

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

**A REPORT TO THE
U.S. DEPARTMENT OF DEFENSE**



LEGACY RESOURCES MANAGEMENT PROGRAM

documenting the findings of an

ANALYSIS OF MAPS DATA FROM MILITARY INSTALLATIONS

OUTSIDE OF THE LEGACY-FUNDED NETWORK

under

DoD Legacy Project Number 05-103

funded by

Cooperative Agreement DACA87-00-H-0003 (Modification #5)

between

U.S. Army Corps of Engineers

and

THE INSTITUTE FOR BIRD POPULATIONS

prepared by

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November 15, 2006

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 15 NOV 2006		2. REPORT TYPE		3. DATES COVERED 00-00-2006 to 00-00-2006	
4. TITLE AND SUBTITLE Management Strategies for Reversing Declines in Landbirds of Conservation Concern on Military Installations: Analysis of MAPS Data from Military installations Outside of the Legacy-Funded Network				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The Institute for Bird Populations,PO Box 1346,Point Reyes Station,CA,94956				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 32	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

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

ANALYSIS OF MAPS DATA FROM MILITARY INSTALLATIONS OUTSIDE OF THE LEGACY-FUNDED NETWORK

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 landbirds because they often contain portions of vital ecosystems, hotspots of biodiversity, critical breeding habitat, or stopover habitat used during migration. Through its Legacy Resources Management Program, DoD has funded research and monitoring across a network of 78 Monitoring Avian Productivity and Survivorship (MAPS) stations at 13 locations in the central and eastern United States.

Here, however, we consider 46 MAPS monitoring stations that have operated in the past or are still operating (in 2006) using non-Legacy funding sources. These have been operated by installation staff, academic researchers, or volunteers, resulting in 174 station years of banding effort of which 127 station years were used in these analyses of 1992-2003 data. Additional effort is ongoing but started too recently to be considered here. The locations of all MAPS stations on military lands are shown in Figures 5 and 6.

The Institute for Bird Populations collected and verified data (1992-2006) from the non-Legacy funded network of MAPS stations. These data showed effective demographic monitoring of 34 landbird species at 27 of the 46 stations located on DoD installations. Seven of the 34 species are listed in the Partners in Flight North American Landbird Conservation Plan as Species of Continental Importance (SCI).



Figure 1. Wrentit (*Chamaea fasciata*) a species of continental importance in the Partners in Flight Pacific Avifaunal Biome. Photo provided courtesy of Peter LaTourrette.

The goal of this analysis was to report demographic parameter values for as many species as possible, compare them to other regional- or continental-scale estimates, and recommend future monitoring efforts.

Sufficient data were available from a subset of 18 stations to estimate demographic parameters for two avifaunal biomes. Six non-Legacy funded stations within the Pacific Avifaunal Biome contributed data to survival rate estimates for 18 species. Twelve non-Legacy funded stations within the Pacific Avifaunal Biome contributed data to survival rate estimates for 16 species. For each of the species for which survival rates could be estimated, we also calculated a mean annual reproductive index.

Performance measures were formulated by a) comparing the survival rate estimated with survival rate estimates from a continent-wide study that used the entire 1992-2003 MAPS dataset to estimate rates by individual Bird Conservation Regions (where possible), and b) comparing reproductive indices with those calculated for the entire continent from the 1992-2003 dataset.

In the **Pacific Avifaunal Biome**, seven survival rate estimates exceeded the mean estimates for the biome. Of the three species of continental importance featured in this biome (Table 1), only the survival rate of the Pacific-slope Flycatcher (0.468) exceeded that of the mean BCR survival rate estimate (0.459). Although the estimate was lower than the Northern Pacific Rainforest (BCR 5) estimate (0.508), California stations mainly contributed to the estimate which was higher than the Coastal Californian (BCR 32) estimate of 0.410.



Figure 2. Pacific-slope Flycatcher (*Empidonax difficilis*) collecting nesting material.

The Wrentit survival rate (0.462), estimated mainly from Camp Pendleton data, was considerably lower than that estimated for coastal California (0.550). Similarly, the California Towhee survival rate (0.493), again estimated mainly from Camp Pendleton data, was considerably lower than the coastal Californian estimate (0.512).

Table 1. Effective monitoring (X) of SCI species on current (bold) or discontinued (normal) MAPS stations on military installations located within the Pacific Avifaunal Biome.

Installation	Station No.	Pacific-slope Flycatcher	Wrentit	California Towhee
Fort Lewis	11915	X		
Camp Pendleton	12235	X		
	12236	X	X	X
	12271	X	X	
Miramar NAS	12248	X	X	X
China Lake NWSC	12267	X		

Sixty percent of the reproductive indices calculated for the military installations within the Pacific biome were low in comparison to continent-wide indices, perhaps because most of the data are collected from Pendleton and Miramar stations. These military installations feature highly altered habitats adjacent to highly developed and populated areas of coastal California. In contrast, continental estimates are taken from many stations in less developed areas, including national forests, national parks, or other protected areas.

In summary, for the Pacific biome, survival rate estimates exceeded those given for individual BCR or biome mean rates for half the species. Reproductive indices were generally low and exceeded the continental means in only about 40% of species.

We recommend the reestablishment of Camp Pendleton and Miramar stations to continue monitoring all three SCI species and ten or more other species. We also recommend the establishment of new stations at these locations to provide sufficient data for local survival rate estimates to be made, especially at China Lake where there are many opportunities for monitoring landbirds along a riparian corridor. A cluster of stations could potentially effectively monitor ten or more species, including Pacific-slope Flycatcher.

In addition, we recommend the continued operation of stations at Fort Lewis, Fern Ridge Lake, Hunter-Liggett, Vandenberg AFB, Camp Roberts, and Fort Sill, because they have high capture rates of many species including Pacific-slope Flycatcher, Wrentit, California Towhee, and Winter Wren.



Figure 3. Wood Thrush (*Hylocichla mustelina*), an open forest floor specialist.

In the **Eastern Avifaunal Biome**, 8 of 16 (50%) survival rate estimates from three of the four species of continental importance (SCI; Table 2) exceeded the mean estimates for the region. The estimate for Carolina Wren exceeded estimates for four of eight BCRs, the estimate for Wood Thrush exceeded estimates for four of six BCRs, and the estimate for Indigo Bunting also exceeded estimates for four of six BCRs. The major contributors of data for these species were Arnold Air Force Base, Quantico Marine Corps Base, and Sugar Grove National Radio Station.

The survival rate estimate for the remaining SCI species, Hooded Warbler, was less than the mean estimate but comparable to the estimate from Piedmont BCR. Although most of the data were collected from Fort Polk no estimate is available from the analysis for the corresponding BCR 25 (West Gulf Coastal Plain/Ouachitas).

Biome-wide reproductive indices were considerably higher (up to 200%) than continental indices in all but three cases. For Carolina Wren, an SCI species, and American Redstart reproductive indices were comparable, being lower by only 4 and 8% respectively. We attribute high reproductive indices in the Eastern biome to the fact that military installations in this biome are large in area and not located close to highly developed and populated areas, where nest predation is higher.

However, Wood Thrush reproductive indices were 25% lower than the continental index. Nest predation, nest parasitism, and acid rain are factors shown to lower Wood Thrush reproductive success. Maintenance of large forested areas has been shown to benefit this species, for which negative edge effects on reproductive success can penetrate up to 100m inside a forest or woodlot edge.

