Appendix I. ENVIRONMENTAL PROTECTION PLAN

Glen Dhu South Wind Power Project

Environmental Protection Plan

PREPARED BY

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Environmental Protection Plan (EPP)

1.0 INTRODUCTION

This Environmental Protection Plan (EPP) has been prepared to guide the design and installation of the physical components of the Glen Dhu South Wind Power project.

The purpose of the EPP is to establish procedures and methods to be used in the construction and operation of the Glen Dhu South Wind Power project that reduce impacts on the environment. The EPP applies provincial and, where appropriate, federal regulations & guidelines for construction activities and procedures.

The EPP includes an Emergency Response Plan (ERP) to address environmental emergencies, an Environmental Management Plan which lays out the procedures to be followed during the conduct of the work and a Site Restoration Plan (SRP). This ERP will be harmonized with the contractor's ERP and will be made available to all site personnel.

The EPP incorporates approved design methods for erosion and sediment control, defines set backs from streams and wetlands and areas of environmental or heritage significance. It provides guidance for appropriate engineering designs for surface water management and stream crossings. The EPP also designates the timeframes for seasonally sensitive activities and establishes prohibitions for the project design and construction activities.

This document may be amended from time to time. Amendments will be issued by Shear Wind Inc. (SWI) and the project manager will ensure that all copies will receive amendments.

2.0 EMERGENCY RESPONSE

The following provides contact numbers in the case of emergencies involving: worker safety, public safety, and emergency response to address environmental emergencies.

2.1 Emergency Contact List

Organization	Contact Name	Contact Number
Fire Department	-	**911**
Ambulance	-	**911**
RCMP Police	-	**911**
Hospital	Aberdeen Regional Hospital, 835 East River Road, New Glasgow	**(902) 752-8311**
Poison Control	-	**1-800-565-8161**
Chief Operations Officer, Shear Wind Inc.	Ian Tillard	**(902) 222-8982 (cell)** (902) 444-7420
Project Manager Shear Wind Inc.	TBA	
Health and Safety Officer, Shear Wind Inc.	TBA	
Nova Scotia Department of Environment	Emergency Measures Office	**1-800-565-1633**
Nova Scotia Environment Antigonish	David Shay	**(902) 863- 7389**
Nova Scotia Environment New Glasgow	Randy McDermid	**(902) 396-4193 or 396-4194**
Nova Scotia Department of Labour	Health and Safety - 24 hour Response	**1 -800-952-2687**
NS Department of Natural Resources, Antigonish County	Mark Pulsifer	**(902) 863-7523**
NS Department of Natural Resources, Pictou County	Kim George	**(902) 893-6353**
Environment Canada	Environmental Protection Emergency Response	**1-800-426-6200**
Environmental Advisor Shear Wind Inc.	Robert McCallum	**(902) 292-0514**
Archaeological Artifacts, Special Places Director	Robert Ogilvie	**(902) 424-6475**

2.2 Key Personnel Contact List

Position	Name	Phone Number	Fax Number	Cell Phone Number
Chief Executive Officer, Shear Wind Inc.	Mike Magnus	(902) 444-7420	(902) 444-7425	(902) 456-3146
Chief Operations Officer, Shear Wind Inc.	Ian Tillard, P. Eng.	(902) 444-7420	(902) 444-7425	(902) 222-8982
Project Manager	TBA			
Field Inspector, Shear Wind Inc.	Robert McCallum	(902) 446-8252	-	(902) 292-0514
Health and Safety Officer	TBA			
Senior Environmental Advisor	Robert McCallum	902-446-8252		902-292-0514
Legal Counsel	TBA			
NS Environment, New Glasgow		(902) 396-4194	(902) 396-4765	(902) 396-8342
DNR, Antigonish County	Mark Pulsifer	(902) 863-7523	(902) 863-7342	-
DNR, Pictou County	Kim George	(902) 893-6353	(902) 893-5613	
Fisheries and Oceans, (DFO)	Charles McInnis	(902) 863-5670		
NS Tourism, Culture and Heritage	Robert Ogilvie	(902) 424-6475	(902) 424-0560	-
Maritime Aboriginal Peoples Council	Roger Hunka	(902) 895-2982	-	-
Confederacy of Mainland Mi'kmaq	Norma Prosper	(902) 895-6385 (ext. 240)	-	-
Pictou Landing First Nation	Chief Anne Francis-Muise	(902) 752-4912	-	-
Paq'tnkek First Nation	Chief Michael Gerard-Julian	(902) 386-2781	-	-
Union of Nova Scotia Indians	Nancy Paul	(902) 538-4107	-	-
Mi'kmaq Rights Initiative	Twila Gaudet	(902) 843-3880	-	-

2.3 Guide Map to Regional Hospital

Google Maps

Driving directions to Aberdeen Regional Hospital
(902) 752-8311
42.3 km – about **37 mins**

(A) Baileys Brook
Pictou; Subd. C, NS, Canada

1. Head **southeast** on **Arbuckle Rd** toward **Browns Mountain Rd**	3.8 km
2. Turn **left** at **Barneys River Rd**	6.3 km
3. Turn **right** at **HWY-104**	31.1 km
4. Take exit **25** to merge onto **E River Rd** toward **New Glasgow/Trenton** Destination will be on the left	1.1 km

(B) Aberdeen Regional Hospital
835 East River Road
New Glasgow, NS B2H 3S6, Canada
(902) 752-8311

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

3.0 ENVIRONMENTAL MANAGEMENT PLAN GENERAL PROVISIONS

The Environmental Management Plan (EMP) has been developed to guide site specific construction activities and procedures. The purpose of the EMP is:

1. to manage and minimize risks and potential environmental impacts from construction activities;
2. To ensure that Shear Wind's commitments to minimizing environmental effects are met;
3. To ensure development activities meet all provincial, federal and municipal requirements;
4. To provide mitigation of the potential environmental impacts due to construction activities; and,
5. To provide a reference document for planning and/or conducting construction activities that may have an impact on the environment.

This EMP was developed by Shear Wind to describe the protection measures to be followed by Shear Wind personnel and all contractors required for activities associated with development of the Glen Dhu Wind Power Project. Shear Wind's appointed project manager will be responsible for the enforcement of these procedures.

3.1 Construction Environmental Mitigation Measures

A. Design Specifications

1) Construction specifications will be completed to turbine manufacturer's technical specifications for:
    1) Access Roads and Crane Platforms
    2) Civil works, Crane and Road Requirements
    3) Other engineering design specifications pertaining to the Glen Dhu Wind Project as specified by SWI and their project engineers;

If a conflict arises between technical specifications and regulatory requirements, regulatory requirements shall prevail, unless amendments are approved by the appropriate regulatory body.

B. Work Areas

1) All construction activities will be restricted, as much as practically possible, to approved work spaces, designated access roads and turbine sites;

2) During tower foundation construction, the crane platform areas may also serve as storage areas for material (e.g. reinforced steel) and machinery.

C. Runoff Control and Prevention of Sedimentation

1) When possible, the contractor will avoid grading immediately before or after heavy rain events, which would further loosen the road surface and promote runoff of graded material;

2) Aggregate which is to be used in or near watercourses will be washed quarried material;

3) For construction activities near watercourses, erosion and sediment control measures will be used to minimize erosion and ensure silt containment. The contractor will be responsible for maintaining these erosion and sedimentation control systems to ensure their effectiveness. These measures are outlined in Section 4.4;

4) All silt fences will maintain a minimum setback distance from water courses and wetlands of 10m;

5) Any water which intrudes into excavations that will be removed by pumping will not be discharged directly into any wetland or watercourse. If discharge water from pumping operations contains Total Suspended Solids (TSS) which exceeds 25 mg/l above the background condition of the watercourse at the site, discharge water from excavation will be pumped to a designated area up-gradient and downstream of the excavation. The discharge may be either be allowed to spill onto the ground and return to the watercourse following the natural topography, providing that the discharge is greater than 100 metres from a natural drainage course. Sedimentation bags, or containers with washed gravel will be used to dissipate flow and reduce erosion;

6) Following completion of construction and once vegetation has established non bio-degradeable erosion and sediment barriers will be removed from those areas which may be flooded by watercourses under high flow seasonal conditions to prevent these materials from being entrained in the watercourses;

7) If bridge footing excavations intrude into a watercourse for any reason, the contractor will be responsible to obtain prior environmental approvals and permitting for the watercourse alterations, diversions or temporary barriers as necessary to complete the installation;

8) Material placed in or adjacent to the watercourses for the temporary diversion will be removed as soon as possible by the contractor after the construction of work is completed;

9) SWI will conduct visual assessments, both quarterly and after severe storm events, of the site to ensure the effectiveness of erosion and sedimentation control measures, unless otherwise approved by NSE.

10) SWI and the Contractor will follow the *Nova Scotia Erosion and Sediment Control Manual* and/or follow the erosion and sediment control plan as outlined in this document (Section 4.4);

11) Any loss of containment or release of sediments will be reported immediately to the project manager and to NSE.

D. Bedrock Removal and Blasting

1) Where possible, rock excavation will be performed by ripping rather than blasting. Should blasting be required, no blasting will occur unless otherwise approved by NSE;

E. Pits

1) All aggregate sources will be approved by the project engineer and based on considerations such as the Pit and Quarry Guidelines (NSDOE May 4, 1999);
2) The Contractor will be responsible for obtaining NSE approvals for Pits greater than 2 hectares in size. Quarries of any size require NSE approval;
3) The slopes of all excavation pits will be constructed to a 3:1 slope;
4) If a pit is inconspicuous and poses a perceived safety hazard, the area will be marked with signs and/or fencing, depending on its location;
5) Pits may be backfilled with native material, and seeded with non-invasive, native, herbaceous plant species. Alternatively, pits may sloped to 3:1, stabilized, erosion controlled, and reclaimed to allow water to naturally collect within the pits to provide wetland habitat. In compliance with Section 6 of the Migratory Bird Regulations (MBR), this activity may not be conducted during the breeding season if birds which may use embankments for nesting sites are identified in the pit(s), typically between May 1st and August 31st for most species;
6) If adequate borrow pits and/or disposal sites are not available within the project area, offsite sources of fill will be used.

F. Vehicle and Equipment Operation and Fueling

1) All personnel, vehicles, equipment, etc…will follow all applicable traffic regulations and posted site speed limits and traffic controls;
2) Appropriate dust suppression measures will be used as required. Water will be used for dust suppression. The use of any other substance for dust is to be avoided;
3) Storage of petroleum, oil and lubricants (POL) on site during the construction phase will be in designated areas and will be done in compliance with applicable provincial and federal regulations, codes and guidelines;

4) The contractor will maintain an onsite emergency spill containment kit to adequately control any loss of fuel or lubricant by equipment;
5) Waste petroleum products, oils and lubricants (POL) will be properly contained and not released into the environment. Waste POL and all spent containers will be contained and removed from the site for proper disposal at an approved disposal facility;
6) Vehicles will be fueled at designated sites away from wetlands and watercourses (minimum distance 50 m);
7) The transportation of dangerous goods will be conducted in compliance with the Transportation of Dangerous Goods Act;
8) The construction site will have restricted access signage to prevent trespassing or inadvertent entrance by public vehicles. ''Restricted Access'' signs will be posted at the entrance of primary access roads which leave private property and enter onto public right-of-ways;
9) Equipment and vehicles will yield the right-of-way to wildlife;

G. Construction Waste

1) Construction waste will be removed from the project area and disposed of at an approved location or facility;
2) Disposal of waste materials from construction activity will be in accordance with NSDTC's Standard Specifications (1980 and revisions) for Access Road Construction;
3) Unless otherwise directed by the project manager, limbs and timber will be chipped at the site, in accordance with the Nova Scotia Forest Fire Protection Act. Non-combustible material, overburden and rock will be disposed of where their use as fill material is impractical;
4) Waste disposal areas will be located where they do not negatively impact rivers, wetlands or any watercourse.
5) Portable toilets will be used at the construction site so that no untreated sewage is disposed of in the watercourses or on site;

H. Species of Concern, Rare and Endangered Species, and Historic Artifacts

1) A buffer area of 30 m will be established around rare plants using surveying ribbon and signs to prevent unauthorized intrusion;
2) Should excavation uncover historic artifacts, work at the excavation site will cease and the project engineer will be contacted immediately. The project manager will contact the appropriate authorities from the Department of Tourism, Culture and Heritage and First Nations. Work on site will re-commence work following regulatory clearance;

I. Surface Water, Wetlands, Watercourses

1) No construction will occur within 30 metres of a wetland or watercourse unless otherwise authorized by Nova Scotia Environment (NSE);
2) Culverts will be installed as per the requirements of NSE;
3) The design of all water crossings and culverts will be approved by an individual who has successfully completed Nova Scotia Watercourse Alteration training;
4) Disposal of any agent, either directly or indirectly, will not be permitted into any watercourse or wetland;
5) Prior to construction, watercourses will be inspected at locations upstream, adjacent to, and downstream of the site. The conditions of these areas will be photographed as background information on the riparian zone and stream features at each water crossing.

J. Wildlife Encounters

1) Garbage disposal will occur at designated disposal locations throughout the project for removal;
2) Harassment of any wildlife by site personnel will not be permitted;
3) Wildlife sightings will be reported to the project engineer or designate;
4) Any disruption or injury to wildlife will be reported to the local Provincial Wildlife Officer;
5) In the event of encounters with injured wildlife at the worksite, the project engineer or designate will contact the local Provincial Wildlife Officer. No attempt will be made to move the animal and no person at the worksite will come into direct contact with the animal;
6) Dead animals will be reported, as soon as possible, to the project engineer or designate who will notify the local Provincial Wildlife Officer. The locations of animals will be marked and reported to the project engineer or designate. The project engineer or designate will record the date and time it was found; state of decomposition; injury sustained (if identifiable); and species. This information will be kept on file with Shear Wind for incorporation into the post-construction monitoring program;

K. Fires / Medical Emergencies

1) All site personnel will be responsible for fire prevention and will conduct their work in a safe manner to prevent fires;

2) Flammable waste will not be disposed of on site but will be removed for disposal in an appropriate manner;
3) Smoking will be prohibited within 50 m of flammable products;
4) Some personnel will have taken the training course for dealing with energy industry fires but not for wildland fires. In the event of a wildfire, the workers will follow the Contractor Emergency Response Plan;
5) In the event of a fire on or near the turbine site, onsite personnel will attempt to put out the fire if it is safe to do so, using the onsite firefighting equipment. The fire will be reported immediately to the project engineer or designate. If the fire cannot be contained, the nearest fire department (Barney's River Volunteer Fire Department) will be contacted at 9-1-1.
6) In case of medical emergencies, the Contractor Emergency Response Plan will be adhered to;
7) Shear Wind Inc. will provide members of the nearest fire departments and medical rescue personnel with project plans and access road layouts for the project area. GPS coordinates for the road alignments and turbine locations will be provided to emergency responders for their reference;

4.0 ENVIRONMENTAL PROTECTION PLAN

The following are general guidelines that promote environmental protection:

- Plan operations from "cradle to grave";
- Report unsafe acts and/or acts that could result in harm to the environment;
- Address the issues if they are known, do not turn a blind eye;
- Conserve soil;
- Protect water resources;
- Control emissions;
- Prepare emergency response plans;
- Manage waste;
- Do not litter;
- Conduct HSE inspections;
- Regulatory inspections may be conducted at any time and participation and cooperation is required;
- If an incident occurs follow proper procedures;
- Practice good housekeeping at all times;
- Report HSE issues internally and externally as required;
- Maintain records as required;

4.1 Access Road Construction

4.1.1 Clearing and Grubbing

- Any merchantable timber present on the road alignment will be cut, decked and removed for sale or reuse;
- Only the areas required for the road alignment, construction work areas and laydown areas will be cleared and grubbed;
- Burning of cleared and grubbed material is not permitted. Excess brush and cleared materials will be chipped and the chips distributed over the site unless otherwise directed.
- In consultation with the environmental advisor brush piles may be created around cleared areas as wildlife habitat. The locations and size of such brush pile will be determined by the requirements of individual sites and the discretion of the environmental advisor;

4.1.2 Road Specifications

- The specifications for the road characteristics will be provided by the wind turbine provider and the contractor providing the heavy lift crane. However, road side slopes will be designed to achieve a maximum 2:1 slope (horizontal:vertical). Figure 4.2: Typical Access Road Cross Section and Ditch Detail shows the specifications to be followed for the access roads;
- Prior to construction, the final road specifications will be reviewed by the project manager, project engineer (civil) and environmental advisor for compliance with applicable provincial standards and environmental guidelines who will advise the Turbine provider and the contractor on any required amendments.

4.1.3 Construction Methods

- The access road will be logged and all timber skidded to appropriate log decks;
- All stumps will be stripped by bulldozer and piled along the boundary of the cleared right-of-way;
- Surface soils will be stripped to both sides of the access road;
- Subsoils will be stripped to the underlying parent material layer and piled on both sides of the access road, adjacent to surface soil piles;
- Subsoils will be stripped from the ditchline and placed in the middle of the road to build up the road traveling surface;
- During road construction, a trench will be dug with a backhoe, running parallel to the road. The ditch will be filled with stripped non-salvageable materials, and ultimately filled in;

- Previously piled subsoils will be feathered back into the ditchline;
- Previously piled topsoils will be feathered back into the ditchline over the subsoils;
- Where steep hills, small hills or knolls are encountered, the tops of the hills will be cut and pushed down the road to reduce the slopes required for travel;

4.2 Water Crossings

For the sizing of the culverts and bridges, *the Design Flow Formula Map for Nova Scotia for 1:100 Year Storm Event (Permanent Structures)* [updated in 2008] will be consulted. The constant from the map (Ci) for all of Cape Breton Island and the portion of Antigonish County Northeast of Highway 104, will be used. This constant is 2.25 (as recommended by Randy McDermott, NSE) and specified in the *Watercourse Alteration Certification Training Manual (Appendix C amendment*) and is applicable to eastern Pictou County and Antigonish.

The drainage area will be delineated using a combination of applied methods (Watercourse Alteration Guidelines) and computer programming. Basically, the area will be mapped with both the 5m contour data as well as recent aerial photographs. The zones of delineation were set out making sure to cross the contour lines at 90 degrees. Instead of overlaying a dot grid and counting, the GIS program is able to give precise calculated area measurements in hectares.

4.3 TURBINE SITES

The preparation and construction of turbine sites will follow the applicable requirements of Section 3.1 *a* through *m*. In addition, the following requirements will apply.

4.3.1 Clearing and Grubbing

- Any merchantable timber present on the turbine sites will be cut, decked and removed for sale or reuse.
- Only the areas required for the turbine layout, construction pad and crane will be cleared and grubbed;
- Burning of cleared and grubbed material is not permitted. Excess brush and cleared materials will be chipped and the chips distributed over the site unless otherwise directed;
- In consultation with the environmental advisor, brush piles may be created around cleared areas as wildlife habitat. The locations and size of such brush piles will be determined by the requirements of individual sites on the advice and discretion of NSDNR and the wildlife advisor;
- Two lift stripping of soils may occur if subsoils are suitable to do so;
- Surface soils will be stripped and pushed to the boundary of the cleared site;
- A second stripping of subsoils may occur if possible, and will be pushed to the boundary of the turbine sites;
- Subsoils will be leveled to provide a suitable working surface;

4.4 Project Erosion & Sediment Control Options

Shear Wind would like to emphasize that it recognizes that successful erosion / sedimentation control requires correct installation of controls specific to site conditions, while also recognizing that ongoing maintenance is essential for successful outcome.

The planning strategies and structural components presented in this document are as equally important as the conceptual understanding of the principles of their implementation to ensure good construction performance and protection of the environment.

As such Shear Wind is providing what it perceives to be Best Management Practices for the project. Within the project, at the field level, any of these practices may be installed. Each area within the project will require specific control plans to be developed on-site using the principles and guidelines presented in conjunction with the lead Contractor (TBD).

