

American Woodcock (*Scolopax minor*) Management Proposal

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Executive Summary

The American woodcock (*Scolopax minor*) is a popular game bird in the northeastern North America. Despite reducing hunting pressure, the regional population of American woodcocks continues to decrease significantly. It is suggested that despite hunting pressure, the true nature of the decline in woodcock population stems from the preferential regrowth of what was once young, early successional forest. These successional forests are a preferred habitat of woodcocks, and thus limitation to poor-quality habitat has lead to increased woodcock mortality. In order to resupply the American woodcock with necessary habitat for a stable population, this proposal determines the immediacy of action, explores successional forest management techniques used by other American woodcock managers, and explores a method of its own.

Introduction

Description/Taxonomy

The species of interest in this conservation plan is the American woodcock (*Scolopax minor*). There are 7 species of woodcocks in the genera *Scolopax*, however *S. minor* is the only one found in North America. The woodcocks belong to the family of shorebirds and wading birds *Scolopacidae*. The American woodcock is a small, stocky, solitary shorebird with a long bill and large head (Figure I). The markings on the woodcock are highly cryptic, and their appearance is most similar to the genus *Gallinago*, or snipes (Sibley, 2000).



Figure I – American woodcock (*Scolopax minor*) with worm

As adults, they weigh 7 ounces and are generally 11" in length with a 18" wingspan (Sibley, 2000). The bill of the bird is usually twice the length of its head of which the tip is independently prehensile. Measurement of the bill is used for sex determination. Three outer primaries of the wings are modified to induce a whistling noise during flight; size of these primaries can indicate sex and age class (Martin, 1964).

The American woodcock is among the top 10 species of migratory game birds throughout the United States Northeast. It is considered a popular game bird, providing a cumulative of 3.4 million days of recreational hunting per year (Kelley, 2001). Estimates in the 1980s suggest that approximately 1.1 million woodcocks were harvested annually; however, more recent estimates in 1999 by the USFWS suggest the annual harvest has declined to 435,000 woodcocks (Dessecker & McAuley, 2001).

Life History - Habitat

Instead of living the life of a typical shorebird, the American woodcock lives in forested areas, preferring secondary successional forests with limited canopy but abundant understory cover (Sperry, 1940). Although woodcocks prefer secondary successional forests, they inhabit multiple habitat types. Habitat requirement differs based on time of day (roosting or feeding grounds) and stage of migration (either wintering or breeding grounds; Dessecker & McAuley, 2001). In order to understand American woodcock habitat requirements, it is important to consider that their living area varies based on temporal and reproductive habits.

American woodcocks prefer secondary successional forests as a feeding ground, due to protection from shrubs; but more importantly, they prefer this habitat due to the presence of earthworms on which they subsist upon (Sperry, 1940). Transitioning to and from roosting grounds at dawn and dusk, woodcocks roost at night in clearings, agricultural or fallow fields, and sparse woodlands (Sepik & Derleth, 1993a).

Life History - Reproduction/Breeding Habitat

American woodcocks breed and nest in the northeast and mid-Atlantic states (spanning Maine to northern Florida) during the Spring and Summer. The breeding ground habitats are typically clearings (pastures, plantations, harvested woodlands, etc.). On breeding grounds (also known as singing grounds), male woodcocks court females through an elaborate "dance-flight." This flight entails a whistling sound produced from the woodcock's modified primaries, circling through the air, and returning to the takeoff location at high speed (Sibley, 2000).

American woodcocks are ground-nesting birds, with a clutch size of usually 3-4 eggs, with a 59% chance of survival (McAuley, Longcore, & Sepik, Renesting by American woodcocks (*Scolopax minor*) in Maine, 1990). As with daytime feeding grounds, woodcocks prefer secondary successional forests with high shrub density (Dessecker & McAuley, 2001).

Life History - Migration/Migration Habitat

Migration by American woodcocks from breeding grounds to wintering grounds takes place in on autumn nights, peaking during the first week of November (Sepik & Derleth, 1993b). Little is known about the migration habitat or migration habits of American woodcock, other than there are 2 main migration routes classified as the "Central region" and "Eastern region" (Myatt & Krementz, 2007). Since they are no longer an ocean dwelling shorebird, migration paths have proven to be difficult to determine due to lack of obvious geography for the birds to follow (shoreline; Myatt & Krementz, 2007).

A telemetry study by Myatt and Krementz on determining woodcock migration habits in the Central region (2007) found that woodcocks utilized stopover sites on the route often for more than 4 days at a time - suggesting a profound refueling at stopover sites. They also found that woodcocks tended to utilize mixed successional and mature forests; however, they also speculate this had to do with limited potential habitat in the first leg of the migration through Illinois and Indiana (which are highly field agricultural). It has been noted by studies in the past (Sepik & Derleth, 1993a) as well as through personal communication from woodcock biologists (Allen & McAuley, 2012), that woodcocks tend to use the most available habitat, regardless if it is ideal or not. The telemetry study also indicated that the woodcock do not concentrate a specific geographical location for stopover, suggesting that large geographic areas are required for woodcock migration (Myatt & Krementz, 2007).

Habitat use is still being determined for the Eastern region by USGS surveys started in 2010 led by USGS wildlife biologist Daniel G. McAuley and Brian Allen (2012). Preliminary work seems to confirm notions put forward by Sepik and Derleth (1993a), and Allen and McAuley (2012) that woodcocks in the Eastern region are utilizing less-than-ideal mature forest habitat. Allen and McAuley's work also is attempting to correlate survival through the fall migration with hunting and the use of these habitats, versus managed, young, successional forest habitats.

