Endangered Species UPDATE

Including a Reprint of the latest USFWS Endangered Species Technical Bulletin

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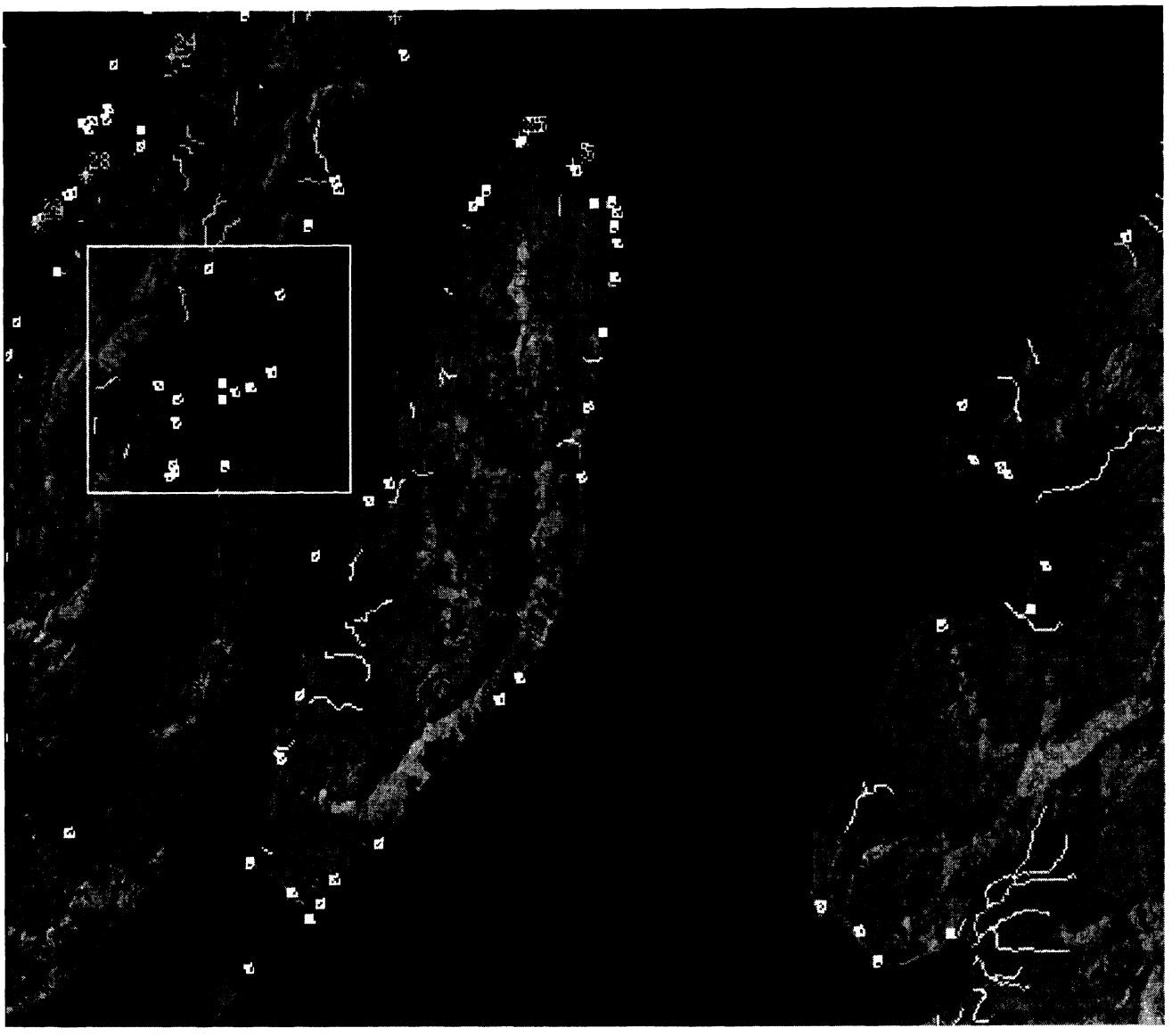

In this Issue

Remote Sensing, Geographic Data and the Conservation of Biological Resources

by

Richard Podolsky

We must rise above the earth to the top of the atmosphere and beyond, for only then will we fully understand the world in which we live. – Socrates

New Tools for an Old Trade

What astronomers tell us about the structure of our universe is continuously revolutionized by the development of new and more powerful telescopes. In much the same way, microbiology has been redefined by the development of the electron microscope. The same is true for ecologists. Some ecologists search for patterns in nature on their hands and knees with nothing more than a 10X hand lens, while others use satellite images to make observations about the earth's ecosystems. Both are "reading the landscape," but they come to very different conclusions because of the difference in the tools they use.

For ecologists few things can take the place of having one's feet firmly planted on the ground and having a good hard look around. But backing away and viewing the earth from above is at times crucial. This birds-eye-view is becoming especially critical because humans are increasingly having global impact on the earth's surface. Examples of global impact include the effects of greenhouse gasses on global weather, the effect of accelerating tropical deforestation on the earth's biodiversity, and the cumulative impact of urban development on open space and wilderness areas. To monitor these human-induced global changes requires being able to observe large sections of the earth simultaneously. For this task digital satellite imagery and other remotely sensed products hold significant promise. But until the recent advances in desk-top computers, accessing and analyzing digital earth imagery was possible only with main-frame computers and demanded specialized training.

How does an ecologist achieve this birds-eye-view of earth? Other than climbing a high hill or going aloft in an airplane, the primary way is through remotely sensed data such as aerial photographs or satellite images. Beginning in the early 1970s, large format digital images of the earth's surface were acquired by multispectral scanners on board the series of orbiting Landsat satellites launched by the United States. Digital images are computer generated pictures from multispectral data transmitted from the satellites to earth. More recently the French satellite SPOT has joined Landsat in the high resolution digital imagery market place. Japan and India have recently launched earth imaging satellites as well.

Remote Sensing for Conservation Biology

There are numerous aerial image products, both photographic and digital. The most common method of using photographic images is to "interpret" them by combining field and laboratory work. An ecologist or conservation biologist using aerial photos, a stereoscope and a planimeter can quantify surface features of a portion of the earth, but the process is a manual one and thus time consuming when applied to millions of acres and thousands of square kilometers.

For large sections of the earth, digital satellite imagery in concert with powerful desktop computers empowers individuals, not necessarily with discipline training in remote sensing, with the ability to analyze any digital image product. Ecologists who have access to this information-rich digital data will be able to make observations for large sections of the earth quickly and accurately.

