FEASIBILITY OF THE BIOREGIONAL MONITORING PLAN FOR NORTHERN GOSHAWKS IN THE WESTERN GREAT LAKES

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Abstract: In an effort to better understand northern goshawk (*Accipiter gentilis)*, population status and track changes at a large scale, the U.S. Forest Service (USFS) has developed the bioregional monitoring plan. The plan requires random sampling of 688 ha (1,700 ac) primary sampling units (PSUs) across all potential goshawk breeding range within each bioregion. Broadcast surveys of conspecific calls are used to detect presence of territorial goshawks within each PSU. The first pilot-study utilizing the bioregional design was conducted on two National Forests in Colorado in 2003. In 2004, we field-tested the bioregional design to determine actual costs, time needed, fieldwork logistics, and detection rates associated with PSU survey work for the Great Lakes bioregion. In addition, we surveyed known active nests to determine actual detection rates for active goshawk nests in Wisconsin. The mean total cost to survey a PSU was $1157.27 or $8.09 per calling station, to complete two visits. The mean time to complete each PSU survey was 23.1 hr. We detected goshawks at 60% of the PSUs (N= 5) and 100% of known active nests (N= 10) surveyed. This data provides region-specific information on the effectiveness of broadcast surveys for goshawks in Wisconsin and costs associated with the bioregional monitoring design. We believe that the bioregional design is an acceptable approach to estimating goshawk population size and status in this bioregion. A description of the bioregional monitoring plan is provided in Appendix B.

Key words: *Accipiter gentilis*, broadcast survey, detection rate, goshawk, survey costs, Wisconsin.

Conspecific broadcast surveys are a commonly used technique to survey for goshawks (Kennedy and Stahlecker 1993, Joy et al. 1994, Watson 1999, McClaren 2003). However, results from these surveys fail to address changes in population abundance or breeding density beyond the local scale. In addition, results from individual local surveys are difficult to compare between studies because of differences in methodologies,

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terminology, data interpretation, and reporting (Anderson et al. 2004). Although detection surveys have been successful for small-scale projects, development of a design that surveys goshawks at a large (e.g. statewide or ecoregion) scale needs to be implemented.

The Wildlife Society (TWS) Technical Review (Anderson et al. 2004) developed several recommendations regarding the status and population trends of goshawks in western U.S. This review identifies the need to standardize data collection, sample to assess population trends and goshawk-habitat relations at a broad scale, determine relationship of population and subspecies, address limitations of existing data, standardize protocols and terminology, and support intensive long-term studies. The review committee states that these recommendations are appropriate for goshawk populations throughout North America. The proposed bioregional monitoring plan addresses several of the TWS recommendations, thus suggesting the importance of altering current goshawk monitoring methods.

To compare goshawk survey information at a broad scale, scientists from the USFS and elsewhere have proposed the bioregional monitoring plan. The plan uses detection rates from broadcast surveys to determine the status of goshawks and the habitat they occupy over a 5-yr period. The objectives are (1) estimate the number of goshawks within a bioregion, (2) evaluate changes in goshawk numbers over time, and (3) assess whether changes in numbers are associated with habitat changes (C. Vojta, USFS, personal communication). The bioregional monitoring plan is the first attempt to study goshawks at a scale this large. Bioregional monitoring does not measure nest productivity, so current monitoring would need to continue if productivity results are deemed important.

We conducted a pilot study to assess the feasibility of the bioregional monitoring plan in north central Wisconsin during the 2004 breeding season. Ferland (2003) was first to pilot the bioregional design in the San Juan and Rio Grande National Forests of southwestern Colorado. That work presents a perfect opportunity to compare and contrast implementation of the bioregional design in different ecosystems. In addition to testing the feasibility of the bioregional design in the western Great Lakes, we surveyed known active nests to accurately estimate detection probabilities of broadcast surveys for goshawks in Wisconsin. To our knowledge, detection probabilities have not been assessed before in

Wisconsin. Our objectives were (1) determine actual costs and other logistics of the bioregional design, (2) determine detection rates of broadcast surveys in the region, and (3) use these results to accurately determine the sample size needed to complete a robust population estimate.

