Appendix 11

Comprehensive Species Planning

Appendix 11 A: Passerine Assessment

Appendix 11 B: Passerine Working Group

Appendix 11 C: Passerine Issues & Concerns

Appendix 11 D: Passerine Goals and Objectives

Appendix 11 E: Passerine Problems and Strategies

Appendix 11 F: Grassland Passerine Management System

Appendix 11 G: Inland Fisheries Management System

Appendix 11 H: Brook Trout Management Plan

PASSERINE ASSESSMENT

Final Draft

11 September 1998

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

WILDLIFE DIVISION

RESOURCE ASSESSMENT SECTION

Thomas P. Hodgman

TABLE OF CONTENTS

Page

INTRODUCTION AND SCOPE 7

FOREST BIRDS
SCOPE 8
NATURAL HISTORY 9
General Description 9
Distribution and Migration 9
Survival and Reproduction 10
Foods and Foraging Strategies 11
HABITAT ASSESSMENT - DECIDUOUS FOREST AFFILIATES 12
Habitat Use 12
Past Habitat 12
Current Habitat 13
Habitat Projection 14
HABITAT ASSESSMENT - CONIFEROUS FOREST AFFILIATES 15
Habitat Use 15
Past Habitat 15
Current Habitat 16
Habitat Projection 17
POPULATION ASSESSMENT - DECIDUOUS FOREST AFFILIATES 19
Past Populations 19
Current Populations 19
Population Projections 20
POPULATION ASSESSMENT - CONIFEROUS FOREST AFFILIATES 22
Past Populations 22
Current Populations 23
Population Projections 24

SCRUB-SHRUBLAND BIRDS
SCOPE 38
NATURAL HISTORY 39
General Description 39
Distribution and Migration 39
Survival and Reproduction 39
Foods and Foraging Strategies 40
HABITAT ASSESSMENT - UPLAND AFFILIATES 42
Habitat Use 42
Past Habitat 42
Current Habitat 42
Habitat Projection 43
HABITAT ASSESSMENT - UPLAND OR WETLAND AFFILIATES 44

Habitat Use....44
Past Habitat....44
Current Habitat....44
Habitat Projection....44
POPULATION ASSESSMENT - UPLAND AFFILIATES....46
Past Populations....46
Current Populations....46
Population Projections....47
POPULATION ASSESSMENT - UPLAND OR WETLAND AFFILIATES....49
Past Populations....49
Current Populations....49
Population Projections....50

WETLAND BIRDS
SCOPE....56
NATURAL HISTORY....57
General Description....57
Distribution and Migration....57
Survival and Reproduction....58
Foods and Foraging Strategies....59
HABITAT ASSESSMENT....60
Habitat Use....60
Past Habitat....60
Current Habitat....61
Habitat Projection....62
POPULATION ASSESSMENT....63
Past Populations....63
Current Populations....63
Population Projections....64

GRASSLAND BIRDS
SCOPE....69
NATURAL HISTORY....70
General Description....70
Distribution and Migration....70
Survival and Reproduction....71
Foods and Foraging Strategies....71
HABITAT ASSESSMENT....73
Habitat Use....73
Past Habitat....73
Current Habitat....74
Habitat Projection....74
POPULATION ASSESSMENT....76
Past Populations....76
Current Populations....76
Population Projections....77

SWALLOWS

SCOPE 81
NATURAL HISTORY 82
General Description 82
Distribution and Migration 82
Survival and Reproduction 82
Foods and Foraging Strategies 83
HABITAT ASSESSMENT 84
Habitat Use 84
Past Habitat 84
Current Habitat 84
Habitat Projection 85
POPULATION ASSESSMENT 86
Past Populations 86
Current Populations 86
Population Projections 87

LIMITING FACTORS 91
Forest Fragmentation 91
Silvicultural Practices 93
Global Warming 95
Weather-related Factors 96
Fire 97
Insect Outbreaks and Availability 97
Competition 98
Habitat Quantity and Quality 98

MANAGEMENT 100
Regulatory Authority 100
Past and Current Management 100
Partners In Flight 100

USE AND DEMAND ASSESSMENT 106
Past Use and Demand 106
Current Use and Demand 106
Use and Demand Projections 107

SUMMARY AND CONCLUSIONS 109
Forest Birds 109
Scrub-Shrubland Birds 109
Wetland Birds 110
Grassland Birds 110
Swallows 111

LITERATURE CITED 112

LIST OF TABLES

Table 1. Passerine birds of forested habitats in Maine....26

Table 2. Distribution and migration information for selected forest Passerines in Maine....28

Table 3. Aspects of the reproductive biology of selected forest Passerines that breed in Maine....31

Table 4. Area (sq. mi.) of timberland in Maine by stand type....33

Table 5. Trends in numbers of selected forest Passerines observed in Maine based on data from the North American Breeding Bird Survey....34

Table 6. Passerine birds of scrub-shrub habitats in Maine....51

Table 7. Breeding distribution and migration information for scrub-shrubland Passerines in Maine....52

Table 8. Aspects of the reproductive biology of selected scrub-shrubland Passerines that breed in Maine....54

Table 9. Trends in numbers of selected scrub-shrubland Passerines observed in Maine based on data from the North American Breeding Bird Survey....55

Table 10. Breeding distribution and migration information for wetland Passerines in Maine....66

Table 11. Aspects of the reproductive biology of selected wetland Passerines that breed in Maine....67

Table 12. Trends in numbers of selected wetland Passerines observed in Maine according to the North American Breeding Bird Survey....68

Table 13. Distribution and migration information for grassland Passerines in Maine....78

Table 14. Aspects of the reproductive biology of selected grassland birds that breed in Maine....79

Table 15. Trends in numbers of grassland birds observed in Maine according to the North American Breeding Bird Survey....80

Table 16. Breeding distribution and migration information for Maine swallows....88

Table 17. Aspects of the reproductive biology of breeding swallows in Maine.....89

Table 18. Trends in numbers of swallows observed in Maine according to the North American Breeding Bird Survey 90

Table 19. Partners In Flight priority species for all physiographic regions which overlap Maine.....103

LIST OF FIGURES

Figure 1. Rectangular blocks used for the Atlas of Breeding Birds in Maine 36

Figure 2. Approximate boundaries for Partners In Flight's Physiographic Region Which Overlap Maine as modified from MDIFW Wildlife Management District Boundaries 37

LIST OF APPENDICES

Appendix I. Land area (sq. mi.) in various land use classes within each of the 3 PIF Physiographic Regions that overlap Maine as of 1995.....132

Appendix II. Land area (sq. mi.) by habitat types within the 3 PIF Physiographic Regions that overlap Maine and statewide totals as of 1993 133

Appendix III. Percent of FIA plots with various edge types within the 3 PIF Physiographic Regions that overlap Maine and statewide as of 1995.....135

Appendix IV. Alphabetical index of species, sections, and habitat subgroupings for Maine Passerines discussed in the text 136

Appendix V. Taxonomic index of species, sections, and habitat subgroupings for Maine Passerines discussed in the text 140

Appendix VI. Summary of conservation status for Maine Passerines 144

Appendix VII. Population trend (PT) and population trend uncertainty (PTU) criteria for scoring Breeding Bird Survey data in setting Partners In Flight Conservation Priorities.....149

INTRODUCTION AND SCOPE

Passerines are a diverse group of birds that breed in essentially all terrestrial habitats found in Maine. Approximately 105 species of Passerines regularly breed in Maine and about 10 more either pass through during migration or migrate south to overwinter in Maine. Our state's diverse landscape and geographic location as a transition between boreal conditions to the north and more temperate conditions to the south afford a rich diversity of habitats and consequently bird species.

This assessment examines the status and trends for the habitat and populations of 113 species of Passerine birds. These include neotropical migrants as well as year-round and winter-only residents. This document excludes 3 species listed as either Threatened or Endangered in Maine and approximately 6 other species which are either occasional breeders or passage migrants. State-listed Endangered and Threatened species are not included in this "group" assessment as they warrant a greater level of detail than can be provided in the current document.

To facilitate adequate review of all species while maintaining concern for the length of this document, all species have been divided among five categories (i.e., Forest, Scrub-shrubland, Wetland, Grassland, and Swallows); two of these categories have been broken down further into habitat subgroupings. Forest birds are divided into coniferous forest affiliates and deciduous forest affiliates. Scrub-shrubland birds are divided into 2 subgroups; those found strictly in upland habitats and those found in both wetland and upland habitats.

Fortunately, a large body of trend data for populations of Passerines has been developed and maintained through the North American Breeding Bird Survey (BBS). The BBS provides critical population trend information gathered by amateur birders along approximately 3000 survey routes in the U.S. (56 in Maine) and Canada (Sauer et al. 1997). These data allow for a detailed evaluation of population status and trend for most species in this assessment.

FOREST BIRDS

SCOPE

This suite of species is the most diverse group covered by this assessment encompassing 9 families and 54 species (Table 1). This group benefits from the variety and broad distribution of forest types in Maine including stands of tolerant and intolerant hardwoods, spruce/fir *(Picea* spp*./Abies balsamea)*, and mixed stands of oak/pine *(Quercus* spp*./Pinus* spp*.)*, maple *(Acer* spp*.)*, birch *(Betula* spp*.*), and fir. Sixteen species are year-round residents, while 38 occur in Maine only during the breeding season (Table 1). I have subdivided the group into 2 categories: those associated with conifer-dominated woodland and those associated with deciduous-dominated woodland (Table 1).

Omitted from this group are Gray-cheeked Thrush *(Catharus minimus)* and Orange-Crowned Warbler *(Vermivora celata)* which are not known to breed in Maine and occur as passage migrants. Only the Olive-sided Flycatcher and Bicknell's Thrush are listed as Special Concern in Maine. There are no state or federally-listed Endangered or Threatened Passerines that occur in this habitat in Maine.

NATURAL HISTORY

General Description

As Maine is primarily forested, some species in this group are the most abundant Passerines in Maine. The winter residents, such as Black-capped Chickadee (note: scientific names for species discussed in this chapter are presented in Table 1) and Blue Jay, are familiar to most Maine citizens. There is a great variation in size of this group ranging from the 1.2 kg Common Raven to the 6 g Golden-crowned Kinglet. Although, the Common Raven is the largest Passerine in Maine, most forest songbirds are small. Nearly 90% of the 54 species in this group weigh <50 g and approximately 60% are <20 g. This group includes the colorful wood warblers as well as the striking Scarlet Tanager and Baltimore Oriole. In Maine, forest Passerines occur along a gradient of forest types from boreal spruce/fir through mixed oak/pine to pure deciduous associations of American Beech *(Fagus grandifolia)*, Yellow Birch *(B. pennsylvanica)*, and Sugar Maple *(A. saccharum)*.

Distribution and Migration

Of the 54 forest Passerines discussed, 35 (65%) have statewide distributions (Table 2). Of the 19 remaining species, 15 are associated with northern portions of the state, whereas 4 are restricted to southern Maine (Table 2). Of the species without statewide distributions, 12 have broad ranges, but 7 have sparse or localized breeding records. Further, Olive-sided Flycatchers have a statewide distribution, but are not abundant anywhere in our state and are believed to be declining here in Maine and elsewhere (Sauer et al. 1997, Lauber and O'Connor 1993). Bicknell's Thrush is restricted to montane habitat above 915 m (Atwood et al. 1996). Bicknell's Thrush (then as Gray-cheeked Thrush) was recorded within 10 blocks during the 1978-1983 atlas period (Adamus 1987) (Atlas blocks are areas of land which equate to 7.5' topographic quads and were the basis for sampling during the Maine Breeding Bird Atlas project; *see* Fig. 1). Furthermore, Atwood et al. (1996) reported this species at approximately 47 sites including 2 at low elevation coastal forests in the Quoddy Region of Washington County. In addition, these authors examined 5 historical (pre-1992) sites where Bicknell's Thrush was known to occur and verified presence again at all 5 sites. A small group of species were not well-documented during the atlas period (probable + confirmed breeding) including Tufted Titmouse within 14 blocks, Yellow-throated and Philadelphia Vireos within 16 blocks each, Blackpoll Warbler within 34 blocks, Pine Grosbeak and Red Crossbill within 9 blocks each, and White-winged Crossbill within 26 blocks.

Most (56%) forest Passerines are neotropical migrants (any bird in the Western Hemisphere that all or in part breeds to the north of and winters to the south of the Tropic of Cancer; Rappole et al. 1995) and 1/3 are short-distance migrants (for the purposes of this document species that breed in Maine but winter north of the Tropic of Cancer (Sauer et al. 1997) (Table 2). Eastern Phoebe and Winter Wren are probably the first of the forest Passerines to return from their wintering grounds (early April) (Vickery 1978, Wilson et al. 1997) (Table 2). After the breeding season, Olive-sided

and Least Flycatchers are the first to depart (early September) and Hermit Thrushes may be the last to leave, often remaining until late November (Vickery 1978) (Table 2).

Survival and Reproduction

Longevity records (maximum recorded lifespan from banding and band recoveries of wild birds) for this group indicate that most forest Passerines live <10 years (Kennard 1975, Clapp et al. 1983, Klimkiewicz et al. 1983, Klimkiewicz and Futcher 1989). For most Passerines, longevity records approximate actual lifespan in the wild (Clapp et al. 1982). Yellow-bellied Flycatchers have the shortest reported life span at 3 years 11 months and Blue Jays have the longest at 18 years 4 months (Clapp et al. 1983). One would expect the smallest species in the group (the kinglets) to have the shortest life span; perhaps data for Yellow-bellied Flycatchers is limited contributing to its short longevity record.

Despite the large number of species in this group, survival data for forest Passerines is limited. Available estimates indicate significant variation in average annual survival (White-breasted Nuthatch: 35% [Karr et al. 1990], American Redstart: 50 - 60% [Sherry and Holmes 1997], Tufted Titmouse: 54% [Karr et al. 1990], Ovenbird: 54% [Savidge and Davis 1974], Black and White Warbler: 71% [Roberts 1971], Wood Thrush: 70% for males and 75% for females [Roth et al. 1996]). Social status in Gray Jay populations is an important influence on survival. Adults on their breeding territory had an 85-90% chance of surviving to the next breeding season, whereas only half of the nonbreeders, forced out of territories by breeders, survived from autumn to the following breeding season (Strickland and Ouellet 1993). Also, hatch year Gray Jays survive better (48%) if they remain on their natal territory compared with hatch year individuals that were forced out during dispersal in June (15%) (Strickland and Ouellet 1993).

Causes of mortality for forest Passerines are diverse. Predation is important for Least Flycatchers (Darveau et al. 1993) and in forest fragments for Ovenbirds (Robinson 1992). Exposure accounts for significant mortality in several species including Hermit Thrush (Erskine 1992), Pine Siskins (Dawson 1997), and Black-capped Chickadees (Brittingham and Temple 1988). Specialized feeders, such as crossbills, are especially vulnerable to starvation when young (i.e., inefficient foragers) and are at the greatest risk for mortality during their first winter (Benkman 1992, Adkisson 1996). A broad group of forest songbirds are vulnerable to collisions with stationary objects (e.g., communications towers, skyscrapers, etc.) during migration (Crawford 1978) including Ruby-crowned Kinglets (Sawyer 1961) and several warblers (*see review by* Moldenhauer and Regeleski 1996 for Northern Parula). Death by collision with vehicles, while seeking grit or salt on winter roads, may be a significant cause of mortality for crossbills (Benkman 1992, Adkisson 1996) and probably Pine and Evening Grosbeaks. Also, egg and nestling mortality may be high for approximately 14 species of forest Passerines in areas where Brown-headed Cowbirds *(Molothrus ater)* are abundant (Ehrlich et al. 1988).

All forest Passerines in Maine are monogamous and 72% use an open cup-type nest. Several species use cavities for nesting (Paridae, Sittidae, and Winter Wren), kinglets construct a pendant-style nest between a forked branch, and Brown Creepers build a

nest underneath a section of loose bark (Ehrlich et al. 1988) (Table 3). Most forest songbirds lay approximately 4 eggs, incubate them for slightly less than 2 weeks, and young are ready to fledge within 2 weeks after hatching (Table 3).

Foods and Foraging Strategies

Nearly all forest songbirds are insectivores, although several species also consume either fruit and/or seeds (Ehrlich et al. 1988). Furthermore, a small group of forest birds are principally seed eaters including the crossbills, other finches and Dark-eyed Junco (Ehrlich et al. 1988). Also, the Corvids are omnivorous and probably the most opportunistic feeders of the group (Ehrlich et al. 1988). Corvids, moreover, are significant nest predators of other birds.

With some exceptions, most species, including the warblers, vireos, kinglets, finches, and nuthatches are foliage or bark gleaners (Ehrlich et al. 1988). The flycatchers generally use a hawking technique to catch insects "on the wing" and Corvids and most thrushes are ground foragers (Ehrlich et al. 1988). A few species (e.g., Black-throated Blue Warbler, Philadelphia Vireo, and Least Flycatcher) are adept at hovering while gleaning insects from foliage (Ehrlich et al. 1988).

Food habits of several Maine Passerines were studied during the spruce budworm *(Choristoneura fumiferana)* outbreak of the late 1970's and early 1980's (Crawford et al. 1983, Crawford and Jennings 1989). Specifically, Crawford et al. (1989) reported 22 species that consumed budworm larvae or pupae. These species included Yellow-bellied flycatcher, Black-capped Chickadee, Boreal Chickadee, Red-breasted Nuthatch, Golden-crowned Kinglet, Swainson's Thrush, Hermit Thrush, Red-eyed Vireo, Blue-headed Vireo, Northern Parula, Black-throated Green Warbler, Magnolia Warbler, Yellow-rumped Warbler, Canada Warbler, Cape May Warbler, Bay-breasted Warbler, Blackburnian Warbler, Nashville Warbler, Ovenbird, Dark-eyed Junco, Purple Finch, and White-throated Sparrow. Among these, 4 warblers (Cape May, Bay-breasted, Blackburnian, and Nashville) were especially effective predators. Blackburnian and Cape May Warblers consumed over 26,000 budworms/ha, more than twice the level of consumption of any other species. Forest Passerines consumed the greatest proportion (87%) of larvae and pupae when budworm populations, overall, were at low densities compared to transitional (23%) and epidemic (2%) levels (Crawford et al. 1983). All 22 species listed above exhibited a functional response to increased budworm density (i.e., consuming more budworms and fewer other food items) (Crawford and Jennings 1989). It is widely accepted that populations of Cape May (Baltz and Latta 1998), Blackburnian (Morse 1994), and Bay-breasted Warblers (Williams 1996a) are irruptive during outbreaks of spruce budworm, however, Crawford and Jennings (1989) found that only Canada Warbler and Golden-crowned Kinglet exhibited numerical responses (i.e., population increases) to increases in numbers of budworms during their study. Forest Passerines appear able to dampen severity of spruce budworm outbreaks given sufficient bird densities and adequate habitat (Crawford and Jennings 1989).

HABITAT ASSESSMENT - DECIDUOUS FOREST AFFILIATES

Habitat Use

Twenty four species of forest Passerines are found primarily in forested habitat where deciduous trees provide the dominant cover type. This habitat includes not only typical northern hardwood stands, but also mixed deciduous/coniferous forests as well. Examples of other forest stands that fit the criteria for this suite of species include successional (but closed canopy) aspen (*Populus* spp.)/birch forests, floodplain forests of Silver Maple *(A. saccharinum)* and Burr Oak *(Q. macrocarpa)*, and mixed beech/hemlock *(Tsuga canadensis)* or birch/fir stands. Many of these sites have been greatly altered by humans or have developed in response to past land use practices.

Past Habitat

Historic land use practices have been important to forest Passerines. Species such as Ovenbird, Rose-breasted Grosbeak, and American Crow, have responded positively to removal of coniferous forest which historically encouraged development of deciduous-dominated forests (Ferguson and Kingsley 1972). Losses of some deciduous habitat occurred as lands were cleared for agriculture. With abandonment of farmland in the twentieth century, many of these areas, especially tilled land, reverted to early successional forests of aspen, birch, and cherry *(Prunus* spp*.)*.

Statewide forest inventories, conducted in Maine since the 1950's, provide the most useful insight for evaluating dynamics of forest covertypes. Results of these inventories are presented for timberland which is "forest land that is producing, or capable of producing, crops of industrial wood (more than 20 cubic feet per acre) and is not withdrawn from timber utilization" (Griffith and Alerich 1996). Therefore, fluctuations in amounts of timberland should be viewed as an index to forest trends and not as absolute increases or decreases. Furthermore, slight variation in protocol prevents direct comparison among all surveys. Meaningful comparisons can only be made based on each report of forest statistics. Therefore, based on the 1972 report which provides comparisons of forest surveys conducted in Maine in the late 1950's and the early 1970's, slight changes in the composition of forested habitats for Maine Passerines have occurred (Ferguson and Kingsley 1972). Area occupied by northern hardwood stands declined markedly from approximately 7,663 square miles in 1959 to about 5,695 square miles in 1971 (Ferguson and Kingsley 1972:7-8). However, slight increases occurred between 1959 and 1971 for aspen/birch forests (Ferguson and Kingsley 1972). Despite declines in area of deciduous forest, slight increases occurred in the volume of Red *(A. rubrum)* and Sugar Maples *(A. saccharum)* with slight declines in volume of Yellow Birch (Ferguson and Kingsley 1972). Between 1971 and 1982, slight increases in the area of deciduous-dominated forest occurred (Powell and Dickson 1984) (Table 4). This trend appears driven by a 55% increase in aspen/birch stands (Powell and Dickson 1984:10-11) (Table 4).

Data from Powell (1985), based on an analysis using number of trees, disagree slightly. Using only the 10 most abundant species, Powell (1985:2) indicated a slight decline in

deciduous forest from 1959 through 1971. But, this trend was reversed by the time of the next survey; abundance of the 5 most common hardwoods increased 5% by 1982 (Powell 1985:2).

Surprisingly little change occurred in Maine's young deciduous forests between 1971 and 1982. The greatest changes occurred in aspen/birch stands with a doubling in area of poletimber over this period (Powell and Dickson 1984:10-11). Increases in early successional forest probably reflect either reforestation following abandonment of agricultural lands or stands regenerating from harvest or fire (over 750 sq. mi. burned between 1940 and 1969 [Ferguson and Kingsley 1972:35]).

Estimates of snags (i.e. standing dead trees) were made available from the 1982 survey as reported by Brooks et al. (1986:22). They estimated that nearly 148 million standing dead deciduous trees occurred in Maine in 1982. Five species (Paper Birch *[B. papyrifera]*: 22.9 million trees, aspen: 21.4, Yellow Birch: 20.2, Red Maple: 19.4, and American Beech: 18.7) comprised 69% of all deciduous snags in Maine (Brooks et al. 1986:22). Slightly more than 109 million deciduous trees had visible cavities; Red Maple (27.0 million trees) and American Beech (20.8) alone, represented nearly 44% of all cavity-bearing deciduous trees (Brooks et al. 1986:23).

Current Habitat

The most detailed data for current forest habitat conditions comes from the 1995 Maine forest survey. According to the survey, 27,639 square miles of forestland occurred in Maine in 1995 (Griffith and Alerich 1996:10). Appendix I provides a breakdown in area of timberland for each of the 3 PIF Physiographic Regions and Appendix II gives additional information on harvested stands and forested wetlands. Area in timberland declined just 1.2% from the 1982 survey (Griffith and Alerich 1996:12-13) (Table 4). However, deciduous-dominated timberlands increased overall (+15.3%) based on all stand types; only oak/pine declined slightly (Griffith and Alerich 1996:12-13) (Table 4). The greatest proportionate increase occurred in elm *(Ulmus americanus)*/ash *(Fraxinus* spp*.)*/Red Maple stands (+41.4%) (Griffith and Alerich 1996:12-13) (Table 4). Unlike the 1971-1982 period, aspen/birch increased only 8.9% (Griffith and Alerich 1996:12-13) (Table 4). Similarly, increases in size classes occurred for all deciduous stand types except oak/pine. In all deciduous forest types, except oak/pine, there were more square miles in sawtimber in 1995 than 1982 (Griffith and Alerich 1996:12-13). For poletimber, the trend was similar with increases in area of deciduous poletimber in 3 of 5 stand types only aspen/birch (-16.3%) and oak/pine (-5.7%) declined (Griffith and Alerich 1996:12-13).

Estimates of standing dead deciduous trees totaled 166.6 million in 1995 (Griffith and Alerich 1996:19). Red Maple (31.2 million trees), Paper Birch (28.3), and American Beech (27.2) and aspen (23.4) represent the largest proportions of any individual species and comprised 2/3 of the overall abundance of deciduous snags statewide (Griffith and Alerich 1996).

Habitat Projection

Outlook for deciduous habitats is difficult to predict. Variables such as disease in American Beech and changing forest practices regulations, including the use of herbicides, make projections especially speculative. Also, evidence of reforestation following abandonment of farmland, although important in some areas, may have largely occurred already. Maine is 90% forested, and on a statewide scale, little area remains to be reforested (Powell and Dickson 1984, Griffith and Alerich 1996).

Statewide trends indicate a slight upward shift in the area occupied by deciduous species. Deciduous stands, especially those dominated by aspen, elm, ash, and Red Maple have a younger age class distribution with most stands in seedling/sapling or pole timber (5.0 - 10.9" dbh for deciduous species) (MDIFW 1998a). Furthermore, harvesting in many of these stands occurs before trees reach sawtimber size ($\geq$ 11" dbh for deciduous species) (MDIFW 1998a). With increasing demands for fiber from deciduous species, it is likely that the age structure within deciduous stands will remain skewed to younger age classes (MDIFW 1998a). If allowed to regenerate without the use of herbicides or other treatment, these stands would develop to the advantage of species such as Philadelphia Vireo which occupies regenerating stands of aspen and birch (Moskoff and Robinson 1996). Griffith and Alerich (1996:12-13) reported a 45% increase (2,549 to 3,693 square miles) in the area occupied by seedling/saplings of deciduous species. Conversion of "future" deciduous stands to coniferous types would likely shift trends to more conifer habitat; the consequences for Passerines would be mixed. Some species like Least Flycatcher may be especially sensitive to tree species composition within deciduous forests (Robinson and Holmes 1984). Furthermore, if Maine experiences a loss of American Beech in its deciduous forests, subtle shifts in Passerine abundance and/or productivity also may take place. Although most species in this group occupy deciduous-dominated mixed stands, 3 species (Great-crested Flycatcher, Ovenbird, and Baltimore Oriole) appear more specialized in selecting stands with particularly high proportions of deciduous trees. Maine is unlikely to lose a large proportion of its deciduous forest. However, given the unpredictability of projecting the amount of deciduous-dominated stands in the future and with a softwood-based forest industry and increased marketability of hardwoods, the status of these 3 species could warrant increased monitoring should trends indicate a decline in deciduous forest or a shift in age class structure.

HABITAT ASSESSMENT - CONIFEROUS FOREST AFFILIATES

Habitat Use

Thirty species of Passerine birds live primarily in conifer-dominated forests. This land cover type ranges from dry pine woodlands on the edge of southern Maine sandplains to nearly even-aged stands of Red Spruce and Balsam Fir in northern Maine. Many forested wetlands, especially the lagg zone around peatlands (i.e., the upland/wetland interface of a peatland) are occupied by Northern White Cedar *(Thuja occidentalis)*, Tamarack *(Larix laricina)*, and Black Spruce *(P. mariana)*. Many of Maine's forestlands are comprised of a mixture of deciduous and coniferous species. On numerous sites coniferous species may have the greatest influence on the composition of mixed stands including oak/pine woodland, Balsam Fir/White Birch stands and hemlock/beech forest. Historic cutting practices may have resulted in conversion of some conifer-dominated stands to deciduous-dominated types. Modern silvicultural practices have attempted to reverse that trend; herbicide application and precommercial thinning effectively reduces deciduous competition during regeneration.

Past Habitat

Conifer-dominated forests of central Maine probably increased following abandonment of small farms, especially those that pastured livestock. Abandoned pasture often reverts to conifer-dominated forest because livestock avoid browsing on conifer foliage, but not deciduous foliage, which if left unmanaged, gives White Pine *(P. strobus)* and Red *(P. rubens)* and White Spruce *(P. glauca)* a "head start" in the development of the subsequent forest. These trees often develop into low grade "wolf trees" which are of little commercial value, but if left on site, may become snags. Such stand-level changes together with some types of forest cutting, which alter the composition of the forest, benefited some forest songbird populations such as Swainson's Thrush (Palmer 1949).

According to Ferguson and Kingsley (1972:7), only very slight declines occurred in the area occupied by spruce/fir stands between 1959 and 1971. However, slight increases occurred between 1959 and 1971 in the area of White and Red Pine *(P. resinosa)* (from 2,464 to 2,831 square miles) (Ferguson and Kingsley 1972:8). However, the volume of those stands increased sharply for spruce (+34% to 5.6 billion ft^3) and Balsam Fir (+42% to 5.1 billion ft^3) (Ferguson and Kingsley 1972:11). Slight increases also occurred for White Pine and Eastern Hemlock, while volume of Northern White Cedar declined slightly between 1959 and 1971 (Ferguson and Kingsley 1972:11). By the 1982 survey, area in conifer-dominated forest continued to decline (Table 4). Powell and Dickson (1984:10-11) reported an overall decline of 3.1% in coniferous forest (Table 4). Increases in pine (+14.9%, 451 square miles) largely tempered the 7.3% decline in spruce/fir (-950 square miles) (Powell and Dickson 1984:10-11) (Table 4).

Based on the abundance of the 5 most common coniferous species, Powell (1985:2) reported a slight increase (+3%) in coniferous trees between 1959 and 1971 and a decrease from 71% to 64% between 1971 and 1982. Declines in coniferous trees were largely the result of a spruce budworm epidemic which caused high mortality of fir and

of harvesting (salvaging) both spruce and fir. However, Balsam Fir and spruce remained the most abundant trees in the 1959, 1971, and 1982 surveys comprising roughly ½ the trees in Maine (Powell 1985:2).

Between 1971 and 1982, area in conifer sawtimber increased by 23.3% to 8,800 square miles while younger poletimber stands declined 10.4% to 5,374 square miles (Powell and Dickson 1984:10-11). Specifically, area in Red and White Pine (i.e., Red and White Pine Group + 1/2 of area in Oak/Pine Group) increased for both saw (+65.8%) and poletimber (+21.1%), while spruce/fir area increased for sawtimber (+12.3%), but declined for poletimber (-14.7%) (Powell and Dickson 1984:10-11).

Brooks et al. (1986:22) estimated that 323 million dead coniferous trees occurred in Maine in 1982. They reported that Balsam Fir alone accounted for nearly 63% of all coniferous snags. Northern White Cedar and Red Spruce contributed 47.3 and 39.4 million snags, respectively (Brooks et al. 1986:22). The sheer number of Balsam Fir stems, makes it the most important snag tree in Maine. However, many of these snags are short-lived, rot quickly, and fall to the ground. Northern White Cedar represents only 14.7% of all coniferous trees (>12.7 cm dbh) on Maine timberland (Powell and Dickson 1984:20), but considering its resistance to decay, its importance as a snag tree for cavity-nesting and bark-gleaning Passerines should not be underestimated. Furthermore, Brooks et al. (1986:23) reported that Balsam Fir and Northern White Cedar accounted for 41.3% and 38%, respectively, of all coniferous trees (live + dead) with cavities.

Current Habitat

Conifer-dominated forest is the most abundant forest type in Maine with over 11,000 square miles in 1995 (Appendix II). Appendices V and VI provide further details on current amounts of harvested stands and various forest types. Estimates of the area of conifer-dominated timberland declined 16.8% to 11,439 square miles (excluding Loblolly/Shortleaf Pine Group because of changes in stand type definitions) and contributed to a slight overall decrease (-1.2%) in timberland in Maine between 1982 and 1995 (Griffith and Alerich 1996:12-13) (Table 4). Despite slight increases in pine stands (+6.0% to 2,046 square miles), the decline in spruce/fir (-20.5% to 9,393 square miles) was the most important influence on these downward trends (Griffith and Alerich 1996:12-13) (Table 4). Size class trends are similar with marked downward shifts in area of both sawtimber (-13.6%) and poletimber (-42.6%) for spruce/fir between 1982 and 1995 (Griffith and Alerich 1996:12-13). Trends for pine stands (i.e., Red and White Pine Group + 1/2 of area in Oak/Pine Group) were mixed with increases in sawtimber (+32% to 1,511 square miles) and declines in poletimber (-33.2% to 447 square miles) (Griffith and Alerich 1996:12-13).

Standing dead conifers account for just over 66.5% of all snags statewide (Griffith and Alerich 1996:19). Balsam Fir continues to have the highest number of standing dead trees in Maine with 207 million stems, more than all species of deciduous snags combined (Griffith and Alerich 1996). Northern White Cedar and Red Spruce, again follow with 45.8 million and 38.2 million dead trees, respectively (Griffith and Alerich 1996). These 3 species combined accounted for 88% of all coniferous snags in Maine in 1995 (Griffith and Alerich 1996).

Current high elevation conifer habitat, although fragmented in distribution, appears abundant and well protected. All lands above 823 m (2700 ft) are protected by either the NRPA (Fragile Mountain Areas) in organized towns or by LURC (Mountain Area Protection Subdistrict) in the unorganized townships. Permits are required from the state agency with oversight authority (DEP, LURC, or both) before any timber harvesting or development projects (e.g., communications towers, wind power generation, ski area expansion) can take place. Habitat at most high elevation sites is largely inoperable for timber cutting (Erskine 1992, L. Alverson, 7-Islands Land Co., pers. comm.) which by default has afforded some protection to these birds. Also, recent estimates of high elevation lands above 914 m (3000 ft) found 40% (9,457 ha) currently in conservation ownership (R. Boone, Univ. of Maine, pers. comm.).

Habitat Projection

It remains unclear whether area of spruce/fir forest will continue to decline (i.e., relative to deciduous stands) (MDIFW 1998a). However, supply of merchantable-sized conifers probably will continue to decline into the 2010's (MDIFW 1998a). Until then and perhaps beyond, efforts to accelerate coniferous stand development will continue (MDIFW 1998a). Past silvicultural practices in northern Maine likely will encourage developing forests to be more even-aged with fewer deciduous trees in mixed stands. Conversion of deciduous and deciduous-dominated mixed stands to coniferous species represents a small but important silvicultural strategy for some landowners and is likely to affect bird populations at least locally. However, use of deciduous species as an alternative source of fiber is likely to increase (MDIFW 1998a).

Estimates of seedling and sapling stage coniferous forest from the 1995 forest inventory indicated an increase of 31.9% (to 2,894 square miles) since 1982. The loss of 34 square miles of pine in the seedling/sapling age class was insufficient to diminish gains of over 35.4% (to 2,811 square miles) in young spruce/fir habitat. Nearly ½ of the 30 Passerines in this group are strongly associated with coniferous forest. Some of these species, such as Red and White-winged Crossbills are highly specialized and could be affected by continued downward trends in coniferous habitat. Although the bulk of Maine's forest industry is based on conifer silviculture and loss of significant proportions of coniferous habitat is unlikely over the long term, use of smaller diameter (i.e., younger) trees may have consequences for some obligate coniferous birds. Younger stands and shorter rotations also may effect structure within Maine forests. Complexities of habitat selection by forest Passerines are not well known and forest practices that influence resulting stand composition, forest structure, and stand age and rotation length need to be carefully scrutinized. For example, Titterington et al. (1979) found Swainson's Thrush absent from recent clearcuts and instead were associated more with stands of conifers >10-15 cm dbh. Also, sufficient age is needed to develop lichen (*Usnea*) growth suitable for nesting Northern Parulas (Lemieux et al. 1996). Furthermore, most of the obligate coniferous forest birds are also nonmigratory, thus, management practices in Maine forests will have sole influence on their habitat.

High elevation conifer habitat, although protected, faces potential degradation via atmospheric deposition and siting of communications facilities (cellular phone and digital

TV towers). Although collocation of communications towers likely will lessen impacts, losses of some high elevation habitat is inevitable given the apparently growing communications industry and the impending digital TV network.

POPULATION ASSESSMENT - DECIDUOUS FOREST AFFILIATES

Past Populations

Based on historical accounts, populations of many forest Passerines have changed over time. Several species appear to occur at higher levels today than in the past including Brown Creeper, Veery, and Wood Thrush which were believed to be uncommon in Maine in the late 19th century (Samuels 1875). In addition, Samuels (1875) reported an increase in Canada Warbler in the late 1800's and Palmer (1949) indicated an increase in Scarlet Tanager in the first half of the 20th century. The Tufted Titmouse also was rare in Maine in the early 1900's (Forbush 1929, Palmer 1949), but has become much more common in recent decades, possibly in response to a warmer climate and ubiquitous winter feeding programs (Boyd 1962).

Populations of 3 Passerines associated with deciduous forests were believed to have declined historically. Palmer (1949) reported a slight decrease in numbers of American Redstarts throughout the 1930's and 1940's, but still believed this species was the most abundant warbler in Maine. Black and White Warblers also were found in fewer numbers during this period (Palmer 1949). Palmer (1949) also wrote that the Eastern Wood Pewee was more abundant in the 19th than 20th century and that the species had experienced a gradual decreasing trend.

As occurs today, some confusion existed with distinguishing Philadelphia Vireo from Red-eyed Vireo. The songs of the 2 species are similar, and to be distinguished visually require good optics and good lighting. Such difficulties prevent an analysis of historic accounts and indeed may affect reliability of current trend estimates as well.

Populations of some species were intentionally reduced in response to crop damage. Baltimore Orioles were shot because of depredation at vineyards (Forbush 1927). American Crows were persecuted in Maine for nearly 100 years because of damage caused to agricultural crops (Palmer 1949). The greatest damage inflicted by American Crows occurs in the spring when birds uproot sprouting corn and beans attempting to eat the seed (Palmer 1949). In response, bounties on crows were enacted by towns between 1798 and 1890, where some towns reported the taking of over 400 crows per year (Palmer 1949). Bounties appeared partially effective as Samuels (1875) reported that populations of American Crows in New England declined towards the end of the 19th century.

Current Populations

Although, no bounties have been in place for over 100 years, crows are the only Passerine in Maine which supports a hunting season under federal authority (*see* Title 50, part 1, section 20.133, *also see* Current Use and Demand). It is unlikely that current harvest levels have any significant impact on statewide populations.

Among the deciduous forest Passerines discussed, Ovenbirds and Red-eyed Vireos are probably the most numerous and Yellow-throated Vireos the least abundant statewide. Trends for many species are variable and nonsignificant, however, several species have trends that are significant over the 30-year history of the BBS (Table 5). Eleven

species show significant ($P < 0.10$) long-term trends (1966-1996) for Maine; 9 species are increasing and 2 species are declining. Eastern Wood Pewee has the greatest declining trend at -3.1% per year and Black-throated Blue Warbler has the largest increasing trend at +15.5% annual change. Thirteen species exhibit significant recent short-term (1980-1996) trends for Maine with 8 positive and 5 negative estimates. Canada Warblers have the greatest decreasing trend for 1980-1996 at -5.0% per year and again Black-throated Blue Warbler has the greatest increasing short-term trend at +23.6% annually. The increasing trends for Tufted Titmouse and Philadelphia Vireo (Table 5) are based on FWS Region 5 data and from the Eastern Spruce/Hardwood Physiographic Region (Fig. 2) data, respectively, because there are too few Maine data to report.

For species with the greatest declines, Lauber and O'Connor (1993), using BBS data, found relatively stable trends for Eastern Wood Pewee for most New England States and the Northern New England and Southern New England Physiographic Regions. Only in the Eastern Spruce/Hardwood Region were slight declines evident (Lauber and O'Connor 1993). These authors also analyzed data for Black-throated Blue Warbler between 1975 and 1989 and noted stable populations for both the Eastern Spruce/Hardwood and Northern New England Physiographic Regions, but a brief decline for Maine from 1984-1988. Despite this apparent incongruence, analyses of Lauber and O'Connor (1993), agree with trends analyzed by the BBS for Canada Warbler. They found a steady decrease in number of Canada Warblers in Maine from 1978 to 1990, from 1970 to 1990 for the Eastern Spruce/Hardwood Region and a brief (1985-1990) but steep decline in the Southern New England Region. They also recorded a steep decline for New Hampshire, but a mixed trend for the Northern New England Region (1968-1990). Lauber and O'Connor (1993) called for management attention on this species, but questioned its effectiveness, because the distribution of the bird is largely outside the U.S. Rosenberg and Wells (1995) ranked Canada Warbler as one of the highest priority species for Maine based on 9% of the global distribution of the species occurring in Maine; more than for any other state.

Lauber and O'Connor (1993) identified 8 other forest Passerines that have experienced declines and may warrant special attention. Increased monitoring for the Veery which appeared in decline and for American Redstart because of difficulties in interpreting data. Great-crested Flycatcher, Black and White Warbler, Baltimore Oriole, and Scarlet Tanager appeared to be experiencing range contractions. Rose-breasted Grosbeak and Wood Thrush appeared in genuine long-term decline and together with Canada Warbler are probably of greatest concern among this suite of forest Passerines.

Population Projections

Populations of only a few species within this group warrant concern into the coming decades. Deciduous forests are common on the statewide landscape and without human-induced mortality factors (except crow hunting), populations of deciduous forest Passerines seem relatively secure. Populations of mature deciduous forest obligates, those with long-term declining trends, small populations, or specialized niches are the obvious species to watch.

Among resident species in this group (Blue Jay, American Crow, Black-capped Chickadee, Tufted Titmouse, White-breasted Nuthatch, and Brown Creeper) all are abundant and seemingly tolerant of human activity. Tufted Titmouse, although having a restricted range, appears to be expanding in both number and distribution (Adamus 1987). The Corvids and Black-capped Chickadee are the least specialized of the group and White-breasted Nuthatch and Brown Creeper the most specialized, but as long as Maine remains so heavily forested even these specialists are not likely to be lost from the state.

Of the remaining species in this group, American Redstart, Black and White Warbler, and Eastern Phoebe are common birds that appear well-adapted to human influences on the forest. Red-eyed Vireos, Ovenbirds, and Black-throated Blue Warblers also are abundant in mature habitats. In contrast, the distribution of Yellow-throated and Philadelphia Vireos could result in loss of these species from our state if they should undergo a range contraction. Furthermore, several species in this group have lost wintering habitat in the tropics including Scarlet Tanager, Baltimore Oriole, and Wood Thrush (Diamond 1991). Again many species (Ovenbird, Scarlet Tanager, Black-throated Blue Warbler, and Wood Thrush) have been targeted as negatively effected by forest fragmentation on their northeast breeding grounds. Other than the Wood Thrush, none seem especially vulnerable in Maine.

Four species however, deserve more attention or future populations indeed could be much lower. The Veery, Rose-breasted Grosbeak, Eastern Wood Pewee, and Canada Warbler appear to need special attention. All four species are considered high priority within the northeast region and all but Eastern Wood Pewee are within the top 12 priority species for Maine (Rosenberg and Wells 1995). In addition, (Rosenberg and Wells 1995) identified Canada Warbler as the highest priority declining species for Maine and called for research to determine the causes of declines in populations of this species. Improved understanding of these birds in their tropical wintering grounds as well as here in Maine could lead to management actions that would help to stabilize their populations in future decades.

POPULATION ASSESSMENT - CONIFEROUS FOREST AFFILIATES

Past Populations

Maine's northerly latitude has offered an abundance of coniferous habitat for breeding Passerines. Historically, populations have shown no downward trends, however, some annual variability in abundance was noted for crossbills, Bay-breasted Warbler, kinglets, and Red-breasted Nuthatch. Bay-breasted Warbler populations continue to fluctuate today as their densities are strongly tied to fluctuations in insect outbreaks, especially spruce budworm (Williams 1996a). Populations of Ruby-crowned Kinglets seem to fluctuate in response to cold weather (Laurenzi et al. 1982) and crossbills not only are specialists for a highly variable food source, but exhibit nomadism in response to its unpredictability (Benkman 1992, Adkisson 1996). Numbers of crossbills, once diminished for decades in response to removal of mature White Pine and Eastern Hemlock, appear to have recovered significantly in the second half of the 20th century (Letourneau 1996).

Populations of some coniferous forest Passerines appear to have increased over the past 100 years. Evening Grosbeaks were absent from the northeast prior to the early 1900's (Erskine 1992) and likely colonized in response to habitat alterations by humans and recurring epidemics of spruce budworm (Vincent 1996). Samuels (1875) reported that Common Ravens were thought to be extremely rare in Maine and Palmer (1949) noted increases since 1935 in Washington, Aroostook, and northern Penobscot Counties. Similarly, Samuels (1875) wrote that Hermit Thrushes were uncommon in southern Maine and later Palmer (1949) reported a noticeable increase between 1924 and 1949. Palmer (1949) also noted a marked increase in Black-throated Green Warblers after about 1909. Interestingly, Forbush (1929) indicated that Swainson's Thrush had a wider distribution than observed at present. Specifically, Palmer (1949) reported that Swainson's Thrush was more common in Knox than Hancock County. Today, Swainson's Thrush would be a rare breeder there, restricted to the immediate coast in Knox County (Adamus 1987). Changes in numbers of all these species probably do not reflect short term changes in food abundance, but rather longer term changes in habitat suitability.

Some decreases also have been noted; Gray Jays experienced some decline in abundance because of unrestricted shooting (Palmer 1949). Although Gray Jays may have been a nuisance at times around logging and sporting camps, Palmer (1949) believed this species was shot more as a living target than because of the damage it caused to personal property. Bicknell's Thrush appears to have disappeared from some mountaintops elsewhere in New England: Mount Greylock in Massachusetts and perhaps 8 other sites (Atwood et al. 1996) and additionally from Dixville Notch and Mount Kearsage in New Hampshire (Richards 1994).

Historic populations of some species, like the Blackburnian Warbler, may have been underestimated because of their secretive habits. Past, and indeed present, estimates of populations and trends need to be measured in view of the difficulties of correctly identifying these species.

Current Populations

Yellow-rumped and Magnolia Warblers are probably the most abundant of this suite of forest songbirds. With their limited distribution atop Maine's largest mountains, Bicknell's Thrush may number the least of the coniferous Passerines.

Long-term (1966-1996) trend estimates again are variable with slightly more significant positive trends; 7 species increasing and 3 species declining. The greatest significant decline for a species in this group is for Pine Grosbeak -15.5% per year based on data for the Eastern Spruce/Hardwood Physiographic Region (because too few data for Maine only). In contrast, the greatest increase over that 30 year time frame was for Pine Warbler at +18.0% annual change. For recent (1980-1996) short-term trends, the total number of species with significant trend estimates dropped to 10 with 6 species showing significant declines and 4 species showing significant increases. Cape May Warbler shows the greatest decline at -15.8% and White-winged Crossbill with the greatest increase at +15.9% (data for Eastern Spruce/Hardwood Forest).

The 2 Special Concern species both appear in long term decline (Table 5). However, trend estimates for Olive-sided Flycatcher (1966-1996: -3.1%, 1980-1996: -3.4%) were nonsignificant despite being based on $\geq$29 routes. Trends for Bicknell's Thrush are difficult to evaluate. Long term trends were significant at -10.1% and short-term trends also were significant at -13.5%. Estimates presented in Table 5 are for Bicknell's and Gray-cheeked Thrushes combined for the entire eastern BBS region and represent $\leq$ 20 routes. Furthermore, the high elevation habitat occupied by these thrushes precludes collecting data with roadside surveys. Consequently, much of these data must come from Gray-cheeked Thrush habitat at higher latitudes (lower elevations) or coastal habitats in the Maritimes and as a consequence are extremely speculative.

Lauber and O'Connor (1993) only presented results for Neotropical Migrants breeding in the northeast U.S., consequently, they did not present data for White-winged Crossbill, Pine Grosbeak, and curiously not for Bicknell's Thrush (Gray-cheeked Thrush at the time of their analysis). However, they do present data for Cape May Warbler, but their analysis was limited by small samples. The only geographic area suitable for analysis was the Eastern Spruce/Hardwoods which revealed a slight increase in Cape May Warblers from 1969-1990. Their analyses, however, did reveal 5 additional species which warranted attention. Tennessee Warblers declined from 1983 through 1989, but Lauber and O'Connor (1993) cautioned that much of the species geographic range lies outside the northeast U.S. and that these data may not indicate a rangewide downward trend. These authors provided similar concerns for Ruby-crowned Kinglets with downward trends in Maine and in the Eastern Spruce/Hardwoods. Olive-sided Flycatchers, despite limited geographic data, declined steadily from 1968 through 1990 for the Eastern Spruce/Hardwood Region. Lauber and O'Connor (1993) identified Olive-sided Flycatchers as a species of "particular concern" among the 87 species that they analyzed. They also identified 2 other species in this group (Bay-breasted Warbler and Swainson's Thrush) as needing attention. Although limited data were available for Bay-breasted Warbler, they noted a sharp decline in numbers starting in 1979 continuing through 1986. This coincides with the last years of the spruce budworm epidemic in northern and eastern Maine (Irland et al. 1988). Finally, they reported a steep steady decline for Swainson's Thrush in the Northeast. Data for Maine, although

temporally limited, supported their regional assessment. A long steady downward trend for Swainson's Thrush populations in the Eastern Spruce/Hardwoods also was evident in their data.

Population Projections

Interestingly, with all the attention paid to declines in neotropical migrants, some of the species of greatest concern are year-round residents. Understanding industrial forest management is essential to projecting future populations of coniferous forest birds. Because industry relies on a continuous inflow of raw materials, wood supply (i.e., coniferous forest) has been estimated well into the future. Concerns about forestry and coniferous forest birds should center on rotation length (i.e., forest age). Species such as Brown Creeper (Shaffer and Alvo 1996) and Winter Wren (Erskine 1992) may be diminished in number if forestry practices do not leave standing dead trees or tops and other slash on site to provide structure. Most specialists within this habitat type are closely tied to older forests and the structure it provides. Further, shorter rotations may limit cone production which doesn't reach a peak in many species until 60 years (Fowells 1965). Reduced cone crops will likely have a negative effect on crossbill populations (Benkman 1992).

Ten of the species in this group are year-round residents (Table 1) and only the Boreal Chickadee and Pine Grosbeak appear to be in significant decline (Table 5). Unfortunately, data from Maine are inadequate to evaluate statewide trends for these 2 species and the crossbills. Even data for the Eastern Spruce/Hardwood Region are marginal for Pine Grosbeak, which may have declined in response to cessation of the spruce budworm outbreak (Erskine 1992) or perhaps locally in response to cutting of mature conifer stands as some anecdotal evidence suggests.

The future is uncertain too for a few migrants that breed in conifer-dominated forests. Improved monitoring is clearly needed for Bicknell's Thrush and Blackpoll Warbler for which there are little data even at a regional scale. More surveys at high elevations would also improve monitoring for Ruby-crowned Kinglet, Boreal Chickadee, and Swainson's Thrush and allow a better evaluation of their status in Maine. Erskine (1992) warned of the effects of acid precipitation on high elevation forests and Bicknell's Thrush populations. Cape May, Tennessee, and Bay-breasted Warblers may be in a low of a natural cycle that historically has followed outbreaks of spruce budworm. It is likely that attempts will be made to control future outbreaks (i.e., reduce vulnerability) through a mix of age classes as opposed to aerial pesticide application, which was so detrimental to many forest birds (*see* Erskine 1992). One of the most disturbing trends for this group is a slow, but steady, downward trend in Olive-sided Flycatchers which prompted its Special Concern designation within Maine. Although some have discounted the value of clearcuts as suitable habitat (Erskine 1992, Seguin 1996), commercial clearcutting which commonly leaves standing snags scattered among regenerating stands, would seem an ideal habitat prescription for Olive-sided Flycatchers. Yet, trend estimates continue to decline despite seemingly abundant habitat. With such a small wintering range, several fold smaller than breeding range (limited to Peru, Ecuador, Colombia and Venezuela) (Rappole et al. 1995), concerns

about winter habitat conditions may hold some of the answers for Olive-sided Flycatchers. However, an improved understanding of the characteristics of habitats used for breeding in North America could help minimize limitations on the breeding grounds.

Table 1. Passerine birds of forested habitats in Maine.

Common Name	Scientific Name	Residency Status	Site Affiliation[1]
Olive-sided Flycatcher	*Contopus borealis*	Breeding Season Only	Mixed-C/D
Eastern Wood Pewee	*Contopus virens*	Breeding Season Only	Mixed-D/C
Yellow Bellied Flycatcher	*Empidonax flaviventris*	Breeding Season Only	Coniferous
Least Flycatcher	*Empidonax minimus*	Breeding Season Only	Mixed-D/C
Eastern Phoebe	*Sayornis Phoebe*	Breeding Season Only	Mixed-D/C
Great-crested Flycatcher	*Myiarchus crinitis*	Breeding Season Only	Deciduous
Gray Jay	*Perisoreus canadensis*	Year-round Resident	Mixed-C/D
Blue Jay	*Cyanocitta cristata*	Year-round Resident	Mixed-D/C
American Crow	*Corvus brachyrhynchos*	Year-round Resident	Mixed-D/C
Common Raven	*Corvus corax*	Year-round Resident	Mixed-C/D
Black-capped Chickadee	*Parus atricapillus*	Year-round Resident	Mixed-D/C
Boreal Chickadee	*Parus hudsonicus*	Year-round Resident	Coniferous
Tufted Titmouse	*Parus bicolor*	Year-round Resident	Mixed-D/C
Red-breasted Nuthatch	*Sitta canadensis*	Year-round Resident	Mixed-C/D
White-breasted Nuthatch	*Sitta carolinensis*	Year-round Resident	Mixed-D/C
Brown Creeper	*Certhia americana*	Year-round Resident	Mixed-D/C
Winter Wren	*Troglodytes troglodytes*	Breeding Season Only	Coniferous
Golden-crowned Kinglet	*Regulus satrapa*	Breeding Season Only	Coniferous
Ruby-crowned Kinglet	*Regulus calendula*	Breeding Season Only	Coniferous
Veery	*Catharus fuscescens*	Breeding Season Only	Mixed-D/C
Bicknell's Thrush	*Catharus bicknelli*	Breeding Season Only	Coniferous
Swainson's Thrush	*Catharus ustulatus*	Breeding Season Only	Mixed-C/D
Hermit Thrush	*Catharus guttatus*	Breeding Season Only	Mixed-C/D
Wood Thrush	*Hylocichla mustelina*	Breeding Season Only	Mixed-D/C
Blue-headed Vireo	*Vireo solitarius*	Breeding Season Only	Mixed-C/D
Yellow-throated Vireo	*Vireo flavifrons*	Breeding Season Only	Mixed-D/C
Warbling Vireo	*Vireo gilvus*	Breeding Season Only	Mixed-D/C
Philadelphia Vireo	*Vireo philadelphicus*	Breeding Season Only	Mixed-D/C
Red-eyed Vireo	*Vireo olivaceous*	Breeding Season Only	Mixed-D/C
Tennessee Warbler	*Vermivora peregrina*	Breeding Season Only	Mixed-C/D
Northern Parula	*Parula americana*	Breeding Season Only	Mixed-C/D
Magnolia Warbler	*Dendroica magnolia*	Breeding Season Only	Coniferous
Cape May Warbler	*Dendroica tigrina*	Breeding Season Only	Coniferous
Black-throated Blue Warbler	*Dendroica caerulescens*	Breeding Season Only	Mixed-D/C
Yellow-rumped Warbler	*Dendroica coronata*	Breeding Season Only	Mixed-C/D
Black-throated Green Warbler	*Dendroica virens*	Breeding Season Only	Mixed-C/D
Blackburnian Warbler	*Dendroica fusca*	Breeding Season Only	Coniferous
Pine Warbler	*Dendroica pinus*	Breeding Season Only	Coniferous
Bay-breasted Warbler	*Dendroica castanea*	Breeding Season Only	Coniferous
Blackpoll Warbler	*Dendroica striata*	Breeding Season Only	Coniferous
Black and White Warbler	*Mniotilta varia*	Breeding Season Only	Mixed-D/C
American Redstart	*Setophaga ruticilla*	Breeding Season Only	Mixed-D/C
Ovenbird	*Seirus aurocapillus*	Breeding Season Only	Deciduous
Canada Warbler	*Wilsonia canadensis*	Breeding Season Only	Mixed-D/C
Scarlet Tanager	*Piranga olivacea*	Breeding Season Only	Mixed-D/C
Rose-breasted Grosbeak	*Pheuticus ludovicianus*	Breeding Season Only	Mixed-D/C
Dark-eyed Junco	*Junco hyemalis*	Breeding Season Only	Mixed-C/D
Baltimore Oriole	*Icterus galbula*	Breeding Season Only	Deciduous
Pine Grosbeak	*Pinicola enucleator*	Year-round Resident	Coniferous
Purple Finch	*Carpodacus purpureus*	Year-round Resident	Mixed-C/D

Table 1. Continued.

Common Name	Scientific Name	Residency Status	Site Affiliation[1]
Red Crossbill	*Loxia curvirostra*	Year-round Resident	Mixed-C/D
White-winged Crossbill	*Loxia leucoptera*	Year-round Resident	Mixed-C/D
Pine Siskin	*Carduelis pinus*	Year-round Resident	Mixed-C/D
Evening Grosbeak	*Coccothraustes vespertinus*	Year-round Resident	Mixed-C/D

[1] Mixed-D/C = deciduous-dominated mixed stands; Mixed-C/D = coniferous-dominated mixed stands.

Table 2. Distribution and migration information for selected forest Passerines in Maine.

Species	Distribution in Maine	Timing of Migration			Wintering Area[3]
		Mean First Arrival[1]	Estimated Arrival[2]	Estimated Departure[2]	
Olive-sided Flycatcher	Statewide	4/23	Late May	Early Sep	NW South America
Eastern Wood Pewee	Statewide	4/26	Late May	Late Sep	Central Am., NW South America
Yellow -bellied Flycatcher	All but Southwest	5/26	Mid May	Mid Sep	So. Mexico and Central America
Least Flycatcher	Statewide	5/18	Early May	Early Sep	So. Mexico and Central America
Eastern Phoebe	Statewide	4/6	Early April	Late Oct	SE U.S. and Mexico
Great-crested Flycatcher	All but Extreme North	5/15	Mid May	Mid Sep	So. Mex., Central Am., Colombia
Gray Jay	All but South & Central	N/A	N/A	N/A	No. U.S. and Canada[4]
Blue Jay	Statewide	N/A	N/A	N/A	U.S.[4]
American Crow	Statewide	N/A	N/A	N/A	U.S.[4]
Common Raven	Statewide	N/A	N/A	N/A	U.S. and Canada[4]
Black-capped Chickadee	Statewide	N/A	N/A	N/A	U. S. and So. Canada[4]
Boreal Chickadee	All but South & Central	N/A	N/A	N/A	No. U.S. and Canada[4]
Tufted Titmouse	Southern 1/3	N/A	N/A	N/A	U.S.[4]
Red-breasted Nuthatch	Statewide	N/A	N/A	N/A	U.S. and So. Canada[4]
White-breasted Nuthatch	Statewide	N/A	N/A	N/A	U.S. and So. Canada[4]
Brown Creeper	Statewide	N/A	N/A	N/A	U.S.[4]
Winter Wren	Statewide	4/14	Early Apr	Early Nov	SE U. S.
Golden-crowned Kinglet	All but extreme Southwest	?	Late Apr[5]	Mid Oct[5]	U.S., So. Canada
Ruby-crowned Kinglet	All but extreme Southwest	4/22	Mid Apr	Mid Nov	So. U.S. and Mexico
Veery	Statewide	5/16	Early May	Late Sep	No. South America
Bicknell's Thrush	Interior Mts. & Extreme East	5/20	Late May	Early Oct	No. South America, Caribbean
Swainson's Thrush	All but South & Central	5/22	Early May	Late Sep	So. Mex, Central Am., No. South America
Hermit Thrush	Statewide	4/22	Mid Apr	Late Nov	SE U.S and Mexico
Wood Thrush	Statewide	5/11	Mid May	Late Sep	Mexico and Central America
Blue-headed Vireo	Statewide	5/3	Early Apr	Late Oct	SE U.S., Mex, Central Am., Caribbean
Yellow-throated Vireo	Extreme Southwest	5/21	Mid May	Late Aug	So. Mex, Carrib, No. South America
Warbling Vireo	Statewide	5/17	Mid May	Mid Sep	Mexico, Central Am., NW South Am.
Philadelphia Vireo	All but Southern 1/3	5/25	Mid May	Mid Oct	Central America
Red-eyed Vireo	Statewide	5/20	Early May	Mid Oct	South America
Tennessee Warbler	All but South & Central	5/18	Mid May	Late Sep	So. Mex., Central Am., Colomb., Venez.
Northern Parula	All but interior York, Cumberland and S. Oxford Counties	5/10	Early May	Late Sep	Mex, Central Am., Carrib., S. America
Magnolia Warbler	Statewide	5/13	Mid Apr	Mid Sep	So. Mexico, Central Am. Caribbean

Table 2. Continued

Species	Distribution in Maine	Timing of Migration: Mean First Arrival[1]	Timing of Migration: Estimated Arrival[2]	Timing of Migration: Estimated Departure[2]	Wintering Area[3]
Cape May Warbler	All but South & Central	5/15	Early May	Mid Oct	Caribbean
Black-throated Blue Warbler	Statewide	5/13	Early May	Mid Oct	Caribbean
Yellow-rumped Warbler	Statewide	4/29	Mid Apr[5]	Mid Nov[5]	So. U.S., Mexico, Central Am., Carrib.
Black-throated Green Warbler	Statewide		Early May	Late Sep	So. Mex., Central Am., Colombia, Venezuela, Caribbean
Blackburnian Warbler	Statewide	5/17	Early May	Late Sep	NW South America
Pine Warbler	Southern 1/3	4/23	Mid Apr	Late Oct	SE U.S.
Bay-breasted Warbler	All but Extreme S. & Central	5/17	Early May	Mid Sep	Colombia, Venezuela
Blackpoll Warbler	NW ½ and Coastal Wash Cty	5/20	Early May	Mid Oct	NW South America
Black and White Warbler	Statewide	5/4	Mid Apr	Late Sep	SE U.S., Mex, Central Am., Carrib., NW South America
American Redstart	Statewide	5/15	Late Apr	Early Oct	So. Mex., Central Am., Carrib., NW South America
Ovenbird	Statewide	5/9	Early May	Late Sep	SE U.S., So. Mex., Central Am., Colombia, Venezuela, Caribbean
Canada Warbler	Statewide	5/19	Early May	Late Sep	NW South America
Scarlet Tanager	Statewide	5/18	Mid May	Late Sep	Colombia, Ecuador, Peru, Bolivia
Rose-breasted Grosbeak	Statewide	5/11	Early May	Mid Oct	So. Mex, Central Am, NW S. Am.
Dark-eyed Junco	Statewide	N/A	Early Mar[5]	Late Dec[5]	U.S., So. Canada
Baltimore Oriole	Statewide	5/12	Early May	Mid Nov	Mex., Central Am., Caribbean, Colombia, Venezuela
Pine Grosbeak	Northern ½	N/A	N/A	N/A	No. U.S., So. Canada[4]
Purple Finch	Statewide	N/A	N/A	N/A	U.S., So. Canada[4]
Red Crossbill	Statewide	N/A	N/A	N/A	U.S., So. Canada[4]

Table 2. Continued

Species	Distribution in Maine	Timing of Migration: Mean First Arrival[1]	Timing of Migration: Estimated Arrival[2]	Timing of Migration: Estimated Departure[2]	Wintering Area[3]
White-winged Crossbill	All but Extreme SW	N/A	N/A	N/A	No. U.S., Canada[4]
Pine Siskin	Statewide	N/A	N/A	N/A	U.S., So. Canada[4]
Evening Grosbeak	Statewide	N/A	N/A	N/A	U.S., So. Canada[4]

[1] Data from Wilson et al. (1997).
[2] Estimates from Vickery (1978).
[3] Rappole et al. (1995).
[4] Small numbers of this species overwinter in Maine in most years (Vickery 1978).
[5] Typical winter range includes Maine.

