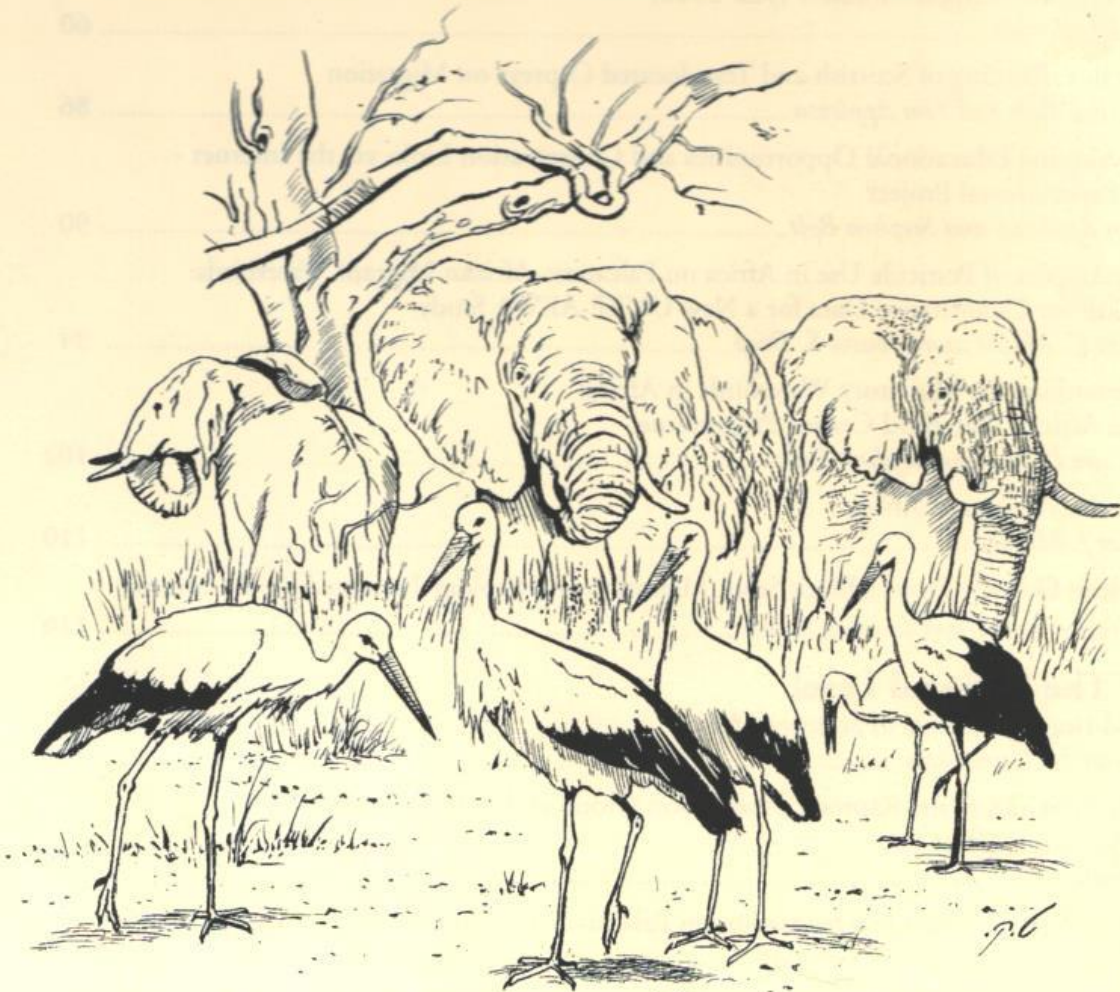




Wings Over Africa

Proceedings of the International Seminar on Bird Migration:
Research, Conservation, Education and Flight Safety
Israel, April 29 - May 11, 2001

Editors: Yossi Leshem, Albert Froneman, Peter Mundy, Hila Shamir



Cover and Black & White Drawings by Tuvia Kurtz

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Satellite Telemetry for International Conservation, Health, and Education

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Abstract

The world's natural resources, and migratory birds in particular, transcend national borders. Space-based radio tracking and monitoring plays a significant role in basic research of free-ranging animals on a global scale. Remote monitoring reveals to us the natural history of species, and it contributes to our research of many contemporary questions and problems. We are using satellite biotelemetry for research issues pertinent to public and environmental health problems, and we educate the public with the results from our study of ecology, conservation, and health.

