Final Report: Establishing a Regional Initiative for Biomass Energy Development for Early-Succession SGCN in the Northeast

Executive Summary

The public is interested in green energy options. Demand for environmentally-friendly alternatives to traditional power generation using fossil fuels is higher than ever, and an increasing number of entrepreneurial groups are looking to address this demand. The result will be an increase in the number of plants and refineries on the landscape in need of biomass feedstock in the form of wood or grass material.

The amount of land needed to supply these facilities is substantial. Even modest sized boilers will require thousands of acres of forest or grass to ensure constant operation 24 hours a day, 365 days a year. In some cases the feedstock necessary to implement these biomass systems is already in place but there will no doubt be an increase in acreage converted to the primary purpose of growing biomass energy feedstock such as warm season grasses (i.e., “switchgrass”) or dedicated woody crops.

This project examined the potential benefits and costs from select biomass energy systems on bird, mammal, reptile, and amphibian species of greatest conservation need (SGCN) for the 13 states that comprise the northeastern region of the US. We compiled and consolidated the state species lists into to a regional list comprised of 470 species (259 birds [55.1%], 69 mammals [14.7%], and 142 herptiles [30.2%]).

There are many types of biomass systems either in place, or proposed, for the region. We elected to investigate only those systems that utilize native species. We then assigned each of the SGCN to a general habitat class based on life history information. With this information we assigned a potential interaction response of positive, negative, no effect, or not applicable to each combination of biomass system and SGCN.

We then summarized the net potential impacts of specific biomass system implementation on SGCN in the Northeast. The landscape of the Northeast can support both wood and grass-based biomass energy systems, but the likelihood of specific implementations will depend on the local landscape. We found that, in general, biomass systems that utilize wood from existing mature forests will result in a net negative impact to SGCN as these forests are converted to a younger state. Biomass systems implemented on existing agricultural land would result in a larger potential net positive for SGCN regardless of which biomass system was implemented.

We did not include any additional importance values to SGCN in this study. That is, we did not consider one SGCN to be more important than another when comparing potential loss or gain. The creation of early successional forest or grassland will create habitat for SGCN that utilize these types and the opportunities for the biomass industry to provide the impetus for expanding these types on the landscape are real. However, it is important for managers to understand the potential impacts to other species as a result. Likely benefits and stresses from each individual project require more detailed evaluation.

Overall, the results of this project show that biomass energy development will impact SGCN at the state and regional levels. We recommend that wildlife resource management agencies become active participants in the planning and implementation phases of biomass energy project development to mitigate potential negatives and maximize potential benefits. Energy developers are far more likely to cooperate with agencies to meet goals for SGCN during planning and development phases. Wildlife agencies should recognize, and plan for, the costs associated with allocating staff time to these efforts.

Introduction

This project was initiated to address the rapid increase in the public demand for green energy alternatives and the expanding industry emerging to respond to that demand. Specifically, we addressed the potential increase in the use and establishment of "biomass" energy applications in the context of this green energy movement and its potential impact on SGCN.

"Biomass" is a generic term. It has been used to describe a range of industrial applications for converting some form of cellulose to some form of energy through refinement and/or combustion. The source "biomass" for these applications ranges from crops grown specifically for biomass use, to various by-products of other processes like construction or food waste

While no biomass energy process is implemented without impact to wildlife species on some level, the greatest potential for impact is undoubtedly from systems using dedicated biomass crops. The acreage required to supply materials to energy refinement facilities is potential very large, and virtually all of the lands that will be put into these biomass crops is presently in some sort of natural, or semi-natural, state. Therefore, the potential for rapid, widespread, and comprehensive structural change of the landscape is high. Landscape changes of this magnitude have been demonstrated to result in major impacts to wildlife species throughout history.

Any change to the landscape will result in both positive and negative impacts to species within that landscape. The clearing of a mature forest will both destroy habitat for some species and create habitat for others. The challenge to wildlife managers in these situations is to attempt to identify and prioritize those species for which habitat destruction or degradation should be avoided depending on a suite of factors. This is no small task especially in the face of such a rapidly expanding new threat like that posed by biomass energy.

Changes on the landscape have led to undesirable impacts to species; particularly those species that have been identified by state wildlife resource agencies as "of greatest conservation need". Some of the biomass systems presently under discussion result in structural or floristic components similar to those needed by species whose natural habitats are increasingly rare on the landscape. This is particularly true for "early successional species" that utilize habitats maintained through frequent disturbance. The natural mechanisms of disturbance include fire, ice, wind, and flood and many of these, particularly fire, have been all but eliminated from the natural landscape.

Some biomass energy systems have the potential to provide components of habitat favorable to these early successional SGCN. While certainly not true for all biomass energy applications, proactive biologists may find common ground with biomass energy developers and producers that could ultimately result in the establishment and maintenance of early successional habitats on a scale that would otherwise be impossible. Biomass energy crops will not provide ideal habitat for SGCN, but they do represent an opportunity that should not be ignored by wildlife habitat managers.

Ultimately, the responsibility for engaging the emerging biomass industry on issues related to wildlife habitat is the responsibility of the wildlife management community. Working cooperatively with the industry in the planning stages of these projects will yield the most significant and long-term benefits for both the biomass energy company and the wildlife resource. If the wildlife community chooses to interact with the biomass industry through regulation and restriction, especially after biomass projects are already under development, then opportunities for a mutually beneficial result are lost and an opportunity for significant improvement to early successional wildlife habitat will disappear.

This project was implemented to provide wildlife biologists with basic information on how biomass energy systems are likely to impact SGCN in the states that comprise the Northeast region as well as for the region itself. It is our goal to improve the understanding of the opportunities certain biomass energy applications present for managing species of greatest conservation need and provide an impetus for biomass developers and wildlife managers to work together for mutual benefit.

Species of Greatest Conservation Need

Each state in the Northeast region recently completed a comprehensive state wildlife action plan (SWAP) that identified those species that require immediate conservation attention.

These species of greatest conservation need (SGCN) will be targeted for conservation action through the State Wildlife Grant (SWG) program in years to come.