Table 3. Aspects of the reproductive biology[1] of selected forest Passerines that breed in Maine.

Species	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Olive-sided Flycatcher	Conif. Tree	Open Cup	3-4[2]	14-17[2]	21-23
Eastern Wood Pewee	Decid. Tree	Open Cup	3	12-13	14-18
Yellow-bellied Flycatcher	Ground	Open Cup	3-4	14[2]	13-14[2]
Least Flycatcher	Decid. Tree	Open Cup	4	12-15[2]	12-16
Eastern Phoebe	Bridge/Cliff	Open Cup	4-5	16	15-17[2]
Great-crested Flycatcher	Decid. Tree	Cavity	5	13-15	12-21
Gray Jay	Conif. Tree	Open Cup	3-4	16-18	15-24[2]
Blue Jay	Conif. Tree	Open Cup	4-5	16-18	17-21
American Crow	Decid. Tree	Open Cup	4-6	16-21[2]	28-35
Common Raven	Cliff/Tree	Open Cup	4-7[2]	18-22[2]	35-44[2]
Black-capped Chickadee	Decid. Tree	Cavity	6-8	11-13	14-18
Boreal Chickadee	Conif. Tree	Cavity	5-8	12-15[2]	18
Tufted Titmouse	Decid. Tree	Cavity	5-7	13-14	15-18
Red-breasted Nuthatch	Conif. Tree	Cavity	5-6	12-13[2]	14-21
White-breasted Nuthatch	Decid. Tree	Cavity	5-8	12-14[2]	14
Brown Creeper	Conif. Tree	Under Bark	5-6	14-17	13-16
Winter Wren	Snag	Cavity	4-7[2]	14-16[2]	16-19[2]
Golden-crowned Kinglet	Conif. Tree	Pendant	8-9	14-15	14-19
Ruby-crowned Kinglet	Conif. Tree	Pendant	7-9	13-14[2]	14-16[2]
Veery	Ground	Open Cup	4	10-14[2]	10-12[2]
Bicknell's Thrush	Low Vegetation[3]	Open Cup[3]	4[4]	13-14[4]	10-13[4]
Swainson's Thrush	Shrub	Open Cup	3-4	10-14[2]	10-13
Hermit Thrush	Ground	Open Cup	3-4[2]	12-13	12
Wood Thrush	Decid. Tree	Open Cup	3-4	12-14[2]	12-14[2]
Blue-headed Vireo	Conif. Tree	Open Cup	4	10-15[2]	14-17[2]
1Yellow-throated Vireo	Decid. Tree	Open Cup	4	14	14
Warbling Vireo	Decid. Tree	Open Cup	4	12-14[2]	12-16[2]
Philadelphia Vireo	Decid. Tree	Open Cup	4	11-14[2]	12-14
Red-eyed Vireo	Shrub	Open Cup	4	11-15[2]	10-12
Tennessee Warbler	Ground	Open Cup	4-6[2]	11-12	Unknown
Northern Parula	Decid.Tree	Pendant	4-5	12-14	11[5]
Magnolia Warbler	Conif. Tree	Open Cup	4	11-3	8-10
Cape May Warbler	Conif. Tree	Open Cup	6-7	Unknown	Unknown
Black-throated Blue Warbler	Shrub	Open Cup	4	12-13	8-12[2]
Yellow-rumped Warbler	Conif. Tree	Open Cup	3-5[2]	11-13[2]	10-14[2]
Black-throated Green Warbler	Conif. Tree	Open Cup	4-5	12	8-11[2]
Blackburnian Warbler	Conif. Tree	Open Cup	4	11-13[2]	Unknown
Pine Warbler	Conif. Tree	Open Cup	4	10-13[2]	10
Bay-breasted Warbler	Conif. Tree	Open Cup	4-5	12-13	11-12
Blackpoll Warbler	Conif. Tree	Open Cup	4-5	11-12[2]	8-12[2]
Black and White Warbler	Ground	Open Cup	5	10-13[2]	8-12
American Redstart	Decid. Tree	Open Cup	4	10-14[2]	8-9[2]
Ovenbird	Ground	Oven	4-5	11-13	8-10
Canada Warbler	Ground	Open Cup	4	12[6]	8-10[6]
Scarlet Tanager	Decid. Tree	Saucer	4	12-14[2]	9-11
Rose-breasted Grosbeak	Decid. Tree	Open Cup	3-4[2]	11-14[2]	9-12[2]
Dark-eyed Junco	Ground	Open Cup	3-5	12-13	9-13
Baltimore Oriole	Decid. Tree	Pendant	4-5	12-15[2]	11-14[2]
Pine Grosbeak	Conif. Tree	Open Cup	4	13-15	13-20

Table 3. Continued.

Species	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Purple Finch	Conif. Tree	Open Cup	4-5	13	14
Red Crossbill	Conif. Tree	Open Cup	3-4	12-18	15-24[2]
White-winged Crossbill	Conif. Tree	Open Cup	2-4[2]	12-14	Unknown
Pine Siskin	Conif. Tree	Saucer	3-4	13-14[2]	14-15
Evening Grosbeak	Conif. Tree	Open Cup	3-4	11-14	13-14

[1] Excerpted from the summaries by Ehrlich et al. (1988) unless otherwise indicated.
[2] See Gauthier and Aubry (1996).
[3] Data for Gray-cheeked Thrush from Ehrlich et al. (1988).
[4] Wallace (1939).
[5] See Degraaf and Rudis (1986).
[6] Kendeigh (1945).

Table 4. Area (sq. mi.) of timberland in Maine by stand type.

	Powell and Dickson (1984:10-11)		Griffith and Alerich (1996:12-13)	
Stand Type	1971	1982	1982	1995
White Pine/Red Pine	2,977.7	3,429.2	1,809.4	1,946.7
Spruce/Balsam Fir	13,091.1	12,141.4	11,818.3	9,392.5
Loblolly/Shortleaf Pine	21.4	13.0	--	10.5
Oak/Pine	41.3	56.6	242.7	199.4
Oak/Shagbark Hickory	423.4	478.9	591.4	708.1
Elm/Ash/Red Maple	538.3	372.2	480.2	679.2
Northern Hardwoods	7,635.0	7,813.9	8602.7	10,013.8
Aspen/Birch	1,515.3	2,351.4	3,227.3	3,515.0
Totals				
Conifer-dominated[1]	16,110.8	15,611.9	13,749.1	11,438.9[2]
Deciduous-dominated[1]	10,132.7	11,044.7	13,023.0	15,015.8
All Types	26,243.5	26,656.6	26,772.1	26,454.7

[1] Includes 50% of area in oak/pine stand type.
[2] Excludes area in Loblolly/Shortleaf Pine stand type because of changes in stand type definitions between years.

Table 5. Trends[1] in numbers of selected forest Passerines[2] observed in Maine based on data from the North American Breeding Bird Survey[3].

	1966-1996			1966-1979			1980-1996		
Species	n[4]	Trend	P[5]	n	Trend	P	n	Trend	P
Olive-sided Flycatcher	37	-3.1	NS	15	0.8	NS	29	-3.4	NS
Eastern Wood Pewee	59	-3.1	0.08	25	2.7	NS	55	-4.1	0.01
Yellow-bellied Flycatcher[6]	122	1.6	NS	58	9.5	<0.01	96	2.1	NS
Least Flycatcher	59	-2.1	NS	33	-3.3	NS	58	-3.5	0.02
Eastern Phoebe	52	0.5	NS	33	-3.5	NS	51	3.7	<0.01
Great-crested Flycatcher	52	3.9	0.03	25	5.6	NS	51	8.0	0.08
Gray Jay[6]	100	1.0	NS	48	2.8	NS	83	1.1	NS
Blue Jay	62	0.1	NS	37	-4.1	NS	61	0.3	NS
American Crow	56	2.4	0.08	37	-1.0	0.63	57	2.9	<0.01
Common Raven	55	-0.7	NS	26	1.8	NS	55	2.3	NS
Black-capped Chickadee	62	3.1	<0.01	36	-4.7	NS	61	3.4	<0.01
Boreal Chickadee[6]	91	-4.7	<0.01	54	-9.3	<0.01	61	-5.8	0.08
Tufted Titmouse[7]	486	2.1	<0.01	293	0.1	NS	460	3.1	<0.01
Red-breasted Nuthatch	61	1.9	NS	27	-1.9	NS	60	1.7	NS
White-breasted Nuthatch	43	2.7	NS	17	1.3	NS	40	5.9	0.01
Brown Creeper	23	-2.1	NS	2[8]	-37.0	NS	22	-9.8	NS
Winter Wren	57	0.0	NS	25	-17.6	<0.01	56	2.9	NS
Golden-crowned Kinglet	42	-1.6	NS	7[8]	10.1	NS	41	0.1	NS
Ruby-crowned Kinglet	39	-3.8	NS	17	-9.2	<0.01	32	-6.4	0.09
Veery	62	-1.7	0.03	37	3.0	NS	61	-3.2	<0.01
Bicknell's Thrush[9]	20	-10.1	0.03	--	--	--	18	-13.5	<0.01
Swainson's Thrush	37	-1.5	NS	15	-1.9	NS	34	-0.3	NS
Hermit Thrush	60	-0.6	NS	33	-9.7	<0.01	59	5.7	<0.01
Wood Thrush	57	-1.0	NS	35	13.2	0.03	55	-3.9	<0.01
Blue-headed Vireo	59	9.4	0.01	24	17.4	0.01	57	2.7	NS
Yellow-throated Vireo[7]	383	-0.2	NS	237	1.7	NS	322	-0.1	NS
Warbling Vireo	41	3.3	NS	14[8]	-1.2	NS	35	2.0	NS
Philadelphia Vireo[4]	67	2.7	NS	22	-3.6	NS	53	6.0	<0.01
Red-eyed Vireo	62	1.5	0.05	35	9.5	<0.01	61	0.6	NS
Tennessee Warbler	30	9.1	0.09	12[8]	20.2	NS	24	-8.8	0.02
Northern Parula	58	3.7	NS	29	8.1	NS	55	-0.3	NS
Magnolia Warbler	56	1.4	NS	22	44.8	NS	56	-0.5	NS
Cape May Warbler	30	2.4	NS	7[8]	30.0	0.01	28	-15.8	0.02
Black-thr. Blue Warbler	49	15.5	0.04	18	0.0	NS	46	23.6	0.05
Yellow-rumped Warbler	61	7.0	0.01	28	34.2	NS	60	5.5	0.05
Black-thr. Green Warbler	60	2.8	NS	27	10.6	NS	59	3.1	NS
Blackburnian Warbler	47	6.3	0.02	13[8]	23.3	0.01	45	2.9	NS
Pine Warbler	28	18.0	0.06	5[8]	11.7	NS	27	13.2	<0.01
Bay-breasted Warbler	30	3.6	NS	9[8]	131.8	NS	25	-3.2	NS
Blackpoll Warbler[4]	37	-3.5	NS	23	25.6	NS	23	-3.7	NS
Black and White Warbler	61	0.6	NS	35	5.6	NS	60	-0.8	NS
American Redstart	61	-2.0	NS	35	-4.5	NS	59	-1.0	NS
Ovenbird	62	1.6	0.04	37	4.9	0.01	61	0.8	NS
Canada Warbler	53	-6.3	NS	21	-11.5	NS	49	-5.0	0.03
Scarlet Tanager	54	3.4	0.06	26	15.6	NS	50	2.1	NS
Rose-breasted Grosbeak	60	2.2	NS	29	8.6	0.05	58	-1.6	NS
Dark-eyed Junco	50	-3.8	NS	22	2.6	NS	43	-4.5	NS
Baltimore Oriole	43	2.5	0.03	22	7.0	NS	39	-0.2	NS

Table 5. Continued.

Species	1966-1996 n	1966-1996 Trend	1966-1996 P	1966-1979 n	1966-1979 Trend	1966-1979 P	1980-1996 n	1980-1996 Trend	1980-1996 P
Pine Grosbeak[4]	26	-15.5	0.03	18	-13.7	<0.01	14[8]	-9.3	0.01
Purple Finch	59	-0.1	NS	34	-5.0	NS	55	-1.5	NS
Red Crossbill[4]	35	7.9	0.01	14[8]	-8.2	NS	22	8.2	NS
White-winged Crossbill[4]	40	16.7	0.09	9[8]	-25.5	NS	32	15.9	0.01
Pine Siskin	24	2.4	NS	6[8]	14.3	NS	20	25.4	NS
Evening Grosbeak	48	6.2	NS	13	-3.1	NS	44	32.6	NS

[1] Using route-regression method of Geissler and Sauer (1990).
[2] Gray-cheeked Thrush and Orange-crowned Warbler are excluded because they occur only as passage migrants in Maine; also excludes nonpasserine birds that use forested habitat.
[3] Sauer et al. (1997).
[4] n = number of Breeding Bird Survey routes upon which trend is based.
[5] P = Statistical significance level; NS indicate nonsignificant trend where P > 0.1.
[6] Data from Physiographic Region 28: Eastern Spruce/Hardwood Forest; data specific to Maine too limited to report (Sauer et al. 1997).
[7] Data from USFWS Region 5; data specific to Maine too limited to report (Sauer et al. 1997).
[8] Results may be unreliable and introduce positive bias when sample size is less than 14 (Sauer et al. 1997).
[9] Data for Gray-cheeked Thrush in Eastern BBS Region (Sauer et al. 1997); includes Bicknell's Thrush.

Passerine Assessment: 9/11/98

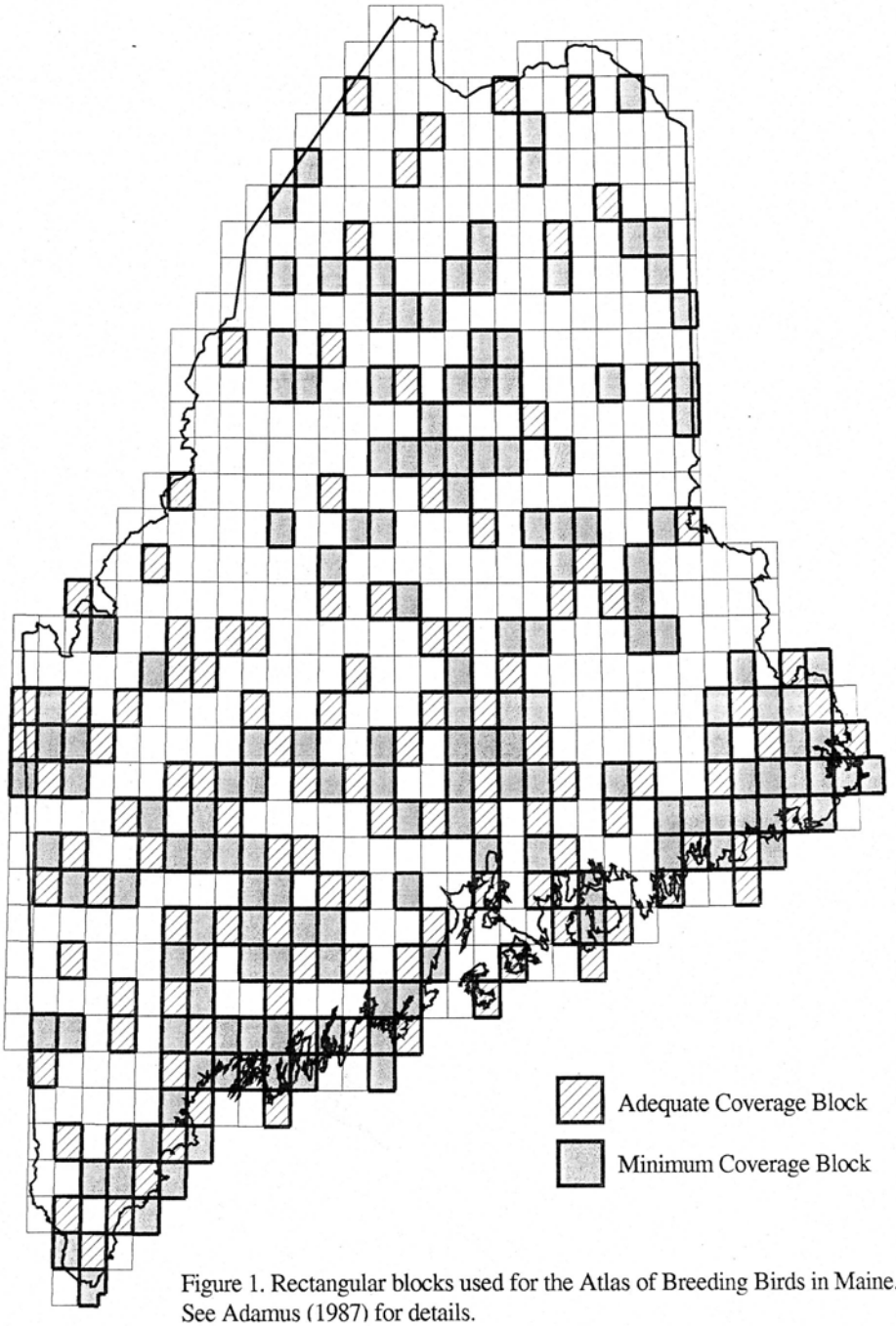

Figure 1. Rectangular blocks used for the Atlas of Breeding Birds in Maine. See Adamus (1987) for details.

Passerine Assessment: 9/11/98

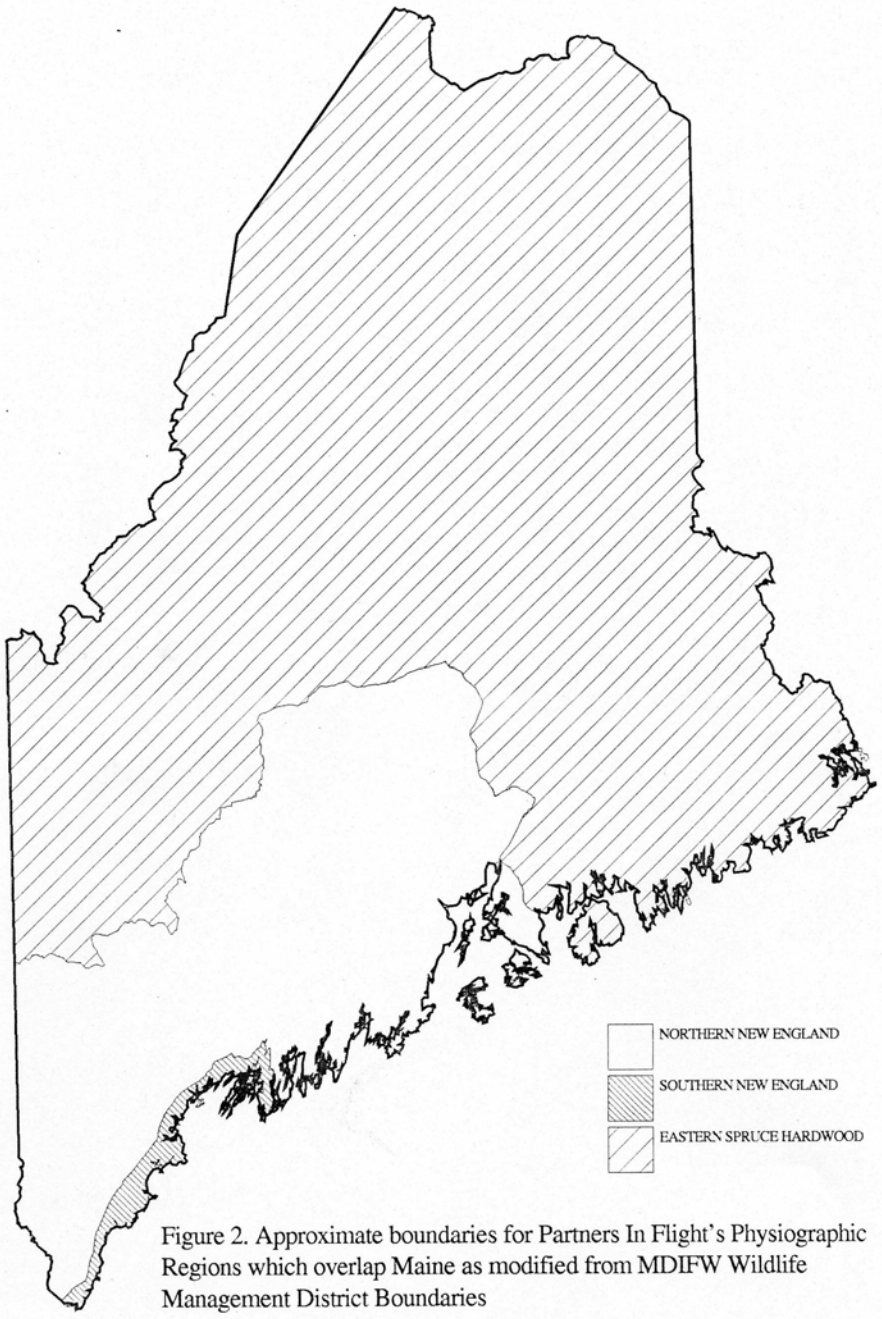

Figure 2. Approximate boundaries for Partners In Flight's Physiographic Regions which overlap Maine as modified from MDIFW Wildlife Management District Boundaries

SCRUB-SHRUBLAND BIRDS

SCOPE

This assemblage includes 37 species of birds and encompasses 7 Families. As a group they use a variety of "intermediate" successional habitats including forest edges, brushy powerline corridors, and scrub-shrub wetlands (Table 6). Four of these species are year-round residents, 5 are winter residents only and the remaining 28 are breeding summer residents. To facilitate discussion of the biology of this large group of birds, I have divided them into 2 groups: strict upland associates and those that are more generalists and use either upland or wetland shrub habitats.

Omitted from this group are Carolina Wren *(Thryothorus ludovicianus)* and Blue-winged Warbler *(Vermivora pinus)* which are exceedingly rare breeding species. However, Orchard Orioles and Loggerhead Shrikes may be less abundant, but have been granted Special Concern status, and therefore, are included. White-crowned Sparrows *(Zonotrichia leucophrys)* which are passage migrants in Maine are omitted from this assessment. There are no state-listed Threatened or Endangered species that rely on this habitat.

NATURAL HISTORY

General Description

This collection of species represents some of the most widely recognized members of Maine's avifauna. Ranging in size from the Blue-gray Gnatcatcher at only 6 g (note: scientific names for species discussed in this chapter are presented in Table 6) to the >100 g Common Grackle, nearly 50% of Maine's scrub-shrubland birds weigh <15 g and 80% weigh <40 g. The American Goldfinch, Orchard Oriole, and Eastern Bluebird are striking in coloration, whereas the waxwings and Northern Cardinal have both brilliant coloration and unique body shape. This group uses a wide variety of habitats typically associated with intermediate levels of succession. Some species are only found in uplands whereas others are often found in scrub-shrub wetlands as well as uplands.

Distribution and Migration

Among the 32 breeding species, 16 have statewide distributions, another 7 occur only in the southern ½ of the state, and a limited number are restricted to either the extreme southwest or extreme northwest portions of the state (Table 7). Orchard Oriole, one of the Special Concern species in this group, was observed as a possible breeder at one site in York County, during the 1978-1983 Atlas period (Adamus 1987). The remaining Special Concern species in this group, Loggerhead Shrike, is believed extirpated from the state, with the last known breeding record from 1963 (Milburn 1981). Among the other less common species: Blue-gray Gnatcatchers were confirmed breeding within only 4 atlas blocks, all southwest of Augusta; Prairie Warblers confirmed in only nine blocks in York and Cumberland Counties; and Fox Sparrow in only 1 block in western Aroostook County (Adamus 1987). These data, however, likely underestimate the distribution of all 3 of these species.

Thirty two species within this group breed in Maine, and of these, 4 species are permanent residents (Table 6). Neotropical migrants make up the largest portion of this group with 17 species (Sauer et al. 1997). Short distance migrants account for 13 species plus 5 birds which migrate to Maine for the winter (Table 6). The Common Grackle and American Robin are the earliest of this group to return to their breeding grounds in Maine (Vickery 1978, Wilson et al. 1997) (Table 7). Eastern Bluebirds, Fox and Song Sparrows also are early to return to Maine, whereas, Willow Flycatchers and Mourning Warblers are the last of this group to return (Vickery 1978, Wilson et al. 1997) (Table 7).

Survival and Reproduction

The longest recorded life span for approximately 70% of this group is <10 years (Kennard 1975, Clapp et al. 1983, Klimkiewicz et al. 1983, Klimkiewicz and Futcher 1989). The Alder Flycatcher has the shortest recorded life expectancy at 3 years 2 months (Clapp et al. 1983). The largest species, the Common Grackle has the longest longevity record at >22 years (Olyphant 1995). Notably, the redpolls have longevity

records of only 6 years for Common Redpolls and 5 years for Hoary Redpolls (Klimkiewicz and Futcher 1987, 1989) and may reflect a lack of banding effort for these species.

Few data are available to estimate survival for scrub-shrub Passerines. For the few species with documented adult annual survival, most estimates are slightly above 50% (Cedar Waxwing: 45% [Witmer et al. 1997], Indigo Bunting: 50% [Payne 1992], Common Grackle: 51.6% [Fankhauser 1971], Eastern Towhee: 58% [Savidge and Davis 1974], Brown-headed Cowbird: 62% for males and 45% for females [Darley 1971], Eastern Kingbird: 69% for males and 54.3% for females [Murphy 1996]). Also, differences in survival of White-throated Sparrows has been suggested by changes in the frequency of white-striped versus tan-striped individuals from the time of fledging to the time of breeding (Falls and Kopachena 1994).

Causes of mortality are not well known for scrub-shrubland Passerines. Chestnut-sided Warblers appear especially susceptible to collisions with man-made structures (Johnston and Haines 1957) and White-throated Sparrows, as with most species (especially immatures) are highly vulnerable during migration and during winter (Fretwell 1968, Falls and Kopachena 1994). Collisions with automobiles inflict significant mortality on Loggerhead Shrikes and is thought to have contributed to the species' decline (Bartgis 1992). Nest predation and brood parasitism are common causes of egg loss and nestling mortality among shrubland birds and can severely impact local populations. Parasite burdens also can be excessive and contribute to loss of nestlings of this group, especially for Northern Mockingbirds (Derrickson and Breitwisch 1992). Colonies of Common Grackles are sensitive to disturbance at nest sites and widespread abandonment has been observed (Peer and Bollinger 1997). Further, nestling Brown-headed Cowbirds may contribute to mortality of host eggs and nestlings by evicting them from nests.

All Passerines in Maine's scrub-shrubland habitats are monogamous (Ehrlich et al.1988). Species within this group use a variety of nesting sites, but except for the 2 cavity nesters, most construct an open cup-type nest (Table 8). Most species lay between 3 and 5 eggs and incubate for just under 2 weeks; most nestlings are ready to fledge within 14 days after hatching (Table 8). Notably, this group includes the Brown-headed Cowbird, the most important brood parasite in Maine and indeed North America. By depositing eggs in the nest of other species, the female cowbird minimizes her investment in raising her own young to the detriment of host species (Ehrlich et al. 1988:619). Furthermore, the many open cup nesting species in this group are most effected by cowbird parasitism, especially those that build nests in shrubs along forest edges and in second-growth habitats (Robbinson et al. 1995).

Foods and Foraging Strategies

According to Ehrlich et al. (1988), most birds in this group are primarily insectivores. Secondarily, shrubland birds feed on fruits and seeds. Some exceptions exist, however; Brown Thrashers and Common Grackles are omnivorous, Cedar Waxwings are primarily frugivores, redpolls and American Goldfinches are granivores, and Northern and Loggerhead Shrikes are carnivores focusing on small birds (Ehrlich et al.

1988). Diets of most of these birds probably change throughout the breeding season as abundance of insects and fruits also change.

The primary foraging method of these birds is to glean food from either vegetation or the ground. Other methods of acquiring food include bark gleaning and hawking (Ehrlich et al. 1988). Specifically, Willow Flycatchers, Eastern Kingbirds and Eastern Bluebirds employ hawking as their primary method of prey capture (Ehrlich et al. 1988). Common Grackles are probably the most opportunistic feeders in the group (Peer and Bollinger 1997) and are predators of eggs and nestlings of other species (Sealy 1994).

HABITAT ASSESSMENT - UPLAND AFFILIATES

Habitat Use

The 20 species of shrubland Passerines that use strictly upland sites occupy a variety of mid-successional habitats in Maine. These habitats include abandoned fields, hedgerows and brushy field edges, powerline corridors, forest edges along highways and railroads, orchards, cemeteries and city parks, and other sites regenerating following logging, forest fire and other disturbances. The abundance of these habitats in the past century, at times, has fostered abundant populations of many of these species.

Past Habitat

Historically this group would have been confined to sites prone to fire such as the downeast barrens and Kennebunk plains and to regeneration following catastrophic insect and hurricane damage. In the more recent past, the conversion of forest to agriculture provided favorable conditions along field/forest ecotones for many of these species, including Brown-headed Cowbirds. The abundance of orchards in many rural areas of Maine was especially important for Eastern Bluebirds and possibly Orchard Orioles. In 1987, 11.6 square miles of productive orchards remained in Maine (USBC 1994:238). Approximately 60% of the area in orchards occurred in Androscoggin, Oxford, and York Counties (USBC 1994:238). Further, with increasing human density throughout the early 1900's, city parks and cemeteries became important habitats for many of the species including Northern Mockingbirds and Chipping Sparrows. As logging activity intensified, many shrubland Passerines also benefited from this pattern of land use.

Current Habitat

Estimates of current scrub-shrub habitat in Maine are difficult to find. One component of these habitats exists in rights of way for powerlines, pipelines, and railroads estimated at over 369 square miles in Maine in 1995 (Griffith and Alerich 1996). Despite being 3-times larger in land area, the Eastern Spruce/Hardwood region has just slightly more area (183 vs. 162 sq. mi.) in rights of way than the Northern New England Region (Appendix I). The amount of scrub-shrub habitat in Maine uplands has probably declined during this century. Much of this decline is associated with the abandonment of farmland and subsequent reforestation, especially in central and southern Maine, where the landscape was heavily agricultural. Washington and Aroostook counties also have experienced declines, but broad-scale reforestation there may have begun decades later than in the more southerly counties. Farmland overall, has declined in Maine nearly 2 ½ fold from 1959 to 1992 (to 1,966 square miles) and similar declines are noted for cropland (USBC 1994:8). Furthermore, where some types of shrub habitat have declined, others have increased. Current forest practices, and those of the last 2 decades, have resulted in regenerating forests favorable to many of the species in this group. Nearly 500 square miles is currently considered recent clearcut with an

additional 3,000 square miles in regenerating stands (Appendix II). It is unknown whether the amount of second growth habitat present today balances the reforestation of abandoned farmland. Those species that breed primarily in northern Maine, like Wilson's Warbler and Lincoln's Sparrow, probably have benefited from the intensification of forest harvesting. However, both species show significant declines for the Eastern Spruce/Hardwood Region over the past 15 years (Maine data are too scant to report). In contrast, habitat for species that are restricted to central and southwestern Maine (e.g., Eastern Towhee and Blue-gray Gnatcatcher) probably has declined. Recent records of Fox Sparrows in northern Maine (Adamus 1987, L. Alverson, 7-Islands Land Co., pers. comm.) probably reflect either increased habitat availability or simply increased survey effort. The majority of species that use scrub-shrub uplands have statewide distributions and whether or not their habitat has declined significantly remains unknown, but some indication may be drawn from population trend data.

Most shrub-dependent bird species occur as edge associates. An index to the amount of edge in each physiographic region places much of Maine's edge habitat (i.e., forest-shrub and forest-agriculture ecotones) in the Northern New England Region (Appendix III). Southern New England, although having only a few samples upon which to base an estimate, has a large amount of forest-shrub edge habitat there (Appendix III).

Habitat Projection

As with other open habitats, dry scrub-shrubland in central and southern Maine will continue to decline as former agricultural areas undergo residential development. Efforts at the Kennebunk Plains and Waterboro Barrens to reintroduce fire could improve habitat for Brown Thrashers, Eastern Towhees and Field Sparrows if the lands are allowed to achieve a mid-successional structure before being reburned. Suppression of fire in Pitch Pine/Scrub Oak *(P. rigida/Q. ilicifolia)* woodland has "set the stage" for declines in those habitats and the bird community there. The continued decline in the orchard industry and the conversion of remaining orchards to dwarf trees also may have an effect on some species (e.g., cavity nesters), yet, these habitats are so uncommon today, their statewide significance is questionable.

The inevitable increase in utility corridors will continue into the foreseeable future. These may be the best habitat for many of these species for the upcoming decades. Vegetation within these corridors should be managed to benefit the widest possible diversity of shrubland birds, with special emphasis on the structural features most important to shrubland birds in greatest decline. Threats via cowbird nest parasitism have been documented in other areas via corridors, however, in landscapes that are predominantly forest such "negative edge effects" are less severe (Rudnicky and Hunter 1993, Robinson et al. 1995).

HABITAT ASSESSMENT - UPLAND OR WETLAND AFFILIATES

Habitat Use

This group of Passerines occupies scrub-shrub habitats described in the previous section, as well as scrub-shrub wetlands. Specific wetland cover types would include alder *(Alnus* spp.*)* and willow *(Salix* spp.*)* thickets, ericaceous wetlands (bogs and fens), and dense tangles of Winterberry *(Ilex verticillata)*, Mountain Holly *(Nemopanthus mucronata)* and stunted Red Maple and Gray Birch *(B. populifolia)*. Historically, Maine has had an abundance of scrub-shrub type wetlands estimated at roughly 1/5 of all inland palustrine wetlands (Widoff 1988:28).

Past Habitat

Habitat for scrub-shrub birds that use both uplands and wetlands probably has not changed as much as for strict upland shrub associates. The amount of scrub-shrub wetland habitat prior to European settlement probably was greater than at present. The near elimination of beavers *(Castor canadensis)* through overtrapping by early fur traders also led to declines in early- and mid-successional wetland habitats, including scrub-shrub wetlands, as flowages regenerated to forest (Lisle 1994). Scrub-shrub wetlands are not necessarily a short-term sere, but often remain static for decades given stable water levels.

Current Habitat

This subset of scrub-shrub birds is more flexible in their selection of habitat and consequently makes greater use of the various covertypes present today. Approximately 600 square miles of scrub-shrub habitat occurs statewide. Nearly half of the total occurs as deciduous scrub-shrub in the Eastern Spruce/Hardwood Physiographic Region (Appendix II). Furthermore, over 180 square miles of peatland occurs in Maine with 90% of that again in the Eastern Spruce/Hardwood Region. Relative to historical levels, there may be significantly more upland scrub habitat throughout Maine owing to changes in forest harvesting practices. Species such as Mourning (Pitocchelli 1993) and Nashville Warblers (Williams 1996b) and White-throated Sparrows (Falls and Kopachena 1994) are reported to benefit from clearcutting and other forms of timber harvesting which often regenerates to a mixture of deciduous and coniferous species. However, trends for these 3 species are mixed (Table 9) and perhaps each has a different set of limiting factors on their respective wintering grounds.

Habitat Projection

Future levels of scrub-shrub habitat may experience decreases at least short term (15+ years) if beaver populations return scrub-shrub wetlands to emergent or open marsh conditions. Also, in parts of Maine, harvesting of peat will reduce the amount of ericaceous shrub habitat through mining operations and perhaps alder and willow habitats along the margins of Maine peatlands. A decline in scrub-shrub wetland

habitat, albeit small, is likely to occur in the coming decades. Fortunately this group is not dependent solely on wetlands, but will use uplands as well.

POPULATION ASSESSMENT - UPLAND AFFILIATES

Past Populations

Populations of many of these species benefited greatly from the clearing of forests for agriculture. The most well known of these species to have expanded its geographic range eastward has been the Brown-headed Cowbird (Lowther 1993, Robinson et al. 1995). Other species benefiting from the conversion of forests to agriculture probably included Yellow and Chestnut-sided Warblers (Palmer 1949, Richardson and Brauning 1995), Field and Chipping Sparrows among others. Many of these species likely benefited from the less mechanized style of farming and the brushy edges created around fields and pastures. Northern Cardinals were far less abundant in the past, owing their current increase to improved wintering conditions offered by feeding stations (Adamus 1987). House Wrens, Blue-gray Gnatcatchers, Gray Catbirds, Mourning Warblers, and Northern Mockingbirds all have expanded their populations (and perhaps ranges) in Maine since the reports of Samuels (1875) and Palmer (1949). Population levels of winter residents in Maine often depend on conditions further north. For example, the number of Northern Shrikes wintering in Maine appears dependent on density of mice and lemmings at higher latitudes (Palmer 1949) (i.e., with lower lemming density, more birds overwinter in Maine). Similarly, incursions of Common Redpolls may be related to seed abundance on their Canadian breeding grounds.

Human activities have not always benefited members of this group. Northern Mockingbirds, valued for their singing ability, once were sold as caged birds in the pet trade (Derrickson and Breitwisch 1992). As a result, local populations, especially around urban centers, were significantly diminished (Derrickson and Breitwisch 1992). Indigo Buntings too have been valued as caged birds, especially in Mexico, however, effects on their populations remain unknown (Payne 1992). Declines in populations of Loggerhead Shrikes beginning in the 1940's has been attributed to collisions with vehicle traffic and to a loss of habitat as farmland became more mechanized and with the removal of brushy hedgerows (Bartgis 1992).

Current Populations

Of the upland affiliates, American Robins and Chipping Sparrows have the widest distribution and consequently the largest populations. In contrast, Orchard Orioles and Loggerhead Shrikes probably number the fewest. Trend estimates for this group are highly variable (Table 9), however, several species have significant long-term (1966-1996) trends. Ten species have significant long-term trend estimates; 60% of these are declining with 40% increasing. Field sparrows have the greatest long-term negative trend at -16.8% annual change and Eastern Bluebirds have the largest positive trend at +12.2%. For recent short-term trend information (1980-1996), again there are 10 species with significant trends and 60% negative, 40% positive. Except for Loggerhead Shrike (*see below*), Brown Thrashers had the greatest recent short term declines at -8.8% and again Eastern Bluebirds had the greatest positive estimates at +17.0%. Trends for Orchard Oriole and Loggerhead Shrike, the only Special Concern species in this group, are difficult to track in Maine because too few survey routes encounter these

species. However, trends for USFWS Region 5 are positive ($P < 0.01$) for both long-term (+2.8%) and recent short-term (+2.6%) trends for Orchard Oriole; nonsignificant declines were reported for Loggerhead Shrikes (1966-1996: -3.1%, 1980-1996: -10.5%) (Sauer et al. 1997) (Table 9).

Lauber and O'Connor (1993) examined trends for several neotropical migrants in the Northeast. Most of the species they analyzed had reasonably stable trends and they expressed little concern for their status. They observed relatively stable trajectories among Indigo Buntings, Chestnut-sided and Prairie Warblers, but with slight to moderate declines in the Southern New England Physiographic Region. Chipping Sparrows exhibited stable or slight increases during the period 1973-1989 in Maine and more broadly throughout the Eastern Spruce/Hardwood, Northern New England and Southern New England physiographic areas. House Wrens were more variable with declines in Maine, whereas trends were level or slightly increasing in neighboring states and throughout the 3 physiographic regions (Lauber and O'Connor 1993). Lauber and O'Connor (1993) analyzed only limited data for trends of Orchard Orioles and Blue-gray Gnatcatchers in the Northeast; too few data were available for Maine.

Population Projections

Populations of upland-afiliated shrubland birds appear generally secure with only a few species that warrant genuine concern. This group occupies habitats that often occur as transition between agriculture (or other man-made disturbance) and mature forest. Those species with distributions in northern Maine appear secure simply through forest practices which will continue to set back succession as a consequence of timber harvesting. Chestnut-sided Warblers are an obvious example of this, a common breeder in regenerating stands throughout Maine, their numbers are secure through the actions of forest management practices. Several species, such as House Wren, Eastern Bluebird, Northern Mockingbird, Northern Cardinal, and Chipping Sparrow coexist well with humans and as a result, their populations should remain secure indefinately. Declines in Eastern Towhees and Brown Thrashers in the northeast (Sauer et al. 1997), widely accepted as loss of habitat (Greenlaw 1996) may result in retraction at the margins of their ranges. With continued declines these species are likely to be lost from some currently occupied sites in Maine.

Prairie Warbler may experience future declines due to their fairly specialized habitat selection within Maine. Prairie Warblers occupy dry shrubby sites and pine barrens (Curson et al. 1994). With a lack of this habitat statewide and the birds distribution restricted to southwest Maine, human impacts from residential development could impart declines on this species through habitat loss and degradation. Furthermore, Prairie Warblers are a common cowbird host often deserting parasitized nests (Ehrlich et al. 1988).

The most imperiled upland-nesting shrubland bird is clearly the Field Sparrow with a restricted geographic range in Maine, and what appears to be a narrow habitat preference. The ephemeral nature of their primary habitat (young shrubby pastures and abandoned fields) together with a low tolerance for nearby human activity (Carey et al. 1994) are likely contributing to the widespread declining trend for this species

throughout its range. Maine does not represent a large proportion of this species range and thus may never contribute significantly to its global conservation. However, conservation of pine barren habitats in Fryeburg, Shapleigh, and adjacent to the Kennebunk Plains (MDIFW ownership) as well as Waterboro Barrens (TNC ownership) may be Maine's greatest contribution to conserving both Prairie Warblers and Field Sparrows especially in view of increasing development pressures in southern Maine.

POPULATION ASSESSMENT - UPLAND OR WETLAND AFFILIATES

Past Populations

Members of this group of birds also benefited from the expansion then subsequent decline of agriculture in Maine. Because this group is less specialized in their habitat use and because scrub-shrub wetlands occur naturally, their populations have been less vulnerable, despite declines associated with upland habitats. Species such as Yellow Warbler (Palmer 1949), Gray Catbird, and Song Sparrow have undoubtedly benefited from the abandonment of farmlands and are tolerant to living in close proximity with humans in brushy hedgerows and landscaped suburban yards. Yellow Warbler populations increased throughout the first half of this century (Palmer 1949). In the industrial forest, populations of Mourning Warblers have expanded because of large tracts of regenerating forests (Pitocchelli 1993). Samuels (1875) believed Mourning Warblers were extremely scarce and reported that only 2 had been collected from Maine by that time. Gray Catbirds and Common Grackles also have expanded their range in Maine since European settlement. Gray Catbirds were restricted to south and west of the Kennebec River until the mid 1800's (Palmer 1949). Similarly, Common Grackles expanded in Maine from the late 1800's to the early 1900's with occupancy of the interior taking place before coastal Washington County (Palmer 1949).

Current Populations

Approximately half of this group has statewide distributions. Willow Flycatcher, Wilson's Warbler and Fox Sparrow are probably the least abundant, whereas Common Yellowthroats and Song Sparrows are most numerous. Data from the BBS (Sauer et al. 1997) reveal that about ½ of the species in this group (n = 7) have significant long-term (1966-1996) trends with 4 (57%) of these species in decline and 3 (43%) with increasing trends (Table 9). Mourning Warblers exhibit the greatest long term increasing trend at +10.8% annually (P = 0.07) and White-throated Sparrows have the greatest significant long-term decline of -3.7% (P < 0.01). For White-throated Sparrows, loss of habitat through reforestation in southern and central Maine may have outweighed gains accrued on northern industrial forestlands. Nine species (64%) have significant recent short-term trends with 3 species increasing and 6 decreasing, however some of these data represent regional estimates, because too few data for Maine are available. Based on Maine-specific data, Mourning Warblers again experienced the greatest significant increase from 1980-1996 (+10.7 %, P = 0.03) and except for Wilson's Warbler (*see below*), Gray Catbirds have the largest significant short-term declines at -4.0% annually (P < 0.01). Breeding bird survey data (Sauer et al. 1997) for 4 of the 15 species in this group (including Wilson's Warbler) were insufficient to examine trends specifically for Maine.

Lauber and O'Connor (1993) analyzed trend data from 1973-1990 for 9 of the species in this group. Specifically, Eastern Kingbirds appeared relatively stable throughout New England with the exception of Connecticut where they steadily declined and in Maine where they increased until 1983 then declined through 1989. In the 3 physiographic regions covering Maine (i.e., Eastern Spruce/Hardwoods, Northern New England, and

Southern New England) Eastern Kingbirds remained stable except for some decline in the Southern New England strata, likely driven by declines in Connecticut. Gray Catbirds and Common Yellowthroats were generally stable during this time. Gray Catbirds also were stable in the Northern New England Physiographic Region, however, they declined in the Eastern Spruce/Hardwood region and increased in the Southern New England region. Common Yellowthroats were stable throughout all 3 of these physiographic regions during 1973-1990 (Lauber and O'Connor 1993). Lauber and O'Connor (1993) also found that populations of Nashville Warblers and Lincoln's Sparrows were variable during this period. They reported that Nashville Warblers increased overall in Maine and New Hampshire, and slightly increased in the Eastern Spruce/Hardwood region and in the Northern New England region. Wilson's, Mourning, and Yellow Warblers all increased in the Eastern Spruce/Hardwood region, however, Wilson's Warbler declined at the end of the period (Lauber and O'Connor 1993). Yellow Warblers remained level in Northern New England, slightly increased in Southern New England and declined in Maine (1981-1990). Only limited data were available for Willow Flycatchers, but overall appeared to be increasing throughout the northeast; Alder Flycatcher also increased overall from 1973-1990 (Lauber and O'Connor 1993).

Population Projections

This set of scrub-shrubland birds should warrant little attention for many years to come. This group uses scrub habitats of both wetlands and uplands and as a consequence are more generalists in their habitat selection. Losses of upland scrub habitat through reforestation is likely to affect this group less than the strict upland-affiliated shrubland birds. Furthermore, there appears to be no species within this group that is restricted to specific types of scrub-shrub habitats (e.g., the xeric sites so often occupied by Prairie Warblers) and none are associated with early seral shrub habitats. The only species that warrant close monitoring is perhaps the Gray Catbird and Eastern Kingbird. Gray Catbirds appear well-adapted to living among human settlements, at least in rural and suburban Maine. Global concern for this bird, however, should center on its relatively small wintering grounds in southeastern Mexico, Central America, and the Caribbean. As a result, Maine's contribution to the conservation of this species appears limited. Eastern Kingbird populations may experience future declines if current trends continue. Scrub-shrub habitat in Maine will undoubtedly continue to decline in the coming decades. Losses of wet scrub-shrub likely will be less than in the uplands. This group of birds may experience some declines in the future but it is unlikely those declines will effect range changes for any of the 17 species in this group.

Table 6. Passerine birds of scrub-shrub habitats in Maine.

Common Name	Scientific Name	Residency Status	Site Affiliation
Alder Flycatcher	*Empidonax alnorum*	Breeding Season Only	Wetlands and Uplands
Willow Flycatcher	*Empidonax traillii*	Breeding Season Only	Wetlands and Uplands
Eastern Kingbird	*Tyrannus tyrannus*	Breeding Season Only	Wetlands and Upland
House Wren	*Troglodytes aedon*	Breeding Season Only	Upland
Blue-gray Gnatcatcher	*Polioptila caerula*	Breeding Season Only	Upland
Eastern Bluebird	*Sialia sialis*	Breeding Season Only	Upland
American Robin[1]	*Turdus migratorius*	Breeding Season Only	Upland
Gray Catbird	*Dumetella carolinensis*	Breeding Season Only	Wetlands and Uplands
Northern Mockingbird	*Mimus polyglottos*	Year-round Resident	Upland
Brown Thrasher	*Toxostoma rufum*	Breeding Season Only	Upland
Bohemian Waxwing	*Bombycilla garrulus*	Winter Resident	Upland
Cedar Waxwing	*Bombycilla cedrorum*	Year-round Resident	Wetlands and Uplands
Loggerhead Shrike	Lanius ludovicianus	Breeding Season Only	Upland
Northern Shrike	*Lanius excubitor*	Winter Resident	Upland
Nashville Warbler	*Vermivora ruficapilla*	Breeding Season Only	Wetlands and Uplands
Yellow Warbler	*Dendroica petechia*	Breeding Season Only	Wetlands and Uplands
Chestnut-sided Warbler	*Dendroica pensylvanica*	Breeding Season Only	Upland
Prairie Warbler	*Dendroica discolor*	Breeding Season Only	Upland
Mourning Warbler	*Oporornis philadelphia*	Breeding Season Only	Wetlands and Uplands
Common Yellowthroat	*Geothlypis trichas*	Breeding Season Only	Wetlands and Uplands
Wilson's Warbler	*Wilsonia pusilla*	Breeding Season Only	Wetlands and Uplands
Northern Cardinal	*Cardinalis cardinalis*	Year-round Resident	Upland
Indigo Bunting	*Passerina cyanea*	Breeding Season Only	Upland
Eastern Towhee	*Pipilo erythrophthalmus*	Breeding Season Only	Upland
	American Tree Sparrow	*Spizella arborea*	Winter Resident
	Wetlands and Uplands		
Chipping Sparrow	*Spizella passerina*	Breeding Season Only	Upland
Field Sparrow	*Spizella pusilla*	Breeding Season Only	Upland
Fox Sparrow	*Passerella iliaca*	Breeding Season Only	Wetlands and Uplands
Song Sparrow[1]	*Melospiza melodia*	Breeding Season Only	Wetlands and Uplands
Lincoln's Sparrow	*Melospiza lincolnii*	Breeding Season Only	Wetlands and Uplands
White-throated Sparrow[1]	*Zonotrichia albicollis*	Breeding Season Only	Wetlands and Uplands
Common Grackle[1]	*Quiscalus quiscula*	Breeding Season Only	Wetlands and Upland
Brown-headed Cowbird[1]	*Molothrus ater*	Breeding Season Only	Upland
Orchard Oriole	*Icterus spurius*	Breeding Season Only	Upland
Common Redpoll	*Carduelis flammea*	Winter Resident	Upland
Hoary Redpoll	*Carduelis hornemanii*	Winter Resident	Upland
American Goldfinch	*Carduelis tristis*	Year-round Resident	Wetlands and Uplands

[1] Small numbers of this species also may overwinter in Maine (Vickery 1978).

Table 7. Breeding distribution and migration information for scrub-shrubland Passerines in Maine.

Species	Distribution in Maine	Timing of Migration			Wintering Area[3]
		Mean First Arrival[1]	Estimated Arrival[2]	Estimated Departure[2]	
Alder Flycatcher	Statewide	4/25	Mid May	Mid Sep	W. Venezuela, Colombia, Peru, & Bolivia
Willow Flycatcher	Southern 1/3	5/24	Late May	Late Aug	Central America
Eastern Kingbird	Statewide	5/13	Early May	Late Sep	Central & S. America
House Wren	Southern ½	5/10	Early May	Mid Sep	So. U.S. & Mexico
Blue-gray Gnatcatcher	Extreme Southwest	5/2	Early May	Mid Sep	So. U.S., Mex, C. Am. & Carib.
Eastern Bluebird	Statewide	4/14	Early Apr	Mid Oct	U.S., Mexico & W. Cuba
American Robin	Statewide		Late Mar[4]	Early Nov[4]	U.S., Mexico & W. Carib.
Gray Catbird	Statewide	5/10	Mid May	Early Oct	Mex., C. Am., Caribbean
Northern Mockingbird	Southeastern ½	N/A	N/A	N/A	U.S.[5]
Brown Thrasher	All but Northwest ¼	5/11	Late Apr	Late Oct	Southern U.S.
Bohemian Waxwing	Nonbreeder		Early Nov	Early Apr	U.S.[5] & Canada
Cedar Waxwing	Statewide	N/A	N/A	N/A	U.S.[5] , Mex., C. Am. & Caribbean
Loggerhead Shrike	Southern 1/3		Mid Apr	Mid Oct	Southern U.S. & Mexico
Northern Shrike	Nonbreeder		Late Oct	Early Apr	U.S.[5] & Canada
Nashville Warbler	Statewide	5/8	Early May	Early Oct	Mexico & C. America
Yellow Warbler	Statewide	5/10	Early May	Mid Sep	So. U.S., Mex., C. Am., S. Am. & Carib.
1Chestnut-sided Warbler	Statewide	5/12	Early May	Mid Sep	Central & S. America
Prairie Warbler	Extreme Southwest	5/14	Mid May	Mid Sep	S. Florida & Carribbean
Mourning Warbler	All but Extreme Southwest	5/26	Mid May	Early Oct	Central & S. America
Common Yellowthroat	Statewide	5/12	Late Apr	Late Oct	So. U.S., Mex., C. Am. & Caribbean.
Wilson's Warbler	All but Southwest ¼	5/17	Mid May	Late Sep	Mexico & C. America
Northern Cardinal	Southern 1/3	N/A	N/A	N/A	U.S.[5]
Indigo Bunting	All but Northwest ¼	5/18	Early May	Early Oct	Mexico, C. Am. & Carib.
Eastern Towhee	Southern ½	5/4	Mid Apr	Mid Oct	U.S.
American Tree Sparrow	Nonbreeder		Late Sep	Late Apr	U.S.[5] & Canada
Chipping Sparrow	Statewide	4/25	Mid Apr	Late Oct	U.S., Mex. & Bahamas
Field Sparrow	Southern ½	5/2	Late Apr	Mid Oct	U.S. & Mexico
Fox Sparrow	Northwest ¼		Early Apr	Mid Nov	U.S.

Table 7. Continued

Species	Distribution in Maine	Timing of Migration: Mean First Arrival[1]	Timing of Migration: Estimated Arrival[2]	Timing of Migration: Estimated Departure[2]	Wintering Area[3]
Song Sparrow	Statewide		Early Apr	Mid Oct	U.S.
Lincoln's Sparrow	All but South & Central	5/14	Mid May	Mid Nov	SW U.S., Mex, & C. Am.
White-throated Sparrow	Statewide	4/20	Mid Apr	Mid Oct	U.S.
Common Grackle	Statewide	3/27	Early Mar	Early Nov	U.S. & Canada
Brown-headed Cowbird	Statewide		Mid Apr	Mid Nov	U.S. & Mexico
Orchard Oriole	Local		Mid May	Early Aug	Mex., Central & S. America
Common Redpoll	Nonbreeder		Early Oct	Mid Apr	U.S.[5] & Canada
Hoary Redpoll	Nonbreeder		Early Dec	Late Mar	U.S.[5] & Canada
American Goldfinch	Statewide	N/A	N/A	N/A	U.S.[5], Canada & Mexico

[1] Data from Wilson et al. (1997).
[2] Estimates from Vickery (1978).
[3] Rappole et al. (1995)
[4] Small numbers of this species overwinter in Maine in most years (Vickery 1978).
[5] Typical winter range includes Maine.

Table 8. Aspects of the reproductive biology[1] of selected scrub-shrubland Passerines that breed in Maine.

Species	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Alder Flycatcher	Shrub	Open Cup	3-4	12-14[2]	12-16[2]
Willow Flycatcher	Shrub	Open Cup	3-4	12-15[2]	11-14[2]
Eastern Kingbird	Decid. Tree	Open cup	3-4	14-17[2]	15-19[2]
House Wren	Snag	Cavity	6-8	13	12-18
Blue-gray Gnatcatcher	Decid. Tree	Open Cup	4-5	13	10-15[2]
Eastern Bluebird	Snag or Box	Cavity	4-5	13-15[2]	15-20
American Robin	Decid. Tree	Open Cup	3-4[2]	11-14[2]	14-16
Gray Catbird	Shrub	Open Cup	4	12-15[2]	9-15[2]
Northern Mockingbird	Shrub	Open Cup	3-5	12-13	11-13
Brown Thrasher	Shrub	Open Cup	4-5	11-14	9-13
Cedar Waxwing	Decid. Tree	Open Cup	3-5	12	16
Loggerhead Shrike	Decid. Tree	Open Cup	5-6	16-18[2]	16-21[2]
Nashville Warbler	Ground	Open Cup	4-5	10-12[2]	11-12[2]
Yellow Warbler	Shrub	Open Cup	4-5	10-12[2]	9-12
Chestnut-sided Warbler	Shrub	Open Cup	4	12-13	10-12
Prairie Warbler	Shrub	Open Cup	4	12	9-10
Mourning Warbler	Ground	Open Cup	3-4	12	7-9
Common Yellowthroat	Shrub	Open Cup	3-5	11-13[2]	8-10[2]
Wilson's Warbler	Ground	Open Cup	4-6	10-13	8-11
Northern Cardinal	Shrub	Open Cup	3-4	11-13[2]	9-10
Indigo Bunting	Shrub	Open Cup	3-4	12-13	9-12[2]
Eastern Towhee	Ground	Open Cup	3-4	12-13	10-12
Chipping Sparrow	Conif. Tree	Open Cup	4	11-14	8-12[2]
Field Sparrow	Ground	Open Cup	3-5	10-12[2]	7-8
Fox Sparrow	Ground	Open Cup	2-5	12-14	9-11
Song Sparrow	Ground	Open Cup	3-4	12-14	9-12
Lincoln's Sparrow	Ground	Open Cup	4-5	12-14	9-12
White-throated Sparrow	Ground	Open Cup	4-6	11-14	8-9
Common Grackle	Decid. Tree	Open Cup	4-5	11-14[2]	12[2]-20?
Brown-headed Cowbird	Decid. Tree	Parasite	4-5	10-13	8-13
Orchard Oriole	Decid. Tree	Pendant	3-5	12-14[2]	11-14
American Goldfinch	Shrub	Open Cup	4-6	10-14[2]	11-17

[1] Excerpted from the summaries by Ehrlich et al. (1988) unless otherwise indicated.
[2] See review by Gauthier and Aubry (1996).

Table 9. Trends[1] in numbers of selected scrub-shrubland Passerines[2] observed in Maine based on data from the North American Breeding Bird Survey[3].