Significant numbers of white-faced ibis breeding at Carson Lake, Nevada continue to be burdened with high levels of DDE, the principal metabolite of DDT, even though no organochlorine insecticides have been found there. We radio marked ten ibis at the breeding colony and tracked them to wintering areas in California's Central Valley and in Mexico. Analyses of invertebrates upon which ibis are feeding at these winter sites are expected to identify source(s) of contaminants and allow remediation. We initiated a study to assess how migratory common loons would be affected by the loss of the fishery at Walker Lake, Nevada. This fishery may collapse in the near future due to increasing salinity of Walker Lake. In addition to this threat, we found the highest mean blood mercury levels documented in loons in North America. Furthermore, the mercury content in the fish that the loons eat exceeds safe levels for consumption by humans who also capture and eat fish from Walker Lake. Thus, the mercury contamination poses a human health threat in addition to an avian health threat. To understand the population effects of the potential loss of prey (i.e., the fishery) and of mercury contamination, one technique we have employed is satellite telemetry to track the migrant loons to their Canadian breeding area and their suspected Mexican wintering area.

We describe and compare the migration routes and wintering areas of broad-winged hawks and Swainson's hawks, tracked throughout the Western Hemisphere using the Argos satellite system. Information linking wintering ground distribution with migratory flyways and breeding grounds is used for resource management and the

conservation of these raptor species. Migratory birds know no political boundaries, and their conservation requires a global effort.

We want to use migratory birds as a symbol, and bird conservation as an example, of the value of international cooperation. We have initiated a joint project of sharing technology and its application to research studies, such as those we have described, for cooperative research and education projects among countries in the Middle East and North America. The educational program will create a global network of children working together to protect shared natural resources. Through the Internet, video conferencing, and student exchanges, children can learn about each other's ecosystems and cultural and natural treasures. We will develop an interdisciplinary, web-based curriculum supported by software that allows children to utilize science and technology to map the movements of birds through habitats in both hemispheres. Communication among schools in the Eastern and Western Hemispheres will allow children to compare parallel migrations of birds on both sides of the world. Our integration of science, technology, and education will create a global network of children learning about each other, the world in which they live, and conservation of their invaluable natural resources.

Résumé

Les ressources naturelles du monde et les oiseaux migrateurs en particulier, dépassent les frontières nationales. La radiométrie spatiale et le suivi jouent un rôle significatif dans la recherche fondamentale sur des animaux vivant en liberté sur une échelle mondiale. Le suivi à distance révèle l'histoire naturelle des espèces, et ceci contribue à notre recherche sur plusieurs questions et problèmes contemporains. Nous sommes en train d'utiliser la bio-téléométrie par satellite pour mener la recherche sur les problèmes auxquels font face la santé publique et environnementale, et nous éduquons le public en utilisant les résultats de notre étude de l'écologie, de la conservation et de la santé.

Le nombre important d'Ibis à face-blanche se reproduisant sur le Lac Carson, Nevada, continue d'être perturbés par des taux élevés de DDE, le métabolite principale du DDT, même si aucun insecticide organochloré n'y a été retrouvé. Nous avons télégraphié 10 Ibis dans la colonie de reproduction et les ont suivis aux sites d'hivernage dans la Vallée Centrale de la Californie et au Mexique. Les analyses des invertébrés sur lesquelles ces Ibis se nourrissent dans les sites d'hivernage aideront à identifier les sources des contaminants et permettront à formuler des solutions.