Using digital satellite imagery makes especially good sense for large regions of the earth where habitats are threatened or where it is risky and costly to conduct on-the-ground surveys. These include remote wilderness areas, tropical rain forests, and oceanic islands. Island ecosystems, in particular, are among the most fragile landscapes on earth being inhabited by small, endemic populations that are inherently prone to extinction from habitat destruction.

Ecologists Inadvertently Excluded from Remote Sensing

Even though satellite images contain some of the best data about large regions of the earth, they are not routinely referenced by ecologists and land use managers let alone town managers and private land owners. Only research universities, government agencies, and large corporations have been able to use satellite images on a day to day basis. The irony is that satellite images contain some of the best data pertaining to a variety of earth resources, data that are needed more now than ever before.

Several years ago co-workers and I at the Island Institute, an environmental research center in Rockland, Maine, initiated a project to develop our own in-house software system to analyze and manage a library of digital images of Maine's 3,000 islands. With a Research and Development Grant from Apple Computer, Inc., we designed and developed a system to analyze SPOT and Landsat satellite images and aerial photos on a color-enabled Macintosh computer. We selected the Macintosh because of its graphical interface, affordability, and sophisticated graphic and imaging capabilities. We established several design constraints regarding the functionality of the software. Our goal was to be able to view, modify, enhance, and analyze digital images of any place on earth from our desk tops. The software we have developed is called GAIA, an acronym for Geographic Access, Image and Analysis (Podolsky et al 1990). GAIA Software was written

for the Island Institute by Bill Shelley and Francesco Antognini and, among features to be described below, integrates both raster and vector data with a relational data base. GAIA also allows users to easily create thematic maps critical to analyzing habitats for endangered species.

Image Acquisition

Earth imaging satellites such as SPOT and Landsat carry scanners that are similar to cameras. Like most cameras, the scanners in satellites are sensitive to differences in the light reflected off the earth. Vegetated areas will give a different reflectance from urban areas. Also, pine forests, broad-leaved forests, grasslands, agricultural areas, wetlands and bodies of water each give different reflectances because they absorb different amounts of light in various spectral bands. As the satellite passes over a ground receiving station, the digital data are downloaded to a central processing facility. But rather than storing these data on film, the data are stored digitally on magnetic tape and thus available for analysis and manipulation on a microprocessor.

GAIA software allows the display of both Landsat and SPOT images, which differ in their spectral and spatial sensitivities (Table 1.). The SPOT satellite has 4 linear arrays of sensors which detect radiation in 4 spectral bands. Purchasers of SPOT data can buy multispectral (MS) data that has a ground resolution of 20m or panchromatic data with ground resolution of 10m. The Landsat Thematic Mapper (TM) satellite can detect 6 spectral bands with ground resolution of 30m plus one thermal infra-red band with ground resolution of 120m. The Landsat Multispectral Scanner (MSS) can detect 4 spectral bands with a ground resolution of 80m.

Digital satellite images are ultimately composed of millions of tiny visual sub-units called picture elements or "pixels". Individual pixels can be seen on screen only at high levels of zoom. When viewed directly on a computer screen pixels appear as different colored "tiles" in a mosaic, in much the same way that Seurat's impressionistic paintings are actually composed of a multitude of tiny colored dots. Whether one is working with SPOT or Landsat images, these pixels represents a radiometric manifestation of a portion of the earth's surface. Similar pixels have similar radiometric manifestation or what is referred to as a reflectance "signature." The technology described here relies on two premises, first, that different pixels have a unique signature and second, that this signature is consistent for a given class of pixels regardless of their location in an image.

Satellite images can be purchased

Table 1. Specifications of SPOT and Landsat Satellite image products.

Satellite Image and Area Covered (km)	Spectral Bands (μm)	Which Part of the Spectrum	Resolution (m)
SPOT	0.50-0.59	blue	20
Multispectral (MS)	0.61-0.68	red	20
(60km X 60km)	0.79-0.89	near IR	20
Panchromatic	0.51-0.73	Panchromatic	10
Landsat	0.45-0.52	blue	30
Thematic Mapper (TM)	0.52-0.60	green	30
(180km X 180km)	0.63-0.69	red	30
	0.76-0.90	near IR	30
	1.55-1.75	short wave IR	30
	2.08-2.35	short wave IR	30
Thermal	10.3-12.5	Thermal IR	120
Landsat	0.5-0.6	green	80
Multispectral	0.6-0.7	red	80
Scanner (MSS)	0.7-0.8	near IR	80
(180km X 180km)	0.8-1.1	near IR	80

Endangered Species UPDATE

A forum for information exchange on endangered species issues
October 1992 Vol. 9 No. 12

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The Endangered Species UPDATE welcomes articles related to species protection in a wide range of areas including but not limited to: research and management activities and policy analyses for endangered species, theoretical approaches to species conservation, and habitat protection. Book reviews, editorial comments, and announcments of current events and publications are also welcome.

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 editor.

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Cover: GAIA software image overlaying streams and eagle nest locations (white boxes) on Landsat TM satellite image of south central Alaska. Land shows as gray, water as black. (Detail of box in Fig. 1, pg. 4; Photo credit as in Fig.1, pg. 4)

The views expressed in the Endangered Species UPDATE are those of the author and may not necessarily reflect those of the US Fish and Wildlife Service or The University of Michigan.

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Image Processing

When purchased on magnetic tape it is necessary, for two reasons, to process the data. First, the complexity of the data needs to be reduced and second, the data have to transcribed to a Macintosh compatible medium, e.g. 40 megabyte tape or Syquest cartridge.

There are a number of clustering algorithms, e.g. nearest neighbor or maximum likelihood, that can be employed to reduce the complexity of the raw data. Data clustering can be done using a variety of image processing software running on a Macintosh or a DEC/VAX computer. The result is that rather than 16 million possible combinations (3 eight bit bytes, or 256 cubed) for each pixel there are only 64 possible values, or classes. Each class may represent differences in vegetation, land use etc. Finally, a color is assigned to each of the classes to allow distinguishing them on screen.

Verifying the Image Classification

Like any remotely sensed data, processed digital imagery has to be verified or "ground truthed." Ground truthing entails visiting several locations or "training sites" and associating a surface feature with each class of data. Once all 64 classes have been visited and verified in the field the entire image is considered "classified."

The exciting part of the ground truthing process is that once a class of pixels is categorized as a particular surface feature or habitat, *all* the pixels of that class *throughout the entire image* are then identified. Rather than having to visit each and every point in a given image it is only necessary to ground truth a sample of pixel clusters. For example, the images included with this article cover two million acres of south central Alaska and were ground truthed by visiting 21 random sites in seven days of field work. The resultant classification of habitats were found to be 92 percent accurate when compared to photo-interpretation of aerial photographs of the same areas.

