Integrated Natural Resource Monitoring on Army Lands and Its Application to Conservation of Neotropical Birds

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Abstract — The U.S. Army is responsible for managing 5.0 million ha (12.4 million acres) of land on 186 major installations world-wide. The Land Condition Trend Analysis (LCTA) Program is the Army's integrated monitoring and data collection program designed to fulfill the Army's natural resource information and management needs. Implementation of this program was initiated in 1987, and over 50 installations nationwide have begun or plan to implement LCTA. This paper describes the LCTA approach to natural resource monitoring and provides examples of LCTA applications for monitoring neotropical migratory birds and their habitats on Army installations. Activities on other Department of Defense lands related to conservation and monitoring of neotropical birds are also described.

INTRODUCTION

The United States military faces the unique challenge of being a public land steward while fulfilling its primary mission of maintaining a well-trained, combat-ready fighting force. The Department of Defense (DOD) recognizes the need to be a leader in environmental compliance and natural resource management if it is to maintain the land base necessary to meet its mission requirements (Cheney 1989).

Conservation of neotropical migratory birds is directly relevant to the military's ability to complete its mission requirements. Military installations often are protected from increased urbanization and agricultural development, sometimes becoming inadvertent refuges for wildlife and plant populations in a surrounding landscape of increasingly degraded habitats. Once a species requires legal protection at the state or Federal level, its presence on an installation can result in loss of training time and access to areas of endangered species habitat. This can result in both a monetary impact as well as a reduction in military readiness.

A significant percent of the known populations of four of the five Federally endangered bird species that are category A neotropical migrants (preliminary neotropical migratory bird list, Research Working Group 1992) breed on DOD installations. These include the golden-cheeked warbler (*Dendroica chrysoparia*), black-capped vireo (*Vireo atricapillus*), Kirtland's warbler (*Dendroica kirtlandii*), and California's least Bell's vireo (*Vireo bellii pusillus*). The fifth Federally endangered species, the peregrine falcon (*Falco peregrinus*) may occur as a transient on several installations.

Aside from its responsibility as a public land steward, it is in the military's self-interest to participate in programs such as Partners in Flight that have the goal of conserving species before they require legal protection.

Conservation and management of neotropical migratory birds requires information on current status of and trends in populations and habitats. Partners in Flight emphasizes comprehensive monitoring programs to meet these information needs.

This paper focuses on the U.S. Army's approach to natural resource inventory and monitoring and its application to monitoring of neotropical migrants and their habitats. The Army faces a significant challenge, managing approximately 5.0 million ha (12.4 million acres) of land on 186 major installations world-wide (Diersing et al. 1988). To meet this challenge, the Land Condition Trend Analysis (LCTA) Program was developed at the U.S. Army Engineering Construction Engineering Research Laboratory (USACERL) as the Army's standardized natural resource inventory and monitoring program. LCTA is currently implemented or scheduled for implementation at over 50 Army installations nationwide (fig. 1).

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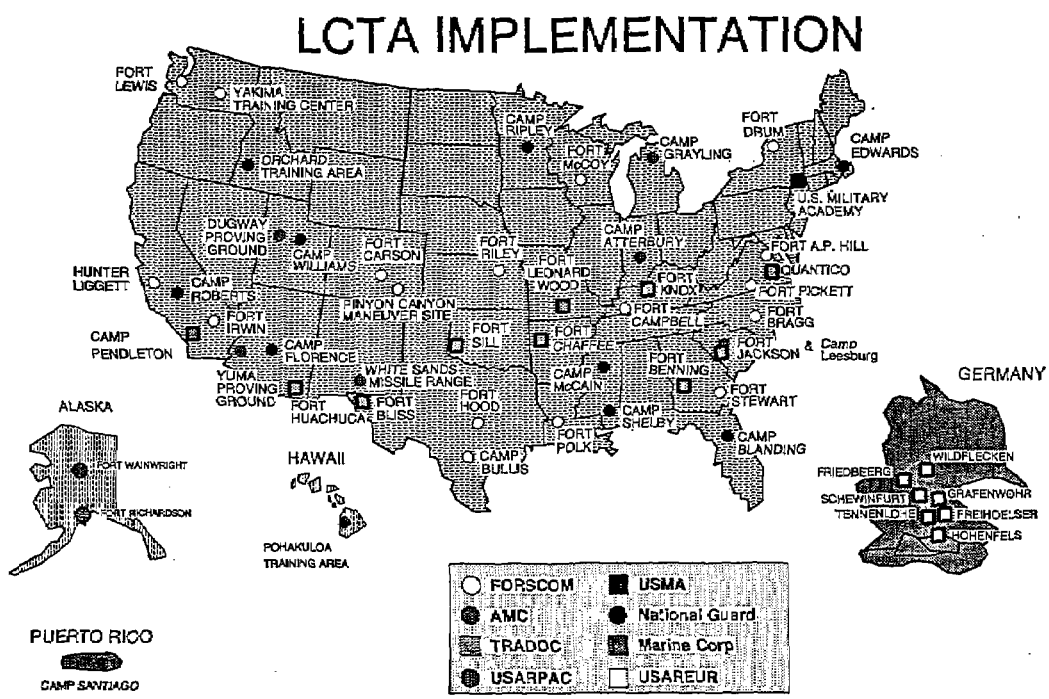

