MANAGEMENT STRATEGIES FOR REVERSING DECLINES IN LANDBIRDS OF CONSERVATION CONCERN ON MILITARY INSTALLATIONS

EXECUTIVE SUMMARY

The U.S. Department of Defense manages over 420 military installations throughout the United States that cover approximately 10 million hectares. These installations provide important habitats for many songbird species because they often contain portions of important ecosystems, hotspots of biodiversity, critical breeding habitat, or stopover habitat used during migration.

Locations of six MAPS stations on Fort Leonard Wood, MO, superimposed on National Land Cover Dataset. Circles represent 2-km radii around each station.

Natural resource managers of installations face considerable challenges in balancing the application of federal laws that protect bird populations with the requirements of military mission. This is especially relevant where management activities such as those associated with readiness and sustainment of military ranges may impact Neotropical migrant birds that breed on DoD installations throughout the United States.

Other activities, such as logging and cattle grazing on installations may also impact breeding bird populations. Ecological models that quantify the effects of landscape pattern and structure on avian population dynamics can help managers meet these challenges. Managers require decision-making tools that will enable them to predict the effects of proposed land use change and habitat management on avian demographics, including population densities, reproductive success, and the direction of population trajectories.

The Institute for Bird Populations, through its Monitoring Avian Productivity and Survivorship (MAPS) program (1994-2001), effectively monitored 31 landbird species on 13 DoD installations (or groups of nearby installations) across the eastern and central United States. Of these 31 species, we identified ten that are nationally or regionally listed (as of December, 2002) by the US Fish and Wildlife Service as "***Birds of Conservation Concern***."

We combined banding data for these species with data from the National Land Cover Dataset (NLCD; 1992) and constructed landscape-scale (1000's of hectares) management models for reversing the declines in Neotropical migratory birds and other resident and migratory landbirds.

MAPS intern recording wood thrush data at Crane Naval Surface Warfare Center, Indiana.

Using a state-of-the-art statistical approach, we combined multiple regression analyses with model selection by an information complexity criterion (ICOMP). From these analyses we constructed 44 demographic-landscape models relating to numbers of adults and young, population trend, and reproductive success.

We intend to test these models, in collaboration with natural resource managers of installations, by monitoring the effects of new or ongoing spatially extensive management actions and comparing them with model predictions.

Table 1. Population trends from MAPS data for ten species of management concern that were effectively monitored between 1994 and 2001 on 13 DoD installations. Increasing adult populations are denoted by (+) symbols and declining populations are denoted by (-) symbols. Shaded cells indicate statistical significance (0.001 P<0.10) of the trend.The numbers of species of management concern and the total number of species effectively monitored are provided for each installation.

Installation / ***Species Common Name***	Fort Belvoir/ Fort A.P. Hill	Pax. River/ Indian Head/Dahlgren	Tidewater, VA Naval Complex	Fort Bragg	Jefferson Proving (Big Oaks NWR)	Fort Knox	Crane Naval Warfare Center	Fort Leonard Wood	Fort Leavenworth/ Sunflower	Fort Riley	Camp Swift	Fort Hood	Camp Bowie
Forest													
Acadian flycatcher	-	+	+		+	+	+	-					
Wood thrush	-	-	+	-	-	+	+	+	+	+			
Worm-eating warbler		-			-	-	+	-					
Louisiana waterthrush	-	+				-	+	-	+	+			
Kentucky warbler		-			-	-	+	-	-				
Scrub/successional													
Bewick's wren												-	-
Blue-winged warbler					-	-	-	+					
Prairie warbler				-	-	+	-	+					
Field sparrow					-		-	-	-	+		-	-
Painted bunting											-	+	+
Species of concern	**3**	**5**	**2**	**2**	**7**	**7**	**8**	**8**	**4**	**3**	**1**	**3**	**3**
Total species monitored	**15**	**17**	**14**	**14**	**24**	**16**	**22**	**21**	**16**	**17**	**6**	**12**	**8**

Species of management concern were identified at 13 DoD installations or groups of nearby installations (above). Four locations east of the Appalachians (Belvoir to Bragg) most effectively monitor forest species of management concern, except Fort Bragg where prairie warblers are also common breeders.