Life History - Wintering Habitat

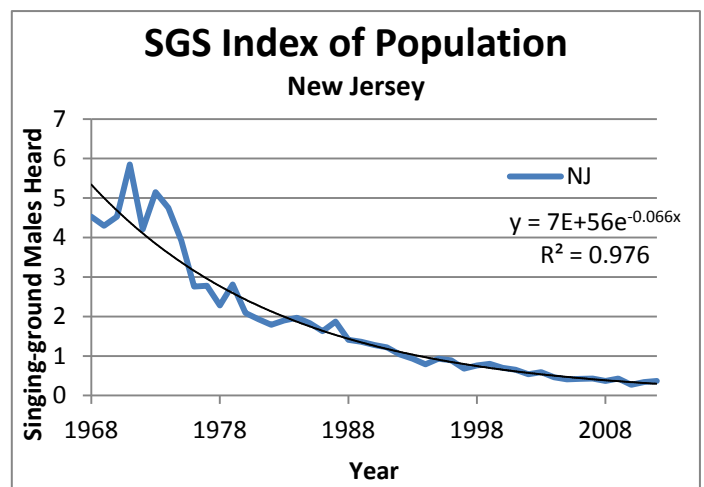
American woodcocks winter in the southeast and southern states of the United States (southern Florida west to southern Texas; Sibley, 2000). They arrive in the South by mid-December. There, the woodcocks utilize a mix of young successional forests and mature, upland forests; and contrary to the summer, spring, and fall, they feed exclusively at night during the winter (Myatt & Krementz, 2007).

Population Status

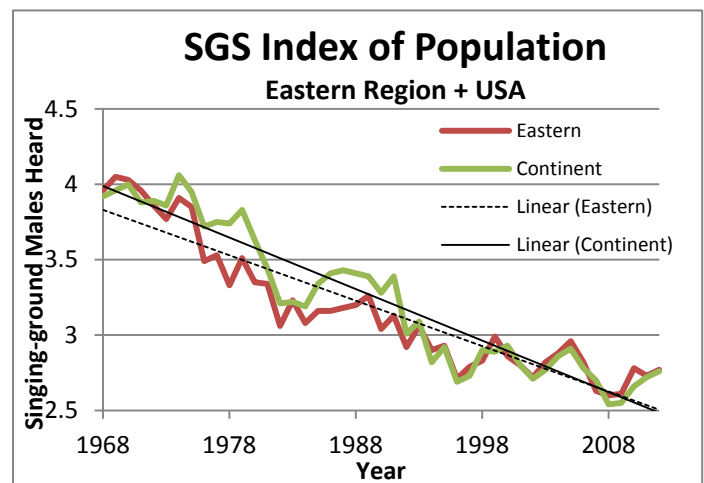
The life history traits (small size, cryptic coloration, and dense brush habitat) of American woodcock make it extremely difficult to gather accurate and reliable population data. Population is thus determined by making estimates and indices based off of survey metrics (Cooper & Rau, 2012).

Singing-ground surveys (SGS) use a metric of the number of males singing on singing-grounds heard by individuals on pre-determined routes. This metric provides a breeding population index, as the number of males singing should be proportional to the effective population size at any given time (Cooper & Rau, 2012). SGS have reported an overall 1.5-2% decline per year in the number of singing males over the past 45 years (Table I, Graphs I + II; Cooper & Rau, 2012;

Dessecker & McAuley, 2001; Dessecker &



Graph II – SGS Counts for NJ 1968-2012. Adapted from data from "American woodcock population status, 2012," by T. R. Cooper and R. D. Rau, 2012. Laurel, Maryland: Fish and Wildlife Service.



Graph I – SGS Counts for Eastern Region and USA 1968-2012. Adapted from data from "American woodcock population status, 2012," by T. R. Cooper and R. D. Rau, 2012. Laurel, Maryland: Fish and Wildlife Service.

Pursglove, 2000; Myatt & Krementz, 2007; Allen & McAuley, 2012).

Another metric used is the Wing-collection Survey (WCS). The WCS is dependent on hunter participation in submitting and wings from the woodcocks they have hunted (Cooper & Rau, 2012; Dessecker & McAuley, 2001). Since age and sex can be determined from wings, the WCS provides indices of woodcock recruitment through determining sex and age-class ratios (Cooper & Rau, 2012). No significant change has been seen in recruitment rates since 1963 (Cooper & Rau, 2012).

Population Threat

The most immediate threat to the American woodcock population is the reversion of post-agricultural land in the northeastern United States back to mature forest. Forests that were once secondary, successional young forests are being preferentially abandoned to allow regeneration (United States Department of Agriculture, 2006). A positive correlation has been observed between decreasing seedling/sapling stands and decreasing American woodcock population on those stands (Dessecker & Pursglove, 2000). It has also been observed that population declines have dampened in New England, likely due to a cycling succession regime due to timber harvest (Dessecker & Pursglove, 2000).

Since American woodcock prefer secondary, successional young forests for feeding during their fall migration, they are left to utilize non-ideal alternative habitats. Preliminary data from the habitat-use telemetry surveys by McAuley and Allen (2012) indicate that woodcocks are left to utilize non-ideal habitats when compared to other study sites in Maine. In addition, they are seeing about a 20% increase in mortality rate for migrating woodcocks in New Jersey over the rate found in Maine (Allen & McAuley, 2012).

A hypothesis was provided by Allen based upon observations made by him during deceased woodcock retrieval; he believes that there is increased predation in unfamiliar habitat by domestic housecats, other mammals, and raptors (Allen & McAuley, 2012). It is still unsure what the true nature of the mortality is, but it has been proposed for long that it is, in fact, due to high predation either on the ground-nest eggs, or birds themselves (McAuley, et

al., 2005; Mendall, 1944). In non-ideal habitats such as mature forests with less dense understory, increased predation will likely occur; thus, this is the current proposed reason behind the American population decline (Kelley et al., 2008; Dessecker & Pursglove, 2000; Dessecker & McAuley 2001).