The difference between erosion and sediment control methods is defined and summarized for the purposes of this document and all related activities on at construction projects as follows:

- Erosion Control is the process whereby the potential for erosion is minimized and is the primary means in preventing the degradation of downstream aquatic resources;
- Sedimentation Control is the process whereby the potential for eroded soil being transported and/or deposited beyond the limits of the construction site is minimized and is, for all intents and purposes, a contingency plan.

Both erosion and sedimentation control measures are dynamic and need to respond to requirements encountered throughout construction. Therefore, both temporary and permanent erosion and sedimentation control measures should be expected to evolve throughout construction to varying degrees based on site conditions and field performance of implemented measures.

Shear Wind Inc. will install erosion controls immediately after a disturbance resulting from a project in an erosion prone area. Erosion controls will be properly maintained, reinstalled as necessary and/or replaced until restoration is complete.

Erosion and sedimentation control measures required can be classified into two categories:

1. Temporary Measures: Those measures during the construction phase that may be completely removed to facilitate further construction that has other erosion control measures associated with it; and
2. Permanent Measures: Incorporated into the overall design of the development to address long-term post construction erosion and sedimentation control.

Temporary erosion and sedimentation control measures will be constructed at the start of the construction phase. However, additional measures will likely need to be constructed throughout construction. Permanent erosion and sedimentation control measures can be constructed during or at the end of the construction phase.

Examples of temporary measures include:
- Seeding;
- Slope texturing;
- Synthetic permeable barrier,
- Mulching;
- Hydroseeding;
- Biodegradable coverings;
- Filter fence;
- Fibre rolls and wattles;

Examples of permanent measures include:
- Offtake ditches;
- Energy dissipater;
- Earth dyke
- Gabion;
- Rock check;
- Sediment pond/basin;

Dependent on site conditions, some temporary measures will be retained for a longer duration to render its life span more permanent. With both temporary and permanent measures, the functional longevity of the method to be used will be taken into account prior to implementation.

This is not limited to the duration of the project, but to return to pre-disturbance conditions. The Construction Consultant/Environmental Monitor will consult with construction personnel on the appropriate measures to be taken. The measures outlined in the following tables discuss various erosion and sedimentation control locations of ideal use, advantages and limitations.

Table 1. Methods for Protection of Exposed Surfaces

Method	Slopes	Ditches & Channels	Large Flat Surface Areas	Borrow & Stockpile Areas	Advantages	Limitations
Topsoiling	X	X	X	X	Placing topsoil provides excellent medium for vegetation root structure to develop in; organic content promotes plant growth, reuse organics (topsoil or peat) stripped from the site at start of grading; absorb raindrop energy to minimize erosion potential	Cannot be effective without seeding and allowing time for plant growth; not appropriate for slopes steeper than 2H:1V (steep slopes will require soil covering over topsoil and specialized design); dry topsoil susceptible to wind erosion, susceptible to erosion prior to establishment of vegetation
Seeding	X	X	X	X	Inexpensive and relatively effective erosion control measure, effectiveness increases with time as vegetation develops, aesthetically pleasing, enhances terrestrial and aquatic habitat	Must be applied over prepared surface (topsoiled), grasses may require periodic maintenance (mowing), uncut dry grass may be a fire hazard, seeding for steep slopes may be difficult, seasonal limitations on seeding effectiveness may not coincide with construction schedule, freshly seeded areas are susceptible to runoff erosion until vegetation is established, reseeding may be required for areas of low growth
Mulching	X	X	X	X	Used alone to protect exposed areas for short periods, protects soil from rainsplash erosion, preserves soil moisture and protects germinating seed from temperature extremes, relatively inexpensive measure of promoting plant growth and slope protection	Application of mulch on steep slopes may be difficult, may require additional specialized equipment not commonly used.
Hydroseeding-Hydromulching	X	X	X	X	Economical and effective on large areas, mulch tackifier may be used to provide immediate protection until seed germination and vegetation is established, allows re-vegetation of steep slopes where conventional seeding/mulching techniques are very difficult, relatively efficient operation, also provides dust and wind erosion control	Site must be accessible to Hydroseeding Hydromulching equipment (usually mounted on trucks with a maximum hose range of approximately 150 m), may require subsequent application in areas of low growth as part of maintenance program

Riprap Armoring	X	X			Most applicable as channel lining with geotextile underlay, used for soils where vegetation not easily established, effective for high velocities or concentrations, permits infiltration, dissipates energy of flow from culvert inlets/outlets, easy to install and repair, very durable and virtually maintenance free, flexible lining for ditches with ice build-up	Expensive, may require heavy equipment to transport rock to site and place rock, may not be feasible in areas of the province where appropriate rock is not readily available, may be labour intensive to install (hand installation); generally thickness of riprap is higher when compared to gabion mattress
Gravel Blankets	X	X			Stabilizes soil surface with rock lining thus minimizing erosion, permits construction traffic in adverse weather, may be used as part of permanent base construction of paved areas, easily constructed and implemented, can be used to stabilize seepage piping erosion of slope	Must be designed by qualified geotechnical personnel, expensive, may not be feasible in areas of the province where gravel is not readily available, areas of high groundwater seepage may require placement of non-woven geotextile underlay and additional drainage measures
Biodegradable Erosion Control Products	X	X			Provides a protective covering to bare soil or topsoiled surface where degree of erosion protection is high, can be more uniform and longer lasting than mulch, wide range of commercially available products	Use must be based on design need of site, certification of physical properties and performance criteria (tractive resistance) is required, labour intensive to install, temporary blankets may require removal prior to restarting construction activities, not suitable for rocky slopes, proper site preparation is required to seat onto soil correctly; high performance is tied to successful vegetation growth
Cellular Confinement System	X	X		X	Lightweight cellular system and easily installed, uses locally available soils or grout for fill to reduce costs	Not readily used in construction, expensive, installation is labour intensive (hand installation), not suitable for slopes steeper than 1H:1V
Planting Trees and Shrubs	X		X	X	Establishes vegetative cover and root mat, reduces flow velocities on vegetative surface, traps sediment laden runoff, aesthetically pleasing once established, grows stronger with time as root structure develops, usually has deeper root structure than grass	Expensive, revegetated areas are subject to erosion until plants are established, plants may be damaged by wildlife, watering is usually required until plants are established

Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
Slope Texturing	X			X	Roughens slope surface to reduce erosion potential and sediment yield; suitable for clayey soils	Additional cost; not suitable for silty and sandy soils; not practical for slope length <8 m for dozer operation up/down slope

Table 2. Methods for Runoff Control

Method	Slopes	Ditches & Channels	Large Flat Surface Areas	Borrow & Stockpile Areas	Advantages	Limitations
Slope Texturing	X		X	X	Contouring and roughening (tracking) of slope face reduces runoff velocity and increases infiltration rates; collects sediment; holds water, seed and mulch better than smooth surfaces; promotes development of vegetation, provides loss of soil reduction in soil erosion compared with untracked slopes	May increase grading costs, may cause sloughing in sensitive (wet) soils, tracking may compact soil, provides limited sediment and erosion control and should not be used as primary control measure
Offtake Ditch	X		X	X	Collects and diverts sheet flow or runoff water at the top of a slope to reduce down slope erosion potential, incorporated with permanent project drainage systems	Channel must be sized appropriately to accommodate anticipated flow volumes and velocities, lining may be required, may require design by qualified personnel, must be graded to maintain positive drainage to outlets to minimize ponding
Energy Dissipater	X	X			Rip rap or sandbags slow runoff velocity and dissipate flow energy to non-erosive level in relatively short distances, permits sediment collection from runoff	Small diameter rocks/stones can be dislodged; grouted rip-rap armouring may breakup due to hydrostatic pressures, frost heaves, or settlement; may be expensive, may be labour intensive to install; may require design by qualified personnel for extreme flow volumes and velocities

Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials, synthetic liner required underneath to prevent undercutting
Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	May be expensive, not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)
Synthetic Permeable Barriers		X			Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in grades	Not to be used as check structures, must be installed by hand in conjunction with Biodegradable components, become brittle in winter and are easily damaged by construction. Only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation
Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2:1

Table 3. Methods for Sediment Control

Method	Slopes	Ditches & Channels	Large Flat Surface Areas	Borrow & Stockpile Areas	Advantages	Limitations
Riparian Zone Preservation	X	X	X	X	Preserve a native vegetation buffer to filter and slow runoff before entering sensitive (high risk) areas, most effective natural sediment control measure, slows runoff velocity, filters sediment from runoff, reduces volume of runoff on slopes	Stipulate construction activities with careful planning to include preservation areas, freshly planted vegetation for newly created riparian zones requires substantial periods of time before they are as effective as established vegetation at controlling sediment
Brush or Rock Filter Berm	X	X	X	X	More effective than silt fences, uses timber and materials salvaged from site during clearing and grubbing, can be wrapped and anchored with geotextile fabric envelope	More expensive than silt fences, temporary measure only, not effective for diverting runoff, expensive to remove, not to be used in channels or ditches with high flows
Fibre Rolls and Wattles	X				Function well in freeze-thaw conditions, low cost solution to sheet flow and rill erosion on slopes, low to medium cost flow retarder and silt trap, can be used on slopes too steep for silt fences or straw bale barriers, biodegradable	Labour intensive to install (hand installation), designed for slope surfaces with low flow velocities, designed for short slope lengths with a maximum slope of 2:1
Pumped Silt Control Systems (Silt Bag)		X			Filter bag is lightweight and portable, simple set up and disposal, sediment-laden water is pumped into and contained within filter bag for disposal, different aperture opening sizes (AOS) available from several manufacturers; for emergency use only under overflow conditions	May be expensive, requires special design needs, requires a pump and power source for pump, suitable for only short periods of time and small volumes of sediment laden water, can only remove particles larger than aperture opening size (AOS)
Silt Fence	X		X	X	Economical, most commonly used sediment control measure, filters sediment from runoff and allows water to pond and settle out coarse grained sediment, more effective than straw bale barriers	May fail under high runoff events, applicable for sheet flow erosion only, limited to locations where adequate space is available to pond collected runoff, sediment build up needs to be removed on a regular basis, damage to filter fence may occur during sediment removal, usable life of approximately one year

Earth Dyke/Barrier			X	X	Easy to construct, relatively inexpensive as local soil and material is used; can be easily converted to Sediment Pond/Basin	Geotechnical design required for fill heights in excess of 3 m, may not be suitable for all soil types or sites; riprap spillway and/or permeable outlet may be required
Gabions		X			Relatively maintenance free, permanent drop structure, long lasting (robust), less expensive and thickness than rip-rap, allows smaller diameter rock/stones to be used, relatively flexible, suitable for resisting high flow velocity	Construction may be labour intensive (hand installation), extra costs associated with gabion basket materials, synthetic liner required underneath to prevent undercutting
Rock Check Dam		X		X	Permanent drop structure with some filtering capability, cheaper than gabion and armouring entire channel, easily constructed	Can be expensive in areas of limited rock source, not appropriate for channels draining areas larger than 10 ha (4 acres), requires extensive maintenance after high flow storm events, susceptible to failure if water undermines or outflanks structure
Log Check Dam		X			Equally effective as silt fences for sediment trapping and straw bale barriers as drop structure, may include timber salvaged from site during clearing operations, most applicable at clearing/grubbing stages of construction	May be expensive, not commonly used after stripping stage, not appropriate for channels draining areas larger than 4 ha (10 acres), labour intensive to construct, gaps between logs may allow sediment laden runoff to escape, logs/timbers will rot over time (not permanent)
Synthetic Permeable Barriers		X			Reusable/moveable, reduces flow velocities and dissipate flow energy; retains some sediments; used as grade breaks in grades	Not to be used as check structures, must be installed by hand in conjunction with Biodegradable components, become brittle in winter and are easily damaged by construction. Only partially effective in retaining some sediment, primarily used for reducing flow velocities and energy dissipation

Table 4. Control Methods and Appropriate Construction Activity.

METHOD	Clearing & Grubbing	Stripping	Borrow Sources	Sub Excavation	Stockpiles	Cut Slope	Fill Slope	Ditches / Channels	Culverts	Temporary Haul Roads
Silt Fence	X	X	X		X	X	X		X*	X
Gabions								X	X	
Brush or Rock Filter Berm	X	X	X		X	X	X			
Continuous Berm	X	X	X		X	X	X			X
Earth Dyke Barrier	X	X	X		X	X	X			X
Inlet Protection								X	X	
Rock Check Structure								X		
Log Check Structure								X		
Synthetic Permeable Barrier								X		
Straw Bale Check								X		
Straw Bale Barrier			X		X	X	X			X
Biodegradable Erosion Products					X	X	X	X		
Rip Rap Armouring								X	X	
Cellular Confinement System						X	X	X		
Gravel Blankets						X	X	X		
Energy Dissipaters								X	X	
Sediment Ponds and Basins		X						X		
Slope Drains						X	X			
Offtake Ditches		X	X	X		X	X			
Seeding			X		X	X	X	X		
Mulching			X		X	X	X	X		
Hydroseeding			X		X	X	X	X		
Topsoiling			X		X	X	X	X		
Planting Trees and Shrubs						X	X	X		
Fibre Rolls			X		X	X	X			
Riparian Zone Preservation	X	X	X	X	X	X	X	X		X
Pumped Silt Control Systems								X	X	
Slope Texturing			X	X	X	X	X			X

Notes:
* Suitable for spilling basin at culvert inlet

Personnel associated with this project will adhere to the following generic guidelines:

- Maintain existing vegetation cover whenever possible and minimize the area of disturbance by minimizing travel. Maintaining existing vegetation cover is the best and most cost-effective erosion control practice;
- Retain and protect vegetation layer to reduce erosion potential;
- All vehicular traffic must stay within designated accesses. All suspected off RoW travel must be reported immediately to the Environmental Monitor/Construction Consultant;
- Install all erosion and sediment control practices prior to any soil disturbing activities, when applicable;
- Avoid frequent or unnecessary travel over erosion prone areas;
- Install silt fence on the down-slope perimeter of all steep (3:1 or greater slope) disturbed areas according to the attached installation instructions;
- Add mulch, straw crimping or silage along with native vegetation seed to all disturbed areas as required;
- Upon final abandonment, areas that have erosion potential may be straw crimped and or matted and seeded to return the area to pre-disturbance conditions in a timely fashion.

Inspection & Maintenance

Continued inspection and maintenance of erosion and sedimentation control measures may be required after completion of construction. Regular inspections should be conducted on a weekly basis or as required with respect to storm events and snow melt.

The contractor will be responsible for maintenance of the erosion control works installed under this EPP during construction. During operations, Shear Wind will be responsible for maintenance.

Inspection and maintenance will continue until the erosion control is no longer required. The following circumstances and conditions will determine this outcome:

a. Revegetation of bare soil was successful;
b. No obvious erosion scour is observed;
c. No obvious bedload of silt and sediment laden runoff is observed;
d. Inspection and maintenance report indicates satisfactory performance;

All maintenance preformed on erosion and sediment control measures will be recorded.

4.5 Vegetation Management Program

Shear Wind recognizes that each operational region is unique and that weed management that is effective in one area, may not be effective in another. However, Shear Wind's policy to control vegetation will be based upon the species identified during discussions with landowners, regulators and field assessments.

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Shear Wind will take the following approach to vegetation management:

- Prevention
- Chain of Custody
- Procedures for Vegetation Control
- Monitoring
- Identification

4.5.1 Prevention

- Prevention is paramount to an effective weed management program;
- Shear Wind will attempt to minimize the potential for weed introduction/invasion by seeding all disturbed areas with landowner approved seed mixes.

4.5.2 Seeding

- Use a certified native seed mix. Purchase only certified seed from a recognized member of the Canadian Seed Growers Association (CSGA). Obtain a certificate of analysis that identifies weeds found in samples of analyzed by a seed lab;
- Broadcast versus seed drills shall be utilized. If the area has minimal disturbance then broadcast the seed but use a packing wheel attachment or covered chains dragged over the seed to enhance contact with the soil;

4.5.3 Operational Considerations

- Avoid driving vehicles across infestations. Fence off areas of infestation if necessary;
- Ensure imported materials (gravel, clay) are free of vegetative matter and soil. Avoid importing straw because it is very difficult to assess for weeds;
- Ensure equipment used during treatment programs is clean and free of any weed debris before entering the area that has been treated.

4.5.4 Chain of Custody

Successful implementation of the weed management program is dependent on awareness and participation by all parties active in the pasture and immediate surrounding area. It requires commitment from management, planning, communication, training, reporting and follow-up.

Shear Wind's Vegetation Management Policy guidelines will include:

- If landowners manage or implement a vegetation control program on surrounding lands, during the planning process Shear Wind will solicit their participation in a cooperative weed management program;

- Only licensed applicators licensed in the jurisdiction in which the lands are located may enter upon and treat vegetation on a Shear Wind site;
- The Senior/Lead Operator, in consultation with the Environmental Co-coordinator and licensed contractor, shall specify the herbicide (mixture) to be used on the access roads, turbine leases, transmission RoWs, or other facilities;
- The Senior/Lead Operator shall insure that the contractor complies with all Workplace Hazardous Material Information System requirements, and that the contractor has a spill response plan and appropriate spill response equipment in place;
- The Senior/Lead Operator shall review site-specific environmental sensitivities with the contractor as part of the required project Pre-Job Meeting;
- Shear Wind employees will fulfill the day-to-day components of the weed management program.

4.5.5 Procedures for Vegetation Control

Shear Wind will use information collected in prior seasons to evaluate the infestation of noxious and invasive species over time and prepare a weed treatment plan for operations in the upcoming year.

As no one method of vegetation control may be effective, the following procedures will be implemented in a synergistic manner for all Shear Wind operations on project lands:

- The most effective and least costly method of weed control is to prevent their establishment;
- Integrated weed management may combine chemical, mechanical and natural controls with each measure implemented as needed. Treatments should not be employed on a scheduled basis but used in response to a situation identified during past monitoring;
- After a site has been cleared, prepared and seeded, regular monitoring and weed pulling is necessary in order to keep the site from being overrun by undesirable plant species. This prevents extensive root systems from forming. Once established, these root systems become extremely difficult and costly to remove completely;
- Preventative control must be incorporated for all operations. Construction machinery used in decommissioning is to be washed before entering work areas. This is to help prevent spread of nuisance, restricted or noxious weeds;
- Monitoring of the areas over a 2-5 year period (if location undergoing reclamation) or during the lifetime of a facility, is required to alleviate problems as they occur or until weeds are controlled and vegetation is established as appropriate. As monitoring occurs, disturbed areas will also be checked for new occurrences of weeds, and appropriate control methods will be applied to any outbreaks;

4.5.5.1 MOWING

- Shear Wind may rely on mowing as an effective form of weed control in the area;
- Repeated mowing controls perennial weeds by depleting root reserves. It will also prevent seed production of annual and biennial weeds;
- If only one mowing is planned, it should be completed during the budding stage of perennial weeds;
- Mowing must be completed early in the season, before vegetation sets seeds and multiple mowing treatments may be utilized;
- Mower selection will also be considered. Rotary mowers with one or more horizontal blades will cut plants at the highest setting above ground level to reduce potential impacts to nesting species. Lightweight mowers may be used to cut herbaceous weeds;
- Mowing will be completed during the construction phase and may be ongoing through operations as part of the Weed Management Program;
- To prevent conflicts with nesting birds, the *Migratory Birds Act* and *Species at Risk Act,* and still maintain effective weed control, mowing will not be completed during the critical breeding season and will be completed after July 15 unless vegetation characteristics dictate mowing within the time frame. Where weed control requires earlier intervention, field surveys will be done to identify active nests or other conflicts so that these may be avoided during the mowing operations;
- Direct impacts to vegetation will be limited to within the surveyed boundaries of the access and lease boundaries. Mowers will travel off trails while mowing but otherwise will utilize existing access roads, minimizing additional soil disturbance.