Map of the southeastern portion of the United States featuring the locations of DoD installations where MAPS stations were operated through 2002.

Three locations in Indiana and Kentucky, Fort Jefferson (now Big Oaks NWR), Fort Knox, and Crane Naval Surface Warfare Center, support eight species of management concern including three scrub/successional species.

Three locations in Kansas and Missouri, Fort Leonard Wood, Fort Leavenworth and Fort Riley, also support breeding populations of five forest and three scrub/successional species.

In Texas, the more scrubby habitats typical of Camp Swift, Fort Hood, and Camp Bowie allow effective monitoring of three scrub/successional species of management concern.

Overall, seven locations, Fort Jefferson, Fort Knox, Crane Naval Surface Warfare Center, Fort Leonard Wood, Fort Leavenworth, Fort Riley, and the Pax. River , Indian Head, and Dahlgren (MD) Navy installations can effectively monitor between 16 and 22 landbird species each.

Species-landscape models revealed important predictors of avian demographics among the ten species of management concern. Overall, selected models for those species that prefer to nest in forests and woodlands suggest that land managers should conserve large areas of contiguous forest (upwards of 700 ha) in a 1256 hectare, 2-kilometer radius area. Clearly, within those forested areas, canopy cover, as well as the density of undergrowth and ground cover, should be managed in a manner consistent with published microhabitat management procedures for the target species.

Acadian flycatcher. Management for this species should be directed at maintaining high reproductive success by conserving large tracts of contiguous forest – this will increase the numbers of adults (because core area is a positive function of total forest cover), but will increase the numbers of young at an even higher rate, and tend to produce source habitat. We conclude that maintaining contiguous forest tracts of between 500 and 900ha would benefit Acadian flycatchers. Water sources, agricultural land (possibly misclassified clearcut) and even shrubland should be maintained in small patches that total only 5-10% of the landscape.

Wood thrush. Because wood thrush populations decrease with increasing levels of forest management, we suggest that maintaining contiguous forest tracts of between 600 and 900ha will benefit wood thrushes in both the eastern and central regions of the United States. Small areas of agricultural land (eastern) and both forest and shrubland edge (central) also appear to be beneficial to both adult and young wood thrushes, presumably because those habitats fulfill post-breeding and post-fledging needs of the species.

Worm-eating warbler. Overall, on military installations in eastern and central United States, worm-eating warbler demographic parameters were found to be negatively related to forest fragmentation, although small areas of shrubland appeared to be beneficial, presumably, as in wood thrush, for post-breeding and post-fledging dispersal of both adults and young. We recommend that, for worm-eating warblers, land managers should maintain contiguous forest tracts of at least 1,000 hectares (within a 2-kilometer radius area) with small patches of adjacent shrubland.

Louisiana waterthrush. We suggest that a successful management strategy for Louisiana waterthrush is to maintain the upland forested streams, that provide primary breeding habitat, in near pristine condition, and to manage forested areas in such a way as to maintain or increase the amount of dense, shrubby forest-edge habitat for post-fledging utilization, while decreasing the overall amount of shrubland cover in the landscape.

Kentucky warbler. Kentucky warblers appear tolerant of some degree of forest fragmentation, especially in the western portion of their range, where they appear to breed in forest remnants and isolated woodlots. Our models suggest that, while the total amount of forest cover should be kept high and the total amount of forest edge (and thus the amount of forest fragmentation) should be kept low, small amounts of shrubland edge should be maintained, again probably as a target location for post-breeding and post-fledging dispersal. We recommend that large patches of contiguous forest should be maintained covering 50-80% of the area (600-1000ha in a 2-kilometer-radius area), and that small patches of shrubland habitat that cover 5-15% of the area (60-180ha in the 2-kilometer-radius area) should be scattered through the landscape. Moderate levels of fragmentation such as these can also provide some amount of habitat suitable for scrub/successional species.