STUDY AREA

Ten distinct bioregions were delineated within the breeding range of goshawks in North America. Our study was located in the Great Lakes bioregion, which includes Wisconsin, Michigan, eastern Minnesota, northeastern Iowa, and small portions of northern Illinois and Indiana (C. Vojta, U.S. Forest Service, personal communication). We surveyed for goshawks in Oneida, Vilas, Iron, Price, and Taylor counties of Wisconsin.

The study area was predominantly comprised of coniferous, deciduous, and mixed forests interspersed with large tracts of forested and non-forested lowlands. Upland forests were predominantly sugar maple (*Acer saccharum*), eastern hemlock (*Tsuga canadensis*), birch (*Betula* spp.), aspen (*Populus tremuloides*), pine (*Pinus* spp.), oak (*Quercus* spp.), and/or basswood (*Tilla americana*). Lowland forest types ranged from black spruce (*Picea mariana*) and tamarack (*Larix laricina*) bogs to red maple (*Acer rubrum*), American elm (*Ulmus americana*), and black ash (*Fraxinus nigra*) swamps (Kotar et al. 2002).

Major recreation/tourism activities in the study area include hunting, fishing, hiking, biking, skiing, off-highway vehicle use, and snowmobiling. Major resource management is timber harvesting.

Mean monthly temperatures ranged from –11.9 °C (12.2 °F) in January to 19.6 °C (66.2 °F) in July. Mean monthly rainfall ranged from 10.3 cm (4.1 in) in July to a mean monthly snowfall of 29.5 cm (11.6 in) in January. Mean annual precipitation totals were 92.5 cm (36.4 in), with slightly more snow than rain (National Oceanic and Atmospheric Administration, http://www.crh.noaa.gov/).

METHODS

Primary Sampling Units

The bioregional monitoring design requires random sampling of 688 ha (1,700 ac) PSUs across all potential goshawk breeding range. Each PSU represents the average size of a goshawk territory based on studies in California and Arizona (USDA Forest Service, unpublished data). Broadcast surveys were used to detect presence or absence of goshawks within each PSU, following methods similar to those reported by Kennedy and Stahlecker (1993) and Joy et al. (1994). PSUs were sampled twice during the breeding season, once during both the nestling and fledgling-dependency periods.

To select the areas for sampling, we placed a grid of PSUs over the entire contemporary breeding range of goshawks in Wisconsin. Next, two strata were calculated for each PSU, percent forest cover and accessibility (public vs. private ownership). We used 60% forest cover and 50% public ownership as the cut-off for each strata. Each PSU was then placed into one of the four (e.g. good habitat-good access, marginal habitat-poor access, etc.) stratification outcomes. By stratifying the study area this way, we can concentrate most of our resources surveying areas that have good habitat and accessibility, while still searching within all possible breeding habitat.

We sampled 5 non-random PSUs in north central Wisconsin in 2004 (Fig. 1). We selected these because they contained historic (N= 4) or reported (N= 1) goshawk nesting areas that had become inactive in the past 10 years. One of the PSUs was stratified as marginal habitat-easy access and the other four were primary habitat-easy access.

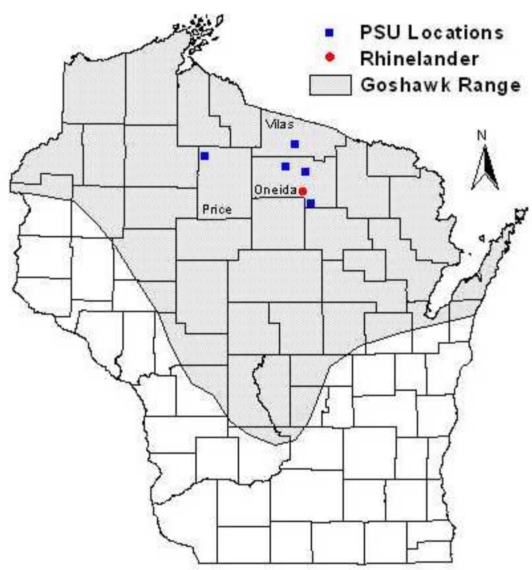

Fig. 1. PSU locations surveyed during the 2004 goshawk breeding season in north central Wisconsin.

Each PSU was surveyed with 13 calling stations placed 200 m apart along 11 parallel transects 250 m apart (Fig. 2). This was slightly different than Ferland (2003) who used 10 transects to cover each PSU. The starting location of each adjacent transects was offset 100 m to allow maximum survey coverage of the entire PSU. This design results in 143 calling stations per PSU.