Nous avons initié une étude pour évaluer comment les grèbes seront affectés par l'absence de la pêche sur le Lac Walker, au Nevada. Cette pêche risque de s'effondrer dans un proche avenir à cause d'une augmentation de la salinité du Lac Walker. En plus de cette menace, nous y avons trouvé la moyenne la plus élevée du niveau de mercure dans le sang enregistré dans les grèbes de l'Amérique du Nord. De plus le contenu de mercure dans le poisson que les grèbes mangent, dépassent les niveaux acceptables pour la consommation par l'homme qui pêche aussi dans le Lac Walker. Ainsi, la contamination de mercure représente une menace aussi bien à la santé humaine que la santé avienne. Pour comprendre les effets de la population sur la

perte potentielle de proies (c-à-d la pêche) et de la contamination du mercure, nous avons utilisé une technique, de télémétrie par satellite, pour suivre les grèbes migrateurs de leurs sites de reproduction au Canada à leurs sites d'hivernage habituels au Mexique.

Nous décrivons et comparons les routes de migration et les sites d'hivernage des petites buses et Buse de Swainson, suivi partout dans l'Hémisphère Ouest en utilisant le système de satellite «Argos». L'information liant la distribution terrestre des quartiers d'hivernage aux routes de migration et sites de reproduction est utilisée pour la gestion des ressources et la conservation de ces espèces de rapaces. Les oiseaux migrateurs ne connaissent pas les frontières politiques, et leur conservation demande un effort global.

Nous voulons utiliser les oiseaux migrateurs comme un symbole, et la conservation des oiseaux comme un exemple de la valeur de la coopération internationale. Nous avons initié un projet conjoint pour le partage de la technologie et son application aux études de recherche, comme montré ci dessus, pour la recherche coopérative et pour les projets d'éducation parmi les pays du Moyen Orient et de l'Amérique du Nord. Le programme d'éducation va créer un réseau global des enfants travaillant ensemble pour sauvegarder les ressources naturelles utilisées en commun. Par le biais de l'Internet, conférence-vidéo et échanges estudiantines, les enfants pourront étudier les écosystèmes des autres pays, et les trésors culturels et naturels. Nous allons développer un curriculum basé sur le web et interdisciplinaire soutenu par un disque dur qui permettra aux enfants d'utiliser la science et la technologie pour suivre les mouvements des oiseaux dans les habitats des deux hémisphères. La communication parmi les écoles dans les hémisphères de l'Est et de l'Ouest, permettra aux enfants de comparer la migration parallèle des oiseaux sur les deux côtés du monde. Notre intégration de la science, de la technologie, et d'éducation créera un réseau global pour des enfants qui apprendront à se connaître les uns les autres, du monde dans lequel ils vivent, et de la conservation de leurs précieuses ressources naturelles.

White-faced Ibis Studies

The white-faced ibis (*Plegadis chihi*) is a long-legged wading bird that feeds primarily on invertebrates in wetlands and irrigated croplands. They are highly social colonial nesters and often forage in large aggregations. Due to restricted nesting habitat and potential vulnerability to pesticides, this species is listed by the U.S. Fish and Wildlife Service as a migratory non-game bird of management concern.

Continued troubling levels of DDE have been documented by Dr. Charles Henny (United States Geological Survey; USGS) in a large segment of the white-faced ibis population nesting at Carson Lake in western Nevada. Of twenty eggs collected in 1996, 45% contained >4 ppm DDE, and eggshells averaged 18.3% thinner than normal. This represented no improvement from DDE levels documented in 1985-86, which is contrary to patterns shown for most other avian species in the USA. Analyses of upper digestive tract contents in 18 Carson Lake ibis revealed no organochlorine insecticides; the conclusion is that