Figure 1. — Installations that have implemented or are scheduled to implement the Land Condition-Trend Analysis (LCTA) Program. Does not include some Natural Guard installations scheduled for implementation in 1993.

LAND CONDITION TREND ANALYSIS (LCTA) PROGRAM

Background and Objectives

In spring of 1984 an independent expert review panel reviewed natural resource management programs on selected military installations and civil works projects (Jahn et al. 1984). Their recommendations catalyzed development of a standardized natural resource inventory and monitoring program on Army lands. The LCTA program was recommended for Army-wide implementation in 1987.

LCTA's goals are: 1) evaluate capability of land to meet multiple-use demands of the U.S. Army on a sustained basis, (2) monitor and evaluate changes in natural resources relative to current land uses, (3) delineate biophysical and regulatory constraints to land use, (4) serve as a basis for amending land management plans to ensure long-term resource availability, (5) implement standardized data collection, analysis, and reporting procedures that enable compilation and evaluation of data and other information on an army-wide basis, and (6) characterize flora and fauna on army installations (Diersing et al. 1992).

Methods

The LCTA approach is to integrate field data collection, GIS and remote sensing technologies, and data analysis and retrieval capabilities into a comprehensive natural resource inventory and monitoring program.

Data collection on permanent field plots is the basis for natural resource monitoring in LCTA (Tazik et al. 1992). The standard LCTA field plot is 100 x 6 m with a 100-m line transect forming the longitudinal axis.

Allocation of permanent core plots is based on a stratified, random design. Stratified allocation of core plots is accomplished by integrating an unsupervised classification of satellite imagery with digitized soil surveys using the Geographic Resources Analysis Support System (GRASS) developed at USACERL (Warren et al. 1990). The number of core plots allocated to each reflectance category-soil mapping unit combination is proportional to the amount of total area the combination covers on an installation.

These permanent plots are monitored on an annual basis and data are collected on soils, slope, aspect, land use, surface disturbance, ground cover, canopy cover, and woody plants (Tazik et al. 1992). Collection of bird and small mammal data on a subsample of plots is the standard requirement for wildlife data, although other auxiliary wildlife data may be collected depending on installation requirements. Additional special use plots may be monitored to meet installation-specific information needs.

A plant community classification (PCC) for each plot is derived from an algorithm of cover type and percent of top-most aerial hits on the transect. The algorithm is based on a modification of Unesco (1973) and Driscoll et al. (1984) vegetation classifications. The LCTA plant community classification is a broad-based, generalized classification. Cluster analysis and other techniques are being evaluated to enhance the utility of plant community classifications at the individual installation level (D. Kowalski, USACERL, pers. communication).

LCTA Avian Census Methods

Birds are censused annually at a subsample of approximately one-third of permanent core plots up to a total of about 60 plots using a modified point-count transect technique (Blondel et al. 1981). Each plot is censused once each morning and evening by slowly walking the length of the LCTA plot in 6 minutes, recording all birds seen or heard within 100 m of the plot (Line Out). Upon reaching the end of the plot, the observer stops for 8 minutes and again records all birds seen or heard within 100 m (End Point). Finally, the observer walks back to the starting point in a period of 6 minutes, again recording any birds detected within 100 m of the plot (Line In). All morning censuses are conducted between 0.5 hour before and 4 hours after sunrise on relatively calm, rainless days. The evening census is conducted during the 4 hours prior to sunset. The inventory is conducted within a 2- 4-week period corresponding to the seasonal peak in breeding bird activity.

Data currently entered into the LCTA database include installation and plot ID, date, species, total number of pairs and individuals observed (largest of the 3 counts), whether it was a morning or evening count, flyovers observed during counts, and incidental sightings between plots.