Because the satellite sensors are "sampling" the earth's surface vis-a-vis reflected radiation there is a chance for error. The major types of error include errors of omission, where the image fails to recognize and thus omits a surface feature that exists in the field, and errors of commission, where a selected pixel class incorrectly contains elements of other classes. The accuracy of any parameters derived from the classified images depends on the accuracy of the habitat classes. Consequently, data verification through ground truthing is critical.

Manipulating, Enhancing and Analyzing Images

GAIA Software enables the user to "paint" the screen with a full SPOT or Landsat image and then zoom in or out or pan to any portion of the image (see cover and Fig.1). A major feature of GAIA is its ability to analyze satellite images and derive precise acreage summaries for any and all pixel classes. GAIA accomplishes this by way of a pixel tally routine which sums the number of pixels in a selected portion of an image by class, converts the pixel count to acreage and outputs the data as an ASCII file. This analytical capability is the heart of GAIA because it allows the user to "ask" the Macintosh for the total acreage, or the acreage by pixel class for all or any portion of an image. These data are easily imported into other software environments for quick analysis and display.

Another capability of GAIA is the ability to incorporate graphic data files such as road maps, tax maps, and topographic maps. Such files are commonly used in Geographic Information Systems. These digitized maps are co-registered and overlaid onto the satellite images. This allows the user to build several layers of data on-screen and, for example, tag property ownership to a given habitat feature. Hence, we might know from analyzing pixels that a given landscape is one third wetland, but until we have overlaid the tax map we wouldn't know who owned the wetlands or the likelihood of their long-term preservation.

Outputting Images

There are several mediums, and numerous devices, for outputting color data from the Macintosh. These include color thermal printers, film recorders, pen plotters and ink jet printers. Each of these has their advantages but for outputting digital earth imagery I have found that film recording yields the highest resolution as well as outputs to a very flexible medium, photographic film.

Habitat Acreage Reports Aid Endangered Species Studies

In addition to outputting color maps, GAIA is capable of extracting acreage measurements of all habitats in both aerial photographs and satellite imagery. This feature allows one to conduct detailed studies of wetlands and other key habitats. Through this approach coworkers and I have ascertained that approximately one third of all wetlands on the south coast of Maine are in parcels that are less than ten acres in area, the minimum size needed to grant them protection (Podolsky and Conkling 1991, 1992).

Specifically, acreage reports allows endangered species biologists to address important questions that influence population viability. For example, if one knows the minimum area requirements for a given species than the acreage reports can be used to rank landscapes in terms of their ability to meet these minimum habitat needs. This can be an indispensable tool in deciding what lands to protect.

At the level of the ecological community, acreage reports can be used to directly measure landscape richness (Podolsky et al. 1992). This is based on the assumption that regions that contain a high diversity of habitats relative to other areas appear to support richer assemblages of plants and animals. All else being equal, landscapes of high diversity should be given a higher priority in terms of protection because by protecting them a greater number of species are covered.

Finally, if one has digitized maps that contain information on the location of critical populations these data can be overlaid onto the imagery to help guide

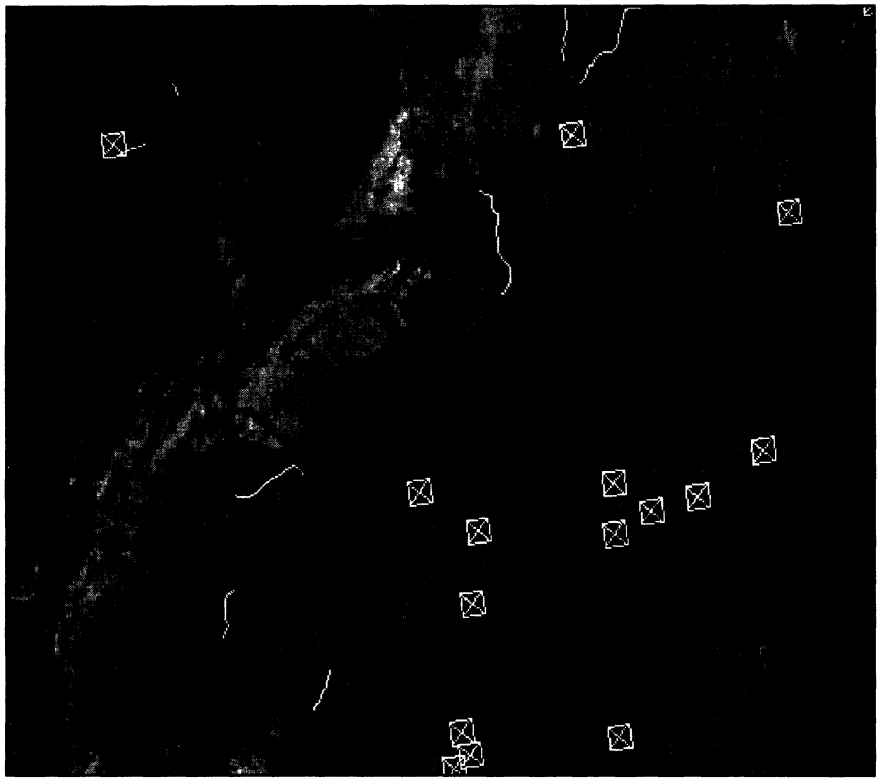

Figure 1. Detail of GAIA software image shown on cover. Overlay of streams (white lines) and eagle nests (x-squares) on Landsat TM image of Sawmill Bay area, Prince William Sound, Alaska. Water shows as black, wetlands as dark gray, drier areas as light gray. (Overlay data courtesy of Phil Schemps, USFWS; Landsat TM data courtesy of EOSAT Corporation; Image processing by GAIA Software.)

the acreage analysis. In this way one can easily measure habitat selection by comparing the habitats in close proximity to a given population or resource to the availability of habitats across the entire image. This approach allows biologists to say with confidence that a given species is "sub sampling" the environment by associating with a certain subset of all available habitats.

Implications and Conclusions

With GAIA Software the possibilities of analyzing critical landscapes anywhere in the world is greatly expanded (Podolsky and Conkling 1991, 1992). For example, it is possible to find out if the portion of a landscape set aside as a nature preserve is large enough to guarantee the preservation of critical biological resources. It is also be possible to confirm reported or ostensible data regarding land use practices. For example, tree felling on protected land could be identified. The extent of damage caused by a number of natural or human-induced disasters such as hurricanes, fires, or oil and toxic waste spills, could be quantified rapidly.