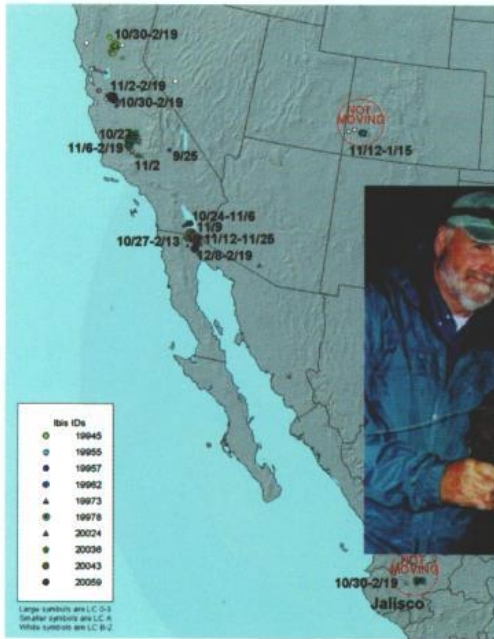
DDE/DDT contamination is not occurring on the Nevada breeding grounds. Identification of contaminant sources is highly desirable because it is likely that different regional cohorts of ibis and other wildlife species are frequenting those same areas.

Accordingly, the Center for Conservation Research & Technology (CCRT), the Raptor Research Center of Boise State University, USGS, U.S. Fish and Wildlife Service, and Nevada Division of Wildlife conducted a pilot study in 1997 to determine whether white-faced ibis could be tracked via satellite-received telemetry. This was part of another study funded by the Department of Defense (DoD) Legacy Resource Management Program. Two ibis were successfully tracked via satellite. This proof-of-concept led to an investigation into source(s) of DDE contamination in ibis, which are known to frequent various DoD lands throughout the western United States.

In early May 2000, with our cooperators, we captured 15 white-faced ibis from the vicinity of a nesting colony at Carson Lake, NV. Ten birds were marked with 20g Platform Transmitter Terminals (PTTs). Blood samples (~1ml) were taken from the brachiocephalic vein. PTT transmissions were received by Argos satellites, and location estimates relayed to CCRT. To conserve battery energy to obtain locations after the birds left the breeding area, we programmed the units in an unconventional manner. During the breeding season, the PTTs transmitted only six hours every two weeks, while we hoped to maintain battery integrity with minimal loss of capacity. The PTTs were programmed to begin transmitting eight hours every three days in October, near the time our subjects should be departing the breeding ground. The plan was a success, and eight PTTs produced high quality locations for the detailed information we needed to identify potential sources of DDT.

Three of our ten migrating birds had high levels (range 0.38-0.67 ppm) of blood DDE, and four others had low levels (range 0.025-0.116 ppm). Winter fieldwork began in January of 2001. Using the most accurate Argos location data to guide us, we visited the wintering sites of our sentinel ibis from Carson Lake and collected samples of invertebrates where ibis were feeding. We have made necessary collections from sites near Guadalajara, Mexico and in California's Central Valley between the Bakersfield and Yuba City areas. During these visits we documented associated bird life, habitat characteristics, and farming practice. Sampling at the winter locales of the remaining two subjects will be conducted during January of 2002. Those two individuals, wintering in Mexico (Colorado River Delta area), had high DDE blood levels. Of the entire sample of 10 ibis tracked via satellite, PTT sensors indicate that one subject died in western Colorado during migration and either another bird is possibly dead, or the PTT is off in Jalisco State, Mexico.

Samples of prey from the winter areas may reveal significant sources of contaminants posing a threat to numerous species. As hereafter related, the DoD and CCRT made significant technology contributions to a recent study that revealed and prompted mitigation of organophosphate pesticide poisoning of thousands of Swainson's hawks in Argentina. The parallels between these studies are undeniable and compelling.