There was also concern in the past that hunting was the primary cause for the decline in American woodcock population. Early studies believed that hunting before the completion of migration (which has now been confirmed as having large stopovers; Myatt & Kremenz, 2007) left woodcocks extremely vulnerable to population decline (Sepik & Derleth, 1993b). However, a study comparing hunted to non-hunted woodcock sites found no difference in survival curves between hunted and non-hunted sites over 3 years, and it was suggested that hunting mortality was compensatory (McAuley, et al., 2005). However, the authors also suggest that as habitat availability declines, hunting mortality may become additive.

Current Conservation and Management

Regulations/Hunting Restrictions

Federally, American woodcocks are protected under the Migratory Bird Treaty Act. This act protects migratory birds by making it illegal to capture, kill, hunt, or sell birds listed under this act. However, since the American woodcock is considered a game bird there is an exception that allows the Department of the Interior (which houses the Fish and Wildlife Service) to conduct hunting seasons within the population status and conservation guidelines of game bird species (U.S. Fish and Wildlife Service , 2012).

Due to the nature of the Migratory Bird Treaty Act, there is a requirement for a hunting season and back limit on the American woodcock. Historic woodcock hunting season duration and daily bag limits (60 days and 6 birds) are nearly identical to current day in the Central region (65 and 5, respectively); yet in the Eastern region, a strong depression has been put on the daily bag limit and hunting season duration (30 and 3; Cooper & Rau, 2012). Just recently (2011 and 2012 seasons), the Central region has cut back drastically on its duration (45 days) and bag limit (3). This is due to a pact between US Fish and Wildlife Service and the Atlantic

and Mississippi Flyway Council in that regulations are set annually based on population estimates (U.S. Fish and Wildlife Service , 2012), which have declined drastically (McAuley, et al., 2005). However, these tight regulations have yet to see an increase in the number of males found on SGS (McAuley, et al., 2005; Allen & McAuley, 2012; Cooper & Rau, 2012). Specifically, New Jersey strictly follows the regulations put forth by the USFWS. Also, the State requires the possession of Harvest Information Program certification - a program through which data are collected similar to the WCS.

Conservation/Restoration

Initiatives to restore American woodcock habitat have been proposed in the 2008 "American Woodcock Conservation Plan". A select few of the conservation regions mentioned in the conservation plan have created "young forest initiatives": Atlantic Northern Forest Initiative, Appalachian Mountains Young Forest Initiative, Northern Young Forest Initiative, Upper Great Lakes Young Forest Initiative, Atlantic Coast Young Forest Initiative, and Lower Great Lakes Young Forest Initiative (Wildlife Management Institute, 2012). Facets of these programs include private landowners adopting "woodcock-friendly" practices such as "creating young forest through logging, mechanical brush-cutting, the use of herbicides, and controlled burning" (Kelley et al., 2010). Specific work by the Moosehorn National Wildlife Refuge (the refuge from which Allen & McAuley work from) includes the continual rotation of clearing areas for succession, and keeping them in a successional loop (U.S. Fish and Wildlife Service, 2011).

A few notable conservation projects taking place in New Jersey are on the Wallkill River National Wildlife Refuge in Sussex County and the formation of a "Southern New Jersey Young Forest Network" similar to the Young Forest Initiatives. The Wallkill River National Wildlife Refuge is actively maintaining 1000 acres of young forest to benefit woodcock but also various other prairie/field species. They plan to keep the areas in succession by cutting, burning, mowing, and livestock grazing (Kelley et al., 2010). Meanwhile, the Southern New Jersey Young Forest Network is putting together a team of wildlife management areas that will maintain young successional forest habitat. Included in this network is the Higbee Beach

Wildlife Management Area in Cape May National Wildlife Refuge, of where Allen & McAuley do their New Jersey portion of woodcock habitat use studying (Kelley et al., 2010; Allen & McAuley 2012).

Strategies

Strong increase in SGS male counts on wood harvested and young successional maintained forests have been found on the Second College Grant, Dartmouth College Refuge, and the Moosehorn National Wildlife Refuge included in the Young Forest Initiatives (Kelley et al., 2010). In addition to opening woodcock habitat, these management techniques have opened habitat for other game birds and young forest-using songbirds (Kelley et al., 2010). Since the start of the Young Forest Initiatives in 2004, 8 states have increased the amount of young forest, while 7 have decreased (New Jersey leads with a 50% increase in young forest). Other than the two increases noticed independently on the Young Forest Initiative refuges, woodcock density has yet to be determined, but is expected to have rises correlated with increases in young forest area (Kelley et al., 2010).

PVA

In order to conduct a Population Viability Analysis (PVA), data on SGS singing male counts were taken from "American woodcock population status, 2012," by T. R. Cooper and R. D. Rau, 2012. Laurel, Maryland: Fish and Wildlife Service (table I). From this data, the discrete rate of change (λ) of the population was determined for each yearly interval. From these discrete rates of change, an average rate of change and variance in the rates of change for the population were determined. Using the average λ , a 100 year PVA was constructed with stochasticity within the variance of the initial data, using the most recent estimation of woodcock population in New Jersey (179,495 as found in the American Woodcock Conservation Plan; Kelley et al., 2008).