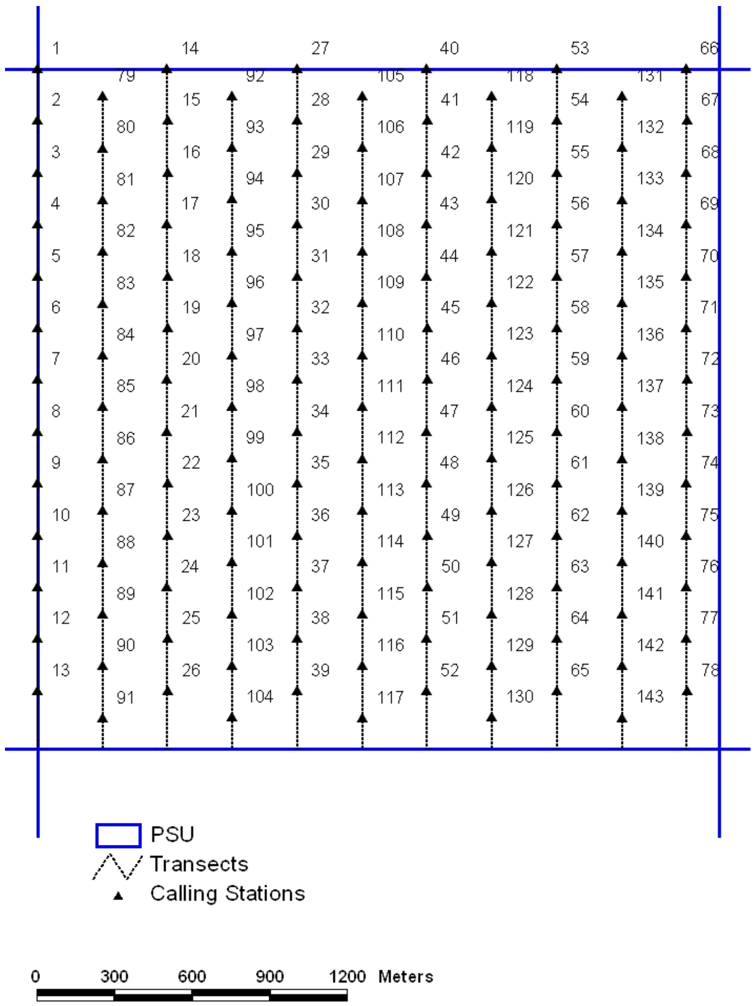

Fig. 2. Survey station grid for each PSU using the Bioregional Monitoring Plan.

PSU maps with transects and calling stations were generated using Arcview 3.2 (ESRI, Redlands, CA) and extensions. Latitude and longitude locations for each calling station were uploaded onto Garmin GPS units, models GPS76 and GPSmap76 (Garmin Ltd., Olathe, KS), using the Minnesota DNRGarmin tool (Version 1.2.3).

At each station we used a FOXPRO Model 48B (FOXPRO Systems, Lewistown, PA) digital caller to broadcast the calls. The adult alarm call (from a commercial compact disk) was played during the nestling period visit. Both the adult alarm and juvenile food-begging calls (USDA Forest Service training compact disk) were played during the fledgling-dependency visit. Calls were played at 85-90 dB standardized with a Digital Sound Level Meter (RadioShack, Fort Worth, TX). At each station, calls were played for 20 sec followed by 10 sec of listening, and repeated for 7 bouts. Between each bout, the caller was rotated 90° to provide 360° of coverage. We listened for an additional 30 sec after all calling bouts were completed, for a total survey time of 4 min per station. We also listened and watched for goshawks when walking between calling stations. Stations were skipped if they were located in lakes or in large, treeless bogs where coverage was achieved from adjacent stations. If a visual or auditory detection of an adult or juvenile occurred, the survey ended for that PSU.

We recorded survey date, surveyor(s), PSU name, visit number, weather information, station number, start time, forest type, structural stage, raptor detection, and comments (see Appendix A for PSU survey form and forest type/structural stage codes). In addition to goshawks, we recorded all other hawks and owls heard or observed. Once a response was detected, we recorded the type (auditory, visual or both), age of the bird, location, direction, and estimated the distance of detection. Staff were trained in the field on survey procedures, goshawk identification, and orienteering in an attempt to standardize the abilities of each surveyor. The PSU surveys ran from 24 May to 29 July 2004.