Each state chose to approach the completion of the SWAP differently, so the results of this analysis vary greatly between states in the region. For the purpose of examining species at the regional level, it may be more defensible to examine those species that are members of the same guilds to identify patterns and commonalities. One such commonality in lists of SGCN within the Northeast is the presence of species that utilize early successional vegetation as a primary component to their habitat. Overall, species that require patches of native grass, shrub, or combinations of those are uniformly in decline.

Much of this decline is attributable to the landscape changes that occurred during the latter portions of the 19th and early 20th century. Much of the landscape was dominated by small family-run agricultural operations characterized by hedgerows, patches of unworkable land, and fallow fields. In most areas, the forest was in a young seral stage due to the local demand for fuel wood, construction materials, and other industrial applications. The mosaic of these types provided favorable, productive habitat for many species of wildlife.

With the decline of this agrarian system and the rise of suburbanization, these habitats became increasingly fragmented or replaced on the landscape. The result is a region-wide decline in the species that use these types as habitat.

To our knowledge no truly "regional" list of SGCN presently exists. That is, a list of species thought to be representative of those species of greatest need at the regional level. Therefore, we elected to use all of the mammals, birds, and herptiles listed by any state in the region to comprise such a list SGCN common to all states were rare even in these groups. In all, 469 species were included in this analysis (142 herptiles, 259 birds, and 69 mammals).

Biomass Energy Systems in the Northeast

This project focused on those biomass energy systems that would yield a realistic potential to result in habitat usage for SGCN on the ground. To that end, we elected to omit several biomass options that utilized material classified as a "waste product" like construction waste, crop residue, or other by-products. We did not consider corn, soybeans, or other high intensity agricultural food crops due to their requirements for significant and frequent soil amendments, soil disturbance, and relative low value as wildlife cover. Similarly, we did not consider dedicated crops comprised of exotic or invasive species as viable alternatives (e.g., *Miscanthus*) no matter how they are harvested or implemented. We examined biomass systems that employed native species or species that have been widely used for energy already such as switchgrass (*Panicum virgatum*) or willow (*Salix spp.*).

The type of crop is only a small consideration when evaluating biomass energy system implementation and their value to wildlife species. Factors such as the density of planting, timing of harvest, or requirement for fertilization are perhaps more significant factors impacting the potential for wildlife benefit. Other factors include management intensity, amount of residual crop post-harvest, and even the size or shape of the biomass field.

We included 6 types of biomass systems in this analysis. These types represent systems already in place or in discussion within the Northeast. The likelihood of implementation for these systems is certainly not uniform across the landscape but taken at the regional level represent those applications that have the highest probability of impacting thousands of acres of land.

Native Warm Season Grasses

The potential for native warm season grasses (NWSG) as a biomass energy crop was first identified in the 1970's when researchers from the Department of Energy examined several types of native plants for favorable characteristics as biomass. Switchgrass was selected as the representative species for the C^4 grasses due to its heartiness and widespread range. This species was identified as a good candidate for biomass development and was demonstrated to be relatively easy to plant and maintain. More recently, "switchgrass" has been used to describe a suite of native warm season grasses such as indiangrass, big bluestem, and *P. virgatum* planted for biomass energy (unfortunately).

The cellulose produced from NWSG can be burned directly in a boiler, densified into pellets or briquettes, or used to make ethanol. While somewhat difficult to establish over existing cool season grass, the NWSG stands are perennial once they have matured to 2-3 years and require minimal annual maintenance. The typical yields on NWSG stands are 4-6 tons per acre with new varieties and techniques promising yields nearly double that. Most stands will remain productive for 8-10 years before requiring re-establishment

The wildlife benefits of NWSG are well documented. There are several USDA supported incentive programs that actively promote the establishment of NWSG stands as wildlife habitat, buffer strips, and nutrient traps. The major difference between stands planted for wildlife and those planted for biomass energy is the density of the planting. NWSG stands providing maximum wildlife benefit have a substantial component of bare ground, forbs, and even occasional woody species. Stands established for biomass tend to be very dense with little bare ground and, over time, may become largely monocultures depending on the site conditions.

Native warm season grass stands would typically be harvested for biomass after the plant has gone dormant in the fall of the year but before heavy snows flatten the stems. The later harvest minimizes the impact to nesting and fledging birds that result from haying cool season grass stands in the same landscapes. Ideally, most of the seeds from the plants would remain on the ground and available to wildlife in the winter months and some standing grass would be left standing to provide some cover for species utilizing the fields.

NWSG is most viable in states with significant amounts of the landscape already in some sort of pasture or fallow land. Underutilized lands (which are often developed after agricultural operations cease), and marginal crop lands would provide the greatest economic opportunities and the potential for NWSG as a viable biomass crop likely decreases heading northward through the region.

Grass Monocultures

The use of grass monocultures as a biomass crop is very similar to the benefits for multi-species NWSG stands. Often a single species will outperform others under a given set of field growing conditions. Monocultures also reduce the variability in production that may be more desirable for growers with long-term supply contracts.

Typically, dedicated grass monocultures will not provide the same quality of habitat that NWSG stands would but both may have minimal value to SGCN especially at the highest densities. However, monoculture stands may benefit some species particularly when considering the quality of the cover types that are being replaced by the grass monocultures. Again, this would be largely dependent on the landscape of implantation.

It is important to note that cool season grasses are not considered to be viable options for biomass. While many northeastern states have successfully implemented cool season grasses as wildlife habitat, we are not aware of any interest in using cool season grasses as biomass feedstock.

Dedicated Deciduous and Coniferous Woody Species

The concept of woody plantations is not new. Silviculture of both hardwood and coniferous species are ubiquitous to the Northeast region ranging from Loblolly pine (*Pinus taeda*) in the southeastern portions of Virginia to white pine (*Pinus strobus*) in northern Maine. Most existing stands of trees are the result of replanting after even-aged harvest or following agriculture. More recently, dedicated biomass plantings of species such as willow (*Salix*) have shown a great deal of promise as a profitable biomass crop.

Stands of woody plants grown for biomass tend to utilize fast-growing species that are likely to work well on within the site characteristics, and require little or no maintenance. In a typical application trees are planted in relatively close-spaced rows throughout the field although the exact configuration will vary with tree species.