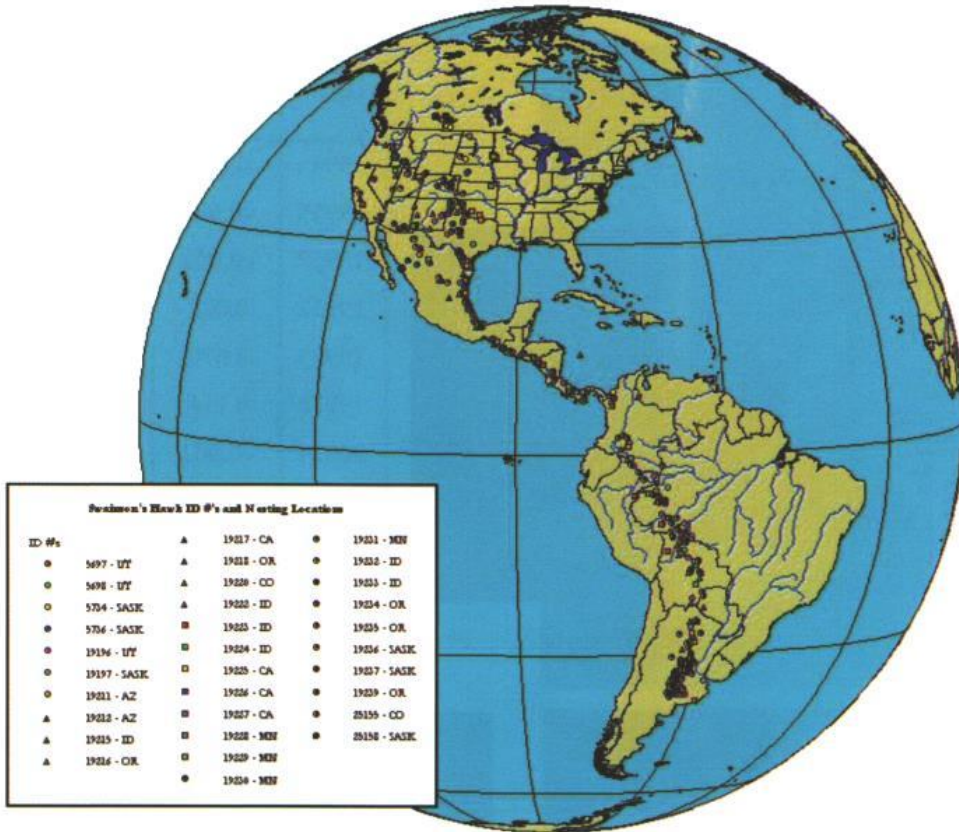
PTT ID	Detected Level (ppm)	Rating
19945	0.380	High Level
19955	<0.002	No detect
19957	<0.002	No detect
19962	0.027	Low Level
19973	0.670	High Level
19978	0.116	Low Level
20024	<0.002	No detect
20036	0.062	Low Level
20043	0.670	High Level
20059	0.025	Low Level



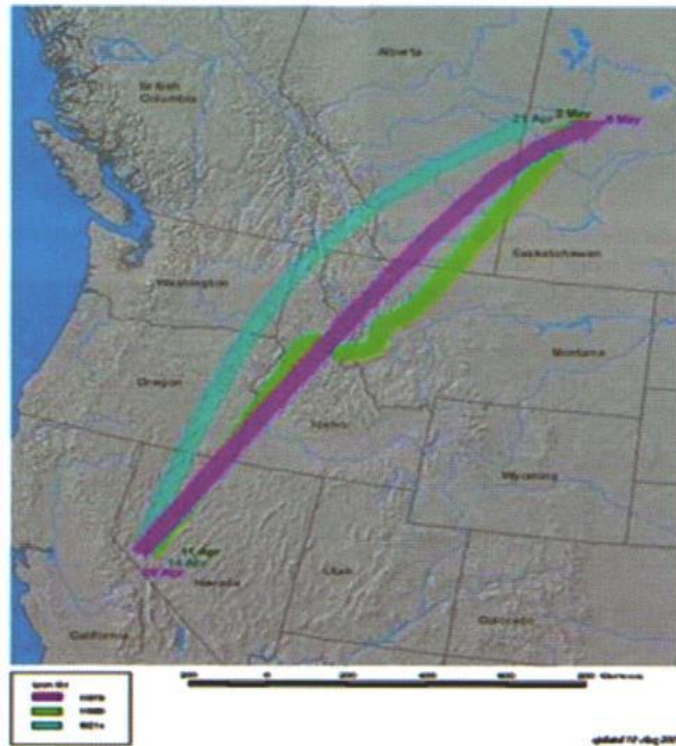
Above left: White faced ibis (Plegadis chihi) carrying a PTT. Right: Common Loon (Gavia immer)