PVA Results

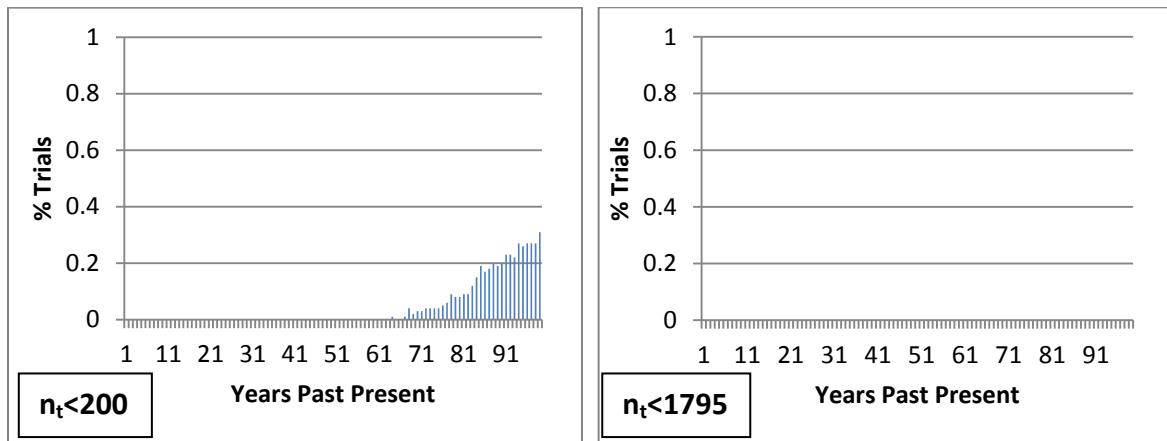
From the PVA modeling, the population rarely went extinct (0-1% extinction every 100 trials), however, the population did manage to go below 8% of its initial population on 95-

100% of 100 trials (table III). Even 20-30% of 100 trials went below 200 individuals which is the amount usually considered as the bare Minimum Viable Population for non-migratory bird species (meanwhile, the American woodcock is migratory; Thomas, 1990) (table III).

N (0)	mean λ	std (λ)	λ deviate	Low pop % Threshold	Low Pop Amt	% Extinction	% Low Pop
179495	0.957502	0.1583157	1.135784514	0.0011	200	0.0%	27.0%

Table III - Parameters for PVA analysis and results/analysis for one run of 100 trials

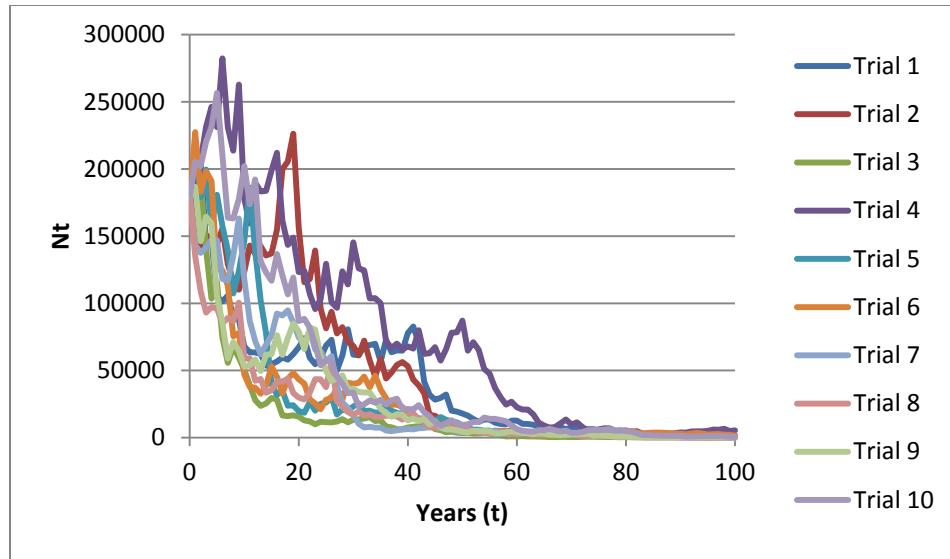
These results are bleak for the status of the American woodcock, as at least 20% of each 100 trials reaches less than 200 (~0.1% of initial population) individuals by 85 years past present (graph III). And at least 65% of each 100 trials below 1795 (1% of initial population) individuals by 85 years (graph IV).



Graph III - Percentage of trials below population threshold (200) for each year past present

Graph IV - Percentage of trials below population threshold (1795) for each year past present

These observations, along with the sample of 10 trials of the PVA analysis on the following page indicate that the decline of the population will be sudden (graph V).



Graph V - Sample of 10 trials of PVA analysis showing population trend (dN_t) over the span of 100 years (t)

Conservation/Management Plan

Recovery Objective

As explored previously, the preferred (and only present) method of restoring American woodcock population is to create young, successional forest habitat. It has been declared by the Progress Report of the Woodcock Conservation Plan (Kelley et al., 2010) that a number of additional acres must be maintained by each state within the woodcock's range to be able to stop the decline, make a partial recovery, or a full recovery (table IV).

By stopping the decline, the population will reach a stable population size at which it neither increases nor decreases. To be able to accomplish this, only 962 acres would have to be cleared in the northern portion of New Jersey to stabilize the population there. This seems a relatively feasible goal, as the land will still have to be managed as well. However, to stabilize the population in the remainder of New Jersey, 6955 acres would have to be cleared and managed - a feat in itself.

In order to create a healthy population size, wildlife managers suggest aiming for the population seen in 1970 (3,073,339 individuals; Kelley et al., 2008; Cooper & Rau 2012; Kelley

et al., 2010). However, the acreage needed to accomplish these goals is significant (6954 for north NJ, and 48,415 for the remainder; table IV). However, the partial recovery acreages are only 2-3 times larger than the stabilization acreage requirements, and seem much more feasible over the span of a few years.

Conservation/Management Strategy/Implementation

As demonstrated by the Young Forest Initiatives, management by creating young, successional forest through methods of cutting, burning, and mowing had profound results on increasing the amount of males singing found on SGS (and thus possibly the population on those sites). Therefore, continuing to use these methods to increase the acreage of successional forest will be the most successful in increasing woodcock population.

In various papers, Daniel G. McAuley proposed managing at least 25% of any open land area by clearcutting on a 40 year rotation (McAuley, Longcore, & Sepik, 1990; McAuley, et al., 2005; Dessecker & McAuley, 2001). However, as of lately he has changed his opinion likely due to the severity of the population decline and data from his habitat use survey; as in a personal communication in 2012, he indicated that "they just have to come out here with a tractor and strip cut every so often, like every 4 or 5 years, so things can keep changing". So although various papers indicate a longer time period between cuts, it seems logical to create a continually shifting mosaic pattern.