My co-workers and I have used SPOT and Landsat data and GAIA to map and analyze wetlands, deforestation, marine resources and tropical rainforests (Podolsky and Conkling 1991, 1992). It is also possible to monitor the rate of change in critical resources by conducting time series analyses on the pixel tally data derived from two images acquired several years apart.

In addition to being used as a tool for land use management, GAIA is also being used to address several basic research questions. One of these basic research areas is biogeography, a subdiscipline of ecology that explores the geographic underpinnings to the distribution and abundance of plants and animals. Analyzing acreage data exported from GAIA with a statistical analysis package facilitates testing a variety of biogeographic hypotheses. Some of the hypotheses I am testing include: to what extent is the diversity of a landscape a function of its size or location (Podolsky et al 1992)? How does the shape of a parcel of land or the distance it is to neighboring parcels influence what plants and animals are found there?

GAIA Software allows many life science professionals who have been unable to use satellite images because of cost or lack of technical expertise to now do so. In addition to conservation applications, any discipline that needs to analyze the surface of the earth and currently does so through aerial photography, stands to benefit from the capabilities described here. This includes, but is not limited to, cartography, geology, forestry, conservation and agriculture.

Winston Churchill once said that the further away from something one gets, the further into the future one sees. This was certainly the case with the first photographs of the entire planet earth sent home by the Apollo astronauts. These images had an immediate and lasting impact on how we perceive our watery planet. For the first time we could hold the entire earth in our mind's eye and see it for what it is, an island traveling through space with a finite cargo. It is hard to predict what impact easy access to high resolution earth imagery may have, but our hope is that it will allow us all to more intelligently manage this fragile island earth.

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Note: If you have questions regarding GAIA Software or if you would like to acquire the program, please contact Richard Podolsky at: GAIA Software, Inc., 235 W. 56th St. New York, NY 10019-4330. Tel. 212-246-4686; Fax. 212-246-6974.

Illinois' Endangered Species Program: An Innovative Approach

by

Deanna Glosser

The State of Illinois' endangered species program was born in October of 1972 when the Endangered Species Protection Act was enacted. The goals of this Act were to "prohibit the transfer, sale, and possession of products or skins of animals in danger of extinction, to create a Board to determine which species are endangered, and to provide penalties for violations of the Act" (P.L. 77-2186).

From the commencement of this protection effort, two entities have been responsible for the protection of endangered species within Illinois: the Endangered Species Protection Board (Board) and the Department of Conservation (Department). There were two major initiatives undertaken by these two groups within the first five years of passage of the Act.

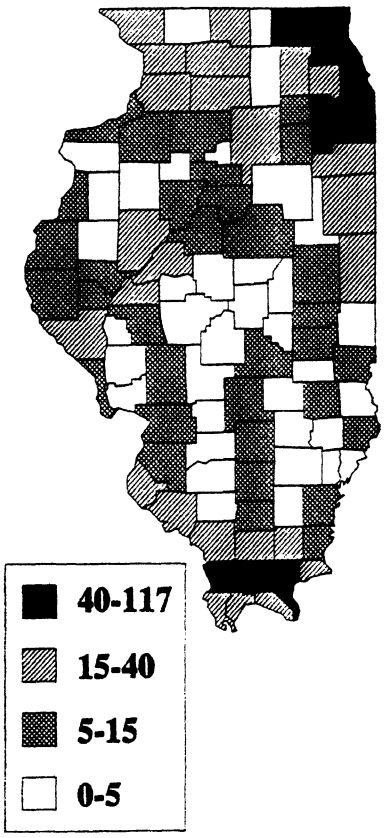


Figure 1. Map of Illinois showing the number of listed species recorded in each county.

The Endangered Species Protection Act Evolves

The first was the establishment of a permitting process for the possession and disposal of endangered species, including live animals and/or products. The species to be protected by this Act included such non-native species as the leopard, tiger, cheetah, polar bear, kit fox, green turtle, and members of the crocodile family.

A Board, composed on nine members appointed by the governor was also established by this Act. The Board was empowered to "designate additional species as endangered species, which it considers to be in practical danger of extinction in a wild or natural state" (P.R. 77-2186, Sec. 7). In 1977, the Board adopted an official state list of endangered species, constituting the second major initiative of the program.

The program continued evolving, with the hiring of a full-time staff person in 1978, and the initial listing of endangered plants in 1980. In 1985, revisions were successfully made to the Act that greatly enhanced the Department's ability to protect listed species. One of the most significant changes was a provision requiring state and local units of government to consult with the Department to determine the effects of their actions on listed species and their essential habitat. Other major revisions included extending protection to plants, and the addition of threatened animals for listing.

Although revisions were made to the Act in 1985, funding was not provided to the Department for implementation of the new provisions until fiscal year 1990, when four staff persons were hired. The initial goals of the Department's program were to promulgate rules for implementation of the consultation process and development of recovery planning strategies. The Board remained responsible for the listing of endangered and threatened species, and published a major revision in 1990. The Board's two-member staff also conducts species status surveys and assists the Department in protection efforts.

Species Status

There are currently 500 species listed as endangered or threatened in the state of Illinois: 356 plant and 144 animal species. The animal species include: 29 fish, 9 reptiles and 3 amphibians, 43 birds, 10 mammals, and 50 invertebrates. Of the 500 state listed species, 29 are also federally listed.

Several exciting discoveries have occurred in the past several years. A dragonfly species thought to be globally extinct, the Hine's emerald (*Somatochlora hineana*) was collected in the Des Plaines River corridor in Will County. Steps were quickly taken to add this species to the state list as endangered and to recommend it for federal listing. Studies are now underway to determine the critical habitat for this species as part of the federal listing process. Similarly, a significant population of a moth species thought to be globally extinct, *Papaipema eryngii*, was located in a large Department-owned prairie in northeastern Illinois. It, too, was added to the state list as endangered.

As demonstrated in Figure 1, the largest concentrations of listed species occur in northeastern and southern Illinois. For example, Lake County, located in far northeastern Illinois, has 299 known occurrences of 116 state listed species, whereas, Livingston County, located in central Illinois, has two known occurrences of only two species. The dramatic difference in numbers is directly related to habitat availability.

Forty percent of Illinois' listed species are wetland dependent. Some of the largest areas of wetlands are located in northeastern Illinois. For instance, 10.2% of the acreage in Lake County are

Table 1. Number of actions reviewed through the endangered species consultation process since July 1, 1990.