Below: Broad-winged hawk (Buteo platypterus)



Swainson's Hawk migration route



Migration of Instrumented Common Loons from Walker Lake to Saskatchewan, Spring 2000

Common Loon Studies

Walker Lake, in west central Nevada, is a troubled desert terminal lake with an uncertain future. Decreased water flows, largely caused by diversion for agricultural use over the past hundred years, have greatly reduced its volume and degraded its water quality. The lake's fishery is seriously threatened, and this could have a devastating effect on bird species that rely upon the food resource it provides. Among these species is the common loon (*Gavia immer*). Each spring and fall, large numbers of common loons migrate to Walker Lake and spend up to a month resting and feeding before continuing their journey. Because biologists presently have little information regarding the breeding and wintering grounds of the segment of the common loon population that uses Walker Lake, it is impossible to estimate the possible effects of the loss of this food resource. Likewise, planning management strategies that might mitigate the effects of such a loss in resources is futile without first determining the importance of the fishery in the ecology of the loons. By capturing and radio marking sentinel individuals with satellite-received transmitters, we have begun to study the loons' movements in order to answer these questions. Managers may then use the information to address the greater implications of the possible loss of this migratory cohort of common loons that is at risk.

In January 1999, analyses of blood samples from the loons we captured in 1998 revealed very high levels (near lethal) of mercury in three of six individuals. Subsequent inquiries suggest that mercury levels in Walker Lake fish likely contributed to the loons' contamination. It also is possible that the loons are exposed to mercury on their wintering areas or on their migration route to Walker Lake. Our study has expanded, and is now interdisciplinary and collaborative in nature. We presently seek to also determine the extent and sources of mercury contamination within the Walker River Basin, its effects on humans and wildlife species, and to link the common loon to the most likely areas of exposure to mercury.

We have tracked four spring migrants (one in 1998, three in 2000) to breeding locales (see map below). All sites fall within a circle having a radius of 75 miles in west central Saskatchewan. Accordingly, evidence is building that migratory loons staging at Walker Lake comprise a discrete geographic segment of the overall common loon population. We have now captured 72 loons during spring and fall migrations, and their mean total blood mercury (ww) was 2.92 ppm (range 0.15 - 9.46 ppm). Levels exceeding 3.0 ppm pose behavioral, reproductive, and physiological impacts at the individual and population level. That threshold is met by 45% of our migrants; a higher rate than is documented anywhere else in the U.S.

Length of stay on Walker Lake is likely a factor related to mercury levels. Initial analyses of water, sediment, and biota samples collected throughout the basin point to historic gold mining operations as a significant mercury source.

Swainson's Hawk Studies

The Swainson's hawk (*Buteo swainsonii*) is listed as a species of concern by five states and the Bureau of Land Management, and as a special emphasis species by the U.S. Forest Service. Nesting population declines were reported over much of their range in the early 1990s. With no obvious reason for this decline, scientists postulated that problems along migration routes or on wintering areas were responsible. In 1995 and 1996, CCRT monitored Swainson's hawk distribution on and off military installations in the western U.S., where their numbers had been diminishing at an alarming rate for unknown reasons.

