Endangered Species UPDATE

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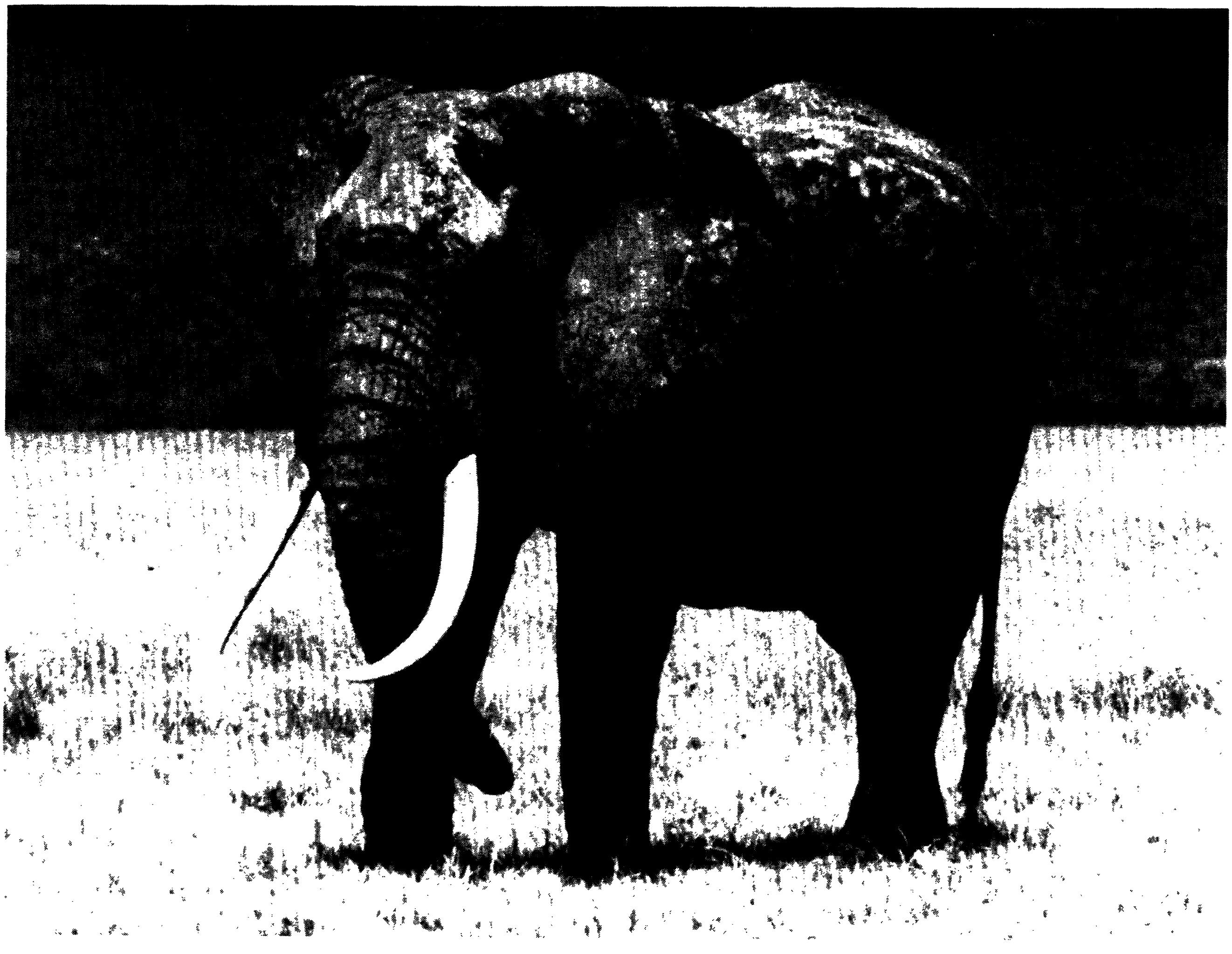

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Surveying Wintering Loons from the Air

First of Special Series: Virginia Department of Game and Inland Fisheries Nongame and Endangered Species Program

Genetics and Elephant Conservation

by

Laura L. Bischof

Preservation of the genetic health of endangered species is increasingly recognized as an important part of conservation biology. Genetic diversity provides the reservoir of flexibility with which species can adapt to a changing world over the long term. Thus, the preservation of genetic diversity is a key factor for insuring any species' long term survival. The susceptibility of both captive and wild populations to inbreeding and outbreeding depressions, the long term effects of habitat fragmentation and small population size, and the determination of species boundaries are issues that arise repeatedly in conservation biology. Genetic studies are extremely useful in addressing these issues. New technical developments have made the application of genetic technology faster, cheaper, easier, and more accessible than ever before. Here I discuss two examples of genetic studies performed on African and Asian elephants, and their applications to conservation programs.

Mitochondrial DNA Variation of African Elephants

The plight of the African elephant has drawn worldwide attention over the last several years. Pressures from human habitation and resultant habitat loss have fragmented elephant populations and restricted them to a fraction of their former range. Heavy poaching for ivory caused drastic declines in population numbers in many areas, prompting CITES to ban all trade of elephant products in 1989. The ban was credited for a significant drop in the price of ivory and reduction in poaching activity, and was recently extended for another two years. While East African elephant populations have stabilized, populations in Southern African countries such as Zimbabwe and Botswana are booming. Elephant overpopulation within many protected areas is resulting in patchy destruction of habitat. Partly for this reason, several south African countries have expressed the desire to resume a legal ivory trade. [See box.] The issue of how best to conserve elephants is by no means resolved.

I have been participating in a project to genetically characterize elephant populations across Africa. This research is being conducted in the laboratory of Dr. Alan Templeton at Washington University in St. Louis and is funded by Wildlife Conservation International. The project was developed by Dr. Nicholas Georgiadis, Dr. David Western, and Dr. John Patton, to examine the feasibility of using genetic techniques to regulate the ivory trade. Illegal wildlife products are discovered at several points during shipment, and the determination of their origin is often difficult or impossible. The ability to determine the geographic origin of ivory and other elephant products would be very useful for both the enforcement of current trade bans, and for the regulation of any future restricted trade.

Our research has been made possible by the polymerase chain reaction

The Ivory Trade and Conserving the African Elephant

The delegates to the eighth meeting of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) in Japan this year decided to continue the ban on the international trade in elephant ivory. This decision was hailed as a victory by most of the conservation community. At the previous meeting of CITES in late 1989, the African elephant had been placed on Appendix I, which prohibited international trade for commercial purposes. That decision was deemed necessary because the total elephant population had been cut in half, from somewhere over 1.3 million to just over 600,000, in the preceding ten years. The ivory trade ban worked; in the subsequent two years, both illegal hunting and ivory market prices plummeted.