Scrub/successional species-landscape models typically suggested that maintenance of a heterogeneous mosaic of different habitat types is desirable. In general these species were captured at those stations surrounded by landscapes that contained various levels of forest fragmentation. This fragmentation resulted either from active management of the forested landscape or from habitat types that naturally form heterogeneous mosaics, such as the shrublands of central Texas.

Bewick's wren. We suggest that Bewick's wrens benefit from maintaining a mosaic of shrubland and forest (open, low-canopy oak-juniper woodland) with small patches of grassland. The shrubland component is the most important and should be maintained as large patches with complex shapes covering 40% or more of the area. The forest component provides trees for song perches and snags with cavities for nesting. This suggests that there likely are relationships that could be explored between the adjacency of forest and shrubland and various demographic parameters. Developed areas and large core areas of agriculture should be kept to a minimum in the landscape. While their edges may be attractive to adult Bewick's wrens, they have a negative effect on numbers of young and productivity, tend to reduce population trends, and appear to act as population sinks.

Blue-winged warbler. We recommend maintaining landscapes with 60-90% total forest cover (750-1100ha in a 2-kilometer-radius area) in a fragmented landscape interspersed with small patches of shrubland. We also suggest maximizing the spatial complexity of the forest/shrubland edge. These strategies are designed primarily to increase reproductive success; we suggest, however, that they may increase adult population sizes as well.

Prairie warbler. We suggest that the optimal management strategy for prairie warblers is to maintain relatively small brushy openings in extensive forested habitat. This could be accomplished by appropriate forestry practices, including creation of small clearcuts, group selection, or even mechanical thinning, or by carefully controlled fire practices.

Field sparrow. For field sparrows, we recommend that managers maintain a fragmented landscape of forest (about 50% of the landscape) with many patches of grassland covering 25-40% of the total landscape, each of a size less than about 150ha (about 100ha of core area). Ideally, these grassland areas should be proximal to areas of shrubland or abandoned agriculture (covering 10-25% of the landscape) along the edges of forest. In this way, management can maintain the open patchy landscape that provides good habitat for field sparrows. Rotation of "disclimax" management among the different patches may provide the key for optimal field sparrow management, and will likely benefit other species of successional and scrubland habitats.

Painted bunting. We suggest that the ideal landscape pattern for painted bunting (shown below courtesy of Steven Kazianis) populations may be similar to that for field sparrow populations, whereby a mosaic of relatively large sized patches of forest (with a total landscape coverage of 40-70%), shrubland (10-20%), grassland (10-20%), and agriculture (10-20%) are actively maintained (or rotated through time) in the landscape.

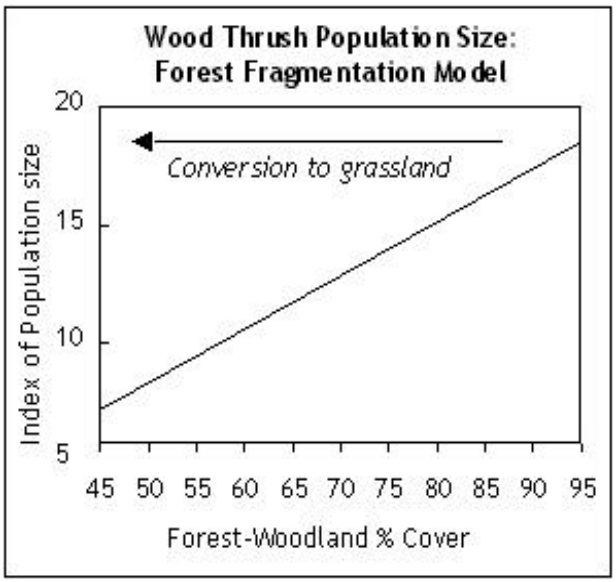
Importantly, for painted buntings (and likely other species) many small, scattered sources of water, including riparian areas and other wetlands, should be conserved or restored because the shrubby vegetation at the water's edge is likely to be an important resource for foraging. In areas where cattle grazing is allowed, lush waterside vegetation is often lacking, because it is either trampled or eaten by cattle. Cattle grazing also undoubtedly increases the probability of cowbird parasitism which can drastically reduce annual reproductive success. Thus, cattle should be excluded from all or part of these natural water sources.