Thirty Swainson's hawks were captured and tagged with satellite-received transmitters during July, August, and September 1996, in eight locales within the western United States and Canada: California (one), Colorado (three), Idaho (six), Minnesota (two), Oregon (six), Utah (three), Arizona (two), Saskatchewan or Alberta, Canada (seven). Birds typically departed from nesting areas in mid to late September and arrived in Argentina beginning in the second week of November. By late November, 25 of the 30 Swainson's hawks had crossed the Argentinean border and by mid-December had settled into the Pampas region of central Argentina. In January of 1996, scientists visited different areas indicated by the satellite derived location data. They counted over 4,000 dead Swainson's hawks, killed as an apparent side effect of pesticide applications to Argentinean croplands, and these scientists believed the actual mortality numbers might have exceeded 20,000. This loss represented a serious threat to the survival of the species. Biologists in Argentina gathered blood samples for chemical analyses and attempted to gather behavioral data to relate behavior and ecology to land uses, environmental contaminants, and other threats.

We learned that the catastrophic population decline resulted from the use of a toxic organophosphate pesticide, recently brought into use on the Argentinean Pampas where these hawks winter in communal roosts. Through the use of remote satellite tracking and monitoring technology, this environmental problem was identified and, within 18 months, remedied through collaborative government and private sector management and education. Keeping this raptor off the endangered species list saved millions of federal dollars by avoiding costly large-scale research and recovery programs and related habitat management activities in North America. This application of wildlife tracking via satellite is a perfect demonstration of the unique advantage this technology can provide in the study of a wide-ranging species.

Broad-winged Hawk Studies

Modern organophosphate insecticides are short-lived in the environment. These insecticides are toxic to raptors, but they are unlikely to be detected in animal blood or tissue unless the animals are sampled soon after exposure. Researchers postulate that pesticide exposures, and habitat alteration, in their wintering areas in Central and South America may be adversely affecting broad-winged hawk (*Buteo platypterus*) populations, and those of other Neotropical migrants. However, it is unknown whether broad-winged hawks concentrate

in certain areas in their winter range and what specific biological threats they might be exposed to during this part of their annual cycle. Essentially, the extent to which conditions encountered in the winter range affect the populations that breed in North America is unknown. This is largely because very little is currently known about the wintering ecology of this small, forest-dwelling raptor. The broad-winged hawk is a Neotropical migrant that breeds in eastern and central North American forests and winters primarily from Southern Mexico south through Central America to northern South America (Bolivia and Northern Brazil), with small numbers wintering in southern Florida. Its population status is of concern due to the decline in numbers of birds encountered at some migration observation points since the 1970s and in some areas of its breeding range in the eastern United States. Information is available on the natural history of the broad-winged hawk in North America, but little is known of its wintering ecology. Within the continental United States, breeding numbers appear to be stable in some areas but decreasing in others. The Puerto Rican population is classified as Endangered, and these declines are attributed to habitat alterations. Similarly, in the eastern United States, some areas have reported declines in broad-winged hawks associated with human development and alteration of woodlands.

CCRT's broad-winged hawk research focuses on identifying critical habitat during the breeding season, along migration pathways, and during the boreal winter period. The approach is to integrate radio tracking via satellite, field monitoring, remote sensing, and a geographical information system (GIS) to identify locations and important landscape and nest site features used by the species. This study is filling gaps in knowledge concerning aspects of broad-winged hawk migration and wintering biology and is providing data critical for the development of a management plan for broad-winged hawks on federal, state, and private lands throughout its annual range.

Because broad-winged hawks tend to travel in large flocks that are easily identified on NEXRAD radar imagery, CCRT and the Clemson University Radar Ornithology Laboratory are attempting – for the first time ever – to correlate migration data of individuals with flock activity. Results from this study will be useful in the development of an effective resource management strategy for this species that can be applied throughout the Americas. Additionally, information collected about land use practices and environmental contaminant uses will be relevant to the conservation of a variety of other wildlife species. CCRT tracked (via satellite) broad-winged hawks from North America to their wintering areas and is describing important land cover types at the hawks' destinations (both breeding and wintering). Our research will provide information on the extent to which North American nesting populations associate with natural and modified habitats across the non-breeding range.