The trade ban was not popular with all African nations. Elephant populations in some of the southern African states were not as threatened by illegal hunting, and several countries managed their herds with legal culls. These countries wanted to sell ivory, meat, and skins and invest revenues in conservation programs. In 1991, Zimbabwe, Malawi, Namibia, Zambia, and Botswana established an ivory marketing consortium, and together with South Africa proposed, at the Japan meeting, a controlled re-opening of the ivory trade by downlisting their elephant populations to Appendix II. Their proposal was countered with the argument that re-opening the trade was detrimental to the species as a whole for it would encourage illegal hunting in other parts of Africa. The general consensus was that heavily hunted elephant populations need to recover, effective conservation programs need to be established across the continent, and reliable controls to regulate the trade itself need to be instituted. Eventually the southern African nations bowed to these arguments and withdrew their proposals.

Though the outcome at CITES maintained the ivory trade ban, it did not answer the questions posed by the southern African proposals. Can wildlife conservation benefit from international trade? Is the goal of CITES to stop trade when species become endangered, or to help manage wildlife populations by encouraging sustainable levels of trade? Is it possible to re-open trade in a culturally important and charismatic species like the elephant? Will countries reinvest revenues from wildlife harvest into conservation?

The African elephant is the test case.

- John G. Robinson and Dorene Bolze
Wildlife Conservation International
New York Zoological Society
Bronx, NY 10460

(PCR), a technique which can amplify small, specific pieces of DNA from even very degraded tissue. Although we have not obtained DNA from cleaned and carved ivory, raw tusks frequently have bits of dried tissue at the base which can be used for genetic analysis. Using PCR we have amplified segments of mitochondrial DNA from dried tissue scraped from tusks and from small samples taken from live animals by a noninvasive biopsy dart (Karesh et al.1989). After amplification, the DNA is cut with a battery of restriction enzymes and electrophoresed through agarose gels. The resulting patterns of bands are characterized as mitochondrial DNA variants, known as haplotypes.

Mitochondrial DNA is particularly well suited to this study for two reasons. Certain regions of mitochondrial DNA evolve at a faster rate than single copy nuclear genes in mammals (Brown et al. 1979). This makes mitochondrial genes useful for studying genetic variation at the population level. In addition, mitochondria are maternally inherited. Elephants are known to have a matriarchal social system, where females remain in stable family groups and adult males travel alone or in bachelor groups when not escorting an estrous female. Although all elephants can travel large distances, females are more likely to stay in one area than males. Due to its relatively high mutation rate and maternal inheritance, mitochondrial DNA will show geographic variation and population subdivision of elephants at a higher level of resolution than will most nuclear markers.

We have characterized the mitochondrial haplotypes of elephant populations in Kenya, Tanzania, Botswana, Zimbabwe, and South Africa. Figure 1 shows the relative frequencies of haplotypes occurring in these countries. The results show that elephants have a highly subdivided population structure. Significant frequency differences exist between many populations, even some in close proximity. Several haplotypes appear to be restricted to either east African or south African regions. Two haplotypes, those represented by the South Africa population, are common to all regions. These haplotypes probably indicate low but ongoing gene flow across the continent over time. At present, over 40% of tusks can be assigned a geographic origin with the PCR technique. Given the highly subdivided structure of elephant populations, it seems likely that genetic screening of additional DNA regions will increase the resolving power of this technique.

We have also estimated the mitochondrial DNA variability in the North American captive elephant population and compared it to estimates from wild populations. Mitochondrial variation was found to be markedly higher in the zoo population than in any single wild population. Haplotype frequencies most resembled those in western Zimbabwe. Haplotype profiles of captive elephants were consistent with expectations based on their reported source of capture. Three elephants of unknown origin appear to have come from East Africa (1) and Zimbabwe (2). Overall, the high level of variability presents a favorable outlook for a captive elephant breeding program.

Information from studies such as this has implications for the management of wild populations as well. Habitat fragmentation can have long term genetic and evolutionary consequences (Templeton et al. 1990). The degree to which habitat fragmentation affects a species depends in part on whether fragmented populations were already genetically isolated from each other and on how dispersal is affected. The extent to which protected areas are conserving or disrupting natural population processes can be determined by genetic analysis. Genetic methods are the only reliable means of determining patterns of gene flow, and should be used to test predictions based on behavior and dispersal ability. For example, if elephant males do disperse further than females, we expect nuclear markers to show higher levels of gene flow than has been detected with mitochondrial DNA. Studies testing this hypothesis are currently underway.

We now know that elephant maternal lineages show natural population subdivision. However, evidence of slow but ongoing gene flow across large distances suggests that migration corridors may be important for elephant conservation over the long term. Infrequent long distance dispersal may be impor-

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Readers include a broad range of professionals in both scientific and policy fields. Articles should be written in an easily understandable style for a knowledgeable audience. For further information, contact the editors at the number listed below.

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Cover:
Male African elephant (*Loxodonta africana*) in Ngorongoro Crater, Tanzania. Photo by Nicholas Georgiadis.

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tant for maintaining the genetic cohesion of this species. Migration corridors established for elephants will have cascading effects that will benefit other species as well. By characterizing the genetics of wild elephant populations we are gaining valuable information on population structure, historical and current patterns of gene flow, and overall genetic diversity. An accurate understanding of these phenomena is of prime importance in making informed decisions for conserving African elephants.

DNA Fingerprinting of Asian Elephants

The plight of the Asian elephant has not been as publicized as that of the African elephant, but it is much more serious. The Asian elephant has been listed on CITES Appendix I since 1976. An estimated 30,000 to 55,000 Asian elephants remain in the wild, less than one tenth the number of African elephants. This decline has been mainly due to habitat loss, although poaching is also problematic. Pressure from human populations continues to fragment and isolate elephant populations throughout their range. In recognition of the Asian elephants' endangered status, the American Association of Zoological Parks and Aquariums (AAZPA) has formed an Asian elephant species survival plan (SSP), with the goal of creating and maintaining a self-sustaining captive population.

