally wet years when fishes are not collected in such refugia, breeding activities may not begin or may be broken off, so that no successful reproduction occurs. Manipulation of water levels by dams and dikes, as well as alteration of drainage patterns, can result in reduced concentrations of fish. The wood ibis, therefore, has declined through its former range in the United States.

Alligators not only build gator holes, they wander in search of food, moisture, and mates. Wandering has effects on wetland vegetation by keeping open narrow waterways in the glades and preventing colonization by red mangrove. Naturally occurring islands, such as bayheads, are also maintained by resident alligators and perhaps start on the remnants of alligator nests in the sawgrass. Craighead (1968) has provided many insights into the importance of the alligator in maintaining the vegetational structure of the Everglades. The alteration of ancient drainage patterns with accompanying abnormal periods of drought and fires that destroy vegetation and peat, as well as the decline of the alligator in areas where it was formerly abundant, may have altered forever the wetland communities of southern Florida.

The alligator is the top predator in its environment and may feed on almost any animal it can catch. Numerous studies in the literature confirm that arthropods, particularly crustaceans *(Procambarus* sp., *Callinectes* sp.), fish, birds, mammals (particularly muskrats, *Ondatra zibethica,* and nutria, *Myocastor coypus),* and snails *(Pomacea paludosa)* are main food items, depending on habitat and size class of alligator (Valentine, *et al.,* 1972; McNease and Joanen, 1977; Fogarty and Albury, 1967; Giles and Childs, 1949), although correlation between prey choice and prey availability is not well understood. Of particular interest is the relationship between alligators feeding on the apple snail, *Pomacea*

paludosa, and the Everglades kite, *Rostrhamus sociabilis,* whose only food is the snail. Fogarty and Albury (1967) found apple snails composed 56.8 percent by volume of the stomach contents of 36 alligators in Broward County, Florida, and Martin and Hight (unpub. ms.) reported that 73 percent of the food items of alligators at the Loxahatchee National Wildlife Refuge Everglade kite management area consisted of apple snails. Such a relationship is of concern because of the extremely precarious status of the endangered kite.

As with the alligator, surprisingly little is known of the role of other crocodilians in wetlands habitats. One series of studies in the Amazon showed that resident crocodiles, *Melanosuchus niger* and *Caiman crocodilus,* play a vital role in nutrient cycling in an environment poor in nutrients and electrolytes (Fittkau, 1970, 1973). The species feed on numerous types of prey, primarily fish, and move into areas such as mouth-lakes of Amazonian rivers which are nutrient poor. Feces and scraps of the crocodiles form an allochthonous basis for primary production and serve as the foundation for a food chain which in turn benefits fish production. In some parts of the Amazonian drainage, removal of crocodilians — a practice initially thought to increase fish production by reducing predation — has caused a sharp decline in numbers of fishes, thus adversely impacting the human population which relied on fishing. Whether crocodiles play a similar function in other ecosystems is unknown, although Harper (1930) notes that in the Okefenokee Swamp, fishermen relate fishing success to the number of alligators nearby. The more alligators there are, the better the fishing.

The Everglades of southern Florida apparently play a vital role in the ecology and biotic success of the American crocodile, *Crocodylus acutus.* The crocodile once ranged through southern Florida from Palm Beach County on the Atlantic coast through the Keys, with occasional individuals along the Florida Gulf Coast (LeBuff, 1957; Odgen, 1978). As Many as 2,000 animals may have inhabited the region although an exact estimate is difficult to obtain because of lack of reliable historical data. Presently, the distribution of the species is centered in upper Florida Bay and around Key Largo, with numbers estimated between 100 and 400, including an estimated 20-25 breeding females (Ogden, 1978).

Reasons for the decline of crocodiles have been documented in the scientific and popular literatures (Horan, 1977; Lang, 1975; Ogden, 1978). The decline involved a combination of harrassment and killing by humans through such means as shooting, trapping, disturbance of individuals especially during nesting activities, road kills, and direct habitat destruction. Although the American crocodile cannot be considered a strictly estuarine or marine species, it does frequent environments which may have a high salinity content. The salinity question is extremely important to young crocodiles. When hatchlings emerge from the nest and enter the water, they cannot tolerate salty water because they initially have no special salt excreting mechanisms to survive hyperosmotic conditions. On the other hand, if young crocodiles complete their juvenile period of life entirely in fresh water, they never develop the physiological capabilities to tolerate excess salts found in the habitats frequented by the adults.