Table 2. Effective monitoring (X) of SCI species on current (bold) or discontinued (normal) MAPS stations on military installations located within the Eastern Avifaunal Biome.

Installation	Station No.	Carolina Wren	Wood Thrush	Hooded Warbler	Indigo Bunting
Fort Polk	14464			X	
	14482			X	
Arnold AFB	16688	X			X
Fort Stewart	16697	X			
Quantico USMC	16664		X		
	16665		X		
	16676		X		
Sugar Grove NRS	15627	X			X
Fort Drum	15539		X		
	15540		X		
West Point MA	15542		X		

Stations at Fort Polk, Arnold Air Force Base, Fort Stewart, Quantico, Sugar Grove, and Fort Drum, where many high values were obtained, are located in large forested areas. We recommend that Fort Polk, and Fort Drum stations should be reestablished. Furthermore, Arnold Air Force Base, Sugar Grove NRS, and Quantico Marine Corps Base stations should continue to operate.

Overall, in the Eastern Avifaunal Biome, survival rate estimates were higher than, or comparable with, individual BCR estimates and pooled means. In addition, reproductive indices were mostly higher than continental indices or at least comparable.

We conclude that military installations in the Eastern biome provide excellent bird habitats and support healthy productive populations because the installation maintains extensive patches of habitat in relatively less disturbed areas.

As reported in analyses of Legacy-funded MAPS station data (Nott et al. 2003) healthy avian populations can be associated with military lands upon which the objectives of Readiness and Range Sustainment are consistent with providing large military training areas buffered from adjacent private lands. The overall goal is to manage such areas to maximize training opportunities, reduce the risk of wildfire, and protect natural resources.



Figure 4. Indigo Bunting (*Passerina cyanea*) prefers weedy/shrubby successional habitats. Photo courtesy of Ernesto Scott

Future demographic monitoring of landbirds on DoD lands should take into consideration a list of target species before establishing new monitoring stations, such that station locations will be expected to effectively monitor one or more target species of conservation concern. Target species may be chosen on the basis of regional or continental lists such as those published by Partners in Flight, US Fish and Wildlife Service, individual state authorities, or other conglomerations of bird conservationists such as Coordinated Bird Monitoring alliances.

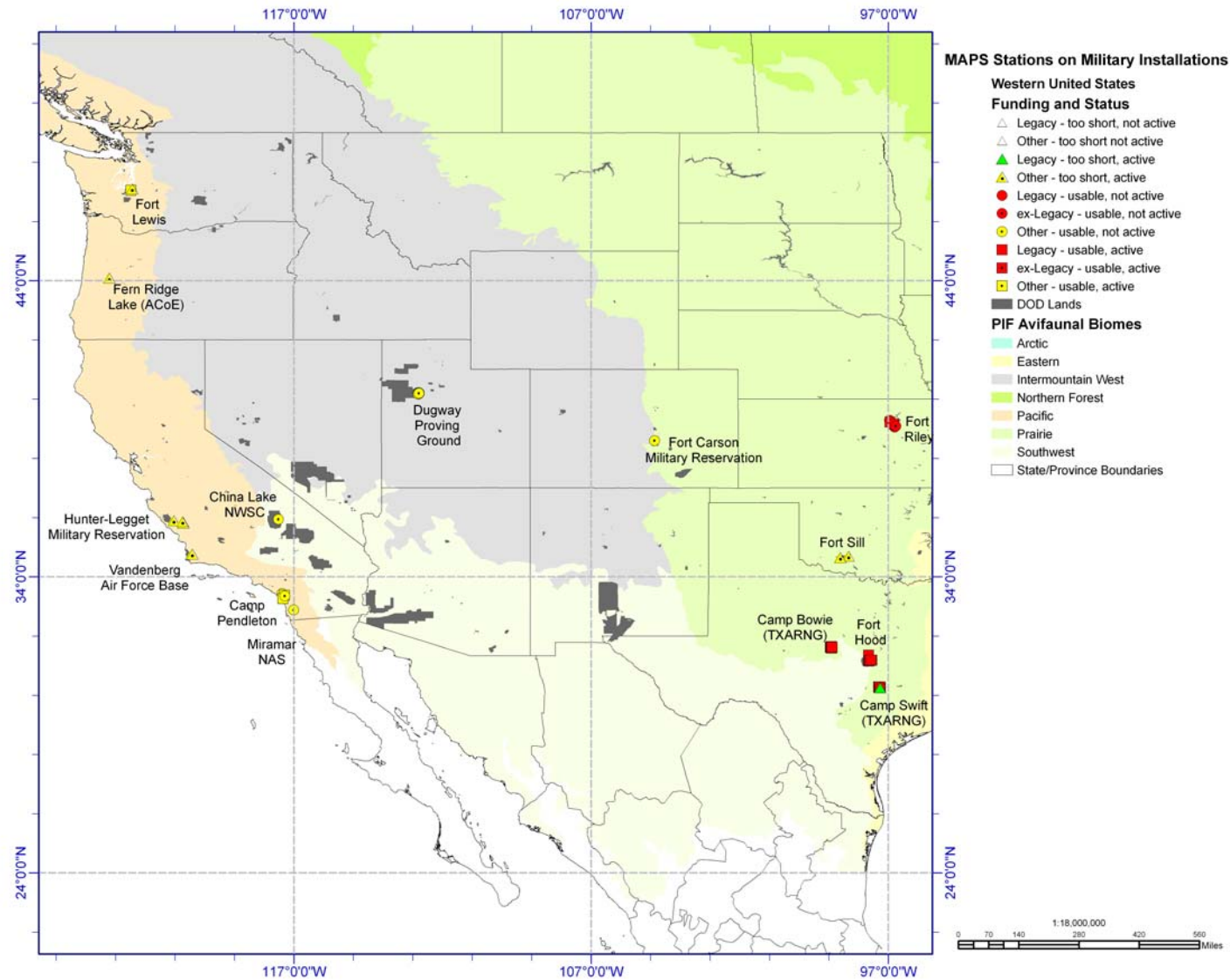


Figure 5. MAPS stations located on military lands in the western United States showing stations that are funded by the Legacy Management Resources Program or other sources, usable or not in survival rate analyses, and active (in 2006) or inactive, superimposed upon Partners in Flight avifaunal biomes.