Captive breeding programs are becoming an important part of conservation strategies for many species. No longer can zoological parks stock and re-stock their collections from "limitless" wild populations. Not only must captive populations be self-sustaining, but many will eventually be used as source populations for reintroduction programs. Loss of variation due to genetic drift and inbreeding depressions in small captive populations can threaten the success of breeding and reintroduction programs. Consequently, managers are very concerned that species in captivity retain genetic diversity over time. The relative effectiveness of different management strategies for maintaining genetic diversity is still being discussed (Haig et al. 1990). However, successful implementation of almost any genetic management plan necessitates a working knowledge of either a) the genetic variability of the captive population, b) the relationships among potential breeding individuals, or both. Several techniques have been used to survey genetic variation in zoo populations, such as allozymes, nuclear ribosomal DNA, and mitochondrial DNA (Templeton et al. 1987). Unfortunately, complete pedigree information is often unavailable for captive populations. Paternity of older captive individuals is often unknown. Genetic techniques can be useful tools for gathering pedigree data. DNA fingerprinting is one technique that can be useful for determining paternity and degrees of relatedness.

DNA fingerprinting is a method of characterizing specific regions of genomic DNA containing highly variable numbers of tandem repeats (VNTRs). DNA is cleaved with restriction enzymes which cut at specific sequences. The DNA is then electrophoresed through an agarose gel to separate fragments according to their size. After being transferred to a nylon membrane it is "probed", or bound, with a radioactively labeled piece of DNA containing a complementary core sequence. When exposed to photographic film, a distinct pattern of 10-30 bands is revealed which is highly variable among individuals. Any given individual will share roughly half its bands with its mother and half with its

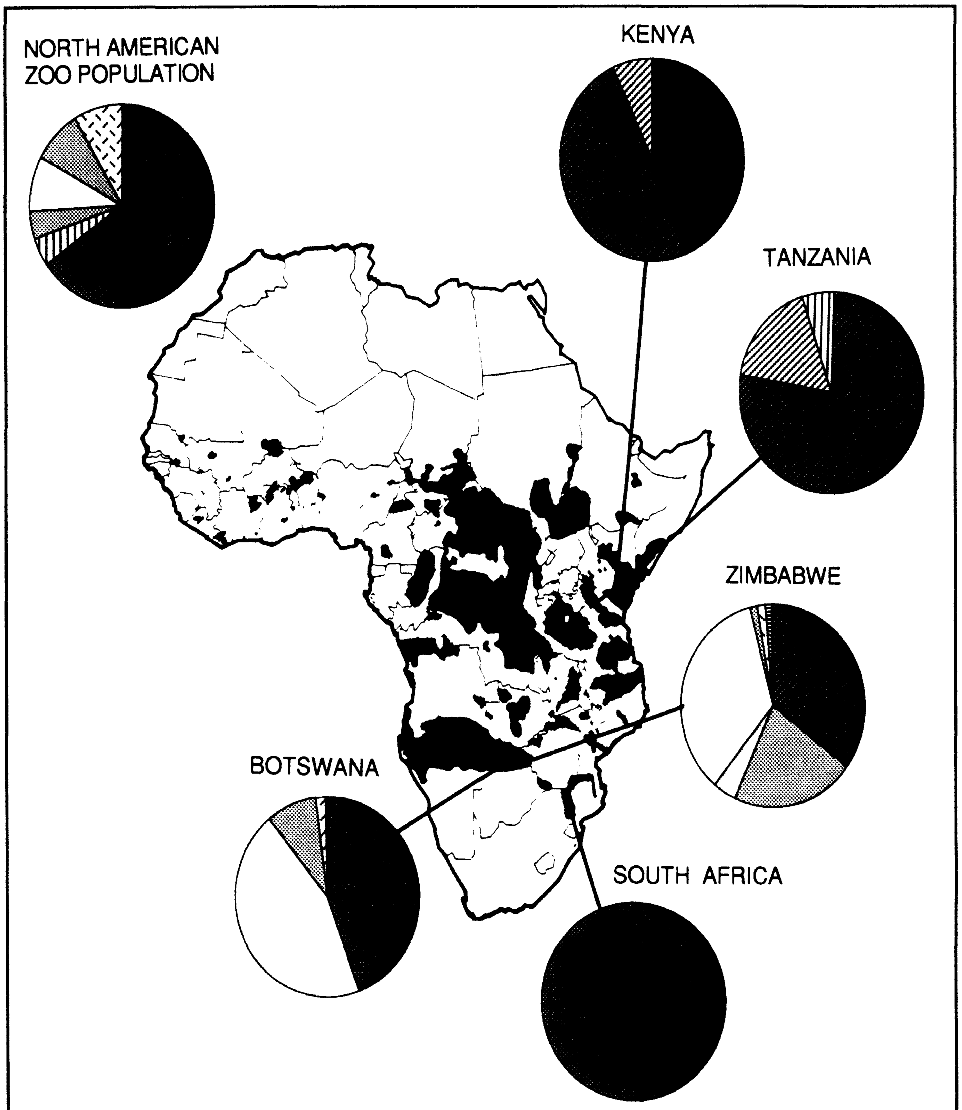

Figure 1. Mitochondrial DNA haplotype frequencies of African elephant populations in selected African countries and in North American zoos. The current distribution of elephants is shaded.

father. This makes DNA fingerprinting particularly useful in determining parentage when one of the parents is known.

I conducted a DNA fingerprinting study of captive Asian elephants with Dr. Deborah Duffield in Portland, Oregon, using the probe M13. M13 is a commonly used probe which produces variable fingerprints in a wide variety of species (Ryskov et al. 1988). Figure 2 shows the fingerprints of a known dam, its calf, its known sire, and an unrelated bull. In this case, several "obligate" paternal fragments (those bands in the offspring that are not shared with the mother) can be traced to only one of the two males, verifying the true sire.

Unique fragments occasionally arise in an offspring by mutation. Although rare, this can be problematic if all potential sires are not available for analysis. We were unable to determine the paternity of one calf with a "unique" fragment in a case where one of the potential sires was unavailable. Nonetheless, in cases where all potential fathers are accessible, this method can provide valuable pedigree information. DNA fingerprinting has been successfully used on birds (Lifjeld et al.1991), reptiles (Templeton et al.1990), and mammals (Tegelstrom et al.1991) in both captive and wild populations. It can also add pedigree information when combined with other genetic techniques such as mitochondrial DNA analysis (Morin & Ryder, 1991).