Man has altered the salinity content of the crocodile's habitat through drainage and channelization, which has reduced the flow of fresh water into Florida Bay. Instead of a gradual rise in salinity with accompanying gradual adaptation as the crocodiles mature, the juveniles face an environment with high salinity to which they cannot adjust. As a result, few crocodiles survive to replace adults lost to the population and the numbers have steadily declined in some remote areas, such as in parts of Everglades National Park,

despite protection from human disturbance for almost 30 years (Ogden, 1978). Human alteration of the wetland drainage patterns of south Florida has had a major impact on the status of the species and may severely hamper attempts to reintroduce it into formerly favorable habitat.

EXAMPLES FROM COASTAL WETLANDS

The Key mud turtle, *Kinosternon bauri bauri,* and the Cudjoe Key rice rat, *Oryzomys argentatus,* are south Florida species restricted to fresh water wetlands on the lower keys. A limited amount of habitat is available in the porous limestone of the area which unfortunately is rapidly being drained and developed for housing (Spitzer and Lazell, 1978). The fresh water marshes have been drained in an attempt to eliminate the breeding sites of mosquitos. The Key mud turtle does not possess any mechanisms for tolerating salt (Dunson, pers. comm.) and loss of marsh could extirpate both the mud turtle and rice rat. Wandering turtles are also killed in large numbers by highway traffic as they go from marsh to marsh.

Salt marshes have been known to be extremely productive. Living in some of the marshes on the South Atlantic and Gulf Coasts is a unique assemblage of snakes physiologically adapted to a saline environment. One species, the Atlantic salt marsh snake, *Nerodia fasciata taeniata,* inhabits the coastal marshes of Volusia, Brevard, and Indian River Counties in Florida. Like the Key mud turtle, the Atlantic salt marsh snake faces the threat of habitat destruction and drainage of habitat in its limited range. Habitat modification, however, has introduced an entirely new threat to the genetic uniqueness of the subspecies, namely hybridization with closely related subspecies of fresh water snakes. Habitat alteration allows the fresh water species to invade areas to which they were previously not adapted. The two subspecies interbreed and the physiologically distinct salt marsh snake loses its identity as a result of breakdown of ecological isolating mechanisms (Dodd, 1978).

EXAMPLES FROM INLAND FRESH WATER WETLANDS

Many inland species of endangered and threatened fishes, amphibians, and reptiles are dependent on wetlands. The slackwater darter, *Etheostoma boschungi* (Wall and Williams, 1974), a small (50-60 mm) colorful fish of northern Alabama and southern Tennessee, inhabits small to moderate-sized creeks (up to 12-m wide and 2-m deep), typically with slow current most of the year, but depends on small shallow wetlands for reproduction (Boschung, 1976). During the months of December and January, the darters aggregate and begin their spawning migration. They usually move upstream a distance of 1.6 to 5 km, reaching their wetland spawning habitat in February. The spawning habitat consists of seepage areas in open fields adjacent to the stream. Spawning takes place in shallow water (2 to 8 cm) with eggs deposited exclusively on juncus grass, *Juncus acuminatus,* although several other species of sedges and grasses are present. When eggs hatch, larval fish remain in the immediate area for a period of 4 to 6 weeks before moving to the stream. Although small and widely spaced, these wetland habitats are essential to the continued survival of the slackwater darter. Any barrier which would prevent the darters from reaching their spawning areas or destruction of the wetlands would further reduce the population of the threatened fish.