4.5.5.2 HAND PULLING

- Hand pulling may be effective for small patches of perennial weeds however it is most effective for annual and biennial weeds. Pulling of annual weeds prevents seed production. If weeds are in flower, bag and dispose of them at an approved garbage facility to prevent seed spread;
- Hand pulling is most effective when you are trying to prevent the establishment of new species;
- Pulling and digging individual plants may be used to eradicate very small-scale infestations;

4.5.5.3 CHEMICAL CONTROLS

- Herbicide application that results in soil sterilization is strictly prohibited;
- Always notify adjacent landowners/occupants prior to the application of herbicides;

- If required permits will be obtained from regulatory bodies for the application of herbicides within 30 metres of an open water body. Pesticides must not be stored, mixed or equipment cleaned within 30 metres of an open body of water;
- Herbicide drift is a concern for ground application. Contractors are responsible for ensuring that any herbicide applications conducted are done so in a safe and responsible manner. The choice of chemical should be made with adjacent land uses in mind;
- Herbicides should not be sprayed when winds are excessive (winds over 16 km/hr are considered a drift hazard). Applications should occur only when winds are blowing away from water bodies, sensitive sites, or areas of concern (as identified by regulators and/or landowners). Conditions of temperature inversions should also be avoided;
- Presently, chemical control on leases is accomplished through low-volume application of approved herbicides directed specifically toward weed species. The herbicide application is performed primarily with backpack sprayers, although some applications have been completed with hand-held nozzles attached to hydraulic truck-mounted sprayers via a rubber hose. Regardless of the specific spray equipment, reasonable efforts must be made to minimize impacts to desirable low-growing shrub and herbaceous species present. Low-volume applications entail lightly wetting of the foliage of undesirable woody species. The herbicide is then transferred throughout the plant, including into the roots, resulting in the death of the plant. Since foliar herbicide application requires leaves on the target plant, this method of herbicide treatment is performed only during the summer months when the vegetation is actively growing. There is very little impact to adjacent vegetation or the environment due to the limited amount of herbicide applied, the selected application to only undesirable weeds, and the careful selection of the herbicide mixture;
- During rainfall, herbicides are moved from land into waterbodies by runoff. The occurrence of herbicides in the waterbodies depends on the intensity and timing of the rainfall and location and timing of herbicide applications. Herbicide application requires extra care and caution to ensure water quality, and aquatic and riparian habitats will not be affected by the application. Natural vegetation should be left along natural water bodies to ensure bank stability and to provide a natural buffer and filter for chemicals;

4.5.6 Monitoring

Monitoring of locations is required to alleviate problems as they occur or until weeds are controlled and vegetation established as appropriate;

4.5.7 Protection of Flora & Fauna SARA Species during Vegetation Management

- In order to comply with the SARA and MBCA, as a requirement of the regulatory approval process, Shear Wind has already conducted flora and fauna assessments on the affected lands;
- The data collected during those assessments will be used to identify known, probable, or other habitat types, species at risk locations, and the likelihood of species at risk

occurring within a specific area (i.e. LSD, section, etc…). The information collected in the preliminary stages will be used to create effective vegetation management strategies that avoid or protect species at risk, and ultimately comply with SARA and MBCA;

- For example, vegetation requiring control may require mowing but occur within a setback distance identified in assessments. In that instance, hand spraying or tillage, or weed pulling may be an appropriate response;
- As with any effective management strategy, Shear Wind's vegetation management strategy will be dynamic and require thoughtful execution.

4.6 Culvert Maintenance

All maintenance will be carried out in accordance with the *Nova Scotia Watercourse Alteration Specifications (2006)* or updated versions thereof.

4.6.1 Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs;

4.6.2 Limit the removal of accumulated material (i.e., branches, stumps, other woody materials, garbage, etc) to the area within the culvert, immediately upstream of the culvert and to that which is necessary to maintain culvert function;

4.6.3 Remove accumulated material and debris slowly to allow clean water to pass, to prevent downstream flooding and reduce the amount of sediment-laden water going downstream.

5.0 SITE RESTORATION PLAN (SRP)

The objective of the SRP is to remove all garbage from site, control erosion as may be necessary, restore soil capability, and reclaim the project areas and associated disturbed portions to a land capability which is equivalent to pre-disturbance characteristics.

Reclamation will take place once construction equipment has left the location or as soon as soil and weather conditions permit. The landowners will be notified prior to the initiation of the reclamation activities and again upon completion. Reclamation success is dependent good landowner communication and upon favourable conditions in the root zone for optimum crop growth. The key soil factors that determine root zone quality include the water holding capacity, organic content, structure and consistence, salinity, nutrient balance and soil regime.

5.1 Interim Reclamation

Shear Wind Inc. shall attempt to reclaim all disturbed land surfaces within 2 growing seasons. Interim reclamation, including site and debris clean-up, slope stabilization and re-contouring with subsoil, and spreading of topsoil shall be done progressively and concurrently with operations.

Reclamation of the sites during production requires re-contouring the non-use portion of each surveyed lease.

The subsoil will be used to re-contour each site to allow natural drainage patterns to exist without creating slopes that have the potential for erosion.

Any unexpected disturbances that occur outside the immediate working area of the sites will be reclaimed to pre-development conditions immediately.

5.2 Final Project Reclamation

Timeline

Decommissioning	Activity	Timeline	Off Site Land Use Requirements
Turbines	Removal of tower and turbine infrastructure	May – July	Use provincial, municipal or private roads for access to water or soils; May require temporary work space for equipment storage prior to removal from project lands; Use of water from local sources for reclamation purposes; Reclamation of borrow
	Removal of transformers	May – July	
	Partial excavation and removal of cement base to depth >1.5 meters	June – July	
	Removal of gravel pads and gravel from access	July – August	
	Recontouring of pad and access roads	July – August	
	Reclamation of surface soils	August – September	
	Re-seeding	September -	

		October	pits at pre-approved locations; Use of landfill or recycling activities for equipment/waste disposal.
Power Lines/ Transformer Station	Removal of above ground poles and lines	May – July	
	Removal of transformer station and associated infrastructure	May – July	
	Removal of gravel pads	June – July	
	Removal of interconnection lines and infrastructure	July – August	
	Removal of access roads	July – August	
	Recontouring of pad and access roads	August – September	
	Reclamation of surface soils	September - October	

Soils

- Upon cancellation and abandonment of the locations, all disturbed areas are to be re-contoured to pre-construction conditions. Loading of slopes with unconsolidated material will be avoided during slope re-contouring;
- All grades and drainages will be restored by removing any culverts and fills;
- Topsoil replacement should not be done until all subsoil leveling and cleanup has been completed, to prevent mixing by leveling after topsoil replacement;
- Surface diversion berms will be installed, as required. Run-off will be diverted to stable and vegetated off-right-of-way areas;
- In areas that have compaction problems, rip compacted subsoils, with a multi-shank ripper to an approximate depth of thirty (30) centimetres. Postpone ripping until subsoils dry out so that they fracture when ripped. Disc ripped subsoils to smooth the surface. Limit discing to that necessary to break up clods so as to minimize the potential for further compaction. Topsoil compaction on cultivated fields will be alleviated by cultivation;
- Remove all foreign materials including geotextile;
- Bridges, fences and culverts are to be restored to meet or exceed pre-construction conditions;
- Rocks/stones exposed on the surface as a result of construction activity will be removed from the right-of-way prior to and after topsoil/surface material replacement. The concentration of surface and profile rocks will be equivalent to, or better than the surrounding fields. Rocks/stones will be disposed of at a site approved by the landowners;
- Any areas with rutting or erosion gullies will be re-contoured and all strippings will be replaced evenly over all portions of disturbed areas. Replacement of soils during wet

weather or high winds will be avoided. This will prevent damage to soil structure and reduce the potential for erosion of topsoil;

- Once sub-soil has been adequately reclaimed, topsoil will be replaced. Replaced topsoil will be disced to alleviate compaction and break up aggregates then harrowed to create an adequate seed bed;
- Erosion control in the form of matting, hale bales and/or cross ditching may be necessary on slopes;
- Complete re-contouring and stabilization of disturbed areas. Smooth water channeling ruts and outside berms. Ensure that all erosion control and water management measures (e.g. water bars, drainage dips, culverts and ditches) are working;
- If grading or other earthwork is required to facilitate vehicle/equipment on areas, strip and salvage topsoil and organic material for replacement during clean-up procedures;
- Complete scarification of the disturbed areas with disc or multi-shank ripper;
- Replace soil material and surface strippings from the down slope locations;
- Where soils have been disturbed, implement appropriate reclamation procedures (i.e. seeding, erosion blankets, slash rollback, straw crimping, etc.) to promote stability of the site, soil preservation, and plant re-establishment. Ensure the natural drainage is restored;

Vegetation

- Once topsoil has been re-distributed, disturbed areas will be re-seeded, as soon as weather permits, with an approved Canada #1 Certified Seed mixture from a local source. The Certificates of Analysis will be retained for documentation. Seed mixture design will be based upon observations of vegetation species in surrounding areas, discussions and recommendations put forth by the landowners and regulators, and availability of seed mixtures;
- Cover crops may be planted in areas requiring seeding of natives. If native vegetation seeding is to occur in the fall, plant the cover crop in the spring of the same year;
- Additionally, disturbed areas will likely require perennial species for long-term protection. The seed mix approved by the regulators and/or landowners/occupants will be used on all disturbed soils. The contract inspectors will mark these areas needing seeding on survey maps, so that crews can easily locate the areas and apply the seed as soon after disturbance as possible. In areas away from water, and where natural seed sources are available, contractors may depend on natural seeding.
- Seeding rates and methods will be based upon characteristics of the area, weather conditions, erosion potential of slopes, and landowner recommendations;
- Fertilizer may be needed in some cases but will not be applied unless approved by regulators and/or landowners;
- Locations should be monitored monthly during growing seasons. Typical monitoring should occur in June, July, and August or until a Memorandum of Surrender has been obtained. Monitoring will consist of visually inspecting the areas to ensure vegetation

has been established and is healthy, erosion has been mitigated, and landowner concerns have been adequately mitigated;

- Restore gates and fences;

6.0 Monitoring Program for Surface Water Impacts

6.1.1 Shear Wind's Commitments

As part of its environmental program, Shear Wind Inc. has made the following commitments regarding monitoring the project for surface water impacts during construction; operations; and maintenance:

- Shear Wind Inc. will conduct visual inspections, both quarterly, and after severe storm events, on the site to ensure the effectiveness of erosion and sedimentation controls;
- If issues are noted during these assessments, Shear Wind Inc. will take the necessary steps to ensure erosion and sedimentation controls are repaired, replaced, upgraded, or installed as necessary;
- Shear Wind Inc. will provide summaries of the monitoring program to NSE on a quarterly basis, and reports will be submitted to NSE within 30 days from the last day of the preceeding quarter;
- If an immediate or large scale impact is noted following a severe storm event, updates may be provided to NSE at that time;

7.0 Spill Response

Shear Wind Inc. recognizes its responsibility for its operations and the effects that these operations have on employees, landowners, the public and the environment. Although facilities and operating procedures are designed to prevent upsets that could result in a spill, spills may occur.

To a large extent, effective spill response is dependent on the amount of planning that is undertaken before a spill occurs. Sound planning will help reduce the number of spills, improve the success of response activities, reduce environmental impact, decrease conflict with regulatory agencies and the public, and lower spill response costs. Spill planning is a continuous process that requires commitment, cooperation and input. Components of planning include:

- Company policy and spill strategy;
- Spill prevention;
- Contingency plans;
- Equipment readiness (know local contractors);

Shear Wind Inc. will take immediate action to control a spill including:

- Shut in the source of the spill and start documentation;
- Assess the spill;
- Initiate containment and recovery;
- Protect the public and worker safety;
- Supervise the spill clean-up;
- Prepare status reports;
- Remediate and reclaim the affected area; and
- Conduct a de-briefing session to help prevent a similar incident.

Shear Wind Inc.'s policy in regard to spill planning and control operations involves:

- Authority to initiate emergency actions;
- Reporting structures for notification and approvals;
- Authority for expenditures related to spill activities;
- Authority to activate additional resources as needed;
- Authority to respond to unidentified spills.

If a spill occurs, a single authority will immediately assume overall responsibility for coordination of response actions. For small spills one individual can oversee the entire operation, especially if that individual can obtain advice and support from internal resources, spill specials, regulatory staff and others.

7.1.1 Containment and Recovery

Once a spill has occurred, it is important for Shear Wind to initiate a well-organized response that includes shutting in the source, initiating containment and recovery, clean-up and reclamation. As no two spills are alike, it is impossible to provide a rigid set of instructions. Trained personnel must adapt to the unique circumstances of the spill and use available resources. If one technique fails, a new approach or improvisation of existing methods must be attempted. In general, spill response should be approached as follows:

- **Spill notification** - is the starting point for initial response. Documentation starts at this stage and must be continued until the site is reclaimed. Activate the spill contingency plan, mobilize resources, confirm spill and shut-in the spill source;
- **Assessment of incident factors** - includes the identification of hazards associated with the incident (hazard assessment), the site assessment and security of the impact.
- **Set objectives** – following the site assessment, the response team should develop an action plan that includes clear and concise objectives.

The priorities are to protect human life, property and the environment. An action plan that outlines objectives will likely be developed by company personnel with input from regulatory agencies**;**

- **Incident control** – includes containment, recovery and spill management with a focus on communication. Control is accomplished by having a defined incident commander with authority and availability to resources;
- **Evaluation** – the spill response must be evaluated on a continuous basis and changes made to the action plan if necessary. The entire response team must be briefed when changes occur.

7.1.2 Containment and Recovery Techniques

- **Dikes, bellholes, trenches** – the most common method of containing a land spill is to use a combination of dikes, bellholes and trenches around the spill perimeter, with feeder trenches inside the spill itself to move fluids towards a recovery area. Feeder trenches can be constructed by hand or mechanical excavation only when the area has been deemed safe and continuous monitoring is undertaken.
- **Inverted weirs** – this technique is used when it is necessary to allow the natural movement of water to leave the spill site. An inverted weir consists of an earthen berm supported with sand bags or a plastic liner and the appropriate-sized culverts on an angle to contain oil inside the spill perimeter.
- **Filter fences** – can be constructed with pins and chicken wire or snow fence and bales (straw or hay). Filter fences can be effective to contain spills without severely affecting the natural movement of water.
- **Sorbent** – It may be appropriate to use a combination of natural sorbents (like straw or hay) with commercial synthetic sorbents. The overuse of sorbents can create a disposal problem and generate unnecessary waste.
- **Ice-slots** – in general, oil spilled under solid ice will flow with the current, with significant portions becoming trapped in pockets under the ice. The containment and recovery technique involves creating an opening in the ice (ice-slot) downstream of the spill and then recovering accumulations or removing ice from the opening, back to the source point of the spill. In using this technique it is important to follow the following steps:
    - Assess the weight-bearing capacity of the ice, water depths and current patterns;
    - Locate the ice-slot such that it is at an angle to the current (30 degree maximum) with a slight "J" into the main current to promote the movement of oil towards the recovery area;

- Construct the ice-slot using backhoes, chain-saws or ice-augers providing the ice weight-bearing capacity is adequate and there are no flammable vapours under the ice. The ice slot should be approximately .75m or 2ft wide;
- Place a skimmer or vacuum unit in the ice-slot;
- Recover accumulations or pockets of oil and contaminated ice. Consider in-situ burning as an alternative;
- If there are natural openings in the ice it may be possible to use booms and skimmers. Caution should be taken when working in these natural conditions with respect to weight-bearing capacity.

7.1.3 Spill Waste Disposal

- Waste materials that are generated from a spill should be minimized and managed so that there are no long-term problems with disposal. The following are some of the common waste materials associated with spills and some options for disposal:

- **Contaminated fresh water** – removal and hauling by vacuum truck to an approved disposal facility;

- **Contaminated soil** – excavation by machinery or hand, loading, hauling, and disposal at an approved disposal facility

- **Vegetation/sorbents** – incineration, approved landfill;

- **Garbage** – incineration, approved landfill;

- **Construction materials** – clean and reuse, approved landfill, incineration;

- **Contaminated ice and snow** – store in secure containment until ice melts and recover spilled product for disposal.

8.0 Training/Contingency Planning/HSE

Shear Wind Inc. has a Corporate Health Safety & Environment Program which will be followed during construction, operations, and maintenance. The HSE Program outlines procedures for training, reporting and contingency planning and is summarized below:

8.1 ORIENTATION FOR NEW EMPLOYEES

Each new employee and contractor will have an orientation familiarizing him/her with ***Shear Wind Inc.*** Safety Policy, Probationary Period, Terms of Employment-plus work instructions and process sheets pertinent to the job. Every reasonable attempt will be made to ensure these are understood before contractors and employee signs acceptance and begins work.

<u>PROJECT SITE SPECIFIC ORIENTATION: Contractors & Employees</u> (Conducted by Site Manager or Supervisor)
<u>Items Covered:</u>

Shear Wind Inc. Safety Policy and Expectations
Contractors (manager, supervisor and employee) responsibility
Hazard identification specific to the project and site
Environmental protection requirements
Personal Protective Equipment (PPE) as required
Equipment, machinery safety
Training and training documentation required
Tailgate meetings conducted and documented
Near-Miss, Incident, Accident reporting and documentation
Emergency plan and procedures
List of all hazardous chemicals to be brought on site (MSDS)
Safe work procedures required

<u>TRAINING: Contractors & Employees</u>

Job, equipment specific training (is each employee trained, competent to do the job – is that training documented)
Safe work procedures are in place and employees trained on the procedures
First Aid training as required
Training for employees on Rights and Responsibilities (OH&S Act.)
WHMIS Training (chemical identification, safe handling procedures, MSDS knowledge and location)
Transportation of Dangerous Goods (TDG)

<u>TRAINING SCHEDULE</u>

Job specific training updated as required
WHMIS training (review yearly)
First Aid (up-dated as required)
TDG (every 3 years)

8.2 SAFE WORK PROCEDURES

Job specific, safe work procedures prepared and employees trained
All employees are encouraged to recognize, identify, and suggest improvements to the safety work procedures.

8.3 HAZARD IDENTIFICATION

<u>JOH&S Representative or JOH&S Committee:</u>

The JOH&S Representative or the individual members of the JOH&S Committee, will conduct informal audits on a daily basis.

The JOH&SC will conduct a formal audit / inspection once a month prior to the regular meeting.

Employees:

Each and every employee, contractor and contract employees are expected to conduct an informal audit / inspection of their work area to identify hazards daily before starting work. (How can I get hurt here today and how can I prevent that from happening)

PROCEDURE FOR CONTROLLING IDENTIFIED HAZARDS

Eliminate:

Where possible the hazard will be eliminated.

Guard and/or control:

Where elimination is not possible the identified hazard will be guarded and/or controlled using recognized engineering methods and/or safe work procedures.

Personal Protective Equipment (PPE):

Where the identified hazard cannot be eliminated or controlled with engineering methods Personal Protective Equipment will be required.

TRACKING & MONITORING THE RESULTS:

Worker's Compensation figures will be monitored to track the results of our safety program.

Hazard / Near - miss / Incident / Accident and Solution reports will be tracked and monitored.

NOTE: ***This OH&S Program has been developed in co-operation with the Occupational Health and Safety Representative.***

Appendix I: Inquiry & Complaint Reporting Procedures

Shear Wind Inc.

Inquiry & Complaint Reporting Procedures

Shear Wind Inc. has developed a procedure for receiving, recording, investigating, resolving and reporting public inquiry or non-compliance events which may occur from time to time on the Glen Dhu Wind Power Project. One of the key outcomes of the process is to ensure there are steps taken so that Shear Wind can learn from our experiences and maintain diligence in its ongoing operations.