DNA fingerprinting may be useful to indicate general levels of relatedness when there is no pedigree data available at all. As expected, indices of fragment sharing have been found to correlate with relatedness in several species studied (Gilbert et al.1991). We have found that a similarity index, S (where $S = 2N_{ab}/[N_a+N_b]$, and N_a and N_b are the number of fragments scored in individual a or b, and N_{ab} is the number of fragments shared by both) has a positive relationship with relatedness when tested on Asian elephants of known pedigree. Although this method could not reliably distinguish animals of distant relatedness (i.e. first cousins) from either nonrelatives or relatives, animals with $S < .38$ were always unrelated, and 78% of unrelated pairs fell into this category.

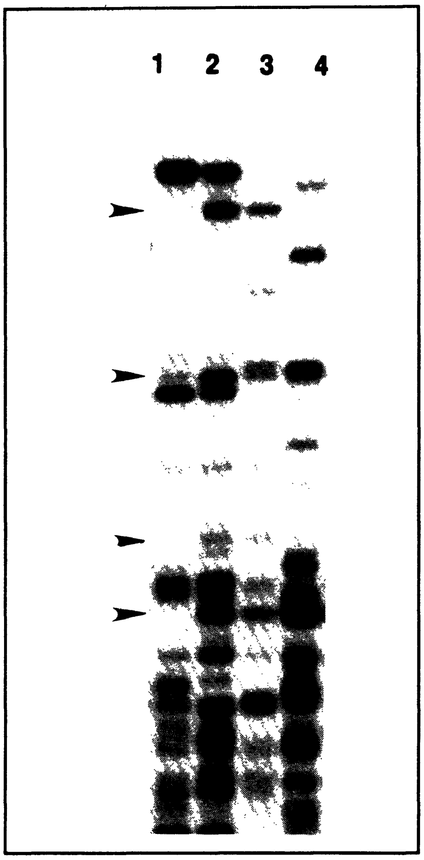

Figure 2. DNA fingerprints of Asian elephants. 1=dam, 2=calf, 3=sire, 4=unrelated male. Paternal fragments are labelled with arrow.

Animals with $S > .62$ were always closely related (i.e. parent-offspring or full siblings), and 60% of close relatives scored above .62. While this technique cannot provide detailed pedigree data by itself, it can be useful as a guide to suggest relatedness or nonrelatedness. The use of additional probes and/or the development of species-specific probes may increase the resolution of the technique, as has recently been shown by Gilbert et al. (1991) in their work with lions.

Several important cautions about DNA fingerprinting must be noted. Technical difficulties due to linkage, allelism, and comigration of fragments have been discussed in detail elsewhere (Lynch 1988, Cohen 1990). In addition, both population structure and population history will effect the efficacy of this technique. Population bottlenecks, a history of inbreeding, and population subdivision may reduce the variability of DNA fingerprints (Nichols & Balding 1991). Separate populations of the same species having different histories will show different calibration curves of similarity index to relatedness (Gilbert et al.1991). Preliminary screening of the proper reference population should be conducted to determine which probes are most effective, the amount of variation present, and the correlation of similarity index to relatedness for that population. If implemented properly, DNA fingerprinting can be a useful management tool for determining paternity and relatedness in the Asian elephant and other species in captivity.

Summary

Genetic tools have multiple applications to endangered species conservation. Genetic testing can often be applied to specific questions such as those described here: determination of origin of an animal product, or the determination of paternity. Genetic studies reveal population structure and history, and characterize the existing diversity we are trying to preserve. This provides insights that are crucial for effective conservation planning. The more we know about the genetics of natural and captive populations of endangered species, the more we can make informed and intelligent management choices for their preservation.

Acknowledgements

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Virginia Department of Game and Inland Fisheries Nongame and Endangered Wildlife Program

by

Karen Terwilliger and Toni Harrison

Since its establishment in 1916, the Virginia Department of Game and Inland Fisheries, (VDGIF), has been responsible for "conserving, protecting, replenishing, propagating, preserving, and increasing populations" of wildlife of the Commonwealth (Code of Virginia § 29.1-103). VDGIF has established a number of programs to achieve this broad mandate. Conservation of fish and wildlife is accomplished through a series of survey, research, management, and regulatory processes by the Department's Fish Division and Wildlife Division, respectively. Enforcement of laws and monitoring of resources are performed by the Law Enforcement Division. Public outreach programs, designed by the Public Relations and Resource Education Division, target both children and adults through an extensive K-through-12 environmental education curriculum, the distribution of information through the media, and a variety of promotional materials and presentations including pamphlets, posters, and bookmarks. The Policy, Planning, and Environmental Division maintains a computerized database, the Fish and Wildlife Information System (FWIS or BOVA) for use in environmental reviews and responses to public requests for information. The life history, biological, and locational data on more than 2000 species are used in the research, management, predictive modeling, and protection efforts of the agency.

Land acquisition, leasing, cooperative agreements, and variety of other land conservation mechanisms are employed by the Lands and Engineering Division to secure wildlife habitat and to provide access for recreational opportunities focused on wildlife. All of these programs work in concert, and each represents an integral part of the agency's conservation effort.

Funding for VDGIF's program has come primarily from sportsmen through license fees and taxes on hunting and fishing equipment. For more than 40 years the federal aid in fish and wildlife restoration acts, generally known as the Pittman-Robertson and Dingell-Johnson acts, respectively, have provided for the return of federal taxes on sporting equipment to state wildlife agencies. These funds are the major sources of revenue for the Department. More recently, programs such as boating safety, boat registration, and the Nongame Fund—which accepts direct contributions or refunds from the state income tax checkoff to be used in support of projects benefiting nongame species of wildlife—have provided additional sources of revenue for the Department.

Increased attention to the endangered species of Virginia developed in the 1970's during the environmental awareness decade and resulted in the passage of key state and federal legislation. Virginia's Endangered Species Act was passed in 1972 and amended in 1977. This legislation prohibits the taking, transportation, sale, etc. of endangered and threatened species except as permitted, and empowers the Board of VDGIF to adopt the federal list of endangered and threatened species and to implement regulations to further protect these species. The Federal Endangered Species Act was passed in 1973. Section 6 of this Act provided for cooperative agreements between the federal government and the states. VDGIF entered into a cooperative agreement with the United States Fish and Wildlife Service (USFWS) in 1976 relating to the management of federally endangered and threatened animals in Virginia. This agreement gives the Department the lead role in and authority for conserving federally threatened and endangered species in the Commonwealth, and has lead to the development of an excellent cooperative program between the Department and USFWS.