APPLICATIONS FOR NEOTROPICAL MIGRATORY BIRDS

Because LCTA implementation is being phased in on Army installations over a period of several years, multi-year data sets currently are available for only a few installations. However, the available data is currently being reviewed and analyzed by the Natural Resources Management Team at USACERL in order to realize its full utility for natural resource management. The examples below show how LCTA data can be applied to monitoring and management of neotropical migratory birds.

Data Summary

The LCTA database and reporting capabilities allow quick retrieval of information for reporting summary statistics and species lists by installation and by year. Examples of summary statistics include relative frequency, number of observations, relative abundance, and importance values. Measures of species diversity, evenness, and richness can also be calculated. These summary statistics can compiled and reported in table or graph formats for use by managers to characterize and describe the installations avifauna in management plans and other environmental reporting requirements.

The LCTA database can also be referenced to auxiliary databases. In the case of neotropical migrants an auxiliary database was created listing North American species and their migratory status based on a preliminary list compiled by the research working group (RWG) of Partners in Flight (RWG 1992). This auxiliary database has been cross-referenced with LCTA avian census data for several military installations to compile species lists of neotropical migrants occurring on those installations (Tazik 1991).

Species/Habitat Relationships

Land managers need to know how land use and their management actions affect wildlife occurrence and abundance. Since LCTA data for vegetation, land use, and wildlife are collected on the same plots on annual basis, species/habitat relationships can be examined and related to patterns and trends in land use and condition.

As an example, suppose an Army resource manager wants to know which plant communities on the installation are preferred by a neotropical bird species. Using LCTA data, the relative abundance of each species in each plant community classification (PCC) can be compared with the expected abundance based on the relative frequency of plots in each PCC. Table 1 shows the relative abundance of each category A neotropical migratory species in each PCC and the relative frequency of plots in each PCC for a single year of LCTA data from Fort Drum, New York. Figure 2 represents this data graphically for an individual species. Although there are 15 plant community classifications for Fort Drum, they are grouped into five categories in Table 1 for clarity. These data can help focus a manager's attention on those habitats most important to an individual species or group of species.

Once a resource manager identifies habitats of interest or concern, the next step would be to determine where those habitats occur on the installation. One way to accomplish this is through costly and time-consuming ground surveys; however, vegetation cover maps developed from remote sensing applications are potentially more cost-effective and have the advantage of being replicated relatively easily over time. Researchers at USACERL are working to create supervised classifications of satellite imagery based on the LCTA plant community classifications with defined confidence estimates. This includes efforts to improve image processing and conduct accuracy assessments on selected installations (C. Bagley, USACERL, pers. communication).

The annual collection of avian census and vegetation, and satellite imagery for each installation potentially will allow resource managers in the future to monitor changes in habitats and their use by neotropical migratory birds over time.

Monitoring Trends

Partners in Flight recognizes that land managers need timely, quantifiable data on current or predicted trends in populations, land use, and habitat in order to assess the effects of natural resource plans and management prescriptions on neotropical migratory birds. Multi-year field data are now

Table 1. — Relative abundance (row frequency) of category A neotropical migratory bird species on 1990 LCTA plots on Fort Drum, New York. Relative frequency of plots is shown below PCC heading (n = 60).