In addition to creating habitat for woodcocks, managing open areas can be beneficial to other native species that require an early successional habitat (as demonstrated in the Young Forest Initiative). The method of controlled burning can also restore plant communities requiring fire for seed-dispersal or flowering mechanisms (i.e. *Schwalbea americana*; Kelly, 2006). A prime candidate of vast acreage that is lacking a once-present fire dynamic is the New Jersey Pinelands. Not only would controlled burning open up habitat for woodcock, but it would restore native fire regimes. However, opening up niches also allow for non-native species to propagate. Following the clearing, a round or two of invasive species management would have to take place, as invasives tend to infiltrate newly cut areas. This was present as

an additional, necessary management tactic in some of the Woodcock Conservation Plan proposals (Kelley et al., 2008).

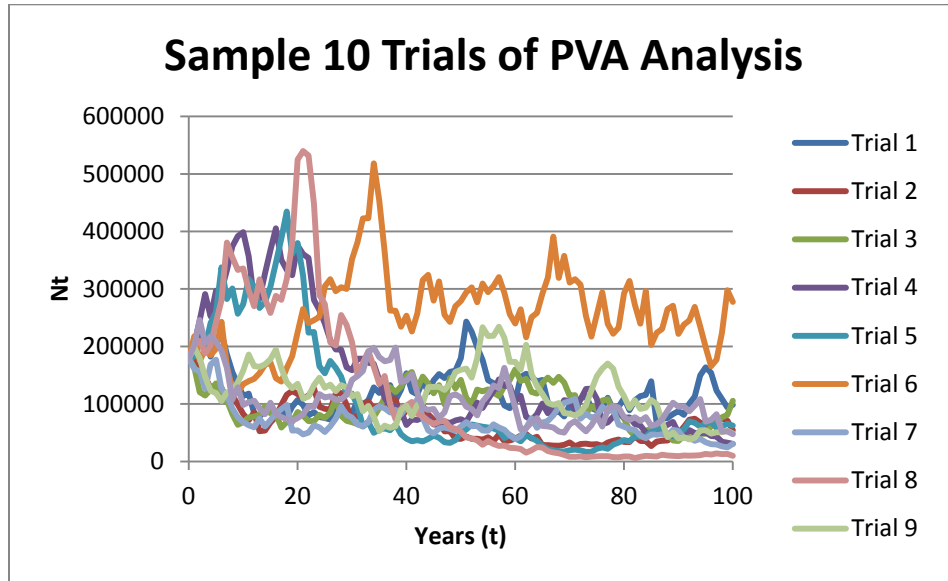
Therefore, the management plan would be as follows:

- Cutting, burning, and mowing would take place on still young, but leaving early succession, forests; or on vast swaths of forest that previously had canopy gaps, glades, or fire regimes that have since been missing due to human interference.
- After management, invasive species would be managed as needed.
- SGS would be conducted every 4 or 5 years to monitor for woodcock population growth (prior to the additional management).
- Rotational cutting, burning, or mowing would take place on the same or adjacent sites every 4 or 5 years.

The basis of these management plans is largely unsupported because the entire foundation of American woodcock population estimation is flawed in itself. The entire population trend is based on estimates from population numbers that are statistically and significantly lower than what the projection is. There have also been studies questioning and exploring the validity of the SGS population estimates. One study mentions that breeding and nesting in the South, Midwest, and even far North have been documented and perhaps even increased due to forest management in the South (Whiting, 2006). The author suggests that since woodcocks are known to take advantage of whichever habitat and conditions they may find, that perhaps they simply do not go in the range of where the surveys are taking place. Thus, the author believes that SGS are not a good indicator of regional population, since there may be a shift in utilized habitat. More information needs to be gathered on the life history of American woodcocks (for example, current mortality and birth rates), which would hopefully provide insight into better population estimates.

Sustainable Harvest Model/Results

Since harvesting was not the issue in the case of this game animal, and population projection requires life history statistics that were not available, I ran a PVA by modifying the λ to 1 (indicating a stable population being reached through management) with the same amount of variance as the initial statistics yielded (graph VI).



Graph VI - Sample 10 trails of PVA analysis using a stabilized λ value (1)

As expected, there were 0% extinction and 0% low populations (<200) reached, as indicated in table V.

N (0)	mean λ	std (λ)	λ deviate	Low pop % Threshold	Low Pop Amt	% Extinction	% Low Pop
179495	1	0.1583157	1.04303308	0.0011	200	0.0%	1.0%

Table V - Parameters for PVA analysis and results/analysis for one run of 100 trials using a stabilized λ value (1)

Through the management techniques, if even the minimum acreage required for stabilization is met, the population of American woodcocks will overcome extinction.

Table I – Singing-ground male counts from 1968-2012. Adapted from "American woodcock population status, 2012," by T. R. Cooper and R. D. Rau, 2012. Laurel, Maryland: Fish and Wildlife Service.