Determining Detection Rates

Detection rates of conspecific broadcast surveys for goshawks have not been assessed in Wisconsin, which is critical in determining the sample size needed for a robust population estimate. To accurately estimate detection probabilities, we investigated detection rates using broadcast surveys at 10 active nests in the study area.

Similar to the PSU surveys, the active nest surveys used conspecific calls and were completed during the nestling and fledgling-dependency periods. We used Arcview 3.2 to establish one survey transect (at a randomly selected compass bearing) tangential to a circle, with a radius between 1 and 140 m selected randomly, placed around the nest tree. A 140 m circle is the maximum distance that a nest could be located from any calling station using the bioregional monitoring scheme (see Fig. 2). Next, a survey station was placed at the intersection point of the circle and the survey transect, and 200 m before and after the intersection point. Each survey lasted until the three calling stations were completed or a response (auditory, visual, or both) was detected.

Geographical Information System (GIS) maps were used in the field and station locations were manually loaded into GPS units. We recorded the same information and detection parameters that were used for the PSU surveys. We also measured the distance from each detection to the nest tree. The active nest surveys ran from 2 June to 9 July 2004.

RESULTS

Primary Sampling Units

In 2004 we surveyed PSUs during the nestling (N= 5) and fledgling-dependency (N= 3) periods. We had three responses for a PSU detection rate of 60% (3 of 5), and sampling period rate of 38% (3 of 8). All responses were from adults and occurred during the nestling period. The Butternut Creek PSU and Stone Lake PSU detections were both auditory and visual (67%), while the High Lake PSU was a visual response (33%). An active nest was found at Butternut Creek a few days following the detection and at Stone Lake shortly after the survey started. No nest was found at High Lake, so we surveyed it and the other PSUs during the fledgling-dependency period as well.

We spent 45 surveyor-days (21 d total) completing 651 calling surveys (mean = 31/d). Total time spent surveying was 155.5 hr, for a mean rate of 14.3 min per station. A total of 29 hr were spent commuting for a mean commute time of 1.3 hr per PSU. We found a strong linear relationship between travel costs and distance (Fig. 3). The overall mean survey and commute time for each PSU was 23.1 hr.

The average hourly salary of our 2-person crew was $12.00. We drove a total of 1,136 miles, and equipment costs were $1490.00. Pre- and post fieldwork time was estimated at 102 hr total. Therefore, the overall mean cost to survey each PSU was $1157.14, or $8.09 per calling station (Table 1).

Table 1. Cost breakdown for goshawk surveys following the bioregional design in north central Wisconsin during the 2004 breeding season.

	Cost per station
Survey[a]	$2.87
Mileage[b]	$0.52
Commute[a]	$0.53
Equipment	$2.29
Pre- Post- fieldwork[a]	$1.88
(Forms, Maps, Training, Data Entry)	
Total	$8.09

[a] based on personal cost of $12.00/hr
[b] based on $0.30/mile, which includes vehicle cost

Determining Detection Rates

We received responses at 71% (5 of 7) and 90% (9 of 10) of nests during the nestling and fledgling-dependency survey periods, respectively. This provides an 82% (14 of 17) detection rate for all surveys. However, with the nest as the sampling unit, the detection rate was 100%, because a response was observed at all active nests during one of the visits. The three additional nests surveyed during the fledgling-dependency period included nests found at the Butternut Creek and Stone Lake PSUs, and while searching one other historic goshawk territory in early July with a caller. All 10 nests surveyed successfully fledged young. Mean estimated hatching and fledging dates for goshawk nestlings were 19 May and 26 June, respectively in 2004. Of the 14 detections, 64% were auditory and visual, 22% were auditory, and 14% were visual. Nestlings or fledglings were detected in 14% (2 of 14) of the responses.

The mean distance of first detection to the nest tree was 139 ± 88 m (Table 2). Sixty-five percent of the detections were located in northern hardwood, northern hardwood with yellow birch, and hemlock hardwood forest types. Of these forest types, 82% (9 of 11) were in the sawlog to late-successional structural (i.e., stage 4 and 5) stages (Table 2).

Table 2. Distance to nest tree, forest type, and structural stage at first detection during PSU and active nest surveys in 2004 field season.