Shear Wind Inc. is implementing a Contact Management Program to:

- Record enquiries, comments and complaints;
- Develop, manage and record responses to enquiries, comments and complaints;
- Support data collection and reporting requirements;
- Support communication, liaison and notification activities;
- Record communication, consultation and liaison activities;
- Assist the project team in managing issues;

Shear Wind Inc. will handle all comments and complaints concerning the Glen Dhu Wind Power Project in a timely and prudent fashion.

Procedures

Shear Wind Inc. will manage the contact management data with responsibility to:

- Track and report out on enquiries and follow-up actions required; and
- Coordinate responses to enquiries.

Public Complaints

Complaints will be considered either reportable or non-reportable as follows:

- **Reportable** – An expression of concern or inquiry related to a specific topic or event that is related specifically to Shear Wind Inc.'s operations and requires Shear Wind to take corrective action;
- **Non-Reportable** – An expression of concern or inquiry related to general industry-related activities, and includes non-project specific issues and concerns. These complaints typically will not require action by Shear Wind Inc. Responses to Non-Reportable public complaints will be as described in Sections 1, 3, 4, 11, and 12 below.

Recording

1. Public or regulatory concerns and enquiries will be recorded by the person(s) receiving the complaint. Any person witnessing, or involved in, an event shall report it verbally to their supervisor and on an Inquiry/Complaint form.

2. If required by regulations or the terms and conditions of approval the appropriate/designated person(s) shall immediately report the event to appropriate regulatory authorities.

Management

3. Recorded information will be provided to the Shear Wind Inc. Chief Operating Officer (COO), or person(s) delegated by the COO to receive such information;
4. The recorded information will be entered into Shear Wind Inc.'s internal Contact Management Database within 96 hours of occurrence outlining the circumstances as known at that time and indicating what further investigations may be required. Responses will be as indicated below.

Resolution

5. Shear Wind Inc. will designate person(s) for ensuring that a Reportable Public Complaint is addressed, as outlined in this document. Shear Wind Inc. will acknowledge receipt of Reportable Public Complaints within 5 business days of receiving the complaint back to the complainant or inquirer.
6. Toward resolution, Shear Wind Inc. will evaluate the root causes of the complaint, investigate the issue(s) and report the findings back to Shear Wind Inc. management.
7. If resolution of the complaint can be handled in the 5 business day time frame (indicated in Step 5) Shear Wind will include information related to the response with the acknowledgement of receipt.
8. Shear Wind Inc. will make suitable efforts to resolve complaints and inquiries through thoughtful and timely responses or negotiations with complainants or inquirers.
9. In such a case that Shear Wind Inc. commits to implementing a solution, Shear Wind Inc. shall inform the complainant of the expected time frame for implementation.
10. An issue is "resolved" where Shear Wind Inc. has considered complaints and inquiries in good faith and has formulated and implemented, or committed to implementing, the appropriate solutions in a time frame acceptable to both parties.

Communicating Responses

11. Responses will be coordinated and provided by Shear Wind Inc. in a manner appropriate to the type of inquiry, and may include:
    - Meetings in person
    - Telephone calls
    - Emails
    - Letters

Record Keeping

12. Documentation to support recording, management, resolution and communication response standards shall be filed in accordance with the Shear Wind Inc. Corporate Records Management Program.

13. Shear Wind Inc. will use its Contact Management Database to record Reportable Public Complaints [and Regulator Inquiries], acknowledgements of receipt, and responses to any such complaints. The database will ensure accurate records maintained and will be used to develop required reports.

Self Auditing

14. Within 90 days of a Reportable Public Complaint being entered into the Contact Management Database, Shear Wind Inc. shall review the file to verify that the resolution has been achieved.
15. Unless a file in the Contact Management Database is referred to mediation or becomes the subject of a judicial proceeding or an arbitration, any outstanding actions under this process shall be audited every 90 days until the file is resolved.

Mediation

16. If the Self Auditing demonstrates that a Reportable Public Complaint has not been resolved through the resolution process herein, and subject to Sections 17 and 18, below, Shear Wind Inc. will engage a mediator who will be responsible for attempting to facilitate an agreement of resolution between Shear Wind Inc. and a complainant. Shear Wind Inc. will therefore send a notice of mediation to the complainant within 5 business days of having completed the Self Auditing.
17. Engagement of the mediator under Section 16, above, is conditional on the complainant providing agreement in writing to participate in mediation upon receiving notice of mediation from Shear Wind Inc.
18. Mediation is not required where, after the first 90-day audit period, the issue has been resolved.
19. The “Mediation Period” is the later of 30 days from the issuance of the notice of mediation or a date to be agreed on in writing by Shear Wind and the complainant in question.

Alternative Dispute Resolution

20. In lieu of mediation or if no agreement is reached through mediation within the Mediation Period, Shear Wind Inc. will consider other appropriate forms of alternative dispute resolution. Alternative dispute resolution may include, but is not limited to, arbitration.
21. Where Shear Wind Inc. identifies arbitration as an appropriate dispute resolution mechanism, it shall follow the applicable procedural rules set out in the

Arbitration Act, R.S.N.S., c. 19, s. 1, if the complainant agrees to the following terms:

a) All arbitration costs due in advance of a decision from an arbitrator or umpire shall be paid by each party submitting to arbitration in equal parts;

b) Where payment of arbitration costs are specified, billed or estimated prior to the decision from an arbitrator or umpire, but are not due until after a decision is rendered, the complainant's portion shall be submitted and held in trust to the benefit of Shear Wind Inc. for the duration of arbitration; and

c) If non-binding arbitration is identified as the appropriate alternative dispute resolution mechanism, and unless otherwise agreed to and specified by Shear Wind Inc. and the complainant, only the provisions relating to timelines and selection, removal and misconduct of arbitrators, umpires and referees shall apply. To be clear, unless otherwise agreed to and specified by Shear Wind Inc. and the complainant, the decision or award made by an arbitrator or umpire shall not be final and binding on the parties and agreement to non-binding arbitration does not constitute "submission" under the *Arbitration Act*, R.S.N.S., c. 19, s. 1.

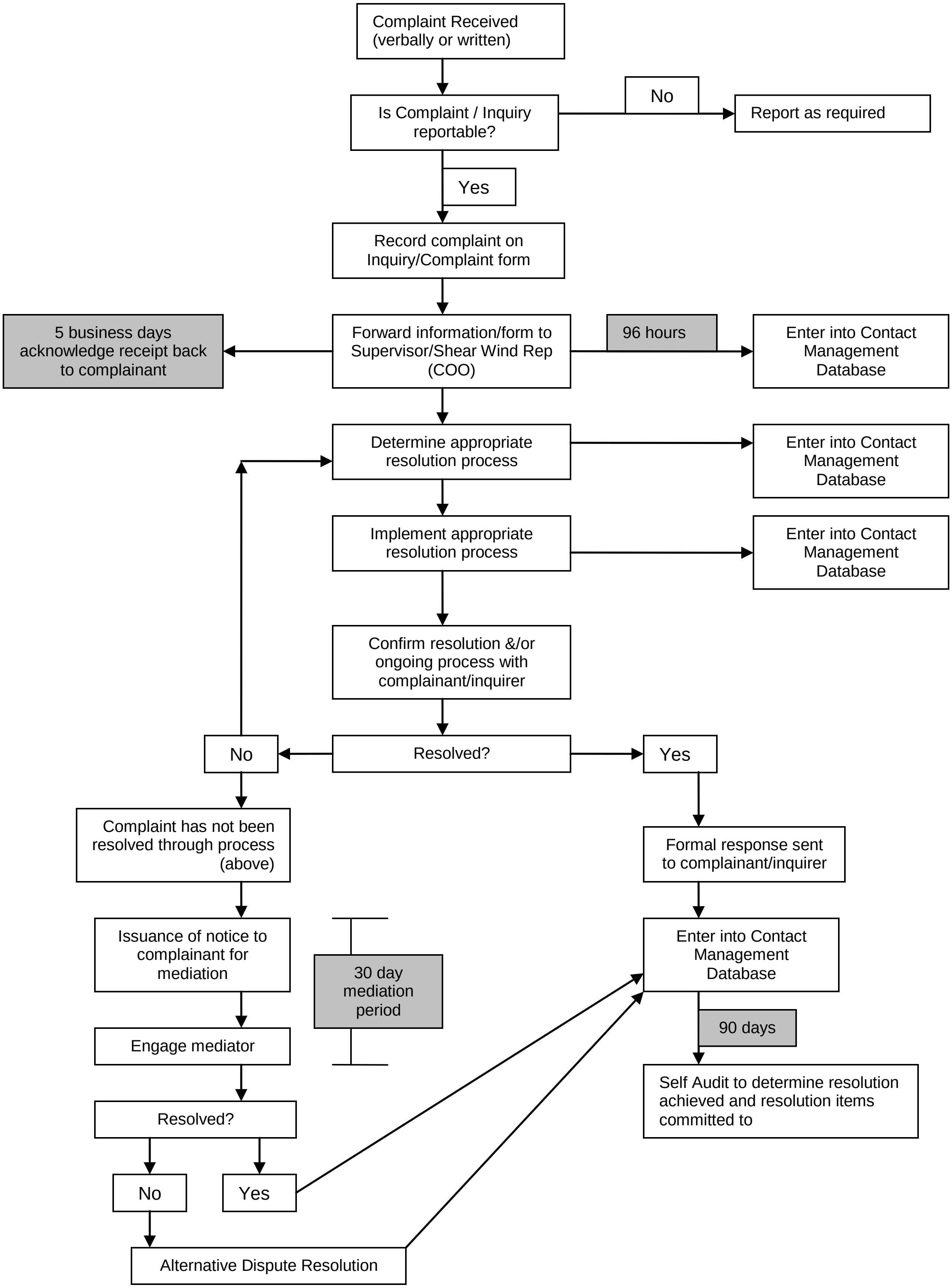
Contact Information Provided to the Public

The Shear Wind Inc. corporate website will provide advice on how to contact Shear Wind Inc. to register concerns and complaints.

Flow Chart

See following page.

Shear Wind Inc.



Shear Wind Inc.

APPENDIX I INQUIRY / COMPLAINT FORM

INQUIRY / COMPLAINT FORM	
Date of Inquiry:	Time:
Name of Person Taking Inquiry:	Title:

Name of Person(s) Making Inquiry/Complaint:
Mailing Address:
Phone Number of Person(s) making Inquiry:
Other Number (specify):
Email Address:

Inquiry or Complaint Details:

Inform the person that Shear Wind Inc. will respond within 5 business days.

CHAIN OF CUSTODY:

1. Person Taking Complaint: ______________________________ Signature

2. Person Accepting Complaint form from #1.

Name **Signature** **Date**

3. Person Responsible for Resolution

Name **Signature** **Date**

Appendix II: Spill Report Form

Shear Wind Inc.

Spill Report Form

AREA ______________________ LOCATION ______________________

LANDOWNER ______________________ PHONE # ______________________

OCCUPANT ______________________ PHONE # ______________________

INCIDENT DATE ______________________ SPILL TYPE ______________________

SOURCE OF SPILL ______________________ REASON FOR SPILL ______________________

SPILL VOLUME (m^3) ______________________ VOLUME RECOVERED (m^3) ______________________

ON-LEASE AREA AFFECTED (m^2) ______________________

OFF-LEASE AREA AFFECTED (m^2) ______________________

METHOD OF RECOVERY ______________________

DISPOSAL LOCATION ______________________

SPILL REPORT SUBMITTED TO REGULATORY AGENCY: ❑ YES ❑ NO DATE: ______________________

SPILL LOCATION AND DETAILS:

Appendix II. PRIORITY LIST OF SPECIES FOR FIELD ASSESSMENTS

Priority List of Species for Field Assessment 2011 (birds and vegetation not included)

VERTEBRATES	HABITAT
Mainland Moose	several small distinct populations between Antigonish and Shelburne County.
Little Brown Bat	The little brown bat can be found in most of the United States and Canada except for the south central and south eastern United States and northern Alaska and Canada. The little brown bat lives along streams and lakes. It forms nursery colonies in buildings. In the winter it hibernates in caves and mines.
Alewife	The alewife is found in rivers and lakes along the eastern coast of North America, from Newfoundland to North Carolina, and the adults live in coastal marine waters 56 to 110 m (180 to 350 ft) deep. Landlocked populations exist in several Ontario and New York lakes. Since the Welland Canal was built in 1824, the alewife has spread throughout the Great Lakes.
Brook Trout	They grow and survive best in temperatures between 13° and 18°C (55° and 65°F). Brook trout, which like other char and trout are a coldwater species, can survive a wide range of temperatures, from near 0°C (32°F) to around 22°C (72°F). Many mistakenly consider deep, coldwater lakes the ideal habitat for brook trout. However, brook trout are not a deep-water species. They can tolerate that environment, but seldom will they use depths greater than 4.6 to 6 meters (15 to 20 feet) unless temperatures in shallower water are too high and no other coldwater refuge areas exist. In fact, when water temperatures are high, brook trout are more likely to concentrate where a spring seeps, in cold water that may be only a foot deep, than to venture into deeper water of favorable temperature. Such behaviors contrast with those of most other chars, particularly lake trout Brook trout can be found in even the smallest spring-fed streams, especially where cover is available. Fingerlings prefer shallow water about 41 cm (16 in.) deep, and adults do not need much more than that. In streams, they prefer areas where the substrate consists of gravel and cobble with diameters of between 2 and 25 cm
Lake Trout	From a zoogeographical perspective, lake trout are quite rare. They are native only to the northern parts of North America, principally Canada but also Alaska and, to some extent, the northeastern United States. Lake trout have been introduced into many other parts of the world, mainly into Europe but also into South America and certain parts of Asia. In Canada, approximately 25% of the world's lake trout lakes are found in the province of Ontario. Even at that, only 1% of Ontario's lakes contain lake trout.

VERTEBRATES	HABITAT
Pearl Dace	Cool, clear headwater streams in the south, bog drainage streams, ponds and small lakes in the north, and in stained, peaty waters of beaver ponds" (Scott and Crossman 1973). Usually over sand or gravel (Page and Burr 1991). Spawns in clear water over sand or gravel in weak or moderate current (Scott and Crossman 1973).
Brook Stickleback	This species generally occupies cool, clear, heavily weeded, spring-fed creeks, small rivers, lakes, and ponds, usually in shallow, quiet to flowing pools and backwaters over sand or mud. Sometimes it burrows into soft bottoms. Occasionally this fish can be found in brackish water. In a lake in Manitoba, adults were most abundant at the outer margin of emergent vegetation (Moodie 1986). Eggs are deposited in a nest made of plant material by the male just above the bottom in shallow water
Long-Tailed Shrew	Mountainous, forested areas (deciduous or evergreen) with loose talus. Rocky damp areas with deep crevices covered by leaf mold and roots are preferred. May occur along small mountain streams. Will use artificial talus created by road construction and pit mines. "SOREX DISPAR is probably the most stenotopic mammal in eastern North America..." (Webster 1987). Trapping results reported by Richmond and Grimm (1950) suggest that Long-tailed Shrews spend most of their time in the labyrinth of spaces between rocks about a foot beneath the surface. Nest sites are usually associated with natural subterranean tunnels among boulder crevices.
Northern Long-eared bat	The Northern Long-eared Bat (Myotis septentrionalis) is found in many regions of Canada. Although there are numerous records of its presence in eastern Canada and the United States, it has only been recorded sporadically in the west. This particular type of bat has two habitats: a winter hibernation habitat as well as a summer roosting and foraging habitat. The Northern Long-eared Bat hibernates in caves or abandoned mines during the cold winter months. During the summer months the Bats commonly use crevices behind peeling bark or cavities in partially-decayed trees as summer day roosts. Within thick forests, summer activity may be focused along watercourses and small ponds
Eastern Pipistrelle	Prefers partly open country with large trees and woodland edges. Avoids deep woods and open fields. Probably roosts in the summer in tree foliage and occasionally in buildings; may use cave as night roost between foraging forays. Usually hibernates in caves and mines with high humidity. Generally, maternity colonies utilize manmade structures or tree cavities; often in open sites that would not be tolerated by most other bats

VERTEBRATES	HABITAT
Southern Flying Squirrel	Prefers deciduous and mixed forests, particularly beech- maple, oak-hickory and poplar. Also occurs in old orchards. In New Hampshire, preferentially used areas with large shagbark hickories and beeches; males tended to use areas with large oaks, females tended to use areas with abundant snags (Fridell and Litvaitis 1991). Favors small, abandoned woodpecker holes for den sites; also uses nest boxes and abandoned bird and squirrel nests outside tree cavities
Fisher	Fishers inhabit upland and lowland forests, including coniferous, mixed, and deciduous forests. They occur primarily in dense coniferous or mixed forests, including early successional forest with dense overhead cover (Thomas et al. 1993). Fishers commonly use hardwood stands in summer but prefer coniferous or mixed forests in winter. They generally avoid areas with little forest cover or significant human disturbance and conversely prefer large areas of contiguous interior forest (see USFWS 2004). Powell (1993) concluded that forest type is probably not as important to fishers as the vegetative and structural aspects that lead to abundant prey populations and reduced fisher vulnerability to predation, and that they may select forests that have low and closed canopies. Several studies have shown that fishers are associated with riparian areas (see USFWS 2004), which are in some cases protected from logging and generally more productive, thus having the dense canopy closure, large trees and general structural complexity associated with fisher habitat
Wood Turtle	Habitat destruction and fragmentation due to intense development and accompanying stream alterations are serious problems in the southeastern portion of the Wood Turtle's range. protection of wooded stream corridors, nesting, feeding, basking, and overwintering sites, and an upland buffer would be necessary to include in preserve design Lives along permanent streams during much of each year, but in summer may roam widely overland and can be found in a variety of terrestrial habitats adjacent to streams, from deciduous woods, cultivated fields, and woodland bogs, to marshy pastures. Use of woodland bogs and marshy fields is most common in the northern part of the range
Snapping Turtle	southern new brunswick and parts of mainland nova scotia in ponds, lakes, slow-moving streams and sometimes in brackish water if these water bodies have soft mud bottoms and abundant aquatic vegetation
American Eel	move from salt water into fresh water when quite young and spend their adult life in fresh water returning to spawn in tropical oceans up to several decades later. Widely distributed in freshwaters, estuaries and coastal marine waters connected to the Atlantic Ocean. Although small streams may be critical to the persistence of eels in a watershed, they may use these streams only once or twice a year, while moving to and from more preferred habitats.

VERTEBRATES	HABITAT
LICHENS	
Vole Ears	This large foliose lichen is known in Canada only from Nova Scotia, New Brunswick, and the island of Newfoundland, where it inhabits cool, humid and coastal conifer forests dominated by Balsam Fir. Although there are 24 known sites for the lichen in these regions, few individuals (133 thalli) are known. While recent surveys have increased the number of known locations, the lichen has been extirpated from 11 sites in the last 30 years. This lichen is a sensitive indicator of air pollution and acid precipitation, which are its main threats. Other threats include forest harvest and browsing by moose
Boreal Felt Lichen	found in atlantic provinces with most records from NL. Limited in NS, believed extirpated in NB. Mature moist conifer dominated forests, especially around the margins of peatlands. It grows on branches or trucks of balsam fir, black spruce, white spruce and occasionally red maple trees.
Ghost Antler Lichen	chalky white to pale grey lichen that has been found in higher elevation cool, humid, spruce-fir forsts in quebec, fundy and atlantic coasts of NB, Maine, NS. Seven areas in NS. Immersed in fog and cloud cover. Balsam fir, red spruce, and black spruce twigs and branches provide required substrate. Coastal and high-elevation spruce-fir forests shuld be searched.
INVERTEBRATES	
Monarch Butterfly	butterfly; surveys for monarchs should be condusted in areas with potential to support milkweed species in mid to late summer and should be conducted by someone familiar with milkweed species. Common milkweed: very common in lower Saint John river valley and possibly north central nova scotia
VERTEBRATE PLANTS	see separate list- March 2011-- vegetation short lists- subdivided into upland and wetland groupings

Appendix III. AVIAN STUDIES

Avian Baseline Study & Environmental Impact Assessment Glen Dhu Wind Farm

John Kearney

John F. Kearney & Associates

For: Stantec

Proponent: Shear Wind Inc.