Little work has been done in quantifying the benefits of dedicated woody biomass stands (deciduous or coniferous) on SGCN within the Northeast. Many SGCN utilize shrub or regenerating forest stands as habitat, so it is conceivable that woody biomass planting have the potential for mimicking the structural characteristics of these habitats without significantly impacting the producer's ability to maintain or harvest the stand, although more research on this topic is needed.

Native Forest Regeneration

The dense flush of woody vegetation that follows an even-aged timber removal operation provides a great deal of habitat for some species of wildlife. Recently the markets for timber and, in some states, restrictions on the silvicultural practice of even-aged management (i.e., "clear cutting") has drastically reduced the total amount of harvested forest in a given year. This has had a large and detrimental impact on the species of wildlife that require young forest for habitat.

The interest in using wood as a dedicated biomass crop will certainly provide new incentives for the harvest of existing mature timber stands. The most attractive stands will be too young or over-stocked to produce quality saw timber in the future and so will be most valuable chipped for biomass. The resulting coppice growth from stumps and from species released with the removal of the overstory would constitute a sustainable source of woody material into the future. The exact rotation and yield is largely dependent on the type of mature forest that was cut.

This system will likely find the most widespread application in the predominantly forested states in New England, where major portions of the landscape are already in some sort of forested land cover. There are many examples of operational and proposed facilities planning on burning wood chips obtained from existing forest surrounding the facilities.

Timber Stand Improvement

The idea of practicing "timber stand improvement" (TSI) techniques to maximize the growth and health of mature forest stands is standard silvicultural practice. The challenge to implementing TSI has always been recouping the costs for the removal of the unwanted material without exceeding the profitability of timber on the stand. With the interest in woody waste for biomass energy, now land managers can realize some economic benefit to completing TSI operations on stands of maturing timber.

Typically, an improved stand of timber will have a more open canopy and less "weed tree" competition with the canopy and sub-canopy. In turn, the increased light to the forest floor and reduced competition for nutrients results in a significant increase in the herbaceous and shrub layers in the stand. This can have positive benefits to wildlife utilizing these layers within the forested environment.

Identifying Biomass Impacts to SGCN

Assigning Habitat Groupings

We employed a land cover-based interaction classification in order to determine which biomass applications were likely to have the greatest impacts on SGCN in the Northeast. This permits us to assess each biomass/SGCN interaction and allow for "fine tuning" of interactions where appropriate.

The first step in this process was to acquire the SGCN lists for each state in the Northeast. Then, we reduced each list only to those taxa addressed in this study; mammals, birds, reptiles and amphibians. We examined the remaining lists to identify potential conflicts between state lists and to remove duplications resulting from sub-species or naming differences. The result was a list of all the species in the Northeast for these groups.

The next step was to assign a general habitat grouping to each of the species. This classification assignment was based on the general habitat needs for the species based on their life history (Table 1). We employed a 9-class classification that included:

Table 1. Classification used for SGCN general habitat.

Class	Description
Mature Forest - Coniferous	Species primary habitat consisting of predominantly mature coniferous forest types
Mature Forest - Deciduous Mix	Species primary habitat type consisting of predominantly mature deciduous and mixed forest types
Woodland Grassland/Field Mix - Edge Species	Species primary habitat types associated with woodlands, grasslands, edge species. Usually areas of high interspersion and fragmentation of single stand types
Early Successional Forest	Species primary habitat consisting of early successional forested types, regenerative growth, and/or woody shrub species
Grassland	Grassland obligate species
Generalist - Highly Variable	Generalist species that utilize a wide variety of habitats. Also included are species with large home ranges.
Wetland / Marshland /Tundra / Coastal	Species primary habitat types consisting of wetlands, fresh/salt water marshlands, tundra, or coastal (pelagic or dune systems) these species are not likely to be affected by biomass conversions
Agriculture Edge	Species that utilize edge habitats that specifically benefit from agricultural (row crop) practices
Conifer Edge	Species that utilize edge habitats associated with coniferous dominated stands

While general, this level of classification forced us to assign a single value to each of the SGCN. In some instances where species did not show affinity for a type, we chose the most limiting value based on the species life history.

Land Cover Changes Resulting from Biomass

With this information, we developed the likely interaction and response for each species given any biomass system implementation in any landscape. Ultimately, the impacts to SGCN are based on changes to the present landscape. Species responses will be positive, negative, or unchanged based on the present land use and the biomass land use after implementation.

We considered only natural and semi-natural land cover types as potential targets for biomass conversion. These classes included mature deciduous forest, mature coniferous forest, shrubland/young forest, row crop, and pasture/hay.

Using these classes as the current land cover, the 6 biomass systems as the resulting land cover, and the general SGCN habitat groupings we determined a likely response for each SGCN. For each SGCN habitat grouping, we evaluated the likely response to the change from an existing land cover class (5 classes) to each of the biomass system types (6 types).

Assessing Impacts to SGCN

We created a simple interaction code to reflect the likely response of SGCN for a given biomass development activity. These codes were:

SGCN Response Code	Description
1	Potentially positive
-1	Potentially negative
0	little or no effect
.	Not Applicable - potential effect unlikely

For example, if the present land use for a specific land area is “mature deciduous forest” and a biomass developer elects to cut the entire stand and allow the remaining stumps to coppice regenerate, then we can predict the likely impact to SGCN based on the following:

- SGCN that utilize mature deciduous forest will be negatively impacted because that type is no longer present
- SGCN that utilize early successional forest or shrub land will be positively impacted as that type replaced the mature forest (a type those species did not utilize)
- SGCN that do not utilize mature deciduous forest or regenerating forest/shrub land will not be impacted either way

For the purposes of this study, we assumed a positive or negative response to include one or more aspects of the species' life history requirements. This would include habitat availability, quality, productivity, health, etc. We also made no attempt was made to consider the severity of the impact at the species level.

Species assigned to the "Generalist - Highly Variable" and "Wetland / Marshland /Tundra/ Coastal" classes did not experience any impact from the biomass systems we examined since none of those types are predicted to be replaced or installed as a result of biomass development.

We made no attempt to further evaluate the potential impacts to SGCN from biomass development. There is a great deal we do not know about the response of SGCN to new types that are presently rare on the landscape – particularly those that would be essentially industrial applications. Our assessment is limited to the change in landscape and the perceived benefit those changes would provide. Other factors including specific stand management practices, harvest timing, species interactions, are not inconsequential, but are beyond the scope of this investigation to evaluate.