	1966-1996			1966-1979			1980-1996		
Species	n	Trend	P	n	Trend	P	n	Trend	P
Alder Flycatcher	58	0.3	NS	20	1.8	NS	57	-0.2	NS
Willow Flycatcher[4]	327	3.1	<0.01	161	7.1	<0.01	294	2.0	0.01
Eastern Kingbird	52	-0.6	NS	36	3.3	NS	50	-3.6	0.02
House Wren	23	-2.5	0.05	12[5]	3.7	NS	21	-4.0	<0.01
Blue-gray Gnatcatcher[4]	329	2.9	0.05	159	0.6	NS	301	3.2	0.01
Eastern Bluebird	22	12.2	0.06	9[5]	-8.8	NS	20	17.0	0.02
American Robin	62	-0.7	0.10	37	-2.2	NS	61	-0.4	NS
Gray Catbird	54	-2.4	<0.01	37	-0.1	NS	52	-4.0	<0.01
Northern Mockingbird	16	5.6	<0.01	6[5]	26.6	<0.01	14	0.9	NS
Brown Thrasher	32	-3.1	NS	24	-0.7	NS	24	-8.8	0.04
Cedar Waxwing	61	3.0	0.08	36	0.9	NS	60	1.8	NS
Loggerhead Shrike[4]	23	-3.1	NS	15	-13.1	0.02	8[5]	-10.5	NS
Nashville Warbler	62	-4.2	NS	32	-5.5	NS	59	-0.9	NS
Yellow Warbler	54	0.3	NS	34	0.7	NS	51	-1.1	NS
Chestnut-sided Warbler	62	-1.6	0.06	35	2.5	NS	61	-1.5	NS
Prairie Warbler[4]	325	-0.9	NS	201	-2.2	0.03	285	0.6	NS
Mourning Warbler	28	10.8	0.07	4[5]	-26.3	NS	25	10.7	0.03
Common Yellowthroat	62	-1.3	0.04	37	-1.0	NS	61	-1.3	0.08
Wilson's Warbler[6]	74	0.8	NS	42	7.5	0.04	49	-4.9	0.05
Northern Cardinal[4]	549	0.2	NS	395	0.6	NS	521	0.9	<0.01
Indigo Bunting	32	3.4	NS	10[5]	-11.4	NS	31	-0.5	NS
Eastern Towhee	19	-5.6	0.02	16	-1.2	NS	16	-6.8	0.01
Chipping Sparrow	56	0.9	NS	37	4.2	0.09	55	0.2	NS
Field Sparrow	25	-16.8	0.02	21	-31.4	<0.01	12[5]	-5.2	0.09
Fox Sparrow[6]	21	-0.3	NS	4[5]	-5.2	NS	19	-1.9	NS
Song Sparrow	61	-3.5	<0.01	37	-7.9	<0.01	60	-1.1	0.04
Lincoln's Sparrow[6]	122	0.7	NS	59	13.5	<0.01	101	-3.2	0.03
White-throated Sparrow	62	-3.7	<0.01	37	-4.6	<0.01	61	-3.6	<0.01
Common Grackle	59	-0.6	NS	37	-1.0	NS	58	-0.3	NS
Brown-headed Cowbird	52	-5.1	0.01	36	-6.2	0.02	49	-4.0	<0.01
Orchard Oriole[4]	257	2.8	<0.01	147	2.2	0.05	220	2.6	<0.01
American Goldfinch	58	-1.5	NS	36	-9.2	<0.01	55	4.0	<0.01

[1] Using route-regression method of Geissler and Sauer (1990).
[2] Carolina Wren and Blue-winged Warbler are excluded because they are rare breeders in Maine; White-crowned Sparrow excluded because occurs as passage migrant in Maine; Orchard Oriole included because of Special Concern status; also excludes nonpasserine birds that use Scrub-Shrub habitat.
[3] Sauer et al. (1997).
[4] Data from USFWS Region 5; data specific to Maine too limited to report (Sauer et al. 1997).
[5] Results may be unreliable and introduce positive bias when sample size is less than 14 (Sauer et al. 1997).
[6] Data from Physiographic Region 28: Eastern Spruce/Hardwood Forest; data specific to Maine too limited to report (Sauer et al. 1997).

WETLAND BIRDS

SCOPE

This section covers 9 species of wetland-associated Passerines including 2 families (Troglodytidae and Emberizidae). Species are Marsh Wren *(Cistothorus palustris)*, Northern Waterthrush *(Seiurus noveboracensis)*, Louisiana Waterthrush *(S. motacilla)*, Palm Warbler *(Dendroica palmarum)*, Saltmarsh Sharp-tailed Sparrow *(Ammodramus caudacutus)*, Nelson's Sharp-tailed Sparrow *(A. nelsoni)*, Swamp Sparrow *(Melospiza georgiana)*, Red-winged Blackbird *(Agelaius phoeniceus)*, and Rusty Blackbird *(Euphagus carolinus)*. Sharp-tailed Sparrows only recently were divided into separate species (i.e., Nelson's and Saltmarsh) by the A. O. U. Committee on Classification and Nomenclature (A.O.U. 1995). As such, much of the published literature for Sharp-tailed Sparrows does not explicitly describe which of the "new" species was studied and must be inferred from subspecies (if given) and or study location. Consequently, in this assessment the species' common name will be presented parenthetically when some interpretation was necessary. I excluded Seaside Sparrow *(Ammodramus maritimus)* from this group which is an exceedingly rare species, breeding at perhaps as few as 1 site in southern Maine in some years. I also excluded Sedge Wren *(Cistothorus platensis)* which is listed as Endangered under the Maine Endangered Species Act. All 9 species included in this section breed in Maine; there are no winter residents in this group. In general, this group uses a variety of wetland habitats throughout the state.

NATURAL HISTORY

General Description

Wetland Passerines covered by this assessment range in size from the diminutive Palm Warbler at approximately 10 g to the Rusty Blackbird at about 6 times larger (64.3 g males; 55.2 g females) (Dunning 1984). Most species possess a mottled brown coloration, but the blackbirds (except the female Red-winged Blackbird) have dark, solid-colored bodies. The yellow and red epaulets of the adult male Red-winged Blackbird, which are, used in territorial displays (Yasukawa and Searcy 1995) gives the species its name. The Rusty Blackbird is so named for the rust-colored feather margins on the upper portions of its body. A variety of nest sites are selected, but in Maine, these are almost always associated with some form of wetland habitat.

Distribution and Migration

Of this group, Northern Waterthrush, Palm Warbler, Swamp Sparrow, and Red-winged Blackbird have statewide distributions (Table 10) (Adamus 1987). However, Palm Warblers breed only locally in peatland habitats (Wilson 1996) and are scattered widely across the state (Adamus 1987). Of the wetland Passerines, Louisiana Waterthrushes have the smallest geographic range, limited to extreme southwestern Maine (Adamus 1987). Saltmarsh Sharp-tailed Sparrows are restricted to saltmarsh habitats along the coast; however, a few Nelson's Sharp-tailed Sparrows may nest in freshwater marshes. Saltmarsh and Nelson's Sharp-tailed Sparrows occur sympatrically from the New Hampshire border to at least as far north as the Weskeag River in Thomaston (MDIFW, unpublished data). Consequently, an overlap zone (potential hybrid zone) of approximately 120 miles occurs in southern and midcoast Maine.

During 1978-1983, when surveys were conducted for Maine's Breeding Bird Atlas, confirmed breeding locations for Louisiana Waterthrush, for both species of Sharp-tailed Sparrows, and for Rusty Blackbirds appeared limited. Louisiana Waterthrush was confirmed as breeding in only 5 atlas blocks with an additional 7 blocks reporting possible or probable breeding; all 12 blocks were in southwestern Maine (Adamus 1987). Presence of Louisiana Waterthrush may be overlooked if surveys are not conducted early in the breeding season (Robinson 1995). Saltmarsh Sharp-tailed Sparrows only recently have been recognized as a unique species, therefore, it was likely confirmed as breeding at $\leq$ 5 sites along the southern Maine coast (observed at a maximum of 11 atlas blocks assuming all locations within overlap zone were Saltmarsh not Nelson's). According to Adamus (1987), Nelson's Sharp-tailed Sparrow is only slightly more abundant. From Lincoln County east, Adamus (1987) reported Nelson's in only 12 blocks, of which only 6 were confirmed as breeding. Rusty Blackbirds were confirmed as breeding within only 14 atlas blocks, although they were "possible" or "probable" breeders at roughly 3 times that number of blocks (Adamus 1987).

The blackbirds are the earliest to return of the wetland Passerines in Maine with Red-winged Blackbirds returning by late March and Rusty Blackbirds a few weeks later (Vickery 1978, Wilson et al. 1997) and both largely depart by mid to late October with a few remaining into December (Vickery 1978). Sharp-tailed Sparrows are the last of this

group to arrive by mid May and early June (Vickery 1978, Wilson et al. 1997). Northern Waterthrushes and Marsh Wrens are the first of the wetland Passerines to depart for their wintering grounds with most individuals gone before early October (Vickery 1978).

Only the 2 waterthrushes and Palm Warbler are neotropical migrants (Table 10) (Sauer et al. 1997). All other species within this group, surprisingly, are short distance migrants (Sauer et al. 1997). Some Red-winged Blackbirds winter in the Caribbean (Rappole et al. 1995), however, the migratory northern population of Red-winged Blackbirds, winter in the southern U.S., not Mexico (Yasukawa and Searcy 1995).

Survival and Reproduction

For Marsh Wrens, nest success (i.e., percent fledged from all nests) depends on habitat quality; ranging from nearly 40% at a site with shallow water and low densities of emergent vegetation to just over 60% at a site with deeper water and higher vegetation density (Leonard and Picman 1987). Annual survival rates of adult (Saltmarsh) Sharp-tailed Sparrows are approximately 50 - 60% with no difference between sexes but also may vary widely in response to habitat quality (Post and Greenlaw 1982). For first-year (Saltmarsh) Sharp-tailed Sparrows, annual survival was only about 7%; this is a minimum estimate based on banding returns (i.e., the estimate could be higher as banded birds may have returned but were not captured). Life span records for (Saltmarsh) Sharp-tailed Sparrows have been reported at 10 years for males and 6 years for females (Greenlaw and Rising 1994). Similarly, 2 male Red-winged Blackbirds have been reported at 14 years (Low 1950, Fankhauser 1967) and an adult female at 9 years (Fankhauser 1967). Adult annual survival rate averaged between approximately 40 - 60% (Fankhauser 1967, Searcy and Yasukawa 1981) with no sex-specific differences (Yasukawa and Searcy 1995), but appears to vary depending on degree of sexual dimorphism (Searcy and Yasukawa 1981). The oldest Rusty blackbird on record was nearly 9 years (*see* Avery 1995) and the oldest Palm Warbler at 6 ½ years (Kennard 1975), but little additional information is available on survival rates or natal philopatry for either species.

Environmental factors are some of the most significant causes of mortality including winter severity among Rusty Blackbirds (Avery 1995), and spring tide flooding of saltmarsh habitat for nestling Sharp-tailed Sparrows (Greenlaw and Rising 1994). Predation, especially of nestlings and newly fledged young may be important causes of mortality for all wetland Passerines and a variety of avian and mammalian predators may be responsible. Interestingly, Northern Harriers *(Circus cyaneus)* and wading birds are predators of Sharp-tailed Sparrows (Greenlaw and Rising 1994). Marsh Wrens have been reported as destroying the eggs of bitterns (presumably *Botaurus lentiginosus*) (Forbush 1929), the eggs (Ehrlich et al. 1988) and nestlings of Red-winged Blackbirds (Picman 1977a) and of other Marsh Wrens (Picman 1977b). In turn, Red-winged Blackbirds may destroy the eggs of Marsh Wrens (Ehrlich et al. 1988).

Although all wetland Passerines in Maine have altricial young, they use a diverse array of nest sites and wetland habitats. A more detailed summary of some aspects of the reproductive biology of this group is presented in Table 11.

Foods and Foraging Strategies

As a group, Maine's wetland songbirds are insectivorous while on their breeding grounds. Marsh Wrens appear exclusively so (Ehrlich et al. 1988), whereas Red-winged Blackbirds are probably the most opportunistic consuming significant amounts of grains when agricultural areas are nearby (averaging 42% of the diet for males and 21% for females) (McNichol et al. 1982). As with other Passerines, nestling diets are comprised entirely of insect matter (Ehrlich et al. 1988).

Wetland sparrows forage for insects among vegetation, at the waters edge, and glean items from the surface film. Capable of balancing on a *Spartina* stem, Sharp-tailed Sparrows are adept at removing seeds when none are available on the ground (Greenlaw and Rising 1994). The 2 species of blackbirds use nearly any manner of insect capture including partially submerging themselves and probing rotten sticks for insect larvae (Rusty Blackbird) and occasionally aerial capture of flying insects (both species) (*see* Avery 1995, Yasukawa and Searcy 1995). Also, both Rusty and Red-winged Blackbirds use a "gaping" method to acquire food which entails inserting bill into soft soil or vegetation, then opening it (thus prying the substrate apart) to reveal insect prey (Orians 1985, Avery 1995).

HABITAT ASSESSMENT

Habitat Use

Passerines in this group use several types of wetlands, however, most species are associated with open/emergent marshes (DeGraaf and Rudis 1986). Marsh Wrens and Red-winged Blackbirds use similar habitat in Maine; typically palustrine emergent wetlands with abundant cattails (Typha) and a portion of open water (DeGraaf and Rudis 1986, Jobin and Gauthier 1996, Tanguay and Robert 1996). In Maine, Palm Warblers are associated with peatlands especially those with extensive areas of woody vegetation (Stockwell 1994). Among the sparrows, Sharp-tailed Sparrows occur in saltmarsh habitats along Maine's coast (Greenlaw and Rising 1994) (although [Nelson's] has been reported at least 1 inland marsh [Adamus 1987]) and Swamp Sparrows use scrub-shrub and emergent habitats especially when they occur as a mosaic (Banville and Gauthier 1996). Both species of waterthrush overlap in their habitat use (Craig 1985). Louisiana Waterthrushes are associated with forested riparian areas with fast moving water (Craig 1985), whereas Northern Waterthrushes also are found in forested wetlands and on the shores of lakes and ponds where ground cover is dense close to the water (Craig 1985, Eaton 1995). Rusty Blackbirds are the most "boreal" of the blackbirds and in Maine inhabit lakeshores, riparian zones along streams and around ponds, forested wetlands, and bogs (Avery 1995).

Past Habitat

Prior to European contact, Passerine birds associated with wetlands in Maine probably had the greatest amount of habitat available. Since then, the amount of wetland habitat has been altered significantly. Because much of the early settlement in Maine occurred along the coast (Russell 1980, Cronon 1983), saltmarsh habitats and the bird populations they supported probably suffered the earliest and greatest overall losses (Widoff 1988). As many of Maine's early settlers kept livestock, the harvest of salt hay (i.e., *Spartina*) placed farming activities in coastal wetlands (Widoff 1988). Disturbance and habitat alteration resulted from hay cutting in saltmarshes. Because undisturbed senescent vegetation is important for nesting Sharp-tailed Sparrows (Tufts 1962 *cited in* Erskine 1992), harvesting of salt hay in colonial times must have reduced the quality of saltmarsh habitat for these birds. Erskine (1992) estimated that habitat for (Nelson's) Sharp-tailed sparrows declined by $\geq$ 50% because of ditching and draining of saltmarshes in the Maritimes. Advancing development inland, largely brought about by the timber industry and improvements in technology, shifted agriculture away from the coast to land that was "easier to work" (Widoff 1988). However, urban centers developed from these small coastal towns and loss of saltmarsh habitat through filling and draining (Widoff 1988) became a far less benign activity than hay cutting and probably continued largely unabated into the early 1970's. Inland wetlands too were subject to human alteration, especially floodplain forests and small palustrine forested and scrub-shrub wetlands (Widoff 1988) which likely impacted waterthrush habitat.

Altered by land clearing for pasture and other farming activities, Maine's inland freshwater wetlands bore the weight of a growing human population with increasing

demands on natural resources. By the 1980's, Widoff (1988:ii) estimated losses of vegetated wetlands at approximately 2% of Maine's total wetland resource. Chief causes of loss since European settlement have been commercial and residential development (~63 square miles), hydropower development (~47 square miles), and agriculture (~31 square miles). These areas seem small, however, these represent total loss of wetland habitat, more difficult to quantify and likely several fold more widespread, has been the change in form and function of wetlands, which may have consequences for habitat quality for wetland birds.

Widdoff (1988:51) listed 11 peatlands in Maine that have been mined for peat historically. The total area affected equals 3.5 square miles, nearly 95% of which is located in Washington County (Widdoff 1988:51). Some additional losses, presumably of less magnitude, have occurred during highway construction.

Much of the original emergent marsh habitat in Maine was the result of either natural constrictions in streams and rivers or by the activities of beaver. Beaver populations, and hence the marsh habitat they create, declined significantly during the height of the European fur trade (Lisle 1994). Habitat for Swamp Sparrows, Red-winged Blackbirds, and perhaps Marsh Wrens probably declined as a result of overharvest of beaver populations. With advancing succession, abandoned flowages often reverted to damp forest and probably became suitable for Northern Waterthrushes.

Current Habitat

The Maine Wetland Inventory reported 2,784 square miles of wetlands in 1988 (Widoff 1988:11). The Maine GAP analysis project made a preliminary estimate of freshwater wetlands at about 3,000 square miles (Appendix II). These are likely underestimates, which overlook forested wetlands; actual wetland area in Maine is probably closer to 10,000 square miles (A. Calhoun, University of Maine, pers. comm.). The amount of freshwater wetlands is distributed roughly in proportion to land area in the 3 physiographic regions; approximately 18 square miles in Southern New England, 570 square miles in Northern New England, and 2,315 square miles in the Eastern Spruce/Hardwood regions (Appendix II).

With a resurgence of Maine's beaver population (Lisle 1994), habitat for many wetland birds has increased in the past half century. Beaver populations have been held "in check" by trapping until recently and many previously abandoned sites have been at least temporarily reflooded in the past 50 years (Lisle 1994). Consequently current habitat conditions for most wetland songbirds, but especially Red-winged Blackbirds and Swamp Sparrows, has undoubtedly increased. Unfortunately, despite abundant conservation concern in coastal ecosystems, and indeed protection efforts there, similar increases in saltmarsh habitat are not likely to occur. Thus, concern over habitat quality for Sharp-tailed Sparrows, as opposed to quantity, seems more appropriate at present. There appears to be little overall concern for the loss of peatland habitat (Wilson 1996) and only one peatland, Denbo Heath in Deblois, is currently being mined commercially (Widdoff 1988).

Habitat Projection

Recognition that small wetlands are important at the community and ecosystem level has resulted in trends towards their protection. Acknowledging that vernal pools are important lends support to conservation of all forms of wetlands. Incremental losses of all types of wetland habitats important to Passerines is likely to continue, however, large scale developments that take place in wetlands (e.g., bridge and highway bypass construction) will need to be mitigated. Unfortunately, the function of wetlands, both hydrologically and ecologically, remains poorly understood.

Future riparian habitats seem well protected if statewide zoning protects buffers along streams, however, information on the distribution of waterthrush territories relative to proximity from streams and lakeshores is needed. Habitat for Rusty Blackbirds in northern and western Maine may be less favorable following clearcutting, which opens up patches within the forest. These habitats are more suitable, at least at first, to Common Grackles *(Quiscalus quiscula)* and competition may reduce habitat availability for Rusty Blackbirds (Erskine 1992). However, the extent to which Rusty Blackbirds can coexist with Grackles is unknown; unfortunately, much about the ecology of Rusty Blackbirds is poorly documented. Inland freshwater marshes will continue to experience increased recreational use and the extent to which these activities can coincide with Marsh Wrens and Red-winged Blackbirds is probably high. Other nonpasserine birds that use the same habitats, such as bitterns and rails may be less able to withstand increasing recreational activity. Because Sharp-tailed Sparrows are so dependent on saltmarsh habitat, losses of this type of wetland has reduced their numbers in North America (Rising 1996). Saltmarsh habitats in Maine will continue to experience threats from development, especially in York and Cumberland Counties, which will place Saltmarsh Sharp-tailed Sparrows in direct conflict with human activities there.

POPULATION ASSESSMENT

Past Populations

Little information on historic populations of wetland Passerines is available. For most species, populations are probably much the same as they were prior to European settlement. Further, Palmer (1949) stated that populations of Rusty Blackbirds have not fluctuated during the first half of the 20th century. Those species that benefited from agricultural development, chiefly the blackbirds, experienced increased populations with production of corn and small grains in the northeast (Jobin and Gauthier 1996) and on their southern wintering grounds. Locally, Red-winged Blackbird populations were reduced because of depredations on grain crops (Samuels 1875) and more recently planted corn (Forbush 1929). Effects of control efforts at mixed species roosts may have little effect on Rusty Blackbirds if they constitute <1% of communal roosts (Avery 1995). There is some indication that Marsh Wrens did not occur in Maine until the twentieth century. Perkins (1935) reported the first nesting record for Marsh Wrens in 1935 from Berwick. Further, Erskine (1992) reported only "scattered records from 1938-1955" in the Maritimes, despite the geographic range described by Forbush (1929) as including southern New Brunswick. In New Hampshire, numbers may have peaked between 1940 and 1970, but have experienced unexplained declines in the past 20 years (*see* Robbins 1994). Numbers of Northern Waterthrushes were considered low in northern and eastern Maine in the first part of the 20th century (Palmer 1949). Further, it appears Louisiana Waterthrush has long been restricted to a small population in southwestern Maine (Palmer 1949).

Populations of wetland Passerines that breed in beaver flowages likely mirrored the decline in beaver populations following the colonial fur trade. Populations of wetland birds in abandoned flowages presumably lingered for many years until advancing succession returned much of their more open wetland habitat to forest. Populations of wetland Passerines probably remained at this level until early in the 20th century when beaver populations and the habitat they create rebounded (Lisle 1994). Expansion of Swamp Sparrows into Northern New Hampshire since the early 1900's, may be explained in part by increases in beaver-influenced wetlands (Gavutis 1994). Sharp-tailed Sparrow populations probably recovered when changes in agricultural practices curtailed harvesting of salt hay.

Current Populations

Basic information about the population status of most wetland Passerines is lacking. Louisiana Waterthrush is probably the rarest of wetland Passerines described in this assessment. Furthermore, where range overlap occurs between the 2 species of sharp-tailed sparrows, the utility of the Maine Breeding Bird Atlas is limited. Also, Rusty Blackbirds were probably inadequately surveyed for Maine's Breeding Bird Atlas and given their Special Concern status, appear to warrant a thorough on-the-ground evaluation of their status in northern and western Maine. Preliminary surveys in 1997 revealed few sites occupied by Rusty Blackbirds in Northern and Western Maine (MDIFW, unpublished data).

Most wetland birds especially those with narrow habitat requirements are poorly surveyed by the BBS. The BBS provides reliable Maine trend estimates for only 3 wetland Passerines (i.e., Northern Waterthrush, Swamp Sparrow, and Red-winged Blackbird). Sufficient data to estimate trends are available on a regional basis for 4 additional species; data for sharp-tailed sparrows are too scant to report. In Maine, Red-winged Blackbirds are in significant ($P <$ 0.01) recent and long-term decline, whereas Swamp Sparrows show a nonsignificant increase (Sauer et al. 1997) (Table 12). In contrast, Red-winged Blackbird populations in New Hampshire appear stable (Sauer et al. 1997), while Elkins (1994) stated that density there is much higher than in the early 1900's. Todays abundant, widely distributed populations of Swamp Sparrows in Maine seem to parallel a similar situation reported by Gavutis (1994) in New Hampshire where populations were low historically but increased in the early to mid 1900's. Trends for Northern Waterthrush in all 3 time periods are nonsignificant (Table 12), whereas Marsh Wrens showed a declining long-term trend ($P < 0.10$) and Louisiana Waterthrush had a declining recent, short-term trend ($P = 0.08$) for the Northeast region (Sauer et al. 1997) (Table 12).

Population Projections

Apparent stability of Swamp Sparrow populations raises no immediate concern. Red-winged Blackbirds, although showing recent declines in Maine and indeed throughout the Northeast (Sauer et al. 1997), warrants little alarm as the species is one the most abundant birds in North America (Yasukawa and Searcy 1995), and clearly abundant in Maine as well. Marsh Wren populations, however, with a more spotty distribution in Maine (Adamus 1987) and fluctuations in New Hampshire (Robbins 1994) and the Maritimes (Erskine 1992) may not be as secure. Clearly, inadequate coverage of Marsh Wren habitat by the BBS contributes to our weak understanding of their status in Maine and makes projections about future populations tentative at best. Understanding the differences in population dynamics and habitat use of these 3 species (preferably in the same wetland) would contribute to conservation of Marsh Wrens and indeed other species that share the same habitat. Palm Warblers, with no apparent broad-scale threats to their habitat, also appear secure, however, they may be especially vulnerable to collisions with towers during migration (Wilson 1996).

Sharp-tailed Sparrows and Rusty Blackbirds are obviously species that we have too little data to make a detailed judgment about their status and future populations. Sharp-tailed Sparrow habitat lies in conflict with human use along Maine's coast. Saltmarshes that lay behind (inland of) barrier beach environments are probably the most susceptible to disturbance. Fortunately, much of this habitat in extreme southern Maine is part of the National Wildlife Refuge System. Also, wetlands such as Scarborough Marsh, through their sheer size afford some degree of isolation from human activity. Losses of small populations of sharp-tailed sparrows at small estuarine wetlands along the coast may occur because of adjacent development and disturbance. Where these habitats are naturally fragmented (i.e., isolated) and where development pressures historically have been less (but may increase in the future), like in Hancock and Washington Counties, sharp-tailed sparrows are likely to be most vulnerable.

Populations of Northern Waterthrush appear secure, whereas recent declines in Louisiana Waterthrush numbers may warrant closer monitoring. The interaction of forestry practices, Common Grackles, and Rusty Blackbirds appears poorly understood. Further assessment of Rusty Blackbirds in Maine's portion of the Eastern Spruce/Hardwood Region (their occupied range in Maine) also may be needed, however, the remoteness of their habitat probably bodes well for their future.

Table 10. Breeding distribution and migration information for wetland Passerines in Maine.

Species	Distribution in Maine	Timing of Migration			Wintering Area[3]
		Mean First Arrival[1]	Estimated Arrival[2]	Estimated Departure[2]	
Marsh Wren	Coastal ½	5/18	Early May	Early Oct	SE U.S., NE Mexico & Bahamas
Northern Waterthrush	Statewide	5/9	Late April	Early Oct	S. Mex., C. Am., Carib, Ecuador - Surinam
Louisiana Waterthrush	Southwest ¼	5/1	N/A	N/A	S. Mex., C. Am., Carib, Colombia & Venez.
Palm Warbler	Statewide	4/21	Mid Apr	Mid Nov	SE U.S., Caribbean & E. Central America
Nelson's Sharp-tailed Sparrow	Coastwide	5/26	Mid May	Late Oct	Gulf Coast States and Coastal California
Saltmarsh Sharp-tailed Sparrow	Southern Coast	5/26	Mid May	Late Oct	S. Atlantic & Gulf Coast States
Swamp Sparrow	Statewide	4/27	Mid Apr	Late Nov	N. Mexico, Midwest & Southeast U.S.
Red-winged Blackbird	Statewide	3/27	Late Feb	Late Dec	Mexico, Carib. & Southern U.S.[4]
Rusty Blackbird	All but South & Central	4/6	Late Mar	Early Dec	Midwest & Southeast U.S.

[1] Data from Wilson et al. (1997).
[2] Estimates from Vickery (1978).
[3] Rappole et al. (1995)
[4] Small numbers of this species overwinter in Maine in most years (Vickery 1978).
[5] Typical winter range includes Maine.

Table 11. Aspects of the reproductive biology[1] of selected wetland Passerines that breed in Maine.

Species	Mating System	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Marsh Wren	Polygyn.	Emergent Vegetation	Spherical	4-6[2]	14-16[3]	13-16
Northern Waterthrush	Monog	Ground	Open Cup	4-5	13-14[4]	10
Louisiana Waterthrush	Monog.	Ground	Open Cup	5	13	10
Palm Warbler	Monog.	Ground	Open Cup	4-5	11-12[5]	10-12[5]
Sharp-tailed Sparrow	Promisc.	Ground	Depression	3-5	10-12[4]	8-11[4]
Swamp Sparrow	Monog.	Low Vegetation	Open Cup	4-5	12-15	9-13[4]
Red-winged Blackbird	Polygyn.	Emergent Vegetation	Open Cup	3-4	10-12	11-157
Rusty Blackbird	Monog.	Coniferous Tree	Open Cup	4-5	14	11-13

[1] Excerpted from the summaries by Ehrlich et al. (1988) unless otherwise indicated.
[2] Dependent on food availability (Verner 1965).
[3] See Verner (1965).
[4] See Gauthier and Aubry (1996).
[5] See Ibarzabal and Morrier (1996).

Table 12. Trends[1] in numbers of selected wetland Passerines[2] observed in Maine according to the North American Breeding Bird Survey[3].

	1966-1996			1966-1979			1980-1996		
Species	n	Trend	P	n	Trend	P	n	Trend	P
Marsh Wren[4]	48	-5.6	<0.01	30	-6.6	NS	34	-5.1	<0.01
Northern Waterthrush	52	-1.0	NS	19	-1.2	NS	47	2.0	NS
Louisiana Waterthrush[4]	267	-1.2	NS	127	0.9	NS	230	-2.5	0.08
Palm Warbler[5]	40	3.4	NS	13[6]	1.3	NS	36	4.3	0.03
Swamp Sparrow	37	2.5	NS	16	-7.4	0.01	30	5.2	NS
Red-winged Blackbird	56	-4.0	0.01	37	-2.5	NS	55	-2.1	0.02
Rusty Blackbird[5]	52	4.0	NS	37	-2.9	NS	25	10.3	NS

[1] Using route-regression method of Geissler and Sauer (1990).
[2] Sharp-tailed Sparrows are not listed because data are unavailable for Maine or the Northeast; excludes Seaside Sparrow, which is a rare breeder in southern Maine; Also excludes species listed as Endangered or Threatened under the Maine Endangered Species Act and nonpasserine birds that use this habitat.
[3] Sauer et al. (1997).
[4] Data from USFWS Region 5; data specific to Maine too limited to report (Sauer et al. 1997).
[5] Data from Physiographic Region 28: Eastern Spruce/Hardwood Forest; data specific to Maine too limited to report (Sauer et al. 1997).
[6] Results may be unreliable and introduce positive bias when sample size is less than 14 (Sauer et al. 1997).

GRASSLAND BIRDS

SCOPE

This group includes 7 species, representing 2 families (Alaudidae and Emberizidae). Five species, known to breed in Maine, are included: Horned Lark *(Eremophila alpestris)*, Vesper *(Pooecetes gramineus)* and Savannah Sparrows *(Passerculus sandwichensis)*, Bobolink *(Dolichonyx oryzivorus)*, and Eastern Meadowlark *(Sturnella magna)*. Two species, which breed in the arctic, but winter in Maine, are included: Snow Buntings *(Plectrophenax nivalis)* and Lapland Longspurs *(Calcarius lapponicus)*. These winter residents, along with Horned Larks, use Maine's frozen lakeshores, agricultural areas, and barrens (Rising 1996) as respite from the harsh arctic weather of their breeding grounds. American Pipits *(Anthus spinoletta)*, an alpine/tundra species, and Grasshopper Sparrows *(Ammodramus savannarum)* are listed as Endangered under the Maine Endangered Species Act and consequently are not discussed. An assessment of Grasshopper Sparrows in Maine has been prepared previously (MDIFW 1992).

NATURAL HISTORY

General Description

Birds within this group constitute a diverse assemblage of species adapted to early seral communities. Most species are small <50 g. Savannah Sparrows are the smallest at approximately 17 g (Wheelwright and Rising 1993), whereas Eastern Meadowlarks reach nearly 124 g (Lanyon 1995). The 2 nonbreeding species, Lapland Longspurs and Snow Buntings, average 27.3 g to 42.2 g, respectively (Dunning 1984). Most species exhibit some form of cryptic coloration; the male Bobolink in breeding plumage is unique (Martin and Gavin 1995) with black body and yellow and white/gray patches dorsally. All species are ground nesters, most often using a shallow depression, which is well concealed by surounding/overhanging vegetation (Ehrlich et al. 1988).

Distribution and Migration

Among the 5 breeding species, only Eastern Meadowlarks and Vesper Sparrows are not distributed statewide (Table 13) (Adamus 1987). Of those species with statewide distributions, Bobolinks and Savannah Sparrows occur at moderate densities. Horned Larks have a much more patchy distribution and were confirmed as breeding at only 2 locations during the survey period for Maine's Breeding Bird Atlas (1978-1983) (Adamus 1987). Recent evidence (W. Sheehan and N. Famous, pers. comm.) suggests that Horned Larks breed at more sites than indicated by the Maine Breeding Bird Atlas. Snow Buntings appear more abundant in Maine than are Lapland Longspurs (Vickery 1978), although fewer Lapland Longspurs may be reported because they are less visible and more difficult to identify.

Birds within this group may be categorized 3 ways in their approach to migration and wintering distribution. First, 4 species spend only the breeding season in Maine, (i.e., Savannah Sparrow, Vesper Sparrow, Bobolink, and Eastern Meadowlark). Only the Bobolink is a neotropical migrant restricted to South America during winter; the remaining 3 short distance migrants winter from southern North America to northern South America (Rappole et al. 1995, Sauer et al. 1997). The 3 short distance migrants arrive in Maine by mid April and depart in late October (Table 13) (Vickery 1978, Wilson et al. 1997), although a few Eastern Meadowlarks may overwinter in Maine each year (Vickery 1978). Bobolinks are the last of the grassland Passerines to arrive reaching Maine in early to mid May (Vickery 1978, Wilson et al. 1997) and leave in late September through early October (Vickery 1978). Secondly, Horned Larks (i.e., "Prairie"; *E. a. praticola*) breed in Maine and a few may overwinter here (Vickery 1978, Beason 1995) together with the migrant *E. a. alpestris* from northeastern Canada. The third approach, that of Snow Buntings and Lapland Longspurs, is to arrive in Maine in October (Vickery 1978) and normally depart for the arctic by late March or early April (Vickery 1978, Wilson 1997), thus only overwintering in Maine to avoid the extremes of the tundra in winter. Also, Snow Buntings, Horned Larks and Lapland Longspurs associate in mixed flocks (Knight 1908, Palmer 1949).

Survival and Reproduction

Only limited information is available concerning survival rates (often expressed simply as annual return rates to a specific site) for breeding birds within this group. Annual survival estimates for adult Savannah Sparrows in Quebec ranged from 31 - 45% (Bedard and LaPointe 1984). In New Brunswick, however, adult survival estimates were approximately 40 - 90% for females, 40 - 80% for males and often exhibited wide annual variation (Wheelwright et al. 1992). Fledging success was unaffected by mating system ranging from 71 - 93%, but in some years, survival of adult female Savannah Sparrows may be lower if their mate was polygynous (Wheelwright et al. 1992). The oldest recorded Savannah Sparrow was just under 7 years (Klimkiewicz and Futcher 1987) and the oldest Bobolink at 8 years 1 month (Klimkiewicz and Futcher 1989). Among adult Bobolinks, annual return rates are higher for males (approximately 44 - 63%) than for females (approximately 25 - 40%) (Martin 1974, Gavin and Bollinger 1988). A complex of behaviors surrounding their foraging strategy and egg laying/incubation afford Bobolinks higher nest success (63.6% of eggs from primary nests fledged young, 48.6% of eggs from secondary nests fledged young) than other polygynous blackbirds (Martin 1974). For species that breed on agricultural lands, normal farming activities (e.g., grazing, tillage, and especially haying) can be a significant cause of mortality among nestlings and recent fledglings of all breeding species and is well documented for Bobolinks (Bollinger et al. 1990). Predation is common among grassland birds especially during the nesting season (*see review by* Martin and Gavin 1995), and Savannah Sparrows, not unlike other vertebrates, appear to make habitat use decisions to minimize risk of predation (Watts 1991). Specifically, availability of dense patches of cover within grassland habitat allow Savannah Sparrows and probably other species to avoid avian predators (Watts 1990, 1991). Also, agricultural pesticides have contributed to mortality among Eastern Meadowlarks and Horned Larks (Griffin 1959, Deweese et al. 1983).

Of the 5 breeding grassland birds, all are ground nesters. Bobolinks are the last to nest of the group (Sample et al. 1989 *cited in* Bollinger and Gavin 1992) making them the most vulnerable to mortality from haying. Details of reproductive biology of the 5 breeding grassland birds is presented in Table 14.

Foods and Foraging Strategies

Grassland birds that breed in Maine are primarily insectivorous and secondarily granivorous. Horned Larks, however, deviate from this pattern being primarily seed eaters, but also taking insects and other invertebrates as available (Ehrlich et al. 1988). As with other grassland species, Horned Larks feed insects (almost exclusively) to their young (Beason 1995). Savannah Sparrows may have the broadest niche of the group with a rather generalist diet and an array of methods for acquiring food (Wheelwright and Rising 1993). Snow Buntings and Lapland Longspurs are voracious insect predators on their tundra breeding grounds when capturing food for nestlings (Lyon and Montgomerie 1995, Lanoue and Doyon 1996). Diets of wintering Snow Buntings are almost exclusively seeds, but along the coast, food items also may include small

crustaceans gleaned from wrack (i.e., debris washed ashore and often deposited at the high tide mark) (Knight 1908, *also see review by* Lyon and Montgomerie 1995).

During summer, all species forage singly on the ground (Beason 1995). Typical foraging behavior is exemplified by Horned Larks which forage by walking slowly and picking up insects that flush ahead of them or seeds that have fallen to the ground (Beason 1995). Bobolinks and Savannah Sparrows occasionally glean insects from nearby vegetation (Ehrlich et al. 1988, Wheelwright and Rising 1993) and Eastern Meadowlarks also probe the soil and manure/clods for food (Lanyon 1995). In addition, Horned Larks may cause crop damage by uprooting and eating sprouting wheat, oats, and milo (Rosenberg et al. 1991 *cited in* Beason 1995). On the wintering grounds, Snow Buntings, Horned Larks, and Lapland Longspurs often occur in small, occasionally mixed flocks, frequently seen feeding in fields and along shorelines (Samuels 1875, Forbush 1929, Beason 1995). In winter, Snow Buntings forage by simply gleaning seed fallen from weeds, especially annuals. When necessary, they occasionally glean from the plant while in fluttering flight, or land on a stalk and use their bill to free additional seeds from the dried inflorescence.

HABITAT ASSESSMENT

Habitat Use

This suite of species, breeders and nonbreeders alike, use a variety of early successional/open habitats dominated by herbaceous vegetation, chiefly graminoids, while in Maine. Coastal dunes and shorelines also are frequented by this group, especially the winter residents. Of any species in the group, Horned Larks have the greatest affinity for bare ground and poorly vegetated areas (Beason 1995); Vesper Sparrows, however, select sparsely vegetated habitat with an abundance of small openings (bare patches) (Whitmore 1979, Vickery 1993, Rising 1996). The remaining breeding species are more likely to occur in more densely vegetated areas of mixed grasses and forbs (Whitmore 1979, Vickery 1993). Sandplain grasslands of southern Maine, blueberry barrens, fields and pastures of Waldo, Hancock, and Washington Counties, and the agricultural lands (principally those under the U.S.D.A.'s Conservation Reserve Program) of Aroostook County comprise the habitats with the greatest diversity of grassland bird species in Maine. Habitat availability has declined in the recent past for many of the species (Rising 1996), but lately, conservation efforts have focused on these rare communities and grassland birds have begun to receive greater consideration.

Past Habitat

Early successional upland habitats existed in Maine long before European settlement (Cronon 1983) and the advent of modern agriculture. Sandplain grasslands of southern Maine were undoubtedly maintained by fire; whether natural or intentionally set by native peoples remains the subject of conjecture. These areas, together with the blueberry barrens of eastern Maine (of similar origin and perhaps maintenance), coastal marshes, and wet meadows, likely supported populations of grassland birds long before colonial times (Bonneau 1996). With widespread agricultural development in Maine during the 1800's, habitat for many grassland birds undoubtedly was expanded (Wheelwright and Rising 1993, Beason 1995, Martin and Gavin 1995, Rising 1996) and Horned Larks may have begun breeding in Maine in response to land clearing for agriculture (Palmer 1949). Habitat for Savannah Sparrows was probably the greatest around 1900 than at any other time in Maine's history (Wheelwright and Rising 1993). In central Maine (Kennebec and Waldo Counties) by 1880, slightly more than 80% of the land area was in some form of agricultural practices (MDIFW 1992). By 1930, these same counties had dropped in agricultural area to approximately 65% (MDIFW 1992). From 1959 to 1992, total farmland in Maine has declined nearly 60% (USBC 1994:8). Pasture alone has declined 16% just between 1987 and 1992 to 240 square miles (USBC 1994:230). Only slight increases were noted between 1987 and 1992 in the area of wild blueberries; 33.1 square miles in 1987 compared to 34.7 square miles by 1992 (USBC 1994:241). Throughout southern New England, including southern Maine, early successional habitat for a variety of vertebrates has largely reverted to forest (Litvaitis 1993). The near precipitous decline in area of farmland in Maine has isolated

some populations of grassland birds and increases the importance of native grasslands and barrens for these species.

Current Habitat

Species discussed in this section are not the most threatened birds using this habitat type. Even so, habitat for grassland birds is significantly less now than during the era of widespread agricultural development following the colonial period. Griffith and Alerich (1996:10) reported idle farmland occupied 182 square miles with an additional 267 square miles of pasture. Other reports place only 77.9 square miles of abandoned field statewide in Maine with an additional 1,800 square miles of grasslands (Appendix II). Estimates from the latest census of agriculture (USBC 1994:8), place Maine's total farmland area at 1,966 square miles, but that likely includes some woodland, especially that used for pasture. Estimates of total farmland as high as 2,400 square miles have been made (Appendix II). It's uncertain what portion of the 834 square miles of cropland estimated by Griffith and Alerich (1996:10) is tilled versus used for hay and blueberry production. However, the census of agriculture reports 34.7 square miles in wild blueberries (USBC 1994:241), 240.2 square miles in pasture (USBC 1994:170), and 331.5 square miles in hay production (alfalfa + tame hay + wild hay + haylage) (USBC 1994:230-231). The Maine GAP Analysis Project found 52 square miles of blueberry land in Maine (Appendix II), 90% of which is in the Eastern Spruce/Hardwood Physiographic Region. The Northern New England region has the greatest amount of grassland habitat (1,159 sq. mi.) owing almost exclusively to the remaining agricultural fields and pastures there (Appendix II). Although we probably have more total open habitat today than we did prior to the colonial period, the quality of some of our current habitats (i.e., blueberry barrens following Valpar treatment) may be less suitable for some species. Also several species of grassland birds may be area sensitive (Vickery et al. 1994). Of this group, Vickery et al. (1994) found Vesper and Savannah Sparrows, Bobolinks, and Eastern Meadowlarks to exhibit a positive area effect within grassland habitats; Vesper and Savannah Sparrows seem to be most sensitive to patch size. Low incidence of Bobolinks and Eastern Meadowlarks complicates drawing conclusions as to their area sensitivity and too few Horned larks were encountered to conduct analyses (Vickery et al. 1994). Some habitats, especially natural sites in southern Maine increasingly are threatened with development pressures. In Aroostook County, after the demise of small farmsteads, the practice of removing hedgerows that once divided small pastures and hay land to facilitate large-scale tilling practices, actually may have increased patch size. With some of this land out of production via the USDA's Conservation Reserve Program (CRP), habitat for area sensitive grassland birds in Aroostook County is at present widespread.

Habitat Projection

Creation of grassland habitat for birds is unlikely to take place in Maine in the future. However, protection of existing natural (barrens) and manmade (agricultural) sites through purchases or conservation easements would be desirable. Enhancements to grassland habitats via changes in mowing schedules both on farms and at airfields,

expansion of controlled burning, and perhaps through reducing the use of Valpar on blueberry barrens, if feasible, might foster stability in some grassland bird populations. The benefits of setting aside highly erodable land for conservation purposes, and for grassland birds in particular, may be short-lived if CRP enrollment criteria are relaxed or if the program is inadequately funded. Habitat for grassland birds in Maine may be reduced further by the continued reversion of abandoned fields to woodland, despite the supposition of Lyon and Montgomerie (1995) that there is no obvious degradation of winter habitat for species such as Snow Buntings. Habitat along shorelines should remain in abundance, however, the effects of continued recreational development, although summer oriented, remains uncertain. In general, a slow erosion of grassland habitats is likely to occur and the quality of those habitats may decline at an even faster pace. Conservation of grassland habitats is needed, and in places, underway. Perhaps future declines in habitat will be offset by gains from conservation efforts and decreases in grassland bird populations may be slowed.

POPULATION ASSESSMENT

Past Populations

Grassland bird populations, like other species of early successional habitats presumably responded well to the clearing of the eastern forests for agricultural purposes initiated during the colonial period (Bonneau 1996, Rail 1996). The most extensive historical information on grassland bird abundance is for the blackbirds. Bobolinks benefited greatly from the expansion of rice as a commercial crop in the southern states (Forbush 1929). Market hunting for "rice-birds" (i.e., Bobolinks) around the turn of the century, probably exacted a heavy toll on populations and may have led to early declines (Forbush 1929). Populations in Maine likely mirrored trends observed in other eastern states as evidenced by declines reported by Palmer (1949). Forbush (1927) reported that numbers of Bobolinks in coastal New England towns by the late 1920's had declined compared to the period 1875-1900. Described as a rare winter resident by Forbush (1927), Eastern Meadowlarks were thought to be increasing in winter especially along the southern coast of Maine. Furthermore, Palmer (1949) described an apparent range expansion of the Eastern Meadowlark in Maine around the turn of the century. Also, Norton (1926) reported an increase between about 1890 and 1925, which led to higher densities of Eastern Meadowlarks than Bobolinks in southwestern Maine. Palmer (1949) reported declines of Vesper Sparrows that began around 1918 from which the species presumably has not yet recovered. In the latter part of the 19th century, Vesper Sparrows were a common breeding species in many parts of Maine. Not documented as breeding in Maine until 1900 (Swain 1900), Horned Larks probably have never been abundant, however, early records indicated that their numbers may have been greater and more widely distributed in Maine than at present.

Current Populations

Of the grassland birds discussed in this section, Horned Larks are the least represented. Adamus (1987) confirmed breeding at only 2 sites and probable breeding at only 5 additional sites (recorded at only 17 atlas blocks statewide). Horned Larks were probably inadequately surveyed during the atlasing period, especially in Aroostook County. Only 4 of the 5 breeding grassland bird species are currently reported from the BBS in Maine; too few routes with Horned Larks prevent analysis. Eastern Meadowlarks appear to be the species of greatest concern with a significant long-term decline of 8% per year in Maine (Table 15). Furthermore, Eastern Meadowlarks appear to be declining significantly throughout the U.S. and Canada (Sauer et al. 1997). Bobolinks also appear to be declining (Table 15) (Sauer et al. 1997), yet, Lauber and O'Connor (1993) reported overall stable populations in the Northeast between 1968 and 1990, marked by slight increases during the 1970's then slight declines during the 1980's. For the last 16 years, Sauer et al. (1997) reported nonsignificant declines for Bobolinks in the northeast region. Not all grassland birds in Maine, however, are in decline. Savannah Sparrow populations appear stable over the 30-year BBS period (Sauer et al. 1997) with a slight decline from 1971 through 1986 and an increase during the late 1980's (Lauber and O'Connor 1993). Although Vesper Sparrows show long-

term declines in the northeast and nonsignificant declines in Maine (Sauer et al. 1997), the number of routes with them in Maine is too low to place much confidence in their trend estimates (Table 15). Savannah Sparrow populations appear the most secure of any of the four species and although Bobolink numbers warrant watching, trends for Eastern Meadowlarks demand attention. Further assessment of Vesper Sparrow and Horned Lark populations also is needed.

Population Projections

If agriculture continues to decline in Maine, especially dairy farming, habitat and consequently populations of many grassland birds also will likely decrease. Furthermore, on Maine blueberry lands, populations of grassland birds may be affected by herbicide use. Understanding why some species of grassland birds are in decline (e.g., Eastern Meadowlark) while others appear to be stable (e.g., Savannah Sparrow) would help conservation efforts for communities of grassland birds. Further, are there specific management practices that could be employed on the breeding grounds to stem declines? Unfortunately, grassland bird ecology, at least in Maine, has received little research attention (Vickery 1993). However, a set of pamphlets developed by Jones and Vickery (1997a, 1997b, 1997c) on grassland bird conservation should help to raise awareness of the needs of grassland birds. Modification of mowing practices, chiefly timing, on farms and on other nonfarm private lands (airfields) clearly would boost fledging success for most species nesting in Maine fields (Bollinger and Gavin 1992). Curiously, Ehrlich et al. (1988) described Eastern Meadowlarks and Vesper Sparrows as common hosts for cowbird eggs whereas all other species in this group are listed as occasional hosts for cowbirds. An association between declines of these species and nest parasitism is possible, however, Brown-headed Cowbirds too have experienced significant long-term declines since the late 1960's (Sauer et al. 1997). According to Lauber and O'Connor (1993), Brown-headed Cowbirds in Maine have undergone fluctuations from 1973 through 1990; populations were believed to have increased during the late 1980's. Populations of grassland birds wintering in Maine probably are less affected by activities in Maine than spring weather in their arctic breeding grounds. With declines in Eastern Meadowlarks traversing numerous states and physiographic regions, the causes may be linked to conditions in their wintering habitat. Unfortunately, such declines are not so easily explained as nearly half of the winter range of Eastern Meadowlarks occurs in the U.S. Even so, declines in Eastern Meadowlark populations need attention. Furthermore, numbers (and distributions) of Horned Larks, Bobolinks and Vesper Sparrows also warrant further study. With threats to their breeding habitats and declines observed from the BBS, the future for most grassland Passerines may remain uncertain.

Table 13. Distribution and migration information for grassland Passerines in Maine.

Species	Distribution in Maine	Timing of Migration: Mean First Arrival[1]	Timing of Migration: Estimated Arrival[2]	Timing of Migration: Estimated Departure[2]	Wintering Area[3]
Horned Lark	Statewide	N/A	N/A	N/A	U.S. & Mexico[4]
Vesper Sparrow	All but NW 1/3	4/23	Mid Apr	Mid Oct	Southern U.S. & Mexico
Savannah Sparrow	Statewide	4/28	Early Apr	Early Nov	Southern U.S., Caribbean & Mexico
Snow Bunting	Statewide[5]		Early Oct	Early Apr	Southern Canada & Northern U.S.
Lapland Longspur	Statewide[5]		Late Sep	Late Mar	Northeast, Southeast & Great Plains States
Bobolink	Statewide	5/15	Early May	Early Oct	N. Argentina, Paraguay & Bolivia
Eastern Meadowlark	All but NW ¼	4/19	Early Apr	Late Oct	S. U.S, Mex., Carib., C. Am. & Colombia - French Guyana[6]

[1]Data from Wilson et al. (1997).
[2] Estimates from Vickery (1978).
[3] Rappole et al. (1995)
[4] Typical winter range includes Maine.
[5] Winter distribution - does not breed in Maine
[6] Small numbers of this species overwinter in Maine in some to most years (Vickery 1978).

Table 14. Aspects of the reproductive biology[1] of selected grassland birds that breed in Maine.

Species	Mating System	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Horned Lark	Monog.	Ground	Depression	3-4	11-12	8-12[2]
Vesper Sparrow	Monog.	Ground	Depression[3]	3-5[2]	11-14[2]	9-14[4]
Savannah Sparrow	Monog.	Ground	Depression[5]	3-6	12-13	7-11[2]
Bobolink	Polygyn.	Ground	Depression	5-6	10-13	10-14
Eastern Meadowlark	Monog.	Ground	Depression[6]	3-5	13-15	10-12

[1] Excerpted from Ehrlich et al. (1988) unless otherwise indicated.
[2] See Gauthier and Aubry (1996)
[3] At base of grass or forb clump (Rising 1996).
[4] DeGraaf and Rudis (1986).
[5] Well hidden by clump of grass or shrub (Rising 1996).
[6] With domed canopy of grass.

Table 15. Trends[1] in numbers of grassland birds[2] observed in Maine according to the North American Breeding Bird Survey[3].

	1966-1996			1966-1979			1980-1996		
Species	n	Trend	P	n	Trend	P	n	Trend	P
Horned Lark[4]	210	-3.7	<0.01	156	-5.8	<0.01	130	0.3	NS
Vesper Sparrow	17	-3.3	NS	8[5]	-1.1	NS	12[5]	-2.8	NS
Savannah Sparrow	38	1.2	NS	21	3.4	NS	38	1.5	NS
Bobolink	48	-1.0	NS	32	3.1	NS	46	-6.4	<0.01
Eastern Meadowlark	32	-8.0	<0.01	26	-10.0	<0.01	25	-7.1	<0.01

[1] Using route-regression method of Geissler and Sauer (1990).
[2] Excludes nonpasserine birds and those listed as Threatened or Endangered under the Maine Endangered Species Act.
[3] Sauer et al. (1997).
[4] Data from USFWS Region 5; data specific to Maine too limited to report (Sauer et al. 1997).
[5] Results may be unreliable and introduce positive bias when sample size is less than 14 (Sauer et al. 1997).

SWALLOWS

SCOPE

Members of the Family Hirundinidae that breed in Maine are the sole representatives of this group. Six species: Purple Martin *(Progne subis)*, Tree Swallow *(Tachycineta bicolor)*, Northern Rough-winged Swallow *(Stelgidopteryx serripennis)*, Bank Swallow *(Riparia riparia)*, Cliff Swallow *(Hirundo pyrrhonota)*, and Barn Swallow *(Hirundo rustica)* are included. As members of the Subfamily Hirundininae, they are typical swallows. These species use a variety of open habitats, many are colonial nesters, and frequently forage for flying insects in large (sometimes mixed) groups over forests, fields, and wetlands. As habitat generalists (but nest site specialists), swallows do not conveniently fit any of the 4 sections previously presented in this assessment; therefore they are included as a separate group.

NATURAL HISTORY

General Description

Most members of this group of closely related species are small, ranging in weight from 14.6 g for Bank Swallows (Dunning 1984) to approximately 24 g for Cliff Swallows (Brown and Brown 1995), except for Purple Martins which are much larger averaging 49.4 g (Dunning 1984). Swallows have short stout bodies and rather large wings affording them excellent maneuverability as they forage for flying insects. Only male Purple Martins lack a light colored breast. All species are dark dorsally, and many, especially Purple Martins and Tree Swallows, exhibit an iridescent coloration.

Most species in this group, to some degree, are colonial nesters and some appear to depend on manmade structures for nesting sites. Tree Swallows and Northern Rough-winged Swallows are the least colonial of this group. Although Purple Martins and Barn Swallows nest in groups, their colonies do not reach the magnitude observed for Cliff and Bank Swallows.

Distribution and Migration

Among the swallows, only the Purple Martin and Northern Rough-winged Swallow do not occur statewide (Table 16) (Adamus 1987). Among the 4 species with statewide distributions, Tree and Barn Swallows have the most continuous distributions and occur at the highest densities (Adamus 1987).

By late march and early April, swallows arrive on the breeding grounds (Robertson et al. 1992, Brown and Brown 1995, DeJong 1996). All species are present in Maine by the end of April (Vickery 1978, Wilson et al. 1997). Tree Swallows are typically the first to arrive, as early as late March (Vickery 1978, Wilson et al. 1997). Departing for the wintering grounds in late August and September (Vickery 1978), most individuals leave about the time when flying insect abundance also declines (Robertson et al. 1992, Brown and Brown 1995, DeJong 1996). All species are neotropical migrants, except Tree Swallows (Sauer et al. 1997), which winter only as far south as Central America, but as far north as the mid Atlantic states (Rappole et al. 1995). Occurring sympatrically across Maine (Adamus 1987) and much of North America during the breeding season, Bank, Cliff, and Barn Swallows are more variable in their winter distributions (Table 16). Of the swallows occurring in Maine, only the Northern Rough-winged Swallow and Purple Martin have year-round resident populations outside of North America (Rappole et al. 1995).

Survival and Reproduction

As with other birds, hatching year individuals experience considerably higher mortality rates than older birds. In Tree and Cliff Swallows, survival rates have been estimated at 21% and 17% for first year birds, respectively; birds $\geq$ 1 year old had approximately 2-3X the probability of survival of hatch year individuals (Robertson et al. 1992, Brown and Brown 1995). Although a variety of mortality factors exist, exposure, often

accompanied by cold wet weather and low insect densities, seems to be the chief cause of mortality especially of nestlings and early spring migrants (Palmer 1949, Erskine 1992, Brown and Brown 1995, DeJong 1996). For nestling Barn and Cliff Swallows, ectoparasites may be the primary cause of mortality (Shields and Crook 1987, Brown and Brown 1995). Among nestling Cliff Swallows, mortality is lowest at intermediate-sized colonies (100-249 nests) because parasite burdens increase with colony size, especially among late nesting pairs (Brown and Brown 1995). In contrast, adult Cliff Swallows experience their lowest mortality rates in large colonies (≥250 nests) (Brown and Brown 1995). The oldest recorded swallow was a Barn Swallow at 15 years 11 months (*see* Landry and Bombardier 1996). Northern Rough-winged Swallows have the shortest longevity record at 5 years 11 months (Clapp et al. 1983).

Although swallows use a variety of nesting strategies, all are primarily monogamous and have to altricial young. Table 17 provides a summary of some aspects of the reproductive biology of Maine swallows.

Foods and Foraging Strategies

Swallows are well known for their ability to capture insect prey on the wing. Easily observed while feeding in open habitats, some swallows also forage above the forest canopy provided flying insects are available. Cliff Swallows are especially adept at group foraging and use specific vocalizations to alert other conspecifics of a foraging patch (Brown and Brown 1995). Thus, in times of food scarcity a swarm of insects may be more effectively followed allowing for repeat feeding bouts (Brown and Brown 1995). Typical foraging behavior for swallows is diurnal capture of flying insects while on the wing, but occasionally all species will take insects from the ground (Ehrlich et al. 1988). Only Tree Swallows differ by occasionally gleaning insects from foliage (Ehrlich et al. 1988).

Swallow diets are comprised of a variety of flying insect taxa (Robertson et al. 1992, DeJong 1996). Tree Swallows, however, have a broader diet, which includes not only insects, but fruits and seeds (Forbush 1929) and likely facilitates their more northerly winter range and earlier spring arrival than other swallows (Robertson et al. 1992).

HABITAT ASSESSMENT

Habitat Use

This group uses air space above primarily open areas including, pastures, fields, marshes, and open water in aerial pursuit of flying insects. Apparently generalists in their foraging habitat, swallows seem to have specific nesting requirements. The availability of cavities for Tree Swallows and Purple Martins, soft mud and a sheltered ledge or cliff face for Barn and Cliff Swallows, and earthen banks for Northern Rough-winged and Bank Swallows may be limiting at times in some areas of Maine. Human activities have altered the landscape, but swallows have adapted well to the open farmlands and small towns throughout much of rural Maine.

Past Habitat

In Maine during precolonial times, this group probably was restricted to areas recently affected by forest fire and to the many naturally occurring marshes, meadows, and lakeshores for foraging habitat. It is unknown whether these species foraged above the forest canopy more in the past than they do today. It is likely, however, that the abundance of swallows is driven by the availability of flying insects and open space in which to forage for them. With widespread agricultural development following the colonial period in New England, habitat for swallows probably greatly increased (Speich et al. 1986). It's obvious that during this time, Purple Martins and Barn Swallows became adept at using manmade structures (almost exclusively) for nesting (Speich et al. 1986). In contrast, large scale aerial spraying of pesticides undoubtedly was detrimental to food availability (Erskine 1979) and evidence of organochlorines in swallows has been reported in western populations (Shaw 1984).

Estimates of nonforested habitat in Maine exceeded 3,483 square miles in 1982 with Aroostook County contributing the largest portion at 766 square miles (Brooks et al. 1986:13). Brooks et al. (1986:13) provides an indication of snag availability for cavity nesting swallows. They reported over 470 million dead trees occurred in Maine in 1982. Furthermore, nearly 182 million of these had visible cavities. Balsam Fir and Northern White Cedar were the most important conifer snags and Red Maple and American Beech were the most important hardwoods for providing cavities (Brooks et al. 1986:22-23).

Current Habitat

Estimates of all nonforested land in Maine approaches 3,225 square miles, however, some of this habitat is unsuitable occurring in urban areas or at high elevations (Griffith and Alerich 1996:10). Much of the farmland in Maine, where swallows once lived, has reverted to forest or has experienced residential development. Roughly 2,400 square miles of farmland remains in Maine (Appendix II). This undoubtedly has reduced the amount of habitat for this group. However, nesting habitat for tree swallows is likely higher today than in the colonial period as abandoned orchards and pastures have matured and nest box programs have become popular. Also, the recent increase in

beaver populations has provided both foraging habitat (the flowage itself) and nesting sites (snags). Bank and Northern Rough-winged Swallows too, have expanded opportunity for nesting (DeJong 1996) with no real declines in naturally cut banks and an abundance of sand and gravel pits (87 sq. mi., *see* Appendix II) across the state. However, the loss of old farm buildings, and with them suitable habitat for nesting, has occurred throughout rural Maine and may be contributing to the decline in Barn Swallows reported by Sauer et al. (1997).

Griffith and Alerich (1996:19) reported over 497 million standing dead trees (>12.7 cm dbh) in Maine in 1995. Of these, 66.5% were conifers with the remaining 33.5% deciduous (Griffith and Alerich 1996:19). It's unclear, however, what proportion of these snags are located near suitable foraging habitat.

Habitat Projection

With continued urbanization in southern Maine and advancing succession of abandoned farmland, it is likely that foraging habitat for swallows will decline slightly in the coming decades. In Maine, the fate of the USDA's Conservation Reserve Program (CRP) could influence swallow populations if large areas of CRP land are not reenrolled in the program. Land now maintained as grassland (under the auspices of CRP) with only limited mowing provides better habitat for most species (Johnson and Schwartz 1993) than if these areas were converted to potato, soybean, or Christmas tree production. Also, prospects for shortened rotations in future Maine forests has the potential to affect swallows on a broad scale by reducing the number of large diameter trees (i.e., potential cavity trees). However, there appears to be a growing awareness, among private forest landowners, of the value of cavity trees for wildlife. Artificial nest sites, readily used by both species of cavity nesting swallows, together with the abundance of snags along watercourses, bordering farmlands, and throughout the many private woodlots will assuredly provide suitable habitat for nesting into the foreseeable future. Also, landscape-level pesticide use is unlikely to be authorized in the future except in the cases of extreme insect irruptions. Fragmentation of forest habitats probably is not detrimental to swallows because the opening in the canopy increases foraging opportunity nearer the ground. Also, swallows rarely serve as hosts for Brown-headed Cowbirds (Ehrlich et al. 1988). Except for nesting constraints on Barn Swallows, overall habitat availability for swallows throughout Maine should remain plentiful.