August 2008

Executive Summary

This report presents the findings of a baseline study and an environmental assessment of the potential impact of the Glen Dhu Wind Farm on birds.

Bird surveys were conducted over a 13-month period from June 2007 to July 2008. These consisted of a preliminary assessment (June-July 2007) and four seasonal components; autumn migration (August-October 2007), winter season (November 2007-March 2008), spring migration (April-May 2008), and peak breeding season (June-July 2008).

The cold winters and cool summers, and fertile and well-drained soils have favoured the growth of a predominant hardwood forest on the Pictou-Antigonish Highlands. A fully mature, climax forest in this area consists of shade-tolerant Sugar Maple, Yellow Birch, and Beech. Today, forestry is the main human activity in the study area, followed by deer hunting, recreational vehicle use, and hiking.

Research methods varied according to the season and to meet the multiple objectives of a baseline study and risk assessment. During the autumn and spring migration periods, three types of surveys were conducted; migration stop-over, nocturnal passage, and diurnal passage. The winter survey gauged the number of birds overwintering in the study area and their distribution in different woodland habitats. The breeding bird survey measured the number and species of birds that nest in the study area with particular attention to their habitat requirements.

In total 3,650 individual birds of 80 species were recorded during the autumn migration stop-over surveys. The highest numbers occurred during the periods, August 28 to September 6 and October 7 to 16. The diversity of bird species was highest during the 30-day period from August 28 to September 26. The highest counts were achieved when wind was calm, or with light winds from the northwest, west, and north. More birds were seen in the most disturbed habitats and with the most “edge”, i.e., the “clearcut, regenerating, and early succession” habitat type. Twenty-four species demonstrated significant habitat relationships.

The before dawn descent of Hermit Thrushes was the most distinctive aspect of the autumn nocturnal passage counts. This species was heard on ten of sixteen nocturnal counts with the number of thrush notes heard ranging from 1 to 89 from September 11 – October 19. The highest number of calls was heard on October 1st.

Nine species of hawks and eagle were observed during the autumn diurnal passage surveys. These occurred in small numbers and irregularly at all observation points throughout the autumn. Thus, the study area does not appear to be an important site for diurnal raptor passage during the autumn migration. The most common of these raptors, the Bald Eagle, consisted of a local population that is not migratory.

The Common Raven, also a local population, was the most frequently seen passerine species during the diurnal passage surveys. For woodpeckers and small to medium-sized passerines (i.e., excluding ravens), 49% of observations recorded a flight direction of west, compared to 18% for east, 13% for north, and 20% for south. This pattern of flight direction held for all wind directions.

Few birds wintered on the Pictou-Antigonish Highlands, especially on the higher elevations where winter conditions are the most extreme. The density of birds in winter increases with lessening amounts of edge and with rising amounts of forest cover. Thus clearcuts and early succession forest had the smallest densities of birds (0.55/hectare) and mature deciduous the largest

(1.77/hectare). Only 19 species of birds were seen in the study area during the winter period. The most common bird was Black-capped Chickadee, occurring in all habitats but most abundantly in mature deciduous.

In total, 4,916 individual birds of 75 species were recorded during the spring migration stop-over surveys. The data suggests that spring migration stop-over in the study area consists of three waves of decreasing intensity. In mid-April, the first wave in is dominated by American Robins, Dark-eyed Juncos, and Song Sparrows. The second wave in late April and early May consists largely of Yellow-bellied Sapsuckers, Northern Flickers, Ruby-crowned Kinglets, Hermit Thrushes, Yellow-rumped Warblers, and White-throated Sparrows. The third wave in mid to late May is made up of flycatchers, forest warblers, and Red-eyed Vireos. The peak in total birds occurred from April 11-30 with a peak in species diversity from April 21-30. The highest mean counts occurred when the night wind was from the southeast at 12 to 19 km/hour on average, the second highest mean counts when winds were from the south at 7 to 11 km/hour. Habitat relationships with birds were not as strong in the spring migration stop-over as in the autumn. One can discern, as in the autumn, the influence of the edge effect as mean total birds tends to decrease with decreasing edge and increasing forest canopy; from clearcuts to mature deciduous forest. Seventeen species demonstrated significant habitat relationships during the spring migration.

The nocturnal passage counts were much lower in the spring than in the fall. Very few Hermit Thrushes were heard, and the pattern of their sounds was different.

Diurnal passage migration was also much less in the spring than in the fall. No birds were seen in twenty-four percent of the one-half hour observation blocks compared to only eight percent in the autumn. The mean number of birds seen per block was 3.00 birds in contrast to 7.08 birds in the autumn. Hawks, water birds, woodpeckers, and passerines were less diversified by species and less abundant in total numbers than in the autumn. Only the Red-tailed Hawk was seen more frequently in the spring (24% of time blocks) than in the autumn (12%). The locally resident Bald Eagles and Common Ravens were present in comparable numbers and frequency during the spring. Sixty-seven percent of woodpeckers and passerines were flying northeast or east. It is worth noting that the most common flight direction during the daytime in both the autumn and spring was 45 degrees from the prevailing nocturnal flight direction described for Maritime passerines, that is, west rather than southwest and east rather than northeast.

The breeding season surveys consisted of three components: crepuscular and nocturnal birds, early breeders, and peak season breeders.

Twilight and nocturnal area searches detected breeding birds that are not normally seen during the daytime. These include American Woodcock, Great Horned Owl, Barred Owl, and Northern Saw-whet Owl. The three owl species were heard in a mix of forest habitats with the Barred Owl the most associated with mature Sugar Maple-Yellow Birch-Beech habitat. The American Woodcock was found almost exclusively in clearcut and regenerating areas, often near a wet area.

Bird species that began their nesting season before June 1 were considered early breeders in this study. The twenty-four point counts along the migration stop-over transects were used to survey these birds. The most abundant early breeder was White-throated Sparrow with a mean of 2.71 per point count station and occurring at 92% of the stations. It was closely followed by the American Robin with a mean of 2.54 and occurrence of 92%. Species occurring on two-thirds or more of the point count stations were in rank order, Ovenbird, Yellow-rumped Warbler, Dark-eyed Junco, Magnolia Warbler, Blue Jay, Black-capped Chickadee, Hermit Thrush, and Yellow-bellied Sapsucker.

There were significant differences in the use of habitat types by total number of early breeders. Highest counts were obtained in clearcuts, and early succession forest followed by mid to late succession mixed aged mixed forests. There were no significant differences between particular habitat types. Nine species of early breeders demonstrated significant habitat relationships.

The peak breeding survey consisted of 204 point counts dispersed throughout the study area. Each point count was surveyed one time between June 3 and July 3. Red-eyed Vireo was the most common bird during the peak breeding season and was detected on 74% of all point counts. The White-throated Sparrow, American Robin, and Ovenbird maintained their ranking among the top four most common species and were detected on 57-61% of point counts. The Black-throated Green Warbler was also seen or heard on 57% of point counts. There were significant statistical differences in the total number of peak breeding birds according to habitat type. The highest counts were obtained on residential and agricultural habitat, followed by disturbed forest habitat to mature forests in decreasing order. There were also significant differences between individual habitat types. The clearcut and early succession habitat had significantly greater number of birds than mature coniferous and deciduous. The clearcut and early succession alongside mature deciduous habitat and the mid to late succession habitat both had greater total birds than mature deciduous. Species diversity follows the same pattern relative to habitat use. There were significant differences in species diversity at the overall habitat level of analysis and between specific habitat types. Clearcuts and early succession forests were significantly more diverse in bird species than mid to late succession, mature coniferous, and mature deciduous. Clearcuts and early succession forests alongside mature deciduous, mid to late succession forests, and residential and agricultural land were more diverse than mature deciduous. Fifteen species showed significant preference for specific habitat types. For two species, their numbers were significantly higher in one habitat type than all five other habitats. These were Ovenbird for mature deciduous and Black-throated Green Warbler for mature coniferous. Among the other species showing statistically strong preferences for specific habitats were Alder Flycatcher, White-throated Sparrow, Song Sparrow, and Common Yellowthroat for clearcuts and early succession forests, Least Flycatcher, Mourning Warbler, and Common Yellowthroat for clearcuts and early succession alongside mature deciduous, and Red-eyed Vireo and Least Flycatcher for mature deciduous.

The mean number of birds seen at each of the point count stations was considerably higher in the early breeding season compared to peak breeding; nearly twice as high. This is due to the fact that the early breeding point counts in April and May were conducted repetitively. The mean of total of birds was highest with calm winds (13.38) and lowest at wind speeds up to 20-29/km/hr (11.25), but these differences proved to be not statistically significant; nor were the effects of visibility (fog). The number of birds detected was significantly less in light rain compared to no precipitation (8.69 vs. 12.23). The time of morning, from sunrise to 4 hours after sunrise, did not have significant effect on the mean total birds detected.

In total from June 2007 to July 2008, 90 species of breeding birds were found in the study area of which 28 were possible breeders, 34 probable breeders, and 28 confirmed breeders using the criteria of the Maritime Breeding Bird Atlas.

Both the nocturnal passage and diurnal passage surveys in the autumn point to the need to evaluate the risk to migrating and commuting bird for collisions with wind turbines.

The nocturnal passage surveys provided evidence that the American Woodcock and Hermit Thrush are descending to the ground in the dark from one hour to one-half hour before sunrise during their autumn migration. Those birds descending to ground in the immediate vicinity of wind turbines are thus potentially at risk from collisions with the rotating blades. It was also noted that these descents are of the greatest magnitude under calm wind conditions. Thus there might be a natural mitigation of this risk as the blades may not be rotating when the numbers descending are highest. There is a need to understand this phenomenon more completely. An acoustic monitoring study should be conducted in the autumn of 2008 to evaluate further the potential risk of collision for these species and possible mitigation measures.

Wind turbines may also pose a threat to the American Woodcock during the time they are engaged in breeding flight songs. Male woodcocks will use almost any size open, relatively flat, area as a display ground, sometimes far from their preferred diurnal habitat. During the first few years after construction, it may be necessary to cover open areas with brush or find other ways to discourage woodcocks from using the cleared areas around newly constructed wind turbines as a platform for their flight songs.

During the diurnal passage the species most likely to be flying at the height of the blade sweep are Bald Eagle (38% of observations), Sharp-shinned Hawk (33%), Red-tailed Hawk (33%), Common Raven (22%), warbler species unspecified (15%), American Robin (14%), passerine species unspecified (7%), and Yellow-rumped Warbler (6%). Of particular concern among these species are Bald Eagle and Common Raven. They are present throughout the spring and autumn and were among the species most often seen during the diurnal passage surveys, particularly the latter. The analysis suggests that soaring birds such as diurnal raptors, gulls, and corvids are more likely to be flying at blade height when the turbines are placed near steep cliff edges. In addition, the data suggest that Bald Eagles are the most likely to fly at blade height due both to vertical air flows and a higher flying altitude, with or without air current assistance. Additional studies documenting the overall and seasonal abundance of raptors and corvids in the study area and more detailed behavioural studies at specific proposed turbine sites in the autumn of 2008 would further define the risks involved. Until additional research becomes available, serious consideration should be given to setting back wind turbines from steeply-inclined ridges where updrafts are most conducive for soaring. Again, the optimal set-back distance requires further study.

The two species listed as “special concern” by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Peregrine Falcon and Rusty Blackbird were seen only once each in the study area in the autumn migration. The three species listed as “threatened” by COSEWIC were seen during the breeding season. These are Chimney Swift, Olive-sided Flycatcher, and Canada Warbler.

Two Chimney Swifts were seen together in flight in early July 2008 at the extreme southwest corner of the study area. Generally Chimney Swifts nest in towns or cities, and it is most likely these were foraging birds. While it is possible that Chimney Swifts will nest in large dead trees in mature forests, there is not enough evidence at this time to warrant a consideration of the possible impacts of a wind farm on this species.

The Olive-sided Flycatcher was seen on 8 occasions during the spring migration and on 12 breeding point counts. This suggests the species is fairly widespread in the study area in suitable nesting habitat; clearcuts and early successional forests. The existence of large snags in clearcut or burned areas adjacent to forests appears to be a critical component of this species habitat. The causes of decline of this flycatcher are unknown and are puzzling since the availability of suitable habitat is increasing. Due to the unknown causes for the decline in the Olive-sided Flycatcher, it is difficult to assess the impact of a wind farm on its population in the study area. The construction of a wind farm should not negatively affect the habitat available to Olive-sided Flycatchers. Where wind turbines are placed in habitats suitable for this species, large snags should be cut down for at least 150 metres around their perimeter. This will help lessen the risk of collisions with rotating wind turbine blades.

The Canada Warbler was seen on four occasions. The first two were during the breeding season in 2007; one a single individual near Vamey's Lake and a pair in the southern portion of the study area. In 2008, a male accompanied by a female was singing near the edge of Vamey's Lake in their spring migration period, and a single male in the exact same location as in 2007 in the southern portion of the study area. The breeding habitat of the Canada Warbler is moist, mixed coniferous-deciduous forest, with a well developed understory, often near open water. The decline of Canada Warbler is believed to be related to the loss or degradation of nesting habitat. Studies in New England and the Middle Atlantic States reported the Canada Warbler was one of the top five species most sensitive to forest fragmentation. At a more site-specific level, studies have shown that the clearing of brush and understory in forests, as well as grazing by ungulates, negatively affects their population. The clearing of land for turbine construction is not likely to impact the Canada Warbler since turbines are built on higher ground, way from moist woodlands. The construction or improvement of roads and the construction of ancillary structures should avoid removing forest understory in wet areas.

This study shows repeatedly the importance of a variety of forest habitat types for bird populations. Cleared and early successional forest habitats with a high degree of edge are critical for many birds during the migration and breeding periods. Mid to late successional and mature coniferous forests are the preferred habitat of a number of the most common breeding birds. Deciduous forests may be essential as overwintering areas and provide the habitat of the first and fourth most abundant birds in the study area during the peak breeding period, Red-eyed Vireo and Ovenbird. At this time, the greatest threat to the mature Sugar Maple-Yellow Birch-Beech hardwood forest and associated bird habitats on the Pictou-Antigonish Highlands is from harvesting for firewood. Given that wind farm development would take place in a variety of early to late successional forest areas, the loss of mature deciduous woodlands would likely be small, especially in comparison to forestry operations. For those species listed as "Yellow" status by the Province of Nova Scotia or as a "Priority Species" by Partners in Flight, recovery depends on a broad, concerted effort by all forest users. This is the approach recommended by Partners in Flight. Their plan focuses on conserving and restoring the populations of the Canada Warbler and Black-throated Blue Warbler since in doing so, the situation of all other stable or declining species would improve as well.

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Introduction

This report presents the findings of a baseline study and an environmental assessment of the potential impact of the Glen Dhu Wind Farm on birds.

The proposed Glen Dhu Wind Farm is located on the Pictou-Antigonish Highlands between New Glasgow and Antigonish, Nova Scotia. The proposal calls for the development of up to 75 wind turbines with a total 100+ megawatt capacity. The study area for this assessment thus encompasses a large area of approximately 5,500 hectares. The actual wind turbines placements and associated infrastructure, when completed, would occupy closer to 100 hectares, spread over the entire study area. The location of the study area is outlined in red in Figure 1 (click blue hyperlink to view figures and tables, and then click blue "return to text" link to continue reading document).

Bird surveys were conducted over a 13-month period from June 2007 to July 2008. These consisted of a preliminary assessment (June-July 2007) and four seasonal components; autumn migration (August-October 2007), winter residency (November 2007-March 2008), spring migration (April-May 2008), and peak breeding season (June-July 2008).

This report on the survey results is written both for those people who know much about birds and their ecology and those people who may have a limited knowledge of birds but are interested in the environmental dimensions of wind farm development. Throughout the text, hyperlinks are provided to an online bird guide of the Cornell Laboratory of Ornithology for those who wish to know more about the species being discussed in the text.

In order to begin an avian environmental assessment of a wind farm site, it is necessary to describe the basic social and ecological context in which this development would take place.

The Natural History of the Glen Dhu Wind Farm Site

An outline of the natural history of the Glen Dhu Wind Farm site is important for understanding some essential dimensions of the autumn migration of birds in the area. Geological and cultural histories greatly influence forest habitats and these, in turn, affect the use of the area by migrating birds. The information in this section is based on Davis and Browne (1996) unless otherwise noted.

Geological History

The geological history of the Glen Dhu Wind Farm site begins with the volcanic activity of the Pre-Cambrian period that ended some 540 million years ago. Remnants of this time can be seen in the neck of an ancient volcano at Sugarloaf Hill just south of Malignant Cove and in the lava rock on the beaches at Arisaig Point. During the Silurian and Devonian periods (443 to 354 million years ago), the area was covered by a shallow sea in which marine sediments were deposited over the base rock. The fossils that can be easily seen at Arisaig Provincial Park; the brachiopods, trilobites, crinoids, cephalopods, ostracods, and bryozoans; demonstrate the rich diversity of life that characterized this period.

During the late Devonian period, a process of mountain building, known as the Acadian Orogeny, lifted these sediments along a number of fault lines to form the Pictou-Antigonish Highlands. This particular mountain building process included the Northern Appalachians from New York to Newfoundland and the Gaspé. It is upon these Highlands that the Glen Dhu wind farm site is located. The largest of the fault lines is the Hollow Fault which extends from Cape George to New Glasgow. Between Bailey's Brook and Malignant Cove, the Hollow Fault today forms a straight valley with a high and steep forested cliff on its southern side. This valley is known as the Hollow or *Glen Dubh*, the Gaelic words for Dark Valley (see Figure 2). It is after this scenic landscape that the wind farm is named.

During the Carboniferous period, the Pictou-Antigonish Highlands became an island surrounded by the sea. With time the sea receded, and erosion carved the various subsidiary fault lines of the Highlands into valleys. Marshy Hope, along the Trans-Canada Highway, is one example of these valleys. The elevation of the Highlands ranges between 100 and 300 metres above sea level providing spectacular views of the Northumberland Strait and surrounding countryside as exemplified in Figure 3.

Water and Soil

Unlike much of Nova Scotia, there are very few lakes and ponds on the Pictou-Antigonish Highlands. There are, however, many rivers and streams which follow a branching pattern in draining to the sea. The water is somewhat acidic with a ph that averages 6.4. Soils are relatively shallow, shaly loams with substantial levels of organic material in the surface layer.

Climate

Because of their elevation, the Pictou-Antigonish Highlands experience longer winters, lower temperatures and greater daily temperature ranges, greater precipitation and more snowfall, and shorter growing seasons than in surrounding lowland areas. Freezing temperatures last from November to April, precipitation exceeds 1200 mm and snowfall exceeds 300 cm per year. The Highlands experience higher relative humidity and hence more cloudiness than the lowlands, and of practical importance to this study, has greater exposure to winds. Figure 4 shows how the higher humidity on the Highlands can result in cloudy conditions when it is sunny elsewhere.

Plants and Forest

The cold winters and cool summers, and the fertile and well-drained soils have favoured the growth of a predominant hardwood forest on the Pictou-Antigonish Highlands. A fully mature, climax forest in this area consists of shade-tolerant Sugar Maple, Yellow Birch, and Beech. The Highlands represent the most northeastern distribution of this type of forest in North America. Figure 5 shows a mature Sugar Maple-Yellow Birch-Beech woodland in the study area.

When disturbed by fire, disease, or logging, this forest will regenerate first with shade intolerant species such as red maple, white and grey birch, and aspen. As forest succession continues more shade tolerant species such as spruces and fir intrude into the understory. At mid-successional stages, shade tolerant species form a mixed hardwood-softwood forest. If left undisturbed, the forest will in most cases return to a mature Sugar Maple-Yellow Birch-Beech forest once again. Plants of the Alleghanian floral element, which is usually found further south, are associated with this forest.