Many turtles spend much of their time in lakes and rivers during the spring and summer. In autumn, the turtles migrate to adjacent wetlands to hibernate. One species, the Plymouth red-bellied turtle, *Chrysemys rubriventris bangsi,* is known only from a limited area in Massachusetts (Graham, 1969; Lazell, 1977) and there may be only 200 individuals remaining (Lazell, pers. comm.). While the lakes inhabited by the species have not been seriously impacted, many of the surrounding marshes and bogs have been drained for housing. If the activity continues, the Plymouth red-bellied turtle might disappear because of the destruction of its wintering sites. Continuing destruction of isolated wetland marshes and bogs, especially in the northeast, has caused many turtle enthusiasts to voice concern for the survival of the bog turtle, *Clemmys muhlenbergi,* a secretive, small, and attractive species. While recent studies on the distribution of the species reveal that it is not as rare as previously believed and new colonies are continually being discovered (Arndt, 1978), the rate at which known colonies have disappeared merits special concern.

Mud turtles are generally considered completely aquatic although the yellow mud turtle, *Kinosternon flavescens,* has adapted to xeric conditions of the southwestern United States and adjacent Mexico. One isolated population, the Illinois mud *turtle,Kinosternon flavescens spooneri,* inhabits wetlands and sloughs of the remnant sand prairies of Illinois and adjacent Iowa and Missouri. Although the species was encountered in large numbers during the 1940's and 1950's, it has declined to the point where it is virtually extinct in Missouri and Illinois, with only a single major remaining population on Big Sand Mound in Iowa. While all the causes of its decline are somewhat obscure, drainage of wetlands and ponds for development and agricultural purposes has eliminated most of the species in many areas (Brown and Moll, 1978; Morris, 1978). Like the Plymouth red-bellied turtle, a small range coupled with drainage of the wetlands on which it depends has brought the species close to extinction. Another species confined to midwest wetlands, Kirtland's water snake, *Clonophis kirtlandii,* may be endangered because of drainage of its microhabitat (S. Taylor, pers. comm.); studies on it are just beginning.

Highway construction and development have contributed to the decline of the Santa Cruz long-toed salamander, *Ambystoma macrodactylum croceum,* and San Francisco garter snake, *Thamnophis sirtalis tetrataenia,* both of which are confined to limited ranges in California. The salamander depends on adequate water in ponds and marshes to allow its larvae to complete their development. At one time, the only known locality of the species was almost destroyed by a freeway. Since then, other populations have been discovered and steps taken to restore its original habitat (U.S. Fish and Wildlife Service. 1977). The garter snake inhabits dense, continuous emergent vegetation bordering fresh water marshes in San Mateo County and appears to be semiaquatic (Barry, 1978). Like other species of reptiles, its decline has occurred in part because of drainage and modification of wetlands on which it and its prey depend.

EXAMPLES FROM DESERT WETLANDS

In the arid southwestern United States, wetland habitats are usually associated with lowland areas along major streams. Exceptions to this are found in the spring-fed desert areas. Wetland islands in the desert support endemic and disjunct populations of plants, fish, and wildlife which have survived there since the Pleistocene Epoch (approx. 20,000 years ago). Hundreds of species of plants, fish, and wildlife are associated with the wetlands, and depend on them for survival. Many of the organisms are threatened with extinction.

The Ash Meadows region in southern Nye County, Nevada, and adjacent lnyo County, California, is perhaps the best example of a desert wetland in the southwestern United States. The area is well known to biologists for its high level of wetland-dependent and aquatic endemics. The only other area in the arid region of North America to match the aquatic diversity of Ash Meadows is the Cuatro Cienegas Basin in the Chihuahuan Desert of east central Mexico (Minckley, 1969).

Located in the eastern part of the Death Valley System, Ash Meadows lies east of the Amargosa River. Wetlands in the area are maintained by flow from several dozen springs and seeps ranging in discharge from a few gallons per min. to more than 2,000 gallons per min. At least 20 springs contain native fishes (Soltz and Naiman, 1978). The springs are fed by an extensive ground water system which extends more than 167 km northeast of Ash Meadows. Many of the endemic plants, fish, and wildlife found in the wetlands of Ash Meadows are endangered.