POPULATION ASSESSMENT

Past Populations

Little is known about past populations of swallows; however, one can safely assume that swallow populations reached their apex following the colonial period (ca. 1800-1920) when the landscape in much of southern, central and northeastern Maine was predominantly in agriculture. However, Palmer (1949) stated that populations of Tree Swallows reached their peak shortly after many of our inland waterways were dammed and thus killed trees that later became nest sites. Recognized as predators of flying insects, swallows were believed to benefit the farmer and the community in general. As such, populations of Purple Martins were encouraged (Taverner 1922) around homesteads and probably led to in the construction of elaborate artificial nesting sites for them (i.e., “martin houses”). Erskine (1992) believes Cliff Swallows did not occur as far north as the Maritimes until much of the landscape had been converted to agriculture and they adapted to nesting on man-made structures. Similarly, Knight (1908) stated that they probably did not occur in Maine until 1800. However, Forbush (1929) and Palmer (1949) believed that they were always present in Northern New England, but in lower numbers than in the early 1900’s. Although not discussed by Samuels (1875) and “not recorded” in Maine by Forbush (1929) or May (1930), Northern Rough-winged Swallows likely were present after 1900, but in very small numbers in southern Maine along with Bank Swallows which have similar nest site and foraging requisites. European Starlings compete heavily for nest sites with Tree Swallows and Purple Martins (Palmer 1949, Weitzel 1988) and House Sparrows *(Passer domesticus)* are believed to have greatly diminished the numbers of Cliff Swallows by usurping nest sites (Forbush 1929). House Sparrows also compete for cavities with Purple Martins, but martins usually are not displaced (Knight 1908, Palmer 1949). Nesting habitat was diminished further for Cliff Swallows as the exteriors of farm buildings were painted or constructed of non-wooden materials. Cliff Swallow nests will not adhere as long to the smooth surfaces of metal and painted siding as to buildings with traditional rough-sawn exteriors (Forbush 1929). Use of pesticides, both on and off farms, may have reduced populations of flying insects with concomitant declines in swallows (Erskine 1979, Cyr and Larivee 1993) during the mid 20th century. Present populations for most swallows probably lie somewhere between those of precolonial times (before ca. 1700) (low) and those at the peak of the agricultural period (ca. 1800-1920) (high).

Current Populations

Among the 6 species within this group, the Northern Rough-winged Swallow is the least well represented statewide; during the survey period for Maine’s Breeding Bird Atlas (1978-1983), it was confirmed as breeding at only 29 locations (Adamus 1987). However, despite its broad distribution, this species is considered the most frequently overlooked swallow (DeJong 1996), often being confused with Bank Swallows (Erskine 1992). Consequently, abundance and perhaps distribution of Northern Rough-winged Swallows probably is underestimated. According to trend estimates for Maine from the BBS, 3 species of swallows (Tree, Bank, and Cliff) appear to be stable or slightly

increasing over the long term (1966-1995), while Barn Swallows show a significant decline during the same period (Sauer et al. 1997) (Table 18). Following analysis of BBS data, Lauber and O'Connor (1993) also reported a recent (1982-1990) decline in Barn Swallows in Maine and overall throughout the Northeast. Trend estimates for Northern Rough-winged Swallows and Purple Martins are not available from the BBS because they were recorded on too few (<14) survey routes, but in the Northeast region, appear to be slightly increasing (Sauer et al. 1997; Lauber and O'Connor 1993). During the first 15 years of the BBS, 1966-1979, all 4 swallows with sufficient data were stable or showing nonsignificant increases in Maine. But, within the past 16 years (1980-1995), 3 species appear to be in decline (Table 18). Only Cliff Swallows were increasing during that period (Sauer et al. 1997) (Table 18), however, Lauber and O'Connor (1993) had difficulty interpreting trends in Cliff Swallow populations and needed additional data to draw conclusions. The BBS is believed to inappropriately sample colonial species such as many swallows (Erskine 1992), so trends for Tree and Barn Swallows, the most ubiquitous of the group, are probably the most realistic.

Population Projections

As property values increase, abandoned farmland will continue to be subdivided for residential and commercial development, especially around urban areas and may lead to slight reductions in swallow populations. Some offset is possible for cavity nesting swallows as suburban landowners often provide nest boxes and because concrete and brick buildings provide reasonable nesting substrate for Cliff Swallows. Although, Erskine (1979) estimated that in Canada, nest boxes contribute only 2% to annual production of Tree Swallows. Further, continuing declines in the amount of open land and the number and design of agricultural buildings also may lead to decreases in breeding populations of a few species over the long term. House Sparrows and European Starlings, despite declines since 1966 (Sauer et al. 1997), will continue to compete with swallows for suitable nest sites. Competition will be especially keen near farms and urban centers, where food resources are abundant. The only real conservation concern within this group is the significant decline of Barn Swallows observed by Sauer et al. (1997), but even so, their densities remain high and distribution wide. As a group, swallows have adapted well to human development, and consequently, populations should remain secure.

Table 16. Breeding distribution and migration information for Maine swallows.

Species	Distribution in Maine	Timing of Migration			Wintering Area[3]
		Mean First Arrival[1]	Estimated Arrival[2]	Estimated Departure[2]	
Purple Martin	Southeast ½	5/20	Late Apr	Late Aug	Caribbean & South America
Tree Swallow	Statewide	4/17	Early Apr	Late Sep	Atlantic & Gulf Coast, Mexico & C. Am.
Northern Rough-winged Swallow	Southern ½	5/6	Late Apr	Late Aug	Mex, C. Am., Carib. & S. America
Bank Swallow	Statewide	5/13	Mid Apr	Late Aug	Bolivia, Paraguay, Colombia, Brazil, Venezuela, & Guyana
Cliff Swallow	Statewide	5/10	Late Apr	Mid Sep	Argentina, Uruguay, Paraguay & S. Brazil
Barn Swallow	Statewide	5/5	Mid Apr	Late Sep	South America

[1]Data from Wilson et al. (1997).
[2] Estimates from Vickery (1978).
[3] Rappole et al. (1995).

Table 17. Aspects of the reproductive biology[1] of breeding swallows in Maine.

Species	Mating System	Nest Location	Nest Type	Number of Eggs	Incubation Period (days)	Nestling Period (days)
Purple Martin	Monog.	Tree[2] or "Martin House"	Cavity	4-5	15-18	26-31
Tree Swallow	Monog.	Tree	Cavity	3-7[3]	13-16	18-22[3]
Northern Rough-winged Swallow	Monog.	Bank	Burrow[4]	5-7[3]	15-16[3]	18-21[3]
Bank Swallow	Monog.	Bank	Burrow	4-5	14-16	18-24
Cliff Swallow	Monog.	Bridge, building or cliff face	Mud Gourd	4-5	13-16[3]	21-24
Barn Swallow	Monog.	Building, bridge, or tunnel	Cup	4-5	13-17	18-23

[1] Excerpted from Ehrlich et al. (1988) unless otherwise indicated.
[2] In the east, almost exclusively uses man-made "Martin Houses".
[3] See Gauthier and Aubry (1996)
[4] Often excavated by another species, either Belted Kingfisher or Bank Swallow (DeJong 1996).

Table 18. Trends[1] in numbers of swallows observed in Maine according to the North American Breeding Bird Survey[2].

	1966-1996			1966-1979			1980-1996		
Species	n	Trend[2]	P	n	Trend	P	n	Trend	P
Purple Martin[3]	275	3.2	0.02	212	3.1	0.01	198	0.9	NS
Tree Swallow	59	0.4	NS	37	3.8	NS	58	-0.8	NS
Bank Swallow	34	4.0	NS	23	0.7	NS	27	-3.8	NS
Northern Rough-winged Swallow[3]	348	0.2	NS	185	-5.1	NS	276	0.4	NS
Cliff Swallow	49	1.0	NS	25	2.7	NS	43	6.6	NS
Barn Swallow	56	-3.6	<0.01	37	1.7	NS	54	-5.4	<0.01

[1] Using route-regression method of Geissler and Sauer (1990).
[2] Sauer et al. (1997).
[3] Data from USFWS Region 5; data specific to Maine too limited to report (Sauer et al. 1997).

LIMITING FACTORS

Much attention has been drawn to avian conservation by declines in migrant Passerines as evidenced by trend estimates from the North American Breeding Bird Survey (Terborgh 1989). Two primary explanations have been offered for declines of migrant Passerines (Petit et al. 1995). First, habitat loss and fragmentation on the breeding grounds increases probability of nest predation and parasitism, which in turn decreases productivity as habitat quality is lowered (*see* Finch 1991, Petit et al. 1995). Second, for species wintering in the neotropics, deforestation forces species into poorer quality habitat that reduces survival rates (*see* Robbins et al. 1989, Finch 1991). Arguments for limitation on the wintering versus breeding grounds have only recently been addressed (Sherry and Holmes 1995) with most effort directed at nearctic breeding habitat. However, Sherry and Homes (1995) indicated that some species indeed compete on their wintering grounds, which implied some degree of habitat limitation. A third factor, the importance of migration stopover habitat, has been largely overlooked, yet may be especially critical for long distance migrants (McCann et al. 1993). Moore et al. (1995) suggested that successful migration, the probability that a migrant will make it to its destination, is the combination of an individual bird's ability to meet its daily energy demands for flight each night, and to avoid predators, manmade and natural obstacles, and severe weather events. Migration is especially stressful for young birds, which are subordinate to older birds, and having less experience in selecting the highest quality feeding areas, are less efficient foragers (Moore et al. 1995). The importance of specific limiting factors during these 3 critical periods (breeding, wintering, and migration) largely governs survival of individuals and drives population trends up or down.

Forest Fragmentation

The effects of habitat fragmentation on this group of birds has been well documented for midwestern forests (Brittingham and Temple 1983, Gibbs and Faaborg 1990, *also see* Thompson 1995), but has received less attention in northern forest habitats (Rudnicky and Hunter 1993, Sabine et al. 1996). Lower abundance of some forest birds in edge habitats may simply result from the lack of suitable habitat in clearcuts "beyond" the forest edge and not avoidance if the edge itself (King et al. 1997). For example, Red-eyed Vireo and Hermit Thrush were less abundant in edge areas, but their territories were not distributed differently than simulated, randomly placed territories (King et al. 1997). Despite an apparent lack of avoidance, deleterious effects of fragmentation do exist and include cowbird nest parasitism, increased nest predation, and more simply, loss of interior forest. Such consequences may differ in agricultural and suburban landscapes than in primarily forested landscapes (Rudnicky and Hunter 1993, Robinson et al. 1995, Sabine et al. 1996).

Effects of nest parasitism are greatest where Brown-headed Cowbirds have access to early successional habitats such as pastures and fields (Robinson et al. 1995). Ehrlich et al. (1988) described 54% of the forest species in this assessment as "rare" or "uncommon" cowbird hosts and 14% as "common" or "frequent" cowbird hosts. Red-eyed Vireo is one of the most frequent forest-associated hosts for cowbirds and Red-

winged Blackbirds and Louisiana Waterthrushes are the only frequent hosts among wetland Passerines (Ehrlich et al. 1988). Many Maine Passerines that share habitat with cowbirds have evolved defenses against brood parasitism, but still lose considerable energetic investment when they abandon parasitized nests or construct new nests atop parasitized ones. Although cowbirds are declining in Maine (Sauer et al. 1997), host species that occur in largely agricultural landscapes may experience limits to their population growth with sustained parasitism by cowbirds. In forested landscapes, like northern, western, and portions of eastern Maine, agricultural habitat is less available than in central and southern Maine. Furthermore, Elliott (1987) reported that abrupt forest/clearcut edges did not positively affect the abundance, density, or diversity of songbirds. Increased edge effects caused by timber harvesting should not result in significantly increased nest parasitism.

A similar scenario occurs with nest predation, as Rudnicky and Hunter (1993) reported. They found no relationship between distance from edge on nest predation except for nests placed in shrubs. Overall these results differ from many other studies (*see* Wilcove 1988, Thompson et al. 1995) which documented higher nest predation nearer edges. Forest/clearcut edges probably function differently than agricultural/forest edges as food sources for predators and diversity of nest predators may be lower along edges in forested landscapes (Thompson et al. 1995). Fragmenting forests and open habitats for residential development may be especially detrimental. With such land use changes, predation by domestic cats, Striped Skunks (*Mephitis mephitis*), and Raccoons (*Procyon lotor*) may limit populations especially of ground nesting birds (Turner 1994). Also, nests in forested riparian (i.e., lands bordering a body of water) buffer strips in eastern Maine had higher levels of nest predation than riparian areas surrounded by intact forest (Vander Haegen and DeGraaf 1996). Riparian buffer strips appear to concentrate activity and serve as travel corridors for potential nest predators (Vander Haegen and DeGraaf 1996), quite unlike forest/clearcut edges. Complicating these studies are reports that small mammal predation may be an important source of nest failure (Haskell 1995, R. Field, U.S.G.S., B.R.D., pers. comm.). Most studies of nest predation, however, have used quail eggs, which are too large for small mammals to puncture or carry, thus predation rates by interior forest nest predators may have been greatly underestimated (Haskell 1995).

Area sensitivity of forest birds is a concern of many ecologists and land managers. Unfortunately, minimum area requirements for forest birds in Maine have not been well studied. However, spatial needs for several species have been investigated in the mid-Atlantic states (Robbins et al. 1989). The 4 species that appeared the most area sensitive that also occur in Maine (in decreasing order of sensitivity) were Black-throated Blue Warbler, Canada Warbler, Northern Parula, and Black and White Warbler. Red-eyed Vireo, Ovenbird, Scarlet Tanager, and Rose-breasted Grosbeak did not appear area sensitive according to Robbins et al. (1989). In Maine, Hagan et al. (1997) reported data on area sensitivity for several forest birds. They found positive area effects among Veery, Red-eyed Vireo, Bay-breasted warbler, Boreal Chickadee, Red-breasted Nuthatch, Scarlet Tanager, Ruby-crowned Kinglet, Brown Creeper, Blue Jay, Eastern Wood Pewee, Olive-sided Flycatcher, and Magnolia Warbler among others. They also recorded various negative area effects exhibited by Red-breasted nuthatch, Blue-headed Vireo, Blackburnian Warbler, Yellow-bellied Flycatcher, and Black and

White-warbler. Some of these findings are in direct contrast to those of Robbins et al. (1989). Area sensitivity is not restricted to forest birds. Vesper and Savannah Sparrows may be especially sensitive to small patches of grassland/barren habitat in Maine (Vickery et al. 1994).

Despite correlative relationships between patch size and species presence, few studies have made a causal link to habitat quality via reproductive success. Small patches of forest that have higher proportion of edge may lack the structural diversity or types of microhabitats (or microclimates) found in larger patches (Robbins et al. 1989). Gibbs and Faaborg (1990) found reduced pairing success among Ovenbirds in small forest fragments. They suggested smaller fragments might have warmer temperatures and consequently drier conditions on the forest floor where Ovenbirds forage. Furthermore, King et al. (1996) reported higher nest survival for Ovenbirds at interior sites than near edges. King et al. (1996) concluded that ovenbird reproductive success might be affected by fragmentation via clearcutting. However, the abundance of mature habitat at the regional scale and the propensity for Ovenbirds to renest after initial failure may mitigate detrimental effects on Ovenbird reproductive success (King et al. 1996).

Silvicultural Practices

A variety of silvicultural practices are used in Maine and elsewhere for commercial growth of trees. Forest management is not a limiting factor by itself, but because removal of trees alters songbird habitat, some species may be unable meet their habitat requirements following harvesting. In turn, some species may find recently harvested or regenerating sites suitable habitat, whereas the preharvest mature forest was not used. Furthermore, several studies have been conducted in Maine and neighboring states and provinces which help to understand how Maine's forest Passerines are effected by such changes in their habitat.

The effects of forest management on Passerines are probably best discussed in terms of even-aged versus uneven-aged management. Clearcutting, Seed Tree, and Shelterwood are 3 silvicultural systems that promote even-aged regenerating forests. Various forms of partial harvesting, often with multiple entries (removals) promote uneven-aged stands. There has been much emphasis in the literature on the effects of clearcutting on bird habitat (Thompson et al. 1995). This largely has been due to changes in plant species composition and structure immediately after harvesting. Effects of a harvesting strategy depend on which bird species are of concern (Titterington 1977, Hagan and Grove 1995). Hagan et al. (1997) concluded that in northern Maine, resident species were most abundant in mature conifer stands, short-distance migrants had their highest abundance in early successional habitats and <1/3 of neotropical migrants preferred clearcut or regenerating stands. Burgason (1977) suggested that Boreal Chickadee, Gray Jay, Pine Grosbeak, and Spruce Grouse were negatively affected by clearcutting; Ruffed Grouse was the only species positively affected. Derleth et al. (1989) found an increase in richness and diversity in deciduous and mixed stands but not conifer stands treated with small clearcuts. Of the species effected, only Red-breasted Nuthatch and Cape May Warbler declined, whereas 17 other species increased following cutting. Derleth et al. (1989) reported that most of the

increases were scrub-shrub or forest edge associates. Interestingly, for Brown-headed Cowbirds they found nonsignificant increases in deciduous and mixed sites and nonsignificant declines on coniferous sites. Among nest predators, Derleth et al. (1989) found a significant increase in Common Ravens using conifer sites, nonsignificant declines overall for American Crows, and nonsignificant increases on conifer and deciduous sites, but nonsignificant decreases in use of mixed sites by Blue Jays. In the study by Titterington et al. (1979), using discriminant analysis, they reported that the most important determinant of species composition in Maine's spruce/fir ecosystem overall was the presence of a mature coniferous canopy. Within regenerating clearcuts, the presence of residual slash, dense raspberry, or deciduous regeneration determined which species would use those sites.

The use of partial harvesting is becoming more prevalent on industrial forestlands in Maine (MDIFW 1998a). As with clearcutting, species are both positively and negatively effected. Webb et al. (1977) reported that numbers of Black-throated Green and Blackpoll Warblers, Winter Wrens, Ovenbirds, and Least Flycatchers declined with increasing intensity of forest removal. In contrast, Chestnut-sided and Black and White Warblers, American Redstart, White-throated Sparrow, Rose-breasted Grosbeak, and Veery increased overall with increasing intensity of harvest. However, effects may be brief, about a decade for most forest species (Morgan and Freeman 1986). Webb et al. (1977) also found that Ovenbirds, Winter Wrens, and Wood Thrushes decreased immediately after a heavy partial cutting (i.e., removal of 100 % of marketable trees over 35.6 cm dbh), but increased greatly (i.e., 2 - 3X) within 10 years after cutting. Webb et al. (1977) reported the opposite response for Chestnut-sided Warbler and White-throated Sparrow.

Such stand-level effects may be important locally, but some species may select habitat at the landscape scale. Hagan et al. (1997) found that several species were associated with landscape homogeneity (i.e., uniformity of habitats within 1 km of study points) and that few species preferred heterogeneous landscapes. Further, in areas where either clearcutting or partial harvesting methods were employed, no bird species were lost from the landscape (Hagan and Grove 1995). This suggests that landscape-level management for forest birds is more important than harvest method assuming some degree of landscape level consideration is given to amount and distribution of harvested and residual stands (Hagan and Grove 1995). Furthermore, these findings also suggest that species that favor both early successional and late successional forests can be managed simultaneously, if attention is given to patterns of harvesting on the landscape (Hagan and Grove 1995). Species that are most susceptible to cutting activity may not be Passerines, but instead specialists that depend on large areas of old forest like large woodpeckers, diurnal raptors and owls, Spruce Grouse, and perhaps White-winged and Red Crossbills (Hunter 1992, Hagan and Grove 1995).

The concern over the effects of herbicides used in forest management (i.e., conifer release) should center over the indirect effects of changes in habitat rather than direct toxicity (*see* Lautenschlager 1986). Unlike some pesticides, herbicides used in Maine are water-soluble not fat soluble, consequently, chronic accumulation of an herbicides synthetic molecules is considered negligible. Herbicides are used most often several years after harvest to reduce competition between deciduous species (shrubs and

young trees) and conifer seedlings (Lautenschlager 1991). The result is a more vigorous regenerating conifer stand and ultimately a shorter rotation of the favored species. Despite the ability to kill broad-leaved vegetation, most herbicides are applied at levels, which merely suppress vigorous growing deciduous species (Lautenschlager 1991), although many individual deciduous trees are killed. As a result, the overall diversity of plants is static; yet, the numbers of deciduous stems is greatly reduced. Furthermore, aerial application often is not uniform throughout a treated area. Portions that were missed, often referred to as "skips," maintain the regenerating plant community in proportion to the pretreated stand. Purposely leaving strips of untreated vegetation has been proposed to greatly enhance the density of deciduous plants and associated fauna in treated areas.

Bird communities using treated areas follow a similar pattern where overall density and diversity of birds are similar on plots both receiving and not receiving herbicide treatment (Morrison and Meslow 1984). However, densities of individual species may fluctuate. Numbers of Common Yellowthroats, Lincoln's Sparrows, Alder Flycatchers, and Wilson's Warblers may be reduced (Santillo et al. 1989, Lautenschlager 1991), whereas White-throated and White-crowned Sparrows may increase following treatment (Lautenschlager 1991). Santillo et al. (1989) found higher densities of birds in areas with increasing complexity of the regenerating stand. Because herbicides reduce growth of deciduous species, vegetation complexity is reduced (Morrison and Meslow 1984) and birds requiring such structural components become limited. Morrison and Meslow (1984) also reported that some species altered their foraging strategy on treated sites indicating that foraging efficiency too may be affected by treatment. Lautenschlager (1991) also reported a phenomenon, which may effect reproductive success. He suggested that because treatments are performed in summer and fall (after the breeding season), individuals that successfully reproduced one year then return to the same area the following year may be deceived by similar vegetation communities except that the standing deciduous stems fail to refoliate. Species with the greatest site fidelity are most likely to be effected.

Temporal considerations also may be important. Considering that treated sites will more quickly return to mature conifer forest, then species requiring that habitat will ultimately benefit despite a loss of habitat following harvest. Species using scrub-shrub cover will have fewer numbers of years to use regenerating habitats before they become unsuitable. Balancing the amount of treated, untreated, and unharvested habitat will determine the population levels for many forest and scrub-shrub species.

Global Warming

Speculation about global climate change has been debated for many years. How detectable changes will be remains unclear, however, several species or groups of species would most likely be affected should Maine's climate become warmer. One consequence of a warmer global climate would be melting of substantial amounts of polar ice, which in turn would cause sea levels to rise. Such an event could greatly reduce the amount of saltmarsh habitat for sharp-tailed sparrows. Effects will depend on the rate at which seawater encroaches on nearby freshwater marshes and forested

wetlands and how quickly saltmarsh plants will adapt to these new substrates. Too, the adaptability of Saltmarsh Sharp-tailed Sparrows may be less than Nelson's Sharp-tailed Sparrow; the latter occasionally nesting at inland sites in Maine.

Warming of Maine's climate also will likely lead to shifts in the ranges of plant species. Conifer forests will shift further north and many conifer-covered summits may be replaced by hardwood forests. Such changes would obviously be detrimental to Bicknell's Thrush and Blackpoll Warbler. The loss of conifer forest in general would be detrimental to a great number of species, whereas, deciduous associated species may benefit. Species such as Black-throated Blue Warblers could experience increases in productivity by as much as 25% if precipitation is lower and temperatures warmer than at present (Rodenhouse 1992). Changes in climate and subsequent ecological changes will undoubtedly be complex and it is possible that many additional factors (e.g., increased drought, increased storm severity, shifts in the Gulf Stream) may make predictions extremely speculative.

Furthermore, plant communities will not necessarily move as a unit. The geographic range of each plant species is likely to shift independently (Hunter 1992). The same too could be said for bird communities; some species ranges may shift as they adapt to improved or depleted habitat conditions while others are unable to adapt and their populations decline. Hunter (1992) suggested that year-round resident birds, not migratory birds, would be most vulnerable to such changes. Specifically, he cautioned that highly specialized resident species, like the crossbills, are most likely to be negatively effected.

Weather-related Factors

In addition to the effect of cool weather on insect availability, extreme weather conditions of all types also may limit bird populations in the short term (Brenner 1966). One of the best-studied topics of extreme weather on birds is that of drought. Prolonged dry periods effect birds populations in a variety of ways. The most obvious limiting mechanism is the lack of free water for drinking which often is not a problem in Maine, but may be for some species especially during southward migration in late summer and early fall. Drought too may limit insect populations, especially aquatic insects (Brenner 1966). Among forest birds, those associated with deciduous forest, especially insectivores and nectarivores, are more likely to be affected than species found in coniferous forests. Ovenbirds and Red-eyed Vireos may be especially vulnerable (*see review by* Rotenberry et al. 1995).

Extreme winter weather, particularly prolonged cold periods may reduce populations. These effects may be especially important for short distance migrants wintering in the southern U. S. (Sauer et al. 1997). Prolonged cold periods coupled with rainy weather often results in mortality of young tree swallows (Robertson et al. 1992) and many years may be required for populations to recover from large-scale die offs following failed or delayed insect emergence. Availability of food for granivorous species, such as Maine's winter residents, may be limiting during and after severe snow and ice storms. Further complicating this issue, crusty snow conditions may increase overnight heat loss and

consequently energy expenditure for Snow Buntings as they roost in soft snow (Forbush 1929) to minimize heat loss.

Hurricanes are another extreme weather event that may limit populations locally. Destructive windstorms occasionally occur in Maine, but effects are most likely to be seen to our south. Individuals caught in such storms during migration, may perish from exposure. More broadly, however, is the effects of loss or alteration of favorable habitat conditions. Obviously species requiring closed canopy forest are most likely to be detrimentally effected while species of earlier successional stages or edge-associates are most likely to benefit. Wunderle et al. (1992) found insectivores to be less effected than nectarivores by Hurricane Gilbert in montane habitats in Jamaica. Such diet-specific influences indicated that effects of hurricanes are greatest after rather than during storms (Wunderle et al. 1992). They also suggested that some species moved between habitats (i.e., changed their habitat use) following disturbance.

Fire

Wildland fires are not as common in Maine as in some parts of North America, but loss of habitat due to fire could be a local limiting factor for some species in Maine. Often, fire sets back succession, and once burned, habitats formerly suitable for forest species, become habitat for scrub-shrub and grassland birds and swallows. In general, species that forage on the ground tend to benefit from fires, whereas species that are foliage gleaners are often negatively effected (Rotenberry et al. 1995). Fire may be an important factor in the quantity of wintering and stopover habitat for migrants. Prescribed burning is often used as a management tool to improve habitat quality for various wildlife species, however, not all species benefit from fire. Among coniferous forest birds, Cape May and Magnolia Warblers and Golden-crowned Kinglets may be limited by burning especially in lowland sites (Dawson 1979).

Insect Outbreaks and Availability

Nearly all Passerines that breed in Maine exploit insects during the breeding season often for themselves and especially for their young. Periodic outbreaks of insects have both positive and negative effects on birds species (*see* Rotenberry et al. 1995). Best known is the irruptive nature of some birds in response to insect outbreaks such as spruce budworm (Morse 1994, Williams 1996a, Baltz and Latta 1998). Recent short-term declines in species such as Cape May and Bay-breasted Warblers (Table 5) may be indicative of low populations of these predators following a decline in their prey. Crawford and Jennings (1989) discuss the degree of utilization of budworms for several coniferous forest species in Maine. Temporal considerations also must be given because extreme defoliation by spruce budworm will result in stand mortality and ultimately loss of mature forest habitat for Passerines. The resultant regenerating forest, however, is heavily used by scrub-shrub nesters such as Common Yellowthroats. Gypsy Moths (*Lymantria dispar*) also are prone to outbreaks in southern Maine and neighboring states which ultimately have impacts on bird species (*see review by* Rotenberry et al. 1995). Unlike Spruce Budworms, Gypsy Moth caterpillars

are eaten opportunistically by birds (Smith 1985). Smith (1985) found large amounts (i.e., Gypsy Moth present in >50% of gizzards examined for a single species) of Gypsy Moths in only 4 species of birds: Black- and Yellow-billed Cuckoos, European Starling, and Blue Jay. During an outbreak, Gypsy Moths defoliate large areas of deciduous and deciduous-dominated (especially oak) woodland. Such defoliation reduces habitat quantity and quality for forest interior species that use these habitats. Conversely, edge-associated species tend to respond favorably following a defoliation episode. As migrants return from the south, depending on their route of migration, they may stopover in states where habitats have been effected more extensively and more frequently than has southern Maine. These changes in habitat quality for interior forest species, probably manifested as lowered foraging efficiency, could reduce the number of migrants reaching Maine.

Populations of most species of insects do not fluctuate as do budworms and Gypsy Moths, however, insect availability is variable from year to year and as a consequence may limit bird species in some years. A cool, wet spring often can lead to reproductive failure for many species as availability is reduced under such conditions. Also, any factors on the wintering grounds that reduces insect availability may be experienced greatest by younger birds, and if of extended duration, may lead to lower numbers of returning migrants of all suites discussed in this assessment.

Competition

Inter- and intraspecific competition can be a strong force in habitat use and foraging efficiency and ultimately in natural selection. A thorough discussion of competition in songbirds is beyond the scope of this assessment, however, a few species appear particularly vulnerable to competition with exotics. Competition between House Finches *(Carpodacus mexicanus)* and Purple Finches may limit Purple Finch numbers in suburban habitats, especially during harsh winters (Shedd 1990). Competition between European Starlings *(Sturnus vulgaris)* and Great-crested Flycatchers for nest cavities can be keen and may limit great-crested populations where starlings are abundant (Erskine 1992). Intense competition exists for smaller cavity nesting species as well. House Wrens, House Sparrows, and Eastern Bluebirds all compete heavily with Tree Swallows for nest sites (Robertson et al. 1992). Competition is not limited to the breeding season, and Sherry and Holmes (1995, 1996) provide reviews of competition for wintering habitat, which too may limit populations.

Habitat Quantity and Quality

It can be said that all limiting factors for Maine Passerines are indirectly a subset of either habitat quantity or quality. Many species live in what could be considered transition habitats. Most of Maine's grassland and upland shrub habitats are not static, if left unmanaged would eventually become forest. Human activities are largely responsible for the early successional habitats present today in Maine. Too, some habitat is inevitably lost in the process of development (e.g., road construction, peat mining). However, as important as quantity is, measures of quality are the "currency"

for reproductive success. Suitable habitat may be available but it may be of poor quality. For example, Cliff Swallows will abandon a seemingly adequate colony when parasite burdens limit fledging success (*see* Brown and Brown 1995). Similarly, cutting of the first crop of hay in spring may eliminate Bobolink nests and young if timing of cutting is not sufficiently late to allow the young to fledge (Bollinger and Gavin, 1990, 1992). In both instances, suitable habitat was available, but external factors prevent successful reproduction there. Habitat quality and availability are probably the most important overall limiting factors for Passerines on their breeding grounds (and perhaps on migration and wintering grounds also). Relationships among limiting factors are complex and must be carefully addressed to ensure management efforts for a species or suite of species produce desired outcomes.

MANAGEMENT

Regulatory Authority

Several federal laws broadly protect passerine birds. The Lacey Act of 1900, which regulates interstate commerce of wild birds, and the Migratory Bird Treaty Act of 1918, were the earliest laws with jurisdiction over this group. The Clean Water Act of 1972 and the Coastal Zone Management Act also afford some protection for habitats used by wetland Passerines. Similarly, state wetland laws also seek to prevent loss of wetland habitat and thus indirectly benefit Passerines.

Activities that require capture or handling of Passerines are regulated at both state and federal levels. Obtaining wild birds for the purposes of research and/or education requires a scientific collection permit from MDIFW and the USFWS. Rehabilitation of Passerines also requires a wildlife rehabilitators permit from MDIFW and USFWS.

Past and Current Management

Before the 1990's, management of Passerines focused on public requests for information/public presentations, participation in the Maine Breeding Bird Atlas Program, review and approval for scientific collection and banding permits, and providing nest boxes at Wildlife Management Areas and other state-owned lands. Songbird issues were addressed by Regional Biologists within the Wildlife Management Section and by the Endangered and Nongame Wildlife Project until the Wildlife Resource Assessment Section was reorganized in 1992. Since then, responsibility for Passerine birds within the Wildlife Resource Assessment Section, resides solely within the Bird Group, except for Endangered and Threatened species, which is shared between the Endangered and Threatened Wildlife Group and the Bird Group. Recently, MDIFW has helped sponsor research projects at the University of Maine examining ecological aspects of forest songbirds.

With financial support from the Maine Endangered and Nongame Wildlife Fund (chiefly from the sale of loon license plates), detailed efforts for songbird management are underway within the Wildlife Resource Assessment Section. Status and distributional surveys for wetland and grassland Passerines are the current focus of field efforts. Bird Group personnel conduct 3 BBS routes and assist on a fourth and contribute to a study of timing of migration for Passerines and other birds. Also, IFW personnel have cooperated on a regional monitoring program for mountaintop forest birds.

Partners In Flight

In the early 1990's, a coalition, known as Partners In Flight, was formed between federal and state natural resource agencies (including MDIFW), educational institutions, and private conservation groups to focus their collective efforts on the most important issues facing landbird conservation in the western hemisphere. Those species that winter in Central and South America and breed in North America were of primary concern having experienced population declines in parts of their range as evidenced by

the BBS. As such, Partners In Flight has worked to prioritize species of conservation concern for each state and region in the U.S. Beyond that, through Partners In Flight's "Flight Plan", several physiographic areas (Fig. 2) have been identified in each region of North America as units for a planning process that will identify research, management, monitoring, and outreach needs necessary to implement effective bird conservation strategies from coast to coast.

Partners In Flight has addressed identifying which species are of highest conservation priority since its inception. The Colorado Bird Observatory compiled a set of ranking criteria based on the combination of threats to bird populations on their breeding as well as on their wintering grounds. Another approach was developed by Rosenberg and Wells (1995), which focuses on the proportion of a species global population that falls within each state and physiographic region. For Maine, Rosenberg and Wells (1995) have identified 12 species of Neotropical Migrants for which Maine has the greatest responsibility for conserving (because large proportions of their global population fall within Maine, not simply because they are declining). These 12 species (and their percent of global population that occurs in Maine) are: Black-throated Blue Warbler (19.0%), Blackburnian Warbler (16.9%), Northern Parula (14.2%), Blue-headed Vireo (13.0%), Canada Warbler (9.0%), Yellow-bellied Sapsucker (8.9%), Veery (8.3%), Black and White Warbler (6.8%), Ovenbird (5.8%), Chestnut-sided Warbler (5.7%), American Redstart (5.6%), and Rose-breasted Grosbeak (5.3%).

Both the Colorado Bird Observatory and Rosenberg and Wells (1995) rankings have been used as components of a larger model to assign final, overall priority ranking scores for each bird that occurs in each physiographic region of the northeast. Three physiographic regions overlap Maine's boundaries (i.e., Southern New England, Northern New England, and Eastern Spruce/Hardwoods) (Fig. 2). The 3 highest ranking Passerines for each of these 3 physiographic regions that also breed in Maine are: Southern New England - Saltmarsh Sharp-tailed Sparrow, Seaside Sparrow, and Wood Thrush; for Northern New England - Nelson's Sharp-tailed Sparrow, Bicknell's Thrush, and Wood Thrush; and for the Eastern Spruce/Hardwoods - Nelson's Sharp-tailed Sparrow, Bicknell's Thrush, and Canada Warbler. Additional priority species and a summary of rankings are presented in Table 19. Results of this overall process will contribute directly to management plans for each physiographic region. Each plan will include population and habitat objectives for each of these species.

Each state or group of states has a working group comprised of individuals dedicated to conserving bird populations. Nearly 70 individuals representing over 40 agencies, institutions, and organizations have participated in Maine Partners In Flight meetings and activities. Coordination of the Maine Partners In Flight working group resides within the Bird Group at MDIFW's Resource Assessment Section. A member of the Bird Group also serves as Maine's representative to the Northeast Partners In Flight Working Group. Within the Maine working group, small focus groups have emerged to address specific issues important to landbird conservation in Maine. Some of the current focus groups include: atlasing/monitoring, information/education, and a group working to conserve habitat for grassland birds. More information about Partners In Flight activities in Maine, is available at www.state.me.us/ifw/pif.

Table 19. Partners In Flight priority species for all physiographic regions which overlap Maine.

Physiographic Region[1]	Priority Level[2]	Species	Total PIF Score[3]	POP[4]	AI[5]	PT[6]
Southern New England	I	Saltmarsh Sharp-tailed Sparrow	28	??	5	3
		Golden-winged Warbler	27	<1?	2	5
		Blue-winged Warbler	26	10.3	5	5
		Seaside Sparrow	26	??	5	3
		Wood Thrush	24	2.5	4	5
		Louisiana Waterthrush	23	2.5	4	3
		Prairie Warbler	23	1.6	3	5
		Baltimore Oriole	22	3.1	5	5
		Canada Warbler	22	<1	3	4
		Black-throated Blue Warbler	22	<1	2	3
	II	Rose-breasted Grosbeak	21	1.2	4	5
		Scarlet Tanager	21	2.7	4	4
		Eastern Wood-pewee	20	1.0	4	4
		Black and White Warbler	20	1.2	4	4
		Great-crested Flycatcher	20	<1	3	5
		Brown Thrasher	20	<1	3	5
		Field Sparrow	20	<1	3	5
		Least Flycatcher	19	<1	3	5
		Eastern Kingbird	19	<1	4	5
		Eastern Towhee	19	2.1	4	5
		Purple Finch	19	<1	3	5
	III	Bobolink	19	<1	2	3
	IV	Blue Jay	17	1.9	5	5
	V	Gray Catbird	17	5.4	5	2
Northern New England	I	Golden-winged Warbler	27	<1	2	5
		Nelson's Sharp-tailed Sparrow	25	??	2?	3
		Bicknell's Thrush	25	??	4	4
		Wood Thrush	24	3.7	5	5
		Chestnut-sided Warbler	23	3.5	5	5
		Sedge Wren	23	<1	2	5
		Canada Warbler	22	2.0	4	3
		Blackburnian Warbler	22	1.1	3	5
		Bay-breasted Warbler	22	<1	2	3
	II	Veery	21	3.7	5	5
		Scarlet Tanager	21	3.3	4	5
		Eastern Wood-pewee	20	1.3	4	5
		Purple Finch	20	1.2	4	5
		Field Sparrow	20	<1	3	5
		Purple Finch	20	1.2	4	5
		Field Sparrow	20	<1	3	5
		Brown Thrasher	20	<1	3	5
		Gray Catbird	19	3.1	4	5
		Least Flycatcher	19	1.5	4	5
	III	Black-throated Blue Warbler	21	2.8	3	2
		Bobolink	18	1.6	3	2
	IV	Common Yellowthroat	18	1.6	5	5
		Barn Swallow	17	<1	5	5
	V	Eastern Phoebe	18	4.2	5	3
		Black and White Warbler	18	3.3	5	2

Table 19. - Continued.

Physiographic Region[1]	Priority Level[2]	Species	Total PIF Score[3]	POP[4]	AI[5]	PT[6]
Northern New England	V	Ovenbird	19	2.6	5	2
		Rose-breasted Grosbeak	19	2.2	5	2
Eastern Spruce/Hardwoods	I	Nelson's Sharp-tailed Sparrow	29	??	5	5
		Bicknell's Thrush	26	90+?	5	3
		Canada Warbler	25	31.5	5	5
		Bay-breasted Warbler	25	15.4	5	3
		Cape May Warbler	23	12.7	4	4
		Black-throated Blue Warbler	22	25.8	5	1
		Bobolink	22	15.5	4	5
		Wood Thrush	22	5.2	3	5
	II	Purple Finch	21	21.9	5	5
		Veery	21	21.9	5	5
		Nashville Warbler (Eastern)	21	12.7	5	4
		Blackpoll Warbler	21	1.1	3	5
		Boreal Chickadee	20	??	4	5
		Palm Warbler	20	??	5	3
		Rose-breasted Grosbeak	19	16.1	5	2
		Least Flycatcher	19	8.7	4	5
		Eastern Wood-pewee	19	3.4	3	5
		Olive-sided Flycatcher	19	3.0	3	5
		Pine Grosbeak	19	??	3	5
	IV	White-throated Sparrow	15	??	5	5
	V	Red Crossbill (Eastern)	15+	52.0	5	1
		Blue-headed Vireo	17	29.2	4	1
		American Redstart	16	27.1	5	2
		Northern Parula	19	25.3	5	1
		Blackburnian Warbler	19	25.0	4	1
		Evening Grosbeak	17	17.9	5	4
		Magnolia Warbler	17	17.9	5	2
		Black and White Warbler	18	15.7	5	2
		Black-throated Green Warbler	20	15.3	5	2
		Ovenbird	19	13.5	5	2
		Cedar Waxwing	13	13.1	4	1

Table 19. - Continued.

Physiographic Region[1]	Priority Level[2]	Species	Total PIF Score[3]	POP[4]	AI[5]	PT[6]
Eastern Spruce/Hardwoods	V	Chestnut-sided Warbler	19	12.7	4	2
		Winter Wren	13	12.3	4	1
		Hermit Thrush (Eastern)	15	10.2	5	1
		Song Sparrow	15	10.0	4	5

[1] Southern New England approximates Wildlife Management District 24; Northern New England approximates WMD's 15, 16, 17, 20, 21, 22, 23, 25, and 26; Eastern Spruce/Hardwood approximates WMD's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 27, 28, 29, and Baxter State Park. Note: WMD approximations of PIF regions exclude WMD 30 (coastal islands).

[2] Categories of birds based on how they qualify for conservation status: I = High Total PIF Concern Score ($\geq$22)for a physiographic area; II = High local or physiographic area priority (total score = 19 to 21 and AI + PT $\geq$ 8); III = Additional watchlist species (total score = 20 or total score = 18 or 19 if PT = 5); IV = Additional species which are abundant but declining (AI + PT = 10); V = High responsibility (% of population $\geq$ 5).

[3] Partners In Flight's "Concern Scores" for PIF's Physiographic Regions that overlap Maine calculated by assigning a rank (from 1 to 5) to the following 7 categories then summing across all categories. Thus, scores range from 7 to 35 with 35 having the highest possible conservation concern within the physiographic region. Categories are: Global Abundance, Global Breeding Distribution, Global Wintering Distribution, Threats to Breeding within physiographic region when known - global when not known, Threats to Nonbreeding within physiographic region when known - global when not known, Population Trend within physiographic region, Area Importance - abundance and distribution relative to global range. See Appendix VII, and Hunter et al. (1993) for more details.

[4] Percent of global population of a species in that physiographic region.

[5] Area Importance: a score between 1 and 5 which relates relative abundance (from BBS data) of a species in region "X" relative to its maximum abundance in any region. If regional relative abundance is >50% of "max" then score = 5. An AI of 1 indicates truly peripheral species.

[6] Population Trend: a score between 1 and 5 which assesses quality of trend data (PTU: Population Trend Uncertainty) from the BBS to interpret actual BBS trend estimates; See Appendix VII.

USE AND DEMAND ASSESSMENT

Past Use and Demand

A series of federal surveys of wildlife-associated recreation provide the most useful information relative to use and demand of Passerine birds. Early surveys (1955 - 1970) focused on consumptive use of wildlife and greatly overlooked the public's interest in nongame species, including songbirds. In 1975, the survey was used to gauge whether nonconsumptive use of wildlife was important to the public. In 1975, 276,000 Maine citizens from 36,000 households participated in wildlife viewing within Maine (USFWS 1975). Much of this probably stems from winter bird feeding and encounters with wildlife while picnicking or on vacation.

The 1980 national survey was the most thorough examination of nonconsumptive wildlife use to date. Of all types of wildlife, songbirds are most frequently involved in nonconsumptive uses by Americans, both at home and while traveling (Shaw and Mangun 1984). Of Americans over 16 years of age, 93 million (55%) participated in some form of nonconsumptive wildlife use and 26 million maintained bird feeders (Shaw and Mangun 1984). According to the 1980 survey among New England residents, only waterfowl ranked higher than songbirds (of 17 wildlife categories) in participation by nonconsumptive users while away from home (USFWS and USBC 1982). Interestingly, 17% of New England residents said they could identify 21-40 birds by sight or sound, yet only 6.3% maintained a life bird list (USFWS and USBC 1982). In 1980, over 800,000 Maine citizens participated in nonconsumptive recreation and nearly 60% of these residents do not participate in consumptive wildlife activities like hunting and fishing (Boyle et al. 1988).

By 1985, the number of nonconsumptive participants nationwide rose to 134.7 million with total nonconsumptive expenditures at $14.3 billion (USFWS 1988). At home, 82.5 million Americans fed wild birds (USFWS 1988). In Maine, 735,000 (85%) residents directly participated in some form of nonconsumptive wildlife recreation and spent nearly $68 million to do so in 1985 (USFWS 1988). On a national basis, 6 years later, the number of nonconsumptive wildlife recreationists (>6 years old) who traveled away from home for the purpose of participating in nonconsumptive wildlife activity increased by 10%, whereas those who participated in these activities while at home declined by 6%. Although survey methodology may have changed slightly, the number of Maine residents in 1991 directly participating in nonconsumptive wildlife recreation also declined to 548,000 citizens but spent $110 million (USFWS and USBC 1993). The most frequent activity in which Maine residents were engaged while at home was feeding wild birds and other wildlife with nearly ½ million residents participating on average for 8.1 months and spending nearly $25 million (USFWS and USBC 1993).

Current Use and Demand

Nearly 63 million Americans (>16 yrs) participated in some form of nonconsumptive wildlife recreation in 1996, spending almost $30 billion in that activity (USFWS and USBC 1997:5). However, participation decreased 17% from 1991 estimates, yet expenditures increased 21% over that same time period (USFWS and USBC 1997:6).

Nationally, 30% of U.S. residents participated in “wildlife watching” while at home; for New England that statistic jumps to 35% (USFWS and USBC 1997:38). In Maine, 443,000 citizens enjoyed some form of wildlife viewing during 1996 (USFWS and USBC 1997:112). Additionally, 454,000 persons participated in nonconsumptive use of wildlife while away from home in Maine (USFWS and USBC 1997:113). In terms of wildlife viewing, Maine truly is “Vacationland” as only 29% of these participants (454,000) were residents but 71% were nonresidents; Maine ranks fourth in states with the highest level of nonresident wildlife-watching participants (USFWS and USBC 1997:113). Overall expenditures by wildlife watchers in Maine was $16.5 million in 1996 (USFWS and USBC 1997:115).

Feeding wild birds is the most popular activity for nonconsumptive users nationwide, while at home, with 52.2 million participants in 1996 (USFWS and USBC 1997:36). Motivations for participating in nonconsumptive wildlife recreation are diverse and differ with skill level. Advanced birders are more interested in achievement (e.g., “listing”), whereas casual birders participate simply to be outdoors and experience nature (McFarlane 1994). These differences appear to carry over to volunteer surveys such as the Christmas Bird Count (CBC) and BBS. Also, Boxall and McFarlane (1993) found larger numbers of novice birders and fewer advanced birders as first time participants when compared to all CBC participants. As essential as volunteer birders are to monitoring programs, Boxall and McFarlane (1993) found that most participants cited viewing birds and being out in nature as the greatest determinant of participation; collecting important scientific data was important to only a few participants. Also, Boxall and McFarlane (1993) found larger numbers of novice birders and fewer advanced birders as first time participants when compared to all participants.

Since 1972, Maine has maintained a hunting season that permits the harvest of crows within federal guidelines. This followed a migratory bird Convention signed with Mexico in 1936 and later amended in 1972, which outlawed the taking of members of the family Corvidae. Accordingly, Maine permits a 124-day split season (14 Mar - 30 Apr and 16 Jul - 29 Sep) with no daily bag or possession limits. The split season excludes the peak breeding period for crows in Maine as is mandated by federal guidelines. The number of persons engaging in crow hunting in Maine is unknown, but the sport is likely popular among some individuals.

Use and Demand Projections

Increasing trends in nonconsumptive users traveling to view wildlife is likely to continue, especially with increasing awareness of nature in elementary schools and by the tourism industry. Boyle et al. (1988) cited an increase in the number of whale- and seabird-watching trips as indication that participation will increase. Furthermore, the “Teaming With Wildlife” initiative seeks to build a funding base from this increase in interest. As early as 1980, participants in nonconsumptive wildlife recreation generally supported the concept of increasing revenue sources for nongame conservation (Shaw and Mangun 1984). However, participants were more likely to support voluntary programs and even general tax revenue sources than imposing additional taxes (user fees) on supplies and equipment (Shaw and Mangun 1984). The interest in nongame

wildlife seems to be increasing, for birds especially, with the operation of mail order companies and franchise stores for bird feeding supplies and nature hobbyists. The colorful plumages and vibrant songs of Maine's birds coupled with the challenges of identification will likely continue to lure increasing numbers of nature enthusiasts for decades to come.

SUMMARY AND CONCLUSIONS

Forest Birds

Over 50 species of Passerine birds breed in Maine woodlands and most are migrants leaving the rigors of Maine in winter for warmer climates to our south. Habitat for forest birds has been dynamic since Europeans settled Maine. Despite agricultural activities that cleared much of the southern and central Maine landscape, Maine is once again mostly forested; 90% according to latest estimates (Griffith and Alerich 1996). Such fluctuations in land cover presumably had devastating effects on some species in parts of our state, while other species (Evening Grosbeak) are relative newcomers, benefiting greatly from the changes in land use patterns. Olive-sided Flycatcher and Bicknell's Thrush occur in this habitat and are recognized as Special Concern by MDIFW. Declining trends and a virtual absence of information, respectively, were the reasons for their listing. Maine holds the highest proportion of Black-throated Blue and Blackburnian Warblers of any state in the Northeast (19.0% and 16.9% of the global breeding population, respectively). Our forests are diverse and extensive and despite an active forest products industry, these and most other species that occur in the northern forest are not in decline, however, some species do warrant concern. Veery, Rose-breasted Grosbeak, Eastern Wood Pewee, and Canada Warbler are high priority species with apparent downward trends. Increasing our understanding of their ecology in Maine as well as our monitoring efforts should improve conservation for these and other forest songbirds. Cooperative efforts through Partners In Flight and other conservation groups may help to reverse these trends.

Scrub-Shrubland Birds

Nearly 40 species of Passerines use habitats such as brushy powerline corridors, shrubby abandoned fields, and scrub-shrub wetlands as breeding or wintering habitat in Maine. This diverse group of birds uses a variety of habitats, that like forested sites, have fluctuated in abundance since European immigrants settled the area. Most shrubland species would have been restricted to sites of past forest fires, peatlands, and thickets along watercourses. As the land was cleared, then subsequently abandoned, habitat for this group of songbirds increased as early successional species, and ultimately intolerant tree species began to dominate abandoned fields and pastures. Populations of scrub-shrubland birds followed these trends in land cover and may have declined significantly, however, edges of fields, roadways and powerline corridors will likely provide significant amounts of habitat for many of these species. Scrub-shrubland birds that are in most need of conservation are those that appear specialized in their habitat selection and are at the margins of their range here in Maine. Two species, Orchard Oriole and Loggerhead Shrike are recognized as Special Concern in Maine. Trends for Orchard Orioles in the northeast are significantly increasing; future increases in their numbers in southern Maine could warrant dropping them from Special Concern status. Loggerhead Shrikes, however, may have experienced a range contraction, which has placed the Maine population so low as to be considered extinct. Declines in Eastern Kingbird, Brown Thrasher, Eastern Towhee,

and especially Field Sparrow warrant closer attention. Habitat loss is cited as the chief cause of their decline and efforts to increase monitoring and to improve awareness of the importance of these mid successional habitats would further conservation of these species. Acquisition or easement of scrub-shrub habitats alone may be inadequate protection for some types of this habitat. Many of these sites require active management to maintain conditions favorable to specific Passerines.

Wetland Birds

Nine species of Passerines appear dependent on wetland habitats for breeding in Maine. Palustrine forested wetlands, riparian areas, and saltmarshes are used. Wetland birds have not undergone the tremendous loss and recovery of habitat as have the forest Passerines. Instead, wetland habitats have declined over time, especially floodplains and forested wetlands following hydropower development. Disturbance in coastal wetlands has changed over the past 200 years. Saltmarshes, once the focus of hay harvesting, are surrounded by development as nearby beaches have become some of Maine's busiest tourist areas. An increase in beaver populations and consequently in small flowages has occurred in the latter half of the 20th century. Habitat for a few species of Passerines has been increased/improved across Maine. Populations of only 3 species of wetland Passerines are well documented in Maine as the patchy distribution of wetlands does not lend itself to adequate monitoring by roadside bird surveys. Populations of Marsh Wrens appear to warrant increased monitoring with a significantly declining trend and less than 50 routes reporting for the entire northeast region. No species within this group are designated Special Concern, however, Saltmarsh Sharp-tailed Sparrows are restricted to saltmarshes along the southern Maine coast. Also, no trend data are available for either species of sharp-tailed sparrow for anywhere in the northeast and their distribution has been addressed only recently. Furthermore, Rusty Blackbirds are widely scattered across northern and western Maine; their status and distribution too is poorly known. As increases in wetland habitat are unlikely in the future, concern for maintaining quality of existing habitat may become a top priority. Despite protections afforded by shoreland zoning, acquisition or conservation easement for wetland sites, whenever possible, also should be considered.

Grassland Birds

In a state that is so heavily forested, it's no wonder that Maine is home to only a handful of grassland birds. Even so, most of these species are believed to be part of Maine's precolonial avifauna, despite a perceived paucity of habitat for them. Sandplain grasslands and blueberry barrens apparently were the primary habitats occupied by these birds prior to European settlement. Changes in agricultural practices obviously benefited most members of this group, many of which were much more numerous as well as widespread in the past. Unfortunately many of these species are in significant decline. Horned Lark, Bobolink, and especially Eastern Meadowlark are experiencing the most significant declines. Eastern Meadowlark trends are especially troubling considering the breadth of their decline nationwide. Efforts to improve our knowledge of

the distribution of significant grassland bird populations are ongoing in Maine, and such data could be used to facilitate acquisition of important sites. However, purchasing or obtaining conservation easements on grassland habitats may be a short-term solution, as most grassland sites in Maine will require periodic management to maintain their current position in succession. Furthermore, educational programs to improve awareness of the importance of timing of mowing also are underway. The future for some grassland birds in Maine is not bright, but with increased understanding of their habitat needs, improved monitoring, and greater outreach, some of these trends may be reversed.

Swallows

Six species of swallows breed in Maine and despite their specific nest requirements, as a group they are habitat generalists using open habitats throughout our state. Many species are associated with water, where as insectivores, they can forage on abundant populations of flying insects, many of which are aquatic. Habitat for swallows has varied over the past 300 years, but for some species is probably better today than before European settlement. Interestingly, some swallows have abandoned natural sites and adopted man-made structures almost exclusively. Populations of swallows appear relatively stable, however, Barn Swallows are significantly declining. The use of sheltered ledges inside barns and sheds may be contributing to their downward trend as many of these structures have collapsed or have been replaced by modern, fully enclosed facilities. It’s uncertain how far declines in Barn Swallows will go, but if suitable nest sites are most limiting, programs that have proved so successful for Eastern Bluebirds could be developed for Barn Swallows as well.

LITERATURE CITED

Adamus, P. R. 1987. Atlas of breeding birds in Maine, *1978-1983*. Maine Department of Inland Fisheries and Wildlife, Augusta, ME. 366pp.

Adkisson, C. S. 1996. Red Crossbill *(Loxia curvirostra). In* A. Poole and F. Gill, eds. The Birds of North America, No. 256. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

American Ornithologists' Union. 1995. Fortieth supplement to the American Ornithologists' Union *Check-list of North American Birds*. Auk 112:819-830.

Atwood, J. L., C. C. Rimmer, K. P. McFarland, S. H. Tsai, and L. R. Nagy. 1996. Distribution of Bicknell's Thrush in New England and New York. Wilson Bulletin 108:650-661.

Avery, M. L. 1995. Rusty Blackbird *(Euphagus carolinus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 200. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Baltz, M. E. and S. C. Latta. 1998. Cape May Warbler *(Dendroica tigrina) In* A. Poole and F. Gill, eds. The Birds of North America, No. 332. The Birds of North America, Inc., Philadelphia. PA.

Banville, D. and S. Gauthier. 1996. Swamp Sparrow. Pages 1010-1013 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Bartgis, R. 1992. Loggerhead Shrike *(Lanius ludovicianus).* Pages 281-297 *in* K. J. Schneider and D. M. Pence., eds. Migratory nongame birds of management concern in the northeast. U.S.D.I., Fish and Wildlife Service, Newton Corner, Massachusetts. 400pp.

Beason, R. C. 1995. Horned Lark *(Eremophila alpestris)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 195. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Bedard, J. and G. LaPointe. 1984. Banding returns, arrival times, and site fidelity in the Savannah Sparrow. Wilson Bulletin 96:196-205.

Benkman, C. W. 1992. White-winged Crossbill *(Loxia leucoptera)*. *In* A. Poole, and F. Gill, eds. The Birds of North America, No. 200. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Bleakney, J. S. 1972. Ecological implications of annual variation in tidal extremes. Ecology 53:933-938.

Bollinger, E. K., P. B. Bollinger, and T. A. Gavin. 1990. Effects of hay-cropping on eastern populations of the Bobolink. Wildlife Society Bulletin 18:142-150.

Bollinger, E. K. and T. A. Gavin. 1992. Ecology and conservation of eastern Bobolink populations. Pages 497-506 *in* J. M. Hagan III and D. W. Johnston, eds. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington D. C. 609pp.

Bonneau, R. 1996. Savannah Sparrow. Pages 978-981 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Boxall, P. C., and B. L. McFarlane. 1993. Human dimensions of Christmas Bird Counts: implications for nonconsumptive wildlife recreation programs. Wildlife Society Bulletin 21:390-396.

Boyd, E. M. 1962. A half-century's changes in the birdlife around Springfield, Massachusetts. Bird-Banding 33:137-148.

Boyle, K. J., V. A. Trefts, and P. S. Hesketh. 1988. Economic values for and uses of Maine's Inland fish and wildlife resources. Maine Agricultural Experiment Station, Misc. Publication 698. University of Maine, Orono, Maine 45pp.

Brenner, F. J. 1966. The influence of drought on reproduction in a breeding population of Red-winged Blackbirds. American Midland Naturalist 76:201-210.

Brittingham, M. C. and S. A. Temple. 1983. Have cowbirds caused forest songbirds to decline? BioScience 33:31-35.

Brittingham, M. C. and S. A. Temple. 1988. Impacts of supplemental feeding on survival rates of Black-capped Chickadees. Ecology 69:581-589.

Brooks, R. T. and K. J. Sykes. 1984. Sampling land use edge from aerial photographs - line transect vs. circular pattern. USDA Forest Service, Research Note NE-321, 6pp.

Brooks, R. T., T. S. Frieswyk, and A. Ritter. 1986. Forest wildlife habitat statistics for Maine: 1982. U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Resource Bulletin NE-96. 146pp.

Brown, C. R., and M. B. Brown. 1995. Cliff Swallow (*Hirundo pyrrhonota*). *In* A. Poole and F. Gill, eds. The Birds of North America, No. 234. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Burgason, B. N. 1977. Bird and mammal use of old commercial clearcuts. M. S. Thesis, University of Maine, Orono. 53pp.

Carey, M., D. E. Burhans, and D. A. Nelson. 1994. Field Sparrow *(Spizella pusilla)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 103. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Clapp, R. B., M. K. Klimkiewicz, and J. H. Kennard. 1982. Longevity records of North American Birds: Gavidae through Alcidae. Journal of Field Ornithology 53:81-124.

Clapp, R. B., M. K. Klimkiewicz, and A. G. Futcher. 1983. Longevity records of North American Birds: Columbidae through Paridae. Journal of Field Ornithology 54:123-137.

Craig, R. J. 1985. Comparative habitat use by Louisiana and Northern Waterthrushes. Wilson Bulletin 97:347-355.

Crawford, H. S., R. W. Titterington, and D. T. Jennings. 1983. Bird predation and spruce budworm populations. Journal of Forestry 81:433-435, 478.

Crawford, H. S. and D. T. Jennings. 1989. Predation by birds on spruce budworm *Choristoneura fumiferana*: functional, numerical, and total responses. Ecology 70:152-163.

Crawford, R. L. 1978. Autumn bird casualties at a northwest Florida TV tower: 1973-1975. Wilson Bulletin 90:335-345.

Cronon, W. 1983. Changes in the land. Hill and Wang, New York, N.Y. 241pp.

Curson, J. D., D. Quinn, and D. Beadle. 1994. Warblers of the Americas: an identification guide. Houghton Mifflin Company, Boston, Mass. 252pp.

Cyr, A. and J. Larivee. 1993. A checklist approach for monitoring neotropical migrant birds: twenty year trends in birds of Quebec using EPOQ. Pages 229-236 *in* D. M. Finch and P. W. Stangel, eds. Status and management of neotropical migratory birds. U. S. D. A. Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. General Technical Report RM-229. 422pp.

Darley, J. A. 1971. Sex ratio and mortality in the Brown-headed Cowbird. Auk 88:560-566.

Darveau, M., G. Gauthier, J. L. DesGranges, and Y. Maufette. 1993. Nesting success, nest sites, and parental care of the Least Flycatcher in declining maple forests. Canadian Journal of Zoology 71:1592-1601.

Dawson, D. K. 1979. Bird communities associated with succession and management of lowland conifer forests. Pages 120-131 *in* R. M. DeGraaf and K. E. Evans, compilers. Management of north central and northeastern forests for nongame birds. USDA Forest Service, General Technical Report NC-51, 268pp.

Dawson, W. R. 1997. Pine Siskin *(Carduelis pinus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 280. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

DeGraaf, R. M. and D. D. Rudis. 1986. New England wildlife: habitat, natural history, and distribution. U. S. D. A. Forest Service, Northeastern Forest Experiment Station, General Technical Report NE-108, 491pp.