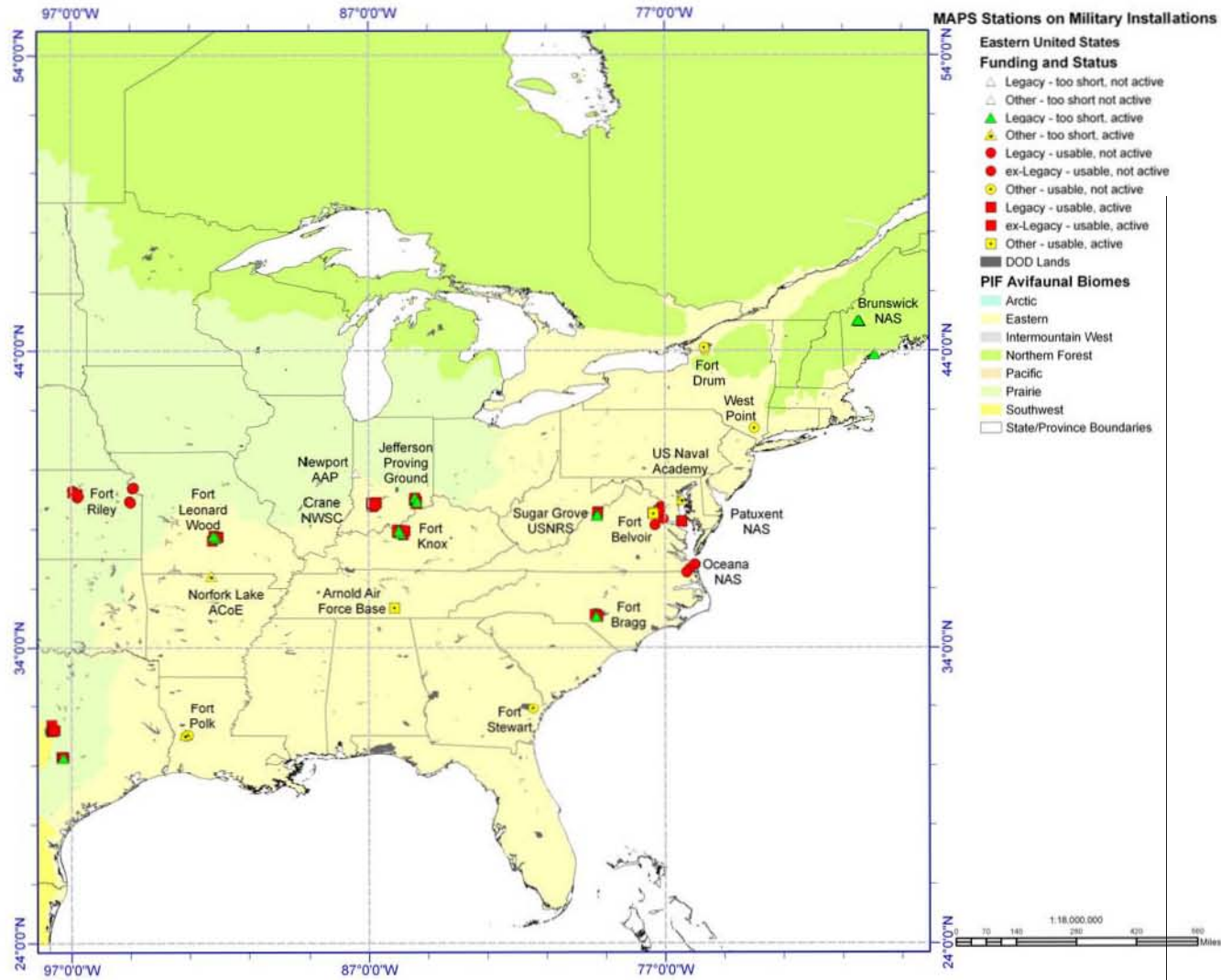


Figure 6. MAPS stations located on military lands in the eastern United States showing stations that are funded by the Legacy Management Resources Program or other sources, usable or not in survival rate analyses, and active (in 2006) or inactive, superimposed upon Partners in Flight avifaunal biomes.

BACKGROUND

The Institute for Bird Populations, through its Monitoring Avian Productivity and Survivorship (MAPS) program (1994-2005), effectively monitored 34 landbird species on 13 U.S. Department of Defense installations (or groups of installations) across the eastern and central United States. Of these 34 species, ten are nationally or regionally listed (as of December, 2002) by the US Fish and Wildlife Service as “*Birds of Conservation Concern*.” However, the MAPS program has collected banding data from other DoD lands through banding efforts not supported by the Legacy program. Here we report on the distribution of these stations (Figures 1 and 2), their periods of operation, and a brief species-specific report for a) birds of management concern as defined under the Legacy funded research (eastern avifauna), and b) species of continental conservation importance.

Unlike Legacy-funded MAPS stations, which are distributed throughout the southeastern and southern states, non-Legacy stations are distributed on military lands throughout North America, and include stations in the mountainous states and the western states. Basic station data for the western portion of the United States (west of 97 degrees W) are given in Table 3, and basic station data for the eastern portion of the United States (east of 97 degrees W) are given in Table 4. We expect that the lists of breeding species banded in the western portion will differ from those associated with Legacy-funded stations that all lie within the eastern portion.

The Partners in Flight North American Landbird Conservation Plan list species of continental conservation importance by seven North American regions called avifaunal biomes (Rich et al., 2004). Table 5 shows a breakdown of the distribution of MAPS stations on military lands with reference to each of these biomes. Stations that operated for only one year were not included in this list, excepting those that started in 2005 and are expected to continue operating. A total of 46 stations operated under non-Legacy funding. A further 18 stations were established using Legacy funding but were subsequently independently operated; we have not included those stations in this study.

ANALYSIS OF MAPS DATA FROM MILITARY INSTALLATIONS OUTSIDE OF LEGACY-FUNDED NETWORK

Table 3. Summary information of 25 MAPS stations located on military lands in the western United States. Station numbers in bold are expected to operate in 2007. Italics denotes stations that operated for less than four consecutive years of the 1992-2003 period such that data are not usable for survival analyses

Installation	Station No.	County	State	Habitat	Latitude	Longitude	Elev. (m)	Yrs. Operated
Fort Richardson	<i>17720</i>	Anchorage	AK	deciduous forest	61 13 40	-149 42 10	122	1994-95
Fort Lewis	11915	Pierce	WA	coniferous forest	47 03 20	-122 29 15	107	1994-2006
	<i>11964</i>	Pierce	WA	coniferous forest	47 06 04	-122 28 46	107	1997,2001-5
Fern Ridge Lake	11242	Lane	OR	oak woodland	44 05 11	-123 14 48	98	2004-2006
Hunter Liggett Mil. Res.	<i>12330</i>	Monterey	CA	willow riparian	35 53 39	-121 04 25	240	2003-2006
Vandenberg Air Force Base	12346	Santa Barbara	CA	willow riparian	34 45 51	-120 27 31	84	2004-05, 2007-
Long Beach Naval Shipyard	<i>12247</i>	Los Angeles	CA	shrub	33 46 30	-118 18 00	30	1996
Camp Roberts	12355	Monterey	CA	willow riparian	35 48 40	-120 45 32	164	2004-2006
	12356	Monterey	CA	willow riparian	35 51 35	-120 46 46	150	2004-2006
Camp Pendleton	<i>12235</i>	San Diego	CA	oak woodland	33 26 00	-117 24 10	744	1995-1999
	<i>12236</i>	San Diego	CA	oak woodland	33 22 51	-117 19 20	55	1995-2002
	<i>12271</i>	San Diego	CA	willow riparian	33 16 02	-117 22 17	8	1998-2002
Miramar NAS	<i>12248</i>	San Diego	CA	woodland/shrub	32 52 47	-117 00 29	140	1996-2002
Naval Weapons Station, Seal Beach	<i>12314</i>	San Diego	CA	willow riparian	33 21 14	-117 18 15	95	2001-2005
China Lake Naval Weapons Center	<i>12267</i>	Inyo	CA	woodland/shrub	35 56 40	-117 31 30	1600	1998-2002
Utah Test and Training Range	<i>12312</i>	Boxelder	UT	shrub	41 09 02	-112 57 42	1286	1999-2000
Dugway Proving Grounds	<i>12274</i>	Tooele	UT	juniper shrub	40 13 10	-112 49 45	1416	1996-2002
	<i>12275</i>	Tooele	UT	juniper shrub	40 13 30	-112 48 15	1479	1996-2002
	<i>12276</i>	Tooele	UT	juniper shrub	40 13 20	-112 47 10	1479	1996-2002
	<i>12277</i>	Tooele	UT	juniper shrub	40 10 30	-112 49 30	1350	1996-2002
	<i>12278</i>	Tooele	UT	juniper shrub	40 11 25	-112 47 30	1410	1996-2002
	<i>12279</i>	Tooele	UT	juniper shrub	40 11 45	-112 47 50	1440	1996-2002
Fort Sill	14456	Comanche	OK	woodland/grass	34 41 41	-098 22 15	344	1994, 04-2006.
	14516	Comanche	OK	riparian	34 39 02	-098 39 04	340	2004- 2006
Fort Carson	<i>12252</i>	El Paso	CO	riparian	38 36 10	-104 51 50	1905	1993-1997