There are five species of plants endemic to Ash Meadows and approximately 60 species are found there and in other desert oases in the Death Valley System (Jim Reveal, pers. comm.). All five endemic plants of Ash Meadows are endangered. The most endangered is the nitrewort *(Nitrophda mohavensis),* which has been reduced to one small area at the south end of Carson Slough, formerly the major wetland area in Ash Meadows (Beatley, 1976). In addition to the endemic plants in Ash Meadows, several disjunct populations of plants are threatened. Cooler wetland habitats along shaded stream banks support isolated populations of more northern and mountain species. The shooting star *(Dodecatheon pulchellum),* generally distributed along cool shaded,stream banks in the northern Great Basin, now occurs only in Ash Meadows in the southern part of the Great Basin. Of the 18 species and subspecies of fishes which were endemic to the Death Valley System, three species and two subspecies occurred in Ash Meadows. One of these, the Ash Meadows killifish (*Empetrichthys merriami*) is extinct. Populations of remaining fishes have been seriously depleted and could become extinct unless steps are taken to acquire and protect the remaining habitat.

The primary threat to threatened and endangered plants and wildlife of Ash Meadows is the adverse alteration or destruction of wetland habitat resulting from diversion of surface flow and excessive pumping of ground water for agricultural uses. Wetland losses were especially severe in the late 1960's and early 1970's when excessive pumping lowered the water table in all aquatic habitats and some dried completely. After years of legal confrontations, the Supreme Count in 1976 upheld a lower court decision which limited the amount of ground water pumping in Ash Meadows. In 1977 the major agricultural interests in Ash Meadows sold their land (approximately 36 km^2) to a real estate company. Plans are being considered to subdivide the land and sell it in small plots or individual lots. The future of the Ash Meadows wetlands remains uncertain.

The Owens pupfish *(Cyprinodon radiosus)* provides a striking example of how wetlands can be protected and endangered species saved through the cooperative efforts of private citizens, and local, state, and Federal governments. The Owens pupfish, once thought to be extinct, is one of four native fishes restricted to the Owens River Valley, which is part of the Death Valley System. In the early 1900's, the pupfish was abundant in desert wetlands in the northern part of the Owens Valley near Bishop, Mono, and Inyo counties, California. Increased demands on available water in the area coupled with wetland drainage projects resulted in a drastic decline in the species. Additional reduction in numbers resulted from predation by exotic fishes introduced into the area (Miller, 1961).

In 1968, the California Department of Fish and Game coordinated efforts of private organizations, the Los Angeles Water Department (Los Angeles requires part of the water supply from the Owens Valley), and Federal agencies in the establishment of the Owens Valley Native Fish Sanctuary in Fish Slough. After renovation of portions of the wetland to a safe and stable condition, native fishes were reintroduced (Miller and Pister, 1971). This type of cooperative action is essential if many endangered wetland-dependent species are to survive.

Scarcity of water throughout the arid Southwest has focused attention on wetlands as sources of water to fulfill human needs, usually for irrigation or for livestock. Abuse of wetlands has created problems for resident herpetofauna. For instance, marshes are ditched and channelized, thus exposing tadpoles to predation. Cattle trample both toads and tadpoles. As a result, species such as the black toad, *Bufo exsul*, and Amargosa toad, *B. boreas nelsoni,* both restricted to very small marshlands in California and Nevada, respectively, face an uncertain future (Busack and Bury, 1975).

EXAMPLE OF THE WHOOPING CRANE

One of the best known endangered birds and perhaps the best example of an endangered species' dependence on a variety of wetland habitats is the whooping crane, *Grus americana.* The population at Aransas National Wildlife Refuge reached a low — 13 adults and 2 young — in 1941. Current estimate of remaining wild cranes in the Canadian flock is approximately 75 birds. Prior to human interference, the whooping crane population was estimated at 1,300 to 1,400 birds. Its endangered status and biology have been documented by Allen (1952, 1957). The whooping crane's life cycle encompasses a distance of approximately 4,200 km between the Northwest Territories of Canada and the Aransas National Wildlife Refuge on the Texas coast. In April, whoopers leave the Aransas Refuge, migrating northward along the Central Flyway, arriving at their traditional breeding grounds in Wood Buffalo National Park in the Northwest Territories by late April or early May. Cranes build their nests in wetland areas in water 0.3 to 0.6 m deep and remain in the area during spring and summer months. The last known whooping crane nest in the United States was observed in 1889 (Miller, *et al.*, 1974).