	CT	DE	ME	MD	MA	NB	NH	NJ	NY	NS	PA	PEI	QUE	RI	VT	VA	WV	Eastern	Continent
1968	2.8	0.99	6.11	1.97	3.43	8.85	3.9	4.53	4.19	4.15	1.95	5.16	5.83	1.96	3.24	1.4	1.52	3.96	3.92
1969	2.92	0.81	5.99	1.94	3.47	8.67	4.12	4.3	4.33	3.78	1.83	5.15	5.87	1.71	3.95	1.39	1.52	4.05	3.96
1970	2.59	1.01	6.6	1.81	3.48	7.98	3.71	4.53	3.81	3.37	2.02	5.77	5.79	2.2	3.56	1.21	1.41	4.03	4
1971	2.79	0.68	5.98	1.76	3.15	7.83	4.18	5.85	4.13	3.81	1.94	4.73	5.49	1.67	4.05	1.12	1.37	3.96	3.88
1972	2.55	0.85	5.92	1.67	3.4	7.28	3.56	4.21	3.96	3.6	1.89	4.71	5.85	1.48	3.49	0.97	1.42	3.86	3.89
1973	2.53	1.03	6.11	1.6	3.21	7.83	4.04	5.15	4.02	3.75	1.9	4.92	5.74	1.2	3.94	1.16	1.34	3.77	3.86
1974	2.58	0.92	6.34	1.53	2.8	8.3	3.83	4.75	4.08	3.86	1.67	5.86	5.14	1.01	4.27	1.02	1.29	3.91	4.06
1975	2.03	1.84	6.57	1.48	2.75	6.37	3.8	3.92	3.66	3.7	1.7	5.07	5.37	0.89	4.36	0.97	1.3	3.85	3.95
1976	2.05	0.46	6.14	1.35	2.74	7.66	3.85	2.76	3.7	3.61	1.71	4.83	5.84	0.79	4.52	0.93	1.23	3.49	3.72
1977	1.74	0.67	5.2	1.32	2.66	5.85	3.75	2.78	3.67	3.57	1.68	4.62	6.18	0.62	3.35	0.82	1.18	3.53	3.75
1978	1.85	0.47	5.04	1.28	2.75	6.31	3.66	2.28	3.32	3.76	1.62	4.72	6.32	0.59	3.55	0.79	1.07	3.33	3.74
1979	1.81	0.53	5.52	1.23	2.46	5.25	3.98	2.81	3.6	3.42	1.7	3.98	5.74	0.53	3.36	0.69	1.15	3.51	3.83
1980	1.8	0.68	4.75	1.21	2.6	6.01	3.88	2.09	3.88	3.38	1.52	3.77	5.5	0.43	2.96	0.74	1.09	3.35	3.63
1981	2.01	0.66	5.47	1.15	2.36	5.64	3.39	1.93	3.69	3.22	1.51	3.84	5.97	0.46	2.16	0.72	1.14	3.34	3.44
1982	1.75	0.65	4.24	1.08	2.2	5.64	3.5	1.79	3.39	3.1	1.47	4.33		0.37	2.96	0.65	1.08	3.06	3.21
1983		1.1	4.68	1.01				1.9	3.62	3.28	1.49						1.04	3.23	3.22
1984	1.65	0.5	4.74	0.98	2.33	5.13	3.42	1.97	3.21	3.14	1.54	4.34	5.56	0.33	2.88	0.81	1.01	3.08	3.19
1985	1.64	0.54	4.85	0.93	2.28	5.39	3.56	1.83	3.57	3.26	1.47	4.28	5.88	0.27	2.65	0.52	0.97	3.16	3.34
1986	1.73	0.58	5.15	0.87	2.2	4.51	4.36	1.63	3.29	3.34	1.52	4.51	6.09	0.24	2.87	0.55	0.96	3.16	3.41
1987	1.5	0.57	5.44	0.84	2.17	4.97	3.79	1.87	3.2	3.03	1.45	3.82	6.18	0.22	3.31	0.53	0.93	3.18	3.43
1988	1.73	0.56	5.02	0.81	2.12	5.75	3.73	1.41	3.42	3.22	1.41	4.31	6.01	0.19	3.58	0.47	0.9	3.2	3.41
1989	1.35	0.54	5.16	0.78	2	6.84	3.68	1.36	3.06	3.19	1.37	4.47	6.25	0.17	3.48	0.43	0.88	3.26	3.39
1990	1.37	0.73	4.13	0.75	1.96	5.8	3.48	1.28	3.4	3.01	1.47	3.96	5.76	0.15	3.24	0.44	0.89	3.04	3.28
1991	1.4	0.35	4.64	0.71	1.93	5.4	3.77	1.22	3.42	3.18	1.61	3.85	6.01	0.13	3.36	0.41	0.83	3.13	3.39
1992	1.28	0.37	4.06	0.66	1.82	5.19	3.48	1.04	3.18	3.17	1.37	3.79	5.83	0.11	2.42	0.42	0.82	2.92	3.01
1993	1.15	0.49	4.33	0.65	1.77	6.26	3.48	0.93	3.1	3.21	1.42	3.64	6	0.1	2.75	0.39	0.79	3.06	3.09
1994	1.21	0.47	4.01	0.62	1.76	6.41	3.5	0.79	2.78	2.95	1.23	3.42	5.78	0.09	2.63	0.36	0.78	2.9	2.82
1995	1.29	0.45	4.1	0.59	1.72	5.96	3.87	0.93	2.89	3.07	1.37	3.59	5.83	0.08	2.62	0.31	0.8	2.93	2.92
1996	1.28	0.49	3.5	0.58	1.68	5.19	3.79	0.89	2.74	3.1	1.33	3.89	5.36	0.07	2.52	0.3	0.74	2.71	2.69
1997	1.13	0.48	3.75	0.55	1.68	5.83	3.76	0.68	2.78	2.94	1.28	3.75	5.5	0.06	2.65	0.32	0.74	2.79	2.73
1998	1.09	0.76	3.71	0.51	1.62	5.76	3.72	0.76	2.81	2.98	1.41	3.56	5.68	0.05	2.93	0.27	0.7	2.83	2.9
1999	1.18	0.36	4.03	0.49	1.78	6.6	3.96	0.8	2.86	3.23	1.32	3.33	5.82	0.05	3.35	0.27	0.7	2.99	2.89
2000	1.04	0.54	4.16	0.48	1.62	6.15	3.48	0.7	2.7	3.19	1.09	3.55	5.66	0.04	3.44	0.26	0.68	2.86	2.93
2001	0.97	0.35	3.73	0.47	1.52	6.52	3.57	0.65	2.64	3.04	1.26	3.37	5.54	0.04	2.69	0.22	0.65	2.8	2.8
2002	0.9	0.39	3.46	0.43	1.51	6.2	3.55	0.54	2.58	2.88	1.24	2.87	5.6	0.03	2.46	0.22	0.63	2.72	2.71
2003	0.9	0.36	3.75	0.42	1.47	6.78	3.85	0.59	2.68	2.85	1.23	2.96	5.6	0.03	2.65	0.22	0.64	2.82	2.77
2004	0.88	0.37	3.81	0.4	1.52	6.77	3.87	0.46	2.83	3.01	1.25	2.99	5.75	0.02	2.7	0.2	0.6	2.88	2.86
2005	0.87	0.36	3.88	0.38	1.38	7.44	3.81	0.41	2.64	2.94	1.28	3.1	6.06	0.02	2.9	0.19	0.58	2.96	2.91
2006	0.82	0.29	3.79	0.37	1.37	6.65	3.61	0.42	2.68	2.79	1.17	3.33	5.78	0.02	2.93	0.18	0.57	2.82	2.78
2007	0.82	0.29	3.5	0.35	1.27	5.88	3.13	0.43	2.52	2.8	1.14	3.19	5.48	0.02	2.45	0.17	0.57	2.63	2.7
2008	0.83	0.29	3.53	0.34	1.33	5.6	3.23	0.37	2.4	2.7	1.24	2.72	5.5	0.01	2.25	0.17	0.56	2.6	2.54
2009	0.79	0.31	3.42	0.32	1.31	5.17	3.73	0.43	2.59	2.65	1.22	2.98	5.64	0.01	2.49	0.14	0.55	2.61	2.55
2010	0.76	0.31	3.58	0.31	1.23	6.71	3.72	0.27	2.78	2.95	1.29	2.79	5.48	0.01	2.61	0.14	0.52	2.78	2.66
2011	0.86	0.3	3.68	0.29	1.2	6.44	3.35	0.34	2.61	2.72	1.15	2.91	5.71	0.01	2.39	0.15	0.52	2.73	2.72
2012	0.84	0.29	3.64	0.28	1.14	6.79	3.69	0.37	2.67	3.04	1.06	3.24	5.62	0.01	2.56	0.13	0.52	2.77	2.76