ANALYSIS OF MAPS DATA FROM MILITARY INSTALLATIONS OUTSIDE OF LEGACY-FUNDED NETWORK

Table 4. Summary information of 21 MAPS stations located on military lands in the eastern United States. Station numbers in bold are expected to operate in 2007. Italics denotes stations that operated for less than four consecutive years of the 1992-2003 period such that data are not usable for survival analyses

Installation	Station No.	County	State	Habitat	Latitude	Longitude	Elev. (m)	Yrs. Operated
Fort Polk	14464	Vernon	LA	longleaf pine	30 59 46	-093 07 53	213	1995-2000
	14482	Vernon	LA	mixed riparian	31 01 16	-093 03 23	29	2001-2004
	14524	Vernon	LA	coniferous forest	31 01 48	-093 11 25	92	2005- 2006
	14463	Vernon	LA	longleaf pine	31 01 08	-093 04 17	229	1995-1998
Norfolk Lake (ACoE)	14512	Baxter	AR	mixed forest	36 25 21	-092 18 24	200	2004- 2006
Newport Chemical Depot	13349	Vermillion	IN	forest/shrub	39 51 41	-087 26 35	190	1997,1999-01
Arnold Air Force Base	16688	Franklin	TN	managed pine	35 20 50	-086 07 50	345	1999-2006
Fort Stewart	16697	Liberty	GA	longleaf pine	31 55 38	-081 27 15	7	1999-2002
Shaw Air Force Base	16696	Sumter	SC	deciduous forest	33 48 00	-080 27 30	60	2001
US Naval Academy	16723	Anne Arundel	MD	grassland	38 59 07	-076 27 26	5	2005-2006
Quantico Marine Corps Base	16664	Stafford	VA	deciduous forest	38 31 40	-077 23 40	76	1995-2006
	16665	Prince William	VA	deciduous forest	38 33 10	-077 24 40	76	1995-2006
	16676	Stafford	VA	deciduous forest	38 30 40	-077 23 30	76	1997-2006
	16666	Stafford	VA	deciduous forest	38 32 10	-077 24 20	76	1995-96
Sugar Grove National Radio Station*	15627	Pendleton	WV	mixed forest	38 34 44	-079 16 13	536	2001-2006
	15628	Pendleton	WV	mixed forest	38 30 40	-079 16 46	658	2001-2006
	15665	Pendleton	WV	coniferous forest	38 30 23	-079 16 59	625	2005-2006
	15666	Pendleton	WV	coniferous forest	38 27 18	-079 17 36	718	2005-2006
Fort Drum	15539	Jefferson	NY	deciduous forest	44 01 40	-075 39 00	260	1992-2001
	15540	Jefferson	NY	shrub	44 06 20	-075 40 30	180	1992-2001
West Point Military Academy	15542	Orange	NY	deciduous forest	41 23 10	-073 59 00	253	1993-2001

* data used for 2001-2005 period

METHODS AND RESULTS

Distribution of non-Legacy Funded MAPS Stations

Figure 5 shows the locations, funding source and operational status of MAPS stations on military lands in the western portion of the United States. A total of 25 non-Legacy supported MAPS stations are, or have been, operating at 15 locations in the western portion of the United States. One station (not shown in figure) at Fort Richardson, Anchorage, Alaska is the only non-Legacy supported station in the Arctic Avifaunal Biome and can be used for survival rate analysis (1994-1998). In the Pacific Avifaunal Biome, 13 stations at five locations include Fort Lewis, WA (2); Fern Ridge Lake (ACoE), OR (1); Camp Roberts and Hunter-Liggett military reservations, CA (3); Vandenberg AFB, CA (1); Long Beach Naval Shipyard, CA (1), Camp Pendleton, CA (4); and Miramar NAS, CA (1). Data from seven stations were used for survival rate analysis because the other six operated for less than four years. Eight stations still operated in 2006. One inactive station at China Lake NWSC is the only non-Legacy supported station in the Southwest Avifaunal Biome and can be used for survival rate analysis (1998-2002).

In the Intermountain West Avifaunal Biome six stations operated on Dugway Proving Ground, UT between 1996 and 2002, inclusive. Further west in Colorado, a single station operated from 1993 to 1997 on Fort Carson Military Reservation. Fort Sill in the Prairie Avifaunal Biome supports two stations that have only operated since 2004.

Table 5. Distribution of 135 MAPS stations that operate, or have operated, on military installations throughout the United States. Stations are classified by their length of operation and their association with one of seven PIF Avifaunal Biomes. The establishment of some stations was supported by funding from the Legacy Resources Management Program, however, 46 stations operated with alternative funding.

Avifaunal Biome	Operated >3 years			Operated <4 years			All
	Legacy	Other	Total	Legacy	Other	Total	
Arctic	0	0	0	0	1	1	1
Northern Forest	0	1	1	6	0	6	7
Pacific	0	5	5	0	8	8	13
Intermountain West	0	7	7	0	0	0	7
Prairie	25	1	26	1	1	2	28
Eastern	50	12	62	10	9	19	81
Southwest	5	1	6	0	0	0	6
Totals	80	27	107	17	19	36	143

Figure 6 shows the locations, funding source and operational status of MAPS stations on military lands in the eastern portion of the United States. A total of 21 non-Legacy supported MAPS stations are, or have been, operating at 11 locations in the eastern portion (east of 97 degrees W) of the United States. All these locations (17 stations) lie within the Eastern Avifaunal Biome including Fort Polk, LA (4); Norfolk Lake, AR (1); Newport Ammunitions Plant, IN (1); Arnold Air Force Base, TN (1); Fort Stewart, GA (1); Shaw Air Force Base, SC (1); US Naval Academy, MD (1); Quantico Marine Corps Base, VA (4); Fort Drum, NY (2); and West Point Naval Academy, NY (1). Data from one Fort Polk station, the Newport Ammunitions Plant station, and the US Naval Academy station could not be used for survival rate analyses. In addition, two locations are operated by IBP and funded through the Army Corps of Engineers (ACoE). Thus, four Sugar Grove USNRS, WV stations were added to the Eastern biome bringing the total number of stations to 21, of which data from only 12 stations were used in survival analyses. The other location (not tabulated) lies within the Northern Forest Avifaunal Biome at Brunswick NAS/CERES, ME with six stations that have only operated since 2003.