DeJong, M. J. 1996. Northern Rough-winged Swallow (*Stelgidopteryx serripennis*). *In* A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 234. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Derleth, E. L., D. G. McAuley, and T. J. Dwyer. 1989. Avian community response to small-scale habitat disturbance in Maine. Canadian Journal of Zoology 67:385-390.

Derrickson, K. C. and R. Breitwisch. 1992. Northern Mockingbird *(Mimus polyglottus)*. *In* A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 7. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Deweese, L. R., L. C. McEwen,, L. A. Settimi, and R. D. DeBlinger. 1983. Effects on birds of Fenthion aerial application for mosquito control. Journal of Economic Entomology 76:906-911.

Diamond, A. 1991. Assessment of the risks from tropical deforestation to Canadian songbirds. Tansactions of the 56th North American Wildlife & Natural Resource Conference. 56:177-194.

Dunning, J. B., Jr. 1984. Body Weights of 686 species of North American birds. Western Bird Banding Association Monograph no. 1, 34pp.

Eaton, S. W. 1995. Northern Waterthrush *(Seiurus noveboracensis). In* A. Poole and F. Gill, eds. The Birds of North America, No. 182. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The birder's handbook: a field guide to the natural history of North American birds. Fireside Books. New York, N.Y. 785pp.

Elkins, K. C. 1994. Red-winged Blackbird. Pages 340-341 *in* C. R. Foss, ed. Atlas of breeding birds in New Hampshire. Audubon Society of New Hampshire/Arcadia, Dover, N. H. 414pp.

Elliott, C. A. 1987. Songbird species diversity and habitat use in relation to vegetation structure and size of forest stands and forest-clearcut edges in north-central Maine. Ph.D. Dissertation, University of Maine, Orono. 84pp.

Erskine, A. J. 1979. Man's influence on potential nesting sites and populations of swallows *Hirundinidae* in Canada. Canadian Field-Naturalist 93:371-377.

Erskine, A. J. 1992. Atlas of breeding birds of the Maritime Provinces. Nimbus Publishing Limited and the Nova Scotia Museum. 270pp.

Falls, J. B. and J. G. Kopachena. 1994. White-throated Sparrow *(Zonotrichia albicollis). In* A. Poole and F. Gill, eds. The Birds of North America, No. 72. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Fankhauser, D. P. 1967. Survival rates in red-winged blackbirds. Bird-Banding 38:139-142.

Fankhauser, D. P. 1971. Annual adult survival rates of blackbirds and starlings. Bird-Banding 42:36-42.

Ferguson, R. H. and N. P. Kingsley. 1972. The timber resources of Maine. U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Resource Bulletin NE-26. 129pp.

Finch, D. M. 1991. Population ecology, habitat requirements, and conservation of neotropical migratory birds. USDA Forest Service, Rocky Mountain forest and Range Experiment Station, General Technical Report RM-205. 26pp.

Forbush, E. H. 1927. Birds of Massachusetts and other New England states; part II. land birds from bob-whites to grackles. Massachusetts Department of Agriculture. 461pp.

Forbush, E. H. 1929. Birds of Massachusetts and other New England states; part III. land birds from sparrows to thrushes. Massachusetts Department of Agriculture. 466pp.

Fowells, H. A. 1965. Silvics of forest trees in the United States. U.S.D.A. Agricultural Handbook No. 271

Fretwell, S. 1968. Habitat distribution and survival in the Field Sparrow (Spizella pusilla). Bird Banding 39:293-306.

Gauthier, A. 1996. Yellow Warbler. Pages 866-869 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Gauthier, J, and Y. Aubry. eds. 1996. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Gavin, T. A. and E. K. Bollinger. 1988. Reproductive correlates of breeding-site fidelity in Bobolinks *(Dolichonyx oryzivorous)*. Ecology 69:96-103.

Gavutis, G. W., Jr. 1994. Swamp Sparrow. Pages 332-333 *in* C. R. Foss, ed. Atlas of breeding birds in New Hampshire. Audubon Society of New Hampshire/Arcadia, Dover, N. H. 414pp.

Geissler, P. H., and J. R. Sauer. 1990. Topics in route-regression analysis. Pages 54-57 *in* J. R. Sauer and S. Droege, eds. Survey designs and statistical methods for the estimation of avian population trends. U. S. Fish and Wildlife Service, Biological Report 90 (1).

Gibbs, J. P. and J. Faaborg. 1990. Estimating the viability of ovenbird and Kentucky warbler populations in forest fragments. Conservation Biology 4:193-196.

Greenlaw, J. S. 1996. Eastern Towhee *(Pipilo erythrophthalmus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 262. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Greenlaw, J. S. and Rising 1994. Sharp-tailed Sparrow *(Ammodramus caudacutus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 112. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Griffin, D. N. 1959. The poisoning of meadowlarks with insecticides. Wilson Bulletin 71:193.

Griffith, D. M. and C. L. Alerich. 1996. Forest Statistics for Maine, 1995. U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Resource Bulletin NE-135, 134pp.

Hagan, J. M. and S. L. Grove. 1995. Selection cutting, old growth, birds, and forest structure. Manomet Observatory, Division of Conservation Forestry, unpublished report. 36pp.

Hagan, J. M., P. S. McKinley, A. L. Meehan, and S. L. Grove. 1997. Diversity and abundance of landbirds in a northeastern industrial forest. Journal of Wildlife Management 61:718-735.

Haskell, D. G. 1995. A reevaluation of the effects of forest fragmentation on rates of bird-nest predation. Conservation Biology 9:1316-1318.

Hunter, M. L., Jr. 1992. Paleoecology, landscape ecology, and conservation of neotropical migrant Passerines in boreal forests. Pages 511-523 *in* J. M. Hagan, III and D. W. Johnston, eds. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington D. C. 609pp.

Hunter, W. C., M. F. Carter, D. N. Pashley, and K. Barker. 1993. The Partners in Flight species prioritization scheme. Pages 109-119 *in* D. M. Finch and P. W. Stangel, eds. Status and management of neotropical migratory birds. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-229. 422pp.

Ibarzabal, J. and A. Morrier. 1996. Palm Warbler. Pages 900-903 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Irland, L. C., J. B. Dimond, J. L. Stone, J. Falk, and E. Baum. 1988. The spruce budworm outbreak in Maine in the 1970's - assessment and directions for the future. Maine Agricultural Experiment Station, Bulletin 819, University of Maine, Orono. 119pp.

Jobin, B. and S. Gauthier. 1996. Red-winged Blackbird. Pages 1030-1033 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Johnson, D. H., and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conservation Biology 7:934-937.

Johnston, D. W. and T. P. Haines. 1957. Analysis of mass bird mortality in October, 1954. Auk 74:447-458.

Jones, A. L. and P. D. Vickery. 1997a. Conserving Grassland Birds: managing agricultural lands including hayfields, crop fields, and pastures for grassland birds. Massachusetts Audubon Society and U. S. Fish and Wildlife Service. 17pp.

Jones, A. L. and P. D. Vickery. 1997b. Conserving Grassland Birds: managing small grasslands including conservation lands, corporate headquarters, recreation fields, and small landfills for grassland birds. Massachusetts Audubon Society and U. S. Fish and Wildlife Service. 17pp.

Jones, A. L. and P. D. Vickery. 1997c. Conserving Grassland Birds: managing large grasslands including conservation lands, airports, and landfills over 75 acres for grassland birds. Massachusetts Audubon Society and U. S. Fish and Wildlife Service. 17pp.

Karr, J. R., J. D. Nichols, M. K. Klimkiewicz, and J. D. Brawn. 1990. Survival rates of birds of tropical and temperate forests: will the dogma survive? American Naturalist 136:277-291.

Kendeigh, S. C. 1945. Nesting behavior of wood warblers. Wilson Bulletin 57:145-164.

Kennard, J. H. 1975. Longevity records of North American birds. Bird-Banding 46:55-73.

King, D. I., C. R. Griffin, and R. M. DeGraaf. 1996. Effects of clearcutting on habitat use and reproductive success of the ovenbird in forested landscapes. Conservation Biology 10:1380-1386.

King, D. I., C. R. Griffin, and R. M. DeGraaf. 1997. Effect of clearcut borders on he distribution and abundance of forest birds in northern New Hampshire. Wilson Bulletin 109:239-245.

Klimkiewicz, M. K. and A. G. Futcher. 1987. Longevity records of North American birds: Coerebinae through Estrildidae. Journal of Field Ornithology 58:318-333.

Klimkiewicz, M. K. and A. G. Futcher. 1989. Longevity records of North American birds, supplement 1. Journal of Field Ornithology 60:469-494.

Klimkiewicz, M. K., R. B. Clapp, and A. G. Futcher. 1983. Longevity records of North American birds: Remizidae through Parulinae. Journal of Field Ornithology 54:287-294.

Knight, O. W. 1908. Birds of Maine. Charles H. Glass & Co., Bangor, Maine. 693pp.

Landry, L. and M. Bombardier. 1996. Barn Swallow. Pages 714-717 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Lanoue, A. and M. R. Doyon. 1996. Lapland Longspur. Pages 1184-1185 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Lanyon, W. E. 1995. Eastern Meadowlark. *(Sturnella magna)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 160. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Lauber, T. B., and R. J. O'Connor. 1993. An analysis of breeding bird survey data for neotropical migrants in the northeastern United States. Unpublished Report.

Laurenzi, A. W., B. W. Anderson, and R. D. Ohmart. 1982. Wintering biology of the Ruby-crowned Kinglet in the lower Colorado River Valley. Condor 84:385-398.

Lautenschlager, R. A. 1986. Forestry, herbicides, and wildlife. Pages 299-308 in J. A. Bissonette, ed. Is good forestry god wildlife management? Maine Agricultural Experiment Station, University of Maine at Orono. Miscellaneous Publication No. 689. 377pp.

Lautenschlager, R. A. 1991. Response of wildlife in northern ecosystems to conifer release with herbicides. College of Forest Resources, Maine Agricultural Experiment Station, University of Maine, Orono. Miscellaneous Report No. 362. 12pp.

Lemieux, G., B. Limoges, and L. Choiniere. 1996. Northern Parula. Pages 862-865 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Leonard, M. L. and J. Picman. 1987. Nesting mortality and habitat selection by marsh wrens. Auk 104:491-495.

Letourneau, V. 1996. Red Crossbill. Pages 1066-1069 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec.

Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Lisle, L., II. 1994. Beaver recolonization in south-central Maine. M.W.C. Thesis. University of Maine, Orono. 38pp.

Litvaitis, J. A. 1993. Response of early successional vertebrates to historic changes in land use. Conservation Biology 7:866-873.

Low, S. H. 1950. Red-winged Blackbird 14 years old. Bird-Banding 21:114-115.

Lowther, P. E. 1993. Brown-headed Cowbird *(Molothrus ater)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 47. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Lyon, B. and R. Montgomerie. 1995. Snow Bunting and McKay's Bunting *(Plectrophenax nivalis and Plectrophenax hyperboreus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, Nos. 198-199. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Maine Department of Inland Fisheries and Wildlife. 1992. Grasshopper sparrow assessment. Unpublished Report, Wildlife Resource Assessment Section, Bangor, ME, 43pp.

Maine Department of Inland Fisheries and Wildlife. 1998a. MAINE'S FORESTS: Trends (1982-1995) and Projections (1998-2020). Unpublished Report, Wildlife Division, Augusta, ME, 21pp.

Maine Department of Inland Fisheries and Wildlife. 1998b. Standard estimates of area used in species assessments. Unpublished Report, Wildlife Division, Augusta, ME, 8pp.

Martin, S. G. 1974. Adaptations for polygynous breeding in the Bobolink, *Dolichonyx oryzivorous*. American Zoologist 14:109-119.

Martin, S. G. and T. A Gavin. 1995. Bobolink *(Dolichonyx oryzivorous)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 176. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

May, J. B. 1930. The distribution of the rough-winged swallow in New England. Bird-Banding 1:29-33.

McCann, J. M., S. E. Mabey, L. J. Niles, C. Bartlett, and P. Kerlinger. 1993. A regional study of coastal migratory stopover habitat for neotropical migrant songbirds: land management implications. Transactions of the 58th North American Wildlife and Natural Resource Conference. 58:398-407.

McFarlane, B. L. 1994. Specialization and motivations of birdwatchers. Wildlife Society Bulletin 22:361-370.

McNichol, D. K., R. J. Robertson, and P. J. Weatherhead. 1982. Seasonal, habitat, and sex-specific food habits of Red-winged Blackbirds: implications for agriculture. Canadian Journal of Zoology 60:3282-3289.

Milburn, T. 1981. Status and distribution of the loggerhead shrike Lanius ludovicianus in the northeastern United States. U.S.D.I. Fish and Wildlife Service, Newton Corner, Massachusetts. 77pp.

Moldenhauer, R. R. and D. J. Regeleski. 1996. Northern Parula *(Parula americana)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 215. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Moore, F. R., S. A. Gauthreaux, Jr., P. Kerlinger, and T. S. Simons. 1995. Habitat requirements during migration: important link in conservation. Pages 121-144 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Morgan, K. and B. Freeman. 1986. Breeding bird communities in a hardwood forest succession in Nova Scotia. Canadian Field-Naturalist 100:506-519.

Morrison, M. L. and E. C. Meslow. 1984. Response of avian communities to herbicide-induced vegetation changes. J. Wildl. Manage. 48:14-22.

Morse, D. H. 1994. Blackburnian Warbler *(Dendroica fusca)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 102. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Moskoff, W. and S. K. Robinson. 1996. Philadelphia Vireo (Vireo philadelphicus). *In* A. Poole and F. Gill, eds. The Birds of North America, No. 214. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Murphy, M. T. 1996. Survivorship, breeding dispersal and mate fidelity in Eastern Kingbirds. Condor 98:82-92.

Norton, A. H. 1926. Report of Arthur H. Norton, field agent for Maine. Bird-Lore 28:464-465.

Olyphant, J. C. 1995. An incredible recovery. North American Bird Bander 20:28.

Orians, G. H. 1985. Blackbirds of the Americas. University of Washington Press, Seattle.

Palmer, R. S. 1949. Maine Birds. Bulletin of the Museum of Comparative Zoology. Volume 102. Harvard College, Cambridge, Massachusetts. 656pp.

Payne, R. B. 1992. Indigo Bunting *(Passerina cyanea)*. *In* A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 4. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Peer, B. D. and E. K. Bollinger. 1997. Common Grackle *(Quiscalus quiscula)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 271. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Perkins, A. E. 1935. Notes on some rare birds in southwestern Maine. Auk 52:460.

Petit, D. R., J. F. Lynch, R. L. Hutto, J. G. Bake, and R. B. Waide. 1995. Habitat use and conservation in the neotropics. Pages 145-197 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Picman, J. 1977a. Destruction of eggs by the Long-billed Marsh Wren *(Telmatodytes palustris palustris).* Canadian Journal of Zoology 55:1914-1920.

Picman, J. 1977b. Intraspecific nest destruction in the Long-billed Marsh Wren *(Telmatodytes palustris).* Canadian Journal of Zoology 55:1997-2003.

Pitocchelli, J. 1993. Mourning Warbler *(Oporornis philadelphia). In* A. Poole and F. Gill, eds. The Birds of North America, No. 72. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Post, W. and J. S. Greenlaw. 1982. Comparative costs of promiscuity and monogamy: a test of reproductive effort theory. Behavioral Ecology and Sociobiology. 10:101-107.

Powell, D. S. 1985. Forest composition of Maine: an analysis using number of trees. U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Resource Bulletin NE-81. 40pp.

Powell, D. S. and D. R. Dickson. 1984. Forest statistics for Maine: 1971 and 1982. U.S.D.A. Forest Service, Northeastern Forest Experiment Station, Resource Bulletin NE-81. 194pp.

Rail, J. F. 1996. Eastern Meadowlark. Pages 1034-1037 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Rappole, J. H., E. S. Morton, T. E. Lovejoy III, and J. L. Ruos. 1995. Nearctic avian migrants in the neotropics: maps, appendices, and bibliography. Second Edition. Conservation and Research Center, National Zoological Park, Smithsonian Institution. 324pp.

Richards, T. 1994. Gray-cheeked Thrush. Pages 218-219 *in* C. R. Foss, ed. Atlas of breeding birds in New Hampshire. Audubon Society of New Hampshire/Arcadia, Dover, N. H. 414pp.

Richardson, M. and D. W. Brauning. 1995. Chestnut-sided Warbler. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 190. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Rising, J. D. 1996. A guide to the identification and natural history of the sparrows of the United States and Canada. Academic Press, San Diego, CA. 365pp.

Robbins, C. S., D. K. Dawson, and B. A. Dowell. 1989. Habitat area requirements of breeding forest birds of the middle Atlantic states. Wildlife Monographs 103. 34pp.

Robbins, G. C. 1994. Marsh Wren. Pages 206-207 *in* C. R. Foss, ed. Atlas of breeding birds in New Hampshire. Audubon Society of New Hampshire/Arcadia, Dover, N. H. 414pp.

Roberts, J. O. L. 1971. Survival among some North American wood-warblers. Bird-Banding 42:165-184.

Robertson, R. J., B. J. Stutchbury, and R. R. Cohen. 1992. Tree Swallow (*Tachycineta bicolor*). *In* A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 11. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Robinson, S. K. 1992. Population Dynamics of Breeding Neotropical migrants in a fragmented Illinois landscape. Pages 408-418 *in* J. M. Hagan III and D. W.

Johnston, eds. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington D. C. 609pp.

Robinson, S. K. and R. T. Holmes. 1984. Effects of plant species and foliage structure on the foraging behavior of forest birds. Auk 101:672-684.

Robinson, S. K., S. I. Rothstein, M. C. Brittingham, L. J. Petit, and J. A. Grzybowski. 1995. Ecology and behavior of cowbirds and their impact on host populations. Pages 428-460 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Robinson, W. D. 1995. Louisiana Waterthrush *(Seiurus motacilla) In* A. Poole and F. Gill, eds. The Birds of North America, No. 151. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Rodenhouse, N. L. 1992. Potential effects of climatic change on a neotropical migratory landbird. Conservation Biology 6:263-272.

Rosenberg, K. V. and J. V. Wells. 1995. Importance of geographic areas to neotropical migrant birds in the northeast. Unpublished Report.

Rosenberg, K. V., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. Birds of the lower Colorado River valley. University of Arizona Press, Tucson, AZ.

Rotenberry, J. T., R. J. Cooper, J. M. Wunderle, and K. G. Smith. 1995. When and how are populations limited? The roles of insect outbreaks, fire and other natural perturbations. Pages 55-84 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Roth, R. R., M. S. Johnson, and T. J. Underwood. 1996. Wood Thrush *(Hylocichla mustelina) In* A. Poole and F. Gill, eds. The Birds of North America, No. 246. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Rudnicky, T. C. and M. L. Hunter, Jr. 1993. Avian nest predation in clearcuts, forests, and edges in a forest-dominated landscape. Journal of Wildlife Management 57:358-364.

Russell, H. S. 1980. Indian New England before the Mayflower. University Press of New England, Hanover, N. H. 284pp.

Sabine, D. L., A. H. Boer, and W. B. Ballard. 1996. Impacts of habitat fragmentation on pairing success of male ovenbirds, Seiurus aurocapillus, in southern New Brunswick. Canadian Field-Naturalist 110:688-693.

Sample, D. W. 1989. Grassland birds in southern Wisconsin: habitat preferences, population trends, and response to land use changes. M. S. Thesis, University of Wisconsin, Madison, WI.

Samuels, E. A. 1875. Birds of New England and adjacent states. Noyes, Holmes and Co. Boston, Mass. 591pp.

Santillo, D. J., P. W. Brown, and D. M. Leslie, Jr. 1989. Response of songbirds to glyphosate-induced habitat changes on clearcuts. J. Wildl. Manage. 53:64-71.

Sauer, J. R., J. E. Hines, G. Gough, I. Thomas, and B. G. Peterjohn. 1997. The North American Breeding Bird Survey results and analysis. Version 96.2. Patuxent Wildlife Research Center, Laurel, MD.

Savidge, I. R. and D. E. Davis. 1974. Survival of some common Passerines in a Pennsylvania woodlot. Bird-Banding 45:152-155.

Sawyer, P. J. 1961. Report on the cause of mortality and the morphometry of seventy Ruby-crowned Kinglets killed at the WENH-TV tower in Deerfield, New Hampshire. Bird-Banding 32:161-168.

Sealy, S. G. 1994. Observed acts of egg destruction, egg removal, and predation on nests of Passerine birds at Delta Marsh, Manitoba. Canadian Field-Naturalist 108:41-51.

Searcy, W. A. and K. Yasukawa. 1981. Sexual size dimorphism and survival of male and female blackbirds (Icteridae). Auk 98:457-465.

Seguin, R. 1996. Olive-sided Flycatcher. Pages 666-667 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Shaffer, F. and R. Alvo. 1996. Brown Creeper. Pages 748-751 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Shaw, G. G. 1984. Organochlorine pesticide and PCB residues in eggs and nestlings of tree swallows, *Tachycineta bicolor*, in central Alberta. Canadian Field-Naturalist 98:258-260.

Shaw, W. W., and W. R. Mangun. 1984. Nonconsumptive uses of wildlife in the United States. U. S. D. I. Fish and Wildlife Service, Resource Publication 154. Washington D.C. 19pp.

Shedd, D. H. 1990. Aggressive interactions in wintering house finches and purple finches. Wilson Bulletin 102:174-178.

Sherry, T. W., and R. T. Holmes. 1995. Summer versus winter limitation of populations: what are the issues and what is the evidence? Pages 85-120 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Sherry, T. W., and R. T. Holmes. 1996. Winter habitat quality, population limitation, and conservation of neotropical-nearctic migrant birds. Ecology 77:36-48.

Sherry, T. W., and R. T. Holmes. 1997. American Redstart *(Setophaga ruticilla) In* A. Poole and F. Gill, eds. The Birds of North America, No. 277. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Shields, W. M. and J. R. Crook. 1987. Barn swallow coloniality: a net cost for group breeding in the Adirondacks. Ecology 68:1373-1386.

Smith, H. R. 1985. Wildlife and the Gypsy Moth. Wildlife Society Bulletin 13:166-174.

Speich, S. M. H. L. Jones, and E. M. Benedict. 1986. Review of natural nesting sites of the barn swallow in North America. American Midland Naturalist 115:254-284.

Stockwell, S. S. 1994. Habitat selection and community organization of birds in eight peatlands of Maine. Ph. D. Dissertation, University of Maine. 113pp.

Strickland, D. and H. Ouellet. 1993. Gray Jay *(Perisoreus canadensis) In* A. Poole, P. Stettenheim, and F. Gill, eds. The Birds of North America, No. 40. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Swain, J. M. 1900. Prairie horned larks nesting in Maine. Auk 17:387-388.

Tanguay, S. and M. Robert. 1996. Marsh Wren. Pages 766-769 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of

Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Taverner, P. A. 1922. Birds of eastern Canada. Second Edition. Canada Department of Mines, Geological Survey. Memoir 104, No. 3, Biological Series. 290pp.

Terborgh, J. W. 1989. Where have all the birds gone? Princeton University Press. Princeton, N.J.

Thompson, F. R., III., editor. 1995. Management of midwestern landscapes for the conservation of neotropical migratory birds. U.S.D.A. Forest Service, North Central Forest Experiment Station, General Technical Report NC-187. 207pp.

Thompson, F. R., III., J. R. Probst, and M. G. Raphael. 1995. Impacts of silviculture: overview and management recommendations. Pages 201-219 *in* T. E. Martin and D. M. Finch, eds. Ecology and management of neotropical migratory birds: a synthesis and review of critical issues. Oxford University Press, New York, N.Y. 489pp.

Titterington, R. W. 1977. The utilization of northern Maine clearcuts by nesting and wintering birds. M. S. Thesis, University of Maine, Orono. 62pp.

Titterington, R. W., H. S. Crawford, and B. N. Burgason. 1979. Songbird responses to commercial clear-cutting in Maine spruce-fir forests. Journal of Wildlife Management 43:602-609.

Tufts, R. W. 1962. The birds of Nova Scotia. Nova Scotia Museum, Halifax.

Turner, S. B. 1994. Ovenbird. Pages 290-291 *in* C. R. Foss, ed. Atlas of breeding birds in New Hampshire. Audubon Society of New Hampshire/Arcadia, Dover, N. H. 414pp.

U. S. Bureau of the Census. 1994. 1992 Census of agriculture. Vol. 1. geographic area series. part 19. Maine: state and county data. United States Department of Commerce, Bureau of the Census. 316pp.

U. S. Fish and Wildlife Service. 1975. 1975 National survey of hunting, fishing and wildlife-associated recreation. United States Department of Interior, Fish and wildlife Service.

U. S. Fish and Wildlife Service. 1988. 1985 National survey of fishing, hunting, and wildlife associated recreation. United States Department of Interior, Fish and Wildlife Service. 167pp.

U. S. Fish and Wildlife Service. 1997. 1996 National survey of fishing, hunting, and wildlife associated recreation: preliminary findings. United States Department of Interior, Fish and Wildlife Service. 27pp.

U. S. Fish and Wildlife Service and U. S. Bureau of the Census. 1982. 1980 National survey of fishing, hunting and wildlife-associated recreation. U. S. Government Printing Office, Washington D.C.

U. S. Fish and Wildlife Service and U. S. Bureau of the Census. 1993. 1991 National survey of fishing, hunting and wildlife-associated recreation: Maine. U. S. Government Printing Office, Washington D.C.

U. S. Fish and Wildlife Service and U. S. Bureau of the Census. 1997. 1996 National survey of fishing, hunting and wildlife-associated recreation. U. S. Department of the Interior, Fish and Wildlife Service and U. S. Department of Commerce, Bureau of the Census, Washington D.C.

Vander Haegen, W. M. and R. M. DeGraaf. 1996. Predation on artificial nests in forested riparian buffer strips. Journal of Wildlife Management 60:542-550.

Verner, J. 1965. Breeding biology of the Long-billed Marsh Wren. Condor 67:6-30.

Vickery, P. D. 1978. Annotated checklist of Maine birds. Maine Audubon. 25pp.

Vickery, P. D. 1993. Habitat selection of grassland birds in Maine. Ph.D. Thesis. University of Maine, Orono, ME.

Vickery, P. D., M. L. Hunter, Jr., and S. M. Melvin. 1994. Effects of habitat area on the distribution of grassland birds in Maine. Conservation Biology 8:1087-1097.

Vincent, J. 1996. Evening Grosbeak. Pages 1086-1089 *in* J. Gauthier and Y. Aubry, eds. The breeding birds of Quebec: atlas of the breeding birds of southern Quebec. Association quebecoise des groups d'ornithologues, Province of Quebec Society for the Protection of Birds, Canadian Wildlife Service, Environment Canada, Quebec Region, Montreal, 1302pp.

Wallace, G. J. 1939. Bicknell's Thrush: its taxonomy, distribution, and life history. Proceedings. Boston Society of Natural History 41:211-402.

Watts, B. D. 1990. Cover use and predator-related mortality in song and savannah sparrows. Auk 107:775-778.

Watts, B. D. 1991. Effects of predation risk on distribution within and between habitats in savannah sparrows. Ecology 72:1515-1519.

Webb, W. L., D. F. Behrend, and B. Saisorn. 1977. Effect of logging on songbird populations in a northern hardwood forest. Wildlife Monographs 55:1-35.

Weitzel, N. H. 1988. Nest site competition between the European starling and native breeding birds in northwestern Nevada. Condor 90:515-517.

Wheelwright, N. T. and J. D. Rising. 1993. Savannah Sparrow *(Passerculus sandwichensis). In* A. Poole and F. Gill, eds. The Birds of North America, No. 45. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Wheelwright, N. T., C. B. Schultz, and P. Hodum. 1992. Polygyny and male parental care in Savannah sparrows: effects on female fitness. Behavioral Ecology and Sociobiology 31:279-289.

Whitmore, R. C. 1979. Temporal variation in the selected habitats of a guild of grassland sparrows. Wilson Bulletin 91:592-598.

Widoff, L. 1988. Maine wetlands conservation priority plan: an addendum to the state comprehensive outdoor recreation plan (SCORP). Maine Bureau of Parks and Recreation, Maine State Planning Office, Wetlands Subcommittee, Land and Water Resources Council. 91pp.

Wilcove, D. S. 1988. Forest fragmentation as a wildlife management issue in the eastern United States. Pages 1-4 *in* R. M. DeGraaf and W. M. Healy, comps. Is forest fragmentation a management issues in the northeast? U.S.D.A. Forest Service, Northeastern forest Experiment Station. General Technical Report NE-140. 32pp.

Williams, J. M. 1996a. Bay-breasted Warbler *(Dendroica castanea)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 206. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Williams, J. M. 1996b. Nashville Warbler *(Vermivora ruficapilla). In* A. Poole and F. Gill, eds. The Birds of North America, No. 205. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Wilson, W. H., Jr. 1996. Palm Warbler *(Dendroica palmarum)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 238. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Wilson, W. H., Jr., A. Savage, and R. Zierzow. 1997. Arrival dates of migratory breeding birds in Maine: results from a volunteer network. Northeast Naturalist 4:83-92.

Witmer, M. C., D. J. Mountjoy, and L. Elliot. 1997. Cedar Waxwing *(Bombycilla cedrorum)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 309. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Wunderle, J. M., D. J. Lodge, and R. B. Waide. 1992. Short-term effects of Hurricane Gilbert on terrestrial bird populations on Jamaica. Auk 109:148-166.

Yasukawa, K. and W. A. Searcy. 1995. Red-winged Blackbird *(Agelaius phoeniceus)*. *In* A. Poole and F. Gill, eds. The Birds of North America, No. 184. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Appendix I. Land area (sq. mi.)[1] in various land use classes within each of the 3 PIF Physiographic Regions[2] that overlap Maine as of 1995.

Land Use Classes	PIF Physiographic Regions			Statewide[3]
	Southern New England	Northern New England	Eastern Spruce Hardwood	
Timberland	210.91	5,908.71	20,325.96	26,566.70
Unproductive Forestland	0.00	71.88	510.15	582.03
Unprod. Reserved Forestland	0.00	0.00	20.23	20.23
Productive Reserved Forestland	0.00	9.31	517.72	527.03
Urban Forestland	13.21	43.41	0.00	56.62
Cropland	9.80	316.50	485.41	811.71
Improved Pasture	1.08	167.94	78.25	247.27
Idle Farmland	0.00	54.39	127.21	181.60
Other Farmland	0.00	18.26	10.61	28.87
Bog	0.00	0.23	136.79	257.96
Marsh	0.00	40.36	54.32	94.68
Saltmarsh	40.60	8.84	10.38	59.82
Swamp	0.00	81.59	132.89	327.50
Maintained Rights-of-Way	0.00	162.45	183.13	345.58
Mining & Wasteland	0.00	39.45	43.98	83.43
Maintained Recreation Site	0.00	19.21	46.56	65.77
Industrial & commercial land	10.48	19.91	0.00	30.39
Tract &/or Mult. Fam. Housing	0.00	8.62	0.00	8.62
Single Family Custom Housing	63.30	399.00	225.72	688.02
Other	24.27	16.77	12.40	53.44
Totals[4]	373.65	7,386.82	22,921.73	31,037.28

[1] Determined from 1995 FIA data (percentage of each land use class by region [MDIFW standard estimate - *see* Totals] was applied to acres of land within that PIF region then converted to square miles).

[2] PIF Physiographic regions are defined as: Southern New England = WMD 24; Northern New England = WMD's 15, 16, 17, 20, 21, 22, 23, 25, 26; Eastern Spruce/Hardwood = WMD's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 27, 28, 29, and Baxter State Park.

[3] Statewide estimates include all 3 PIF regions plus WMD 30, therefore, summing the area of a land use class across all 3 PIF regions does not necessarily equal statewide estimates.

[4] Standard estimate of land area (sq. mi.) used in MDIFW species assessments (MDIFW 1998b).

Appendix II. Land area (sq. mi.)[1] by habitat types within the 3 PIF Physiographic Regions[2] that overlap Maine and statewide totals as of 1993.

Habitat Type	Southern New England	Northern New England	Eastern Spruce Hardwood	Statewide
Agricultural Lands				
Abandoned Field	0.00	28.97	47.58	77.90
Blueberry Field	0.00	4.92	46.73	52.01
Grasslands	77.85	1,158.76	573.78	1,835.26
Crops/Ground	5.35	129.17	293.39	433.43
Forestlands				
Clearcut	4.55	94.04	392.56	495.06
Early Regeneration	3.98	103.60	1,968.27	2,090.35
Late Regeneration	0.70	203.84	922.45	1,138.45
Light Partial Cut	2.36	97.14	339.76	442.69
Heavy Partial Cut	0.42	106.52	487.17	598.04
Deciduous	3.35	1,118.42	3,837.16	4,991.78
Deciduous/coniferous	71.33	1,401.75	3,739.83	5,250.81
Coniferous/deciduous	73.27	1,649.06	5,225.98	7,015.82
Coniferous	30.54	509.35	2,446.07	3,077.98
Wetlands (Preliminary)				
Deciduous Forested	13.20	133.23	136.44	286.69
Coniferous Forested	8.77	208.46	1,285.65	1,515.48
Dead-forest	0.07	3.38	7.32	10.87
Deciduous Scrub-shrub	5.05	112.53	416.72	539.01
Coniferous Scrub-shrub	0.29	14.29	45.66	60.88
Dead Scrub-shrub	0.00	0.12	0.34	0.46
Fresh Aquatic Bed	0.03	0.23	0.29	0.56
Fresh Emergent	3.10	65.18	209.00	279.89
Peatland	0.18	16.91	165.66	184.13
Wet Meadow	0.39	16.90	48.39	66.22
Salt Aquatic Bed	0.26	3.68	5.05	19.16
Salt Emergent	12.79	8.05	5.01	27.45
Mudflat	2.42	5.32	4.96	16.07
Sand Shore	0.42	0.39	0.62	2.64
Gravel Shore	0.00	0.41	13.01	13.61
Rock Shore	0.12	0.71	14.14	18.33
Shallow Water	1.59	10.69	43.81	56.86

Appendix II. - Continued.

Habitat Type	Southern New England	Northern New England	Eastern Spruce Hardwood	Statewide[3]
Developed Lands				
Sparse Residential	10.07	106.91	144.25	268.13
Dense Residential	35.79	67.80	32.23	136.91
Urban/Industrial	4.30	1.40	0.00	5.73
Highways/Runways	0.00	2.19	0.99	3.20
Other				
Alpine Tundra	0.00	0.00	7.99	8.04
Exposed Rock/Talus	1.10	2.52	13.49	17.39
Totals[4]	373.65	7,386.82	22,921.73	31,037.28

[1] Estimated from standard estimate of land area used in MDIFW species assessments (*see* Totals) (MDIFW 1998b) and percent land area by habitat type based on area and habitat data from Maine Gap Analysis (Hepinstall et al. *in prep*.).
[2] Southern New England = WMD 24; Northern New England = WMD's 15, 16, 17, 20, 21, 22, 23, 25, 26; Eastern Spruce/Hardwood = WMD's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 27, 28, 29 and Baxter State Park.
[3] Statewide estimates include all 3 PIF regions plus WMD 30, therefore, summing the area of a habitat type across all 3 PIF regions does not necessarily equal statewide estimates.
[4] Standard estimate of land area (sq. mi.) used in MDIFW species assessments (MDIFW 1998b).

Appendix III. Percent of FIA plots[1] with various edge types within the 3 PIF Physiographic Regions[2] that overlap Maine and statewide as of 1995.

Edge Type[3]	Number of Edges in Plot	PIF Physiographic Regions			
		Southern New England	Northern New England	Eastern Spruce Hardwood	Statewide[4]
Forest-Forest	≥1	72.73%	99.07%	97.87%	97.89%
	≥15	21.21%	44.73%	50.73%	48.90%
Forest-Shrub	≥1	48.48%	38.05%	32.45%	34.12%
	≥5	36.36%	15.35%	12.22%	13.33%
Forest-Agric./Herb	≥1	48.48%	70.63%	15.77%	30.39%
	≥5	27.27%	49.00%	9.95%	20.30%
Forest-Cultural	≥1	96.97%	79.57%	17.72%	34.70%
	≥5	78.79%	53.67%	7.96%	20.61%
Shrub-Agric./Herb	≥1	3.03%	1.34%	0.14%	0.48%
Shrub-Cultural	≥1	6.06%	0.40%	0.09%	0.24%
Agric./Herb-Cultural	≥1	24.24%	37.25%	4.07%	12.91%
Hedgerow	≥1	0.00%	18.56%	3.60%	7.42%
Trans. Rights-of-Way	≥1	96.97%	94.79%	73.19%	79.07%
	≥10	72.73%	32.71%	10.37%	16.89%
Utility Rights-of-Way	≥ 1	9.09%	17.22%	4.64%	7.94%
	≥5	3.03%	6.68%	1.61%	2.94%
Aquatic	≥1	78.79%	68.76%	61.06%	63.29%
	≥5	54.55%	30.04%	27.33%	28.38%
Total # of plots[5]		33	749	2,111	2,896

[1] 1/5 acre plots from Forest Inventory and Analysis conducted by Maine Forest Service.
[2] PIF Physiographic regions are defined as: Southern New England = WMD 24; Northern New England = WMD's 15, 16, 17, 20, 21, 22, 23, 25, 26; Eastern Spruce/Hardwood = WMD's 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19, 27, 28, 29, and Baxter State Park.
[3] Definitions of edge types and method used (circular pattern) from Brooks and Sykes (1984).
[4] Statewide estimates include all 3 PIF regions plus WMD 30.
[5] Total number of plots from which potential edge data were collected; of 3001 plots total, edge data were collected from 2,896 plots.

Appendix IV. Alphabetical index of species, sections, and habitat subgroupings for Maine Passerines discussed in the text.

Species	Section	Habitat Subgrouping
Blackbird, Red-winged	Wetland	N/A
Blackbird, Rusty	Wetland	N/A
Bluebird, Eastern	Scrub-Shrubland	Upland
Bobolink	Grassland	N/A
Bunting, Indigo	Scrub-Shrubland	Upland
Bunting, Snow	Grassland	N/A
Cardinal, Northern	Scrub-Shrubland	Upland
Catbird, Gray	Scrub-Shrubland	Wetlands and Uplands
Chickadee, Black-capped	Forest	Deciduous-dominated
Chickadee, Boreal	Forest	Conifer-dominated
Cowbird, Brown-headed	Scrub-Shrubland	Upland
Creeper, Brown	Forest	Deciduous-dominated
Crossbill, Red	Forest	Conifer-dominated
Crossbill, White-winged	Forest	Conifer-dominated
Crow, American	Forest	Deciduous-dominated
Crow, Fish	Omitted[1]	
Finch, House	Omitted[1]	
Finch, Purple	Forest	Conifer-dominated
Flycatcher, Alder	Scrub-Shrubland	Wetlands and Uplands
Flycatcher, Great-crested	Forest	Deciduous-dominated
Flycatcher, Least	Forest	Deciduous-dominated
Flycatcher, Olive-sided	Forest	Conifer-dominated
Flycatcher, Willow	Scrub-Shrubland	Wetlands and Uplands
Flycatcher, Yellow-bellied	Forest	Conifer-dominated
Gnatcatcher, Blue-gray	Scrub-Shrubland	Upland
Goldfinch, American	Scrub-Shrubland	Wetlands and Uplands
Grackle, Common	Scrub-Shrubland	Wetlands and Uplands
Grosbeak, Evening	Forest	Conifer-dominated
Grosbeak, Pine	Forest	Conifer-dominated
Grosbeak, Rose-breasted	Forest	Deciduous-dominated
Jay, Blue	Forest	Deciduous-dominated
Jay, Gray	Forest	Conifer-dominated
Junco, Dark-eyed	Forest	Conifer-dominated
Kingbird, Eastern	Scrub-Shrubland	Upland
Kinglet, Golden-crowned	Forest	Conifer-dominated
Kinglet, Ruby-crowned	Forest	Conifer-dominated
Lark, Horned	Grassland	N/A
Longspur, Lapland	Grassland	N/A
Martin, Purple	Swallows	N/A
Meadowlark, Eastern	Grassland	N/A

Appendix IV. - Continued.

Species	Section	Habitat Subgrouping
Mockingbird, Northern	Scrub-Shrubland	Upland
Nuthatch, Red-breasted	Forest	Conifer-dominated
Nuthatch, White-breasted	Forest	Deciduous-dominated
Oriole, Baltimore	Forest	Deciduous-dominated
Oriole, Orchard	Scrub-Shrubland	Upland
Ovenbird	Forest	Deciduous-dominated
Parula, Northern	Forest	Conifer-dominated
Phoebe, Eastern	Forest	Deciduous-dominated
Pipit, American	Omitted[1]	
Raven, Common	Forest	Conifer-dominated
Redpoll, Common	Scrub-Shrubland	Upland
Redpoll, Hoary	Scrub-Shrubland	Upland
Redstart, American	Forest	Deciduous-dominated
Robin, American	Scrub-Shrubland	Upland
Shrike, Loggerhead	Scrub-Shrubland	Upland
Shrike, Northern	Scrub-Shrubland	Upland
Siskin, Pine	Forest	Conifer-dominated
Sparrow, American Tree	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Chipping	Scrub-Shrubland	Upland
Sparrow, Field	Scrub-Shrubland	Upland
Sparrow, Fox	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Grasshopper	Omitted[1]	
Sparrow, House	Omitted[1]	
Sparrow, Lincoln’s	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Nelson’s Sharp-tailed	Wetland	N/A
Sparrow, Saltmarsh Sharp-tailed	Wetland	N/A
Sparrow, Savannah	Grassland	N/A
Sparrow, Song	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Swamp	Wetland	N/A
Sparrow, Vesper	Grassland	N/A
Sparrow, White-crowned	Omitted[1]	
Sparrow, White-throated	Scrub-Shrubland	Wetlands and Uplands
Starling, European	Omitted[1]	
Swallow, Bank	Swallows	N/A
Swallow, Barn	Swallows	N/A
Swallow, Cliff	Swallows	N/A
Swallow, Northern Rough-winged	Swallows	N/A
Swallow, Tree	Swallows	N/A
Tanager, Scarlet	Forest	Deciduous-dominated
Thrasher, Brown	Scrub-Shrubland	Upland
Thrush, Bicknell’s	Forest	Conifer-dominated

Appendix IV. - Continued.

Species	Section	Habitat Subgrouping
Thrush, Gray-cheeked	Omitted[1]	
Thrush, Hermit	Forest	Conifer-dominated
Thrush, Swainson's	Forest	Conifer-dominated
Thrush, Wood	Forest	Deciduous-dominated
Titmouse, Tufted	Forest	Deciduous-dominated
Towhee, Eastern	Scrub-Shrubland	Upland
Veery	Forest	Deciduous-dominated
Vireo, Blue-headed	Forest	Conifer-dominated
Vireo, Philadelphia	Forest	Deciduous-dominated
Vireo, Red-eyed	Forest	Deciduous-dominated
Vireo, Warbling	Forest	Deciduous-dominated
Vireo, Yellow-throated	Forest	Deciduous-dominated
Warbler, Bay-breasted	Forest	Conifer-dominated
Warbler, Black and White	Forest	Deciduous-dominated
1Warbler, Blackburnian	Forest	Conifer-dominated
Warbler, Blackpoll	Forest	Conifer-dominated
Warbler, Black-throated Blue	Forest	Deciduous-dominated
Warbler, Black-throated Green	Forest	Conifer-dominated
Warbler, Blue-winged	Omitted[1]	
Warbler, Canada	Forest	Deciduous-dominated
Warbler, Cape May	Forest	Conifer-dominated
Warbler, Chestnut-sided	Scrub-Shrubland	Upland
Warbler, Magnolia	Forest	Conifer-dominated
Warbler, Mourning	Scrub-Shrubland	Wetlands and Uplands
Warbler, Nashville	Scrub-Shrubland	Wetlands and Uplands
Warbler, Orange-crowned	Omitted[1]	
Warbler, Palm	Wetland	N/A
Warbler, Pine	Forest	Conifer-dominated
Warbler, Prairie	Scrub-Shrubland	Upland
Warbler, Tennessee	Forest	Conifer-dominated
Warbler, Wilson's	Scrub-Shrubland	Wetlands and Uplands
Warbler, Yellow	Scrub-Shrubland	Wetlands and Uplands
Warbler, Yellow-rumped	Forest	Conifer-dominated
Waterthrush, Louisiana	Wetland	N/A
Waterthrush, Northern	Wetland	N/A
Waxwing, Bohemian	Scrub-Shrubland	Upland
Waxwing, Cedar	Scrub-Shrubland	Wetlands and Uplands
Wood-pewee, Eastern	Forest	Deciduous-dominated
Wren, Carolina	Omitted[1]	

Appendix IV. - Continued.

Species	Section	Habitat Subgrouping
Wren, House	Scrub-Shrubland	Upland
Wren, Marsh	Wetland	N/A
Wren, Sedge	Omitted[1]	
Wren, Winter	Forest	Conifer-dominated
Yellowthroat, Common	Scrub-Shrubland	Wetlands and Uplands

[1] Species omitted from this assessment include state-listed Endangered and Threatened species, exotics, and passage migrants for which consistent stopover sites in Maine are not known.

Appendix V. Taxonomic index of species, sections, and habitat subgroupings for Maine Passerines discussed in the text.

Species	Section	Habitat Subgrouping
Flycatcher, Olive-sided	Forest	Conifer-dominated
Wood-pewee, Eastern	Forest	Deciduous-dominated
Flycatcher, Yellow-bellied	Forest	Conifer-dominated
Flycatcher, Alder	Scrub-Shrubland	Wetlands and Uplands
Flycatcher, Willow	Scrub-Shrubland	Wetlands and Uplands
Flycatcher, Least	Forest	Deciduous-dominated
Phoebe, Eastern	Forest	Deciduous-dominated
Flycatcher, Great-crested	Forest	Deciduous-dominated
Kingbird, Eastern	Scrub-Shrubland	Upland
Lark, Horned	Grassland	N/A
Martin, Purple	Swallows	N/A
Swallow, Tree	Swallows	N/A
Swallow, Northern Rough-winged	Swallows	N/A
Swallow, Bank	Swallows	N/A
Swallow, Cliff	Swallows	N/A
Swallow, Barn	Swallows	N/A
Jay, Gray	Forest	Conifer-dominated
Jay, Blue	Forest	Deciduous-dominated
Crow, American	Forest	Deciduous-dominated
Crow, Fish	Omitted[1]	
Raven, Common	Forest	Conifer-dominated
Chickadee, Black-capped	Forest	Deciduous-dominated
Chickadee, Boreal	Forest	Conifer-dominated
Titmouse, Tufted	Forest	Deciduous-dominated
Nuthatch, Red-breasted	Forest	Conifer-dominated
Nuthatch, White-breasted	Forest	Deciduous-dominated
Creeper, Brown	Forest	Deciduous-dominated
Wren, Carolina	Omitted[1]	
Wren, House	Scrub-Shrubland	Upland
Wren, Winter	Forest	Conifer-dominated
Wren, Sedge	Omitted[1]	
Wren, Marsh	Wetland	N/A
Kinglet, Golden-crowned	Forest	Conifer-dominated
Kinglet, Ruby-crowned	Forest	Conifer-dominated
Gnatcatcher, Blue-gray	Scrub-Shrubland	Upland
Bluebird, Eastern	Scrub-Shrubland	Upland
Veery	Forest	Deciduous-dominated
Thrush, Gray-cheeked	Omitted[1]	
Thrush, Bicknell’s	Forest	Conifer-dominated
Thrush, Swainson’s	Forest	Conifer-dominated

Appendix V. - Continued.

Species	Section	Habitat Subgrouping
Thrush, Hermit	Forest	Conifer-dominated
Thrush, Wood	Forest	Deciduous-dominated
Robin, American	Scrub-Shrubland	Upland
Catbird, Gray	Scrub-Shrubland	Wetlands and Uplands
Mockingbird, Northern	Scrub-Shrubland	Upland
Thrasher, Brown	Scrub-Shrubland	Upland
Pipit, American	Omitted[1]	
Waxwing, Bohemian	Scrub-Shrubland	Upland
Waxwing, Cedar	Scrub-Shrubland	Wetlands and Uplands
Shrike, Northern	Scrub-Shrubland	Upland
Shrike, Loggerhead	Scrub-Shrubland	Upland
Starling, European	Omitted[1]	
Vireo, Blue-headed	Forest	Conifer-dominated
Vireo, Yellow-throated	Forest	Deciduous-dominated
Vireo, Warbling	Forest	Deciduous-dominated
Vireo, Philadelphia	Forest	Deciduous-dominated
Vireo, Red-eyed	Forest	Deciduous-dominated
Warbler, Blue-winged	Omitted[1]	
Warbler, Tennessee	Forest	Conifer-dominated
Warbler, Orange-crowned	Omitted[1]	
Warbler, Nashville	Scrub-Shrubland	Wetlands and Uplands
Parula, Northern	Forest	Conifer-dominated
Warbler, Yellow	Scrub-Shrubland	Wetlands and Uplands
Warbler, Chestnut-sided	Scrub-Shrubland	Upland
Warbler, Magnolia	Forest	Conifer-dominated
Warbler, Cape May	Forest	Conifer-dominated
Warbler, Black-throated Blue	Forest	Deciduous-dominated
Warbler, Yellow-rumped	Forest	Conifer-dominated
Warbler, Black-throated Green	Forest	Conifer-dominated
Warbler, Blackburnian	Forest	Conifer-dominated
Warbler, Pine	Forest	Conifer-dominated
Warbler, Prairie	Scrub-Shrubland	Upland
Warbler, Palm	Wetland	N/A
Warbler, Bay-breasted	Forest	Conifer-dominated
Warbler, Blackpoll	Forest	Conifer-dominated
Warbler, Black and White	Forest	Deciduous-dominated
Redstart, American	Forest	Deciduous-dominated
Ovenbird	Forest	Deciduous-dominated
Waterthrush, Northern	Wetland	N/A
Waterthrush, Louisiana	Wetland	N/A
Warbler, Mourning	Scrub-Shrubland	Wetlands and Uplands

Appendix V. - Continued.

Species	Section	Habitat Subgrouping
Yellowthroat, Common	Scrub-Shrubland	Wetlands and Uplands
Warbler, Wilson's	Scrub-Shrubland	Wetlands and Uplands
Warbler, Canada	Forest	Deciduous-dominated
Tanager, Scarlet	Forest	Deciduous-dominated
Cardinal, Northern	Scrub-Shrubland	Upland
Grosbeak, Rose-breasted	Forest	Deciduous-dominated
Bunting, Indigo	Scrub-Shrubland	Upland
Towhee, Eastern	Scrub-Shrubland	Upland
Sparrow, American Tree	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Chipping	Scrub-Shrubland	Upland
Sparrow, Field	Scrub-Shrubland	Upland
Sparrow, Vesper	Grassland	N/A
Sparrow, Savannah	Grassland	N/A
Sparrow, Grasshopper	Omitted[1]	
Sparrow, Nelson's Sharp-tailed	Wetland	N/A
Sparrow, Saltmarsh Sharp-tailed	Wetland	N/A
Sparrow, Fox	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Song	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Lincoln's	Scrub-Shrubland	Wetlands and Uplands
Sparrow, Swamp	Wetland	N/A
Sparrow, White-throated	Scrub-Shrubland	Wetlands and Uplands
Sparrow, White-crowned	Omitted[1]	
Junco, Dark-eyed	Forest	Conifer-dominated
Longspur, Lapland	Grassland	N/A
Bunting, Snow	Grassland	N/A
Bobolink	Grassland	N/A
Blackbird, Red-winged	Wetland	N/A
Meadowlark, Eastern	Grassland	N/A
Blackbird, Rusty	Wetland	N/A
Grackle, Common	Scrub-Shrubland	Wetlands and Uplands
Cowbird, Brown-headed	Scrub-Shrubland	Upland
Oriole, Orchard	Scrub-Shrubland	Upland
Oriole, Baltimore	Forest	Deciduous-dominated
Grosbeak, Pine	Forest	Conifer-dominated
Finch, Purple	Forest	Conifer-dominated
Finch, House	Omitted[1]	
Crossbill, Red	Forest	Conifer-dominated
Crossbill, White-winged	Forest	Conifer-dominated
Redpoll, Common	Scrub-Shrubland	Upland
Redpoll, Hoary	Scrub-Shrubland	Upland

Appendix V. - Continued.

Species	Section	Habitat Subgrouping
Siskin, Pine	Forest	Conifer-dominated
Goldfinch, American	Scrub-Shrubland	Wetlands and Uplands
Grosbeak, Evening	Forest	Conifer-dominated
Sparrow, House	Omitted[1]	

[1] Species omitted from this assessment include state-listed Endangered and Threatened species, exotics, and passage migrants for which consistent stopover sites in Maine are not known

Appendix VI. Summary of conservation status for Maine Passerines.

Species	Maine Status	Federal Status[2]	No. of States in R5[1]			SRank[3]	GRank[4]	PIF[5]
			E	T	SC			
Flycatcher, Olive-sided	Special Concern		1		2	S4B	G4	19
Wood-pewee, Eastern						S4B	G5	20
Flycatcher, Yellow-bellied				1		S4S5B	G5	18
Flycatcher, Alder					1	S4S5B	G5	17
Flycatcher, Willow						S2S3B	G5	17
Flycatcher, Least						S4B	G5	19
Phoebe, Eastern						S5B,S5N	G5	16
Flycatcher, Great-crested						S5B	G5	17
Kingbird, Eastern						S4S5B	G5	14
Lark, Horned				1		S3B,S3S4N	G5	11
Martin, Purple				1	1	S3B	G5	14
Swallow, Tree						S5B	G5	16
Swallow, Northern Rough-winged						S3S4B	G5	16
Swallow, Bank						S5B	G5	14
Swallow, Cliff				2		S5B	G5	11
Swallow, Barn						S4B	G5	15
Jay, Gray						S5	G5	14
Jay, Blue						S5	G5	13
Crow, American						S5	G5	11
Crow, Fish						S1B	G5	---
Raven, Common					2	S5	G5	13
Chickadee, Black-capped						S5	G5	14
Chickadee, Boreal						S4	G5	14
Titmouse, Tufted						S4	G5	---
Nuthatch, Red-breasted						S5	G5	13
Nuthatch, White-breasted						S5	G5	15
Creeper, Brown						S5	G5	16
Wren, Carolina						SAB,SAN	G5	---
Wren, House						S4S5B	G5	12
Wren, Winter						S4N,S5B	G5	17
Wren, Sedge	Endangered		5	4	1	S1B	G5	22
Wren, Marsh						S4B	G5	18
Kinglet, Golden-crowned						S5B,S5N	G5	18

Appendix VI. - Continued.

Species	Maine Status	Federal Status[2]	No. of States in R5[1]			SRank[3]	GRank[4]	PIF[5]
			E	T	SC			
Kinglet, Ruby-crowned						S4N,S5B	G5	15
Gnatcatcher, Blue-gray						S2S3B	G5	---
Bluebird, Eastern					1	S4B	G5	13
Veery						S5B	G5	22
Thrush, Gray-cheeked						SZN	G5	---
Thrush, Bicknell's	Special Concern				1	S3B	G3G4	24
Thrush, Swainson's						S5B	G5	18
Thrush, Hermit						S4B,S4N	G5	17
Thrush, Wood						S4B	G5	21
Robin, American						S5B,S5N	G5	11
Catbird, Gray						S4B	G5	18
Mockingbird, Northern						S5B,S5N	G5	---
Thrasher, Brown						S4B	G5	16
Pipit, American	Endangered		1			S1B,SZN	G5	14
Waxwing, Bohemian						S2S4N	G5	---
Waxwing, Cedar						S3S5N,S5B	G5	15
Shrike, Northern						S2S3N	G5	---
Shrike, Loggerhead	Special Concern		8		1	S1N,SHB	G4G5	---
Starling, European						SE	G5	13
Vireo, Blue-headed						S5B	G5	18
Vireo, Yellow-throated						S3B	G5	20
Vireo, Warbling						S4B	G5	16
Vireo, Philadelphia						S4B	G5	19
Vireo, Red-eyed						S5B	G5	16
Warbler, Blue-winged						S1B	G5	---
Warbler, Tennessee						S4B	G5	---
Warbler, Orange-crowned						SZN	G5	---
Warbler, Nashville					1	S5B	G5	19
Parula, Northern					2	S5B	G5	19
Warbler, Yellow						S5B	G5	13
Warbler, Chestnut-sided						S5B	G5	23
Warbler, Magnolia						S5B	G5	16

Appendix VI. - Continued.

Species	Maine Status	Federal Status[2]	No. of States in R5[1]			SRank[3]	GRank[4]	PIF[5]
			E	T	SC			
Warbler, Cape May						S4S5B	G5	22
Warbler, Black-throated Blue						S5B	G5	24
Warbler, Yellow-rumped						S4N,S5B	G5	11
Warbler, Black-throated Green						S5B	G5	20
Warbler, Blackburnian				1		S5B	G5	20
Warbler, Pine						S5B	G5	15
Warbler, Prairie						S4B	G5	20
Warbler, Palm						S3S4B	G5	17
Warbler, Bay-breasted						S5B	G5	22
Warbler, Blackpoll					1	S3S4B	G5	18
Warbler, Black and White						S5B	G5	19
Redstart, American						S5B	G5	18
Ovenbird						S5B	G5	19
Waterthrush, Northern						S5B	G5	13
Waterthrush, Louisiana						S2B	G5	22
Warbler, Mourning					1	S5B	G5	17
Yellowthroat, Common						S4S5B	G5	18
Warbler, Wilson’s						S3S4B	G5	15
Warbler, Canada						S4B	G5	23
Tanager, Scarlet						S5B	G5	16
Cardinal, Northern						S4	G5	9
Grosbeak, Rose-breasted						S5B	G5	20
Bunting, Indigo						S5B	G5	12
Towhee, Eastern						S4B	G5	17
Sparrow, American Tree						S4N	G5	---
Sparrow, Chipping						S3N,S5B	G5	14
Sparrow, Field						S3S4B	G5	19
Sparrow, Vesper	Special Concern		3	1	2	S3S4B,SZN	G5	15
Sparrow, Savannah				1	1	S4S5N,S5B	G5	13
Sparrow, Grasshopper	Endangered		2	3	1	S1B,SAN	G4	17
Sparrow, Seaside					1	S1?B	G4	24
Sparrow,								

Appendix VI. - Continued.

Species	Maine Status	Federal Status[2]	No. of States in R5[1]			SRank[3]	GRank[4]	PIF[5]
			E	T	SC			
Nelson's Sharp-tailed Sparrow,						S3S4B	G5	---
Saltmarsh Sharp-tailed					1	S3B	G5	---
Sparrow, Fox						S2S3B,SZN	G5	---
Sparrow, Song						S4N,S4S5B	G5	15
Sparrow, Lincoln's						S5B,S5N	G5	14
Sparrow, Swamp						S5B,S5N	G5	17
Sparrow, White-throated						S4S5B,S4S5N	G5	17
Sparrow, White-crowned						SZN	G5	---
Junco, Dark-eyed						S5B,S5N	G5	14
Longspur, Lapland						S2S3N	G5	---
Bunting, Snow						S4S5N	G5	---
Bobolink				1		S4B	G5	20
Blackbird, Red-winged						S4S5B,S4S5N	G5	14
Meadowlark, Eastern	Special Concern				1	S3S4B,SAN	G5	16
Blackbird, Rusty	Special Concern				1	S3N,S3S4B	G5	16
Grackle, Common						S4N,S5B	G5	11
Cowbird, Brown-headed						S4N,S4S5B	G5	12
Oriole, Orchard	Special Concern				1	S1?B	G5	---
Oriole, Baltimore						S2S3N,S5B	G5	16
Grosbeak, Pine						S3B,S3S5N	G5	16
Finch, Purple						S4N,S5B	G5	19
Finch, House						SE	G5	8
Crossbill, Red						S3S4B,S3S4N	G5	16
Crossbill, White-winged						S3S4B,S3S4N	G5	15
Redpoll, Common						S3S5N	G5	---
Redpoll, Hoary						S1S2N	G5?	---

Appendix VI. - Continued.

Species	Maine Status	Federal Status[2]	No. of States in R5[1]			SRank[3]	GRank[4]	PIF[5]
			E	T	SC			
Siskin, Pine						S5B,S5N	G5	11
Goldfinch, American						S5B,S5N	G5	16
Grosbeak, Evening						S5B,S5N	G5	15
Sparrow, House						SE	G5	12

[1] Number of states within USFWS Region 5 (of 12 total states) that list each species as Endangered (E), Threatened (T), or Special Concern (SC); adapted from French and Pence (1996).
[2] At present, no Maine Passerines are federally-listed as Threatened or Endangered .
[3] The Nature Conservancy's state-level conservation ranking.
[4] The Nature Conservancy's global-level conservation ranking.
[5] Partners In Flight's "Concern Scores" for Maine calculated by assigning a rank, from 1 to 5, to the following 7 categories then summing across all categories, thus, scores range from 7 to 35 with 35 having the highest possible conservation concern within the state. Categories are: Global Abundance, Global Breeding Distribution, Global Wintering Distribution, Threats to Breeding within state when known - global when not known, Threats to Nonbreeding within state when known - global when not known, Population Trend within state, Area Importance - abundance and distribution relative to global range. See Table 19, Appendix VII, and Hunter et al. (1993) for more details.

Appendix VII. Population trend[1] (PT) and population trend uncertainty (PTU) criteria for scoring Breeding Bird Survey data in setting Partners In Flight Conservation Priorities.