Animals

The hardwood forest of the Pictou-Antigonish Highlands provides habitat for many wildlife species. The fertile soils support a diverse fauna which together with rotting logs provide habitat for insects, salamanders, wood frogs, small mammals, woodpeckers, and denning bears. The area, especially the disturbed portions of forest, provides good habitat for deer and moose. The Highlands provide breeding habitats for a wide variety of bird species in which the White-throated Sparrow, American Robin, Red-eyed Vireo, and Magnolia Warbler are the most abundant (Kearney 2007). On a calm night on the Highlands, the air is filled with the calls of Coyotes and Barred Owls.

Culture

The Mi'kmaq, the aboriginal people of Nova Scotia, have inhabited the land for at least eleven thousand years. At the time of European contact, there was a Mi'kmaq settlement near the study area at Merigomish. The Antigonish-Pictou Highlands were likely a hunting area for moose during the winter months. There were a few French settlers on Big Island, near Merigomish, in the early Eighteenth Century (Patterson 1877). A large immigration of Highland Scots to the area began in the 1770s during the Highland Clearance in West Scotland. The Scots settled first in the town of Pictou and in 1783, the settlers arrived in Merigomish and Arisaig. During the first half of the Nineteenth Century, as farmland became less available in the coastal areas, small farms were established on the Highlands. Because of the short growing season and marginal nature of the lands, these farms were eventually abandoned, and the cleared lands reverted to the Sugar Maple-Yellow Birch-Beech forest.

Today, forestry is the main human activity in the study area, followed by deer hunting, recreational vehicle use, and hiking. The area is largely uninhabited except for the seasonal use of hunting camps and summer cottages. Forestry involves the logging of both softwood species for pulp and paper production and hardwood species for firewood. While pulp and paper production was the mainstay of the forest industry in the area, there is, according to local woods workers, increasing demand for hardwoods for firewood. This is the result of a shift in energy consumption patterns away from non-renewable petroleum products to renewable sources such as wood. At the same time, economic conditions in the pulp and paper industry are currently at a low due to high energy costs, unfavourable foreign exchange rates, and decreasing demand. It is reported by woodlot owners that when they clear cut the Sugar Maple-Yellow Birch-Beech forest, it is replanted two to three years later in softwood species and subsequently treated with herbicides to prevent natural succession to a hardwood forest. It remains to be seen if this management practice will continue if economic conditions, favouring the production of hardwoods, keep on their current course. Figure 6 shows a clear cut softwood forest and a stack of sugar maple logs destined for firewood.

The combined activities of forestry and hunting in the study area have, over the decades, led to the development of an extensive network of woods roads. The map in Figure 7 shows the relative scarcity of human habitations in the study area compared to surrounding areas in the lowlands, together with a system of woods roads that matches the branching pattern of the numerous streams and brooks. This road network has led to a patchy forest composition, as it has allowed wood harvesters access to small blocks of forest for logging. Two power lines that run through the study area are the other marks of human infrastructure on the proposed wind farm site.

In summary, the Glen Dhu Wind Farm site on the Pictou-Antigonish Highlands is somewhat isolated from the mainstream of human social and economic activities in the surrounding populated areas in the lowlands. On the other hand, it cannot be classified as a "wilderness" area. The Wildlife Conservation Society Canada in collaboration with the project, "Two Countries, One Forest", has developed quantitative measures of the human ecological footprint in the Northern Appalachian/Acadian Ecoregion. As shown in Figure 8, most of the Glen Dhu Wind Farm site ranks from 11 to 40 on a scale of 0 to 100 relative to the intensity of the ecological footprint from human development activities.

Research Methods and Cautions

Research methods varied according to the season and to meet the multiple objectives of a baseline study and risk assessment.

During the autumn and spring migration periods, three types of surveys were conducted; migration stop-over, nocturnal passage, and diurnal passage. Surveys of migration stop-over determine the number and kinds of birds that land in the study area during their period of migration and the importance of different habitat types in supporting the food and other needs of migrating birds while in the area. Surveys of nocturnal passage migration provide a measure of the number and species of birds that migrate over the study area at night. Surveys of diurnal passage migration examine the number, species, altitude, and behaviour of birds flying over the studying area during the daytime. There is not always a clear distinction between these three dimensions of migration. Birds seen on a migration stop-over survey may have alighted only momentarily while migrating during the day time. Birds that have migrated all night can sometimes be seen flying in great numbers during the early hours of a diurnal passage count as they attempt to gain their bearings or seek suitable feeding areas.

The winter survey gauged the number of birds overwintering in the study area and their distribution in different woodland habitats.

The breeding bird survey measured the number and species of birds that nest in the study area with particular attention to their habitat requirements. This survey was supplemented by counts of bird sounds made by species that are usually detectable only at night or in the twilight hours.

In conducting an environmental assessment of the impact of a wind farm on migrating birds, migration stop-over counts provide an estimate of the overall magnitude of bird migration in the area, and the possible impact of the wind farm on the habitats available for these birds while migrating. While nocturnal and diurnal passage counts also provide a measure of the importance of the area for migrating birds, it is also a critical component for evaluating the risk to birds from collisions with the rotating blades of wind turbines. The breeding and winter surveys provide important information on the numbers, diversity, and habitat use of bird species that permanently reside on the site or in nearby areas, that travel from more southerly areas to breed in the area, or that arrive from more northerly areas to spend the winter on the Pictou-Antigonish Highlands.

Migration Stop-over Surveys

Four transects were established in the study area; one in the northern section, two in the middle, and one in the southern section. Each transect was also located on a property designated as a potential site for the placement of wind turbines. A transect was 1500 metres (m) in length and consisted of three segments of 500 m with different habitat types dominating in each segment. Each transect also had six point counts. The point counts were distributed at stops located at 100 m, 350 m, 600 m, 850 m, 1100 m, and 1350 m along the length of the transect. All birds seen or heard within the distance bands of <50 m, 50-100 m, >100 m, and flying overhead were recorded separately. The placement of the transects is shown in Figure 9. Transects 1 and 3 are located on a westerly section of the plateau of the Pictou-Antigonish Highlands. Transects 2 and 4 are located on steep inclines or near the edge of a ridge.

During the autumn migration, each of the four transects was surveyed once from August 28 to 31. One transect was completed each day from September 2 to 21. From September 22-October 23, each of the four transects was completed 5 times. The transect surveys began at sunrise. Each took approximately 2.5 hours to complete while each point count was precisely 10 minutes in duration.

During the spring migration, each of the four transects was surveyed four times between April 8 to May 7. One transect was completed each day from May 8-31 (except for 5 days when there was heavy rain or dense fog). Each of the four transects was surveyed once between June 1-9. The spring transect surveys were begun one-half hour later than the autumn surveys since many birds became active later in the morning with the cold dawn temperatures and sometimes snowy conditions during the spring.

It is necessary to add some words of caution about the precision of transects and point counts during the migration season. Survey methods are an attempt to measure bird populations in a dynamic and complex situation. During the migration periods, birds can be moving rapidly and concentrated in flocks that can skew results in one direction or another if they are or are not detected. Different species of birds can have behaviours that make them more or less easy to detect than other species. Sudden changes in weather conditions can result in large-scale movements of birds that can last for a very short period and thus easily missed altogether if one is not at the right place at the right time.

Survey methods must thus try to account as much as possible for these “vagaries” of bird migration. Transects are a common method of measuring bird populations during the migration season, and a variation on the “fixed-width line transect” method is the one recommended by the Canadian Wildlife Service (Environment Canada 2007) for the environmental impact assessment of wind farms. In this method, all birds seen within distinct distance bands from the observer walking the transect line are recorded. Ideally, fixed-width line transects work best when coefficients of detectability for each species are first determined by conducting initial transects that measure the distance of each individual bird from the observer and then these coefficients are used to adjust survey results (Emlen 1971).While all line-transect methods have been shown to have significant biases when compared to more intensive and costly survey methods, they remain a viable alternative for environmental impact assessments subject to time constraints (Tilghman and Rusch 1981).

Point counts are the most common survey method for measuring populations of breeding birds and like transects, provide the most accurate results relative to the time and cost invested in the survey (Ralph, Droege, and Saur 1995). Point counts are sometimes used for migration and overwintering studies when there is an interest in the importance of habitat to the migrating or overwintering birds (Lynch 1995; Wang and Finch 2002; Wilson, Twedt, and Elliott 2000).

Using both the line transect and point count methodologies in this study was an attempt to gauge both the main movements of birds through the study area and the use of habitats by birds that stop briefly or spend several days or more. At the same time, an analysis of the birds counted within the 50-m distance band of both the transects and point counts will, in most cases, produce the most reliable results. Nonetheless, some species such as Blue Jays, Common Ravens, and Northern Flicker can sense well in advance the approach of the observer and will leave the 50-m band, or are easily detectable at greater distances than most birds. Thus the greater than 50-m bands will be important in some dimensions of the analysis.

Diurnal Passage Surveys

Diurnal passage surveys were conducted from eight different observation points in the study area. The choice of the observation points was based on the extent to which they provided as close as possible to a 360 degree extended view of the air space around the observation point, the probability this space was located along a migration or commuting corridor, and its proximity to a potential site for the placement of wind turbines. Most of the diurnal passage surveys were conducted from mid-morning to early afternoon, the time when warm air thermals rise from the land. The movements of such birds such as raptors (hawks) and corvids (ravens) are often timed so they can ride these thermals. Diurnal passage surveys were also conducted periodically in the early morning and mid to late afternoon to detect the passage of other species.

The diurnal passage surveys consisted of a number of 0.5 hour blocks of observations. All birds seen or heard during this time were recorded according to their species, location and altitude relative to the observer (not to the point over which they were flying), flight direction, and number of individuals. For each bird, a note was made as to whether the bird was sufficiently close and at the right altitude to pass through the sweep of a turbine blade if a turbine(s) was located at the observation point. During the time of the study, the design of the turbines proposed for this site had a blade sweep between 50 and 125 m in height. In total, 130 observation blocks were completed between August 29 and October 23, and 50 observation blocks April 7 and June 6. The difference in the amount of time spent in diurnal passage surveys between these two seasons is indicative of the greater intensity of autumn passage compared to the spring.

Nocturnal Passage Surveys

Nocturnal passage consisted in listening for bird calls within the one half hour before first light, that is, beginning at one hour before sunrise. This is the time that many passerines (songbirds) descend from higher altitudes in search of landing locations. All bird sounds heard in the half-hour block were counted and when possible, identified to species or family groups. It is important to note that each sound was counted and that individual birds can make a sound more than once when flying overhead.

These auditory counts were originally conducted on an experimental basis for gauging the possible significance of nocturnal movement of birds on the study site. Originally, three nocturnal passage surveys were to be conducted during the autumn migration but the results of these three counts indicated that more surveys were warranted. In total, sixteen nocturnal passage surveys were conducted from September 3 and October 23 and five surveys from May 4-26.

A more thorough monitoring of nocturnal passage would require a greater number of counts and during more periods of the night, aided by computerized acoustic monitoring, thermal imaging, or radar studies.

Winter Survey

The Pictou-Antigonish Highlands in winter are characterized by deep snow, high winds, low temperatures, and hence, dangerous wind chill factors. Access to the higher elevations is possible only by snowmobile. These higher elevations on the upper plateau of the Glen Dhu Wind Farm site were surveyed in the earlier part of the winter before the heavy snowfalls. During the latter half of the winter, the lower elevations that could be safely accessed by walking were surveyed.

The winter survey consisted of standardized area searches in which all the birds in a specific area were counted. The standardized area search is a variation of the fixed-width transect in that birds are counted within distance bands from the walking observer. This enables a certain level of quantification of the abundance of birds in different habitats. However, unlike the fixed-width transects, individual birds were counted on both the outbound and inbound length of the area search. This is possible in winter since there are so few birds that there is little risk of counting individual birds more than once.

From November 1 to March 31, fifteen standardized area searches were conducted in the study area (4 in November, 2 in December, 2 in January, 4 in February, and 3 in March). The outbound length of the area search varied between 1000 and 1900 metres.

Breeding Bird Survey

Nesting in the study area can begin as early as the last week of February (Great Horned Owl) and first week of March (Common Raven) and continue to mid-September (Red-eyed Vireo, American Goldfinch and others). The vast majority of birds, including many of the early and late breeders, are engaged in nesting activities during the months of June and early July. Thus the weeks extending from June 1 to July 15 are referred to in this study as the peak breeding season.

During the peak breeding season, 204 point counts were conducted in the study area. The time of morning for conducting point counts was from one-half hour before sunrise to 4 hours after sunrise from June 1-21. Between June 22 and July 3, point counts were not made more than 3 hours after sunrise since the regularity of singing declines earlier in the morning. No point counts were made after July 3rd when the singing of many birds dropped off dramatically.

Each point count was classified into one of 6 habitat types; 1) clearcut or early succession forest, 2) clearcut or early succession alongside mature deciduous forest, 3) mid-to late succession (mixed) forest, 4) coniferous forest, 5) mature deciduous forest, and 6) agricultural or residential area.

Weather conditions on a potential wind farm pose some problems for obtaining valid point count data. Wind makes it difficult to hear birds. This problem is compounded in a heavily forested area due to the rustling of leaves. Fog makes it difficult to see birds and depresses bird activity. Birds also become inactive in heavy rain. Thus the Glen Dhu Wind Farm site due to its windy conditions and high elevation (hence frequent fog) requires some flexibility in choosing acceptable conditions for conducting point counts. Point counts were not made when wind conditions exceeded 29 km/hour, when visibility was less than 100 metres, or precipitation was greater than a light rain.

The point counts conducted as part of the spring migration stop-over surveys served as a measure of the abundance of early breeders. The start of the breeding period, as opposed to migration period, of these early nesters was determined by using the data of the Maritime Breeding Bird Atlas (http://www.mba-aom.ca/english/breeding_dates.pdf).

Three area searches were made for crepuscular and nocturnal species during the period from April 15-21. There was no attempt to quantify this auditory data but the location of the breeding calls of these species was recorded with a GPS device.

It is important to point out the benefits and limitations of point counts. As mentioned previously in reference to migration stop-over surveys, the detectability of birds can greatly influence survey results. Point counts made during the breeding season are greatly skewed toward detecting singing males. Many birds are probably not seen or heard. Studies estimate that point counts typically detect from 50-80% of the birds present depending on the length of each count or the number of counts performed repeatedly at the same station (Cyr, Lepage, and Freemark 1995; Petit et al. 1995; Barker and Sauer 1995) To detect all of the species and individuals present in forested areas, sampling time at each station was found to be 100 minutes (Buskirk and McDonald 1995). Thus trade-offs must be made among the amount of time sampling at each point, the size of the area to be sampled, and the number of habitats surveyed. Point counts of 10-minute duration thus do not provide good estimates of the absolute population of birds, but as noted by Petit et al. (1995), studies have shown that the mean number of birds of each species detected using these shorter point counts proportionately correspond well with measures of absolute numbers. Hence, they can be used to estimate the relative abundance of the species present. Moreover, if one assumes that a constant fraction of the total population is counted in particular habitats or from one year to the next, then point counts can provide a useful index of habitat use, population trends over time, and responses to changing habitat (Pendleton 1995; Dawson, Smith, and Robbins 1995; Ralph, Droege, and Sauer 1995). Thus the objective of this breeding survey is to provide baseline data to monitor population trends both generally and in relation to habitat changes over time.

Weather Data

Weather observations were taken at the beginning of each transect segment, at each point count, at the start of each standardized area search, and at the beginning of each half hour block in the diurnal and nocturnal passage counts. These observations included temperature, sky cover, cloud type, precipitation, wind direction and speed, and visibility.

Hourly weather data was downloaded for the Caribou Island weather stations for the night before each autumn and spring migration survey. The Caribou Island weather station is located between 35.5 and 41.6 kilometres from the transects and observation points.

Statistical Analysis

The survey data was subjected to a variety of statistical analyses. Dr. Ian McLaren at Dalhousie University provided valuable assistance in conducting the automated back-ward stepping general linear models for the main effects and interactions of weather, habitat, and seasonality variables on the total number of birds in the stop-over surveys. The remainder of the statistical analyses was conducted using the Statistical Package for the Social Sciences (SPSS), Systat, and Excel spreadsheets. The interpretation of all statistical results is that of the author.

Autumn Migration

Overview

The autumn migration of birds in Northeastern Nova Scotia can be first detected in early July with the passage of sandpipers on their journey from Arctic and boreal nesting grounds to the Gulf of Mexico, the Caribbean, Central and South America. These migrating birds occur primarily in coastal areas in Nova Scotia. Many other species, including local nesting birds, begin their southward journey in August with the peak fall migration occurring in the last week of August to early October. By mid-October and early November, many of the birds seen in the study area have arrived from other areas to spend the winter there or to move from there to more southerly or coastal areas later on if food supplies become scarce.

Migration Stop-over

In total 3,650 individual birds of 80 species were recorded during the migration stop-over surveys. These data are used to examine the effects of seasonality, daily weather conditions, and habitat, on the birds migrating through the study area.

The Effects of Seasonality on Migration Stop-over

The number of birds recorded on the migration stop-over surveys was divided into ten-day intervals. The highest numbers occurred during the periods, August 28 to September 6 and October 7 to 16. Figure 10 represents the number of individual birds seen per transect at all distances from the observer (<50 m, 50-100 m, >100 m, and flying overhead) and gives a sense of the overall magnitude of bird activity during the migratory periods. Figure 11, however, represents only the birds counted within 50 m of the observer for each of the three segments (including their point counts) that make up a transect. As discussed in the research methods, the 50 m band within segments and point counts are, for most species, a more representative indication of bird abundance. The small differences in mean total birds per period and the high degree of variance in those means indicate that seasonality did not have a significant effect on the number of birds migrating through the study area. This conclusion was derived using both a one-way analysis of variance (ANOVA) and a backward stepping general linear model (GLM). The latter method also confirmed that seasonality was not a significant effect when compared to other factors such as weather and habitat.

The diversity of bird species was highest during the 30-day period from August 28 to September 26. Figure 12 shows mean total species per day at all distances while Figure 13 presents the mean total species per segment within the 50 m band. Using a univariate GLM and backward stepping GLM, seasonality was a significant and the most powerful effect on species diversity compared to weather and habitat.

The actual composition of species diversity and the mean number of each species by 10-day interval is given in Table 1. For many species, one can discern in this table a clear pattern of their mean numbers either increasing or decreasing during the migration period. However, using a one-way analysis of variance (ANOVA), only 10 species demonstrate a statistically significant seasonality pattern for counts made in the <50 m transect segments. These species are Hairy Woodpecker, Red-eyed Vireo, Winter Wren, Golden-crowned Kinglet, Magnolia Warbler, Black-throated Blue Warbler, Black-throated Green Warbler, Blackburnian Warbler, Ovenbird, and Common Yellowthroat (see Figure 14). Most of these species are decreasing during the migration period, except for Hairy Woodpecker and Golden-crowned Kinglet, which are increasing. It is also important to note that all of these species nest in the Sugar Maple-Yellow Birch-Beech and coniferous woodlots of the Pictou-Antigonish Highlands. Thus, a decreasing seasonal pattern may represent as much the timing of their departure as it is an indication of transients migrating through the study area.

As previously mentioned, some species are more likely to be or more easily detected at distances greater than 50 m due to their behaviour patterns and vocalizations. A one-way ANOVA of transects at all distances from the observer revealed five additional species having a statistically significant seasonal pattern. These are American Crow, American Robin, Cedar Waxwing, Yellow-rumped Warbler, and American Goldfinch (see Figure 15). While many people might think of crows as permanent and largely non-migratory residents throughout Nova Scotia, they are in fact an uncommon bird on the Pictou-Antigonish Highlands. Their presence there in the autumn thus most likely represents a seasonal movement of some kind.