Table II – Hunting season lengths and bag limits 1918-2011. Adapted from "American woodcock population status, 2012," by T. R. Cooper and R. D. Rau, 2012. Laurel, Maryland: Fish and Wildlife Service.

Year	Days in Season		Bag Limit		Year	Eastern	Central	Eastern	Central
	Eastern	Central	Eastern	Central					
1918	60	60	6	6	1965	50	50	5	5
1919	60	60	6	6	1966	50	50	5	5
1920	60	60	6	6	1967	65	65	5	5
1921	60	60	6	6	1968	65	65	5	5
1922	60	60	6	6	1969	65	65	5	5
1923	60	60	6	6	1970	65	65	5	5
1924	60	60	6	6	1971	65	65	5	5
1925	60	60	6	6	1972	65	65	5	5
1926	60	60	6	6	1973	65	65	5	5
1927	60	60	4	4	1974	65	65	5	5
1928	30	30	4	4	1975	65	65	5	5
1929	30	30	4	4	1976	65	65	5	5
1930	30	30	4	4	1977	65	65	5	5
1931	30	30	4	4	1978	65	65	5	5
1932	30	30	4	4	1979	65	65	5	5
1933	30	30	4	4	1980	65	65	5	5
1934	30	30	4	4	1981	65	65	5	5
1935	30	30	4	4	1982	65	65	5	5
1936	30	30	4	4	1983	65	65	5	5
1937	30	30	4	4	1984	65	65	5	5
1938	30	30	4	4	1985	45	65	3	5
1939	30	30	4	4	1986	45	65	3	5
1940	15	15	4	4	1987	45	65	3	5
1941	15	15	4	4	1988	45	65	3	5
1942	15	15	4	4	1989	45	65	3	5
1943	15	15	4	4	1990	45	65	3	5
1944	15	15	4	4	1991	45	65	3	5
1945	15	15	4	4	1992	45	65	3	5
1946	15	15	4	4	1993	45	65	3	5
1947	15	15	4	4	1994	45	65	3	5
1948	30	30	4	4	1995	45	65	3	5
1949	30	30	4	4	1996	45	65	3	5
1950	30	30	4	4	1997	30	65	3	5
1951	30	30	4	4	1998	30	65	3	5
1952	30	30	4	4	1999	30	65	3	5
1953	40	40	4	4	2000	30	65	3	5
1954	40	40	4	4	2001	30	65	3	5
1955	40	40	4	4	2002	30	65	3	5
1956	40	40	4	4	2003	30	65	3	5
1957	40	40	4	4	2004	30	65	3	5
1958	40	40	4	4	2005	30	65	3	5
1959	40	40	4	4	2006	30	65	3	5
1960	40	40	4	4	2007	30	65	3	5
1961	40	40	4	4	2008	30	65	3	5
1962	40	40	4	4	2009	30	65	3	5
1963	50	50	5	5	2010	30	65	3	5
1964	50	50	5	5	2011	45	45	3	3

Table IV - Proposed acreage needed per state to stop decline, partial recovery, or full recovery of American woodcock population. Adapted from "Implementing the American Woodcock Conservation Plan: Progress to Date" by Kelley, J.R., S. J. Williamson, and T.R. Cooper (editors), 2010. Washington, D.C.: Wildlife Management Institute.