AGENCY	JULY 1, 1990-JUNE 30, 1991 (FY '91)	JULY 1, 1991-JUNE 30, 1992 (FY '92)	TOTAL
Local Governments	645	1,447	2,092
State Agencies			
Dept. of Conservation	316	223	539
IEPA	516	664	1,180
Dept. of Commerce and Community Affairs	0	110	110
Dept. of Military Affairs	0	23	23
IDOT	67	85	152
Document Review*	45	15	60
Information Requests*	89	160	249
TOTALS	**1, 678**	**2,727**	**4,405**

*Independent of the consultation requirement

natural wetlands compared with a statewide average of 2.6%. Wetlands within much of central Illinois have been converted, thus eliminating habitat for endangered species. Another factor that has allowed endangered species to persist in areas of intense development in northeastern Illinois is that vast acreages have been protected by forest preserve and conservation districts.

Protection Efforts

The Department is engaged in a wide variety of efforts to protect endangered and threatened species. These include: management, education, and land acquisition. Management activities include wetland enhancement, exotic species control, and prairie burns. The Division of Natural Heritage, which is responsible for the protection of wildlife exclusive of game species, and natural areas within the state, has seventeen field staff and eleven program staff working to protect the natural resources of the state.

The Endangered Species Program, within the Division of Natural Heritage, is involved principally in three activities: a consultation process with state and local agencies, the development of recovery plans, and education, with the consultation process having received the greatest attention since the inception of the program in February 1990.

The 1985 revisions to the Endangered Species Protection Act, required state and local units of government to consult with the Department to determine the effects of their actions on endangered and threatened species. In order to fully implement this provision, it was necessary to promulgate administrative rules, a time-consuming process. To facilitate implementation of this program with state agencies, then Governor Thompson signed Executive Order #7 in October 1985, which established the procedure for complying with the consultation requirement for state agency capital projects. This consultation closely mirrored the federal process.

In December 1990, the administrative rules for the consultation process became effective. One of the goals of the rules is to promote the conservation of listed species by establishing a policy often used in conjunction with wetlands protection: avoidance, minimization, and compensation. All adverse impacts should be avoided or minimized to the extent possible. When this is not practicable, attempts should be made to compensate for adverse impacts.

An issue of concern to all agencies was what actions would require review. Obviously, not all governmental actions would have the potential to impact an endangered species. Therefore, an action requiring review was defined as that which is performed, funded, or authorized by a state or local agency and that will result in a change in the existing environmental conditions. Examples include: municipal sewer and water lines, subdivision plats, and park development.

The requirements of the review process were kept to a minimum to minimize the time needed to complete the consultation process. A one-page Agency Action Report is submitted to the Department. The only information required for the initial review are the name and address of the applicant, the project location, and brief description of the proposed action. The Department has up to 30 days to complete this review process. To date, the average time required for the review is approximately two weeks.

The Natural Heritage Database is examined for known occurrences of listed species. If none are known to occur within the vicinity of the project, the Action Report is signed and returned to the municipality and the process is completed. If a listed species is known to occur, additional information is requested in order that potential impacts may be assessed. This may require the submission of preliminary plans, soil erosion control plans, or other construction plans. These materials are reviewed and if adverse impacts are anticipated, recommendations to avoid or minimize such effects are made by the Department. The Department has up to 60 days to complete this portion of the process.

The results of the review are returned to the municipality which consults with appropriate staff or the developer in the case of subdivision development. If the recommendations are acceptable, an agreement is signed and the process is terminated. If, however, there is disagreement, a meeting may be held to address the differences. Whatever the outcome of the meeting, the process is terminated and the project proceeds. The consultation process, therefore is mandatory, although the recommendations accepted through consultation are voluntary.

Since local and state agencies were notified of the new program in January of 1991, the Department has reviewed

4,405 actions (see Table 1). The largest percentage of these actions (52%) have originated from local agencies.

Of the 4,405 actions reviewed, approximately 2% involve endangered species. While this may seem to be a low percentage, it must be remembered that endangered species are rare and thus impacts to any population could have serious consequences to long-term survival. The consultation process allows the Department and the action agency to become aware of projects threatening state listed species and provides the opportunity to avoid or minimize damaging effects.

The most typical action reviewed by local agencies is a subdivision proposal. Recommendations made when listed species are present may involve: 1. inclusion of a buffer adequate to protect the species present. To maintain water quality for fish or plants this may mean a buffer of 50 to 75 feet; whereas to protect a nesting wetland bird species, a distance of 300 feet or more may be required; 2. use of a conservation easement with strict provisions such as lawn chemical and building prohibitions and requirement to maintain native vegetation; 3. the preparation of a longterm management plan for sensitive natural resources and a funding mechanism to implement the plan. This protects the listed species, future residents of the subdivision, and the municipality; from having to assume responsibility at a later time.

The consultation process has been in place for a relatively short period of time, so its success is difficult to assess; nonetheless, several brief cause studies can demonstrate the tremendous possibilities that exist for providing protection for endangered species from activities that would otherwise go undetected.

Wetlands and Roads Coexist

One of the first consultation projects undertaken involved a northeastern Illinois' local road project. A road was proposed for construction that would bisect a major wetland complex with at least two known listed species, the common moorhen (*Gallinula chloropus*) and the pied-billed grebe (*Podilymbus podiceps*). This road would result in the loss of wetlands through filling and the fragmentation of valuable wetland habitat. As a result of consultation, an agreement was reached that would: alter the wetland mitigation plan to create a larger wetland, prohibit construction activities adjacent to the areas where the birds are nesting during the months of April through June, install a water control structure and culverts to maintain adequate water levels and allow the movement of water, and the conducting of a bird survey after construction has been completed to assess the impacts of the road project. None of these conditions would have been possible without the consultation requirement.

Bird Breeding Habitat Protected

Another example of a project that underwent consultation also involves a wetland in northeastern Illinois. A developer proposed developing a property that contained 68 acres of high quality wetlands that provided breeding habitat for the yellow-headed blackbird (*Xanthocephalus xanthocephalus*) and feeding areas for the great egret (*Casmerodius albus*) which nested in the vicinity. Development was proposed without a buffer to protect the wetlands, including a highly sensitive peninsula. Recommendations were made to the developer that included a prohibition for developing the peninsula, and establishing a 250 foot buffer, which would require an increase in lot size to 3 acres (the land was currently zoned for 5-acre lots; the developer was requesting a decrease to 1-acre lots.)

Local citizens organized an effort to protect this valuable wetland and to ensure acceptance of the recommendations submitted through consultation. At a public hearing, program staff provided an overview of the value of the wetland and the presence of endangered species. The planning commission vetoed the plan as presented and made recommendations to the developer that represented an acceptable compromise to that originally proposed by the Department. This development proposal has recently been withdrawn from consideration. While a proposal may be brought forward again, the consultation process will ensure that discussions take place to protect the endangered species that exist on the site.