The Effects of Daily Weather on Migration Stop-over

The effects of weather on the number of birds migrating in the study area were explored by using automated backward-stepping general linear models. In this statistical procedure, the effects of various weather factors can be tested against each other and the effects of seasonality and habitat. The procedure was run for the 50-m band of the survey samples for entire transects, segments, and point counts (only the last two containing habitat data). Wind direction and wind speed, during both the previous night of the surveys and during the surveys were the factors demonstrating varying degrees of effect on total bird numbers. These weather effects appeared less significant or non-existent in those samples containing habitat data. Nonetheless, the weather factor showing a strong degree of statistical significance in all the samples was the interaction of wind direction and wind speed during the time of the survey. This interaction between wind speed and wind direction for the entire transects is presented in tabular form in Table 2. The highest counts were achieved when wind was calm, or with light winds from the northwest, west, and north. The percent occurrence of these combinations of wind direction and speed is shown in Table 3.

By treating "calm" as a wind direction, the effect of wind direction and speed can be visually represented by plotting these two weather effects with mean total birds in a radar graph (Figure 16). From this visualization, it appears that the total numbers of birds during the autumn migration is likely to be highest when there are light winds at speeds of 0 to 11 km/hr from west to north during the time of the count. The previous statement is visually represented in Figure 17A by removing the "calm" category from the radar graph. A contrast analysis of variance indicated that the number of birds during the counts were significantly higher when wind direction was from the W, NW, and N compared to SE, S, and SW ($p=0.006$).

The analysis of the segment data for wind direction and speed was consistent with the data for entire transects but revealed one anomaly in this pattern. The second highest count recorded for one transect segment was at dawn on September 10th, when there was a light wind from the east following a northeast wind the previous night. That was the only night during the autumn migration period of 2007 when winds were from the northeast. This is represented in Figure 17B.

These findings are consistent with the radar studies of Richardson (1972, 1978) which showed how both diurnal and nocturnal migrants, especially passerines, fly predominately in a broad south southwest to west southwest front over Nova Scotia in the autumn. These SSW-WSW movements were the most dense when winds were from the north to east, providing a tailwind. These SSW-WSW movements were frequently noted at the centre of high pressure systems where winds were light and variable, often around a westerly flow. Finally, north or northwest winds immediately following a cold front brought birds heading southeast or south from inland Maritime areas to the coast or offshore.

Weather did not have a significant effect on species diversity compared to habitat and seasonality when tested by a backward stepping GLM and a univariate GLM. There was some statistical evidence that the interaction of night wind direction and speed had a modest effect on species diversity on transect segments (highest with light to moderate winds from west to southeast). While this finding may indicate some evidence for the occurrence of reverse migration, the small number of species detected at the segment level of analysis means this trend must be viewed with a great deal of caution.

The Effects of Habitat on Migration Stop-over

The habitats on 50-m band of transect segments were classified into five habitat types. These types are based on the natural succession of the Sugar Maple-Yellow Birch-Beech climax forest of the Pictou-Antigonish Highlands. Thus the types follow a sequence from disturbance (primarily by forestry) through to early, mid, and late succession to the mature stage. In addition, mature coniferous woodland can occur naturally where conditions are favourable for their growth (like ravines), or as plantations.

Due to the patchy nature of private woodlot forestry practices in the study area, it is difficult to find a continuous 500 m segment of a "pure" habitat type. Rather, segments tend to be dominated by a particular habitat type. Point counts, however, cover a smaller area (0.25 hectares compared to the 2.5 hectare segments) and thus tend to represent more homogenous habitat units. Table 4 describes the habitat types in more detail and the frequency of their occurrence in the segments and point counts.

Each transect consists of a unique combination of habitat types as represented in the combination of their three segments and six point counts. Transect 1 (see Figure 18) contains within its 1500 m length a model of forest succession. It begins with regenerating clearcuts with some small portions of an early succession species composition (young spruce-fir, birches, and aspen). It then continues into a mid-succession (mixed coniferous-deciduous forest) grading into late succession as the transect continues. In the late succession section, many tall coniferous trees are dead or dying, with more windfalls apparent after any high-wind storm. Finally it becomes an almost pure deciduous forest of Sugar Maple, Yellow Birch, and Beech with a modicum of Striped Maple and Balsam Fir. Transect 2 (see Figure 19) is the most heterogeneous and diversely managed woodland of the four transects and contains spruce, fir, and red pine plantations, clearcuts of Sugar Maple for firewood, and selectively logged mature deciduous. Transect 3 (see Figure 20) is the most heavily logged transect and consists largely of recent and regenerating clearcuts. Transect 4 (See Figure 21) is the steepest transect falling 82 m from mature coniferous at its peak through a mature deciduous slope, to a level mixed forest segment at its end.

The automated back-ward stepping general linear models showed a strong relationship between mean total birds and habitat types for both segments and point counts. The distribution of the birds in the segments and point counts were also similar. Table 5 lists the mean total birds in the 50-m band by habitat type for segments and point counts. More birds were seen in the most disturbed habitats, i.e., the "clearcut, regenerating, and early succession" habitat type. However a pair-wise comparison using the Tukey Honestly Significant Difference (HSD) test indicated that there was a significant difference in habitat type only between "clearcut, regenerating, and early succession" and "mature deciduous". This relationship held at the levels of segments and point counts. This result suggests that during the fall migration the critical habitat factor is the amount of "edge" provided by a habitat. Edge offers diverse food sources, a clear view for detecting predators and for visual orientation when moving, and thickets for protection. The significant habitat difference thus occurred between habitats having the most edge, those disturbed by forestry, and those having the least edge, mature deciduous woodlots.

A univariate general linear model shows that there was also a strong statistical relationship between habitat type and species diversity when compared to other factors affecting the migration of birds. Table 6 lists the mean number of species counted by habitat type for both segments and point counts in the 50-m band. Since the Levene Statistic indicated the analysis of variance of species by habitat did not meet the condition of the equality of variances, it was necessary to do a pair-wise analysis of species by habitat using the Tahmane's T2 test. Nonetheless, no habitat types were significantly different at the 95% confidence level. On the other hand, the analysis of variance of the point counts did meet the necessary conditions and the Tukey HSD test showed a significant positive difference between "clearcut, regenerating, and early succession" with both "mature deciduous" and "clearcut, regenerating, and early succession alongside mature deciduous". These results for species diversity parallel those of total birds and are likely also related to edge effects to some degree.

A species by species pair-wise analysis of the relationship to habitat types also required the use of the Tahmane's T2 test. In total, 17 species demonstrated significant habitat relationships at the segment level of analysis and 9 species at the point count level in the 50-m band. An even fewer number (7 at the segment level and 5 at the point count level) showed significant habitat preferences at the 95% confidence level for specific habitat types (see Table 7). When examined at the 90% confidence level, these numbers increased somewhat (11 species at the segment level and 6 at the point count level). At this confidence level, there was also a somewhat greater distinction in the variety of habitat preferences (see Table 8). As might be expected, many of the species showing the strongest relationship to particular habitat types were those preferring the "clearcut, regeneration, and early succession" habitat and avoiding the "mature deciduous" habitat (Northern Flicker, Ruby-crowned Kinglet, Common Yellowthroat, Song Sparrow, Swamp Sparrow, and White-throated Sparrow). Only the Red-eyed Vireo and Hermit Thrush showed a degree of significant preference for "mature deciduous". The Golden-crowned Kinglet and Yellow-rumped Warbler showed some statistically distinguishable preference for mature coniferous.

When segments and point counts were analyzed by all distances from the observer, six additional species were found to have significant habitat relationships (see Table 9). These were Red-tailed Hawk, Pileated Woodpecker, Blue Jay, Common Raven, White-winged Crossbill, and Pine Siskin. Again, the general tendency was for significant habitat specific results favouring edge habitat (clear-cut, regeneration, and early succession) over mature deciduous.

Nocturnal Passage Migration

The location of the four nocturnal passage listening points is plotted in Figure 22. These cover the northern, middle, and southern sections of the study area, and all are in the same location as a larger set of diurnal passage observation points.

The call notes of most birds heard were classified as either passerine (songbirds) species unspecified or thrush species unspecified. Additional birds that were heard and classified to species level were Black-bellied Plover and American Woodcock. Three Black-bellied Plovers were heard on one occasion (October 14). Passerines were heard on eight of sixteen nocturnal counts with numbers per count ranging between two to three "chip" notes, except for September 26th when 18 notes were heard. The American Woodcock was heard on 4 occasions from October 1-14. One to three wing "twitterings" were heard per count except for October 5th when 26 distinct "twitterings" were heard overhead in the dark. Since some of these birds were circling around, it is estimated that these noises represented 10 to 13 individual birds. On most counts, one of more of these woodcocks landed nearby and gave their ground-based "peent" notes.

The before dawn descent of thrushes was the most distinctive aspect of the nocturnal passage counts. Thrushes were heard on ten of sixteen nocturnal counts with the number of thrush notes heard ranging from 1 to 90. All thrush flight calls heard were those of the Hermit Thrush except for one Swainson's Thrush. Similarly, all thrushes that could be identified in the twilight by sight or by the sound of their ground calls were Hermit Thrushes. Thus, hereafter, the report of the nocturnal passage counts will refer only to Hermit Thrushes.

Each Hermit Thrush count followed a similar pattern. About 10 minutes into the 30 minute count (50 minutes before sunrise), the first flight call of a thrush would be heard. The first notes heard were faint but continued to get louder as the minutes passed, indicating descent. Most of the thrush flight calls were heard from 10 to 25 minutes into the 30 minute count (50 to 35 minutes before sunrise). From 25 to 30 minutes after the start of the count (35 to 30 minutes before sunrise), the calls tapered off, some birds were obviously circling low overhead, flight calls were very loud, and ground calls were heard nearby the observer. After the count was completed, thrushes were frequently and often numerously seen on the roads, usually in mature deciduous woodlands, leading to the location of the migration stop-over transects (30 minutes before, to sunrise). During the migration stop-over surveys, relatively few thrushes were detected compared to what was heard or seen on the ground just before dawn.

Table 10 provides further details on the nocturnal passage of the Hermit Thrush. The thrushes were recorded at all listening points. The highest counts were recorded at Point 6, located in the northeast section of the study area. The second highest counts occurred at Point 4 in the southern section. The three highest counts occurred under similar weather conditions; calm at the time of the count, southwest winds at 7-11 km/hr during the night, and seasonably cool temperatures (-3 to 2 degrees C.). In contrast, the counts for which no thrushes were heard were characterized by winds 20-50 km/hr from a variety of directions with seasonably warm temperatures (8 to 16 degrees C.). The highest number of Hermit Thrush flights calls heard during a 30-minute count was 89 on October 1st. It was estimated that an individual thrush is heard two to three times when passing overhead. Thus this number would represent about 30-45 birds.

Given the widespread and regular occurrence of a Herman Thrush descent over the study area before dawn in the study area, there is evidence suggesting that the Sugar Maple-Yellow Birch-Beech forest of the Pictou-Antigonish Highlands is a major stopover area for this species. While it remains a mystery as to where these birds go after dawn, there is some statistical support, albeit weak, that this species favours mature deciduous habitats. Some of the Hermit Thrushes counted during the stop-over surveys in mature deciduous habitat were almost missed since they were feeding silently on the ground and camoflauged by their plumage in the autumn leaf litter. Indeed some were missed because on more than one occasion, thrushes were seen on the return walk of the transect (but not included in survey results). It is possible that other survey methods and/or the development of a detectability coefficient would provide a better measure of Hermit Thrush abundance in the mature deciduous forest during the autumn migration.

Diurnal Passage Migration

The location of the diurnal passage observation points are shown in Figure 23. Among the seven observation points, three (Points 2, 4, and 5) were visited more regularly due to their location on local flyways. Observation Point 5 is at an elevation of 240 m and overlooks the Hollow or Glen Dhu, and beyond that the coastal slope of the Northumberland Strait. It is 5.6 km from the wharf at Lismore. Observation Point 2, at an elevation of 200 m, overlooks the area where the Hollow broadens out. It overlooks the coastal slope towards Big Island and Merigomish and is 7.8 km from the shore. Observation Point 4, at 210 m, is 14.3 km from the shore. Its view is primarily southward toward the interior deciduous forest of the Pictou-Antigonish Highlands.

Observation Points 5 and 2 were on the edge of steep slopes facing the gradual slope of the coastal plain. Observation Point 4 was on a gentle slope overlooking a valley. These topographical features have significance for the development of warm air thermals and updrafts for soaring birds to be discussed later.

Every bird or every group of birds of the same type passing through the observation space at these points was recorded as one observation. Observations were divided into 30 minute time blocks. If a bird flew through the observation space and then flew through it again later in the same time block, it would have been recorded as two observations. If two or more birds of the same species flew through the observation space flying in the same direction and at the same altitude category, then it was one observation of x number of individuals. If two or more birds of the same species flew through the observation area in different directions or at different altitudes, then there were y_1, y_2… observations of x_1, x_2… individual birds for each flight direction and altitude category.

Diurnal Raptors

Nine species of hawks and eagle were observed during the diurnal passage surveys. These occurred in small numbers and irregularly at all observation points throughout the autumn except for the Bald Eagle (observed in 17% of time blocks), Red-tailed Hawk (12%) and Sharp-shinned Hawk (8%). There was no discernable pattern in the direction of movement of hawks. The median time of observation ranged between 0945-1130 hours for species that were seen more than once. The results of the hawk migration are summarized in Table 11. The study area does not appear to be an important site for diurnal raptor passage during the autumn migration. The most common of these raptors, the Bald Eagle, consisted of a local population that was not migratory.

Water Birds

Water birds were very infrequently seen during the diurnal passage surveys. Most were flying toward the coast at all observation points. The most common was Herring Gull (recorded in 5% of time blocks). The movements of water birds are summarized in Table 12.

Woodpeckers and Passerines

The observations of woodpecker and passerine species are summarized in Table 13.

The Common Raven was the most frequently seen bird during the diurnal passage surveys. This species occurred in 43% of the time blocks, usually in groups of two birds (average of 1.67). The raven, like the Bald Eagle, is a local, non-migratory species. Observations were related to their commuting to different feeding areas and roosts and for the purposes of social displays or riding thermals. On October 7th, seventeen ravens were seen at Observation Point 2 at 0800 hours (45 minutes after sunrise) and appeared to be heading from an inland roost toward coastal feeding areas. Otherwise, there was no directional pattern to the movements of ravens.

Other frequently observed passerines were Yellow-rumped Warbler (24% of time blocks), Blue Jay (22%), American Robin (19%), American Goldfinch (17%), Dark-eyed Junco (15%), and Purple Finch (14%). The most observed woodpecker was Northern Flicker (4%).

The median time of observation for the most abundant species ranged between 0900 and 1100 hours.

The flight directions of observed birds were categorized into only four cardinal directions; north, east, south, and west. This classification was chosen since many birds are frequently changing their headings or start with one heading and end with another.

For woodpeckers and small to medium-sized passerines (i.e., excluding ravens), 49% of observations recorded a flight direction of west, compared to 18% for east, 13% for north, and 20% for south. This pattern of flight direction held for all wind directions. Moreover, west was the prevailing wind direction (39% of all time blocks). A matrix of flight directions during each wind direction category for major species groupings is presented in Table 14. This is visually represented for all species in Figure 24.

A similar pattern emerged for flight direction when compared to wind speed. Fifty-two percent of woodpeckers and small to medium-sized passerine observations recorded a westerly flight direction for wind speeds from 0-19 km/hr, compared to 18% for east, 12% for north, and 18% for south. At 20 km/hr or more, flight directions were more variable. The most common wind speed was 12-19 km/hr (35% of all time blocks) for which category 53% of bird observations recorded a westerly direction, 16% northerly, 16% easterly, and 15% southerly. The pattern of flight directions with different wind speeds can be seen in Table 15 and Figure 25.

Pearson's chi-square test confirmed that the both the wind direction-flight direction and wind speed-flight direction paired categories are significantly different from each other at the 95% level of probability.

These results are once again consistent with the findings of Richardson's (1972, 1978) radar studies. He found that birds migrating southwest during the night and finding themselves over water at dawn, reoriented to the west and northwest, and often continued in this direction throughout the morning. Given the northeast-southwest alignment of the coast of Eastern North America, this re-orientation direction would inevitably bring birds back to land (Baird and Nisbet 1960; Able 1977; Richardson 1972, 1978, 1982, 1990; Alerstam 1990; Licthti 2006). In the case of the study area, the birds observed heading west were already well inland. This could nonetheless be related to a reorientation earlier in the morning over water. It is also possible that the birds in the study area were heading for the coast. Flying west from any point in the study area will bring birds to the coast, along the shores of the Northumberland Strait. Richardson (1998) notes that during diurnal migration birds often concentrate along coastlines, ridges, or rivers, especially when these features are aligned within 45 degrees of the preferred flight direction.

Winter Season

Few birds wintered on the Pictou-Antigonish Highlands, especially on the higher elevations where winter conditions are the most extreme. Throughout the winter period, November through March, the mean number of birds seen per hectare was one.

The location of the winter standardized area counts are shown in Figure 26. Since each area was a different size, the number of birds present in winter is here reported in bird densities per hectare by habitat type. The habitat types are the same five as described for the autumn migration with the addition of a sixth habitat type: residential and agricultural. Agricultural land consisted of hayfields and blueberry farms.

Figure 27 presents the mean number of birds by habitat type during the winter. The differences between habitat types are not statistically significant, as can be seen in the wide 95% confidence limits. This is likely due to the small numbers of birds and total counts. Keeping in mind the statistical limitations, the winter data suggest the inverse of the autumn migration relative to habitat preferences. The density of birds in winter increases with lessening amounts of edge and with rising amounts of forest cover. Thus clearcuts and early succession forest had the smallest densities of birds (0.55/hectare) and mature deciduous the largest (1.77/hectare).

Only 19 species of birds were seen in the study area during the winter period. Table 16 gives the mean number of birds per hectare detected by species and habitat within 50 metres of the walking observer. The most common bird was Black-capped Chickadee, occurring in all habitats but most abundantly in mature deciduous. Three species did have statistically significant habitat preferences; Hairy Woodpecker and White-breasted Nuthatch for mature deciduous and Boreal Chickadee for mature coniferous. Other bird species observed at greater than 50 metres or flying are noted by habitat in Table 17. The most common winter finches during the winter of 2007-2008 were Pine Grosbeak and Common Redpoll. Other winter finches were few or absent.

Spring Migration

Overview

Spring migration in northern Nova Scotia begins in March. As the melt of snow and water bodies progresses during the month, so too does the number of migrating water birds, hawks, and passerines. On the Pictou-Antigonish Highlands it is still very much winter in March, with deep snow cover and low wind chills. During April the pace of migration and the number of returning species increases. During the month of May a wide diversity of birds pass through the area or arrive on their breeding territories. Some migration continues through the first seven to ten days of June for the latest arrivals.

Migration Stop-over

In total, 4,916 individual birds of 75 species were recorded during the spring migration stop-over surveys. As for the autumn migration, this information will be used to examine the effects of seasonality, weather, and habitat on the spring migration of birds in the study area.

The Effects of Seasonality on Migration Stop-over

Figure 28 presents an overall picture of the magnitude of spring migration in the study area with a graph of the mean total number of birds seen per transect at all distances by 10-day period. There is a statistically significant seasonal effect resulting in continuous increase in the number of birds from early April to early June. However, unlike the fall migration, there is a major complication in the counts made during spring migration stop-over. As the season progresses, there is a growing number of birds present that are not migrating but on their breeding territories. To account for this fact, analyses were also made of the total number of birds on migration stop-over by progressively eliminating from the data analysis any species that had started breeding activities (establishment of territories, courtship, nest building, etc). The breeding calendar of the Maritimes Breeding Bird Atlas (http://www.mba-aom.ca/) was used as a reference in establishing these cut-off dates.