				Broadleaf Woodland		
		Grassland	Shrubland	Open[1]	Closed[2]	Dense[3]
		0.400	0.083	0.167	0.283	0.067
	n =[4]					
Bobolink	44	1.000				
Bunting, Indigo	4	0.750		0.250		
Catbird, Gray	16	0.563	0.250	0.125	0.063	
Cuckoo, Black-billed	5	0.600	0.200	0.200		
Cuckoo, Yellow-billed	2	0.500			0.500	
Flycatcher, Alder	21	0.524	0.333	0.048	0.095	
Flycatcher, Great Crested	15	0.333		0.200	0.467	
Flycatcher, Least	25	0.320		0.120	0.520	0.040
Flycatcher, Willow	8	1.000				
Gnatcatcher, Blue-gray	1				1.000	
Grosbeak, Rose-breasted	18	0.111	0.222	0.111	0.389	0.167
Hummingbird, Ruby-throated	1				1.000	
Kingbird, Eastern	16	0.938			0.063	
Kinglet, Ruby-crowned	1			1.000		
Oriole, Northern	18	0.500	0.167	0.167	0.167	
Ovenbird	17	0.150		0.500	0.050	0.300
Redstart, American	29	0.069	0.069	0.138	0.690	0.034
Sparrow, Chipping	27	0.481	0.185	0.222	0.074	0.037
Sparrow, Clay-colored	1	1.000				
Sparrow, Grasshopper	1	1.000				
Sparrow, Savannah	41	1.000				
Swallow, American Tree	11	0.818	0.182			
Swallow, Barn	5	1.000				
Swallow, Northern Rough-winged	1	1.000				
Swift, Chimney	1				1.000	
Tanager, Scarlet	14		0.071	0.214	0.714	
Thrush, Hermit	20	0.050	0.050	0.350	0.500	0.050
Thrush, Wood	26	0.115	0.115	0.154	0.500	0.115
Veery	56	0.143	0.125	0.250	0.393	0.089
Vireo, Red-eyed	49	0.061	0.020	0.306	0.531	0.082
Vireo, Solitary	7	0.143		0.286	0.571	
Vireo, Warbling	8	0.750	0.125		0.125	
Vireo, Yellow-throated	5				1.000	
Warbler, Blackburnian	11	0.273		0.182	0.364	0.182
Warbler, Black-and-white	11		0.091	0.364	0.364	0.182
Warbler, Black-throated Blue	5				1.000	
Warbler, Black-throated Green	12			0.250	0.583	0.167
Warbler, Canada	4			0.500		0.500
Warbler, Chestnut-sided	23	0.435	0.261	0.174	0.043	0.087
Warbler, Golden-winged	3	0.333	0.667			
Warbler, Mourning	2				0.500	0.500
Warbler, Prairie	1				1.000	
Warbler, Yellow	21	0.524	0.429		0.048	
Warbler, Yellow-throated	5	1.000				
Warbler, Nashville	1			1.000		
Waterthrush, Northern	1			1.000		
Wood-Pewee, Eastern	17	0.176		0.235	0.588	
Wren, House	7	0.714		0.143		0.143
Yellowthroat, Common	40	0.375	0.300	0.150	0.100	0.075

[1] *Tree canopy cover >25 percent <=50 percent.*

[2] *Tree canopy cover >50 percent <=75 percent.*

[3] *Tree canopy cover >75 percent.*

[4] *Total number of individuals observed on plots.*

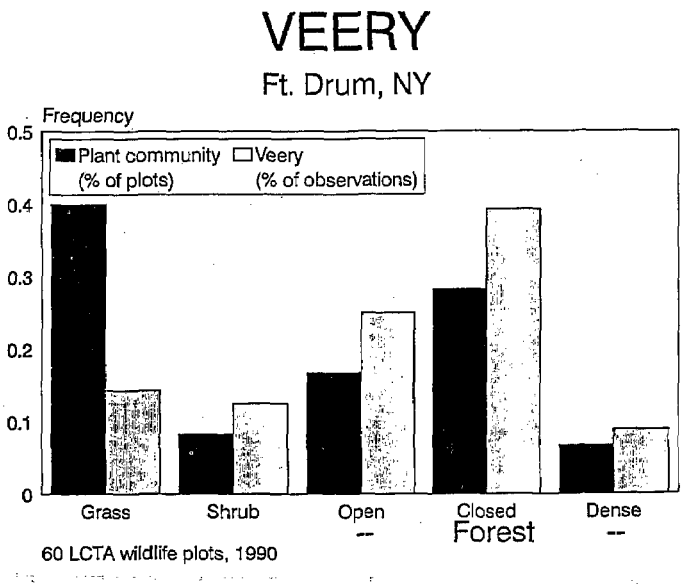

Figure 2. — Relative abundance of the Veery, a common neotropical migrant occurring on Fort Drum, New York, by vegetation classification (1990 data). Graph compares relative abundance to relative frequency of plots in each vegetation class.

available for some installations which is allowing USACERL researchers to assess some key parameters of trend analysis such as sample size adequacy for detecting population trends on installations.

As an example, two years of avian census data from Fort Sill, Oklahoma were used to explore sample size adequacy (A. Anderson and B. Sprouse, unpub. data). Data from 60 census plots were analyzed to determine sample size required to detect a 25 percent change in populations at = α 0.1 and = β 0.2 (Snedecor and Cochran 1980:102). Sample size requirements were determined for detecting change in populations of individual species as well as for various groupings such as by foraging guild, and migratory status.