In October, adult and young whooping cranes begin the migratory flight to the Texas Gulf coast passing through southern Canada, northeast Montana, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Along the path, riverine wetlands are essential for feeding and resting. Cranes feed on aquatic plants and animals in marshes and use wet meadow areas and islands along braided river channels as roosting areas. Along the migratory route, most of the crane's critical habitat areas, identified by the U.S. Fish and Wildlife Service, are wetlands located along stream bottoms and reservoirs (Sheppard, 1978a, 1978b).

Whooping cranes spend the winter in tidal marshes along the Texas coast. Upon arrival, pairs and families of cranes establish feeding and roosting territories. Salt and fresh water marshes provide for the cranes an abundance of food organisms — blue and fiddler crabs, clams, shrimp, and crayfish.

Decline of the whooping crane population resulted from illegal shooting and destruction of wetlands. Wildlife laws enacted during the early 1900's virtually eliminated illegal shooting, but unfortunately did nothing tc prevent continuing destruction of the cranes' wetland habitat.

SUMMARY

In the preceeding examples, the importance of certain wetlands to endangered and threatened species has been illustrated. Wetland habitats vary in size, geography, and biological composition, but are nevertheless essential to survival of endangered and threatened species. Importance of the habitats to endangered and threatened wildlife was not appreciated until recently. Hornaday (1913), in his book, *Our Vanishing Wildlife,* only briefly mentions destruction of marshes and other habitats as a problem in conservation of wildlife. This is somewhat understandable since the most obvious threat to wildlife in the late 1800's and early 1900's was overkill through hunting. Most extinctions during the period were the result of direct killing by man. However, several species became extinct prior to 1900 because of habitat alteration. The harelip sucker, *Lagochila lacera,* appears to be the first fish to become extinct in the United States as a result of human activities (Williams and Finnley, 1977). Another example is the Gull Island vole, *Microtus pennsylvanicus nesophilus,* a small mammal which disappeared when its habitat was destroyed about 1900 by construction of fortifications on the island (Allen, 1972).

The importance of wetlands to endangered and threatened plants, fish, and wildlife varies from one taxonomic group of organisms to another. On the list of approximately 3,200 plant species identified as in need of protection in a report presented to the Congress of the United States by the Smithsonian Institution in 1974, approximately 95 species are aquatic or wetland-dependent taxa. Aquatic and wetland plants are found in a variety of habitats through most of the United States, where the major threat to their survival is destruction or adverse alteration of habitat. As many as nine species of wetland plants may be extinct (Ronald Stuckey, pers. comm.).

Of 33 species and subspecies of United States mammals listed as endangered, five species (15.2 percent) are dependent on wetlands during all or parts of their life cycle. Two species, the Florida panther, *Fells concolor coryi*, and the red wolf, *Canis rufus,* are not considered wetland-related species but manage to survive today only in wetland habitats. There are 70 species of birds on the United States list of endangered and threatened species of which 22 (31 percent) are wetland species.

Reptiles and amphibians are adapted to very different types of habitats. Of 13 United States endangered and threatened reptiles, 4 (30.8 percent) are dependent on wetlands for their survival. Five reptiles are proposed for endangered status, three of which are wetland species. There are six amphibians on the United States endangered and threatened species list and 3 (50 percent) are wetland species. Two species are proposed for the list, one of which survives only in a wetland habitat.

Most fresh water and estuarine fishes depend to varying degrees on wetlands for survival. There are 41 species and subspecies of United States fishes listed as endangered or threatened, 22 (53.6 percent) of which are found in wetland habitats during part of their life cycles.

The value of wetlands to endangered plants, fish, and wildlife is becoming more obvious. Work of scientists combined with increased awareness and concern in the private sector, and state and Federal governments should provide protection to remaining wetlands. Proper precautionary and restorative measures could lead to recovery of damaged wetland ecosystems. Without conservation of wetlands, many endangered and threatened species may disappear before the end of the century.

ACKNOWLEDGMENTS

We would like to thank the following individuals who provided information used in the preparation of this paper: Howard W. Campbell, Marshall Jones, Bruce MacBryde, Ron Nowak, and Ronald Stuckey. We are especially grateful to Dona Finnley for providing editorial comments and Irene Zweig for typing the many drafts of the manuscript.

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