PT			PTU	BBS Trend Quality		
				n		P
Score	Descriptor	Trend	Score			
5	Significant Decrease	Decreasing at or above 1.0% per year on average	1	≥ 34	and	≤ 0.10
					or	
			2	14 - 33	and	≤ 0.10
4	Possible Decrease	Decreasing at or above 1.0% per year on average	3	6 - 13	and	≤ 0.10
					or	
			4	≥ 14	and	0.11 - 0.35
3	Trend Unknown	Change at or above 1.0% per year on average	5	≥ 14	and	> 0.35
3	Insufficient Data	Any Trend	6	6 - 13	and	>0.10
					or	
			7	1 - 5	and	Any P-value
3	No Data	No Data	8	N/A		N/A
2	Stable or No Trend	Trend between -1.0% and +1.0% per year on average	1	≥ 34	and	Any P-value
					or	
			2	14 - 33	and	Any P-value
2	Possible Increase	Increasing at or above 1.0% per year on average	3	6 - 13	and	≤ 0.10
					or	
			4	≥ 14	and	0.11 - 0.35
1	Significant Increase	Increasing at or above 1.0% per year on average	1	≥ 34	and	≤ 0.10
					or	
			2	14 - 33	and	≤ 0.10

[1] To determine a PT score, first choose a trend depending on whether the species is increasing, decreasing, or stable. Then evaluate PTU by checking sample size (n) and significance level (P) and Scores for PTU are not used in the Total Score (*see* Appendix VI), but are important in judging the quality of the trend data.

2000 PASSERINE WORKING GROUP

Invited Participant	Affiliation
Barry Burgason	Forest Products Industry
Debra Davidson	Defenders of Wildlife
Jay Dwight	Southern Maine Representative
Norman Famous	Environmental Consultant/Ornithologist
Susan Hitchcox	Maine Audubon
Ron Joseph	U. S. Fish and Wildlife Service
Don Mairs	Central Maine Representative
Dr. Raymond O'Connor	University of Maine/Research
Jan Pierson	Ecotourism
Jeffrey Romano	Small Woodlot Owners Association
Nancy Sferra	The Nature Conservancy
Bill Sheehan	Northern Maine Representative
George Smith	Sportsman's Alliance of Maine
Vaughn Stinson	Maine Tourism Association
Stanton Bird Club	Birder's Club
Peter Vickery	Regional Passerine Conservation Programs
Wild Bird Crossing	Retail Bird-Related Products

Summary of Working Group Issues and Concerns
Passerines

Forest Passerines

- towers (crosses all species)
- atmospheric deposition (mercury, acid rain, etc.)
- need for outreach re the importance of small woodlots
- forest practices
- habitat fragmentation, sprawl
- predation (house cats, cowbirds)

Shrubland Passerines

- none of the shrub passerines have large area requirements - need to emphasize the value that forest practices can have maintaining populations of these birds
- habitat loss and alteration
- potential to work with utility companies re powerline corridors, pipelines, etc. (Pesticide Control Board training seminars)
- need to prioritize species
- link the habitat requirements of priority species with other shrub wildlife (New England cottontail, black racer)

Wetland Passerines

- incremental loss and degradation of wetlands, especially freshwater wetlands
- impacts to riparian habitat, especially buffers in coastal areas and along rivers and streams
- increase in invasive plant species in wetlands
- recreational use of wetlands (jet skis, ATVs)
- contaminants that alter wetland composition (pesticides for mosquito control)
- wetland fluctuations and water level manipulations
- forestry practices that alter habitat and enhance habitat for competitors (rusty blackbirds)
- “nuisance” situations (red-winged blackbirds in sweet corn, problems at airports)
- need outreach to promote awareness and understanding

Grassland Passerines

- integrating goals and objectives developed for other species (deer, for example) with passerine goals and objectives
- timing of various agricultural activities (mowing, haying, etc.)

- levels of mortality due to free-ranging feral and domestic cats
- downeast Maine is extremely important for upland sandpipers and vesper sparrows; need to continue outreach efforts with the blueberry industry
- timing and dosage of herbicides used in the blueberry industry; herbicides can be detrimental to some grassland birds
- impacts to the use of herbicides and insecticides (regarding salmon) could affect grassland birds
- Are there fields on industrial forest lands that could be managed as fields rather than allowed to revert to forests?
- habitat improvements at airports; important grassland complex at Wells Barren, Kennebunk Plains, and Sanford Airport (bird conservation program at Bradley International Airport in Connecticut as a possible model)
- widening of roads and highways and the potential loss of grasslands, also timing of roadside mowing.
- don't want to encourage grassland habitats along roads, nothing but a "death trap"
- interface with Maine Cooperative Extension providing advice through NRCS on dairy farming/mowing impacts and timing
- outreach with private landowners that have grasslands on their properties, are interested in wildlife, and want to keep the brush down but are not interested in hay. Stress that timing is critical (public service announcements, Best Management Practices - Mass Audubon has three example documents on its website: farmland, large open lands, small open lands).
- changing face of the agriculture industry: larger scale, more chemically intensive, technology that allows hay to be cut earlier, regardless of weather, and more often
- habitat configurations are important: larger areas are better than a series of smaller areas, some species require hundreds of acres
- need to promote the positive aspects of birding/ecotourism without the potential negative impacts
- need outreach materials on attracting birds (pros and cons), viewing birds - how? where?
- Is there adequate habitat on the landscape, or do we need more?

<u>Swallows</u>

- persistence and population levels in Maine are linked to what happens on the wintering grounds (pesticide applications)
- public acceptance of cliff swallows has been a problem in the past
- bank swallows - timing of active mining during the breeding season
- snag retention and persistence of natural cavities
- barn swallows - management options for reversing population declines
- need for outreach - farmers, DOT personnel, foresters, gravel miners

Passerine Management Goals and Objectives 2000-2015

The feasibility, desirability, habitat capability, and possible consequences of the recommended objectives for passerine conservation in Maine are presented below. Some of the objectives are feasible and there is sufficient habitat to meet them. However, because so many species are included under many of the individual objectives, it is not feasible without detailed prioritization, for example "to stabilize then reverse declines" for such large numbers of species even over a 15-year period. Furthermore, some habitat objectives, as written, assume that limiting factors on the breeding grounds are the primary reason for species declines. As a consequence, MDIFW need only alter these limiting factors to stabilize and/or reverse declines. It is widely believed that at least some species are most limited on their wintering grounds especially in the neotropics. The public working group recognized this, but failed to include this important caveat in these objectives. As a result for most species groups, progress toward meeting habitat objectives is possible and will take place, but will not be accomplished in their entirety.

Forest Passerines

Goal: Maintain the diversity and abundance of forest passerines, and increase the understanding and appreciation of forest passerines and their habitat requirements in Maine.

Population Objective 1: Identify forest passerines whose populations in Maine are declining, and stabilize and begin to reverse the decline by 2015. Priority should be given to those species that have greater than 5% of their global populations breeding in Maine.

Desirability: Meeting this objective is highly desirable. Maine has a large responsibility for conservation of several forest passerines.

Feasibility: This objective is not feasible without prioritization given current levels of staffing and funding especially in view of the other species needs identified in this document. Of the 54 species in this group, 40% are either in decline or not adequately monitored by the Breeding Bird Survey (BBS) in Maine. Meeting this objective will require significant effort given that some of these species have a limited range in Maine and/or have specific habitat requirements within this general habitat category. To be feasible, this will require some prioritization, possibly beyond that described above, or would require a significant effort to monitor many small, relatively dispersed populations. The MDIFW will likely be able to work toward this objective and may be able to meet it for some species, but probably will not for all species, even over the 15-year planning period.

Capability of the Habitat: With a large proportion of Maine currently in forested habitat, the landscape within Maine appears capable of supporting this objective. Exceptions to this may be in portions of Maine where fragmentation may be significant enough over the next 15 years to interfere with conservation efforts targeted at area sensitive forest passerines.

Possible Consequences: Meeting this objective would contribute favorably to statewide (and regional) conservation of these species. In contrast, failure to meet this objective for "at risk" species will permit their continued decline, and ultimately, in their listing as either threatened or endangered in Maine and possibly their loss from some forests in our state. A proactive approach targeted at these species could prevent a conservation crisis for species such as

Bicknell's Thrush. The potential exists that increased federal regulations could limit scope, siting, and intensity of harvesting if species such as Canada Warbler reach extremely low population levels. Large forest landowners could play an important role in conserving many of these species. Thus, it is more likely that cooperative relationships could be attained that would ensure sufficient habitat without the need for increased regulation.

Population Objective 2: Through 2015, maintain and monitor forest passerines whose populations have been stable or increasing since 1980.

Desirability: A stable or increasing population of all forest passerines is desirable.

Feasibility: This objective should be obtainable without significant further attention. These 32 species are adequately monitored by the BBS and would require only periodic review of their trend estimates. It is possible that nonsignificant (i.e., "stable") trends for some species could become significant downward trends with increased BBS data. The opposite too may occur and should be considered.

Capability of the Habitat: With the large proportion of Maine currently in forested habitat, the landscape within our state appears capable of supporting this objective. Exceptions to this may be in portions of Maine where fragmentation may be significant enough over the next 15 years to interfere with conservation efforts targeted at area sensitive forest Passerines.

Possible Consequences: Meeting this objective would contribute favorably to statewide (and regional) conservation of these species. In contrast, failure to meet this objective will permit continued decline of several species and ultimately in their listing as either threatened or endangered in Maine, and possibly, to the loss of viable breeding populations of some species. A proactive approach targeted at these species could prevent a conservation crisis for species such as Olive-sided Flycatcher.

Population Objective 3: For forest passerines whose populations are assumed to be cyclical, work in conjunction with partners throughout the planning period (2000-2015) to try to determine long-term, cyclical patterns.

Desirability: Understanding the cyclical patterns of forest passerine populations would help in developing effective conservation programs for these species. In some instances, however, the key limiting factor may be beyond our control, or to modify it may be undesirable.

Feasibility: This objective is feasible, but cannot be achieved without significant partnerships and increased funding. Willing partners probably exist, but roles and strategies would need to be identified. One impediment to meeting this objective would be the length of a given cycle for a species and whether that could be evaluated within the 15-year planning period.

Capability of the Habitat: Initially, it seems that there is sufficient habitat to meet this objective, however, the complexities of factors driving these cycles are not fully known.

Possible Consequences: Meeting this objective would contribute favorably to statewide (and regional) conservation of these species. In contrast, failure to meet this objective could permit a population to decline below a level from which it could not recover. Opportunities for conservation would then be limited to listing as either threatened or endangered in Maine, and ultimately, though not likely, to the loss of viable breeding populations. A proactive approach targeted at these species could prevent a conservation crisis for species such as Red Crossbill.

The potential exists that increased federal regulations could limit scope, siting, and intensity of harvesting if cyclical species reach extremely low population levels. Large forest landowners could play an important role in conserving many of these species. Thus, it is more likely that cooperative relationships could be attained that would ensure sufficient habitat without the need for increased regulation.

Habitat Objective: Maintain and enhance a sufficient amount of high quality habitat to prevent and reverse population declines of forest birds in Maine.

Desirability: This objective is desirable for forest species in general.

Feasibility: This objective assumes that habitat on the breeding grounds is the primary limiting factor for this group of birds. It may be, but for those species for which it is not (e.g., Veery?), this objective is not achievable. The feasibility of this objective is in question because relationships between habitat quality, quantity, and population dynamics are unknown for nearly all species. It is possible to work toward this objective (specifically through examining species/habitat relationships), but it is unlikely to occur even for all priority species within the current planning period. Research into species/habitat relationships will require increased funding, and possibly, reallocation of personnel time.

Capability of the Habitat: Where sufficient amounts of high quality habitat do not exist, forest habitat could be enhanced through changes in forest practices. Management strategies for forest habitats have been examined by numerous studies, but remain to be fully understood for all species.

Possible Consequences: Failure to meet this objective will undermine any steps toward achieving any population objective. The potential exists that increased federal regulations could limit scope, siting, and intensity of harvesting if species reach extremely low population levels. Large forest landowners could play an important role in conserving many of these species. Thus, it is more likely that cooperative relationships could be attained that would ensure sufficient habitat without the need for increased regulation.

Outreach Objective: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of forest passerines and their habitat requirements in Maine.

Desirability: A public informed on the importance of conservation of forest birds is desirable. Also, based on the responsibility that Maine has for several species (i.e., > 5% of global population for several species), this objective is greatly needed.

Feasibility: Development of a formal outreach program is possible, but will require significant partnerships with other agencies and conservation non-governmental organizations (NGO's) and adequate funding. Many of these may already be in place via the Maine Partners In Flight (PIF) Working Group and simply need to be fleshed out. Development of outreach materials (e.g., posters, pamphlets, signage) will require more funding than is currently available and likely will rely heavily on MDIFW's Division of Information and Education.

Capability of the Habitat: Not applicable.

Possible Consequences: Many of these birds are common in suburban backyards, not just northern Maine; therefore, even the average homeowner can and should play a role in their

conservation. An informed public may enhance nesting opportunities for, and survival of, forest passerines through simple action in their woodlots and backyards. Increasing awareness even among professionals could affect habitat management decisions and presumably populations of forest Passerines.

Shrubland Passerines

Goal: Increase or maintain the populations of shrubland passerines, and increase the understanding and appreciation of shrubland passerines and their habitat requirements in Maine.

Population Objective 1: Identify shrubland passerines whose populations in Maine are declining, and stabilize and begin to reverse the decline by 2015. Priority should be given to those species that have greater than 5% of their global populations breeding in Maine.

Desirability: With the exception of Brown-headed Cowbird, stabilizing and reversing the decline of shrubland species is highly desirable. Many birds in this group suffer from loss of habitat (i.e., reforestation), as have grassland species.

Feasibility: This objective is not feasible without prioritization given current levels of funding and allocation of staff time, especially in view of the other species needs identified in this document. Of the 32 species in this group, over 1/2 are either in decline or not adequately monitored by the BBS in Maine. Meeting this objective will require significant effort given these species often have a limited range in Maine and/or have specific habitat requirements. To be feasible, this will require some prioritization above that described in the objective above, or a significant effort would be needed to monitor small, relatively dispersed populations. It is likely that MDIFW will work toward this objective, and may be able to meet it for some species, but probably will not for all species, even within the 15-year planning period.

Capability of the Habitat: Shrubland passerines could benefit from expanded shrub habitat. Existing habitat may be sufficient to meet this objective for some species, but not all.

Possible Consequences: Meeting this objective would contribute favorably to statewide (and regional) conservation of these species. In contrast, failure to meet this objective for “at risk” species will permit their continued decline, ultimately in their listing as either threatened or endangered in Maine, and perhaps the loss of some species at some sites. A proactive approach targeted at these species could prevent a conservation crisis for species such as Prairie Warbler and Field Sparrow. The potential exists that increased federal regulations could impose restrictions on land use should some shrubland species become endangered or threatened. However, it is more likely that cooperative relationships could be developed that would ensure sufficient habitat without the need for increased regulation.

Population Objective 2: Through 2015, maintain and monitor shrubland passerines whose populations have been stable or increasing since 1980.

Desirability: A stable or increasing population of these shrubland passerines is desirable.

Feasibility: This objective is easily obtainable without significant further attention. These 14+ species are adequately monitored by the BBS currently and would require only periodic review of their trend estimates. It is possible that nonsignificant trends (i.e., “stable”) for some species

could become significant downward trends with increased BBS data. The opposite too may occur and should be considered.

Capability of the Habitat: All shrubland species could benefit from expanded shrub habitat. Existing habitat may be sufficient to meet this objective for most species covered by this objective.

Possible Consequences: Maintaining stable or increasing populations of shrubland passerines will benefit conservation of these species in our region, although Maine holds only a small portion of the global population for most of these species. Chestnut-sided Warbler is the only species with >5 % of its global population in our state.

Habitat Objective: Maintain and enhance a sufficient amount of high quality habitat to prevent and reverse population declines of shrubland passerines in Maine.

Desirability: This objective is desirable for shrubland species in general. Trade offs will occur where improving habitat for some species will result in increasing Brown-headed Cowbird populations.

Feasibility: This objective assumes that habitat on the breeding grounds is the primary limiting factor for this group of birds. It may be, but for those species for which it is not (e.g., Eastern Towhee?), this objective is not achievable. The feasibility of this objective is in question because relationships between habitat quality, quantity, and population dynamics are unknown for nearly all species. It is possible to work toward this objective (specifically through examining species/habitat relationships), but it is unlikely to occur even for all priority species within the current planning period. Research into species/habitat relationships will require additional funding, and possibly, reallocation of personnel time.

Capability of the Habitat: Where sufficient amounts of high quality habitat do not exist, shrub habitat could be enhanced though vegetation management plans along utility corridors. Management practices for upland habitats are well known, although what constitutes high quality habitat for all species in question has not been thoroughly addressed. Shrub-dominated upland habitat, because it is often ephemeral, may not be in sufficient quantity (or quality) to meet this objective for all species in this category. Wetland habitats too are difficult to assess because they are influenced by natural fluctuations of beaver populations. Wet shrublands are likely sufficient to support this objective for wetland-associated species.

Possible Consequences: Failure to meet this objective will undermine any steps toward achieving either population objective. The potential exists that increased federal regulations could impose restrictions on land use should some shrubland species become endangered or threatened. However, it is more likely that cooperative relationships could be developed that would ensure sufficient habitat without the need for increased regulation. Cooperative relationships with utility managers could improve habitat quality for several shrubland species and could be part of mitigation negotiations when new corridors are proposed.

Outreach Objective: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of shrubland passerines and their habitat requirements in Maine.

Desirability: A public informed on the importance of conservation of shrubland birds is highly desirable. These birds are common in suburban backyards, and even the average homeowner can play a role in their conservation.

Feasibility: Development of a formal outreach program is possible, but will require significant partnerships with other agencies and conservation NGO's and increased funding. Many programs may already be in place via the Maine PIF Working Group but may simply need to be fleshed out. Development of outreach materials (e.g., posters, pamphlets, signage) will require more funding than is currently available and will likely require heavy reliance on MDIFW's Division of Information and Education.

Capability of the Habitat: Not applicable.

Possible Consequences: An informed public may enhance nesting opportunities for, and survival of, shrubland passerines through simple action in their woodlots, farms, and backyards. Increasing awareness, even among professionals, could affect habitat management decisions and presumably populations of shrubland passerines.

Wetland Passerines

Goal: Maintain the diversity and abundance of wetland passerines, and increase the understanding and appreciation of wetland passerines and their habitat requirements in Maine.

Population Objective: Identify and prioritize species of conservation concern by 2002, determine population trends by 2009, and develop population objectives for all at risk species by 2010.

Desirability: Achieving this objective is critical to understanding the conservation status of several species. It is especially important for species such as Nelson's and Saltmarsh Sharp-tailed Sparrow for which Maine has an inordinate amount of the species' regional/global population.

Feasibility: Identifying and prioritizing wetland passerines of conservation concern is clearly feasible, and much of this analysis already has been done. Determining population trends, however, will be more difficult. Population trend data are adequate for only 3 of 9 species in this category via the BBS. Presumably, not all species would be deemed high priority, however, because several types of wetlands are involved, multiple monitoring programs (albeit small) would need to be implemented. This could not be done without significant volunteer assistance and perhaps volunteer coordination. Design of a monitoring program targeted specifically for Sharp-tailed Sparrows is in draft form, but no plan has been prepared for other species such as Rusty Blackbirds. Furthermore, availability of volunteers to participate in such programs will be more likely in populated areas of the state where Sharp-tailed Sparrows and Marsh Wrens are more broadly distributed compared to Rusty Blackbirds, which occur in portions of the western mountains and remote northern Maine. It is feasible to develop population objectives (if drafted using the format for other groups of passerines), however, achieving those goals, presumably to "stabilize or reverse declining trends," may be problematic, because wetland creation or alteration may not be desirable and difficult given both state and federal jurisdiction over habitat alteration of wetlands.

Capability of the Habitat: Evaluating the amount of habitat needed for wetland passerines will depend on the population objectives to be developed by 2010.

Possible Consequences: Prioritizing, monitoring, and setting population objectives are critical to maintaining populations of several of the species in all currently occupied habitats. More specifically, some species may be in decline currently, but we lack the data to verify this. Without these data and subsequent management efforts, populations of some species could decline to the point they require the protection afforded endangered and threatened species, or perhaps, to the point they disappear from some sites.

Habitat Objective 1: By 2015, increase the acreage of upland buffers of saltmarsh habitat in conservation status by 10,000 hectares, with at least 4,000 hectares in York, Cumberland, and Sagadahoc Counties.

Desirability: This level of protection is clearly desirable for the stability of passerine populations in saltmarsh habitats. It will be difficult to evaluate and reverse declining populations without protecting upland buffers. Without such continued protection, chronic loss of habitat quality will continue as has been seen in some southern Maine marshes.

Feasibility: Meeting this objective will not be possible by the Department alone and without substantial funding. Several NGO's (e.g. land trusts) and other agencies should make it possible to work toward this goal. It is difficult to evaluate the feasibility of this objective without, for example, knowing the history of such efforts over the last two decades (i.e., is this amount realistic given past accomplishments?). It may be possible to achieve this objective at least outside the 3 southern counties identified, but no mechanism currently exists to keep an ongoing, statewide tally of lands that are placed in conservation status. Outreach to other agencies, probably the State Planning Office, will be needed to establish the networks necessary to monitor changes in status of conservation lands above those involving MDIFW.

Capability of the Habitat: Sufficient habitat is available to meet this objective. The availability of funds and willingness of landowners, however, remain uncertain.

Possible Consequences: Providing undeveloped buffers around saltmarsh habitat will ensure habitat quality through minimizing disturbance and maintaining water quality. Failure to meet this objective will result in incremental degradation of habitat quality and could lead to a loss of species diversity at some sites. It is likely that these changes will not fully be realized in the current planning period, but rather appear as a chronic decline in habitat quality and ultimately avian richness. Acquisition or easement of lands buffering wetlands would benefit willing sellers and potentially raise the value of neighboring parcels, outside, but adjacent to conservation lands. Seizure of property under eminent domain is not a reasonable option. Towns may receive less property tax revenue for conserved parcels unless funds can be raised at the time of purchase to offset future tax liability.

Habitat Objective 2: Prioritize peatlands by size, and by 2017, increase the acreage in conservation status for peatlands by 12,000 hectares and adjacent buffers by 24,000 hectares.

Desirability: This level of protection is clearly desirable for the stability of passerine populations in peatland habitats. It will be difficult to effectively conserve populations without protecting upland buffers. Without such continued protection, chronic loss of habitat quality will continue.

Feasibility: Prioritization is clearly feasible with cooperation from Habitat Group personnel. Meeting the latter portion of this objective though, may not be possible by MDIFW alone given current levels of funding and staffing. Several NGO's (e.g. land trusts) and other agencies likely will make it possible to work toward this goal within this time frame. It is difficult to evaluate the feasibility of this objective without, for example, knowing the history of such efforts over the last two decades. Furthermore, it may be possible to achieve this objective, but no mechanism currently exists to keep an ongoing statewide tally (i.e., over time) of lands that are placed in conservation status. Outreach to other agencies, probably the State Planning Office will be needed to establish the networks necessary to monitor changes in status of conservation lands beyond those involving MDIFW.

Capability of the Habitat: Sufficient habitat is available to meet this objective. The availability of funds and willingness of landowners, however, remain uncertain.

Possible Consequences: Providing undeveloped buffers around peatlands will help maintain habitat quality through minimizing disturbance and maintaining groundwater quality. Failure to meet this objective will result in incremental degradation of habitat quality and could lead to a loss of species diversity. These changes will not likely be realized in full during the current planning period, but rather appear as a chronic decline in habitat quality and perhaps avian richness. Acquisition or easement of peatlands and lands buffering wetlands would benefit willing sellers and could potentially raise the value of neighboring parcels outside, but adjacent to, conservation lands. Seizure of property under eminent domain is not a reasonable option. Towns may receive less property tax revenue for conserved parcels unless funds can be raised at the time of purchase to offset future tax liability.

Habitat Objective 3: Identify and prioritize forest riparian and emergent wetland habitats by 2002, and conserve habitat for forest riparian and emergent wetland passerines at 5 priority sites by 2004 and at 20 additional priority sites by 2015.

Desirability: This level of protection is clearly desirable for the stability of passerine populations in forested and emergent wetland habitats. It will be difficult to effectively conserve populations without protecting upland buffers. For forested wetlands, buffering would be less critical as the forest itself provides some level of protection from disturbance. State and federal laws protect forested and emergent marshes. As such, providing upland buffers for these habitats would be more desirable than acquisition of these sites alone.

Feasibility: Identifying and prioritizing forested and emergent wetlands is feasible within the time frame defined, but will require significant cooperation from the Habitat Group and availability of statewide National Wetlands Inventory data. Meeting the latter portion of this objective may not be possible by MDIFW alone given current funding levels. However, the efforts of several NGO's (e.g. land trusts) and other agencies should make it possible to work toward this goal within the identified time frame. It is difficult to evaluate the feasibility of this objective without, for example, knowing the history of such efforts over the last two decades. Further, it may be possible to achieve this objective, but no mechanism currently exists to maintain an ongoing statewide tally (i.e., over time) of lands that are placed in conservation status. Outreach to other agencies, probably the State Planning Office will be needed to establish the networks necessary for monitoring changes in status of conservation lands.

Capability of the Habitat: Sufficient habitat is available to meet this objective. The availability of funds and willingness of landowners, however, remain uncertain.

Possible Consequences: Acquiring forested and emergent wetland habitat would offer lasting protection to those habitats, however, given these habitats are already "protected," conserving upland buffers probably would offer greater opportunities for conservation success for the same cost. Failure to protect the actual wetlands will result in relying on state and federal regulations for protection (i.e., buffers provided by NRPA, shoreland zoning, and provisions of the Clean Water Act). Failure to protect the upland buffer could result in loss of habitat quality, and ultimately, loss of species abundance and richness. Acquisition or easement of lands encompassing or buffering wetlands would benefit willing sellers and potentially raise the value of neighboring parcels, outside but adjacent to conservation lands. Seizure of property under eminent domain is not a reasonable option. Towns may receive less property tax revenue for conserved parcels unless funds can be raised at the time of purchase to offset future tax liability.

Outreach Objective: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of wetland passerines and their habitat requirements in Maine.

Desirability: A public informed about a broad array of species, which in general emphasize the value of wetlands, would be a positive step toward conservation of these habitats for passerines and other wildlife.

Feasibility: Development of a formal outreach program is possible, but will require significant partnerships with other agencies and conservation NGO's and additional funding. Many programs may be in place already via the Maine PIF Working Group and simply need to be fleshed out. Development of outreach materials (e.g., posters, pamphlets, signage) will require more funding than is currently available and will likely require reliance on MDIFW's Division of Information and Education.

Capability of the Habitat: Not applicable.

Possible Consequences: A successful outreach program could help build private partnerships for wetland stewardship, monitoring, and protection that are not currently in place.

Grassland Passerines

Goal: Increase the populations of grassland passerines, and increase the understanding and appreciation of grassland passerines and their habitat requirements in Maine.

Population Objective 1: Identify grassland passerines whose populations are declining in Maine and stabilize and begin to reverse the decline by 2015. Priority should be given to those species that have greater than 5% of their global populations breeding in Maine.

Desirability: Reversing the declines of these species is sorely needed, especially for Bobolinks. Some steps that would stem the declines in these species will be viewed as undesirable by the farmers who already may operate on a narrow profit margin. Striking a balance between the needs of farmers and grassland birds would be the most desirable. Whether this can be done while stabilizing and reversing population declines, is unknown.

Feasibility: Of the five species of passerines considered in this section, Horned Lark and Vesper Sparrow have inadequate monitoring to determine population trend. It is not feasible to develop such a program just for Vesper Sparrow especially in view of upcoming planning for Upland Sandpiper, which shares blueberry barren habitat with Vespers throughout the state. Monitoring of Horned Larks too is problematic in that the species is largely restricted to Aroostook County agricultural lands where relatively few experienced birders live. It is feasible to build a network of volunteers to do this, but may not be desirable given their low (probably <1%) proportion of global population occurring in Maine.

Stabilizing the populations of Bobolinks and Eastern Meadowlarks is feasible, but not without building significant partnerships, acquiring additional funding, and increasing staff dedicated to grassland bird populations. Population trends for these species have been significantly declining for decades, and the specific actions needed to reverse these declines have only been generalized. It is feasible to work toward this objective, but it remains unclear whether or not it is achievable even with increased funding and/or reallocation of personnel time. Unfortunately, this may only be possible once populations have declined to very low levels.

Capability of the Habitat: Today, Maine is approximately 90% forested, and the amount of grassland and barren habitat is probably stable or declining. Decade-long declines in some grassland species reflect the long-term declines in their habitat. The extensive agricultural lands of the early 1900's are now largely reforested, especially in southern Maine. The amount of grassland and barren habitat needed to meet this objective probably exists, but will continue to decline in quality through intensification of agriculture, especially haying, on limited remaining lands and to reforestation of lands abandoned within the last few decades.

Possible Consequences: The consequences of not reversing the declines of Bobolink and Eastern Meadowlark may be much reduced population size with occurrence only on the remaining best quality sites. This situation may actually have taken place with Horned Larks, which once bred in the extensive agricultural lands of central Maine but are now largely restricted to Aroostook County. Populations of Vesper Sparrow will persist, but success will be linked closely to conservation of Upland Sandpiper and management strategies employed by the blueberry industry. Agricultural interests could see increasing pressure to alter farming practices shown to be detrimental if any of these species becomes increasingly rare.

Population Objective 2: Through 2015, maintain and monitor grassland passerines whose populations have been stable or increasing since 1980.

Desirability: A stable or increasing population of this grassland species is desirable.

Feasibility: Currently, this objective includes only Savannah Sparrow and is easily obtainable without significant further attention. Savannah Sparrows are adequately monitored by the BBS and would require only periodic review of trend estimates.

Capability of the Habitat: Sufficient habitat exists to meet this objective; reduction in patch size would be the only immediate concern.

Possible Consequences: Maintaining stable or increasing populations of Savannah Sparrows will benefit conservation of this species in our region, although Maine holds only a small portion of the global population of this species.

Habitat Objective 1: Identify all priority grassland habitats in Maine and improve habitat quality at 50% of these sites by 2007.

Desirability: This would be the most likely means to achieve both population goals and is clearly desirable.

Feasibility: Priority grassland bird populations were identified by the grassland bird survey conducted by Andy Weik (1997-1999). Priority habitats can be identified simply from this database. Research is needed to fully understand what constitutes high quality habitat and how it can be maintained and or enhanced through management practices. For example, why are hayed fields of similar size occupied by several species of grassland birds, whereas sites of similar size that are only mowed (i.e., bushogged) less acceptable? Improving habitat quality at ½ of these sites could be achieved within the time frame though not without significant outreach, partnerships, research, and assistance.

Capability of the Habitat: Improving habitat quality will likely take the form of altering (i.e., delaying) mowing practices, increasing acreage of controlled burns, etc. Grassland habitats in Maine should respond favorably (i.e., improve in quality) to such management practices.

Possible Consequences: Achieving this objective could help to stabilize the populations of declining grassland birds. Failure to achieve this objective will permit the continued erosion of populations of several species in Maine. Delaying timing of mowing is a logical step toward improving habitat quality, but would result in lowered quality of hay and potentially less production per acre with reduced “second crops”. Lowering hay quality and quantity has obvious negative effects on farmers. However, the average landowner seeking to “keep their fields clear of brush” could do so with no economic impact by delaying mowing. Airports might actually spend less money if they were to allow grassy approaches to runways develop over the course of the growing season. Use by gulls and geese too would likely be reduced if mowing were less frequent.

Habitat Objective 2: By 2015, improve management practices to enhance grassland passerine populations on at least 100 additional grassland sites.

Desirability: This approach would be significant in helping to achieve both population goals and is clearly desirable.

Feasibility: Research is needed to fully understand what constitutes high quality habitat and how it can be maintained and or enhanced through management practices. For example, why are fields of similar size that are hayed occupied by several species of grassland birds whereas sites that are only mowed not as acceptable? Improving habitat quality at ½ of these sites could be achieved within the time frame though not without significant funding, partnerships, research, assistance, and outreach.

Capability of the Habitat: Improving management practices will likely take the form of altering mowing practices, increasing acreage of controlled burns, etc. Grassland habitats in Maine should respond favorably (i.e., improve in quality and in fledging success) to such management practices.

Possible Consequences: Achieving this objective could help to stabilize the populations of declining grassland birds. Failure to achieve this objective will permit the continued erosion of

populations of several species in Maine. Delaying timing of mowing is a logical step toward improving habitat quality, but would result in lowered quality of hay and potentially less production per acre with reduced "second crops". Lowering hay quality and quantity has obvious negative effects on farmers. However, the average landowner seeking to "keep their fields clear of brush" could do so with no economic impact by delaying mowing. Airports might actually spend less money if they were to allow grassy approaches to runways develop over the course of the growing season. Use by gulls and geese too would likely be reduced if mowing were less frequent.

Outreach Objective: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of grassland passerines and their habitat requirements in Maine.

Desirability: A public informed about a broad array of species, which in general emphasizes the value of grasslands and barrens, would be a positive step toward conservation of these habitats for passerines and other wildlife.

Feasibility: Development of a formal outreach program is possible, but will require significant funding and partnerships with other agencies and conservation NGO's. Many programs may already be in place via the Maine PIF Working Group and simply need to be fleshed out. Development of outreach materials (e.g., posters, pamphlets, signage) will require more funding than is currently available and likely will require reliance on MDIFW's Division of Information and Education.

Capability of the Habitat: Not applicable.

Possible Consequences: A successful outreach program could help build private partnerships for stewardship, monitoring, and protection of early successional habitats that are not currently in place.

Swallows

Goal: Maintain the diversity and abundance of swallows, and increase the understanding and appreciation of swallows and their habitat requirements in Maine.

Population Objective: By 2003, develop and implement a monitoring system for Purple Martins and Bank Swallows that will have a 90% probability of accurately detecting population trends to within 15% by 2013.

Desirability: Knowing population trend for all passerines is desirable. Bank Swallows are currently monitored adequately by the BBS in Maine; their population trend estimate, however, is nonsignificant despite a large negative trend with over 20 routes reporting this species. Unfortunately, this objective ignores Rough-winged Swallow for which no trend data exist. It would be more desirable to have at least some trend data for Northern Rough-winged Swallows than to reduce variation in Bank Swallow trend data. However, this would be difficult owing to the noncolonial nature and some difficulty of identification (i.e., potentially confused with other species of swallows) of Northern Rough-winged Swallows.

Feasibility: This objective is feasible because of the small numbers of colonial nesting sites, but would require significant volunteer participation and coordination. It is unclear how many

colonies would be needed to meet the monitoring criteria prescribed in this objective. Furthermore, MDIFW has no data regarding how many colonies of each exist. Clearly, there are fewer Purple Martin colonies in Maine than those of Bank Swallows, therefore, if too few exist, it may not be possible to meet the objective statistically for Purple Martins.

Capability of the Habitat: Not applicable.

Possible Consequences: Achieving this objective would provide trend data for Purple Martin which would assist with evaluating the status of their population in Maine and perhaps suggest management options for enhancing their populations. In contrast, additional data on Bank Swallows would be useful, as high variability exists in their trend estimate from the BBS.

Outreach Objective: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of swallows and their habitat requirements in Maine.

Desirability: A public informed on the importance of conservation of Maine swallows is highly desirable. Tree Swallows, in particular, would make excellent models for classroom-based outreach.

Feasibility: Development of a formal outreach program is possible, but will require significant partnerships with other agencies and conservation NGO's. Many of these may already be in place via the Maine PIF Working Group and simply need to be fleshed out. Development of outreach materials (e.g., posters, pamphlets, signage) will require more funding than is currently available and will likely require reliance on MDIFW's Division of Information and Education.

Capability of the Habitat: Not applicable.

Possible Consequences: An informed public may enhance nesting opportunities for Purple Martins and Tree Swallows. Furthermore, knowledgeable Maine citizens may be more sensitive to Bank Swallows nesting in gravel pits, Cliff Swallows on sides of buildings, and to tolerating Barn Swallows in rural outbuildings.

Passerine Problems and Strategies

Problems and Strategies for All Groups of Passerines

Problem: Groups contain too many individual species. Addressing management issues for all species would dilute attention to "at risk" species.

Strategy: Develop featured species approach using PIF priorities as a basis. Also include species of special concern in Maine as well as species with high proportion of global population (>5%) in Maine.

Problem: Some species are not well represented on BBS routes, and therefore, evaluating population trends is problematic.

Strategy: If species that are not currently monitored warrant featured species status, work with partners to develop monitoring program.

Problem: Relying solely on statewide BBS data to monitor population trends may mask what is happening within populations within regions of our state. An increase in singing males assumes increases in paired males and consequently breeding success. Also, need to evaluate for highest priority species, the appropriate metric from BBS data (e.g., # detected per route, # of stops with a species, etc.) to indicate achievement of population objective.

Strategy: On a sample of stops along several BBS routes, examine priority species population dynamics. Evaluate which metric, in addition to statewide trend estimates, is most appropriate indicator to use as measure of progress toward meeting population objective.

Problem: Species may be declining for reasons other than habitat features on the breeding grounds.

Strategy 1: Work with partners to maximize quality of breeding habitat and hence productivity in Maine.

Strategy 2: Continue to provide the best possible monitoring effort to track population declines.

Problem: Habitat objectives assume that habitat quantity or quality on the breeding grounds is limiting populations and that determinants of habitat quality are adequately understood for all priority species.

Strategy: For high priority species, examine relationships between population dynamics (reproductive success, adult survival, etc.) and habitat quality variables to better assess which species are limited on Maine breeding habitats.

Problem: MDIFW does not manage enough habitat to meet the needs of all species of passerines, nor is the upland habitat required by some of these species protected by state law.

Strategy: Significant conservation ownership/easement exists in Maine. Work with Maine Audubon and others to develop Important Bird Areas program. Use a conservation lands coverage together with IBA database to determine what proportion of priority species populations currently occur on "protected" lands.

Problem: MDIFW does not maintain a current coverage of all conservation lands in Maine. Furthermore, any data that we do have are not updated annually.

Strategy: Work with Habitat Group and perhaps State Planning Office to determine agency roles in developing and maintaining a current data layer of all lands under conservation ownership/easement.

Problem: Development of management systems for non-E/T passerines and their implementation need to be integrated, whenever possible, with other species to avoid management actions that compete with one another or that are duplicative.

Strategy: Work with other WRAS Groups to develop, in some cases, integrated management systems, which encompass the needs of several species given their close habitat association. Initial examples might include: Priority Grassland Passerines/Upland Sandpiper/Grasshopper Sparrow and also Priority Shrubland Passerines/Black Racer/New England Cottontail.

Problem: Greater outreach regarding passerine conservation in Maine (Northeast?) is sorely needed.

Strategy: Develop significant outreach programs, perhaps by partnering with other states in the region via NEPIF or through Cooperative Extension to develop materials addressing domestic cat predation, timing of mowing ("bushogging" abandoned fields especially), bird feeding and disease, the role of the small landowner, timing and dosages of herbicides and insecticides, towers and other lighted structures.

Problem: Some species require large patch sizes for a site to be suitable for breeding.

Strategy: Whenever possible, incorporate patch size into habitat conservation initiatives and acquisition priorities by giving preference to sites with large patches, especially in forest and grassland communities.

Problem: Some bird populations can reach nuisance levels in localized areas (e.g., Red-winged Blackbirds in sweet corn, roosting and staging at airports).

Strategy: Develop protocol for dealing with nuisance passerines, presumably through agreement with Regional Biologists.

Problem: The number and scope of objectives identified by the working group cannot be met with current levels of staffing. Furthermore, there are no Bird Group funds available to address any of the objectives; therefore, all funding will need to be raised from outside sources. That level of fund raising will detract from the amount of time dedicated to actual conservation efforts. More importantly, the Bird Group lacks discretionary money that can be used to match against partner contributions.

Strategy: The Department needs to obtain additional sources of funding and/or redistribute existing personnel time to ensure progress toward these objectives.

Additional Problems and Strategies for Forest Passerines

Problem: Length of population cycles for some species may preclude determining long-term patterns within the 15-year planning period.

Strategy: Consider extending this objective into the next planning period, depending on progress toward meeting it, while developing long-term partnerships with other agencies and species experts.

Problem: At population lows for some cyclical species, distribution may be too "spotty" to effectively evaluate trend.

Strategy: Select featured species (if possible) that have not shown extreme lows during population cycles. However, for this reason, these species may not be the best indicators.

Problem: Despite several studies examining forest bird habitat selection and response to forestry practices, information on priority species abundance and interaction with congeners is limited. The habitat objective assumes that effects of forest management on bird populations are well known.

Strategy: Examine habitat relationships that focus on the effects of current forest management practices on priority species (or groups of priority species). Emphasis should be placed on study sites/populations that can be revisited in the future, but recognizing that forest practices are constantly changing. Studies within the current planning period should address the continuum of cutting practices often referred to as "partial cutting."

Problem: MDIFW does not have control over changes in forest management practices nor is forest habitat by itself protected by state law.

Strategy: Assuming industrial forestland will be managed for timber production in the long term, the critical issue is the amount and distribution of various stand types and age classes in space and time (a.k.a. shifting mosaic model). Work with John Hagan and others to develop cooperative agreements with landowners that allow no species to be lost from the landscape. Evaluate a statewide habitat monitoring

approach using satellite imagery and GIS to track broad changes in community types. Whenever possible use actual stand data from forest landowners to monitor these trends and to determine relationships between stand data and species abundance.

Additional Problems and Strategies for Shrubland Passerines

Problem: Improving habitat for shrubland species may lead to increased rates of brood parasitism by Brown-headed Cowbirds.

Strategy: Most studies of brood parasitism have not focused on predominantly forested landscapes like those in Maine. Examine presence of landscape-level thresholds above which brood parasitism becomes important. Also, determine effects of new corridors (e.g., Maritimes and Northeast Gas Pipeline) on increasing distribution of brood parasites.

Additional Problems and Strategies for Wetland Passerines

Problem: Only 3 of 9 species in this category are adequately monitored by the BBS. Determining population trends for all species would require several small monitoring programs.

Strategy: Prioritize efforts toward meeting this objective by examining the likelihood of population decline. This would entail:

1) Species prioritization (presumably based on % of global population in Maine),
2) Evaluation of existing trend estimates at the northeast region level,
3) Consideration of trends in preferred habitats. Also, use Job 113 matrix to further refine priorities for these species.

Problem: Wetland habitat cannot be easily created or altered without significant federal review and approval.

Strategy: Where habitat alteration is critical to species management, enlist partners, especially within the Atlantic Coast Joint Venture, NABCI, and PIF, to work toward raising awareness and thus meeting habitat objectives at the regional level. Develop regional species conservation teams, including multi-agency partners, to address species management.

Problem: Protecting wetland habitat alone may be insufficient to achieve conservation objectives without protecting upland buffers. The role of upland buffers and their size (width) requirement in different landscapes is poorly understood, as is effectiveness of current set backs provided by shoreland zoning.

Strategy: Evaluate the need and effectiveness of upland buffers in commercial/suburban vs. undeveloped landscapes. Also, determine the appropriate set back distance (efficacy of buffers) for development near various wetland types (saltmarsh, emergent fresh marsh, riparian/floodplain forest, etc.).

Additional Problems and Strategies for Grassland Passerines

Problem: Only 3 of 5 species in this category are adequately monitored by the BBS. Determining population trends for all species would require small supplemental monitoring programs.

Strategy: Prioritize efforts toward meeting this objective by examining the likelihood of population decline. This would entail:

1) Species prioritization (presumably based on % of global population in Maine),
2) Evaluation of existing trend estimates at the northeast region level,
3) Consideration of trends in preferred habitats. Also, use Job 113 matrix to further refine priorities for these species.

Problem: Agricultural practices, chiefly mowing, are linked to significant brood mortality for some species. Farmers are continually trying to harvest hay earlier in the season to maximize production and feed quality, and this exacerbates breeding success for species such as Eastern Meadowlark and Bobolink.

Strategy: This is a paradox without a simple solution. Some gains may be made through outreach, which encourages “leave strips” or mowing small fields (with presumably lower richness) first, or simply sacrifice bird production in fields close to the farm; fields mowed later (i.e., often leased or rented, of marginal quality, or far from base of operations) will be productive in years when mowing is delayed for any reason (e.g., wet weather, mechanical failure).

Additional Problems and Strategies for Swallows

Problem: Population objective requires developing a monitoring program for Bank Swallows, which are already adequately monitored by the BBS. In contrast, the objective overlooks Northern Rough Winged Swallow for which no trend data exist.

Strategy: Correct this oversight by replacing, in practice, Bank Swallow with Northern Rough-winged Swallow.

GRASSLAND PASSERINE MANAGEMENT SYSTEM

Thomas P. Hodgman

Bird Group

Wildlife Resource Assessment Section

Maine Dept. of Inland Fisheries and Wildlife

650 State St., Bangor ME 04401

Final: 31 January 2005

TABLE OF CONTENTS

Page

INTRODUCTION 3

MANAGEMENT GOALS AND OBJECTIVES 3

MANAGEMENT DECISION-MAKING PROCESS 5

POPULATION MANAGEMENT SYSTEM 5

HABITAT MANAGEMENT SYSTEM 10

OUTREACH MANAGEMENT SYSTEM 15

REFERENCES 17

LIST OF FIGURES

FIGURE 1. Flow diagram depicting decision criteria for Population Management System for grassland Passerines in Maine 6

FIGURE 2. Flow diagram depicting decision criteria for Habitat Management System for grassland Passerines in Maine 11

FIGURE 3. Flow diagram depicting decision criteria for Outreach Management System for grassland Passerines in Maine 16

INTRODUCTION

This document describes the process used by the Department of Inland Fisheries and Wildlife (MDIFW) to implement research and management programs for obligate grassland songbirds. The species composition of this group of birds was defined by Hodgman (1998) in an assessment of research and management needs. From that assessment, a public working group, convened during summer of 2000, established goals and objectives for management of Maine's grassland Passerines. In addition, an evaluation of the desirability, feasibility, capability of the habitat, and possible consequences have been identified, and a series of problems and strategies for overcoming limitations of the goals and objectives has been drafted.

Among the approximately 120 Passerines that occur in Maine at various times of the year, only a small percentage (about 7%) can be considered grassland obligates. These include 7 species covering 2 families; 4 species occur in Maine only during the breeding season (Vesper Sparrow, Savannah Sparrow, Bobolink, and Eastern Meadowlark), whereas 2 species (Lapland Longspur and Snow Bunting) occur only during the winter. Horned Larks occur in Maine throughout the year, however, most wintering birds are of the *alpestris* subspecies migrating to Maine probably from eastern Canada. Two species, Grasshopper Sparrow and American Pipit, are not directly addressed by this system as they are both Endangered in Maine and consequently warrant individual plans. Probably more than for any other group of songbirds, the management of habitat for grassland Passerines would have direct benefits for other grassland birds, several of which are either Endangered, Threatened, or of special concern in Maine. In addition to Grasshopper Sparrow and American Pipit, species such as Upland Sandpiper, Short-eared Owl, and Northern Harrier will assuredly benefit from the habitat management and outreach that will result from this system.

MANAGEMENT GOALS AND OBJECTIVES

The strategic planning process employed by MDIFW solicits public input in the development of goals and objectives for species management. The following were developed for grassland Passerines:

Goal: Increase the populations of grassland birds, and increase the understanding and appreciation of grassland birds and their habitat requirements in Maine.

Population Objective 1: Identify grassland Passerines whose populations are declining in Maine and stabilize and begin to reverse the decline by 2017. Priority should be given to those species that have greater than 5% of their global populations breeding in Maine.

Population Objective 2: Through 2017, maintain and monitor grassland Passerines whose populations have been stable or increasing since 1980.

Assumptions

- Meaningful objectives can be set at the state level for long-distance migrants given their complex life histories.

- When using North American Breeding Bird Survey (BBS) data to indicate population trend, assume that trend estimates based primarily on counts of singing males are representative of trends for the entire population.

- Sufficient BBS data exist for all species, but especially "priority species" (e.g., those with >5% of their global breeding population in Maine).

- The threshold of 5% is indeed appropriate.

- For species with declining trend or evidence of a declining trend, assume that management activities in Maine can contribute to reversing trend even though the most limiting factor may not be known.

- 1980 is an appropriate date from which to base population change.

- For species in decline for which evidence of cause is closely linked to forces outside Maine, assume detailed monitoring of the population is Maine's greatest contribution to conservation of the species.

Habitat Objective 1: Identify all priority grassland habitats in Maine and improve habitat quality at 50% of these sites by 2007.

Habitat Objective 2: By 2017, improve management practices to enhance grassland bird populations on at least 100 additional grassland sites.

Assumptions

- Priority grassland habitats can be identified based on existing data and technology.

- Determinants of habitat quality for all priority species are known or can be determined.

- Limitations in either amounts or quality of habitat (including management practices) in Maine are influencing population trend.

- 100 additional sites can be identified and landowners contacted to pursue recommendations that will benefit grassland Passerines.

- The amount of conservation land currently in Maine is inadequate to ensure long-term protection of all species in this group at desired levels.

<u>Outreach Objective</u>: By 2005, develop and begin implementing an outreach program that increases the understanding and appreciation of grassland birds and their habitat requirements in Maine.

Assumptions

- "Understanding" refers to an individual's knowledge of a species life history, niche, and conservation status in Maine.

- "Appreciation" refers to an individual's awareness of the difficulties involved in managing a species population or habitat, given current social, political, and financial constraints.

- An appropriate (and receptive) audience can be identified and targeted by above plan.

- A formal outreach plan, however brief, is actually needed.

MANAGEMENT DECISION-MAKING PROCESS

The following three-part management system provides the framework for managing populations and habitats of grassland Passerines in Maine. Further, it identifies a system for improving public understanding and appreciation of this group of birds.

POPULATION MANAGEMENT SYSTEM

<u>Decision Criteria</u>

The following criteria determine the sequence of procedures used to conserve grassland Passerine populations in Maine (Fig. 1). Although this system applies to all species described above, it operates on an individual species basis (i.e., each species is to be run through each population criterion separately). Furthermore, this approach is to be carried out in the form of an annual review, because of the dynamic nature of species priority/special concern lists, population trend estimates, etc.

Criterion A: *Have all species been reviewed for priority status?*

This criterion addresses whether each of the 7 species addressed by this system has been reviewed by this agency to determine the relative urgency of conservation action. The Passerine Working Group simply recommended using a threshold of 5% of global population breeding in Maine as one criterion for prioritization. However, various organizations and agencies since the 1980s have developed, sometimes elaborate, ranking systems to focus attention on certain species (NESWDTC 1999, Carter et al. 2000). These lists of priority birds, in addition to the 5% threshold, are the source of "data" to respond to this criterion.

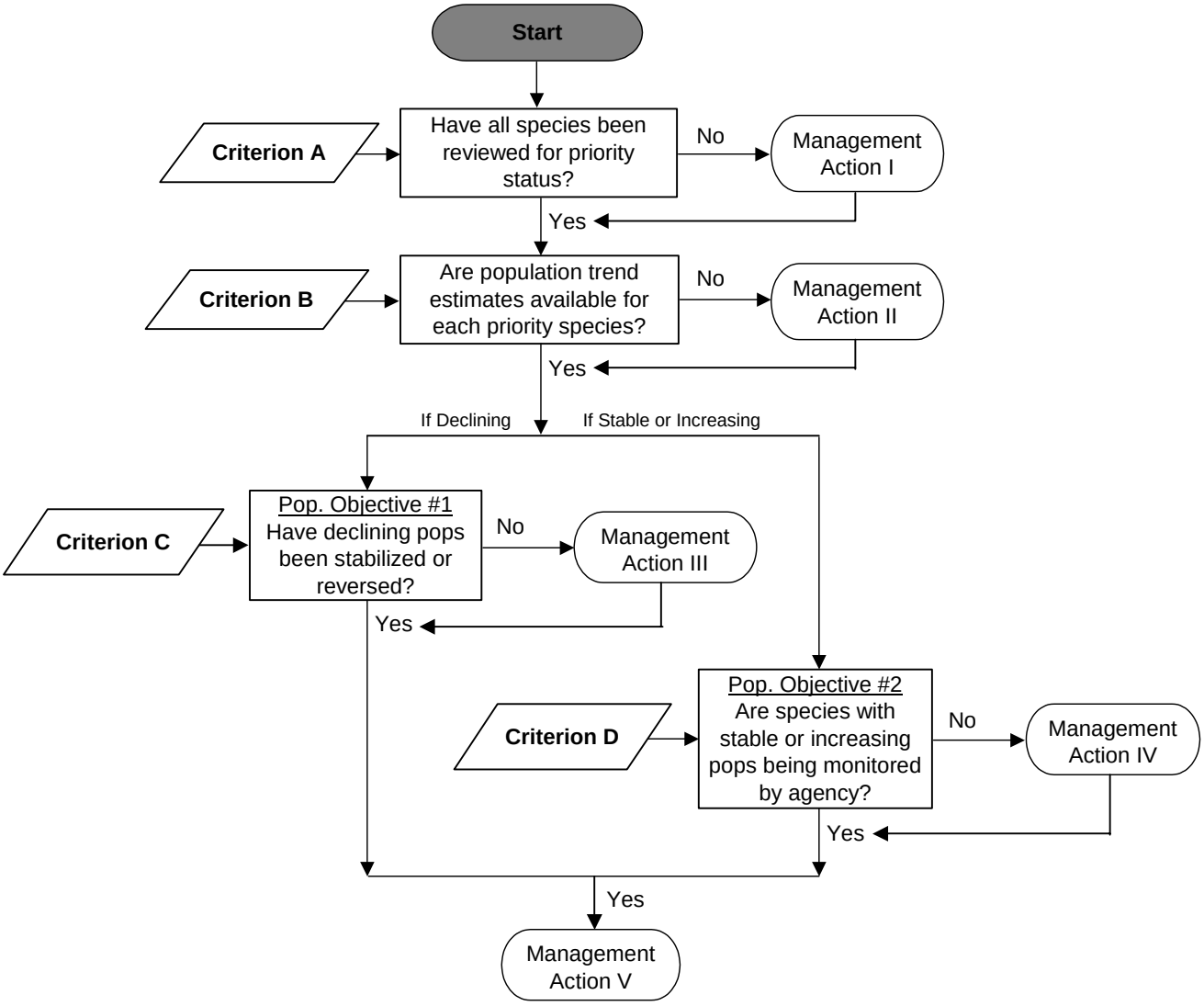

Figure 1. Flow diagram depicting decision criteria for Population Management System for grassland Passerines in Maine.

Rule of Thumb: Species will be considered a priority, and thus addressed by this management system, if upon annual review:

1. They are recognized by Partners in Flight (PIF) as priority birds in categories IA, IB, IIA, IIB, and IIC for either the Northern Spruce-Hardwood Forest (Rosenberg and Hodgman 2000), Northern New England (Hodgman and Rosenberg 2000), or Southern New England (Dettmers and Rosenberg 2000) Physiographic Regions, or,

2. They are listed as a priority within Bird Conservation Regions (BCR) 14 or 30 by the North American Bird Conservation Initiative, or,

3. They are listed by the U.S. Fish & Wildlife Service (USFWS) as a species of management concern, or,

4. They are listed by the Northeast Endangered Species and Wildlife Diversity Technical Committee as a species of conservation concern (NESWDTC 1999), or,

5. They are considered by MDIFW to be a species of special concern, or if,

6. >5% of their global population occurs in Maine.

An affirmative response will require that all appropriate prioritization lists (see "Rule of Thumb" above) and population data have been reviewed (annually) to determine if any of the species in this group qualify. A list of these species will be prepared annually.

Criterion B: *Are population trend estimates available for each priority species?*

This criterion addresses the adequacy of current monitoring programs in Maine. Currently, the North American Breeding Bird Survey (BBS) provides the only reliable data and trend estimates for Passerines breeding in Maine. Also, National Audubon's Christmas Bird Count (CBC) provides data and trend estimates for winter residents.

An affirmative response will require statistically reliable trend estimates based on BBS and/or CBC data.

Rules of Thumb: If species trend estimates are only available from the BBS:
Trend will be based on at least 14 routes in Maine with $P \leq 0.10$ from the most recent half of the BBS period (i.e., currently 1980-2003). If <14 routes are available for Maine in that time period, use trend estimates (same *P*-value and time frame) for Northern New England or Eastern Spruce/Hardwood regions (switch this to BCR 14 or 30 when available) if based on $\geq$ 30 routes for either region.

If species trend estimates are only available from the CBC:
Trend will be based on $\geq$10 circles for Maine.

If species trend estimates are available from both BBS and the CBC:
Use estimate with greatest power according to geographic rule described above.

Trends not conforming to one of these rules of thumb are not reliable.

Rule of Thumb: A declining trend is a statistically significant (P < 0.10) estimate of negative (-) population change.

Criterion C: *For species with declining populations, have declines been stabilized or reversed??*

This criterion addresses whether species with documented declines are no longer in decline. Trend estimates from the BBS and CBC will be the primary sources of data for this criterion.

An affirmative response will require statistically reliable trend estimates.

Rule of Thumb: Populations have stabilized when a species' declining trend ceases to be significant (i.e., $P > 0.10$) for three consecutive yearly updates to either the BBS or CBC. However, estimates must have been based on at least 14 routes or 10 CBC circles (or 30 routes for Northern New England or Eastern Spruce Hardwood regions when Maine data are unreliable) for 3 consecutive years. Population declines have reversed (i.e., increasing) when a species' declining trend (or nonsignificant trend) becomes positive (+) and is significant at $P < 0.10$ for three consecutive yearly updates to either the BBS or CBC. Estimates must be based on at least 14 routes (10 CBC circles) for Maine, or if Maine data are insufficient, 30 routes for Northern New England or Eastern Spruce Hardwood regions.

Criterion D: *Are species with stable or increasing populations being monitored by agency?*

This criterion addresses whether populations of any of the 7 species covered by this management system are stable or increasing and are considered a priority under Criterion A. Further, it asks if these populations are being monitored by MDIFW Staff or its volunteers or partner organizations or agencies. Sources of data for this criterion arise from the North American Breeding Bird Survey (BBS), the Christmas Bird Count (CBC) or local monitoring programs. Trend estimates from these programs provide the data to evaluate this criterion.

An affirmative response will require statistically reliable trend estimates (see "Rule of Thumb" under Criterion B) based on BBS, CBC, or other data.

Rule of Thumb: A stable trend is an estimate of population growth that is either positive (+) or negative (-), but not statistically significant (i.e., $P > 0.10$). An increasing trend is one where population growth is positive (+) and statistically significant (i.e., $P > 0.10$). Note: adequate data (number of routes or circles) are critical to making these judgments, so the "Rule of Thumb" under Criterion B must be followed closely.

Management Actions

The following management actions are the recommended procedures for accomplishing population objectives. Specific management actions result from responses to decision criteria identified in Figure 1.

Management Action I

1) Annually, determine if any species covered by this management system meet priority criteria listed in “Rule of Thumb” under Criterion A.

2) Prepare list of species that will be considered a priority for this management system.

Management Action II

1) If possible, improve BBS coverage by:
    a. Enlisting new volunteers and encouraging long-term commitments.
    b. Increasing participation among currently assigned routes to $\geq$ 90%, or at least 63 of 70 routes run, each year. Participation has declined steadily over the past several years: 1995 (90% of available routes were run), 1996 (100%), 1997 (80%), 1998 (82%), 1999 (70%), 2000 (58%), 2001 (57%), 2002 (49%), and 2003 (41%). Accomplish this via:
        i. Sending a letter to all observers thanking them for their volunteer participation and explaining the importance of BBS data to monitoring species populations.
        ii. Making a follow up phone call to volunteers who have not run their assigned route two or more times since 1997. Encourage these individuals to resume survey or relinquish route to another interested individual.
    c. If possible, increase total number of routes available in Maine. This is not likely for the foreseeable future as the number of routes was recently increased (to 70 routes) for the 2002 survey.

2) If priority species is only a winter resident, encourage increased participation in CBC by:
    a. Determining levels of participation in each Maine circle.
    b. Working to increase participation in circles with few volunteers especially in remote locations.
    c. Ensuring that data from all circles are submitted for analysis by contacting delinquent compilers (if any).
    d. Identifying areas that can support additional circles.
    e. Identifying individuals that can serve as “new” compilers.
    f. Working with local NGO’s to generate volunteers to count in “new” circles.

3) Develop separate monitoring programs for species not adequately monitored by the BBS or CBC if they are recognized as a priority under Criterion A. This will require additional volunteer support and may be coordinated with Maine Audubon.

4) If unsuccessful, or deemed to have too little power to detect trends using BBS at state scale, build partnerships in northeast region to:
    a. Expand BBS coverage using above-mentioned steps, and/or
    b. Develop regional monitoring program specifically targeting poorly monitored species (e.g. Project Mountain Birdwatch).

Management Action III

1) Determine factors contributing to population decline

2) Differentiate between factors that can be affected in Maine and those that cannot.

3) For habitat-related factors, establish partnerships to improve habitat for declining species by:
    a. Identifying stakeholders.
    b. Seeking consensus among experts regarding highest priority approaches to recovery.
    c. Referring to the Habitat Management System.

Management Action IV

1) Review BBS and CBC trend estimates for all priority species.

2) List each priority species with either reliable nonsignificant trends or significant positive trends.

3) Monitor trend estimates annually.

4) Develop monitoring program for species inadequately monitored by existing programs, but assumed to be stable or increasing.

Management Action V

1) Reconvene public working group to revise population objectives for priority species.