In summary, a critical consideration for managing scrub-successional species at the landscape scale is to maintain an appropriately scaled mosaic of successional-stage habitats. It may be possible to integrate such a management strategy into efforts to increase military readiness and range sustainment, as well as into large-scale fire-control efforts and forestry plans.

Applying species-landscape models to landbird conservation efforts on U.S. Department of Defense installations can be a relatively simple process. The hypothetical but realistic example (below) applies to management of the landscape surrounding the Sulphur Creek MAPS station on Crane Naval Surface Warfare Center in Indiana. The installation is heavily forested but is actively managed through small-scale logging and the creation of regeneration gaps.

We explored a multivariate model designed to predict the effect of clearcutting forest, to create grassland, on an index of wood thrush population size (numbers of adults captured). We entered the real values of relevant landscape parameters from this station into the wood thrush model. The 2-kilometer radius area surrounding this station is currently 95% forested. In this case, three landscape model parameters were included – forest cover, forest edge, and agricultural cover. The model estimated the current adult population size index to be approximately 18 individuals.

However, if logging (to create grassland) were to reduce this coverage to 45% the model predicts the population size index to decrease by 65% to six individuals. This is a very simple example. In reality, a manager may want to assess the effects of several alternative management scenarios on species of management concern.

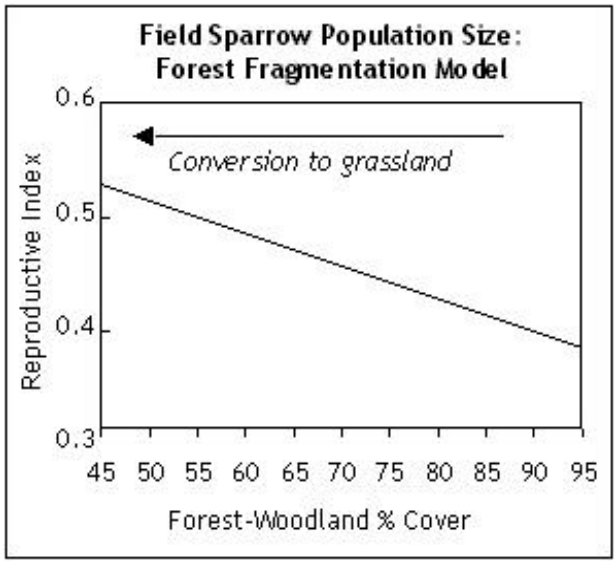


Species-landscape model showing the effect of forest fragmentation on wood thrush adult population size.

A land manager would apply these models in the following manner:

- identify a target species of management concern in an area of the installation.
- using GIS, spatially analyze the existing 2 kilometer radius to obtain estimates of spatial parameters relevant to the target species.
- estimate the expected reproductive success, numbers of adults, and numbers of young.
- using GIS, simulate the proposed management actions (e.g. deforestation) within the existing 2-kilometer radius landscape.
- repeat steps two and three to obtain "new" estimates of demographic parameters.
- Evaluate the demographic predictions relative to management goals.

This process allows managers to assess the likely effects of alternative proposed management actions on the species of management concern.