The statutory obligation for a state and local agency to consult with the

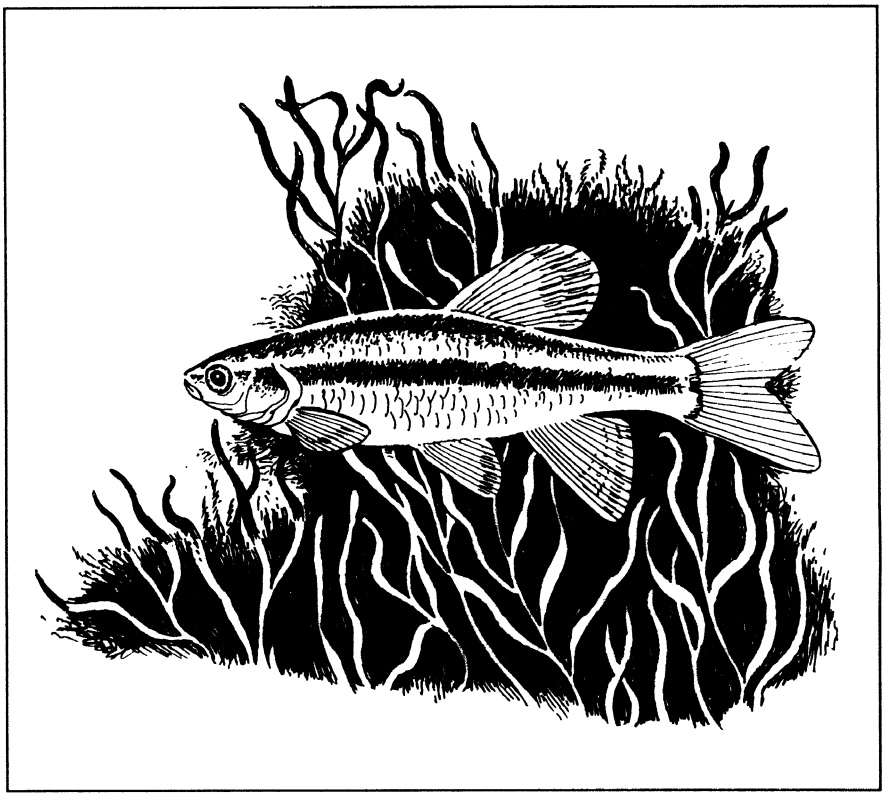


Figure 2. Bluehead shiner (*Notropis hubbsi*). Illustration by Bob Eschenfeldt, provided by the Illinois Department of Conservation.

Department offers a unique opportunity to protect endangered and threatened species. Although the recommendations are not binding, the program is not burdened with the stigmas associated with a regulatory program. Acceptable resolution can often be reached if the local governmental unit, the residents, and other parties, such as the development community, approach the consultation process in a cooperative spirit.

An exciting outcome of the consultation requirement is a Memorandum of Understanding that the Department entered into with a local unit of government to protect endangered species. The Village of Barrington Hills, located in northeastern Illinois, became the first community to agree to conduct surveys of potential habitat for state listed species and to prepare management plans for all sites identified. In exchange, the program staff will provide the information necessary to identify areas to be surveyed and accepted survey methodologies. Upon completion of the survey, the community will be required to submit Action Reports only for actions affecting the sites identified. When the management plans are finalized, Barrington Hills will have assumed responsibility for protecting the state listed species occurring within its boundaries. This represents the first legal agreement between a state agency and a local governmental unit to protect endangered species. Other communities will be offered the same opportunity in the coming months.

Recovery Plans: Bluehead Shiner and Eastern Woodrat

Although the consultation process has consumed vast amounts of time in the past two years, recovery efforts have also been underway. One reintroduction effort was completed in the spring of 1992, and two recovery plans are in the early planning stages.

The reintroduction effort involved the bluehead shiner, *Notropis hubbsi*, (see Figure 2), an endangered species that had not been identified in the state since 1974. This species had only been known from two locations in far southern Illinois. Donor populations were known to exist in Arkansas, Louisiana, and eastern Texas. In early May of this year, researchers from Southern Illinois University in Carbondale collected approximately 1,035 bluehead shiners and released them into one of their historic breeding sites. Monitoring six weeks after the release indicated the presence of adult fish, although no juveniles were found. Monitoring will continue until July 1993.

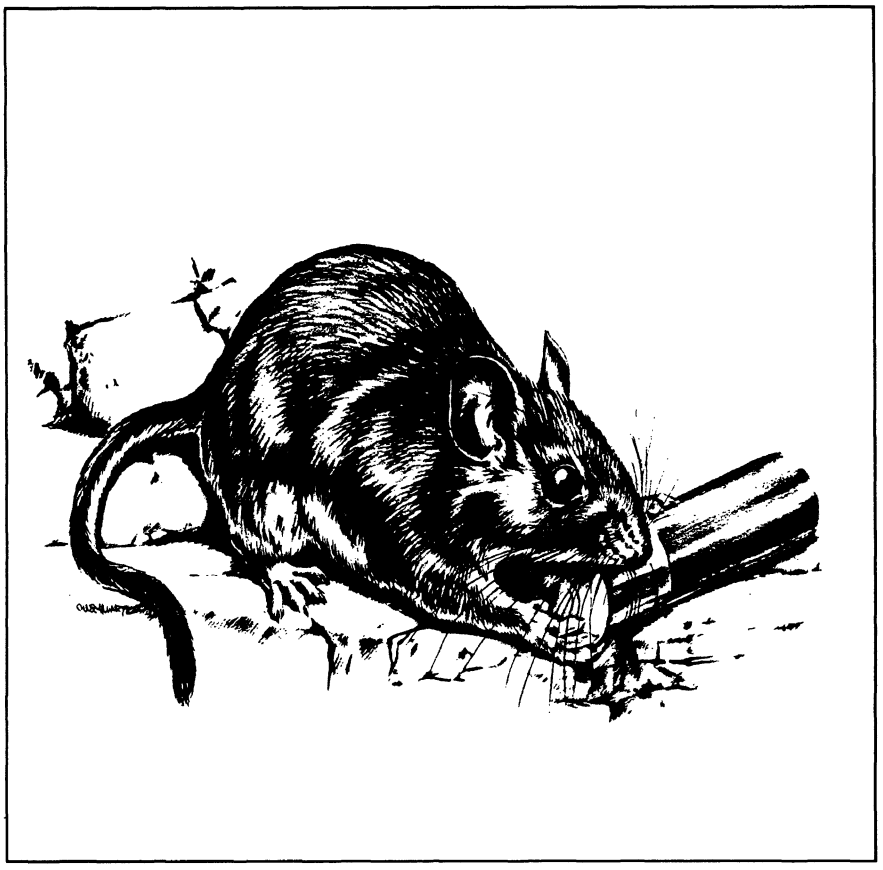


Figure 3. Eastern woodrat (*Neotoma floridana*). Illustration by Charles Schwartz, copyright c.1960 by The Conservation Commission of the State of Missouri. Reprinted by permission.