HABITAT MANAGEMENT SYSTEM

Decision Criteria

The following criteria determine the sequence of procedures used to conserve habitat for grassland Passerines in Maine (Fig. 2).

Criterion E1: *Has a system been developed to prioritize individual grasslands with regard to their importance to grassland Passerines?*

This criterion evaluates which factors should be considered when determining which grasslands should be the focus of agency efforts. A review of the literature pertaining to habitat selection of priority grassland Passerines (and E/T grassland species as well), and the ongoing efforts by Habitat Group to identify these, will be the source of information to answer this criterion.

An affirmative response will require that this review has been completed.

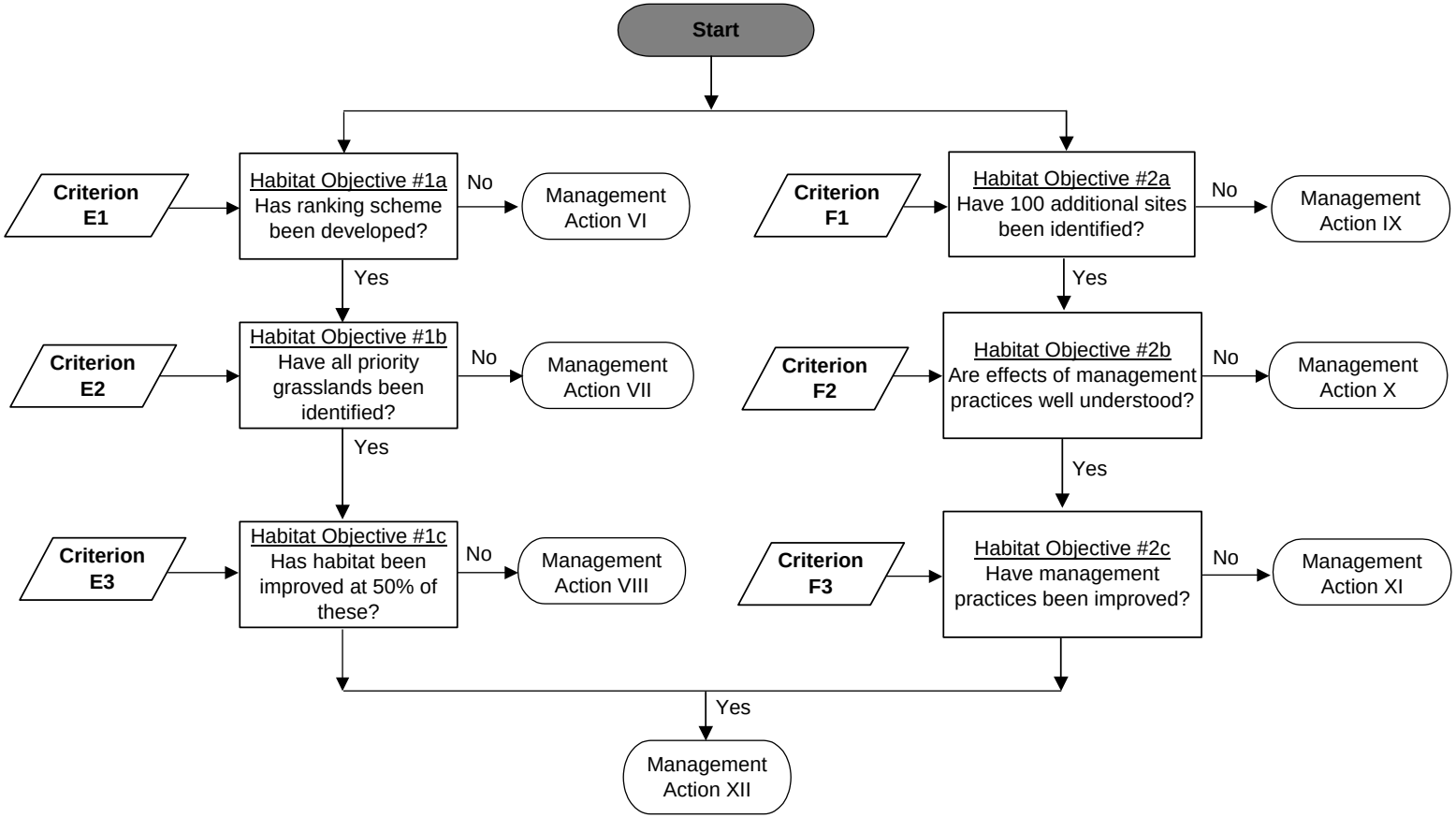

Figure 2. Flow diagram depicting decision criteria for Habitat Management System for grassland Passerines in Maine.

Criterion E2: *Have all priority grasslands been identified?*

This criterion evaluates whether the above prioritization scheme has been used and if individual sites have been identified and their locations mapped. Status of the Habitat Group's Grassland Project will be the source of information to answer this criterion.

An affirmative response will occur when a summary document listing the locations of each priority grassland is available and a GIS coverage of their locations has been developed.

Criterion E3: *Has habitat for grassland Passerines been improved at 50% of the priority sites?*

This criterion addresses whether management actions to improve habitat at ½ of the sites has been accomplished.

An affirmative response will be achieved when management actions at >50% of the listed priority grasslands has been initiated.

Criterion F1: *Have an additional 100 grassland sites been identified for management?*

This criterion addresses whether, in addition to the priority sites, 100 other sites have been identified for potential improvement in management to benefit grassland Passerines.

An affirmative response will require a list of 100 sites, their location, and landowner contact information.

Criterion F2: *Are the effects of various grassland management practices on populations of grassland Passerines in Maine well understood?*

This criterion addresses whether agency staff understand the relative importance of various grassland management practices on the persistence and productivity (via either actual nest success data or indices of reproduction) of grassland Passerines. A review of the scientific literature and consultation with experts, as well as results of our own investigations, will form the basis to evaluate this criterion.

An affirmative response can be made when a summary document describing and comparing various management practices affecting grassland Passerines has been reviewed (if outside our agency) or drafted (if done by our own staff).

Criterion F3: *Have management practices on these 100 sites been altered to improve conditions for grassland Passerines?*

This criterion addresses whether steps have been taken to alter land management activities to benefit grassland Passerines. A list of past and present land management practices for each of the 100 sites forms the basis for evaluating this criterion.

An affirmative response can be made when a summary table has been developed for each site that describes, in detail, which steps have been taken to improve habitat at the site for grassland Passerines.

Management Actions

The following management actions are the recommended procedures for accomplishing habitat objectives. Specific management actions result from responses to decision criteria identified in Figure 2.

Management Action VI

1) Conduct literature review on habitat requirements for all priority grassland Passerines.

2) Prepare list of key habitat characteristics that should be used in a ranking scheme.

3) Compare results of literature review with information available from Habitat Group project.

4) Review data from IFW Grassland Bird survey to determine sites with greatest abundance and diversity.

5) Review Heritage database for occurrences of E/T grassland species.

6) Develop ranking system based on above information.

Management Action VII

1) Create list of sites and generate priority ranks based on scheme described in Management Action VI.

2) Create database of priority Grassland sites that includes the following fields:
    a. Priority Score
    b. Site Name.
    c. Town(s).
    d. Landowner information (if available)
    e. Type of grassland
    f. Management practices
    g. Grassland species present
    h. Element occurrences for E/T grassland species
    i. Comments

3) Create GIS coverage of all priority sites.

Management Action VIII

1) Use database of priority sites to review current management practices at all sites.

2) Identify sites (50% of total number of priority sites) where habitat management, if altered, would benefit grassland Passerines.

3) Contact regional biologists and/or landowner regarding willingness to alter current management.

4) Meet with NRCS staff to explore whether management at some sites could be funded in part by WHIP.

Management Action IX

1) Identify 100 additional sites using the following sources:
    a. Any sites with occurrences of E/T grassland species not included in the “50% of priority sites.”
    b. Sites that met a priority score threshold, but were not included in the 50% targeted for management action.
    c. Sites that have low priority score, but have landowners willing to participate.
    d. State-owned properties that would be easy to manage
    e. Sites already enrolled in WHIP, but that may need slight alterations over time.

2) Create database of 100 additional Grassland sites that includes the following fields:
    a. Site Name.
    b. Town(s).
    c. Landowner information (if available)
    d. Type of grassland
    e. Current Management practices
    f. Grassland species present
    g. Element occurrences for E/T grassland species
    h. Comments

Management Action X

1) Conduct literature review on grassland management practices and habitat quality for all priority grassland Passerines.

2) Identify significant gaps in knowledge and potential consequences.

3) Conduct additional research as needed to fill gaps in knowledge.

Management Action XI

1) Implement alterations to grassland habitat management (following guidelines in Management Action X) on as many sites as possible.

2) Add to database described in Management Action IX the following fields:
    a. Alterations to current management
    b. Dates for each
    c. Area effected
    d. Landowner perception of benefit to Grassland Birds.
    e. Associated costs
    f. Sources of funding.

Management Action XII

1) Reconvene public working group and redraft habitat objective.

OUTREACH MANAGEMENT SYSTEM

Decision Criteria

The following criteria determine the sequence of procedures to be used to improve the understanding and appreciation of grassland Passerines in Maine.

Criterion G1: *Has an outreach plan been developed?*

This criterion simply addresses whether a plan for increasing the understanding and appreciation of grassland Passerines and their habitat requirements in Maine has been assembled.

An affirmative response will be met when a brief document describing outreach materials and a schedule for their distribution have been drafted.

Criterion G2: *Has an outreach plan been implemented?*

This criterion addresses whether a plan for increasing the understanding and appreciation of grassland Passerines and their habitat requirements in Maine has been put in place.

An affirmative response will have been achieved when outreach materials have been developed and distributed.

Management Actions

The following management actions are the recommended procedures for accomplishing outreach objective. Specific management actions result from responses to decision criteria identified in Figure 3.

Management Action XIII

1) Identify target audience.

2) Identify components of plan.

3) Identify and contact potential cooperators (e.g., Maine Audubon, National Wildlife Refuges, etc.).

4) Determine method of delivery (e.g. radio, poster, pamphlet, articles).

5) Identify sites for implementation (e.g., specific refuges and nature centers, radio programs, magazines/newspapers/journalists).

Management Action XIV

1) Prepare outreach materials as planned and scheduled in Management Action XIII.

2) Deliver outreach materials as planned and scheduled in Management Action XIII.

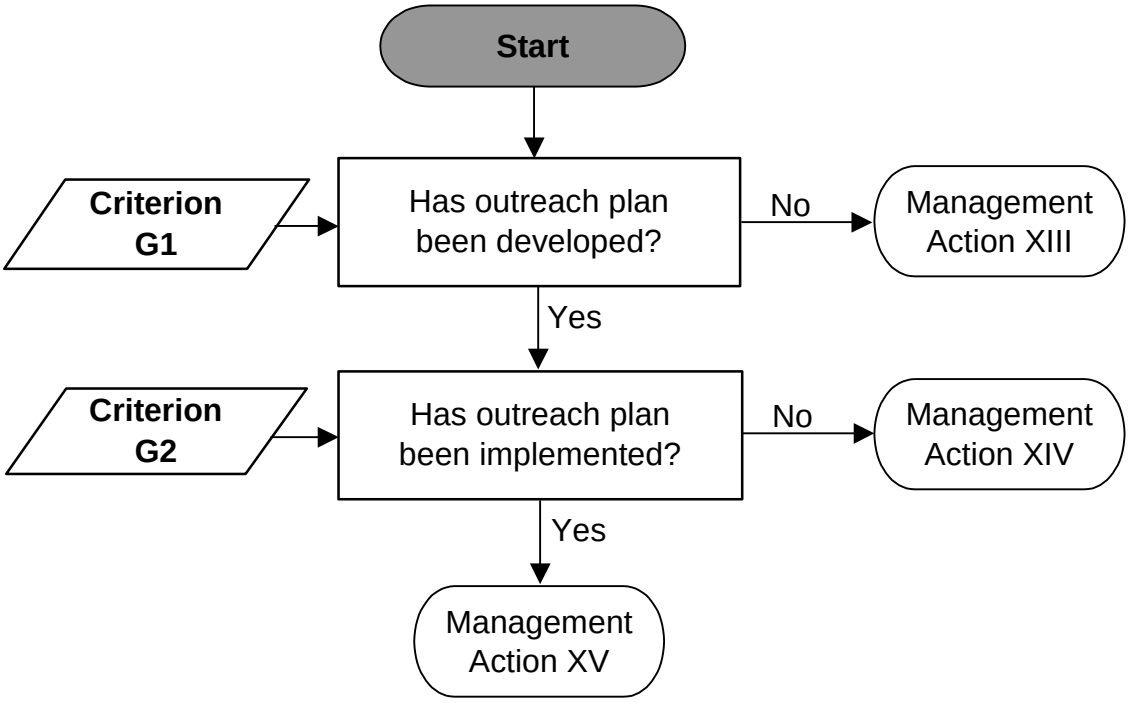

Figure 3. Flow diagram depicting decision criteria for Outreach Management System for grassland Passerines in Maine.

Management Action XV

1) Reconvene public working group and redraft outreach objective.

REFERENCES

Carter, M. F., W. C. Hunter, D. N. Pashley, and K. V. Rosenberg. 2000. Setting conservation priorities for landbirds in the United States: the Partners in Flight approach. Auk 117:541-548.

Dettmers, R. and K. V. Rosenberg. 2000. Partners In Flight Landbird Conservation Plan: Physiographic Area 9: Southern New England. Northeast Partners In Flight Working Group and American Bird Conservancy, The Plains, VA 48pp.

Hodgman, T. P. 1998. Passerine Assessment. Maine Dept. of Inland Fisheries and Wildlife. Wildlife Resource Assessment Section. Bangor, ME 206pp.

Hodgman, T. P. and K. V. Rosenberg. 2000. Partners In Flight Landbird Conservation Plan: Physiographic Area 27: Northern New England. Northeast Partners In Flight Working Group and American Bird Conservancy, The Plains, VA 46pp.

Northeast Endangered Species and Wildlife Diversity Technical Committee. 1999. Wildlife species of regional conservation concern in the northeastern United States. Northeast Wildlife 54:93-100.

Rosenberg, K. V. and T. P. Hodgman. 2000. Partners In Flight Landbird Conservation Plan: Physiographic Area 28: Eastern Spruce Hardwood Forest. Northeast Partners In Flight Working Group and American Bird Conservancy, The Plains, VA 46pp.

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
Inland Fisheries Management System
1991

Inland Fisheries Management System

INTRODUCTION

Although it exists in practice, the "system" used by biologist to manage sportfish in Maine's inland lakes and streams has never been formally documented. The purpose of this portion of the federal aid project renewal documentation is to describe the general criteria used to arrive at management decisions and to define how these decisions are transformed into management procedures or practices, i.e., the management system.

A generic system, as it applies to all species, will be presented. Documentation on the management systems for individual species will be developed in the future, and will be included in the next complete update of Strategic Plans for each species. The same general criteria and management options are often applicable to groups of species, but the values of criteria or levels of a management option may vary by species. For example, if the actual harvest exceeded the allowable harvest for lake trout but was less than the allowable harvest for salmon in the same water, different regulations changes would be needed for each species to bring the overall harvest to the desired level.

DECISION MAKING

The general decision making process for managing the fisheries of a water is illustrated in the flow diagram (Figure 1). The process consists of three elements: (1) information collection and analysis (diagonal boxes in the diagram), (2) problem identification by comparing information with management objectives criteria (diamond shaped boxes), and (3) choice of management options to solve the problem (hexagonal boxes). The diagram includes all information and general criteria used to manage fisheries. However, not all will be applicable to every species or situation. Obviously, if the fishery in question is being managed as a wild population, stocking of hatchery fish would not be considered as a management option. Nor would chemical reclamation be considered as a practical management option in any large lake with a complex drainage system.

Most information needed for the formulation and execution of management plans for individual waters comes from surveys and research conducted by biologists at the seven regional offices and the research staff at Bangor. The biologists not only collect the data, but analyze it, make recommendations and conduct the field management. Management recommendations and work schedules are approved and coordinated by the Director of the Fisheries and Hatcheries Division and the Management Supervisor. A system of Divisional committees is used to formulate general policy, guidelines, and standardized procedures and methods. At present, there are 14 active committees within the Division:

Regulations
Hatchery Fish Quality
Creel Survey
Esocid Management
Planning
Fishing Derby/Bass Tournament
Anadromous-Freshwater Conflicts
Bass Management
Data Management
Hydro-acoustics
River Survey Guidelines
Bait Dealers & Licensing
Angler Questionnaire
Report Format

These committees influence all elements of the decision making process. For example, the Bass Management Committee has directed the surveys needed to obtain biological data on bass, coordinated data collection and established criteria for evaluating management objectives. The Regulations Committee reviews and approves all proposed regulation changes before they are presented for rule making or public hearing, approval of the Commissioner and Advisory Council and final action by the Maine Legislature. The Planning Committee updates statewide species management plans and prepares documentation for federal aid.

FIGURE 1. FISHERIES ASSESSMENT AND DECISION PROCESS

MANAGEMENT ASSESSMENT AND CRITERIA

Public Access

A primary consideration in review of the fishery management plan for a fisheries is whether or not there is adequate public access to the resource, both in terms of the legal access (i.e., rights of way) and in terms of physical access (i.e., pathways and landings). The overall goal of the Department is to secure legal public rights-of-way to all publicly owned waters and to develop, or assist in the development of appropriate pathways and landing facilities. It is the general policy of the Department to cease management, including fish stocking, of any water where access has been denied to the general public by private landowners that exercise trespass rights or threaten prosecution of trespassing anglers or hunters.

A complete list of access needs updated periodically by Regional Fisheries Biologists for each of the seven administration regions. Each list is headed by the top five priority waters in each region. General criteria for determining the adequacy of access and priority of needs are:

- Presence or absence of deeded or de facto rights-of-way
- Existing points of access and facilities
- Public safety conditions
- Degree of public use, primarily fishing pressure
- Public complaints about the difficulty in gaining access
- Relative local, regional, or statewide socio-economic importance of the waterbody
- Size and configuration of the waterbody
- Presence, absence, or configuration of road systems
- Existing or planned land and water use policies or laws

Species Management Goals and Objectives

One of the primary sources of information for the decision making process for the biological management of waters is the set of goals and objectives established for each species that are now documented in the Department's Strategic Plan for Inland Fisheries (Maine Department of Inland Fisheries and Wildlife 1986). Each goal is a general statement of the direction to be taken or the end result to be achieved by management of the species. Objectives are specific levels of achievement which management needs to attain to fulfill the goal. Goals and objectives may be specified for one or more of the following parameters:

- Species distribution
- Population abundance
- Diversity (species, population, or strain diversity)
- Stock densities (fish sizes and ages)
- Allowable harvest
- Angler success rate (number of fish caught or harvested per angler day or hour and percent successful anglers)
- Average size of fish harvested (length and weight)
- Seasonal balance (i.e., summer versus winter)
- Public access

Goals and Objectives given in the Plan are intended to be overall "performance standards" that express an average condition to be maintained by management on a statewide basis. A

management objective for an individual water body may be set below or above the State objective, depending on the productivity of the water body and its suitability as habitat for the species, its level of fishing pressure, and socio-economic-political constraints controlling or affecting public use.

Management goals and objectives are usually statements of the level of fishing quality and quantity that should be maintained or achieved, and are compared to actual trends as revealed by surveys. If stated goals and objectives are being met then the fishery is judged "to be on target" and a continuation of present management practices is indicated. If the fishery is not on target, then the fishery manager continues with a detailed review of survey data to identify specific problems, and decides on the appropriate management option or strategy to bring the fishery up to standard.

Trends in Fishing Quality and Angler Satisfaction

Data collected from on-site creel surveys and volunteer diary reports provide the major source of quantitative information on trends in fishing quality on individual lakes and streams. Questionnaires also provide statistics on general fishing quality on a statewide basis. Certain statistics are used as standard indicators of fishing quality:

- Angler success rate (number of fish caught or kept per angler day or hour
- Average size of fish harvested (length and weight)
- Rate of release of legal fish
- Contribution of wild hatchery fish in mixed populations
- Species composition in the catch
- Proportions of legal and sublegal fish in the catch
- Proportions of size and age groups
- Fish growth rate
- Fish condition factors (ratio of length to weight)

The first two statistics, angler success rate and average fish size, are the primary indicators for fishing quality and are often part of management objectives. Other data on the fishery may also be important. The rate of release of legal fish is valuable for waters where catch and release is being promoted. The proportion of legal and sublegal fish in the catch or proportions of older, large size fish are indicators of exploitation by size and age. The contribution of wild and hatchery fish to the fishery is critical where management is attempting to switch to, or establish a sustainable wild population. Growth rates determine how rapidly fish enter the fishery, and condition factors are indicators of the general health and survival potential of the population. The species composition of the catch is monitored where management is attempting to maintain a desired historical balance of different species.

In Maine, trends in angler satisfaction have seldom been quantified in the form of statistical indicators, although questionnaires have the potentials for obtaining such data. General indications of angler satisfaction come primarily from contacts with anglers during field surveys, public hearings and sportsmen club meetings, visits by the public to regional offices and the Augusta Headquarters, public comment received through the news media, and mailed and phoned correspondence to the Department. Regional biologists and Department administrators are highly sensitive to these public comments and often incorporate them into management decisions. Persistent complaints about poor fishing on a particular water, for example, may confirm statistical trends and thereby reinforce the correctness of pursuing a chosen management option. Public opinion that is at variance with the statistical trends, on the other

hand, may point to the need for more public relations work to inform the public of the facts, or may prompt a re-evaluation of the accuracy of data gathering or analytical methods that generated the statistics.

Public Demand for Species and Species/Habitat Suitability

A change in species targeted for management may be needed if the species is not performing as desired or there is public demand for a change. Because finding the right mix of species and habitat is not an exact science, some fisheries may fail in spite of the best management efforts. Persistent problems with survival or growth of a managed species unrelated to the effects of fishing are an indication that the species is not suited to the habitat and that management should be discontinued in favor of another species. During the early years of fisheries management in Maine, for example, attempts were made to establish salmon and trout fisheries in marginal habitats in order to satisfy local demand for these fisheries. Some of these failed and management was terminated. In a number of cases, brown trout, which are more tolerant of warmer temperatures and competition from warmwater species, provided an acceptable alternative. The use of brown trout in place of native salmonid species that have not performed well continues at the present time.

Although the selection of species for most of the major waters has stabilized, changing habitat conditions may dictate changes in species management. For example, in a few cases deterioration in water quality due to cultural eutrophication has necessitated the termination of lake trout management. The unauthorized introduction of competing species may also force managers to switch to species more tolerant of competition.

Angler Harvest

Over-harvest is indicated when anglers take too many young fish before they reach their growth potential, or in the case of wild fish, before most have a chance to spawn at least once. A condition of under-harvest is indicated when there are too many fish being “stockpiled” in the population, causing intense intra-specific competition and reduced growth rate.

To manage a fishery effectively, particularly if it is undergoing intensive exploitation, it is important to know the total amount of fish being harvested by anglers or at least some reliable index of the harvest rate. Estimates of total harvest require intensive and costly surveys and therefore are not done as frequently as partial surveys that obtain indices. When the total harvest estimate is available, it can be compared to the potential “allowable” harvest to determine whether exploitation is below, above, or at the optimum level. For lakes, the allowable harvest is determined either on the basis of historical data on the past performance of the fishery, or the calculation of a theoretical potential harvest utilizing the morphoedaphic index (MEI) developed by Ryder (1965). Because time-series data on harvest is not available for many waters, fisheries managers are currently using the MEI routinely to establish allowable harvest levels. The MEI is a statistical model that relates fish yield (Y) to total dissolved solids (T) and mean depth (D):

$$Y = 2 \setminus \sqrt{T/D}$$

In practice, the TDS is not measured directly but is obtained from the water conductivity or total alkalinity, which is known to be proportional to the TDS and can be easily measured in the field. There is no method comparable to the lake MEI for estimating potential yield in stream environments. On small streams that can be sampled by electrofishing, estimates of actual fish

populations within representative stream sections are obtained by mark and recapture methods. Estimates obtained over a period of years using standardized sampling procedures are used to determine trends in abundance and size and age structure, which in turn establishes trends in the availability of fish stocks for angling and their response to exploitation. A statewide program for monitoring trout streams is currently in progress. When data on total harvest and population abundance is lacing, indices, such as the catch rate and proportions of age groups in the catch area are used to evaluate relative harvest levels. For example, a high catch rate coupled with a low frequency of fish older than age II or III in the catch of landlocked salmon would indicate heavy exploitation just as they reach legal size, leaving few fish to survive to older ages and more attractive sizes.

Fish Growth and Survival

Stock Balance

A balanced fish population is one that has sufficient numbers of fish in different size and age classes to sustain the population and to provide fishing of a desired quality. Definition of this balance depends on the reproductive, growth, and survival potential of the species in a given environment, and management objectives that specify the level of fishing quality that should be maintained. An imbalance indicates that something is wrong with the population and that corrective management strategies are needed.

At present, Maine fisheries biologists are using the “proportional stock density” (PSD) method (Anderson 1980) and its corollary, “relative stock density” (RSD) as an index of population balance. The PSD is defined as the percentage of the stock that is of a quality size, usually in terms of fish length:

$$\text{PSD (\%)} = \frac{\text{Number} \geq \text{quality size}}{\text{Number} \geq \text{stock size}} \times 100$$

“Stock size” is the length at or near which fish become sexually mature, and is also often the length at which fish become vulnerable to sampling gear. Anderson (1980) defines “quality size” as the size that most anglers like to catch. Defined sizes for stock and quality will vary with species and locations. The appropriate size classifications for Maine-grown fishes are currently under study. Stock and quality lengths for smallmouth bass, for example, have been tentatively set at 7 and 11 inches, while largemouth bass have been assigned stock and quality lengths of 8 and 12 inches. Other size classifications may be used, such as those described by Gabelhouse (1984): “preferred” (fish somewhat larger than quality size that anglers prefer to catch), “memorable” (fish of a size that most anglers remember catching) and “trophy” (a size considered worthy of acknowledgement).

The RSD is the percentage of any defined size group in the stocks. For example, the percentage of fish equal to or greater than 15 inches:

$$\text{RSD15 (\%)} \quad \frac{\text{Number of fish} \geq \text{15 inches}}{\text{Number} \geq \text{Stock size}} \times 100$$

Use of these ratios assumes that the samples contain size distributions that are representative of the population from which they were drawn. Valid samples are best obtained by experimental fishing (fishing with rod and reel to obtain sublegal as well as legal size fish), netting, or in the case of streams, by electrofishing. Angler catches can be size selective and must be used with care in estimating PSDs. Similar ratios are calculated from angler catches to assess stock size availability for angling and relative harvest levels. For example, the proportion of sublegal released or legal kept and released in the total catch, or the proportion of fish in defined age groups are used as indicators of balance or imbalance in harvestable stocks. A shortage of small, young fish may indicate either that reproduction is inadequate or that survival of juvenile stages is poor, or both. A lack of large size fish may indicate a growth problem, poor survival of adult stages due to some habitat deficiency, or excessive angler exploitation that prevents many fish from reaching older ages and large sizes. A lack of reproduction may indicate a lack of suitable spawning and/or nursery area, or fish access to the spawning area is blocked.

Growth Rate and Body Condition

A knowledge of the average growth rate and body condition is considered essential to the proper management of fish species and is routinely monitored by collecting representative samples of fish during creel checks, trapping, netting, or electro fishing. A poor growth rate and low average condition factor is usually an indication that the food (forage base) is inadequate, or that there are too many fish competing for the food supply. It also indicates that management strategies designed to maximize growth potential are not working well (e.g., stocking rates that are too high). Three measurements are required to analyze growth and condition; length, weight, and age. The first two measurements are easily recorded in the field. Age is determined by one of three methods: length in frequency distribution; liberation and recovery of marked or tagged fish of known age; and interpretation of annual layers of bony parts, principally scales or otoliths. The use of length frequencies is generally limited to determining the ages of young stages that are difficult or impossible to age by other means, such as distinguishing young of the year (age 0+) brook trout or bass from yearlings (age I+). Mark and recovery of known age fish is the principal means for positive aging of fish of hatchery origin, but both hatchery and wild fish are frequently aged by scale reading to obtain detailed information on growth histories. To obtain the growth history where samples of observed size for all age classes are inadequate, length at age is back calculated. This method involves recording measurements of scale or otoliths annuli under magnification in the laboratory and applying the following formula to estimate the size at previous ages:

$$L_n = C + \frac{L_t - C}{S_t} S_n$$

Where L_n is the length of fish in the n^{th} year of life, C is a correction factor obtained from a regression of scale length on fish length, L_t is the total length of fish at capture, S_t is the total length of the scale, and S_n is the length of the scale within the n^{th} annulus.

For a general survey of growth patterns, biologists construct tables of average length at successive ages or plot curves of length on age. The growth patterns can then be compared with historical data on the same water, data from similar waters, a State average, or with management objective standards. For statistical comparisons, either the von Bertalanfy or

Ford-Walford growth equations are used, which yield mathematical expressions of increased length or weight per unit time (Gulland 1969). Regressions and covariance analysis are then performed to test differences in intercepts and slopes of growth lines.

Body condition is expressed as some ratio of fish weight to length, and is used as a relative measure of "robustness" and indication of general health. The most commonly used ratio is "Fulton's condition factor", K, (Fulton 1904) calculated as:

$$K = W / L^3,$$

where W is the weight (g) and L is the length (mm). Maine biologists have used this ratio routinely in the past to evaluate differences in body form between populations, but recent studies indicate that it should be only be used for general surveys of condition and only for comparing the relative condition of fish in the same size group. A number of other formulas based on weight-length regression analyses to establish species standards for comparing whole populations are available or under development. All these methods seem to have limitations and are currently being assessed and debated in the fisheries literature (e.g., Cone 1989, Gutreuter and Childress 1990, Murphy et. al. 1991). Until the "best method" is agreed upon by the scientific community, ordinary least squares regression analyses can be applied to Maine data, as recommended by Cone (1989). This method involves regressing weight on length after transforming the data to logarithms and comparing slopes and intercepts of growth lines by analysis of covariance.

A forage survey is also frequently conducted in conjunction with age and growth studies. For example the occurrence of smelt, an important forage for landlocked salmon and other salmonids, is routinely monitored by examining stomach samples from fish collected in creel surveys or by netting. A low percentage of smelt in the diet and/or slow growth of the predator species is used as an indicator of a low abundance of smelt.

Population or Species Survival Status

The survival of a species is dependent on the maintenance of its historical habitat to which it is adapted, and sufficient population numbers to reproduce and perpetuate its kind. A persistent downward trend in population numbers or a series of reproductive failures is an indication that corrective action is needed to save the population. Species that have limited distributions or exist only as single populations are especially vulnerable to extinction and require constant monitoring if their habitat or population abundance is threatened by man's activity or some natural cause.

Although a species may not be threatened with extinction due to its wide distribution, the loss of a population may be of local significance if it is a sportfish species or has some supporting role in the ecosystem. Also, the loss of any population means that a life support system has failed and may be an indication of a larger problem with environmental quality.

MANAGEMENT OPTIONS

Access Acquisition and Development

The development of public access was until recently the responsibility of the Bureau of Parks and Recreation (BPR) in the Department of Conservation, with the Department of Inland Fisheries and Wildlife (IFW) serving in an advisory role. The IFW established its own program in 1986 in response to a federal mandate that now directs IFW to use a portion of the Sport Fish Restoration Act funds for access. The BPR and IFW continue to work together identifying access needs, coordination of programs, and sharing of the workload. The major difference in the two programs is that BPR emphasizes boat access, whereas the IFW program also includes the procurement of foot or carry-in pathways and rights-of-way, as well as the establishment of shoreline easements or purchases to protect fishing areas.

It is the IFW policy to suspend fish stocking or other management costing money if general public access is denied by private landowners who exercise trespass rights or threaten prosecution of trespassing anglers. Some exceptions are practiced in cases where there is a popular winter fishery and winter access is readily attained by anglers, even though access conditions are adverse during the summer.

Although it is the intent of IFW to obtain legal rights-of-way to all publicly owned waters, developed access is not planned in all cases. Those waters designated as “Remote Ponds” in special Resource Protection Districts by the Land Use Regulation Commission (as originally recommended by IFW) are examples where a policy of limited physical access is maintained. The objective in this case is to preserve a wilderness fishing experience and to discourage over-exploitation of an unspoiled natural resource.

Waters in the priority list are placed in one of four categories for type of access needed, depending on whether a high or low level of developed access would be most appropriate for the particular water or location and type of fishery: (1) motorboat, improved; (2) motorboat, unimproved; (3) car top/canoe carry-in, or (4) walk-in. Category 1 is generally reserved for high use waters where the primary mode of fishing is by boat, often near metropolitan areas where constant use necessitates having substantial facilities to handle the recreational traffic. Category 2 is applied where the primary use is by boat but traffic is moderate enough to not require a hard ramp and large capacity parking. Category 3 is applied where the primary mode of fishing is by canoe and there is a desire to preserve natural qualities that would be compromised by too much site development. Category 4 is generally applied to small ponds in ecologically sensitive areas and flowing waters where the traditional mode of fishing is bank fishing or wading.

Fishing Regulations

Fishing rules and regulations are one of the primary management tools of the Department to control and protect fisheries. Except for regulations passed by the Maine Legislature, the Commissioner has the direct power to promulgate or amend fishing and hunting regulations under the Administrative Procedure Act. Proposals by regional management biologists are reviewed and approved by the Regulations Committee of the Fisheries Division, and public hearings may be held before a regulation is submitted to the Commissioner and the Advisory Council for final disposition.

Regulations are designed to control the following attributes of the act of fishing in order to maintain the harvest of fish at acceptable levels:

- When and where fishing is permitted
- Number of fish that can be taken

- Size of fish that may be taken
- Fishing method and terminal gear permitted

A reduction in the bag limit, or increase in the minimum size limit are the most common regulation changes recommended when too many fish are being harvested. A regulation change to affect a higher harvest is indicated when there are certain conditions of imbalance in the population and poor growth; for example, when there has been a stockpiling of younger aged, sublegal fish resulting in intense intra-specific competition for food and a slowing of growth. Liberalized bag limits may serve to affect a higher harvest, reduce the population, and improve conditions for growth. A higher harvest may also be promoted where the population is judged to be under-utilized in order to direct anglers toward new fishing opportunities, or to re-direct fishing pressure away from heavily exploited fisheries. Special size limits, such as "slot limits" that target fish within a limited size range, may be used to effect population balance in size and age groups and to protect spawners.

Manipulation of the season and time of day when fishing is permitted is used to control and angler participation rate (angler days or hours per acre per year). A decrease in the season may be implemented as an indirect means of limiting the harvest. An increase in the season may be used to provide additional fishing opportunities or promote higher use of an under-utilized fishery.

Area closures are meant to protect concentrations of fish that are especially vulnerable to fishing (e.g., spawning concentrations), to protect nursery populations, to distribute the catch (e.g., alternative year closure of a trout pond), or to limit the harvest of stream spawning smelt to protect the forage base for salmonids. Other special types of closures are some portable water supplies that are placed off-limits to fishing and other recreational uses by the Maine Legislature, and special purpose areas, such as Tomah Lake in Washington County that is maintained by the Department as an experimental brook stock water.

Regulation of the fishing method and type of terminal gear is used to limit the harvest, to reduce hooking mortality, or to maintain a certain type of fishing experience. For example, a change from two lines, permitted under general law, to one line in the summer on certain waters, in combination with more restrictive size and bag limits, has recently been used to affect a desired reduction in the harvest. Fly-fishing only or artificial lures only regulations are used as a means of reducing harvest where "quality fishing" (i.e., fish of larger than average size) is the management objective. It is well known that bait fishing causes higher hooking mortality. The use of lures particularly with single hooks, reduce hooking mortality and is more compatible with efforts to promote more "catch and release". Studies have shown that there is no practical difference in hooking mortality caused by flies or lures. The artificial lures only option is preferred by fisheries managers because it is less discriminatory than fly fishing only in terms of accommodating a greater variety of angler preference and use of a wider range of terminal gear. Fly-fishing only; however, is a long standing tradition on some waters.

Fish Stocking

The rearing and stocking of fish is a proven management tool that receives a great amount of time and effort in planning and execution by the Fisheries and Hatcheries Division. The management of wild populations, however, is given first priority where fisheries can be maintained through natural reproduction. Artificial propagation in Maine hatcheries is limited to salmon and trout species but other species are sometimes stocked by collecting eggs or capturing fish and transporting them to other waters. The purpose of stocking is to satisfy

demand where no, or less than desirable, fisheries existed before, to augment natural reproduction, to provide new species and diversity in fishing opportunities, or to restore endangered species or populations.

All stocking is conducted according to policy standards and procedures. The stocking policy for each species specifies the criteria for (1) where stocking can occur in respect to habitat capability, potential effects on other species, and presence of adequate forage; (2) what season they should be stocked; (3) appropriate size and age at stocking; (4) stocking frequency (e.g., annual, semi-annual); (5) stocking rate (number per area); (6) stocking procedure (e.g., aerial, shore vs. boat); and (7) establishes provisions for experimental stocking to develop and test new stocking methods.

Stocking adjustments within the framework of the general policy may be necessary when an imbalance in abundance or age and size structure develops. Stocking rates may be adjusted upward to compensate for greater than expected natural and/or fishing mortality. Rates may be adjusted downward to alleviate over-population, restore the forage base, and improve growth.

Habitat Improvement

Habitat improvement may include (1) reconstruction of habitat lost to human development or natural calamities, (2) modification of natural habitat to affect an improvement in life support, (3) water level control to protect spawning, nursery, and adult areas, or to maintain stable water levels for fishing; (4) chemical reclamation to remove undesirable species; (5) construction of fishways to facilitate fish migration; (6) removal of man-made or natural obstructions to fish migration; or (6) the construction of barriers or maintenance of natural barriers to unwanted fish migration.

Habitat improvement by physical alteration of substrate or riparian areas has been most often been applied to streams. An example is the reconstruction of the natural channeling and bank cover of a number of streams destroyed by logging operations in northern Aroostook County during the 1950's. Recent examples of improvements in natural habitat is the construction of flow deflectors to form pools and cover for brook trout in Black Stream in the Town of Sangerville, and the construction of a spawning reef for lake trout at Craig Pond, East Orland.

Water level control is an important management strategy for protecting fish production on many waters where water flow is manipulated for hydroelectric generation and other water storage purposes. The Department routinely recommends minimum flows and draw down schedules to dam owners through the Federal Energy Regulatory Commission (FERC) permitting process. For example, a draw down schedule that completes the summer draw down by October 15 at Moosehead Lake is designed to protect lake trout spawning. Similarly, a minimum draw down level of 378.5 feet above mean sea level during the period from October 10 to April 30 at Spednic Lake was recently proposed to increase over-winter survival of young smallmouth bass.

Chemical reclamation is an option for reducing or eliminating competition for desired sportfish species, usually brook trout, or to prevent the spread of undesirable species to other parts of a watershed. It involves application of a selective chemical, principally rotenone, to the waterbody to kill the existing fish population and introduction of the desired species once the waterbody has cleared. This option is practical only for small ponds with small, treatable tributaries and that have no outlet or a suitable outlet for erecting a barrier dam to prevent re-invasion of unwanted species. To date, the Department has reclaimed 136 ponds. Although reclamation is

still considered a viable management option to improve fisheries where it can be applied, it is used less frequently than in the past because of increased cost, opposition from camp owners, increased public concern in recent years about the use of chemicals in the aquatic environment, and increased federal restrictions on their application.

The removal of barriers to fish migration, whether natural or man-made, is another means of improving habitat. Many old and abandoned logging dams that created obstacles to fish migration have been removed. The removal of old beaver dams or blasting of minor falls has been used selectively to improve natural migration routes. Conversely, the construction of barrier dams or blockage of channels has been used to prevent the migration of unwanted species.

Numerous dams have been fitted with fishways of various designs to facilitate spawning migrations of adult fish or pass of their young. Except for those fish passage facilities that are monitored by the Atlantic Salmon Commission or the Department of Marine Resources, fishways are routinely inspected by Regional Fisheries Biologists to ensure that they are functional. The Commissioner of the Department of Inland Fisheries and Wildlife has the authority to require a fishway for certain species when a dam blocks (1) upstream passage to useable spawning, nursery or adult area capable of supporting a substantial recreational fishery; (2) upstream passage from useable spawning, nursery, or adult area to lake habitat capable of supporting a substantial recreational fishery; (3) upstream passage to spawning and nursery habitat important to the maintenance of substantial commercial fishery; or (4) adequate downstream passage needed to maintain a substantial recreational or commercial fishery.

Forage Enhancement

Growth and survival of sportfish is dependent on the presence of adequate forage base, i.e., small fishes and invertebrates that serve as prey for predator sport fishes. Forage enhancement may involve the protection of existing populations of forage species and their habitat by regulation, new introductions of these species, or augmentation of depressed forage populations through plantings of eggs or adult fish.

Rainbow smelt received the most management effort because this species serves a multiple purpose role as an essential forage for landlocked salmon and other salmonids, as an important sportfish in its own right, and as a commercially important baitfish. Department considers the smelt's role as a primary forage for salmon and trout as of first priority. Increased sportfishing and commercial harvests of smelt in recent years has fostered increased regulation of these fisheries in order to maintain population levels adequate for good salmonids growth.

Other species that are occasionally transplanted to establish new forage are the landlocked alewife (for salmon and lake trout), lake whitefish (for lake trout), three-spined stickleback (for lake trout and charr), and two invertebrates: crayfish (for bass) and Mysis (to enhance basic forage productivity).

Fish Introduction and Transplants

For the purposes of this discussion, an introduction is defined as the initial stocking of a fish species or a new strain that was not formerly present. A transplant is defined as the capture and transfer of fish or eggs from a donor water to another water where that species is already present.

Since colonial times, the transport and introduction of fishes has modified Maine's freshwater fish community in every region of the state almost on a continuous basis, just as it has throughout the world. In theory, only the state has the authority to transport and release fish into any natural water, and even regulates what species can be released into private waters. In practice; however, many introductions are performed illegally, or accidentally by the public. Such unauthorized introductions may not only affect existing fish communities and other aquatic life, sometimes adversely, but also make it difficult for state agencies to plan and execute protection and management strategies for fisheries. The introduction of exotic species is especially troublesome because of their potential to displace native species or to introduce new fish diseases and parasites.

The practice of introducing new species or establishing new populations of endemic species; however, can be beneficial when carefully planned. An introduction is viable management option where the following conditions are met: (1) it will not adversely affect the existing biotic community, either in the waterbody or in connecting waters within the watershed, (2) there is a demonstrated management need to establish a new fishery or enhance an existing one, (3) that the introduction is wanted or accepted by the public, and (4) that the introduction is compatible with the management of fish species under the jurisdiction of other management agencies.

The first condition is rather idealized because it is never one hundred percent certain that an introduction will not have some adverse effect on the existing biotic community. Based on life history studies and past experience; however, reasonably safe judgments can be made. In the light of recent studies, proposals for introductions made by IFW biologists or by other agencies, which were once considered routine, are now reviewed more carefully for potential adverse impacts. For example, the introduction of rainbow smelt to provide forage for lake trout may be implicated in the decline or disappearance of some whitefish populations. The restoration of anadromous runs of alewife is currently being investigated as a possible cause of declines in certain bass populations. The unintentional spread of muskellunge to Maine waters in the upper St. John River watershed that resulted from an introduction to Lac Frontiere by Quebec biologists is an example of conflicting management objectives, and points to the need for closer inter-governmental review and coordination.

The Department solicits public review and comment wherever the introduction would have a significant impact on recreational use or where there may be a conflict between public desires and the fishery management objectives. There have been some instances, for example, where the Department proposed reclamation of a pond and introduction of a different species that was opposed by local anglers who preferred the existing fishery.

Introduction may be used to (1) establish a new fishery; (2) to re-establish a fishery that previously existed; (3) to replace an existing sport fishery with another; (4) to extend the range of an endangered species, race, or unique population; or (5) to provide forage for sportfish species. An example of a new introduction is the stocking of a deep-dwelling strain of lake trout in Sebago Lake to utilize unoccupied deep-water habitat and to provide additional fishing opportunities in response to growing public demand for diversified coldwater fisheries. New fisheries have also been established in some ponds that were naturally barren of fish life. Future introductions of black bass (smallmouth, largemouth) and possibly other non-native species, either as conducted by the Department or as unauthorized introductions, will doubtless occur in the future as demand for these species increase.

Maine has no nationally recognized endangered freshwater fish species and most species are widely dispersed and abundant. Thus, there has been little need to introduce fish for the

purpose of preserving the species, with one notable exception. The Department currently has a program for expanding the range of the rare Sunapee trout, which is a unique form of the landlocked Arctic charr, and is considered to be of national and state significance worthy of preservation. Until its introduction into new waters, the Sunapee existed as a single population of pure lineage only in Floods Pond. Eggs have been successfully obtained from the Floods Pond stock and reared in a Maine hatchery. The Department's goal is to establish five new, self-sustaining populations. Another distinct variant of the Arctic charr, the blueback trout, exists only in Maine in ten populations. The survival of these unique populations is also being monitored to ensure their continued viability.

Transplants are done to reestablish an extinct natural population or to increase the reproductive capacity of the population that has reached a critical low level of abundance. The only major concerns when conducting a transplant is that the sporting public that has an interest in the donor water agrees to the donation, and that no new diseases or parasites are likely to be introduced into the receiving water. The transplanting of smallmouth bass from Meddybemps Lake and other waters to Spednic Lake, in combination with other management strategies (water level control, exclusion of alewife), is an example to an attempt to use a transplant to help re-establish a once-viable fishery.

Closures to Fishing

This management option, complete closure to fishing, is used only in rare instances by IFW for the purpose of protecting endangered populations or facilitating the recovery of depressed fisheries. Only three cases of note are currently enforced; the closing of Spednic Lake to bass fishing to enhance the chances of recovery of the bass fishery, the closing of Floods Pond to all fishing to increase the chances of sustaining a viable Sunapee trout population that is threatened with extinction, and the closing of Tomah Lake for the purpose of preserving hatchery brook stock.

LITERATURE CITED

Anderson, R.O. 1980. Proportional stock density (PSD) and relative weight (W): interpretive indices for fish populations and communities. Pages 27-33 in S. Gloss and B. Shupp, editors, Practical fisheries management: more with less in the 1980's. Am. Fish Soc., N.Y. Chapter.

Cone, R. Scott. 1989. The need to reconsider the use of condition indices in fishery science. Trans. Am. Fish. Soc. 118: 510-514.

Fulton, T.W. 1904. The rate of growth of fishes. Fish. Bd. Scotland, Annual Rept. No. 22 (Part 3): 141-241.

Gabelhouse Jr., Donald W. 1984. A length-categorization system to assess fish stocks. N. Am. J. Fish. Mgt. 4: 273-285.

Gulland, J.A. 1969. Manual of methods for fish stock assessment, part 1, fish population analysis. FAO Manuals in Fish Sci. 4: 35-43.

Gutreuter, Steve and W. Michael Childress. 1990. Evaluation of condition indices for estimation of growth of largemouth bass and white crappier. N. Am. J. Fish. Mgt.10: 434-441.

Maine Department Inland Fisheries and Wildlife. 1986. Planning for Maine's Inland Fisheries and Wildlife, species assessments and strategic plans, 1986-1991, vol. II, fisheries, part 1: 430 pp.

Murphy, Brian R., David W. Willis, and Timothy A. Springer. 1991. The relative weight index in fisheries management: status and needs. Fisheries 16 (2): 30-38.

Ryder, R.A. 1965. A method for estimating the potential fish production of north-temperate lakes. Trans. Am. Fish. Soc. 94: 214-218.

BROOK TROUT MANAGEMENT PLAN

DEPARTMENT OF INLAND FISHERIES AND WILDLIFE
DIVISION OF FISHERIES AND HATCHERIES

PREPARED BY
FORREST R. BONNEY
REGIONAL FISHERIES BIOLOGIST

MARCH 2001
BROOK TROUT LIFE HISTORY

The brook trout (*Salvelinus fontinalis*) has historically been the most abundant and ubiquitous coldwater game fish occurring in Maine and remains so today despite reductions in brook trout habitat that have occurred since settlement of the state by Europeans began. The brook trout's basic requirements are cool, well-oxygenated water and suitable spawning, nursery, and adult habitat. As long as water temperatures do not exceed about 68° F for extended periods and oxygen levels remain at 5 ppm or greater, brook trout can usually survive and grow. Brook trout may spend part or all of their lives in habitats ranging from the smallest brook to the largest of lakes, provided that the habitat is suitable and competition from other fish is not excessive. In addition, they are capable of spending the adult portion of their lives in marine or brackish waters, and populations of brook trout are found in some of Maine's estuaries.

The species is extremely vulnerable to the effects of predation and competition from other fishes, particularly in the first year or two of life. After attaining a length of about 10 inches, however, trout will feed heavily on other small fishes. There is evidence that larger brook trout may be very effective predators on their own young in certain circumstances. In waters where forage fish are not available to adult trout, they are still capable of good growth rates on a diet of invertebrates if the habitat is productive.

Brook trout are capable of extremely diverse growth rates, which are primarily dependent on such environmental factors as water temperature and food abundance. A five-year-old brook trout may weigh less than two ounces in waters with poor growth conditions. At the other extreme, a trout of the same age may weigh four or five pounds if growth conditions are ideal. Brook trout are generally short-lived, with relatively few survivors beyond three years of age. A few individuals may attain ages of four to six years, but rarely more. For stocked populations, the life span is typically even shorter, with few individuals surviving beyond two years. However, recent efforts to extend the life span of hatchery-reared brook trout through the rearing of eggs taken from wild fish have been successful, and progeny of these fish have lived to age four to date.

Brook trout normally spawn in the flowing waters of brooks or streams in the fall, usually late September to November. In Maine, spawning occurs the earliest in high-elevation waters. Water moving through the gravel prevents the buried eggs from freezing and provides them with oxygen. Shore spawning is successful in some ponds where spring-water inflows occur in gravelly shallows. Survival of shore-spawned trout may be poor if protective cover for emerging fry is not available. Smelt are especially voracious predators of brook trout fry under these conditions. Brook trout eggs hatch in the early spring after over-wintering in the gravel substrate. Young fish use cover for protection from predators and move to the deeper water that serves as adult habitat when they attain greater size.

Brook trout are highly catchable and their numbers are therefore easily reduced by overfishing, especially in the smaller ponds and in streams that have easy angler access. They are, however, very resilient in good habitat, and their numbers can quickly rebound to former abundance under adequate regulatory protection. Furthermore, recent studies indicate that Maine’s wild brook trout populations have not been genetically compromised due to excessive harvest by angling of the older mature fish.

BROOK TROUT MANAGEMENT HISTORY

This species has always served as a food fish, and systematic exploitation of Maine's brook trout populations as a sports fish began in the latter 1800's, when sporting camps flourished by catering to sportsmen in search of superior fishing for brook trout and other gamefish common to the state. Records of the period mention trophy trout of two to six pounds fairly regularly, and a few fish ranged to nine pounds. It appears, however, that where large fish were caught they were not abundant. High numerical catches were of sizes comparable to present-day standards. Angling pressure was relatively light, compared to current standards, well into the early 1900's. As the number of anglers increased and more backcountry roads were constructed, angling pressure increased over the years to current levels.

Nearly all of the State's inland waters were originally suited for brook trout. This situation began to change as timber harvesting became increasingly widespread in the 1800's, accompanied by increases in human population growth, industrialization, and agriculture. Forestry practices such as dam and road construction, river drives of raw wood, and harvesting along shoreline riparian zones led to the destruction of trout habitat. More recently, the indiscriminate use of large mechanized equipment has resulted in the degradation of brook trout habitat through erosion, siltation, and the loss of cover and habitat. Similar losses occurred early in the State's history through widespread clearing for agricultural purposes, especially in the southern and central portions of the state. Loss of habitat as a result of industrial pollution increased in the nineteenth century and continued well into the twentieth century. Efforts to reduce industrial and municipal pollution have resulted in improved water quality and restoration of habitat in some of the major rivers. The imposition of environmental regulations designed to protect natural resources have also resulted in added protection of brook trout habitat in the commercial woodlands of the state. Some forestry companies have voluntarily exceeded regulatory standards in order to protect fisheries resources; indeed, in recent years some commercial landowners have partnered with the Department to restore degraded fisheries habitat.

Scientific brook trout management began with the formation of the Fisheries Research and Management Division in 1951. Prior to this date, the Department’s Commissioners authorized occasional management activities, including stockings. The earliest scientific evaluation of brook trout populations in Maine was conducted by William C. Kendall of the Bureau of Fisheries, U.S. Dept of Commerce, in 1918. His report - specific to the Rangeley Lakes area in western Maine - discussed the physical features and species composition and abundance of these important brook trout waters. In addition, Dr. Kendall compiled records of brook trout harvests from previous documents dating back to the mid-1800’s in which individuals weighing up to 12.5 lb. were recorded. The first systematic fishery survey of statewide significance was conducted by Gerald P. Cooper, Assistant Professor of Zoology at the University of Maine. In a series of reports published from 1940-45, Dr. Cooper and his colleagues reported findings on the fisheries of the Rangeley chain of Lakes, the lower Androscoggin and Kennebec drainage systems, Moosehead Lake, and Haymock Lake. Of particular value for brook trout management were the age and growth data for lightly exploited populations.

Programs to systematically survey brook trout habitat and conduct research projects to provide guidance for the statewide management of this species were implemented soon after the Fisheries Division was established. These research projects included several investigations into the life history of lake and stream populations of both wild and stocked populations.

Efforts to intensively manage the brook trout sports fishery increased with angler use and

concern for the welfare of the species. Increasingly restrictive regulations - in the form of bag limits, minimum length limits, and gear restrictions - have been imposed over the years. The first fly-fishing-only restrictions were imposed on individual waters in the Rangeley and Moosehead areas near the turn of the twentieth century. However, there was no general-law bag limit on trout as late as 1910. At that time there was a 25-pound limit and a 5-inch minimum length limit. As of 1920 there was a 25-trout limit, a 15-pound limit, and a 6-inch minimum length limit. The bag limit for brook trout in lakes has been gradually reduced from 25 fish in 1950 to the current limits of 5 in northern Maine and 2 in southern Maine. In addition, categories of standardized special regulations, including bag and length limits, were implemented in 1996 to account for the variability in growth rates among trout waters and to standardize special brook trout regulations, thereby simplifying a confusing array of special regulations.

Hatchery-reared fish are used to provide a fishery where adult habitat is present but spawning and/or nursery habitat are lacking. Artificial propagation has played a significant role in the management of Maine's brook trout for many years. The first state fish hatchery was constructed in 1895 following a decade of private efforts to hatch and stock trout fry. With the development of additional public hatcheries and rearing stations and the improvement of transportation systems, brook trout stocking gradually increased throughout the state and reached an annual level of one million fish, but has since declined to approximately 600,000 fish per year as a result of improved fish quality and stocking techniques. Today the majority of Maine's brook trout are stocked on a biological basis at the recommendation of fishery managers. The size of the fish at stocking is determined by the quantity and quality of the habitat and the extent of competition from other fish species. A small portion of the brook trout stocking is done on a non-biological or "put-and-take" basis. In these situations, catchable-size trout are typically stocked in waters near population centers to provide immediate angling opportunity with little expectation of holdover due to habitat limitations. Special regulations are frequently imposed on stocked brook trout waters to assure survival of fish to maturity and escapement to larger sizes. Stocking rates, determined from a policy developed by fishery managers, take into account water size, water quality, interspecific competition, and angler use.

In the 1990’s the Department undertook a program to improve its brook trout brood stock. New strains are being developed from wild fish with the goal of producing progeny that retain wild-fish characteristics including greater longevity. Because these strains may grow and behave differently from the more domesticated strains previously stocked, future adjustments in stocking rates may be necessary. Comparative performance studies of the Kennebago and Sourdnahunk strains were recently conducted; results to date indicate that the longevity of both new strains far exceeds that of the older, domestic strains. However, the new strains grow at a slower rate and there is concern on the part of some managers that they will not provide the size quality that anglers of stocked waters have become accustomed to. To that end, a study involving performance evaluation of paired stockings of crosses between the wild and domestic strains is underway. Furthermore, the Kennebago strain performed better both in the hatchery and in the wild and was chosen over the Sourdnahunk strain, which has been discontinued.

The removal of introduced competing warmwater fish species from trout waters by means of chemical reclamation began in 1939. Since that time, about 140 trout ponds have been reclaimed, usually with good – if temporary - results. Due to the expense of the chemical and changing public sentiment, the reclamation program is currently conducted at a modest level. Reclamation remains an especially valuable tool in eradicating illegally introduced fish species before they spread throughout drainages.

The introduction and spread of competing fish species has had substantial impact on the quantity and quality of Maine's brook trout resource. The chain pickerel, a voracious predator, was introduced to Maine in 1818 and by 1850 was well established in many trout waters. More recently, northern pike and muskellunge have been introduced into several drainages where they continue to expand their range. The smallmouth bass had reached its approximate current coastal distribution by the early 1900's, but continues to be illegally introduced into inland drainages; the rate of illegal bass introductions has increased in recent decades, and is a source of concern for brook trout fisheries. White perch and yellow perch, both severe competitors with brook trout, became widespread during the late 1800's. These species remain an active threat, as exemplified by their invasion of the Moosehead Lake drainage, the Rangeley Lakes, and the Fish River Chain of Lakes by yellow perch in the 1950's and 1960's. The often inadvertent spread of white suckers and a number of minnow species caused still further loss, and remains a chronic problem to this day because of their extensive use as live bait. Introductions of smelts, landlocked salmon and lake trout were made into many waters that originally harbored only brook trout, but the extent of their effect on trout remains unknown.

Maine's wild brook trout populations are recognized for their genetic and aesthetic values and efforts to protect them through the imposition of special regulations have recently been expanded. Department policy now formalizes past Fishery Division guidelines by preventing the stocking of hatchery-reared fish in waters with thriving wild populations unless these waters have previously been stocked. In the 1990’s the Department initiated studies to determine the abundance, longevity, rates of harvest, and genetic variability of wild trout populations. More recently, detailed stream surveys have been conducted in an effort to determine more accurately the relationship between stream habitat types and brook trout abundance. It is anticipated that these efforts will be continued into the future to gain additional information. Wild trout populations, once largely taken for granted, are now recognized for their biological, economic, and aesthetic value.

Over the past 50 years, significant advances in knowledge and management expertise have been made relating to Maine's brook trout populations. This knowledge enabled sound and rational management programs for brook trout under historical levels of angler use. However, increasing angler demand for and utilization of brook trout, coupled with stagnant or decreasing funding levels for management (notably, staffing reductions of the Fishery Division's research biologists), are necessitating innovative approaches to brook trout management. For example, the Fishery Division recently developed a set of standardized regulations intended to prevent overharvest, protect genetically important older wild fish, and increase the carry-over of a portion of stocked fish to larger sizes. In the absence of pure research, brook trout data are also being consolidated on computerized statewide databases, which will be used to monitor trends in the fishery. Finally, the Department recognizes and supports the evolving angler ethic regarding the voluntary release of legal-size fish. These changing attitudes, together with the preservation of habitat through reasonable environmental regulations and intensive management efforts, bode well for the brook trout's future.

PAST MANAGEMENT GOALS

Lakes and Ponds

The management goal for the last planning period, commencing in 1986, called for the maintenance of existing availability and quality of brook trout in all Regions except A and B, where these parameters were to be increased. In 1991 the management goal was modified to maintain existing availability and quality of brook trout statewide and to improve fishing quality on waters capable of above-average growth rates. Specific objectives for abundance were to increase the distribution of brook trout from 7,000 to 9,000 acres in Region A and from 3,600 to 4,500 acres in Region B. It was also recommended that the contribution of wild stocks be maximized statewide. Since these objectives were first stated, the distribution of brook trout in Regions A and B have increased substantially (Table 1), exceeding the distribution objectives for these two Regions. The increase in distribution has resulted primarily from the stocking of legal-size brook trout in marginal (limited by unsuitable water quality, temperature, and/or by interspecific competition) habitat with the intent that they be angled before they succumb to these limitations. On a statewide basis, the distribution of principal-fishery brook trout waters has increased from 391,400 acres in 1991 to 393,400 in 1996 and 403,396 in 2001 as additional existing brook trout lakes have been surveyed and added to the inventory.

To meet the abundance objective of maximizing the contribution of wild stocks to the fishery statewide, the Fishery Division formulated and implemented special regulations intended to reduce harvest and afford protection to the genetically-important, sexually-mature individuals of wild trout populations. These special regulations became effective in 1996. Evaluations of the effectiveness of these regulations indicate that, to date, the proportion of age III+ and older brook trout (91% of which were sexually mature) sampled by fall trapnetting was 20% in lakes with regulations of low-to-moderate severity and 26% for lakes with high-to-severe regulations; the proportion of age IV+ trout (97% of which were sexually mature) was 1% and 4% for the same categories. This analysis includes only the first two years post-regulation change; additional increases in the proportion of older fish sampled may accrue over time.

The harvest objective developed in 1986 was to permit removal of 40-50% of the estimated spring legal wild population and, for hatchery-supported populations, removal of 60-80% of the total number stocked over a two-year period following stocking. The objectives were redefined in the 1991 update because these parameters could not be determined for more than a few waters annually with current management capabilities. Instead, future comparisons will rely on the relative number of pounds per acre harvested, as determined from statewide angler surveys and confirmed by field data as resources allow. The harvest objective in the 1991 update was therefore set at 0.5 pounds per acre based on the estimated annual (winter plus summer) statewide harvest rate of 0.45 pounds per acre reported. The annual harvest rate for lakes reported during the last planning period (1996) increased to 1.11 pounds per acre and is currently 0.96 pounds per acre, nearly twice the harvest objective, suggesting that a harvest objective of 0.5 pounds per acre is too conservative.