Following the passage of the Nongame Bill by the Virginia General Assembly in 1981, the Department, which already had the responsibility for conserving and protecting nongame and endangered species, began to receive revenue from the newly-established Nongame Fund. Revenue from a state income tax checkoff, as well as direct contributions, became available to finance efforts to conserve nongame species and to augment Pittman-Robertson and Endangered Species Section 6 funds. Throughout the 1980's, the Department built a strong Nongame and Endangered Species Program, accompanied by steady increases in funding. Then, in 1989 and 1990, tax reforms and new income tax checkoff options caused a decline in receipts that the program received from tax checkoffs. Efforts continue to improve levels of funding and to augment existing programs (see Figure 1.). In 1987, the Department exercised its authority to create a state endangered species list. At that time, 20 species were declared to be endangered or threatened in the state and a list of these species was published in the Virginia Register. A policy for listing and delisting species, and definitions of species of concern and critical habitat, were developed to supplement the new list. Recovery of listed species is accomplished through the development of recovery plans, which involves cooperation and participation of federal, state and local governments, universities, and other organizations. The recovery planning process is now underway for species designated as endangered or threatened within the state.

VDGIF provides general protection to wildlife through state law, which affords blanket protection to all wild animals in the Commonwealth by prohibiting their possession and capture (even the "attempt to capture, take, kill, possess, offer for sale, sell, offer for purchase, purchase, deliver for transporta-

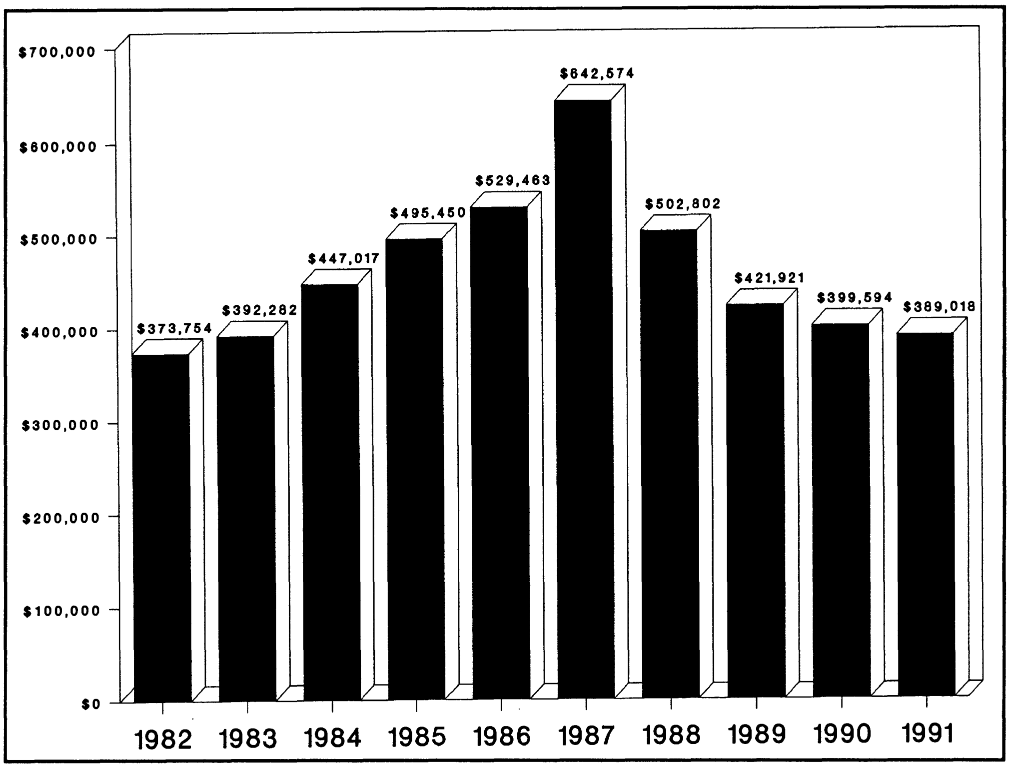

Figure 1. Contributions to the Virginia Nongame and Endangered Species Program, 1982–1991.

tion, transport, cause to be transported, receive, export, import in any manner except as specially permitted and only by the manner and means and within the numbers stated"). General permitting allows specialized restricted use such as collecting specimens for scientific or museum purposes. Also in 1990 the Board adopted new definitions which parallel the definitions in the federal Endangered Species Act and that more clearly state the protection levels afforded by the state law. The most relevant definitions include "take", "harm", "harass", and "special concern". The special concern category essentially creates a watch list similar to the federal definition of "candidate" species which officially recognizes a species as rare and a candidate for possible listing. Virginia's Nongame and Endangered Species Program has built a network of individuals and organizations that cooperate at the federal, state, and local levels. Individuals belonging to civic, academic, governmental, conservation, and education groups across the state assist the Department in promoting sound wildlife conservation and form the "nongame network".

A dynamic, systematic program for conserving nongame species begins with surveys, including inventories and censuses. Once rare animals and their critical habitats are located, this information is entered into the agency's computerized FWIS where it is processed and disseminated. These data, together with information about the biology and habitat requirements of the species, form the basis of the agency's environmental review process which allows the Department to comment on potentially adverse impacts to sensitive areas.

Once sensitive species are located, their statuses are evaluated through scientific surveys and research and are prioritized through a quantitative ranking system which incorporates both population and habitat parameters. In order to be listed, a ranked species may be evaluated by staff of the Department, then recommended for listing to the Board. If the Board accepts the recommendation, the species is listed. The Department also may be petitioned to list a species, in which case a prescribed procedure is followed to determine whether listing is warranted. After the statuses of species are evaluated and prioritized, and species are listed, strategies for their conservation are devised and incorporated into official state recovery plans. Protection, management, education, and enforcement activities are initiated in order to maintain or improve the status of a species, according to the limiting factors of the population and the degree of threat facing the population. As additional data are acquired, landowners and managers are contacted and recovery efforts are modified as required.

In summary, the Department's Nongame and Endangered Species Program has accomplished much during the past decade towards the conservation of Virginia's rarest species and in educating the citizens of the Commonwealth about the conservation needs of these species. However, a great deal more needs to be accomplished in order to slow, and reverse, the tremendous rate of habitat loss and degradation currently underway in the Commonwealth. Only through ongoing outreach programs and combined efforts of the program's "nongame network" can the Department continue to make giant strides towards the effective conservation of nongame and endangered species. VDGIF is committed to the maintenance and enhancement of wildlife diversity, a goal which clearly recognizes the importance of Virginia's rarer forms of wildlife.