Overall, the distribution of the non-Legacy MAPS stations is sparse, especially among those stations that have operated for four or more years, which allows for the estimation of survival rates. Of the 46 non-Legacy funded stations 27 operated for four or more years such that banding data for those stations could be used for mark-recapture survival rate analysis. Consequently, only three datasets were collated for i) six stations in the Pacific Avifaunal Biome (Tables 6 and 8), ii) six stations in the Intermountain West Avifaunal Biome, and iii) 12 stations in the Eastern Avifaunal Biome (Tables 7 and 9).

Survival Rate Analyses

Survival rate analyses were conducted on data from a) six stations in the Pacific Avifaunal Biome (but including China Lake NWSC), resulting in estimates for 18 species, and b) 12 stations in the Eastern Avifaunal Biome (including data from Sugar Grove NRS), resulting in estimates for 16 species. Analysis of Intermountain West data (mainly Dugway data) did not produce any survival rate estimates. Capture histories

were analyzed using a modified Cormack-Jolly-Seber mark-recapture model considering transient individuals (Pradel 1997, Hines et al. 2003, Nott and DeSante 2002). In addition, using 1992-2003 data we estimated apparent survival rates for all species and Bird Conservation Regions. Also, in the Eastern biome, three species for which survival rates were estimated are of continental importance (Rich et al. 2004), Wood Thrush, Hooded Warbler, and Indigo Bunting.

Pacific Avifaunal Biome

In the Pacific biome, four of the six stations used for the Pacific biome captured more than ten species for which at least four individuals per year contributed to the region-wide survival rate estimates (Table 6). Three species for which survival rates were successfully estimated are of continental importance (Rich et al. 2004), Pacific-slope Flycatcher, Wrentit, and California Towhee (Table 8). Camp Pendleton stations 12236 and 12271 contributed data from 15 species including all three species of continental importance (except California Towhee at station 12271). The Miramar NAS station (12248) contributed data from 10 species including all three species of continental importance, whereas China Lake contributed to 11 estimates including Pacific-slope Flycatcher. We recommend that these four stations should be re-opened to continue demographic monitoring of three species of continental importance, and up to 15 other species.

The remaining stations 11915 and 12235 contributed data for only five and three species, and exhibited low capture rates compared to other stations. Fort Lewis (11915) contributed to survival rate estimates for Pacific-slope Flycatcher and we recommend that the station should continue operating. Camp Pendleton station 12235 only effectively monitors three species and exhibits low capture rates for others and we recommend that it should remain closed.

Table 6. Summary information of numbers of adults captured at each of 12 MAPS stations located on military lands in the Pacific Avifaunal Biome that operated for at least four consecutive years of the 1992-2003 period such that data are usable for survival analyses. Station numbers in bold are expected to operate in 2007. Numbers of adults in bold denote effective demographic monitoring of a species at a station. Species in bold are Partners in Flight Species of Continental Importance.

Installation	Station No.	Years of Data Used	Pacific-slope Flycatcher	Ash-throated Flycatcher	Bushtit	Bewick's Wren	House Wren	Swainson's Thrush	Wrentit	Orange-crowned Warbler	Yellow Warbler	Common Yellowthroat	Wilson's Warbler	Yellow-breasted Chat	Western Tanager	Spotted Towhee	California Towhee	Song Sparrow	Black-headed Grosbeak	Lesser Goldfinch	No. of Target Species
Fort Lewis	11915	10	54			11		65		11	69	34	18		60	7		116	15		5
Camp Pendleton	12235	5	19	16	10	4	28	18	1	3	3	2	6		2	17	25	1	37	48	3
	12236	8	54	52	71	32	50	57	132	32	42	154	21	130	1	71	59	159	87	100	15
	12271	5	37	11	93	19	30	54	41	88	122	301	72	69		42	1	241	16	45	13
Miramar NAS	12248	7	30	21	31	22	57	43	97	4	3	11	47	1	2	59	65	4	7	56	10
China Lake NWSC	12267	5	58	17	36	23		26		31	2		88		38	34	12		28	36	11

* 2001-2005 data included

Table 7. Summary information of numbers of adults captured at each of 12 MAPS stations located on military lands in the eastern United States that operated for at least four consecutive years of the 1992-2003 period such that data are usable for survival analyses. Station numbers in bold are expected to operate in 2007. Numbers of adults in bold denote effective demographic monitoring of a species at a station. Species in bold are Partners in Flight Species of Continental Importance.

Installation	Station No.	Years of Data Used	Alder Flycatcher	Red-eyed Vireo	Carolina Wren	Wood Thrush	Gray Catbird	Cedar Waxwing	Yellow Warbler	American Redstart	Ovenbird	Common Yellowthroat	Hooded Warbler	Yellow-breasted Chat	Song Sparrow	Northern Cardinal	Indigo Bunting	American Goldfinch	No. of Target Species
Fort Polk	14464	6		3	19	4					1		36	3		21	5		1
	14482	4		3	9	3	1						34	1		15	1		1
Arnold Air Force Base	16688	5		16	55			2		1	6	71		80		27	83	23	6
Fort Stewart	16697	4		9	21	4				1		18	9			6			2
Quantico Marine Corps Base	16664	9		40	2	66	1				44	1	9			2			2
	16665	9		33	3	53					71		30			1			2
	16676	7		23	17	23	8			1	36	9	18	29		37	18	2	3
Sugar Grove National Radio Station*	15627	5		6	22		51	3	1	4	30	7	1		29	19	24		5
	15628	5		1							11						13	1	0
Fort Drum	15539	10		36		86		6		81	60	3		1					3
	15540	10	153	30		34	130	91	237	27	24	199			166			146	7
West Point Military Academy	15542	9	1	6		51					18		2			2		2	1

* 2001-2005 data included

Intermountain West Avifaunal Biome

Data from six stations at Dugway Proving Ground failed to produce any survival rate estimates. Although hundreds of Lark Sparrows were captured there were too few recaptures to obtain survival rate estimates.

Eastern Avifaunal Biome

Only three stations in the Eastern biome contributed data to regional survival estimates for more than three species (Table 9). Arnold Air Force Base station 16688 contributed data from six species, including Indigo Bunting, a species of continental importance. We recommend that these stations should continue operating. Sugar Grove station 15627 contributed data from six species, including Indigo Bunting. Fort Drum station 15540 captured high numbers of seven species but not including any species of continental concern, or any species listed for BCR 13 (Atlantic Northern Forests) in the USFWS Birds of Conservation Concern (2002) publication. However, combined with station 15539 a total of nine species are effectively monitored including Wood Thrush. We recommend that these stations be re-opened.

Although, capture rates were low at Quantico, stations 16664 and 16665 contributed data to survival rate estimates for Ovenbird and for Wood Thrush, a species of continental importance. The remaining station effectively monitored three common species of successional habitats, whereas most species in the FWS list for BCR 28 (Appalachian Mountains) are associated with large forested areas. These stations should continue to operate. We recommend the addition of three more stations in more forested habitats (if possible) such that Quantico could increase the precision of local survival rate estimates for Wood Thrush ($\Phi = 0.403$, 27%CV) and Ovenbird ($\Phi = 0.469$, 17%CV) and increase the number of species for which local estimates could be made (e.g. Red-eyed Vireo and Hooded Warbler).