Summarizing Impacts at the State and Regional Level

We analyzed the potential impacts of biomass development at the state, as well as the regional, level. Each of the proposed biomass systems has significant potential for affecting thousands of acres within the region, but local applications (i.e., state level and more local) will likely be limited to a few of the systems due to the composition of the landscape, infrastructure, and other factors beyond our immediate project scope.

For each state, we used the state list of mammal, bird, and herptile SGCN to quantify the net impact of each biomass system for each existing land cover class. These were summarized for each taxonomic group. The resulting value in the table is the net gain/loss of SGCN given that land cover change to biomass system pairing. So, for example, for all SGCN birds in New Hampshire there is a potential increase in habitat for 7 SGCN if a row crop field was converted to a "dedicated deciduous woody monoculture". This value was calculated from the difference in the number of SGCN attributed to utilizing row crops versus the number utilizing dedicated deciduous woody monocultures. Values of 0 (i.e., no effect or not applicable) were not included in the calculation.

It is important to note that we placed no importance criteria on the SGCN. That is, we did not consider any one species as more important than another. So, if a landscape change results in habitat for 5 SGCN being replaced with habitat for 3 SGCN, then the net value of that change is -

2 without any further information. In general, we consider a net gain in potential SGCN habitat as positive and a loss as undesirable from a management standpoint.

This process was repeated for each taxonomic group for each state and for the region as a whole. From this information, we can determine which land use changes and biomass systems provide the most potential for gaining habitat and which will result in a loss. The tabular results for each state are provided in Appendix A.

Connecticut

The state of Connecticut is primarily forested (59%) with a significant amount of development (24%). Only about 9% of the landscape is presently in row crop or pasture agriculture which means the potential for the conversion of these types to any biomass crop is less likely than wood-based options.

Of the 77 SGCN in Connecticut, 26 (33.8%) have grassland or grassland/woodland edge as a habitat need. Given the relatively low proportion of area in Connecticut in agricultural types (likely the closest habitat classification for these) it is not surprising that these species are considered rare. Biomass systems focused on these lands would certainly impact these species, but if row crops were converted to grass-based biomass then the total amount of potential habitat would likely increase.

The more likely scenario for biomass systems would be related to extracting wood from the existing forests of the state. This would potentially impact 15 (19.5%) SGCN that utilize either mature deciduous or coniferous forest. In this case, the removal of these forests would potentially negatively impact these species. However, if those mature stands were replaced by young, regenerating native forest or those stands were thinned, the net result would be the potential creation of early successional habitat with more species benefitting from that action than are impacted by it. However, it is important to note that the removal of mature deciduous forest will be disproportionately advantageous to birds and mammals than it would be for herptile species with the latter resulting in a great deal of loss. Given the likelihood that these activities will not significantly impact the total forest landscape, the installation of these biomass systems may provide a way for managers to improve early successional habitats.

Delaware

The landscape in Delaware is predominantly agriculture with row crop and pasture/hay comprising over 50% of the state. Approximately 25% of Delaware is forested. Given this arrangement the most likely biomass systems would be focused on dedicated grass or woody plantations.

We examined 191 SGCN in Delaware (147 birds, 10 mammals, and 34 herps) for potential habitat impacts from biomass. Nearly half (45.5%) of the SGCN in Delaware utilize wetlands or coastal areas as habitat. Therefore, we assume that biomass systems pose little threat to their habitat. A total of 43 species (22.5%) utilize early successional grassland or woodland/grassland edges, and another 9 species utilize early successional forest. Another 45 SGCN are listed as forest obligates (23.6%). Given the relatively small proportion of the landscape classified as mature forest, perhaps it is not surprising that this group comprises a relatively large proportion of SGCN relative to other, more highly forested states.

Given the scarcity of forest, the most likely biomass systems would be dedicated grass or woody systems (native warm season mix, grass monocultures, dedicated woody plantings) replacing existing pasture or row crop agriculture. We surmise that pastures would be more likely targets since lands producing grains are likely more profitable at present, and biomass is not expected to outcompete these cash crops in the near future thus reducing the probability of conversion in the near term. However, it is clear that should biomass systems be implemented on lands that are presently farmed as row crops then a significant amount of early successional SGCN habitat could be established. This would benefit a great number of species (upwards of 40-45 SGCN) and would result in almost no loss of existing SGCN habitat.

Massachusetts

The existing land base to support biomass in the commonwealth of Massachusetts is predominantly forested (64%) with a relatively small amount of agricultural lands (8%). The most economically feasible biomass systems would likely focus on wood taken from mature forest stands.

A total of 102 SGCN listed by Massachusetts (63 birds, 13 mammals, and 26 herps) were included in this study. Of these, 41 (40.2%) were classified as utilizing predominantly wetland or coastal areas. Of the remaining species, 35 were classified as early successional (utilizing either grassland or young forest) and 20 as utilizing mature forest (34.3% and 19.6% respectively). Given the likely focus of emerging biomass systems focused on wood it would seem there may be an opportunity for the establishment of more early successional and young forest in Massachusetts.

The best-case scenario would be achieved by the conversion of mature forest to native regenerating forests. This could be best accomplished with even-aged management or through thinning of mature deciduous stands to increase the amount of woody sub-canopy. However, this activity would disproportionately favor avian and mammalian species over reptiles and amphibians.

Maryland

Maryland has a landscape that is somewhat balanced between forest and agriculture as compared to other states in the northeast. The land use types with the most potential for conversion to biomass are forest and agriculture which comprise 36% and 24% of the state respectively. It is reasonable to assume that both woody and grass-based biomass systems would have a place on the Maryland landscape.

Maryland listed 210 SGCN included in this study (141 birds, 27 mammals, and 42 herps). By habitat grouping, 69 (32.9%) SGCN utilize wetlands/coastal, 68 (32.4%) utilize mature forest, and 60 utilize early successional types (28.6%). The wetland species are not expected to be significantly impacted by biomass activities. Both forest and agriculture areas would likely be suitably attractive to potential biomass development especially given the relative position Maryland occupies with the mid-Atlantic close to several population centers with high energy demand.