A recovery plan for the eastern woodrat (*Neotoma floridana*), (see Figure 3), is being developed cooperatively by the U.S. Forest Service staff on the Shawnee National Forest, Southern Illinois' Department of Zoology, the Endangered Species Protection Board, and the Department of Conservation. Woodrat populations have declined precipitously in the northern part of its range. Two elements of examination are currently underway. One project will involve an intensive examination of the one population that exists in order to determine the cause of the decline in numbers. The second will explore the advisability of reintroducing the woodrat into its former range in the eastern Shawnee Forest. Results of these studies should be available within the next year.

A second recovery plan now in the initial planning stages, moves away from the simple species approach to an ecosystem approach. A methodology has been developed to prepare a recovery plan for wetland-dependent species within the state, with rookeries serving as the basis for examination. This approach is being explored because 40% of the state's endangered species rely on wetlands for some portion of their breeding success and Illinois has already lost 89% of its wetlands.

It is hoped that Illinois' program will continue to expand to strengthen its protection of endangered species. With the transfer of a staff person to this program this fall, greater efforts can be directed to recovery strategies and educational activities, both of which are important components of a protection program.

Deanna Glosser is the endangered species program manager for the Illinois Department of Conservation. She earned her doctoral degree from the Department of Urban and Regional Planning, University of Illinois, Champaign-Urbana.

Report From the Field

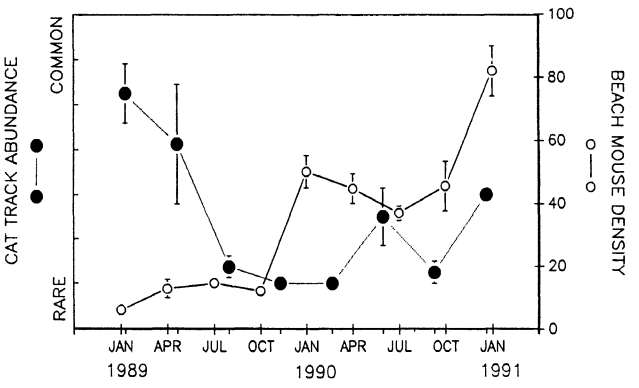
Conservation and Ecology of the Anastasia Island Beach Mouse

by Philip A. Frank

Beach mice are subspecies of the common and widespread oldfield mouse (*Peromyscus polionotus*). These small, nocturnal rodents inhabit sandy beaches along the Gulf coasts of Florida and Alabama, and the Atlantic coast of Florida. Compared to the oldfield mouse, beach mice are very pale in coloration, closely matching the beach sand where they are found. They are habitat specialists, occurring only on beach dunes bordering the coast, and require relatively pristine conditions for their survival. As a result of beachfront development throughout much of their range, the habitat has been greatly reduced and fragmented, and most subspecies are in peril. Of the eight recognized subspecies, five are federally listed as either endangered or threatened, and one form is believed extinct.

The Anastasia Island beach mouse (AIBM, *P.p. phasma*) is restricted to a 14 km barrier island in northeast Florida, although the historic range once extended northward beyond the island for several kilometers. The AIBM was listed as endangered by the U.S. Fish and Wildlife Service (USFWS) and the State of Florida in 1989. I have been studying the ecology of the AIBM on Anastasia Island since 1988 in association with the University of Florida, the Florida Museum of Natural History, and the Florida Game and Fresh Water Fish Commission. The goals of the study are to obtain long-term data on population ecology of the beach mouse for use in developing sound management strategies.

The distribution and abundance of beach mice was determined by live-trapping mice on a series of grids and transects located over the length of the island in a variety of habitat conditions ranging from pristine dunes to severely degraded habitat adjacent to development. Trapping was conducted quarterly from January 1989 to January 1991. Beach mice were distributed over nearly the entire island, with the exception of an area where natural habitat had been replaced with seawall. However, potentially viable populations are believed to occur only at two locations where habitat disturbance was minimal. Luckily, these sites are publicly owned with management sensitive to the needs of beach mice.



Relative abundance of cats, and beach mouse density (mice/ha), from Jan. 1989–Jan.1991. Figure shows standard errors around the mean values.

Beach mouse populations are characterized by a high degree of variability, both among sites within seasons and between seasons. Densities in high quality habitat ranged from 2 mice/ha to 90 mice/ha over the period of study, with an average density of around 30 mice/ha. Densities in degraded habitat were generally about half that of pristine habitat. This difference may have been caused in part by poor habitat, but predation by domestic cats abundant in habitat adjacent to residential development is believed to be a major factor.

Additional evidence that domestic cats depress beach mouse populations was observed at Anastasia State Recreation Area. (See Figure.) During January 1989, a period of typically high beach mouse density, cats were abundant as determined by track counts. Following a reduction in cat numbers by park personnel by October 1989, beach mouse density increased and remained high throughout the remainder of the study. That domestic cats can seriously affect wildlife populations is common knowledge to most field biologists, but documentation in the field is all too often lacking.

Possibly the greatest threat to the beach mouse population on Anastasia Island is the loss of the entire population to a catastrophic hurricane, such as Hurricane Hugo, which devastated the Carolina coast in 1989. To reduce this threat, a second population is being established at Guana River State Park located within the historic range of the AIBM on an adjacent barrier island several kilometers to the north. Using methods developed in a previous beach mouse reintroduction (Holler et al. 1989), twenty pairs of mice from Anastasia Island have been relocated to Guana River State Park in early October. Funding for the reintroduction was provided by the USFWS. The reintroduced population will be monitored at regular intervals over this next year. Success will be determined by the persistence and expansion of the population. It is hoped that the establishment of a second population will significantly enhance the probability for long-term survival for this unique mammal.

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Ivey, R.D. 1949. Life history notes on three mice from the Florida east coast. J. Mammal. 30:157-162.