Fort Polk only contributed data to the survival rate analysis for Hooded Warbler. Stations should be established on Fort Polk to capture Hooded Warblers and more of other species, especially Wood Thrush. Fort Stewart contributed data to only two

common species. Although Sugar Grove station 15628 has low capture rates such that it might be a candidate for discontinuation, management is being planned to increase the diversity of avifauna at this station. Finally, although West Point contributed valuable Wood Thrush data to the regional estimate, it captured few other species. We recommend that several stations might be established to capture Wood Thrush and other species.

Demographic Performance Measures

We compared survival estimates from the non-Legacy biome-specific study with mean estimates from each BCR within those biomes which were derived from MAPS data for the period 1992-2003 (Saracco et al. 2006a). Similarly, we compared mean annual reproductive indices for this study with continental-wide weighted mean annual indices from another IBP study (Saracco et al. 2006b).

Pacific Avifaunal Biome

In the Pacific biome, seven survival rate estimates exceeded the mean estimates for the region (Table 8). Of the three species of continental importance (SCI) featured in this biome, only the survival rate of the Pacific-slope Flycatcher exceeded that of the regional mean survival rate estimate. Although the biome-wide estimate (0.468) was lower than the Northern Pacific Rainforest (BCR 5) estimate (0.508), California stations mainly contributed to the biome-wide estimate which was higher than the Coastal Californian (BCR 32) estimate of 0.410. The Wrentit survival rate (0.462), estimated mainly from Camp Pendleton data, was considerably lower than that estimated for coastal California (0.550). Similarly, the California Towhee survival rate (0.493, again estimated mainly from Camp Pendleton data, was considerably lower than the coastal Californian estimate.

Three species for which Camp Pendleton contributed the majority of data to survival rate estimates that exceeded the mean BCR estimates are Ash-throated Flycatcher, Orange-crowned Warbler, and Spotted Towhee. Although the Yellow Warbler estimate (0.341) was lower than the mean estimate (0.434) it was very comparable with the coastal

Californian estimate (0.354). Survival rate estimates for Bewick's Wren, Swainson's Thrush, and Wilson's Warbler also exceeded regional mean values. Although the remaining species exhibited lower estimates than regional means, the differences were not great in most cases.

Reproductive indices for the Pacific Avifaunal Biome were lower than continental indices in all cases but three. For Song Sparrow, two Pendleton stations and Fort Lewis contributed to an index 25% higher than the continental index. Common Yellowthroat reproductive indices, calculated from data collected at two Pendleton stations, exceeded the regional mean by nearly 275%. Lesser Goldfinch was captured at all the California stations and realized an index ~50% higher than that calculated for all MAPS stations. However, reproductive indices for Ash-throated Flycatcher, Bewick's Wren, and California Towhee are comparable with continental estimates.

Sixty percent of the reproductive indices for the military installations within the Pacific biome are low in comparison to continent-wide indices perhaps because most of the data are collected from Pendleton and Miramar stations. These military installations feature highly altered habitats adjacent to highly developed and populated areas of coastal California. In contrast, continental estimates are taken from many stations in less developed areas, national forests, national parks, or other protected areas.

So, in summary, survival rate estimates exceeded the regional mean for about half the species and reproductive indices exceeded the continental means in only about 40% of species. We recommend the reestablishment of Camp Pendleton and Miramar stations to continue monitoring all three SCI species and ten or more other species. China Lake should also be reestablished to monitor 10 or more species, including Pacific-slope Flycatcher. We also recommend the establishment of new stations at these locations to provide sufficient data for local survival rate estimates to be made, especially at China Lake where there are many opportunities for monitoring landbirds along a riparian corridor.

Eastern Avifaunal Biome

In the Eastern biome, 8 of 16 (50%) survival rate estimates exceeded the mean estimates for the region (Table 9), which included three of four species of continental importance (SCI). The estimate for Carolina Wren exceeded estimates for four of eight BCRs, the estimate for Wood Thrush exceeded estimates for four of six BCRs, and the estimate for Indigo Bunting also exceeded estimates for four of six BCRs. Data for these species was mainly collected on Arnold Air Force Base, Quantico Marine Corps Base, and Sugar Grove National Radio Station. The estimate for the remaining SCI species, Hooded Warbler, was only comparable to the estimate from Piedmont BCR but less than the mean estimate. Although most of the data were collected from Fort Polk no estimate is available from the continent-wide study for the corresponding BCR 25 (West Gulf Coastal Plain/Ouachitas).

The survival rate estimate for Red-eyed Vireo exceeded estimates for six of seven BCRs. No estimates were available for BCRs within the Eastern biome for Cedar Waxwing but the estimated survival rate using data from Fort Drum was higher than the mean estimate for three western BCRs. The estimate for Yellow Warbler is based on captures from Fort Drum alone and exceeded individual estimates reported for three surrounding BCRs, Lower Great Lakes (BCR 13), Appalachian Mountains (BCR 28), and New England/mid-Atlantic Coast (BCR 30). The Song Sparrow estimate was derived from Sugar Grove and Fort Drum data and exceeded two of four BCR estimates, Lower Great Lakes and Piedmont, and was comparable with estimates from the Appalachian Mountains and New England/mid-Atlantic Coast.

The survival rate estimate for Indigo Bunting exceeded estimates for five of eight BCRs. The estimate was derived from Sugar Grove and Fort Drum data. It did not exceed the estimate for Fort Drum's corresponding BCR 13 (Great Lakes) but did exceed the estimate for the Appalachians in which Sugar Grove is located. Although the estimate for American Goldfinch (0.436) is derived from mostly Fort Drum and exceeds the mean estimate it is lower (but comparable) with that for BCR 13 (0.449). Other species exhibited survival rate estimates comparable to that of the BCR from which most of the

data were collected, Gray Catbird (BCR 13), American Redstart (BCR 13), Common Yellowthroat (BCRs 13, 24, and 27), Hooded Warbler (BCR 13), Northern Cardinal (BCRs 24, 28, and 30).

Reproductive indices for the Eastern Avifaunal Biome were considerably higher (up to 200%) than continental indices in all but three cases. For Carolina Wren, an SCI species, and American Redstart reproductive indices were comparable, being lower by only 4 and 8% respectively. We attribute high reproductive indices in the Eastern biome to the fact that military installations in this biome are large in area and not located close to highly developed and populated areas, where nest predation is higher. Stations at Fort Polk, Arnold Air Force Base, Fort Stewart, Quantico, Sugar Grove, and Fort Drum, where many high values were obtained, are located in large forested/successional areas.

However, Wood Thrush reproductive indices were 25% lower than the continental index. Nest predation, nest parasitism, and acid rain are factors shown to lower Wood Thrush reproductive success. Maintenance of large forested areas has been shown to benefit this species, for which negative edge effects on reproductive success can penetrate up to 100m inside a forest or woodlot edge.