Clearly the most beneficial outcomes from implementing biomass systems in Maryland would be from converting existing row crop or pasture to either grasslands or some type of woody crop to create early successional habitat. The removal of mature forests, particularly deciduous forests, would be the most detrimental activity.

Maine

Maine is nearly 75% forested, and agricultural land use comprises only 5% of the landscape. Clearly this would focus any profitable biomass enterprise to utilize wood from mature coniferous and deciduous forests.

The SGCN analyzed include 121 species of bird (105), mammal (6), and herptile (10). Of these, 55 (45.5%) are found primarily on wetland/coastal habitats. A total of 29 SGCN utilize mature forest (coniferous or deciduous; 24%) while only 5 SGCN (4.1%) utilize early successional forest. The other early successional species (i.e., those that utilize grassland or grassland/wood land edge types) account for 27 (22.3%) of the SGCN.

Given this information it seems that the removal of mature forests will result in a net loss of SGCN habitat even if it is replaced by native early successional forest regeneration. Given the amount of available forest in Maine, it is possible that species attributed to the forest classes in this study are of concern due to factors other than habitat loss. Similarly, there is a great potential benefit from establishing grassland habitats, but the biomass systems as presently defined are unlikely to provide successful enterprises or sustained habitat for these SGCN.

In general, we cannot adequately assess the potential impacts of biomass systems in Maine without more specific analysis at the individual species level and, perhaps, in the specific context of projects on the landscape.

New Hampshire

New Hampshire is a predominantly forested state. Over 80% of the state is in either deciduous (58%) or coniferous (23%) forest types. Only 5% of the state is in an agricultural class. Like other predominantly forested states in the northeast, biomass implementation in New Hampshire will likely on focus on wood.

A total of 76 SGCN were considered for this study (48 birds, 13 mammals, and 15 herps). Of these 26 SGCN (34.2%) were attributed to early successional types of grass, forest, or the edges of both. Another 25 (32.9%) SGCN are attributed to wetland/coastal habitats. Deciduous and coniferous forests are utilized by 19 (25%) SGCN.

The most beneficial potential biomass application appears to be the thinning of mature coniferous stands to younger seral stages of native species. This would result in the creation of habitat for several SGCN without impacting many other species. The removal of mature deciduous forests in favor of a dedicated woody biomass system would negatively impact a number of SGCN and would be a less desirable system than allowing native regeneration on those same stands.

New Jersey

New Jersey's landscape is somewhat of a heterogeneous mixture of forest and agriculture away from areas of high intensity development. Forests comprise about 40% of the area while pasture/hay and row crops constitute 20%. This arrangement provides opportunities for both wood and grass based biomass systems.

We analyzed 187 SGCN for New Jersey (148 birds, 11 mammals, and 28 herps). Over 40% of these species are found on wetland or coastal areas, with 26% utilizing forests and 28% using early successional types (grassland, grassland/woodland edges, young forest).

While establishing biomass energy systems on pre-existing agricultural land would yield substantial opportunities for SGCN, removal of mature forest (deciduous) would result in negative impacts to a number of species. Thinning of mature stands may result in some limited, but additional, habitat opportunities.

New York

Contrary to popular perception, the landscape of New York State is predominantly in a natural or semi-natural land cover. Over 50% of New York is forested with an additional 24% in either pasture or row crop agriculture. This arrangement provides a potentially favorable setting for either woody or grass-based biomass systems.

New York has 176 birds (118), mammals (14), and herps (44) listed as SGCN. Of these nearly 50% utilize either mature forest or early successional habitats with a nearly equal proportion found on wetlands or coastal types.

Similar to other northeastern region states with a mix of forest and agriculture, New York SGCN may potentially benefit from the conversion of intensively managed row crop or pasturelands to grass-based biomass. Also similar to neighboring states, any conversion of mature forest to woody plantations or grass would result in a net loss of SGCN habitat except for a limited number of species that benefit from an increased shrub layer resulting from timber stand management thinning. A balanced portfolio of woody and grass based systems may provide a significant opportunity for SGCN as a whole in New York.

Pennsylvania

Pennsylvania is a predominantly forested state, with over 60% of the land area in either deciduous or coniferous forest. There is also a large proportion of the state in either row crop or pasture types (25%). This combination will likely make both wood and grass based biomass energy systems a possibility for the state.

We examined 138 SGCN in Pennsylvania (79 birds, 22 mammals, and 37 reptiles/amphibians). SGCN utilizing either forested or agricultural habitats comprise nearly 70% of the species considered (24% of the species were attributed to wetland types).

Similar to other mid-Atlantic states with a mix of agricultural and forested landscapes, the SGCN of Pennsylvania would benefit most from biomass systems that are implemented on lands presently in active agriculture. The net result of replacing mature forest with biomass is largely negative, but some species would benefit from young forest/shrub following stand thinning. A general increase in the early successional habitat in the state would be a potential benefit to SGCN as a whole.

Rhode Island

Rhode Island is a small state with a relatively large proportion of its land base in a developed state (31%). However, there is still a significant component of the landscape available for wood (48% forest) biomass. With only 8% of the state in agriculture, it is unlikely that these lands will be attractive for biomass development.

Rhode Island listed 138 birds (79), mammals (22), and herps (37) as SGCN. Of these, 40% were attributed to early successional grassland, edge, or young forest habitat types. Mature forest species comprised 28% of the SGCN.

While many of the SGCN in Rhode Island would benefit from an increase in early successional habitat, the available land base for such implementations is likely forested at present. This means that the net impact of removing mature forest in favor of early successional grasses or woody crops would have negatively impact more SGCN than it would benefit. The exception might be for species that would benefit from the thinning of mature stands. This situation is a prime illustration of the inevitable trade-offs that biologists in Rhode Island (and elsewhere) will have to realize when determining how to address the establishment of new habitat with a limited land base.

Virginia

Virginia is the southernmost state in the Northeast region. It is characterized by a large proportion of land in forest (61%) and agriculture (26%). This mix of lands is suitable for supporting biomass development and there are clearly opportunities and interests for both wood and grass in Virginia.

We examined 179 SGCN (96 birds, 23 mammals, and 60 herps) in Virginia. The largest proportion of SGCN was attributed to forested types (34.6%) followed closely by wetland and coastal types (35.2%). Species requiring early successional habitats of grass and/or young forest comprised about 25%.