The 1986 fishing quality objectives were to improve fishing quality in Regions A and B to levels typical of other Regions (0.5 trout caught per angler trip and an average size of 11 inches for open water fishing in lakes) and to optimize public access statewide. The fishing quality goal was met for Regions A and B as of 1996, when these rates were 0.49 and 0.57 respectively. The most recent angler surveys indicate that fishing quality in Regions A and B are similar to those of 1996, with brook trout catch rates per angler trip of 0.43 and 0.44 respectively.

Statewide, the catch rate declined slightly from 0.98 reported in the 1996 update to the current 0.85. Although high levels of fishing quality have been attained on individual waters in Regions A and B stocked with legal-sized fish, it is unreasonable to set fishing quality for those Regions equal to that of other Regions given the lack of principal brook trout habitat and the high angler demand. The current catch rate of 0.5 fish per angler trip, which is approximately half that of the current statewide average, seems maintainable for these Regions with a sustained stocking effort. The fishing quality objective of increasing the average brook trout length in Regions A and B to 11 inches has been exceeded (current average lengths are 12.9 and 12.4 inches, respectively). The statewide average for lakes, derived from clerk surveys and sampled from 1996-2000, is 13.3 inches.

OPPORTUNITY

Lakes and Ponds

Maine has the most extensive distribution and abundance of brook trout in the eastern United States. Brook trout occur in 1,487 lakes (769,264 acres) and provide principal fisheries in 1,135 lakes (403,396 acres) (Table 2). Because it is a more accurate indicator of fishing quality, the amount of habitat providing principal fisheries, rather than the total occurrence, will be used in this document.

Maine's wild brook trout waters are not evenly distributed throughout the state but are concentrated in the interior highlands which have a cooler climate and fewer introduced competing fish species (Figure 1). Those brook trout lakes located in the coastal and interior lowlands are more likely to be dependent on stocking to provide a fishery (Figure 2). Regions D, E, F, and G, which include most of the interior highlands, contain 73% of the lakes and 73% of the acreage in which trout occur. These Regions

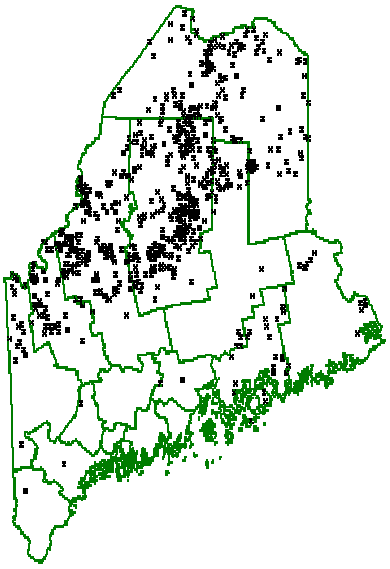

FIGURE 1. LOCATION OF WILD BROOK TROUT LAKES IN MAINE

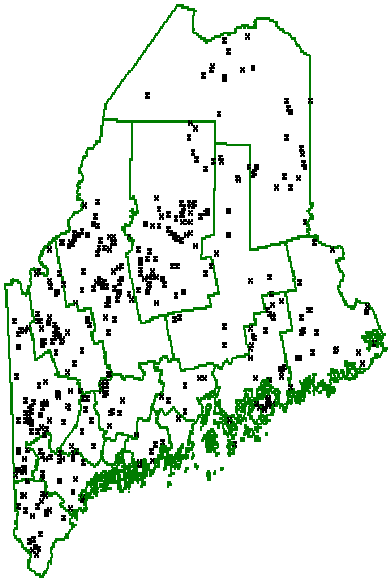

FIGURE 2. LOCATION OF STOCKED BROOK TROUT LAKES IN MAINE

contain an even greater proportion of the lacustrine habitat categorized as principal fisheries: 81% of the lakes and 92% of the acreage.

Because brook trout tend to favor the shallow (littoral) areas of lakes, the size of the body of water is an important indicator of brook trout abundance. Smaller ponds and lakes generally produce more trout per acre than larger, deeper lakes that have proportionally less productive trout habitat for their size. For that reason, an arbitrary-but-realistic size of 200 acres and less is used to designate "typical" brook trout ponds.

Of the 1,135 brook trout lakes that provide principal fisheries, 490 (43%) are currently being stocked (Table 3); these waters account for 58% of the principal-fishery acreage. Conversely,

645 principal brook trout fisheries are sustained by natural reproduction. Of these, 424 lakes and ponds, comprising 81,492 acres, have never been stocked, and therefore contain potentially unique genotypes. In addition, some of the infrequently-stocked lakes may still contain relatively pure genotypes because early stockings were often unsuccessful. Of the stocked lakes, 120 have not been stocked since 1965; 40 have not been stocked since 1955; and 25 have not been stocked since 1945.

Recent work on Maine trout ponds has provided abundance estimates for waters 200 acres or less in size. These data allow for more detailed categorization of brook trout lakes; separation by size, stocking, and competition status is presumed to result in greater accuracy of abundance estimates. Sample sizes remain small, however, and may not be representative of statewide averages. Few estimates of brook trout abundance exist for waters greater than 200 acres in size, and the abundance figures chosen are therefore subject to error. Nonetheless, this method of categorizing habitat has the potential to yield increasingly accurate abundance estimates as additional data are collected. For the current estimates of post-season (late fall) abundance, only principal fisheries are included. The average number of brook trout per acre varies widely. Not surprisingly, waters that were stocked and had little interspecific competition had the greatest number of brook trout (115/acre); those with wild populations and with high interspecific competition had the least (15/acre) (Table 4).

No significant changes are anticipated in the amount of habitat presently available in lakes and ponds during this planning period, though some continued loss of habitat from development and the introduction of competing species to trout waters is anticipated. The loss of habitat through the introduction of competitors can be slowed somewhat by pond reclamation, which has been successful in the past in eradicating some illegal introductions before they spread throughout the drainage.

In the 1990's a reduction in the abundance of older-age (age IV and greater) brook trout was documented by comparing the age structure of relatively unexploited brook trout populations sampled in the 1930's and 1940's to those sampled within recent years. The decline in the proportion of older fish was attributed to increased angler use and harvest, and was an incentive for developing restrictive regulation categories. These regulation classes, which are combinations of low bag limits and high length limits, were intended to restore age and size quality of these population to their former levels (Table 5). They became effective in 1996 on 453 (40%) of Maine's lakes with principal brook trout fisheries. A smaller number of lakes considered to contain exceptional brook trout fisheries have been chosen as 'Fisheries Initiatives' waters, and have had highly-restrictive special regulations applied, also effective 1996, to protect and enhance trophy-class brook trout fisheries. Studies conducted to evaluate the efficacy of these regulations indicate that brook trout lakes with restrictive regulations have a significantly higher proportion of older fish than those with regulations of low to moderate severity. Currently, 380 (33%) of Maine's principal brook trout lakes are managed as 'Size Quality' waters (Table 6). These waters have a minimum length limit of at least 12 inches. On an area-basis, 291,894 acres, or 72% of the total, are included in this category, reflecting the fact that many larger brook trout lakes have restrictive regulations. An additional 24 (2%) of the principal brook trout lakes are managed as 'Trophy' waters, with a minimum length limit of at least 16 inches. These lakes total 6,542 acres in size, representing 2% of the total principal-fishery acreage. The relatively small number of Trophy waters reflects the fact that only a small proportion of Maine's lakes are capable of growing large-size brook trout.

Brooks and Streams

Of Maine's 31,806 miles of flowing water, about 22,248 (70%) are considered to be brook trout habitat (Table 7). As with the distribution of brook trout in lakes, the majority of brook trout streams are concentrated in the interior highlands; Regions D, E, F, and G contain 76% of the miles designated as brook trout stream habitat.

Estimates of brook trout abundance in streams has been determined for representative waters statewide since the 1960's. Because electrofishing is labor-intensive, however, population estimates have been determined for relatively short reaches of stream. Beginning in 1998, this procedure was refined by separating population estimates for some waters by stream type, defined by differences in stream characteristics. Many of the streams were historically selected for population estimates because they contained what was believed to be the best brook trout habitat; they were typically low-gradient, winding reaches with riffle-pool habitat. These streams contained an average of 110 legal-size brook trout per mile. Streams that were steeper, straighter, and had fewer pools averaged only 63 legal-size brook trout per mile. Additional work remains to be done to determine brook trout abundance for other stream types and to expand these samples to obtain an accurate statewide estimate of brook trout abundance in streams.

Brook trout populations in streams are supplemented by stocking if angler demand exceeds the ability of streams to produce brook trout. This situation frequently occurs in the most populous areas of the state. Accordingly, stream stocking is practiced most intensively in Region A, which accounts for 86% of the fall fingerlings and 61% of the spring yearling brook trout stocked statewide in the last three years (Table 8). Statewide, fry account for the largest number of brook trout stocked per stream, but probably provide the poorest returns given their high mortality rates. Fall fingerling stocking can be successful if overwintering habitat, in the form of pools, is available. Frequently, however, it is not, and spring yearlings are stocked with the expectations that immediate returns to anglers will be high and that carryover rates to older ages will be low.

Some loss of stream habitat is expected despite the protective effects of the environmental laws. Although these losses are expected to be relatively small, they will likely occur in those areas of the State not only being the most aggressively developed, but also the areas where the current resource is poorly distributed and the most heavily utilized. Habitat losses, however small, are frequently permanent and thus cumulative. Stream surveys conducted within recent years in Region D suggest that many of Maine's interior rivers and streams that provide brook trout habitat may be degraded as a result of activities associated with log driving and timber harvesting. Although log driving was terminated many decades ago, surveyed streams that were driven tend to remain overwidened, entrenched (incised), and have fewer pools than would be expected. It is assumed that restoration of these streams to their natural state would improve fisheries habitat and therefore brook trout abundance. Efforts to investigate the feasibility of stream restoration on several Western Maine waters are currently underway.

Brook trout abundance and size quality has increased on streams that were selected for special regulations similar to those imposed on lakes. These regulations, imposed as Fisheries Initiatives, included catch-and-release and other restrictions intended to preserve and enhance wild brook trout fisheries. Though the number of streams is not large, those included are some of the state's most valuable brook trout resources.

DEMAND

Lakes and Ponds

Brook trout populations supported by natural reproduction account for 67% of the number and 82% of the acreage of lakes with principal fisheries. New minimum length restrictions of 8, 10, and 12 inches, effective 1996, have been promulgated on brook trout lakes with both wild and stocked populations. Prior to 1996, the statewide minimum length limit on brook trout in both lakes and streams was 6 inches, except in three southern counties where it was 8 inches in lakes. These standardized length regulations facilitated the estimation of allowable statewide harvest estimates, which were obtained by multiplying the estimated supply of brook trout by the maximum allowable harvest, expressed as a percent. For wild brook trout populations, an annual harvest of 50 percent of the available population of fish 6 inches and longer was set as a maximum allowable harvest for previous planning periods. For stocked waters, where natural reproduction is not a consideration, an annual harvest of up to 70% of the available trout was determined to be allowable. Using the estimated springtime standing crop plus a 25% rate of recruitment, an estimate of 2,150,000 brook trout of legal-size (6 inches and greater in length) was estimated for the planning period commencing in 1986. Using the same method, the standing crop of brook trout 6 inches and greater in length was estimated to be 4,139,000 in 1991.

Estimates of statewide brook trout abundance are not being made for this update of the species plan because it is felt that the methodology used for estimation is prone to error, as evidenced by the wide range in estimated abundance from 1986 to 1991.

Although the 6-inch minimum length limit remains in effect in seven northern county lakes and an 8-inch minimum length limit has been imposed on the lakes of the nine southern counties effective 1996, efforts to estimate the allowable brook trout harvest are confounded by the imposition of special (though necessary) length limits on nearly 500 lakes. Furthermore, the concept of 'maximum allowable harvest' is being replaced by 'optimum sustained yield', which implies consideration of size, age, and genetic qualities of wild brook trout populations in addition to their standing stocks when determining appropriate harvest rates. As mentioned previously, there is evidence that imposition of the aforementioned special regulations are reversing the decline in the numbers of older, genetically important brook trout. The success of this effort will be indicated by an increase in the proportion of age IV+ and older brook trout in the population from the current 10% to the historic 20%. Given the loss of older-age fish from brook trout populations, it appears that the previous maximum allowable harvest of 50% of trout 6 inches or greater in length was too high to maintain fishing quality.

The extent of current angler demand on brook trout in lakes is based on the results of angler questionnaires. Creel survey data are available for only a few waters (Table 9), all of which are under 200 acres in size, and are therefore unlikely to be representative of the state at large. Furthermore, those chosen to represent stocked fisheries have either severe interspecific competition or severe regulatory restrictions and therefore likely under-represent statewide harvest figures. Nonetheless, accrual of additional data from surveys of individual waters will eventually yield valuable information on angler use and harvest estimates from brook trout lakes with differing sizes, regulatory restrictions, water-quality limitations, and degrees of interspecific competition. Estimates from the 1999 angler questionnaire indicate an annual demand of 1,882,368 angler days (Table 10), 1,633,496 (86.8%) of which occur in the summer. Of these, 1,488,211 (91.1%) of the angler days occur on lakes.

The voluntary release rate of legal-size brook trout, which was considered to be negligible when the first species plan was written, has increased substantially, and therefore both the number of fish caught and the number kept are now both used as indicators of success. Winter anglers keep half of their catch of legal-size fish; summer anglers keep slightly less than a third. Angler success is lowest in the winter, presumably because most of the better trout waters are closed to ice fishing. Anglers and managers alike are aware that brook trout in small ponds are extremely vulnerable to ice fishing, and that fisheries would be destroyed if this type of fishing were allowed. Likewise, the historical closure to fishing during the fall spawning period should be continued where brook trout are known to reproduce.

Regional estimates of winter angler-use and catch (Table 11) indicate that Regions E and G, located in the northwest section of the state, account for 45% of the statewide angler-days and 45% of the brook trout harvest. On a statewide basis, winter anglers kept 37% of the legal-size trout they caught, a substantial decline from the 48% reported in the 1993-94 angler questionnaire. They caught brook trout at an average rate of 0.47 per day and kept them at a rate of 0.18 per day.

For lakes during the summer season, the highest rates of angler-use and catch occurred in Regions D, and E, which together accounted for 53% of the angler days and 47% of the harvest (Table 12). Statewide, the proportion of legal-size trout kept also declined, from 32% in 1994 to 25% in 1999. Brook trout were caught at a rate of 0.84 per day and kept at a rate of 0.25 per day.

There were no clear trends in catch-rate changes from 1994-1999; the number of trout caught per angler day in lakes increased from 0.40 to 0.47 during the ice fishing season but declined from 0.99 to 0.84 during the summer season.

The mean length of brook trout harvested from lakes (as determined from clerk surveys) is 13.2 inches in the winter and 14.0 inches in the summer (Table 13). Their mean weights are 0.92 and 1.05 pounds respectively, yielding an estimated annual harvest of 362,420 pounds, 40,593 pounds (11%) of which are harvested during the winter and 321,827 pounds (89%) are harvested during the summer. The estimated yield represents a 10% decline from that of 1994. This decline was anticipated given the imposition of restrictive regulations and the increased tendency toward catch and release, and is expected to contribute toward improved brook trout size quality. However, on a per-acre basis, the annual harvest was 0.96 pounds[1] (0.16 pounds were harvested in the winter and 0.80 pounds were harvested in the summer), indicating that the harvest objective of 0.5 pounds per acre is still being exceeded. The current harvest rate represents only a moderate decline from the annual harvest of 1.11 pounds per acre reported in the 1996 update.

Angler demand, which increased in the 1980's as a result of increasing license sales and improved access to once-remote trout ponds, is expected to remain relatively stable during the next planning period. However, harvest is expected to decline as a result of the imposition of restrictive regulations designed to restore quality brook trout fisheries and as more anglers practice catch and release. Conversely, catch rates are expected to rise.

[1] Calculated using acreage of principal fishery waters open to fishing.

Brooks and Streams

There are a total of 22,248 stream miles of habitat, and an estimated 75 wild brook trout 6 inches and longer per mile for streams sampled. However, because the number of brook trout per miles varies considerably with stream type and size, it is not possible to accurately estimate the number of brook trout in streams statewide. Angler use on streams was estimated to be 399,696 angler-days in 1999, a decline of 24% since 1994. These anglers caught an estimated 978,505 legal-size brook trout, or 2.45 per angler; the harvest rate was 0.82 fish per angler-day. The proportion of trout kept declined from 37% in 1994 to 34% in 1999 while the catch rate increased from 2.00 to 2.41 for the same period. Region G, which has the greatest mileage of streams suitable as brook trout habitat, accounted for 20% of the angler-use and 34% of the catch.

Despite the fact that three times as many angler days are spent fishing on lakes as on streams, the number of trout caught is similar because the catch-rate on streams is three times that of lakes. The total number of trout kept is slightly higher on streams because these anglers keep a higher proportion of their catch.

A harvest of 50% of available supply was set as a safe maximum in earlier species plans. However, this standard is difficult to measure given present monitoring capabilities. Instead, brook trout abundance is monitored statewide annually on representative waters, and results, as defined by the estimated number of mature fish per unit of area, indicate that brook trout in streams are not being over harvested at current use levels, although fishing quality has declined in specific streams that receive high levels of angler-use. While this problem has been addressed with the imposition of special regulations on selected streams and rivers that are capable of exceptional brook trout fisheries, there remain many fisheries in smaller streams that have become locally over-fished. Under current levels of staffing, it is not possible to document the locations or extent of these local area of depletion. Overall, future demand during the current planning period, like that of lakes, is expected to remain fairly stable. Therefore, demand should not exceed available supply.

CONSTRAINTS ON OPPORTUNITY

Overall opportunity to use the existing brook trout resource is not severely limited. Unavoidable limitations on the use of this species include regulations designed to sustain their numbers and distribute the catch among anglers, as well as the physical distribution of brook trout populations throughout the state, which is concentrated away from population centers. Use opportunity is also limited by restricted access to some public waters, particularly in the western part of the state. Regulations imposed to protect brook trout populations from over-exploitation include bag, length, gear, and season restrictions. Among the latter, the closure of many brook trout waters to ice fishing is the most use-restrictive; only 225 (20%) of the lakes are open to ice fishing (Table 14); however, these lakes represent 62% of the total acreage because only the larger brook trout lakes (including many of the state's largest lakes) are open to ice fishing. Brook trout waters have traditionally been closed to fishing after Sept. 30 to protect spawning populations. As a result of angler initiatives, the fishing season is being extended throughout October on many stocked lakes and ponds to provide additional opportunity. Waters opened to October fishing have restrictive gear restrictions and are open to catch-and-release fishing only.

Due to angler mobility, the distance of the majority of Maine's brook trout lakes from population centers does not significantly reduce opportunity. Furthermore, the advent of the all-terrain vehicles (ATVs) in the 1980's has resulted in increased use of waters once accessible only by foot. These vehicles are frequently used to access Remote Trout Ponds in violation of LURC zoning standards, though recent legislation restricting their use may alleviate this problem. Landowner restrictions on legal and physical access are significant in some unorganized townships of the state. Private roads are the only means of vehicular approach to many of the trout waters located in northern and western Maine. Public use of many of these roads is often controlled and sometimes restricted resulting in reduced use-opportunity. The total acreage of brook trout lakes with restricted public access is 6,617, or 1.6% of the statewide total (Table 15). Region D has 39 lakes (71%) of the 55 brook trout lakes with restricted public access. Accessibility to many trout waters is in a constant state of change as new logging roads are constructed and old ones degrade to impassability. Overall, however, additional permanent road development has resulted in net gain in road access and use since the 1970's.

Management experience indicates that fishing quality frequently declines as accessibility increases. The Fish and Wildlife Department therefore does not advocate unlimited access to all brook trout waters, but rather equal access for all anglers. To provide a variety of angling opportunity, we recommend that the access to remote trout ponds remain undeveloped. To that end, some remote waters have been designated "wilderness" ponds under Land Use Regulation Commission statutes at the advice of the Department of Inland Fisheries and Wildlife. A total of 170 waters in the unorganized townships of eight counties are protected from permanent road construction within a half mile of their shorelines (Table 16); this number represents a decline of 7 waters (4%) since the 1996 update was written.

Opportunity to fish for brook trout in flowing waters increased with the extension of the open-water fishing season from August 15 in brooks and streams and from September 15 in rivers to September 30, effective 1988. To protect pre-spawning populations, this season extension requires the use of artificial-lures-only and restricts the bag limit to one trout. Angler access to some streams or portions of streams is barred by private landowners who do not allow trespassing, and access to many streams located in the unorganized townships of the state is affected by landowners who control public use on private roads (e.g., the upper sections of the Androscoggin River drainage). The extent of these restrictions on public use has not been quantified, but, thanks to landowner tolerance, is not a severe problem statewide. The

promotion of responsible use of private lands – as well as the resolution of conflicts between landowners and anglers - is addressed through Project Landshare, the Department's landowner relations program, which received new direction and emphasis in 2000.

The opportunity for anglers to use existing brook trout fisheries is expected to remain at approximately the current levels for the next planning period, but it could change unpredictably with any ownership or policy changes of the major woodland owners. The imposition of fees for private road use, while justifiable if reasonable and equitably applied, may discourage some angler use.

The effect of recently-enacted special regulations intended to improve the quality of brook trout fisheries will affect use opportunity to an as-yet unknown degree. The imposition of more restrictive regulations may discourage some anglers from fishing particular waters. However, angler attitudes toward harvest are changing (as evidenced by an increasing rate of voluntary release of legal-size fish), and it is anticipated that the proportion of anglers who fish non-consumptively and those who value "quality" fisheries will continue to increase. These contentions are supported by angler preferences expressed in the Summer, 1999 open water fishing survey; a majority of anglers rated fishing in remote waters and fishing for wild fish as 'very important'. Only a minority felt that 'catching many fish' was very important. Furthermore, the rating of fishing quality by anglers, as reported in open water fishing surveys, increased from 2.1 ("fair") in 1994 to 2.9 ("good") in 1999, implying angler approval of recent management initiatives.

It is also likely that advertisement of the development of quality brook trout fisheries will attract additional angler use. Because of the brook trout's vulnerability to harvest by ice fishing, it is not recommended that use opportunity be increased by opening additional waters during the winter season. In terms of brook trout 6 inches and longer, supply still exceeds angler demand. As evidenced by the loss of older-age fish in the population, however, there has been a decline in fishing quality. Regulations intended to restore brook trout fishing quality in lakes became effective in 1996, and early results indicate that they are effective in meeting this goal.

Table 1. Abundance of Principal Fisheries Brook Trout Habitat (acres) in Lakes, Regions A and B

REGION	YEAR			
	1986	1991	1996	2001
A	7,000	8,100	10,000	14,524
B	3,600	4,000	8,300	8,509

Table 2. Number and Acreage of Maine Brook Trout Lakes as of 2000, by Region

REGION	TOTAL OCCURRENCE		PRINCIPAL FISHERIES		ONGOING INTRODUCTIONS	
	NUMBER OF LAKES	ACRES OF LAKES	NUMBER OF LAKES	ACRES OF LAKES	NUMBER OF LAKES	ACRES OF LAKES
A	120	63,589	93	14,524	0	0
B	97	52,644	37	8,509	0	0
C	189	93,924	80	8,027	1	16
D	233	105,473	193	73,709	0	0
E	402	223,166	369	171,274	3	50
F	191	136,571	129	35,472	1	11
G	255	93,897	234	91,881	0	0
STATE	**1,487**	**769,264**	**1,135**	**403,396**	**5**	**77**

Table 3. Three Year Stocking Summary (1998-2000) for Brook Trout in Lakes, by Region and Age Group[2]

REGION	AGE	NUMBER OF LAKES STOCKED	NUMBER OF ACRES STOCKED	AVERAGE STOCKED PER YEAR		AVERAGE STOCKED PER ACRE	
				NUMBER	POUNDS	NUMBER	POUNDS
A	AD	25	3,964	168	885	0.3	1.4
	FF	53	12,461	34,133	3,744	26.6	2.8
	FY	37	7,700	1,538	1,740	0.7	0.8
	SY	87	15,322	32,494	11,667	13.5	4.8
	ALL	104	24,322	38,333	18,036	13.0	3.3
B	AD	19	17,757	886	951	0.2	0.2
	FF	11	7,130	14,175	1,982	55.4	10.0
	SY	38	13,285	35,361	12,769	8.6	3.1
	ALL	57	27,681	50,422	15,702	13.9	3.6
C	AD	13	2,103	393	554	0.7	1.1
	FF	52	5,617	34,115	3,272	27.0	2.4
	FY	10	425	650	786	2.8	3.3
	SY	30	3,091	5,850	2,038	12.2	4.9
	ALL	60	7,204	41,008	8,631	20.0	3.0
D	AD	9	18,422	525	1,067	0.2	0.4
	FF	70	14,965	124,355	10,618	57.5	5.0
	FR	5	7,165	7,212	30	96.0	0.4
	SY	30	15,858	19,107	6,757	6.4	2.3
	ALL	97	29,896	151,199	18,472	45.7	4.0
E	AD	3	662	298	703	0.5	1.3
	FF	62	6,299	92,758	8,703	48.7	4.5
	FR	1	15	1,400	4	93.3	0.3
	SY	2	487	750	825	2.7	2.9
	All	76	86,013	95,206	14,816	59.1	12.2
F	AD	7	5,684	1,412	3,005	3.8	9.2
	FF	43	46,152	31,977	2,379	14.1	1.1
	FR	1	7,168	38,100	114	5.3	0.0
	SY	20	37,124	15,834	5,986	9.8	4.5
	All	51	50,450	87,323	11,484	12.1	2.6
G	AD	2	1,291	200	550	0.3	0.7
	FF	24	1,602	53,583	4,557	53.9	4.6
	SY	19	7,991	12,530	5,387	10.5	4.4
	ALL	42	9,475	66,313	10,494	35.3	4.5
STATE	AD	78	49,883	2,773	5.337	0.6	1.7
	FF	315	94,226	385,097	35,254	40.0	3.7
	FR	7	14,348	21,312	72	90.2	0.4
	FY	49	8,612	2,005	2,277	0.9	1.1
	SY	241	172,654	140,918	52,183	16.7	6.4
	ALL	490	235,041	552,105	95,123	26.4	4.4

[2] Averages are weighted and therefore may be different from those obtained by simple division.

Table 4. Post-season Estimates of the Number of Brook Trout 6 Inches in Length and Greater in Maine Lakes with Principal Brook Trout Fisheries

LAKE SIZE CATEGORY (ACRES)	STOCKED	SUCKERS PRESENT[3]	ESTIMATED NO. OF BKT/ACRE[4]	TOTAL NO. OF ACRES
<200	No	No	45	12,801
	No	Yes	15	15,382
	Yes	No	115	4,997
	Yes	Yes	40	8,970
Subtotal			**54**	**42,150**
>200	No	No	10	10,010
	No	Yes	3	286,152
	Yes	No	25	491
	Yes	Yes	11	54,562
Subtotal			**12**	**351,215**
TOTAL			**33**	**393,365**

Table 5. General Law and Standardized Special Regulation Classes for Brook Trout Lakes Effective 2000

CLASS	BAG LIMIT	LENGTH LIMIT	LAKE CATEGORY	NO. OF LAKES (ACRES)[5]	
				GENERAL LAW	SPECIAL REGULATIONS
I	2 trout	12 inch minimum; only 1 fish may be greater than 14"	Highest growth potential		118 (117,582)
II	2 trout	10 inch minimum; only 1 fish may be greater than 12"	High growth potential		225 (69,064)
III[6]	2 trout	8 inch minimum	Moderate growth potential and stocked waters where distribution of the catch among anglers is a goal	125 (22,162)	110 (14,753)
IV[7]	5 trout	6 inch minimum	"Put and Take" Stocked waters and remote waters with low angler use	479 (72,622)	1 (9)
None	Various				82(107,282)
Total				**604 (94,784)**	**536 (308,690)**
State				**1,140 (403,474)**	

[3]Although suckers are not the only serious brook trout competitor, they are used as an indicator species of competition, and are in fact frequently present in combination with other competing species.
[4]The number of brook trout per acre for lakes 200 acres and less is estimated from fall population estimates plus harvest estimates, and therefore does not account for recruitment or natural mortality.
[5] Principal fisheries only. A principal fishery is one for which the species is regularly sought by anglers and which makes up a significant portion of the catch.
[6]Class III regulations are general law regulations on lakes in Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Oxford, Sagadahoc, Waldo, and York counties.
[7]Class IV regulations are general law regulations on lakes in Aroostook, Franklin, Hancock, Penobscot, Piscataquis, Somerset, and Washington counties.

Table 6. Number and Acres of Principal Fishery Brook Trout Lakes by Management Objectives[8]

REGION	GENERAL		SIZE QUALITY		TROPHY	
	NUMBER OF LAKES	ACRES	NUMBER OF LAKES	ACRES	NUMBER OF LAKES	ACRES
A	84	13,930	9	594	0	0
B	28	7,379	6	969	3	161
C	46	2,883	33	5,018	1	126
D	121	12,203	70	60,964	2	542
E	186	19,788	170	145,896	13	5,590
F	94	24,539	34	10,925	1	8
G	172	24,238	58	67,528	4	115
STATE	731	104,960	380	291,894	24	6,542

Table 7. Miles of Stream Habitat by Management Region

REGION	ESTIMATED TOTAL STREAM MILEAGE	MILES BROOK TROUT HABITAT	PERCENT BROOK TROUT HABITAT
A	3,729	1,678	45
B	3,598	720	20
C	3,793	2,845	75
D	4,837	3,870	80
E	4,134	3,307	80
F	4,770	3,578	75
G	6,945	6,250	90
STATE	31,806	22,248	70

[8] General: lakes and ponds managed for 'average' fisheries; Size Quality: lakes and ponds managed to protect and enhance trout greater than 12 inches in length; Trophy: managed to protect and enhance trout greater than 16 inches in length.

Table 8. Three Year Stocking Summary (1998-2000) for Brook Trout in Streams, by Region and Age Group

REGION	AGE	NUMBER OF STREAMS STOCKED	AVERAGE STOCKED PER YEAR		AVERAGE STOCKED PER STREAM	
			NUMBER	POUNDS	NUMBER	POUNDS
A	AD	3	54	319	16	93
	FF	16	11,047	905	1,136	88
	FR	8	9,415	179	2,502	33
	FY	6	680	727	56	61
	SY	67	36,569	10,325	311	77
	ALL	73	57,765	12,455	804	70
B	FR	1	52,800	18	26,400	9
	SY	3	183	61	138	46
	ALL	4	52,983	79	13,269	27
C	SY	7	1,142	471	230	96
	ALL	7	1,142	471	230	96
D	SY	9	5,883	2,370	607	247
	ALL	9	5,883	2,370	607	247
E	SY	10	14,568	5,594	546	204
	ALL	10	14,568	5,594	546	204
F	FF	1	1,500	108	1,500	108
	FR	2	16,750	54	8,400	29
	SY	5	1,433	617	275	118
	ALL	8	19,683	779	3,392	85
G	SY	3	583	237	292	119
	ALL	3	583	237	292	119
STATE	AD	3	54	319	16	93
	FF	17	12,880	1,125	1,277	109
	FR	11	38,181	220	5,248	31
	FY	6	680	727	56	61
	SY	104	60,362	19,676	355	111
	ALL	113	112,157	22,067	1,390	81

Table 9. Estimated Brook Trout Catch and Effort for Lakes Less Than 200 Acres in Size, Stocked and Wild Populations. All waters Sampled Are Closed to Ice Fishing

ORIGIN	NO. WATERS SURVEYED	YEARS SURVEYED	ANGLERS	ANGLER DAYS	LEGAL FISH		% KEPT	FISH PER ANGLER	
					CAUGHT	KEPT		CAUGHT	KEPT
Hatchery	3	1998-99	657	7,516	410	140	34	0.05	0.02
Wild	4	1994-98	392	792	344	181	53	0.43	0.23

Table 10. Estimated Brook Trout Catch and Effort by Season and Water Type. From 1998-99, and 1999 Angler Questionnaires. (Numbers in Parentheses are 95% Confidence Intervals)

SEASON	WATER TYPE	ANGLERS	ANGLER DAYS	LEGAL FISH		% KEPT	FISHER PER ANGLER - DAY	
				CAUGHT	KEPT		CAUGHT	KEPT
Winter	Lakes	38,441 (1,468)	248,872 (17,648)	119,644 (21,988)	44,122 (6,293)	37	.48	0.18
Summer	Lakes	124,534 (2,208)	1,239,339 (48,516)	1,055,274 (67,823)	308,062 (6,473)	29	0.85	0.25
	Streams	51,580 (1,897)	399,696 (21,512)	978,505 (66,758)	326,449 (30,275)	33	2.45	0.82
	Both	142,392 (2,123)	1,633,496 (56,310)	2,049,028 (105,316)	635,985 (42,672)	31	1.25	0.39

Table 11. Estimated Brook Trout Catch and Effort, Ice Fishing Season, by Region. From 1998-99 Angler Questionnaire. (Numbers in Parentheses are 95% Confidence Intervals)

REGION	ANGLERS	ANGLER DAYS	LEGAL FISH		PERCENT KEPT	FISH PER ANGLER DAY	
			CAUGHT	KEPT		CAUGHT	KEPT
A	8,016 (972)	40,362 (5,596)	18,610 (7,920)	7,598 (2,831)	41	0.46	0.19
B	7,772 (959)	43,847 (7,616)	11,118 (2,968)	5,193 (1,542)	47	0.25	0.12
C	2,997 (620)	16,537 (3,751)	10,281 (4,679)	4,078 (1,475)	40	0.62	0.25
D	2,579 (577)	8,302 (1,961)	4,809 (2,104)	2,091 (952)	43	0.58	0.25
E	13,940 (1,215)	60,905 (7,934)	33,004 (7,769)	10,874 (2,505)	33	0.54	0.18
F	5,785 (842)	28,609 (5,278)	17,565 (13,170)	5,193 (1,854)	30	0.61	0.18
G	6,643 (877)	51,135 (9,602)	24,256 (15,228)	9,096 (3,108)	38	0.47	0.18
ALL	47,732	249,697	119,643	44,123	37	0.48	0.18

Table 12. Estimated Brook Trout Catch and Effort, Open Water Fishing Season, by Water Type and Region. From 1999 Angler Questionnaire. Sums are not Additive Because Estimates Were Made Independently.

REGION	WATER TYPE	ANGLERS	ANGLER DAYS	LEGAL FISH		PERCENT KEPT	FISH PER ANGLER DAY	
				CAUGHT	KEPT		CAUGHT	KEPT
A	Lakes	22,133	217,362	93,699	27,301	29	0.43	0.13
	Streams	9,689	82,667	108,290	30,872	29	1.31	0.37
	All	28,972	299,485	203,582	58,623	29	0.68	0.20
B	Lakes	14,344	123,187	53,715	18,202	34	0.44	0.15
	Streams	3,420	24,600	29,067	13,581	47	1.18	0.55
	All	17,003	147,824	83,445	31,931	38	0.56	0.22
C	Lakes	6,649	42,461	37,332	14,439	39	0.88	0.34
	Streams	3,800	17,561	58,230	24,128	41	3.32	1.37
	All	9,309	60,558	95,561	38,566	40	1.58	0.64
D	Lakes	42,651	372,947	339,836	69,185	20	0.91	0.19
	Streams	15,009	98,077	255,147	47,170	18	2.60	0.48
	All	49,015	471,559	600,684	116,694	19	1.27	0.25
E	Lakes	42,651	287,308	278,925	73,644	26	0.97	0.26
	Streams	8,739	39,768	133,178	43,793	33	3.35	1.10
	All	46,261	327,550	413,932	117,498	28	1.26	0.36
F	Lakes	13,204	72,719	100,691	46,787	46	1.38	0.64
	Streams	6,934	44,504	109,525	46,001	42	2.46	1.03
	All	18,048	116,467	210,216	92,655	44	1.80	0.80
G	Lakes	18,618	133,620	147,378	56,944	39	1.10	0.43
	Streams	10,069	83,770	250,017	112,422	45	2.98	1.34
	All	23,558	216,650	402,625	170,030	42	1.86	0.78

Table 13. Mean Brook Trout Length (Inches) and Weight (Pounds) from Lakes by Region and Season for the Years 1996-2000. Data From Clerk Surveys. Means are Means of Weighted Means. N is the Number of Surveys.

REGION	WINTER					SUMMER					ANNUAL				
		LENGTH		WEIGHT			LENGTH		WEIGHT			LENGTH		WEIGHT	
	N	MEAN	SE	MEAN	SE	N	MEAN	SE	MEAN	SE	N	MEAN	SE	MEAN	SE
A	9	13.1	0.4	0.74	0.13	1	15.9		1.59		10	12.9	0.40	0.64	0.14
B	7	13.5	0.7	0.97	0.18	4	11.2	1.0	0.46	0.13	9	12.4	0.87	0.83	0.21
C	6	15.0	1.0	1.42	0.29										
D	3	8.9	0.9	0.32	0.10	5	13.5	0.4	1.06	0.17	6	13.7	0.34	1.11	0.11
E	10	14.5	0.6	1.11	0.21	4	14.1	0.4	0.95	0.07	12	14.3	0.18	0.99	0.05
F	3	13.5	2.3	0.91	0.31	2	15.6	0.4	1.37	0.25	4	12.1	1.86	0.74	0.26
G	40	13.9	0.2	0.99	0.06	2	13.6	0.1	0.89	0.06	31	14.3	0.17	1.03	0.04
STATE	78	13.2		0.92		18	14.0		1.05		71	13.3		0.94	

Table 14. Number and Acres of Brook Trout Lakes Open to Fishing, 2000.

REGION	ALL LAKES				PRINCIPAL FISHERIES			
	OPEN SUMMER		OPEN WINTER		OPEN SUMMER		OPEN WINTER	
	NUMBER	ACRES	NUMBER	ACRES	NUMBER	ACRES	NUMBER	ACRES
A	120	63,589	90	60,339	93	14,524	63	11,274
B	97	52,644	71	48,969	37	8,509	18	7,728
C	188	93,270	137	89,339	80	8,027	38	5,605
D	233	105,473	32	44,615	193	73,709	8	14,521
E	400	136,515	87	127,659	129	35,472	34	27,501
F	190	136,515	87	127,659	129	35,472	34	27,501
G	255	93,897	41	65,560	234	91,881	37	64,346
ALL	1,483	768,500	504	605,670	1,133	403,342	225	251,007

Table 15. Principal fishery brook trout lakes closed to general public access or closed to all fishing.

REGION	COUNTY	NUMBER (%) OF:	
		LAKES	ACRES
A	Oxford	1(1)	64 (<1)
B	Lincoln	1	78
	Waldo	1	14
	All	2(3)	92(1)
C	Hancock	3	565
	Washington	1	17
	All	4(5)	582(7)
D	Franklin	19	1,346
	Oxford	7	1,135
	Somerset	13	2,020
	All	39(20)	4,501(6)
E	Piscataquis	2	845
	Somerset	3	435
	All	5(1)	1,280(1)
F	Penobscot	1(1)	134 (<1)
G	Aroostook	2	28
	Somerset	1	70
	All	3(1)	98(<1)
STATE	All	55(5)	6,617(2)

Table 16. Number and Acres of Brook Trout Lakes Zoned as Remote Trout Ponds by the Land Use Regulation Commission (LURC); by Management Region

	LAKE		ACRES	
REGION	NUMBER	PERCENT	NUMBER	PERCENT
A	1	<1	17	<1
B	0	0	0	0
C	3	2	108	2
D	16	9	227	4
E	120	68	3,992	70
F	24	14	727	13
G	13	7	607	11
STATE	177		5,678	

GOALS AND OBJECTIVES
2001-2016

BROOK TROUT IN LAKES

GOAL FOR LAKES AND PONDS: Maintain the current distribution of principal fisheries for brook trout in 1,135 lakes and ponds (403,396 acres).

OBJECTIVES FOR LAKES AND PONDS:

1. Protect/enhance brook trout habitat.
2. Maintain self-sustaining brook trout populations.
    A. Native[9] populations in 424 lakes and ponds (81,492 acres).
    B. Wild[10] populations in 185 lakes and ponds.
    C. Restore the proportion of mature brook trout to historic levels (wherein 50% of brook trout sampled by netting are age III+ or older) to assure genetic diversity and the perpetuation of wild populations.
3. Provide for a variety of fishing opportunities.
    A. Increase the number of fishing opportunities for large fish (Size Quality and Trophy lakes) from the current 454 lakes to 500 lakes.
    B. Maintain the current minimum of 177 Remote Trout Ponds but investigate opportunities to increase this number by promoting the zoning of additional qualifying waters.
    C. Double youth (children less than 16 years old) fishing opportunities from the current 25 to 50.
    D. Increase urban fishing opportunities[11] for catchable legals in areas proximate to larger towns and cities from the current 90 to 180.
4. Improve statewide fishing quality[12].
    A. For all principal fishery waters, increase the average catch rate to 1.0 brook trout/angler day but reduce the number of fish kept/day to 0.25. Increase the average lengths and weights of brook trout kept to 14 inches and 1 pound.
    B. For all principal fishery waters, maintain an average harvest rate of 0.5 pounds/acre for wild brook trout waters and 1.0 pounds/acre for stocked waters.
    C. General management waters (731 lakes and ponds; 105,604 acres): meet angler expectation of a catch rate of 5-6 brook trout/angler-day ranging from 10 to 15 inches long.
    D. Size quality waters (430 lakes and ponds; 291,894 acres): meet angler expectation of the presence of brook trout with a minimum size of 12 to 16 inches long.
    E. Trophy management waters (24 lakes and ponds; 6,542 acres): meet angler expectation of the presence of brook trout with a minimum size of 18 inches and/or 3 pounds.

Capability: Despite continued protection of brook trout habitat by existing environmental regulations, current brook trout abundance and distribution will likely decline somewhat throughout the next planning period through the continued loss of habitat as a result of

[9] Native populations are self-sustaining populations that have never been stocked.
[10] Wild populations are self-sustaining but were established or supplemented by stocking in the past.
[11] Urban fishing opportunities are those that are located within half an hour's drive of an urban center and that are maintained by stocking catchable legals.
[12] Fishing quality is the catch rate and fish size expected by experienced anglers targeting brook trout on a good fishing day.

development and the unauthorized introduction of competing fish species. The contribution of wild stocks can be maximized by protecting trout to spawning size. Wild brook trout lakes have the capability of growing older fish than those now typically present. Historical data indicate that the proportion of trout age IV+ and older a half century ago was twice that of fish sampled in the early 1990's. Regulations intended to meet this objective by protecting spawning-size fish from over-harvest were imposed on many wild brook trout ponds effective 1996 with some additions effective 1998 and 2000, and results indicate that the proportion of older fish is increasing.

The harvest objective of 0.5 pounds per acre for wild brook trout is lower than the present harvest rate because of the current effort to improve the quality of the fishery. While the catch rate and average size are expected to increase, harvest rates will decline. For stocked populations, the higher harvest objective of 1.0 pound per acre is reasonable for most lakes. For waters with suitable water quality, however, a lower harvest rate (enforced by restrictive regulations) may be necessary to allow escapement and carryover of stocked trout to older ages with the intent of creating quality fisheries.

There is adequate habitat to meet the objective of increasing brook trout fishing quality through the stocking of catchable legals. Many oligotrophic lakes currently supporting lake trout and/or salmon fisheries have few trout, possibly as a result of predation by these larger species. Stocked spring yearlings are expected to escape predation and provide additional angler opportunity. An ongoing program provides additional brook trout fisheries in urban areas (primarily Regions A and B) through stockings of catchable legals in waters with marginal habitat. However, there are additional opportunities for enhancing existing fisheries and/or providing additional brook trout fisheries by stocking catchable legals – at varying rates and frequencies - at a yet-to-be-determined number of waters throughout the state.

Feasibility: As evidenced by the increase in the number of legal-size brook trout voluntarily returned and the willingness to accept stricter regulations, anglers are supportive of improved fishing quality. Restrictive regulations recently imposed on waters capable of producing brook trout of above-average size are expected to both maximize the contribution of wild stocks and improve size quality. These regulations are also intended to increase escapement of hatchery-reared trout on selected waters, resulting in increased holdover to older ages. Expansion of hatchery facilities, currently underway, should make these objectives feasible.

Desirability: Maintaining the current distribution of brook trout at 403,396 acres is desirable because of the species' aesthetic and economic value. Maximizing the contribution of wild stocks will ensure perpetuation of the species and maintenance of its genetic traits while improving size quality.

Permitting a harvest of 0.5 - 1.0 lb/acre of hatchery-reared populations will maintain current fishing quality for stocked fish in most waters and improve size-quality on selected waters through recently imposed restrictive regulations. The stocking of spring yearling brook trout in larger lakes with suitable water quality will improve fishing quality for this species in waters where past stocking efforts, including those of fall fingerling stockings, have performed poorly.

Possible Consequences: The objective of maintaining no more than the current brook trout distribution may discourage efforts to expand the species' range into new lakes. Although the brook trout's range within the state has probably already been maximized, the development of new strains by the hatchery system may present new opportunity for distribution into new habitat types in the next planning period. Efforts to maximize the contribution of wild stocks by imposing higher minimum length limits and lower bag limits will result in a reduction in allowable

harvest rates, which will be unpopular with some anglers. The higher length limits imposed on selected waters with both wild and stocked populations may also result in increased rates of hooking injury and mortality despite efforts to minimize these effects through gear restrictions and education. Although the benefits of restrictive regulations outweigh the detrimental effects of hooking mortality, anglers often react negatively to the loss of individual fish to hooking mortality. Increasing brook trout abundance through additional stockings may require changing priorities at rearing facilities, upgrading existing facilities, and/or constructing additional facilities.

BROOK TROUT IN LAKES
MANAGEMENT PROBLEMS AND STRATEGIES

PROBLEM 1. Existing data are inadequate to estimate statewide brook trout abundance and harvest. Since the last update in 1996, the number of estimates of population abundance, standing crop, and harvest estimates have increased from 6 to 22 for wild brook trout lakes and from 43 to 47 for stocked brook trout lakes. However, the sample size remains low in proportion to the total number of brook trout lakes, particularly those greater than 200 acres.

Strategy 1. Initiate a systematic statewide sampling regime to include waters with both wild and stocked brook trout populations, both acreage categories (LE 200 acres and >200 acres), a variety of regulations, intra-specific competition, and varying levels of angler-use. With the assistance of temporary contract help, determine estimates of population abundance, standing crop, and harvest on 30 waters annually.

PROBLEM 2. The effectiveness of new regulations intended to improve brook trout fishing quality to historic levels[13] and maximize the contribution of wild stocks has been only partially evaluated.

Strategy 3. For wild brook trout lakes, evaluate the success of these regulations by comparing the proportion of older-age (age III+ and greater) fish sampled to that from pre-regulation change data. For stocked populations, compare the proportion of age II+ and older fish sampled to that from pre-regulation change data. Data are to be gathered by routine nettings and creel surveys and forwarded to the species author for analysis.

Strategy 4. Gather and evaluate creel survey information on waters with different classes of regulations as described in Strategy 1. Contract with outside labor to assist with data collection.

PROBLEM 3. The relative performance in the wild of the Kennebago and domestic strains in waters with differing water quality and degrees of interspecific competition is unknown.

Strategy 5. Initiate a systematic research program involving multiple-year, paired stockings to determine the relative harvest rate and post-season abundance, size, and age structure of wild and domestic strains in waters of differing water quality and interspecific competition.

PROBLEM 4. The degree to which Maine's Hatchery system can support an expansion of the spring yearling brook trout stocking program is unknown.

Strategy 6. Support efforts to investigate the capacity of existing hatchery and rearing facilities to meet the needs of an expanded brook trout stocking program. If necessary, seek funding to acquire new, or expand current, hatchery facilities, staff, and equipment to accommodate increased trout production.

Strategy 7. Re-apportion current production capabilities to favor brook trout over other salmonids.

PROBLEM 5. Restrictive regulations imposed on Maine brook trout waters effective 1996 have resulted in increased brook trout size and catch rates, thereby creating a more desirable fishery, especially for anglers inclined to release a portion or all of their catch. Increased angler use is desirable economically and is sustainable biologically because restrictive regulations protect the resource from overhavest. However, there has been little advertising of this resource to date, particularly to out-of-state anglers.

[13] By restoring the proportion of age III+ fish sampled to 50% of the total number sampled by netting.

Strategy 8. Advertise Maine's brook trout resource through the Department's Public Information & Education Division and the Maine State Office of Tourism, emphasizing a conservation ethic and the physical beauty of the setting of many of Maine's brook trout waters.

PROBLEM 6. A portion of Maine's public brook trout lakes is inaccessible to anglers because access is denied over privately owned roads.

Strategy 9. Gain appropriate public access rights over private ways by purchase, negotiation and agreement, easement, gift, cooperation with other State Agencies, legislation, and by encouragement of private groups and enterprises.

PROBLEM 7. Angler demand, use-rates, and harvest rates of remote brook trout lakes are unknown. Such knowledge would be useful to determine the effectiveness of current zoning and the need to zone additional waters as LURC Remote Ponds.

Strategy 10. Obtain angler counts on a sample of remote ponds as an indicator of use.

Strategy 11. Determine angler demand through use of the statewide angler questionnaire.

Strategy 12. Petition the Land Use Regulation Commission to determine the number of waters that could be zoned as Remote Ponds. Pursue the zoning of additional waters if there is a potential to do so.

PROBLEM 8. There is anecdotal evidence that Remote Pond zoning standards (including road construction, maintenance of barriers, use of non-permitted vehicles, etc.) are frequently violated.

Strategy 13. Determine the causes and extent of Remote Pond zoning standard violations.

Strategy 14. Develop and implement programs to remediate any problems identified.

PROBLEM 9. Despite consolidation of brook trout regulations into four classes effective 1996, many brook trout waters still retain non-conforming regulations, resulting in unnecessarily complicated law books and in angler consternation.

Strategy 15. Unless there is biological justification to the contrary, assimilate non-conforming brook trout regulations into the most appropriate conforming class. Create new classes of regulations for waters that currently have regulations significantly more restrictive than the current Class I regulation (2 trout, 12 inch-minimum length limit; only 1 may be greater than 14 inches).

PROBLEM 10. Expanding ranges of competitor and predator fish species compromise the goal of maintaining existing brook trout habitat.

Strategy 16. Educate the public as to the detrimental effects of warmwater fish introductions on brook trout and other coldwater fish species.

Strategy 17. Investigate the feasibility of increasing the level of enforcement of existing rules.

Strategy 18. Coordinate and combine the educational and enforcement activities in Strategies 17 and 18 with those designed to prevent the introduction of exotic aquatic plants.

PROBLEM 11. Existing staff and financial resources are inadequate to adequately monitor Maine's brook trout populations in lakes and ponds(see also **PROBLEM 5** under Brook Trout in Streams).

Strategy 19. Seek sufficient staffing and financial resources to fully implement the brook trout management plan(see also Strategy 10 under Brook Trout in Streams).

BROOK TROUT IN STREAMS

GOAL FOR RIVERS AND STREAMS: Maintain fishing opportunities for brook trout in 22,250 miles of flowing water.

1. Protect/restore/enhance brook trout habitat.
2. Maintain the integrity of self-sustaining brook trout populations.
3. Maintain brook trout populations at about 1,350 fish of all sizes for each stream mile classified as permanent brook trout habitat; 5 to 7% of the late summer population should exceed 6 inches.
4. Maintain harvest levels at or below 50% of legal fish available pre-season. This equates to no more than the total number of legal fish remaining by mid-summer.
5. Provide for a variety of fishing opportunities.
    A. Maintain size quality in trophy management waters.
    B. Increase the number of fishing opportunities for large fish.
    C. Maintain and/or increase the number of remote fishing opportunities.
    D. Provide for more youth fishing opportunities.
    E. Increase opportunities in urban areas.
6. Maintain fishing quality at 2.5 legal trout caught and 0.75 harvested per angler day, and an average length of 10 inches.
    A. General management waters: meet angler expectation of a catch rate 5 to 10 brook trout per angler day ranging from 6 to 10 inches long.
    B. Trophy management waters: meet angler expectation of the presence of brook trout with a minimum size of 15 inches and/or 2 pounds.

Capability: Brook trout stream habitat is abundant on a statewide basis. Although lack of habitat does not limit overall goals and objectives, there is evidence that some habitat has been degraded by human activities such as agriculture, timber harvesting, and development. There is less suitable stream habitat in the southern coastal plain, which includes portions of Regions A and B. The majority of streams supporting native brook trout populations statewide are biologically unproductive and do not normally produce trout of exceptional size; thus, there is limited potential statewide for creating quality brook trout fisheries through the imposition of restrictive regulations.

Feasibility: Harvest rates have not, to date, reduced brook trout abundance or opportunity statewide. Some continued loss or degradation of stream habitat is expected to occur as a result of development, including road construction, and agricultural practices. Restrictive regulations intended to improve fishing quality on many of the State's quality brook trout streams were imposed in 1996. The success of these regulations in increasing the average fish size will be evaluated over the next planning period.

Desirability: The stated goals and objective, if met, will maintain the existing brook trout stream fishery overall; maintain or increase the number of remote fishing opportunities; provide for more youth fishing opportunities; and improve fishing quality where growth potential occurs.

Possible Consequences: If special regulations are successful in improving fishing quality in streams capable of growing larger-than-average brook trout, there may be an increase in demand, as well as in use-opportunity. These fisheries are expected to attract non-consumptive and trophy anglers and, in doing so, may displace some of the more traditional anglers. Increased demand may also result in crowding and associated degradation of the aesthetic angling experience on some waters.

BROOK TROUT IN STREAMS
MANAGEMENT PROBLEMS AND STRATEGIES IN ORDER OF PRIORITY

PROBLEM 1. There is a lack of detailed information on the quantity and quality of brook trout habitat, angler demand, harvest, and angling quality of both wild and stocked brook trout stream fisheries.

Strategy 1. Continue an effort initiated during the last planning segment to classify brook trout population estimates by stream type in order to more accurately correlate habitat and brook trout abundance.

Strategy 2. Complete the statewide stream inventory files to determine the quantity and quality of brook trout habitat statewide.

Strategy 3. Compile statewide summaries of voluntary data for brook trout streams to estimate harvest and angling quality.

Strategy 4. Initiate a systematic statewide sampling regime for estimating angler use, harvest, and fishing quality on brook trout streams.

Strategy 5. Determine the extent of stream degradation, habitat loss and potential for restoration through comprehensive stream surveys.

PROBLEM 2. Restricted public access limits use opportunity on some streams, as does the fact that some streams are unnecessarily closed to fishing.

Strategy 6. Improve access to trout streams by purchase, negotiation, easement, or gift. Encourage other state agencies, private groups or enterprises to work toward acquisition of new access and protection of existing access.

Strategy 7. Investigate the feasibility of opening to fishing those streams that are currently closed in order to increase use opportunity, assuring that the regulations imposed are adequate to protect the fisheries from overharvest or degradation. Specifically, the intent of the regulations would be to minimize or eliminate harvest, maintain spawning and nursery function, yet providing angling opportunity.

PROBLEM 3. Environmental degradation from streamside cutting, development, and pesticide/herbicide application threatens some stream fisheries.

Strategy 8. Continue cooperation with other state and federal agencies charged with evaluating and enforcing these areas of degradation. Support legislation intended to minimize or eliminate specific environmental risks. Inform the public and encourage interest and participation in addressing these issues.

PROBLEM 4. The degree of genetic diversity and heterozygosity within Maine's wild riverine brook trout populations has not been evaluated. Therefore, it is not possible to determine either their uniqueness or the degree to which they should receive regulatory protection.

Strategy 9. Determine the genetic diversity of Maine's wild riverine brook trout populations by collecting and analyzing drainage-wide genotype samples from one of the seven major river drainages selected for its abundance of wild brook trout populations.

PROBLEM 5. Existing staff and financial resources are inadequate to adequately monitor Maine's brook trout populations in rivers and streams(see also **Problem 11** under Brook Trout in Lakes).

Strategy 10. Seek sufficient staffing and financial resources to fully implement the brook trout management plan(see also Strategy 19 under Brook Trout in Lakes).

APPENDIX A

COLDWATER WORKING GROUP INPUT

BROOK TROUT MEETING SUMMARY

Issues:

- ✓ Illegal smelt introductions.
- ✓ Are large fish necessary for spawning?
- ✓ Management of "stunted" populations.
- ✓ Habitat protection!
- ✓ Protection of the integrity of native stocks.
- ✓ Habitat degradation: Habitat improvement.
- ✓ Access: public access necessary but ease of access can produce management problems in remote waters.
- ✓ DIFW fishery management program: inadequate staff numbers and finances!
- ✓ Beaver management?
- ✓ Adequacy of LURC protection of headwater streams?
- ✓ Possible impacts of outboard motor emissions on fish and/or the fishery?
- ✓ Insufficient number of remote ponds.
- ✓ Inadequate enforcement of LURC regulations on remote ponds.
- ✓ Educate the public re the benefits of remote ponds.
- ✓ Invest more staff and money into the fishery management program
- ✓ Implement trophy management on as many wild brook trout populations as possible.*****
- ✓ Consider stocking large (14-16 inch) brook trout to provide a put-and-take fishery in urban areas.*

* *These issues were obtained from written input by Gary Corson.*

Goals and Objectives:

LAKES AND PONDS: Maintain? (enhance?) the present? amount and distribution of principal fisheries for brook trout in *1,135 lakes and ponds (403,396 acres) as per present distribution (map attached).*

1. *Protect/enhance brook trout habitat.*
2. *Maintain the integrity of self-sustaining brook trout populations.*
   - A. *Native[1] populations in 424 lakes and ponds (81,492 acres).*
   - B. *Wild[2] populations in 185 lakes and ponds*.
   - C. *Increase the population density of wild brook trout.*
3. *Provide for a wide variety of fishing opportunities.*
   - A. *Maintain size quality in "Trophy Management Waters".*
   - B. *Increase the number of fishing opportunities for "large fish".*
   - C. *Maintain &/or increase the number of "remote" fishing opportunities.*
   - D. *Provide for more youth fishing opportunities.*
   - E. *Increase opportunities in Urban areas.*
4. *Maintain statewide fishing quality[3]:*
   - A. *General management waters = 5-6 brook trout/angler-day ranging from 10 to 15 inches long.*

B. *<u>Trophy management waters</u> = no catch rates other than knowledge than some fish of this size, or larger occur in one of these waters; size ≧ 18 inches/3 pounds.*

RIVERS AND STREAMS: Maintain fishing opportunities for brook trout in 22,250 miles of flowing water.

1. *Protect/enhance brook trout habitat.*

2. *Maintain the integrity of self-sustaining brook trout populations*

3. *Maintain brook trout populations at about 1,350 fish of all sizes for each stream mile classified as permanent brook trout habitat.5 to 7% of the late summer population should exceed 6 inches.*

4. *Provide for a wide variety of fishing opportunities.*
   A. *Maintain size quality in "Trophy Management Waters".*
   B. *Increase the number of fishing opportunities for "large fish".*
   C. *Maintain &/or increase the number of "remote" fishing opportunities.*
   D. *Provide for more youth fishing opportunities.*
   E. *Increase opportunities in Urban areas.*

5. *Maintain statewide fishing quality[3]:*
   A. *General Management Waters = 5-10 brook trout/angler-day ranging from 6 to 10 inches long.*
   B. *Trophy Management Waters, = no specific catch rates other than knowledge than some fish of this size, or larger occur in one of these waters; size ≥ 15 inches/2 pounds.*

[1]Native populations are self-sustaining populations of brook trout that have never been stocked (with brook trout).
[2]Wild populations are self-sustaining populations of brook trout that have been established or supplemented by a stocking program sometime in the past.
[3]For the purposes of this document, fishing quality is the catch-rate and fish size expected by experienced anglers on a good fishing day.

APPENDIX B

Brook Trout Fishing Quality Management Categories[14]

Provide fishing quality opportunities with the following catch and size standards (All fishing quality performance standards are based on "**an experienced angler on a good fishing day**"):

IN LAKES AND PONDS

I. *Management Category A: meet angler expectation of the presence of brook trout with a minimum size of 18- inches and/or 3-pounds. These fisheries could be based on wild and/or stocked populations.*

II. *Management Category B: meet angler expectation of a catch rate of 5 to 10 brook trout per angler day ranging from 10 to 15-inches long. These fisheries could be based on wild and/or stocked populations.*

III. *Management Category C: meet angler expectation of a catch rate of 5 to 10 brook trout per angler day ranging from 7 to 10-inches long. These fisheries could be based on wild and/or stocked populations.*

IV. *Management Category D: wild brook trout populations wherein few, if any, brook trout exceed 7-inches.*

IN RIVERS AND STREAMS

I. *Management Category A: meet angler expectation of the presence of brook trout with a minimum size of 15 inches and/or 2 pounds. These fisheries could be based on wild and/or stocked populations.*

II. *Management Category B: meet angler expectation of a catch rate of 5 to 10 brook trout per angler day ranging from 8 to 12 inches long. These fisheries could be based on wild and/or stocked populations.*

III. *Management Category C: meet angler expectation of a catch rate of 5 to 10 brook trout per angler day ranging from 6 to 8 inches long. These fisheries could be based on wild and/or stocked populations.*

[14] Final management categories based on 1-8-2004 revision.

IV. Management Category D: wild brook trout populations wherein few, if any, brook trout reach 6-in.