Overall, for the eastern biome, survival rate estimates were higher than or comparable with individual BCR estimates and pooled means. In addition, reproductive indices were either substantially higher than, or at least comparable to, continental indices. We conclude that military installations provide excellent bird habitat to support healthy productive populations because they maintain or manage extensive patches of habitat in relatively undisturbed areas. As reported in analyses of Legacy-funded MAPS station data (Nott et al 2003) healthy avian populations can be associated with military lands upon which the objectives of Readiness and Range Sustainment are consistent with providing large military training areas buffered from adjacent private lands. The overall goal is to manage such areas to maximize training opportunities, reduce the risk of wildfire, and protect natural resources.

Table 8. Species-specific data for non-Legacy funded MAPS stations in the Pacific Avifaunal Biome (PIF Species of Continental Importance are in bold) giving the number of stations and of station-years included in the analysis. Mean reproductive index is the mean annual ratio of young to adults and is compared to continental-scale estimates. Survival rate estimates for each species are compared with BCR-specific estimates derived from survival rate analyses of 1992-2003 data from all MAPS stations. Values in bold denote higher than continental reproductive index or higher than regional mean survival rate.

Species	No. of Stations	Station Years	Mean Reproductive Index	Continental Reproductive Index	Survival Rate Estimate	BCR 5	BCR 15	BCR 32	Mean Survival Rate
Pacific-slope Flycatcher	6	40	0.242	0.56	0.468	0.508		0.410	0.459
Ash-throated Flycatcher	5	30	0.085	0.09	0.665			0.636	0.636
Bushtit	5	30	0.349	1.33	0.339	0.423		0.378	0.401
Bewick's Wren	6	40	1.369	1.57	0.511	0.452		0.458	0.455
House Wren	4	25	0.376	0.87	0.185	0.251		0.401	0.326
Swainson's Thrush	6	40	0.099	0.18	0.679	0.589	0.494	0.586	0.556
Wrentit	4	25	0.517	1.23	0.462	0.550		0.618	0.584
Orange-crowned Warbler	6	40	0.490	0.73	0.447	0.436		0.397	0.417
Yellow Warbler	6	40	0.189	0.35	0.341	0.513		0.354	0.434
Common Yellowthroat	5	35	0.956	0.35	0.446	0.440		0.526	0.488
Wilson's Warbler	6	40	0.016	0.69	0.684	0.418	0.428	0.441	0.429
Yellow-breasted Chat	3	20	0.105	0.18	0.402	0.500		0.461	0.480
Western Tanager	5	35	0.029	0.33	0.143	0.494	0.645		0.570
Spotted Towhee	6	40	0.643	0.68	0.522	0.512	0.381	0.549	0.481
California Towhee	5	30	0.407	0.41	0.493			0.564	0.564
Song Sparrow	5	35	1.194	0.95	0.426	0.486	0.475	0.539	0.500
Black-headed Grosbeak	6	40	0.116	0.34	0.519	0.531	0.568	0.541	0.547
Lesser Goldfinch	5	30	0.604	0.44	0.269	0.404	0.301	0.375	0.360

Table 9. Species-specific effort data for non-Legacy funded MAPS stations in the Eastern Avifaunal Biome (PIF Species of Continental Importance are in bold) giving the number of stations and of station-years included in the analysis. Mean productivity is the ratio of young to adults and is compared to continental-scale estimates. Survival rate estimates for each species are compared with BCR-specific estimates derived from survival rate analyses of 1992-2003 MAPS data from all MAPS stations. Numbers in bold exhibit a higher estimate than the mean for all BCRs within the avifaunal biome or all MAPS data.

Species	No. of Stations	Station Years	Study Reproductive Index	Continental Reproductive Index	Survival Rate Estimate	BCR 13	BCR 24	BCR 25	BCR 26	BCR 27	BCR 28	BCR 29	BCR 30	BCR 31	Mean Survival Rate
Alder Flycatcher	2	19	0.299	0.08	0.376	0.385					0.651				0.518
Red-eyed Vireo	12	83	0.093	0.09	0.600	0.527	0.560		0.374	0.604	0.538	0.546	0.614		0.538
Carolina Wren	8	49	1.020	1.06	0.411		0.365	0.487	0.446	0.327	0.431	0.392	0.239	0.513	0.400
Wood Thrush	9	68	0.210	0.28	0.444	0.365	0.449			0.385	0.391	0.438	0.470		0.416
Gray Catbird	5	35	0.712	0.347	0.452	0.474	0.391			0.521	0.499	0.581	0.501		0.495
Cedar Waxwing*	4	30	0.016	0.06	0.521										0.403
Yellow Warbler	2	15	0.630	0.35	0.598	0.533					0.382		0.475		0.463
American Redstart	6	41	0.287	0.31	0.459	0.427	0.593				0.555		0.449		0.506
Ovenbird	10	75	0.575	0.44	0.515	0.544	0.472			0.519	0.576	0.546	0.608		0.544
Common Yellowthroat	7	50	0.711	0.35	0.417	0.414	0.445			0.363	0.465	0.435	0.575		0.450
Hooded Warbler	8	53	0.381	0.28	0.355	0.358	0.472		0.453	0.508	0.456	0.352	0.516		0.445
Yellow-breasted Chat	5	32	0.333	0.18	0.432		0.507	0.482	0.474		0.437				0.475
Song Sparrow	2	15	1.262	0.95	0.391	0.356					0.401	0.267	0.396		0.355
Northern Cardinal	9	58	0.485	0.42	0.527	0.784	0.551	0.556	0.447	0.536	0.536	0.599	0.532		0.568
Indigo Bunting	6	32	0.278	0.12	0.522	0.672	0.501	0.539	0.470	0.500	0.409	0.450	0.541		0.510
American Goldfinch	5	36	0.057	0.04	0.436	0.449	0.529			0.450	0.381	0.281	0.446		0.423

* Mean of survival rate for BCRs 5, 10, and 16

Individual Species Accounts for FWS Species of Conservation Concern

Birds of Conservation Concern (BCC), as listed by the USFWS, were captured, at Legacy-funded stations. In addition to contributing to regional estimates the non-Legacy stations captured 10 species defined as BCC species in the Legacy-funded network of MAPS stations. Some of these data provide useful ancillary data to data collected from the Legacy-funded network. Here we provide comments on those species and particular stations.

Species preferring forested habitats

Acadian Flycatcher

All Acadian Flycatcher captures occurred at the three stations located on Quantico Marine Corps Base in Virginia. Acadian Flycatchers were captured at these stations during all years of operation, from 1995-2005. Seventy-six adult individuals were captured, while only seven juvenile individuals were captured, indicating extremely poor productivity at this location. No recruitment of juveniles into the adult population was detected.

Wood Thrush

Wood Thrush were captured at all of the eastern stations included in the analysis, with the greatest number of captures occurring at station 15539. A total of 313 adults and 66 juveniles were captured at all of the eastern stations. The low number of juveniles compared to adults indicates that habitat at these installations may be poor for Wood Thrush. Additionally, only two individuals captured as juveniles were recaptured as adults, indicating poor recruitment at these stations.

Worm-eating Warbler

Worm-eating Warblers occurred in very low numbers at four of the eastern stations included in this analysis, stations 15542, 16664, 16665, and 16676. Twenty-two adults and seven juveniles were captured at all four of these stations over the course of ten years of operation. This low rate of capture is not sufficient to monitor this species at these stations.