Name	Visit #	Forest Type[a]	Structural Stage[a]	Distance to nest tree (m)
High Lake PSU	1	AB/H	2	N/A[b]
Butternut Creek PSU	1	SC/-	4	74
Stone Lake PSU	1	NHY/H	2	71
White Pine	1	WP/-	5	202
White Pine	2	NH/WP	4	128
Hunting Camp Road	1	HH/-	3	270
Hunting Camp Road	2	NH/H	4	73
Barnaby Rapids	1	NHY/WP	5	30
Moose Creek	1	HH/-	5	30
Moose Creek	2	SC/-	4	204
Bittersweet	1	NHY/-	5	55
Bittersweet	2	NHY/-	5	150
Stone Lake	2	NHY/-	4	203
Butternut Creek	2	SC/-	3	51
Catherine Lake	2	NHY/H	5	300
Alva Lake	2	HH/-	4	163
Gates Lake	2	AB/JP	4	222
Mean				139
SD				88

[a] forest type and structural code information is in Appendix A
[b]silent flyover detection, no nest found

DISCUSSION

Our costs to survey PSUs were slightly higher than those reported by Ferland (2003) in the San Juan and Rio Grande National Forests. The cost per calling station ($8.09 vs. $6.99) was 16% higher. Some of the increase is attributable to higher staff salaries ($0.95 per hr more) and because we surveyed 11 transects per PSU instead of 10. If we had surveyed 10 transects, costs would have been less per PSU (i.e., $1050.70) than that reported by Ferland (2003). In addition, had we surveyed the entire field season, equipment costs (28% of the total) per station would have decreased substantially.

Even though our costs were higher, the mean time to survey PSUs was less than (23.1 vs. 37.8 hr) the Colorado pilot study. This occurred even though they completed each calling station 1.66 min quicker then we did. Additional time and costs were saved due to the more complete road network and less severe terrain to traverse in Wisconsin. Increased access, through the road network, also affected the commute time. Our commute time averaged 1.3 hr per PSU, while theirs was 3.01 ± 1.15 hr. This difference allowed us to devote a greater amount of each day to surveys.

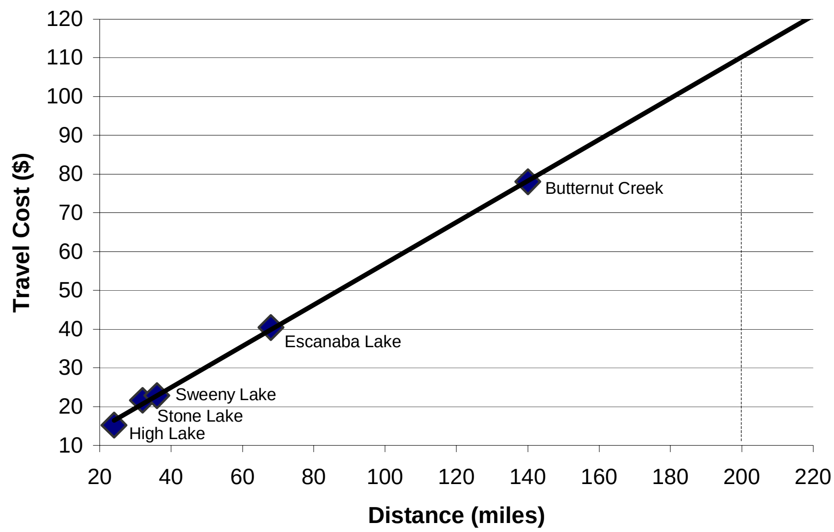

Fig. 3. Relationship between distance (miles) and travel cost ($) to survey PSUs (N= 5) using the bioregional monitoring design in north central Wisconsin during 2004. Round trip distance in miles was measured from Rhinelander, Wisconsin to each PSU. Costs included mileage (at $0.30/mile) and commute time at $12.00 per hr per surveyor.

Detection rates at active nests during the nestling (71%) and fledgling-dependency (90%) periods were similar to those reported elsewhere (see Kennedy and Stahlecker 1993, Watson et al. 1999, and McClaren et al. 2003). These studies also found a higher detection rate during the fledgling-dependency period vs. the nestling period. Contrary to these studies, where the most common type of response reported was auditory only, the majority of responses we detected were both auditory and visual. Nearly all (78%) responses we observed during the fledgling-dependency period were from adults. This contradicts the results of Kennedy and Stahlecker (1993), Watson et al. (1999), and McClaren et al. (2003), which report most responses coming from fledglings. But it supports Joy et al. (1994) where 79% of responses were by adults during this period.