The landscape of Virginia is conducive to biomass development for either wood or grass. Clearly the conversion of mature forests to grass or woody biomass should be avoided as this is expected to result in a net decrease in habitat for SGCN. There appears to be a good opportunity for either grassland systems or potentially woody biomass systems to increase SGCN habitat if they are located on existing row crop or pasture/hay lands.

Vermont

Vermont has a tremendous proportion of its land base in forest (75%) with a modest 15% in agricultural types. Vermont also has a low proportion of its land base in a developed state (5%). While biomass systems may be implemented on agricultural lands in Vermont, it is likely that most development interest will be focused on feedstock in the form of wood.

We examined 108 SGCN in Vermont (57 birds, 33 mammals, and 18 herps) to assess the potential impacts of biomass on their habitat. These SGCN are associated with early successional types (grass and young forest; 36.1%), mature forest (33.3%), and wetland types (22.2%).

The most likely scenario is for mature forests to be targeted as sources of biomass energy. Replacing mature stands of forest (particularly deciduous forests) with biomass energy crop systems will result in a decrease of SGCN habitat. Sound timber management techniques, such as timber stand improvement, appears to provide some positive early successional habitat opportunities.

West Virginia

West Virginia is a predominantly forested state with 79% of the landscape in deciduous forest and an additional 3% in conifer. Only about 11% of the landscape is in agriculture. The most likely scenario for biomass energy development in West Virginia would be with wood.

West Virginia lists 74 birds, 25 mammals, and 39 herps (total of 138) SGCN. Of these about 32% are associated with early successional grassland types. Interestingly, only about 3% of the SGCN listed are attributed to early successional forest types. SGCN utilizing mature forest make up 34% of the list, while wetland species comprise approximately 20% of the SGCN (wetlands comprise less than 1% of West Virginia's land base).

Clearly, there is a need for early successional habitats in West Virginia, but the case for simply reducing the age of forest stands through even-aged management or via thinning is not as clear as in other states. The majority of SGCN in the early successional group are attributed to grassland types but replacing mature forests with grass-based biomass systems is predicted to result in a net loss of SGCN on the landscape. This clearly reveals the limitations of a study like this where no additional priority is attached to SGCN. However, if managers in West Virginia are interested in increasing grasses on the landscape to address those SGCN that utilize that habitat, then it appears as though there are some benefits that could result from those biomass systems.

Regional Summary

Undoubtedly the Northeastern US has great potential to produce biomass for energy applications (Figure 1). Even though the Northeastern region has the largest concentration of population centers in the US, over 80% of the landscape remains in either forest or some type of agriculture (Table 2.). These 2 factors will ensure that biomass energy development occurs in the northeastern states and that the resulting landscape changes will impact Species of Greatest Conservation need at local, state, and regional levels. While several states have a landscapes with a relatively balanced proportion of forest and agriculture suitable for biomass energy applications, most have a clear predisposition towards attracting wood-based systems.

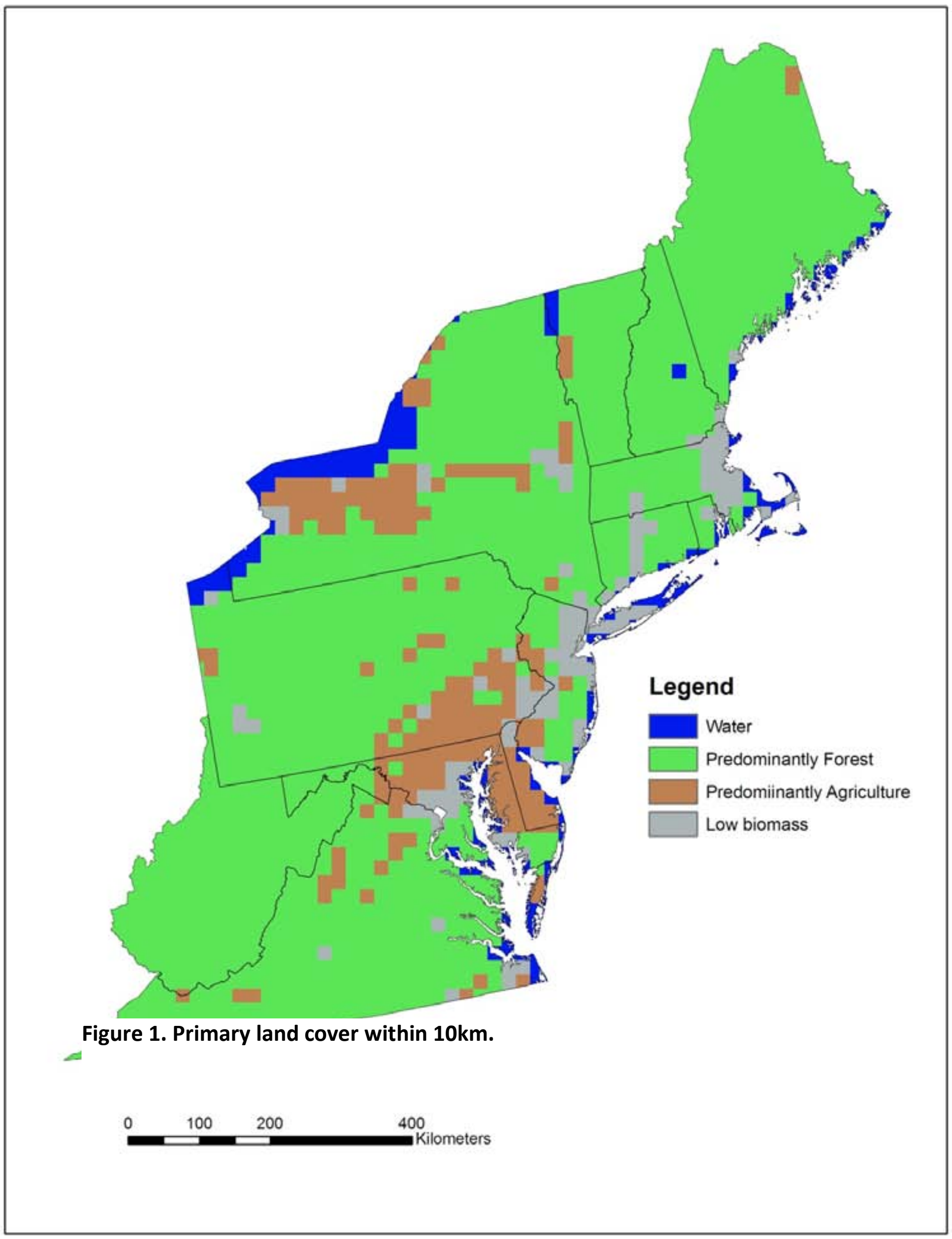

Figure 1. Primary land cover within 10km.