A Closer Look at Conservation Strategies

Examples of how the program and its network functions can be found in the two biodiversity conservation hot spots in the state. One, in the far reaches of the mountainous southwest and the other, 500 miles from it along the Atlantic Ocean, of one of Virginia's most fragile and unique ecosystems, the barrier islands. Let's focus first on the coastal islands. Virginia is fortunate to have not only one of the most pristine, undisturbed barrier island chains in the world, but also a unique and integrated partnership involved in the implementa¨tion of its conservation.

Virginia's barrier island system is comprised of a chain of 20 barrier islands stretching 100+ miles along

Virginia's Atlantic coast. These islands, for the most part, are owned and or managed by a few large institutions, either federal, state, or private. The Nature Conservancy owns the majority of the islands and has established them as the Virginia Coast Reserve. Beginning in 1969 with the funding support of a Charitable Trust, The Nature Conservancy has purchased fourteen islands skirting some 60 miles of Virginia's coast. So important was this purchase and protection that it captured international recognition and was dedicated as a Biosphere Reserve by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) through its Man and the Biosphere Program.

Since that time, The Nature Conservancy and a host of partners have worked together to purchase and protect over 40,000 acres of adjacent mainland waterfront and marsh to secure this as a naturally functioning barrier island ecosystem. The USFWS owns the second largest island component administered through both the Chincoteague National Wildlife Refuge and the Eastern Shore National Wildlife Refuge. Its critical holdings define both the northern and southern most islands in Virginia's chain. USFWS properties on the adjacent mainland also provide the additional buffer for a healthy barrier/bay ecosystem. NASA owns one island as well as significant mainland property.

The State of Virginia owns two islands, one administered by the Virginia Department of Conservation and Recreation and one by the Department of Game and Inland Fisheries. Most of the marshland along the Eastern Shore, subaqueous bottoms and intertidal zone are owned by the Commonwealth. This provides further protection for the shallow bay and marsh system sheltered by the islands and allows it to remain a productive nursery and breeding ground for many species of shellfish, other invertebrates, fish, and a host of birds.

The importance of this area is evidenced by the tremendous acquisition investment made by each of the members of this partnership. Conservation, however, takes many forms. Protection through acquisition is just one of the tools that has secured the islands. Maintaining this fragile and dynamic system requires a coordinated and active management program including survey and monitoring activities for unique populations and habitats, research, education, and enforcement.

The VDGIF Nongame and Endangered Species Program has been fortunate enough to have developed cooperative agreements or programs with all of the major landowners. We coordinate or conduct the many wildlife survey, research, and monitoring efforts. We provide for consistent annual surveys of the breeding avifauna unique to the islands. Some of this work is conducted through universities, some through volunteers, and some through cooperative efforts between state, federal, and private partners. Since each landowner has specific objectives, we work with them to provide the information they need as well as that which we need to maintain proper management perspective over the coastal resources state and region-wide.

K.Terwilliger, nongame coordinator, and Virginia Sheperd, editor of Viginia Wildlife Magazine, erect signing on Barrier Islands to protect beach nesting birds. Photo by Virginia Game Dept.

Our shorebird and colonial waterbird projects are examples this. We conduct marsh surveys and fund the College of William and Mary to conduct aerial surveys which we then compare to ground surveys conducted by an incredible set of volunteers who have conducted the survey for almost 20 years. Breeding plover surveys are conducted each year by the same Department biologists to again maintain observer consistency. Information gathered by these surveys is used to guide management actions and provide to the various landowners in the form of management recommendations. This information is also used to coordinate responses to proposed environmental impacts such as dredging and various forms of coastal development.

Results of these surveys indicate that Virginia has a total of 65,000 colonials nesting pairs of some 25 species. The brown pelican first bred in Virginia in 1989 and it appears that they have taken up permanent residence here. These islands support 131 pairs of piping plovers, one fifth of the United States Atlantic Coast population.

A tremendous research effort is underway through the Long-term Ecological Research Program of the University of Virginia. Supported by the National Science Foundation, researchers are studying the hydrology, geomorphology, and ecological dynamics of this unique system so that all partners can better understand and conserve this precious coastal resource.

These islands were also the home of the first peregrine falcons reintroduced to the Atlantic Coast. Isolated and relatively predator-free, they afforded adequate protection for nine hacking sites. Now almost 20 years later, each of those sites is occupied by a pair or individual bird and four sites continue to produce young. The Delmarva Fox Squirrel occurs in Virginia at only one site, on our largest barrier island, Assateague. An active nest box monitoring program has estimated a fairly stable population of around 250 individuals. Recent radio telemetry and ecological research at the site indicate that the squirrel occupies much smaller home ranges and territories than have been reported for other fox squirrels and Delmarva's elsewhere.

Recent genetic work conducted cooperatively USFWS through the Virginia Museum of Natural History show a great deal more variation than had been previously reported in a study of the genetics of the reintroduced populations in Virginia and Maryland.

With the recent listing of the tiger

beetle and sea beach amaranthe, the Virginia Department of Agriculture and Consumer Services will be joining the conservation team. Recovery efforts are consistent with other beach species and will help to complement existing efforts.

Virginia's barrier islands compose the southeasternmost landform along the Delmarva Peninsula. The natural funnel-shaped geography of this penninsula tends to concentrate tremendous numbers of fall migrating birds. The southernmost tip of the peninsula, at the mouth of the Chesapeake Bay, witnesseses the avian diversity comparable to Cape May at the mouth of the Delaware Bay. The importance of this southernmost tip was recognized by USFWS when the Eastern Shore National Wildlife Refuge was acquired. Banding and observation stations monitor our fall migrants each year as ever smaller numbers are banded; a downward trend has been documented since the early 1980's.

In view of international trends and increased concern for neotropical migrants, a four state initiative was designed to sample these fall migrants. This study, pioneered by the Virginia Department of Conservation and Recreation's Natural Heritage Program, sampled habitats and migrating birds in the hopes of identifying habitats or areas critical to them. Preliminary observations indicate that the islands are heavily utilized by migrating passerines and raptors alike.