The mean distance of first detection to the nest tree (139 ± 88 m), was similar to that reported (141 m) by Kennedy and Stahlecker (1993). Detection distance from the nest tends to be greater during the fledgling-dependency period. Kennedy and Stahlecker (1993) reported a maximum detection distance of 316 m and 707 m during the nestling and fledgling-dependency periods, respectively. Watson et al. (1999) found that 80% of detections occurred ≤100 m from the nest during the nestling period and 47% occurred ≤ 100 m during the fledgling-dependency period. Our detection distances were ≤ 100 m for 71% and 22% of surveys run during the nestling and fledgling-dependency periods, respectively.

SUMMARY

The following are important considerations relative to PSU field surveys in the western Great Lakes region. First, keep the commute distance to each PSU below 140 miles round trip. Even though cost vs. distance is linear (Fig. 3), long commutes tend to reduce survey efficiency. Second, the cost to survey an entire PSU will likely be less than that reported here if the field crews work exclusively on bioregional monitoring for the entire field season. We think that a field crew of two (with at least one experienced surveyor) can completely survey 10 PSUs per yr. Finally, strict adherence to the bioregional design should detect nearly 100% of active nests within surveyed PSUs. However, the detection rate will be less (possibly much less) for occupied territories and active nests that fail during the incubation period.

ACKNOWLEDGMENTS

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Appendix A. PSU survey form and codes for forest type and structural stage (based on Ferland 2003).

Date (mo/day):_____ Page___of___

Surveyor(s):________ **NOGO PSU Survey**

PSU Name: ________________________ **Visit #1 or Visit #2**

Weather: Sunny Partly Cloudy Cloudy Rain **Temp Range:___-___** F

Wind: Calm Light Breeze Med Breeze Windy

Sta. #	Start Time (24 hr)	Forest Type (see list)	Stuct. Stage (1-5)	Raptor Det. (Y/N)	Comments (note weather change)

NOGO – Northern Goshawk
RSHA – Red-shouldered Hawk
BWHA – Broad-winged Hawk
RTHA – Red-tailed Hawk
COHA – Cooper's Hawk
SSHA – Sharp-shined Hawk
MERL – Merlin
BAOW – Barred Owl
GHOW – Great-horned Owl

STRUCTURAL STAGE CODES

1 = Grass/Forbs/Shrub/Seedling (Stand dominance by grasses, forbs, and woody stems < 1" in diameter)

2 = Sapling-Pole (Stand dominance by trees in the 1-9" (2.5-23 cm) DBH size for softwoods and 1-11" (2.5-28cm) for hardwoods; canopy closure < 75% (ocular estimation)).

3 = Sapling-Pole (same as #2 except canopy closure >75%)

4 = Saw to Late-Successional (Stand dominance by trees in the 9" (>23cm) and larger DBH size for softwoods and 11" (>28cm) and larger for hardwoods; canopy closure < 75%)

5 = Saw to Late-Successional (Same as #4 except canopy closure > 75%).

FOREST TYPE CODES (Primary/Conifer)

Note: The Primary code should always be the dominant type (deciduous or coniferous), and a Conifer Code should be entered when a coniferous type is present, but not the dominant forest type.

DECIDUOUS

A =	Aspen
AB =	Aspen/White Birch
NH =	Northern Hardwood (Sugar Maple, Red Maple, Red Oak, Basswood, Ash)
NHY =	Northern Hardwood/Yellow Birch (Sugar Maple, Yellow Birch, Basswood, Ash)
HH =	Hemlock Hardwood (Hemlock, Sugar Maple, Yellow Birch, Red Maple)
O =	Oak
OAB =	Oak/Aspen/White Birch
WB =	White Birch
SH =	Swamp Hardwood (Red Maple, Ash)
NFOR =	Non-forested
OTH =	Other Type (describe in Comments)

CONIFEROUS

PP =	Pine Plantation
WP =	White Pine
RP =	Red Pine
H =	Hemlock
SF =	Spruce/Balsam Fir
SC =	Swamp Conifer (Black Spruce, Tamarack, and Cedar)