Typically, sample size requirements for individual species were high. Sample requirements required to detect a 25% change in populations ranged from 94.7 to > 10,000 plots for the 62 species observed on Fort Sill. The sample size required for 51 of the species was >1,000. Obviously, this preliminary analysis indicates that current sampling is inadequate to detect a population change of 25% for individual avian species on Fort Sill. Various groupings of the data by species (e.g. by foraging guilds, nest substrate, migratory status) and by plots (e.g. plant community classification) reduced sample requirements. However, the number of plots required remained high relative to the number of plots actually censused. Grouping by migratory status of bird species on Fort Sill resulted in the most reasonable sample size requirements (Table 2). Sample requirements for category A neotropical migrants in 1989 and 1990 were 85.3 and 98.7 plots, respectively.

Table 2. — Sample size requirements to detect a 25 percent change in populations of avian species grouped by migratory status at = α 0.1 and = β 0.2. Calculations based on 1989 and 1990 LCTA data collected on Fort Sill, Oklahoma. Migratory category based on preliminary list of North American neotropical migratory terrestrial bird species (Research Working Group 1992).

Year	Migr. Cat.	mean (#/plot)	N	cv	Required sample size
1989	A	6.467	60	65.57	85.3
1989	B	7.367	60	53.66	57.1
1989	R[1]	8.467	60	106.01	223.0
1990	A	5.117	60	70.52	98.7
1990	B	4.717	60	58.82	68.7
1990	R	6.200	60	100.26	199.4

[1] *Resident species.*

The large sample size requirements were related in part to the statistical distribution of the data, variance in plots between years and variance among plots, the relative rarity of many species, and habitat heterogeneity among plots. The latter is due to the necessity of representing all habitat types within the installation boundary rather than focusing on a single, more homogenous habitat type. Factors which may help enhance the robustness of trend analysis include statistical techniques for transforming non-normally distributed data or for non-parametric analysis, determining reasonable *a priori* assumptions for clumping data in order to reduce variance, increased sample size, improved methodology to reduce variance in the data, and determination of what amount of change over what period of time is biologically significant.

Through LCTA, the Army is beginning to collect a large body of data throughout a broad geographic region and across ecologically diverse areas. These data are a significant resource for addressing questions regarding trend analysis in neotropical migratory birds. Guidance and suggestions from the Partners in Flight monitoring working group will be invaluable in efforts to enhance the utility of this data in detecting avian population trends not only at the installation level but also on a continental scale.

Related Army and Department of Defense Programs and Projects

Several research projects are currently underway on Army and DoD lands nationwide that directly or indirectly relate to conservation and monitoring of neotropical migratory birds.

Monitoring programs for Federally endangered neotropical migratory species are ongoing on several Army and Department of Defense installations. These programs emphasize monitoring of population trends and productivity of the Kirtland's warbler, (Camp Grayling, Michigan; National Guard), the black-capped vireo (Fort Hood and Camp Bullis, Texas, and Fort Sill,

Oklahoma; Army), the golden-cheeked warbler (Fort Hood and Camp Bullis, Texas), and the least Bell's vireo (Camp Pendleton, California; Marine Corps).

Some of these species-specific research efforts may have broader applications to monitoring efforts for neotropical migrants. For example, golden-cheeked warbler field data, LCTA vegetation plot data, and satellite imagery were used to create a preliminary map of golden-cheeked warbler habitat on Fort Hood, Texas (Fig. 3). This process could be used to track changes in the abundance and distribution of golden-cheeked warbler habitat. The techniques will require further refinement and accuracy assessment but, in conjunction with other research efforts previously described, could have application for monitoring landscape scale changes in habitats of other neotropical migratory species.