Moving approximately 500 miles from the coastal plain, through the peidmont into the mountains of Virginia, we come to the second example of conservation partnerships. The coldwater streams and rivers of southwest Virginia have long been recognized as a hotbed of aquatic diversity. Twenty-nine species of endangered mussels and seven species of endangered fish rely on the high water quality and undisturbed stretches of these waters. Together with USFWS, local conservation groups, individuals, and The Nature Conservancy, VDGIF is working towards a coordinated approach to watershed protection. Studies are underway to determine the causative factors of faunal declines and active management is addressing those specific factors as identified. Programs to encourage landowners to maintain riparian buffers from grazing, agriculture, developments, and other land disturbing activities are being implemented.

Extensive conservation efforts and research on nest enclosures are used to protect beach nesters, such as this piping plover, from predators. Photo by Bob Cross.

Conservation of these important areas in Virginia are accomplished only through the united efforts of this nongame network, a blend of private, local, state and federal organizations. Virginia's emphasis will continue to be on the prioritization and coordination of these activities so that our limited financial resources can produce the most effective results. As we enter the 1990s and plan for the next decade, the most formidable challenge facing VDGIF and its Nongame and Endangered Species Program is securing a stable and adequate funding source. Time will tell how we are able to rise to that challenge.

Karen Terwilliger is Wildlife Biologist and Toni Harrison is Specialist in the Virginia Department of Game and Inland Fisheries, Nongame and Endangered Species Program.

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Laura Bischof is a graduate student in the Population and Evolutionary Biology Program at Washington University, St. Louis, MO.

Report From the Field

Surveying Wintering Loons from the Air

by Patrick G. R. Jodice

Little is known about the wintering ecology of common loons (*Gavia immer*). Although common loons are not federally listed, they are regarded in many states as threatened or species of special concern. Florida's Gulf coast represents one of the most important wintering areas for common loons in the United States. Hazardous spills and high winter mortality rates (Alexander 1991) highlight the need to increase our knowledge of wintering loon ecology.

As part of a larger conservation program focusing on Gulf coast habitats, the Nongame Wildlife Section (NGWS) of the Florida Game and Fresh Water Fish Commission conducted a pilot project during the winter of 1991-92 to develop survey techniques for wintering loons and associated seabirds. The objectives were to document distribution, define habitat use, and estimate densities of wintering common loons along Florida's Gulf coast. We would also record occurrences of other seabirds, dolphins, and sea turtles.

We chose the Gulf coast from Cedar Key (29°08'N, 83°02'W) to St. Joseph Bay (29°40'N, 85°20'W), a distance along the coast of about 280 km, as the pilot study area. This section of the coast included salt marshes, tidal creeks, rich estuaries, and barrier islands with sandy beaches.

We conducted loon surveys from fixed-wing aircraft. Wintering loons were relatively easy to spot and identify as long as we flew low enough (altitude of 60 m) and slow enough (ground speed < 90 knots). We flew only on days when whitecaps were not present (Beaufort Scale < 2) to standardize observation conditions. For ease of mapping and navigation, we plotted our transects on 5' or 10' latitude and longitude lines. Transect length ranged from 7.6-26.4 km and followed a "stair-step" pattern along the coast, taking us to 10 or 15 nautical miles offshore, then due north or south until we hit the coast again, and so on.

The pilot and I each scanned an unbounded corridor the entire length of the transect while a third person recorded data. Using basic trigonometric functions, we marked the struts of the aircraft to represent 25 m intervals on the water when flying at 60 m. This allowed us to estimate the distance of observed birds from the airplane and thus construct a distributional model to estimate density (Burnham et al. 1980). For each observation we recorded the flock size (i.e., total number of birds seen), side of aircraft (pilot or observer) observed from, perpendicular distance from aircraft to bird, and latitude and longitude as recorded from the aircraft's on-board LORAN C unit. Weather, time, tides, and glare conditions were also recorded. Water depth and distance to nearest land for each observation were recorded from National Oceanographic and Atmospheric Administration charts and GIS data. Data were preliminarily analyzed using program TRANSECT and SIZETRAN (Laake et al. 1979).

A total of 862 loons in 437 flocks were recorded during 8 flights over 1,828 km of transects. I pooled data from all flights and all transect lines to estimate a crude density of 1.13 flocks/km^2. As we expected, most flocks (85.6%) were of single loons and almost all flocks (99.1%) were ≤ 20 loons. Larger groups of 35 (n = 1), 50 (n = 3), and 200 (n = 1) loons were also observed. These large groups were in multi-species gatherings of loons, northern gannets (*Sula bassanus*), double-crested cormorants (*Phalacrocorax auritus*), gulls (*Larus spp.*), terns (*Sterna spp.*), dolphins, and sometimes sea turtles, and probably were centered on schooling fish.

Although we haven't yet analyzed all the data, some points stand out. Number of loons/linear km were greatest between Apalachee Bay/St. Marks National Wildlife Refuge (NWR) and St. George Sound. This area, a system with low wave energy, is dominated by shoals and reefs in the southwest section (where the greatest number of loons were observed) and receives drainage from four major rivers. The area is regarded as a rich estuarine habitat and one of the least polluted coastal regions of the continental U.S. It is possible that abundance of fishery stocks in the Apalachee Bay/St. George Sound area may increase loon use.

Number of loons/linear km seemed fairly consistent between Cedar Key and St. Marks NWR and a bit lower than numbers in the Apalachee Bay area. This area, known as the Big Bend, is dominated by marshes, tidal creeks, and sea grass beds and is characterized by almost zero wave activity. Distribution of loons relative to sea grass beds will be analyzed to determine if loons use this habitat type in proportion to its abundance. Because loons are visual predators, sea grass beds may be avoided if they reduce visibility and thus hunting efficiency. The fewest number of loons/linear km were observed in Appalachicola Bay and on the seaward side of the barrier islands along the Panhandle.

The NGWS plans on expanding wintering loon surveys over the next two years to cover the entire Florida Gulf coast. We will focus on the inshore waters of the Gulf of Mexico out to approximately 45 km (25 nautical miles). We hope to obtain some baseline data on occurrence of loons > 45 km offshore by making use of oceanographic surveys run by other state agencies or private charters. The possibility exists to develop a long term, periodic survey for wintering common loons along Florida's coasts.