Table 2. Land cover for the Northeast Region (from the National Land Cover Dataset).

Land Cover Class	% of Northeast Region
Developed	10.2%
Deciduous/Mixed forest	52.4%
Coniferous Forest	9.9%
Shrublands	2.9%
Agriculture / Hay pasture	19.0%
Wetlands	5.6%

We compiled the SGCN for each of the 13 states in the Northeast region and extracted all the birds, mammals, reptiles, and amphibians for analysis in this study. At present, no list of regional SGCN has been identified nor has any sort of prioritization been completed with the species identified at the state levels. None of the states have attempted to coordinate with their neighbors to select and prioritize SGCN to our knowledge. Therefore, no prioritization has been established here.

The complete regional list of SGCN consists of 470 species (259 birds [55.1%], 69 mammals [14.7%], and 142 herptiles [30.2%]). Each of these species was categorized according to their primary habitat affinity (Table 3).

Table 3. Summary of SGCN for the Northeast Region

Species Groups	Birds	Mammals	Herps	Total in Type	% of Cover Type
Mature Forest - Coniferous	30	5	7	42	8.9%
Mature Forest - Deciduous Mix	41	16	55	112	23.8%
Woodland Grassland/Field Mix - Edge Species	24	23	20	67	14.3%
Early Successional Forest	14	1	1	16	3.4%
Grassland	27	2	9	38	8.1%
Generalist - Highly Variable	6	5	8	19	4.0%
Wetland / Marshland /Tundra / Coastal	115	5	39	159	33.8%
Agriculture Edge	2	6	2	10	2.1%
Conifer Edge	0	6	1	7	1.5%
Total in taxa	259	69	142	470	
% of Taxa Group	55.1%	14.7%	30.2%		

Biomass focused on lands in either forests or agriculture has the potential to immediately impact approximately 62% of the SGCN in the region. Mature forest species comprise over 30% of the total, while early successional species comprise approximately 24%.

From the regional perspective for birds, the most favorable biomass options would be to avoid the removal of existing mature forest and utilize thinning to acquire biomass material. This would result in a net positive for bird SGCN will minimizing the heavy habitat losses of complete stand removal. Where biomass applications are focused on lands presently in agriculture, it would be advisable to replace it with either warm season grass plantings or dedicated woody plantations for maximum SGCN benefit and appropriate to the state in which the planting occurs.

For mammals, the maximum benefit to SGCN would be achieved by replacing agricultural types with either native warm season grass or early successional woody vegetation systems. Complete removal of mature forest will have the most detrimental impacts especially if those areas were converted to some sort of system as opposed to allowing natural stand regeneration.

Amphibians and reptile SGCN are particularly at risk to the conversion of mature forests (particularly deciduous forests) to any sort of biomass energy system. The most significant potential benefits are achieved when existing agricultural lands are converted to some sort of dedicated woody crop or allowed to regenerate naturally.

Taken as a whole, the northeastern SGCN will be further impacted if biomass energy activities are focused on forest lands cleared for some sort of non-woody biomass system. While some benefits could be realized with mature stand thinning and the subsequent increase in understory vegetation, the most obvious benefits would come from the conversion of intensively managed agriculture to some sort of early successional biomass system.

Discussion

The underlying question for wildlife managers is not "If" biomass energy development will impact species of greatest conservation need, but "where" and "how". This is an extremely complex question particularly when specific landscapes and species are involved. When examining potential impacts at the regional level, the most accurate answers would come from the summarization of detailed projects situated in landscapes with a specific suite of species in hand for the entire region. That level of detail is beyond the reach of this project.

However, by attempting to extrapolate the likely combinations of land use and potential biomass systems we are able to glean useful information about the likely impacts on SGCN that use those habitats. This exercise is worthwhile, as it allows the wildlife manager to understand the relative impacts of various practices and apply that information against specific agency objectives for managing SGCN habitats. This project was able to provide general and basic information to allow wildlife managers at the to assess the direction and likely magnitude of biomass applications within their area of interest and to narrow subsequent discussion to more positive outcomes that will ultimately benefit SGCN as a whole.

SGCN at the Regional Level

The process of identifying species of greatest conservation need was implemented at the state level. For the most part, these assessments were conducted with little or no interaction or input from neighboring states, or from the regional perspective. This makes regionalization difficult, since the criterion for identifying a SGCN differed from state to state. Further, little consideration for regional population and distribution was included for most state assessments. So, a species that is considered to be relatively common (and therefore not a SGCN) within one portion of its range may be rare and of-concern at the fringe of its range. As of yet, there has been no determination how to treat these species at the regional level.

In this study, we elected to treat every SGCN in every state equally. That is, each species occurrence on the SGCN list was as important as any other throughout the range. So, the loss of one SGCN via the implementation of biomass systems is mitigated with the gain of another. Clearly this is unrealistic if applied at more detailed spatial and project scales. Users are encouraged to remember this point as they interpret and incorporate this information.

Biomass energy systems do, however, provide a clear opportunity for early successional species habitat management. In nearly all 13 states, early successional species are included in the list of SGCN but the tools available to wildlife managers for creating and maintaining these habitats are dwindling. The implementation of biomass systems (as described in this study) will restore some options but tradeoffs between other SGCN habitat objectives are inevitable and require further consideration. Ultimately, the interest in biomass energy development may supply the only real landscape level alternative for addressing the shortage of shrub and grassland habitat for the region.