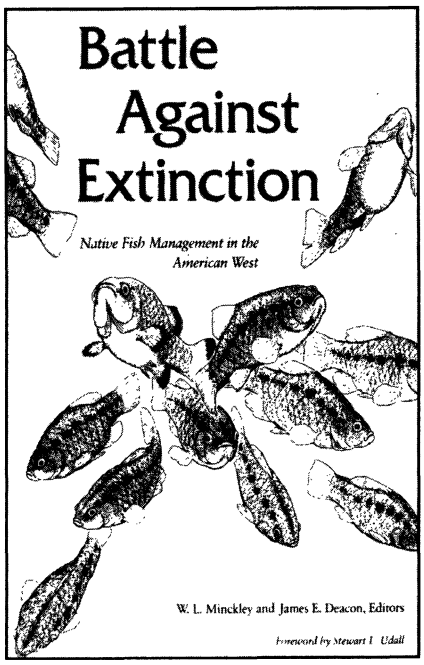
Philip A. Frank is a graduate student in the Department of Wildlife and Range Sciences at The University of Florida, Gainesville, Florida

Book Review

Battle Against Extinction:
Native Fish Management in the American West

Edited by W.L. Minckley and James E. Deacon. 1991.
University of Arizona Press, Tucson, AZ. $40.00 518 pp.

Reviewed by Jeffrey S. Schaeffer



One of the great biogeographical surprises of this century was the discovery that the American West supported a diverse fish fauna. Much of this area is now arid, but at the close of the Pleistocene it was well watered and aquatic habitats were widespread. A series of vast climactic and geological disruptions resulted in the formation of four major desert systems, and trapped fishes in isolated springs, groundwater seeps, lakes, and major river systems.

Speciation within these habitats resulted in the development of many endemic subfaunas. Perhaps the best known example is the Devil's Hole pupfish, which is confined to a single spring located in the heart of Death Valley, California. Many of these species are now imperiled through water development, habitat loss, and the introduction of non-native fishes.

Today, 122 of the estimated 170 species found west of the Continental divide are considered to be in some danger of extinction. *Battle Against Extinction* is a comprehensive treatment of the biological, social, political, and legal issues surrounding the conservation, management, and survival of this fauna.

The 20 chapters of this book include contributions by individuals from Universities, Federal and State agencies, and the private sector. This enhances the volume because many different jurisdictions and points of view are represented.

Chapters 1 and 2 present an overview of the ichthyological exploration of the American West, and an analysis of the problems currently experienced by the western fauna.

The next six chapters deal with the complex social, political, and legal issues surrounding the conservation of endangered fishes and their habitats, and include discussions of ethics and detailed case histories of good and bad management practices by Federal and State agencies.

Chapters 9 through 14 discuss management techniques for endangered fishes, and include chapters on genetic diversity, preserve design, the role of hatcheries, and habitat improvement. This section also contains an overview of the status of the Mexican fauna, and attempts by the Mexican Government to preserve it.

Chapters 15 through 19 examine conservation programs for desert pupfishes, and the faunas of the major river systems. The final chapter provides a summary and overview.

Unlike many volumes compiled by individual authors, there is a coherence to the individual chapters that makes the total work greater than the individual parts. There are no poorly written chapters, and information is presented in an organized fashion using clear tables and figures supported by extensive literature citations. In addition, the information presented here has applications beyond the preservation of western fishes.

Much of the published work in the field of conservation biology has focused on management of terrestrial organisms and habitats; information on aquatic species and their habitats has been scarce. *Battle Against Extinction* corrects this problem by providing numerous case histories, detailed analyses of issues and management tools, and unbiased evaluations of successes and failures. The information presented in the book should be useful to any fisheries scientist involved in endangered species work, and many individual chapters would be useful to teachers in search of readings that illustrate aquatic biodiversity issues.

One thing to keep in mind when reading this book is that many populations of native fishes still exist only through the efforts of a few dedicated individuals who fought for their protection. Many of the battles were won long before the passage of the Endangered Species Act and the emergence of conservation biology as a specific discipline. Some of the contributors placed their careers in jeopardy by acting as advocates for species that no one else valued. *Battle Against Extinction* is a tribute to their efforts, and the quality of the writing reflects their personal commitment. This book will be a valued addition to my personal library, and I highly recommend it to any person interested in biodiversity issues in aquatic ecosystems.

Jeffrey S. Schaeffer is a Ph.D. candidate studying community ecology and energetics in the School of Natural Resources and Environment at the University of Michigan, Ann Arbor, MI 48109-1115. He has a strong interest in the biology of endangered and threatened fishes.

Bulletin Board

Scholarships for Tropical Botany Research Available

The Garden Club of America is offering two $5,000 awards to assist with field work in the area of conservation of tropical botany for graduate students conducting doctoral dissertation research. Applications are due December 31, 1992. For application procedure write: Lori Michaelson, World Wildlife Fund/Garden Club of America Scholarships in Tropical Botany, World Wildlife Fund, 1250 24th St., NW, Washington, DC 20037.

Environmental Education for Preschoolers

Environmental Education for Preschoolers is a new organization focusing on the development, expansion, and evaluation of quality programs in early childhood environmental education. The network is designed to be international and multicultural in scope and sponsors information-sharing meetings and written communications. For further information, or to submit material for the network's newsletter, contact Dr. Ruth Wilson, 418 Education Building, Bowling Green State University, Bowling Green, OH 43403; (419) 372-7278.

Understanding Chimpanzees: Diversity and Survival

This publication of conference abstracts examines the behavioral diversity and survival of chimpanzees and bonobos, both in the wild and in captivity. The abstract topics include social behavior and ecology, cultural traditions, and cognitive abilities. Abstracts addressing survival examine population status in the wild, threats to habitat and survival, development of sanctuaries, and conservation and care in captivity. The publication is 56 pages and costs $4.50, available through The Chicago Academy of Sciences, 2001 N. Clark St., Chicago, IL 60614.

Job Opportunity at TRAFFIC

TRAFFIC, (Trade Records Analysis of Flora and Fauna in Commerce), seeks a Program Officer to initiate and supervise projects and research relating to policy, wildlife conservation, and status and management of species subject to trade and utilization. Qualifications: Master's or Doctoral degree in botany, ecology, wildlife biology, conservation biology, or resource management; at least 2 years experience in field ecology, wildlife management, natural resources management or related conservation work. At least 1 year of experience directly related to wildlife trade or management is necessary. Fluency in English and at least one other language preferred. Public policy experience desired. Send cover letter and resume to: World Wildlife Fund-US, Human Resources Dept., 228M, 1250 24th St., NW, Washington, DC 20037; FAX (202) 293-9211.

USFWS Endangered Species Technical Bulletin

The latest Technical Bulletin was published in the July/August 1992 issue of the *Endangered Species UPDATE*. Once the USFWS produces the next Technical Bulletin, it will be featured in the *UPDATE*.

Announcements for the Bulletin Board are welcomed. Some items from the Bulletin Board have been provided by Jane Villa-Lobos, Smithsonian Institution.

Endangered Species UPDATE

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