BCR	State	Stop	Partial	Full
12	MI	146,408	168,878	191,348
	MN	215,976	240,193	264,409
	WI	101,007	109,751	118,496
Sub-total	US	463,391	518,821	574,252
13	NY	65,055	105,047	145,040
	OH	17,945	26,038	34,131
	PA	6,425	8,431	10,437
	VT	2,270	2,939	3,608
Sub-total	US	91,695	142,455	193,216
14	CT	716	2,104	3,492
	ME	248,686	296,499	344,312
	MA	962	2,832	4,703
	NH	20,408	27,132	33,857
	NY	23,104	35,141	47,178
	VT	19,354	29,207	39,060
Sub-total	US	313,230	392,916	472,602
23	IL	0	130	260
	IN	1,529	3,412	5,295
	MI	30,762	47,609	64,455
	MN	19,847	23,374	26,901
	WI	62,196	77,596	92,997
BCR	Total	114,333	152,121	189,909
28	MD	3,255	4,013	4,770
	NJ	921	3,938	6,954
	NY	32,726	47,808	62,891
	OH	27,771	36,275	44,780
	PA	82,270	108,121	133,973
	VA	29,090	36,999	44,909
	WV	43,982	57,816	71,650
BCR	Total	220,014	294,971	369,927
30	CT	4,400	11,477	18,555
	DE	2,350	6,809	11,267
	ME	2,595	4,953	7,311
	MD	8,435	17,470	26,505
	MA	5,290	7,050	8,810
	NH	2,095	3,011	3,927
	NJ	6,955	27,685	48,415
	NY	1,295	5,360	9,424
	RI	1,065	3,395	5,724
	VA	3,140	6,163	9,186
BCR	Total	37,620	93,372	149,124
Grand Total				1,949,030

Works Cited

- Allen, R. B., & McAuley, D. G. (2012, November 13-14). Personal communication. (T. T. Hardy, Interviewer)
- Cooper, T. R., & Rau, R. D. (2012). *American woodcock population status, 2012*. Laurel, Maryland: U.S. Fish and Wildlife Service.
- Dessecker, D. R., & McAuley, D. G. (2001). Importance of early successional habitat to ruffed grouse and American woodcock. *Wildlife Society Bulletin* , 29 (2), 456-65.
- Dessecker, D. R., & Pursglove, S. R. (2000). Current population status and likely future trends for American woodcock. *Proceedings of the Ninth American Woodcock Symposium* , 3-8.
- Kelley, J. R. (2001). *American woodcock population status, 2001*. Laurel, Maryland: U.S. Fish and Wildlife Service..
- Kelley, J.R., S. J. Williamson, and T.R. Cooper (editors). 2008. American woodcock conservation plan: a summary of and recommendations for woodcock conservation in North America. Compiled by the Woodcock Task Force, Migratory Shore and Upland Game Bird Working Group, Association of Fish and Wildlife Agencies. Wildlife Management Institute, Washington, D.C. 162 pp. Accessed at:
http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/FocalSpecies/Plans/american_woodcock_conservation_plan.pdf
- Kelley, J.R., S. J. Williamson, and T.R. Cooper (editors). 2010. Implementing the American Woodcock Conservation Plan: a summary of and recommendations for woodcock conservation in North America. Compiled by the Woodcock Task Force, Migratory Shore and Upland Game Bird Working Group, Association of Fish and Wildlife Agencies. Wildlife Management Institute, Washington, D.C. 44 pp. Accessed at:
http://timberdoodle.org/sites/default/files/Woodcock_Conservation_Progress_Report-070610.pdf
- Martin, F. (1964). Woodcock age and sex determination from wings. *Journal of Wildlife Management* , 28 (2), 287-93.
- McAuley, D. G., Longcore, J. R., & Sepik, G. F. (1990). Renesting by American woodcocks (*Scolopax minor*) in Maine. *The Auk* , 407-10.
- McAuley, D. G., Longcore, J. R., Clugston, D. A., Allen, R. B., Weik, A., Williamson, S., et al. (2005). Effects of hunting on survival of American woodcock in the Northeast. *Journal of Wildlife Management* , 69 (4), 1565-77.
- Mendall, H. L. (1944). The ecology and management of the American woodcock. *Bird-Banding* , 15 (3), 130-2.

- Myatt, N. A., & Krementz, D. G. (2007). Fall migration and habitat use of American woodcock in the central United States. *Journal of Wildlife Management* , 71 (4), 1197-205.
- Sepik, G. F., & Derleth, E. L. (1993a). Habitat use, home range size, and patterns of moves of the American woodcock in Maine. *Proceedings of the Eighth American Woodcock Symposium* , 41-9.
- Sepik, G. F., & Derleth, E. L. (1993b). Premigratory dispersal and fall migration of American woodcock in Maine. *Proceedings of the Eighth American Woodcock Symposium* , 36-40.
- Sibley, D. A. (2000). *The Sibley Guide to Birds*. New York: Alfred A. Knopf.
- Sperry, C. C. (1940). Food habits of a group of shorebirds: woodcock, snipe, knot, and dowitcher. *Wildlife Research Bulletin* 1 , 3-5. Washington, D.C., USA: United States Biological Survey.
- Thomas, C. D. (1990). What do real population dynamics tell us about minimum viable population sizes? *Conservation Biology* , 4 (3), 324-7.
- U.S. Fish and Wildlife Service . (2012, April 11). *Laws, Regulations, and Policies*. Retrieved from U.S. Fish & Wildlife Service: Migratory Bird Program:
<http://www.fws.gov/migratorybirds/RegulationsandPolicies.html>
- U.S. Fish and Wildlife Service. (2011, September 27). *Managing habitat for woodcock, waterfowl, warblers, and more!* Retrieved from U.S. Fish & Wildlife Service: Moosehorn National Wildlife Refuge:
<http://www.fws.gov/northeast/moosehorn/management.html>
- United States Department of Agriculture. (2006, July). *Northeastern Forest Regeneration Handbook*. Retrieved from United States Department of Agriculture:
http://www.na.fs.fed.us/stewardship/pubs/forest_regn_hndbk06.pdf
- Whiting, R. M. (2006). American woodcock singing-ground surveys: do they reflect population trends? *Proceedings of the Tenth American Woodcock Symposium* , 22.
- Wildlife Management Institute. (2012). *Regional Initiatives*. Retrieved from Timberdoodle.org:
<http://timberdoodle.org/regional-initiatives>