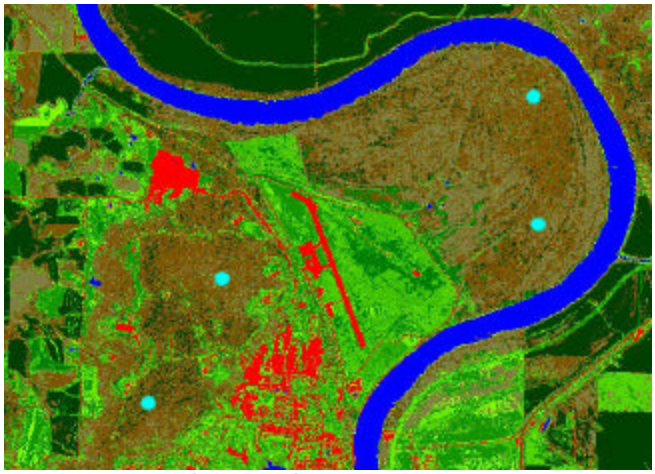
Species-landscape model showing the effect of forest fragmentation on field sparrow reproductive success

Multiple species effects, however, are inevitable. Management actions that benefit one species may adversely affect another species. Although clear-cutting reduces wood thrush populations, it may benefit other species. The predicted effect on field sparrows of converting forest to grassland is a 37% increase in the fledglings produced per adult, from 0.38 to 0.52. Thus, the effects of proposed actions should be assessed on a suite of species of management concern that breed in the same area.

Range sustainment and readiness is crucial to the military mission and necessitates many types of management activities that can impact breeding habitat for many North American songbirds, including Neotropical migrants.

The models constructed in this research can act as guidelines to the potential effects of spatially extensive land management on songbird populations. These include "area" effects on forest birds such as Acadian flycatchers, for which a reduction of the size of forested patches can cause a disproportionate reduction in the population size. For other species, such as field sparrows, these models emphasize the importance of habitat edges as predictors of population size and trajectory.

We conclude that the NLCD (1992) dataset provides an effective but coarsely scaled tool for constructing species-landscape models. It is likely, however, that improved spatial analyses of alternative high-resolution land cover datasets will increase the usefulness of these models.



Supervised classification of multispectral IKONOS imagery for Fort Leavenworth, Kansas showing forested tracts (brown), grassland (green), developed land (red) and locations of four MAPS stations (blue dots). Image provided by courtesy of Andrew Schmidt.

High-resolution land cover datasets, such as the IKONOS multispectral satellite data (Space Imaging Inc.), provide the opportunity to explore species-landscape relationships at a spatial resolution of four meters. Such high-resolution data allow the estimation of important ecological parameters, such as forested canopy cover, because the spatial resolution is less than the crown diameter of many trees. Likewise, high-resolution land cover imagery enables the identification of potentially ecologically important water sources, such as small ponds and creeks, as well as some fire roads and wider trails that may cause habitat fragmentation.

Also, topographical parameters, such as slope, aspect and topographical diversity or complexity, may be calculated from digital elevation models and included in the species-landscape models.

Future landbird monitoring efforts on DoD installations should focus on the effects of land management on *Birds of Conservation Concern* as listed by USFWS. This will require additional clusters of MAPS stations to be established on installations that support abundant or declining populations of those species. We intend improve our models through the development of more sophisticated analysis and modeling techniques.

IBP is already committed to monitoring the effects of recent (or imminent) management actions in the vicinity of existing MAPS stations at Fort Bragg, Fort Leonard Wood, Camp Bowie and Camp Swift. For instance, at Fort Leonard Wood, two MAPS stations have been relocated to act as control sites for studying the effects of "disclimax" management of scrub/successional habitats that provide breeding habitat for prairie warblers. Effectiveness monitoring of this kind is also possible at several other installations including Crane NSWC, Jefferson Proving Ground (Big Oaks NWR), Fort Knox, Fort Riley, and Fort Leavenworth.

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