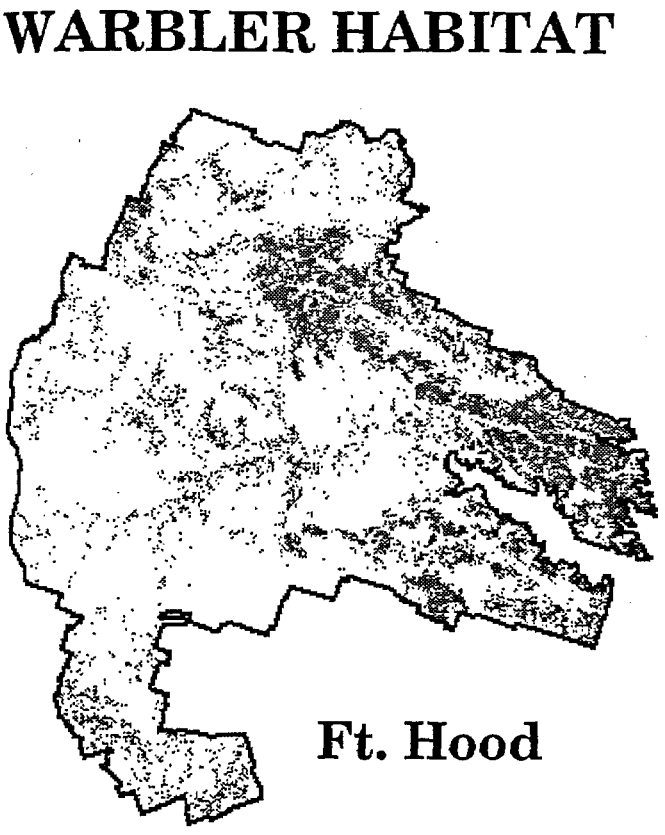

Figure 3. — Preliminary habitat map of the endangered golden-cheek warbler on Fort Hood, Texas. Map is derived from a supervised classification of satellite imagery using LCTA and warbler location ground data.

A related project is underway at Fort Sill, Oklahoma to create a species diversity map for neotropical migrants on the installation based on LCTA plot data and a vegetation cover map derived from aerial photography.

The army is also initiating studies related to monitoring and managing for biodiversity at a landscape scale, including projects related to monitoring riparian and wetland habitats and conserving biodiversity in southeastern U.S. long-leaf pine/wire grass ecosystems. All these projects may have direct or indirect applications in conservation of neotropical migratory bird species.

Interagency Cooperation

Populations and ecosystems do not stop at installation boundaries. Truly effective monitoring and management of populations or ecosystems must be accomplished across the landscape in which they exist. Becoming an active cooperator in Partners in Flight is an example of how the Army and other service branches are seeking to reach beyond installation boundaries to effectively manage their natural resources.

Several potential avenues exist for cooperating with Partners in Flight national monitoring efforts. One proposal under consideration is to develop a military migratory bird conservation network in cooperation with the National Fish and Wildlife Foundation. This proposal would emphasize cooperation within the military and with non-military organizations and agencies.

Once the Monitoring Committee establishes guidelines for a national monitoring based on point count methodology, LCTA data currently collected could be fed into the national database. This may require some modification or addition in data collection and database formats to conform to a national standard. However, the logistical base for such and effort is already in place. Also, a monitoring program for the endangered golden-cheeked warbler on Fort Hood has been initiated based on preliminary recommendations of the Partners in Flight monitoring working group.

Another example, is the establishment of constant effort mist-net stations on Department of Navy lands in cooperation with the Monitoring Avian Productivity and Survivorship (MAPS) Program. MAPS stations were established on three Navy installations in 1992, including the Naval Surface Warfare Center, Indian Head, Maryland; the Naval Surface Warfare Center, Dahlgren, Virginia; and the Naval Air Warfare Center, Patuxent River, Maryland in 1992 (J. Hautzenroder, U.S. Navy, pers. communication).

Two MAPS stations were also started on Fort Drum, an Army installation in New York, in 1992 (R. Leclerc, Fort Drum, pers. communication). At this installation, LCTA special use plots were established at each mist-net station so that vegetation and land-use data at the stations could be compared with data for the rest of the installation.

Most current biodiversity and ecosystem monitoring and management research on Army lands has or will have some element of interagency cooperation at a variety of administrative levels, and include state, Federal, and non-governmental agencies.

CONCLUSION

Monitoring programs that track trends in both habitats and their associated populations are crucial for providing natural resource managers the information they require to conserve and manage neotropical migratory birds. The Army through its integrated natural resource inventory and monitoring program (LCTA) is addressing many of the issues that the Partners in Flight Program has recognized as important to neotropical migratory bird conservation.

Data currently collected on Army installations are providing managers with basic information on species occurrence and distribution on their installations. Refinements in methodology and data analysis promise to increase the utility of these data to monitor trends in populations and habitats. The fact that avian data collection is integrated with other resource and land use data collection activities is one of the strengths of the LCTA approach to natural resource monitoring. Other Army research efforts related to monitoring biodiversity and ecosystems will have both direct and indirect applications to the conservation of neotropical migrants.

Programs with a continental perspective such as Partners in Flight recognize that close cooperation among government and non-government agencies is essential. The Army and other service branches realize this cooperative effort is key to achieving conservation goals, and look forward to working with other Partners in Flight cooperators to enhance conservation of neotropical migratory birds.

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