Additionally, information may be acquired to describe their exposure to habitat alteration and environmental contaminants in their wintering areas. The breeding habitat, migratory pathways, and wintering range of broad-winged hawks are also shared by a number of

other Neotropical migrant species, including several that are species of major conservation concern. This project will set the standard for other research projects to study the movements, migration, and wintering habitats of other Neotropical migratory species.

Education

Children learn best when they are interested in a subject. If educators can spark a child's interest, that child may learn without knowing he is being taught, and he may retain the information long after he has forgotten other, perhaps less interesting facts. Further, children have an innate ability to learn of other cultures without prejudice and to happily coexist with (and appreciate) children of other races and religious beliefs. And children love animals. A new CCRT program, *Eye of the Falcon*, capitalizes on these ideas by incorporating studies of migratory birds, use of advanced technologies, and communication via the Internet into an educational structure that will simultaneously capture the imaginations of children, educate them, and facilitate their appreciation of distant cultures.

We have initiated a pilot educational program, *Eye of the Falcon*, to support and promote conservation education to be developed within the Baltimore City School System in Maryland. This program will combine the most advanced, satellite-based wildlife science with the natural fascination and concern young people have for birds and animals. This combination offers a singular opportunity for math and science curriculum enrichment. *Eye of the Falcon* will be developed around a math, science, and engineering curriculum, which is currently employed in the Baltimore City schools. *Eye of the Falcon* involves the integration of sound science and information with interactive, multi-path software to demonstrate key concepts in science and engineering, and to bring a dynamic research capability into the classroom. The educational software will take the form of a computer-based system designed for students in a laboratory or classroom setting. A series of classroom lessons will also be developed with both a student workbook and teacher's guide to support the technical and educational components of the computer-based programs. The software programming will build and support a progressive and dynamic near-real-time research capability for the students to utilize.

Through the incorporation of CCRT's space-based tracking technology and scientific methods, we will be able to demonstrate and integrate in the classroom fundamental concepts in basic research essential to the conservation of species and habitats locally, regionally, and globally. Through this basic research approach we will be able to develop and implement a curriculum that will support the educational objectives of the school system while providing exciting, real time, state-of-the-art science to the students. This curriculum can be developed and based on both prospective and retrospective scientific information available through current and past research projects.

The ultimate goal behind the pilot project, *Eye of the Falcon*, will be to provide students with an educational experience at the cutting edge of science and technology. In collaboration with the International Center for the Study of Bird Migration at Latrun, Israel, and

participating scientists and educators around the globe, we intend to create a network of children in the Americas, the Middle East, Africa and Europe communicating through the Internet and learning about each other's ecosystems and cultural and natural treasures. Educational software programming will engage new concepts in technology application, sound science, and information systems to bring dynamic conservation education to students all over the world.

References

- Fuller, M.R., W.S. Seegar, and P. Howey. 1995. The use of satellite systems for the study of bird migration. *Israel J. Zool.* 41:243-252.
- Fuller, M.R., W.S. Seegar, J.M. Marzluff, and B.A. Hoover. 1995. Raptors, technological tools, and conservation. *Trans. 60th North Am. Wildl. And Nat. Res. Conf.* pp. 131-141.
- Hensler, G.L., S.S. Klugman, and M.R. Fuller. 1986. Portable micro-computers for field collection of animal behavior data. *Wildl. Soc. Bull.* 14:189 - 192.
- Seegar, W.S., P.N. Cutchis, M.R. Fuller, J.J. Suter, V. Bhatnager, and J.S. Wall. 1996. Fifteen years of satellite tracking development and application to wildlife research and conservation. *John Hopkins APL Technical Digest.* 17:305-315.
- Samuel, M.D. and M.R. Fuller. 1994. Wildlife radio telemetry. T.A. Bookout, (ed.) *Research and management techniques for wildlife and habitats.* Fifth ed. The Wildlife Soc., Bethesda, Md, 370-418.