Louisiana Waterthrush

Louisiana Waterthrushes were captured in very low numbers at four of the eastern stations included in this analysis, stations 15542, 16664, 16665, and 16676. Sixteen adults and nine juveniles were captured at these four stations over the course of thirteen years of operation. Louisiana Waterthrush cannot be monitored at these stations given this low rate of capture.

Kentucky Warbler

One adult Kentucky Warbler was captured at station 16676 located on Quantico Marine Air Corps Base in Virginia during nine years of operation. This species cannot be monitored at this station.

Species preferring successional habitats*Bewick's Wren*

Bewick's Wrens were captured at all western stations included in this analysis. One hundred and forty-nine adults and 168 juveniles were captured at these installations, mostly between 1997-2003, with the greatest number of captures seen at the Camp Pendleton stations in California. At several of the western stations, fourteen individuals that were captured as juveniles returned to their natal stations as adults, representing ~8% of all juvenile captures. This indicates that habitat at these stations was high quality for Bewick's Wrens and recruitment during the years indicated above, and may still be. Additionally, a female Bewick's Wren was captured multiple times at Fort Lewis in Washington over the course of five years; such persistence is indicative of high-quality habitat.

Blue-winged Warbler

Only five Blue-winged Warblers, an insufficient number for effective monitoring, were captured during the time period covered by this analysis, at station 15540 at Fort Drum in New York State. Although Blue-winged Warblers are captured in sufficient numbers to

be effectively monitored at stations funded by the Legacy program, stations in this analysis lack habitat suitable to support Blue-winged Warblers.

Prairie Warbler

Prairie Warblers were captured at a single station at Quantico Marine Corps Base in Virginia. Fourteen adults and sixteen juveniles have been captured during the nine years the station was run. These numbers are insufficient for monitoring this bird at these stations.

Field Sparrow

Over the course of nine years of station operation, six adult and four juvenile Field Sparrows were captured at four of the eastern stations included in this analysis. These numbers are insufficient for monitoring at any of these stations.

Painted Bunting

No Painted Buntings were captured at any of the stations included in this analysis.

Of the ten species of monitoring concern, only three (Acadian Flycatcher, Wood Thrush, and Bewick's Wren) were reasonably well represented at the stations included in this analysis. This is not surprising, since the ten species of management concern were chosen based on their capture rates at stations whose operations were funded by the Legacy Program. Since these stations are located in the central and eastern U.S., it is not to be expected that they would have species in common with the stations located on installations in the western U.S. The only species that occurred at any of the western stations is the Bewick's Wren, which is a common species in much of the western United States, but declining in the eastern part of its range.

Of the six stations included in this analysis that are located in the eastern states, five are located in deciduous forest habitat. Five of the species of management concern (Bewick's Wren, Blue-winged Warbler, Prairie Warbler, Field Sparrow, and Painted Bunting) prefer open or scrub habitat, rendering the majority of the eastern stations

unsuitable for these species. Of the remaining species, only Acadian Flycatcher and Wood Thrush occurred in sufficient numbers for effective monitoring at any of the stations. The specific habitat requirements for successful breeding among three species (Worm-eating Warbler, Kentucky Warbler, and Louisiana Waterthrush), which occurred in very low numbers, were probably not met at these stations.

The stations located at Quantico Marine Corps Base in Virginia, which are still being operated and are expected to be operated in the future, capture sufficient numbers of Acadian Flycatchers and Wood Thrush to effectively monitor these species. Data from these stations may be useful ancillary data to Legacy-funded stations.

Other Partners in Flight Watchlist Species

The following species were captured on at least one of the 25 U.S. DoD stations operated for four or more years and are designated as Watchlist Species by the Partners in Flight North American Landbird Conservation Plan (Rich, et al. 2004). These are species of significant conservation concern, included on this list if they are widespread but exhibiting declines, have restricted distributions or low population sizes, or are exhibiting multiple causes of concern across their range. Few of these species have been previously discussed in Legacy-funded reports because their ranges are restricted to the western United States; all of the species dealt with below were captured on stations located either in California or Utah.

Nuttall's Woodpecker

Twenty-three adult and ten juvenile Nuttall's Woodpeckers were captured at four of the California stations, stations 12235, 12236, 12248, and 12271. The number of individuals at these stations is too low to monitor this species. However, three of these stations are located on oak woodland habitat (12235, 12236, and 12248) that is preferred by this species. Appropriate management of the habitats at these stations may maintain or increase the numbers of Nuttall's Woodpeckers. One male Nuttall's Woodpecker was captured multiple times at one station in Camp Pendleton over the course of six years; such persistence may indicate the presence of at least some high quality habitat.

Bell's Vireo

Two of the stations (12236 and 12271) located on Camp Pendleton in California captured 96 adult and 31 juvenile Bell's Vireos and one of the juvenile birds was recaptured as an adult on its natal station. This fact combined with the low number of juveniles captured compared to adults indicates that productivity at these stations is low. However, a male Bell's Vireo was captured multiple times over the course of five years at one of the Camp Pendleton stations, which may indicate the presence of good quality habitat.

Oak Titmouse

Three stations at Camp Pendleton (12235 and 12236) and Miramar (12248) captured 28 adult and 13 juvenile Oak Titmouse, and one individual captured as a juvenile was subsequently recaptured as an adult. Oak Titmouse commonly occur in the oak woodland habitat type found at these three stations. Though the number of individuals captured is insufficient for monitoring, appropriate management could improve the habitat and allow the local population to increase.

Wrentit

Wrentits were captured at all four of the stations located in California. Two hundred and seventy-one adults and 140 juveniles were captured during the years 1995 - 2002. Six individuals that were captured as juveniles were recaptured as adults at their natal stations, representing ~4% of all juvenile captures. Notably, four out of these six recruitment incidents occurred between the years 2001-2002. Additionally, an individual was captured multiple times over the course of six years at the Miramar station, indicating that habitat at this station may be of high quality for Wrentits.

California Thrasher

California Thrashers were captured at four of the five California stations. Eighteen adults and 25 juveniles were captured between the years 1996 – 2002. Although this is an insufficient number of captures to adequately monitor this species, it is possible that management of the scrub habitat at the Miramar (12248) station in particular may benefit California Thrasher, which favors chaparral habitat.

Brewer's Sparrow

Brewer's Sparrows were captured at stations 12267, 12271, and all of the Dugway Proving Ground stations from 1998 – 2002. Forty-one adults and 168 juveniles were captured at these stations during this time span. These stations exhibit extremely high productivity, which may indicate that these are source populations for surrounding areas.

Overall, six Watchlist species of conservation concern were captured, mostly at the Californian stations of Camp Pendleton and Miramar, which were no longer operating by 2003.

ACKNOWLEDGEMENTS

We thank the DoD Legacy Resources Management Program for financial support for this work. We thank Peter Boice, Alison Dalsimer, Leslie Orzetti, Jane Mallory, Pedro Morales, and Holly Brook of the Legacy Resource Management Program, Joe Hautzenroder and Chris Eberly of the DoD Partners in Flight Program, and Robert Johnson of the US Army Corps of Engineers, Huntsville Division.

We particularly thank the non-Legacy funders and operators of these stations for their commitment to monitoring, data collection, and data submission that have made this analysis possible. We also thank IBP biologists Victor Sepulveda and Ron Taylor for verifying this dataset.

This is Contribution Number 295 of The Institute for Bird Populations.

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