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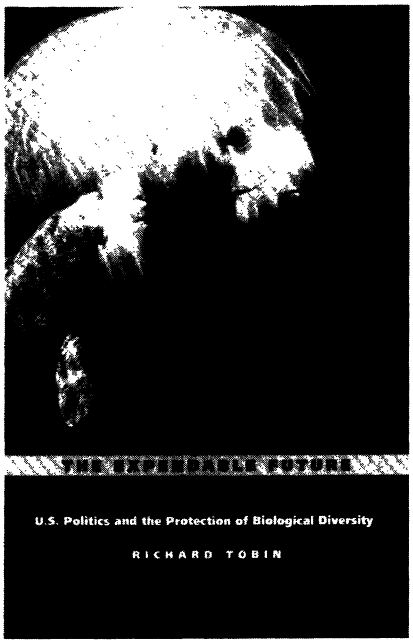
Patrick Jodice is a Regional Nongame Biologist with the Florida Game and Fresh Water Fish Commission in Lake City, FL 32055.

Book Review

The Expendable Future: U.S. Politics and the Protection of Biological Diversity

By Richard Tobin. 1990. Duke University Press, Durham NC. $18.75 paper, $45.00 cloth. x+325 pp.

Reviewed by Joel Heinen



Richard Tobin provides his readers with a thorough, detailed account of endangered species policy in the United States, from more general discussions on biodiversity, through the politics of allocating financial resources to endangered species programs, to the technical (and political) aspects of listing species, and back to more general issues on jurisdiction and assessing performance of such programs. It provides enormously useful insights about the political process itself.

The volume begins with several insights about protection of endangered species from a biological and societal standpoint, e.g. causes of endangerment, importance of some species in local and national economies, and rates of extinction in the modern world. This introductory chapter provides the background for some scientific aspects of the debate, but the strength and fascination of the book are found in the subsequent chapters devoted to the political process.

The import of the book begins in the second chapter. Tobin discusses the endangerment of species as a common property problem, and points out the truism that it is disaster which catches the public's, and hence the political candidate's eye. As such, the slow decline of populations of native flora and fauna are frequently not newsworthy compared to more compelling ecological problems. Tobin provides his framework for policy analysis in this chapter. The questions addressed are whether policies have been implemented as intended, and whether policies have achieved their stated goal.

The discussion on administrative capacities for action (Chapter 3) and financial considerations (Chapter 4) are particularly insightful. The Fish and Wildlife Service (FWS) is in large part responsible for endangered species programs. However, its larger constituency includes many pro-consumption forces (e.g. hunters and anglers), and its position as an agency within the largely pro-development Department of Interior provides some unique constraints to conservation. In addition, the budget cuts in the Carter, Reagan, and Bush administrations provided additional constraints, and it was in this climate that much of the history of endangered species programs in the U.S. emerged. The divided responsibilities of these programs are again addressed in Chapter 9, in which the integrated coordination of FWS and the National Marine Fisheries Service (NMFS) are addressed. Once again, the political balancing act of divided constituencies is the issue.

The chapters on listing species (5 and 6) are mostly historical descriptions, but several insights are provided about the scientific versus the political processes involved; earlier listings included mostly vertebrates, and it was only later, and with much more information, that attention was paid to plants and invertebrates. Chapters 7 and 8 discuss the need for integrated approaches to protecting habitats and the values of learning from past experience by describing some case studies (e.g. grizzlies in the Northern Rockies, the extinction of the Dusky Seaside Sparrow).

Perhaps the most interesting information is found in the last two chapters; assessing performance (Chapter 11) is particularly insightful. Tobin contends that depending on one's perspective, endangered species programs in the U.S. are either modestly successful or a massive failure. There have been more extinctions than recoveries since the Endangered Species Act was passed, but it is impossible to know how many extinctions there would have been had the act not been passed. Endangered species programs are stronger in the U.S. than anywhere else in the world, but the results are not always encouraging. There are definite trade-offs in the process: more recovery planning means less listing given the financial constraints, and both processes are necessary.

Tobin's volume takes an approach to policy analysis similar to Steven Yaffee's 1982 book (Prohibitive Policy. Cambridge:MIT Press), but provides somewhat more detail on the intricacies of the process and includes a good deal of information unavailable at the time of Yaffee's work.

With the upcoming reauthorization of the Endangered Species Act, this is an important book, but perhaps a bit too detailed for the general reader. As such it will be of interest mostly to conservation professionals, policy analysts, and historical and legal scholars interested in endangered species.

Joel Heinen is a former editor of the Endangered Species UPDATE, and currently lecturer at the Biological Station and Ph.D. Candidate in Natural Resources at the University of Michigan.

Bulletin Board

Notes from the Editor

USFWS Endangered Species Technical Bulletin

The Endangered Species UPDATE is thinner than usual this month because it does not include the USFWS Endangered Species Technical Bulletin. We will include the Bulletin as soon as it becomes available, which should be at the time of next month's issue.

Special Series to Begin

With this issue, we begin a Special Series on State Nongame/Endangered Wildlife Programs. During this year, various states' programs will be profiled through articles authored by professionals within their states. We will learn about the organizational structure and funding sources for these states' programs, as well as unique case studies of species conservation. If you would like to contribute an article for your state, please contact me.

Report From the Field/Technical Notes Column

We are happy to introduce this column with this issue. Reports from the Field and Technical Notes describe ongoing research, application of conservation biology techniques, species conservation projects, etc., at the local, state, or national level. If you are interested in contributing to this column, please contact me.

Changing of the Editors

The Endangered Species UPDATE has undergone an change in editorship. Alice Clarke, editor for the past year and a half, has resigned in order to devote her full energies to completing her dissertation, here at the University of Michigan. As incoming editor, I thank Alice for her editorial skill and dedication, making the UPDATE a continual source of endangered species information and ideas. In addition, Alice is largely responsible for procuring the material in our Special Series on State Nongame/Endangered Wildlife Programs. I wish Alice much success in her academic career.

Otto Gonzalez, Associate Editor, and I are proud to carry the torch onward for the UPDATE. We are both doctoral students at the University of Michigan School of Natural Resources. Our professional interests and personal commitments will serve as guiding forces in bringing you the news in this publication.

Please write to me with any comments about the UPDATE. I look forward to serving you.

Judy Tasse
Editor

Endangered Species Symposium

The Conservation Education Section of the North American Association for Environmental Education is sponsoring the Endangered Species Symposium for Educators, July 29–August 1, 1992, at Montana State University, Bozeman, MT. The symposium's goal is to provide a forum for the exchange of methodologies and information among education, industry, and natural resource professionals with the aim of fostering wise decision-making. For more information contact: Kurt Cunningham, c/o Montana Dept. of Fish, Wildlife & Parks, 1420 E. Sixth Avenue, Helena, MT 59620; (406) 444-1267.

Announcements for the Bulletin Board are welcomed.

Endangered Species UPDATE

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