Biomass Systems Implementation and Land Use Change

The single most significant impact to wildlife species has been, and likely always will be, changes to the structure and function of their habitat. SGCN, by definition, are species whose long term existence is threatened by one or more factors often related to habitat. The core element to our analysis is that biomass systems will bring about significant and wide-ranging landscape change in the Northeast, and that change will undoubtedly result in both positive and negative impacts to individual SGCN in the process. The goal is for the professional wildlife community to work cooperatively with other decision makers to consider these impacts when regulating and implementing policies and procedures relative to the implementation of biomass energy systems.

Perhaps the most clearly illustrated point from this work is that the relative impacts to SGCN from biomass systems will ultimately be determined by the types of land use that are replaced with biomass systems on the landscape. Mature forests constitute the most complex and, in some cases, longest undisturbed tracts of habitat in the Northeast. Over 30% of the SGCN identified in this project utilize forests as their primary habitat. Therefore, any biomass system that displaces mature forest in the Northeast is likely to result in a net loss of habitat for SGCN. The only exception to this would be in cases where biomass systems utilize "waste" materials resulting from thinning which, in turn, results in an increase in the lower levels of the forest structure that improves habitat for a select SGCN.

That is not to say that the removal of some mature deciduous forest in favor of more early-successional forest would not result in much needed habitat for a suite of SGCN that require it. For example, the golden-winged warbler (listed as an SGCN in 11 of 13 states) requires early successional forest and may benefit from biomass systems that resulted in an increase in this type on the landscape. In many cases such as this the potential for a successful biomass industry to install thousands of acres of early successional forest are great and represent a real opportunity where other options are limited and/or unlikely. The more complex question requiring additional consideration is whether degrading potential cerulean warbler habitat in favor of better golden-winged warbler is an acceptable trade-off at state or regional levels.

Conversely, biomass systems that are implemented on lands with little value to SGCN at present constitute a clear benefit. Agricultural lands do certainly provide some habitat for SGCN but as a whole they have much lower value than the potential value of the biomass systems that would replace them. Intensively managed agriculture like row crops that require cultivation, herbicides, fertilizers, and are nearly completely harvested and removed from the site have little value compared to a native warm season grass stand or even a dedicated woody plantation.

However, fields presently managed as row crop tend to maintain profitability from year to year and managers are less likely to convert them to biomass crops given the present economic return. It is more likely that the lands that would attract biomass energy development attention are those considered "marginal" in value for high-value commodities and are presently used as pasture or hay land, or are fallow. Further, we propose that these lands have a higher probability of conversion to development than do those tracts with profit potential. In this instance, the conversion of these lands will likely come at a higher SGCN cost than row crops alone. Again, the true overall impact of such a conversion will be determined by the specifics.

In general, we feel that the conversion of pasture (typically short fescue monocultures with little wildlife value), hay lands (cool season stands that are mowed in the breeding season and offer little food or cover in winter months), and fallow lands (often dominated by invasive plant species) to biomass systems such as native warm season grasses or dedicated stands of woody plants would result in, at minimum, a zero net impact in terms of wildlife value. More likely the biomass stands will provide better food and cover options for significantly longer period, and have a higher probability of persisting on the landscape as profitable farmland with a diminished chance of being sold for development.

Biomass Practices and SGCN

We attempted to define and label biomass practices in terms of their potential for both economic feasibility and wildlife habitat potential. For example, for native warm season grass biomass systems we assumed that the stands would only be harvested once per year during the dormant season (typically November and December) and based our interpretation of potential habitat value on those assumptions. If biomass stands are harvested for hay during the bird breeding season, or are stocked at high levels (e.g., greater than 5 tons per acre) their value as habitat will likely decrease. Much work related to best management practices (BMPs) for biomass plantings is ongoing (e.g., Association of Fish and Wildlife Agencies) and forestry BMPs are well established. Little research has been done on the value to wildlife for dedicated woody biomass plantations, but we feel that this is an area that will receive a great deal of attention in the near future. The opportunities for increasing the wildlife value of these stands without impacting profitability are great.

The potential benefits for SGCN are not only measured by factors within the stand itself. The landscape-level impacts of increased early successional habitats will likely be additive even if the stand-level habitat characteristics are less than optimal. For example, lands converted to a native warm season grass mix or monoculture and managed for biomass from pasture may not have the same characteristics or habitat quality as a stand planted as part of the Conservation Reserve Program (CRP), but the act of moving several hundred (or thousand) acres from a low value cover to a higher one will have benefits to species that utilize the stands. Too often biologists point out NWSG how biomass stands are not ideal grassland habitat but fail to acknowledge that their value may very well be better than the type it replaced on the landscape. We postulate that greater quantities of “marginal” habitat may ultimately be better than small quantities of “ideal” habitat on the landscape for some SGCNs.

Wildlife Biologist Place at the Biomass Roundtable

Our primary goal with this work was to lay the groundwork for state wildlife biologists and habitat managers to understand the potential impact that biomass energy development can have on efforts to address SGCN. It is our hope that, with this information, wildlife professionals will realize the importance of engaging the biomass energy industry at the local planning level in order to insert practices that benefit wildlife species or, at minimum, reduce impacts.

Constructive dialog between biologists and developers has to begin as projects are conceived and sited on the landscape. The biomass industry is in relative infancy with respect to widespread applications, so input from biologists at this stage will be most effective for ensuring biomass systems are largely beneficial. Interaction through regulation and litigation should be avoided if at all possible.

Once biomass projects are initiated and financed, developers have a large stake in seeing the project through as designed and are much more likely to resist modifications and challenge regulations proposed by the wildlife community. Efforts to implement wind energy projects on ridges and off-shore areas of the Northeast provide an example of “what not to do” when addressing concerns about impacts to SGCN and other wildlife. Mitigating wildlife impacts, post-implementation regulations, and other actions lead to counterproductive relationships and, ultimately, “either-or” outcomes as opposed to compromise.

We suggest that state fish and wildlife agencies make a proactive and concerted effort to engage biomass industry entities by encouraging wildlife biologists to participate in active communications with their industry counterparts at early in the planning process as possible. Wildlife biologists can offer critical information about harvest operations and planning, species selection and arrangement, and other benefits to well-planned systems such as erosion mitigation. Biomass developers may even find this interaction beneficial when dealing with financing issues such as risk and marketability of biomass as an eco-friendly energy source.