Figure 29 shows the mean total number of birds per transect at all distances by 10-day period without the inclusion of breeding birds. This graph reveals a very different picture of spring migration stop-over in the study area. Using the Tukey Test of Homogeneous Subsets, there is strong statistical support (at the 95% probability level) for a peak migration occurring from April 11-30. When the analysis is conducted for transect segments at less than 50 metres, the peak period is even earlier, from April 11-20, according to the Tukey Test of Homogeneous Subsets (see Figure 30 for the mean total number of birds per transect segment at less than 50 metres). An automated backward stepping GLM also demonstrated the statistical significance of seasonality on total birds recorded. However this effect was not as strong as weather effects (see below).

A similar pattern emerges for the effects of seasonality on species diversity. As demonstrated in Figure 31, there is a steady increase in the mean number of bird species seen per transect at all distances from April 1 to June 9. However, when breeding birds are removed from the analysis, as seen in Figure 32, there is a statistically significant peak in species diversity much earlier, from April 21-30.

Table 18 shows the mean number of each species recorded per transect at all distances by ten-day period while Figure 33 graphically represents 26 species having a statistically significant seasonal pattern in the <50m transect segments.

Many more birds were recorded on the transects during the spring migration than during the previous autumn. This does not mean that the study area is more important as a stop-over area in the spring than in the fall. Birds are much more apparent in the spring as they sing and engage in various territorial and courtship pursuits. This greatly enhances the detectability of birds in a forest environment. For example, the apparent seasonal pattern in the records for the Ruffed Grouse, a non-migratory bird, is due to changes in its detectability. Its “drumming” is apparent throughout the forest in April while for the rest of the year it is usually only seen or heard when disturbed at close range. In addition, as already noted, there is the difficulty of distinguishing birds on migration stop-over from breeding residents. The removal of birds from the stop-over analysis once their breeding season commences has a couple of problems associated with it. First, there is no specific information on the timing of the breeding season in the study area. The use of the data from the Maritime Breeding Bird Atlas is a good alternative but the data may not correspond exactly to the actually timing of breeding on the Pictou-Antigonish Highlands. Second, within one species there can be early and late breeders. Some birds might be present in the study area on migration stop-over while others of the same species have commenced breeding activities.

Despite the limitations of the data, the analysis suggests that migration stop-over in the study area consists of three waves of decreasing intensity. In mid-April, the first wave in is dominated by American Robins, Dark-eyed Juncos, and Song Sparrows. The second wave in late April and early May consists largely of Yellow-bellied Sapsuckers, Northern Flickers, Ruby-crowned Kinglets, Hermit Thrushes, Yellow-rumped Warblers, and White-throated Sparrows. The third wave in mid to late May is made up of flycatchers, forest warblers, and Red-eyed Vireos.

The Effects of Weather on Migration Stop-over

An automated backward stepping GLM indicated that weather, compared to seasonality and habitat, had the strongest effect on the mean number of birds recorded on the survey transects. The most powerful of these effects was the wind direction during the night before the survey. This weather effect was most evident and statistically significant at the level of transect segments. Wind speed also had a strong effect. Table 19 lists the mean number of birds per transect segment at less than 50 metres for each combination of wind direction and speed on the nights preceding the survey. Table 20 lists the number of transect segments for each combination of night wind speed and direction. Figure 34 presents the information in Table 19 in a radar graph. The highest mean counts occurred on six segments when the night wind was from the southeast at 12 to 19 km/hour on average. The second highest mean counts occurred on twenty-one segments when winds were from the south at 7 to 11 km/hour.

Wind direction at the time of the survey for birds seen at all distances during the point counts also were statistically significant as an effect on mean numbers. Counts were highest for the "calm" wind direction closely followed by southeast. Mean numbers were lowest when the wind was from the east or west.

The effects of weather on species diversity followed the same pattern as for total birds at both the segment and point count levels.

The radar studies of Richardson (1971) for the spring migration in the Maritime Provinces demonstrated that the predominant flight direction is northeast, east northeast, and even east. Migration was most dense with west, southwest, and south winds. This study of migration stop-over also shows that migrants were often numerous on days following south winds during the night, more so than any other wind direction than southeast. The highest concentrations following southeast winds might be explained by a westerly drift of nocturnal migrants heading northeast to Cape Breton Island and Newfoundland.

The Effects of Habitat on Migration Stop-over

The same transects were used in the spring migration as in the autumn. These transects and their habitats were previously referred to in Figure 18, 19, 20 and 21. Table 4 describes the habitat types.

Habitat relationships with birds were not as strong in the spring migration stop-over as in the autumn. After removing breeding birds from the analysis, the mean number of birds per transect segment within the 50 metre band in the spring is illustrated in Figure 35. One can discern, as in the autumn, the influence of the edge effect as mean total birds tends to decrease with decreasing edge and increasing forest canopy; from clearcuts to mature deciduous forest. This trend is much clearer by using a backward stepping glm to generate a graph of the least square means of total birds for habitat types (see Figure 36). The least square means adjusts the habitat related means to account for other effects in the model such as season and weather. In this model, there is a distinct and continuous decline in means from clearcuts to mature deciduous.

The ANOVA and Tukey HSD tests, however, showed no significant difference in total birds among habitat types at the segment level or the point count level within the 50 metre band. It was only with total birds at all distances in the point counts that there was a significant difference between habitat types at the 95% confidence level (see Figure 37). In this case, the Tukey HSD pair-wise comparison showed significant difference only between the habitat types of clearcut, regeneration, and early succession with mature deciduous. Given the much higher detectability of birds due to singing, courting, and the lack of foliage through much of the spring season and given the more homogenous habitat types found in the point counts, it is appropriate to look beyond the 50 metre band for habitat analysis.

The automated backward stepping GLMs indicated that habitat had a statistically significant effect on species diversity only at the level of point counts at all distances. The analysis of variance of individual species resulted in eleven species having significant habitat relationships at the level of transect segments in the 50 metre band and thirteen species having significant relationships for point counts at all distance (95% confidence level). Of these, a pair-wise analysis using the Tamhane's T2 test showed that only three species at the level of transect segments in the 50 metre band and seven species at the level of point counts at all distances had statistically significant preferences for specific habitat types. These results are summarized in Table 21. In particular, Alder Flycatcher, Song Sparrow, Lincoln's Sparrow, Swamp Sparrow, and White-throated Sparrow showed some statistically significant degree of preference for clearcuts, regeneration, and early succession habitat. Black-and-white Warbler preferred mid-to-late succession forest, Ruby-crowned Kinglet sought both mid-to-late succession and mature coniferous, while the Black-throated Blue Warbler preferred mature deciduous.

Nocturnal Passage Migration

Nocturnal passage counts were conducted in May at sites 2, 4, and 5, as marked on the map in Figure 22. The nocturnal counts were much lower in the spring than in the fall. Very few Hermit Thrushes were heard (see Table 22) and the pattern of their sounds was different. Rather than being heard overhead, the flight calls of these birds were closer to the horizon near tree-top level. The highest count (6 flight calls) was recorded on May 4 which corresponds with the peak of Hermit Thrush counts during the migration stop-over surveys. Clement (2000, p. 318) notes that the spring migration of the Hermit Thrush follows the reverse route of that taken in the autumn. He goes on to say that numbers in spring vary from year to year, being abundant in some years and nearly absent in others.

Diurnal Passage Migration

The location of the diurnal passage observation points is plotted in Figure 23. These are the same points used during the autumn migration except for the addition of point 8 which looks northeastward "down" the Hollow. Observation methods were the same as in the autumn. However, the flight direction of birds was recorded in eight cardinal directions instead of four.

Diurnal passage migration was much less in the spring than in the fall. No birds were seen in twenty-four percent of the one-half hour observation blocks compared to only eight percent in the autumn. The mean number of birds seen per block was 3.00 birds in contrast to 7.08 birds in the autumn.

Hawks, water birds, woodpeckers, and passerines were less diversified by species and less abundant in total numbers than in the autumn. Only the Red-tailed Hawk was seen more frequently in the spring (24% of time blocks) than in the autumn (12%). The locally resident Bald Eagles and

Common Ravens were present in comparable numbers and frequency during the spring. Table 23 summarizes the occurrence and abundance of birds seen in the spring passage migration survey.

Spring passage migration was most intense in the morning before 10 am. As can be seen in Table 24, sixty-seven percent of woodpeckers and passerines were flying northeast or east, the predominate direction observed by Richardson (1971) in his spring migration radar studies. This is a direct heading to the southwest coast of Cape Breton Island from the study area. Sixty-six percent of diurnal passage took place with winds from the west, southwest, or south. Seventy percent of passage occurred with winds less than twenty kilometres per hour.

It is worth noting that the most common flight direction during the daytime in both the autumn and spring was 45 degrees from the prevailing nocturnal flight direction described for Maritime passerines, that is, west rather than southwest and east rather than northeast. This again suggests that passerines are concentrating along a linear topographic feature, in this case, the shore of the Northumberland Strait which roughly follows a west to east direction.

Breeding Season

The breeding season surveys consisted of three components: crepuscular and nocturnal birds, early breeders, and peak season breeders.

Crepuscular and Nocturnal Breeding Birds

Twilight and nocturnal area searches detected breeding birds that are not normally seen during the daytime. In the study area, this includes American Woodcock, Great Horned Owl, Barred Owl, and Northern Saw-whet Owl. Figure 38 shows the area search routes and the location of each individual bird heard during the survey. Several observations made during the daytime are also included.

The three owl species were heard in a mix of forest habitats with the Barred Owl the most associated with mature Sugar Maple-Yellow Birch-Beech habitat. The American Woodcock was found almost exclusively in clearcut and regenerating areas, often near a wet area.

Early Breeding

Bird species that began their nesting season before June 1 were considered early breeders in this study. The twenty-four point counts along the migration stop-over transects were used to survey these birds. As each species entered their nesting season, they were counted on these point counts as breeders rather than migrants. Between April 8 and June 2, each of these point counts was surveyed nine times. The maximum number of each species observed at each point count station was used for the analysis of early breeding. For each species, only the data obtained during their particular time of breeding was compiled. Better statistical results were achieved using the birds observed at all distances rather than in the 50 metre band.

Table 25 summarizes the results of the point count analysis for early breeders. The most abundant early breeder was White-throated Sparrow with a mean of 2.71 per point count station and occurring at 92% of the stations. It was closely followed by the American Robin with a mean of 2.54 and occurrence of 92%. Species occurring on two-thirds or more of the stations were in rank order, Ovenbird, Yellow-rumped Warbler, Dark-eyed Junco, Magnolia Warbler, Blue Jay, Black-capped Chickadee, Hermit Thrush, and Yellow-bellied Sapsucker.

An analysis of variance (ANOVA) indicated that there were significant differences (at the 95% level) in the use of habitat types by total number of early breeders, irrespective of species (see Figure 39). Highest counts were obtained in clearcuts, and early succession forest followed by mid to late succession mixed aged mixed forests. A pair-wise analysis using the Tukey HSD test revealed no significant difference between particular habitat types occupied by all early breeding birds. A limitation of point count surveys during the breeding season is that they do not adequately account for species that forage in some habitats, such as thrushes do in clearcuts but nest in deeper woods with a complete canopy.

An ANOVA showed significant differences in the use of breeding habitat types by different species only at the 90% level (see Figure 40). Nonetheless, nine species of early breeders demonstrated significant habitat relationships at the 95% level. Pair-wise analysis for individual species also indicated some degree of habitat preference for five species of early breeders (see Table 26). Northern Flicker, Common Yellowthroat, and White-throated Sparrow showed a preference for clearcuts and early succession habitat, Dark-eyed Junco for clearcuts and early succession alongside mature deciduous, and Ovenbird for mature deciduous.

Peak Breeding

The peak breeding survey consisted of 204 point counts dispersed throughout the study area. Their location can be seen in Figure 41. Each point count was surveyed one time between June 3 and July 3. In contrast to early breeding season point counts, priority was given to broad geographical coverage at the cost of intensive coverage at the station level.

Table 27 presents a summary of the results of the peak breeding bird survey. Red-eyed Vireo was the most common bird during the peak breeding season and was detected on 74% of all point counts. The White-throated Sparrow, American Robin, and Ovenbird maintained their ranking among the top four most common species but were detected on 57-61% of point counts rather than on two-thirds or more. The Black-throated Green Warbler was also seen or heard on 57% of point counts.

An ANOVA revealed that there were significant statistical differences (at 95% level of probability) in the total number of peak breeding birds according to habitat type. Figure 42 demonstrates that the highest counts were obtained on residential and agricultural habitat, followed by disturbed forest habitat to mature forests in decreasing order. A pair wise comparison with the Tukey HSD test found significant difference between individual habitat types. The clearcut and early succession habitat had significantly greater number of birds than mature coniferous and deciduous. The clearcut and early succession alongside mature deciduous habitat and the mid to late succession habitat both had greater total birds than mature deciduous.

Figure 43 shows that species diversity follows the same pattern relative to habitat use but with even greater statistical strength. There were significant differences in species diversity at the overall habitat level of analysis and between specific habitat types. Clearcuts and early succession forests were significantly more diverse in bird species than mid to late succession, mature coniferous, and mature deciduous. Clearcuts and early succession forests alongside mature deciduous, mid to late succession forests, and residential and agricultural land were more diverse than mature deciduous.

Individual bird species also showed strong habitat relationships during the peak breeding season. As shown in Table 28, twenty-nine species showed significant habitat relationships at the 95% level of confidence. Of these, fifteen showed significant preference for specific habitat types. For two species, their numbers were significantly higher in one habitat type than all five other habitats. These were Ovenbird for mature deciduous and Black-throated Green Warbler for mature coniferous. Among the other species showing statistically strong preferences for specific habitats were Alder Flycatcher, White-throated Sparrow, Song Sparrow, and Common Yellowthroat for clearcuts and early succession forests, Least Flycatcher, Mourning Warbler, and Common Yellowthroat for clearcuts and early succession alongside mature deciduous, and Red-eyed Vireo and Least Flycatcher for mature deciduous.

Effects of Survey Effort, Seasonality, Weather, and Time of Day on Point Count Results

The mean number of birds seen at each of the point count stations was considerably higher in the early breeding season compared to peak breeding; nearly twice as high. This is due to the fact that the early breeding point counts in April and May were conducted repetitively. Total effort at each point count station was 90 minutes, close to the 100 minutes other studies have determined as necessary to detect all breeding birds present (see Research Methods section). In reality, the effort was much less for those species beginning nesting later in the season. However, all species at all 24 early breeding point count stations were surveyed at least twice.

Table 29 lists the rank of the early breeders in April and May next to their equivalent rank during June and July (with later breeders removed from the scoring). Despite large differences in the absolute numbers of birds recorded per station, 67% of the most common early breeders (occurring on 40% or more of the point count stations) had a difference in rank of only 0 to 3 points. These results provide some further evidence of the usefulness of point counts in measuring the relative rather than absolute abundance of breeding birds.

ANOVA tests were applied to weather, time of day, and total birds data for the peak breeding season (see Figure 44). While the mean of total of birds was highest with calm winds (13.38) and lowest at wind speeds up to 20-29/km/hr (11.25), the differences were not statistically significant. Nor were the effects of visibility (fog). The number of birds detected was significantly less in light rain compared to no precipitation (8.69 vs. 12.23). The time of morning, from sunrise to 4 hours after sunrise, did not have significant effect on the mean total birds detected.

Breeding Status

Throughout the point count surveys, evidence of the breeding status of birds in the study area was noted. Such evidence was also gathered during the preliminary assessment in the study area during June and July of 2007. Using the criteria established for the Maritime Breeding Bird Atlas, each species was classified as a "possible", "probable", or "confirmed" breeder (see http://www.mba-aom.ca/ for more details). In total from June 2007 to July 2008, 90 species of breeding birds were found in the study area of which 28 were possible breeders, 34 probable breeders, and 28 confirmed breeders. Table 30 lists the status of each species.

Risk Assessment and Mitigation Measures

This section will assess the potential effects of wind farm development on the birds in the study area. It is important to note again that this study was conducted before the finalization of turbine placements and turbine design. What was known were the properties upon which turbines would be built and the leading candidate for turbine design.

The risk assessment will be divided into the following topics: collision risks, displacement from disturbance, barrier effects, species of special concern, and habitat effects.

Overview

There are no major concentrations of birds that occurred in the study area during the autumn and migration. Nonetheless, the area is an important migration stop-over for various species of woodland birds. The pre-dawn descent of Hermit Thrushes and the waves of migrating warblers in the autumn, and the woods filled with thrushes and sapsuckers during the spring migration make this area a noteworthy part of the avian ecology of Nova Scotia. However, these events occur over a wide area of the Pictou-Antigonish Highlands and are not unique or confined to the study area or specific turbine properties. The following sections address specific issues related to wind farm development.

Birds at Risk from Collisions with Wind Turbines

Both the nocturnal passage and diurnal passage surveys in the autumn point to the need to evaluate the risk to migrating and commuting bird for collisions with wind turbines.

The nocturnal passage surveys provided evidence that the American Woodcock and Hermit Thrush are descending to the ground in the dark from one hour to one-half hour before sunrise during their autumn migration. Those birds descending to ground in the immediate vicinity of wind turbines are thus potentially at risk from collisions with the rotating blades.

It was also noted that these descents are of the greatest magnitude under calm wind conditions. Thus there might be a natural mitigation of this risk as the blades may not be rotating when the numbers descending are highest.

There is a need to understand this phenomenon more completely. An acoustic monitoring study should be conducted in the autumn of 2008 to evaluate further the potential risk of collision for these species and possible mitigation measures.

Wind turbines may also pose a threat to the American Woodcock during the time they are engaged in flight songs. Male woodcocks will use almost any size open, relatively flat area, with bare ground, short grass, or even patches of snow, as a display ground, sometimes far from their preferred diurnal habitat (Keppie and Whiting Jr. 1994). During the first few years after construction, it may be necessary to cover such open areas with brush or find other ways to discourage woodcocks from using the cleared areas around newly constructed wind turbines as a platform for their flight songs.

During the diurnal passage surveys, the flight altitude, relative to the observation point, of all birds was recorded in categories of <0 m (birds flying below the elevation of the observation point), 0-50 m, 50-125 m (the sweep of the turbine blades if located at the observation point), and greater than 125 m. The species of birds, along with the number of observations, passing through the 50-125 m altitude category is presented in Table 31. The data from the autumn migration was used since there are a much greater number of passage migrants during this season. The species, for which there are more than 10 observations, most likely to be flying at the height of the blade sweep are Bald Eagle (38% of observations), Sharp-shinned Hawk (33%), Red-tailed Hawk (33%), Common Raven (22%), warbler species unspecified (15%), American Robin (14%), passerine species unspecified (7%), and Yellow-rumped Warbler (6%).

Of particular concern among these species are Bald Eagle and Common Raven. They are present throughout the autumn and were among the species most often seen during the diurnal passage surveys, particularly the latter. Table 32 presents data for the flight altitude of these two species by the three most surveyed observations points; Numbers 5, 2, and 4. One might expect that birds would be seen soaring more often at Observation Points 5 and 2 since they are located near the top edge of the southern side of a steep slope overlooking the Hollow and the coastal slope. Both thermals, up-drafts caused by the warmer temperatures at ground level in the lowlands, and orographic flows, caused by vertical step-up of air at ridges, would create favourable conditions for the riding of air currents by soaring birds, especially near the ridge edge. In contrast, Observation Point 4 is not close to the warmer temperatures generated in the lowlands and is located atop a gentle slope from the valley to the south. The data indicate that there is little difference in the tendency of Bald Eagles to fly at blade height among the three observation points. There is a noticeable difference in flight altitudes for Common Ravens between the three sites but these difference are not significant using the Pearson Chi-square test.

However, when a statistical analysis is employed using all observations of all species that flew at blade height at all observation points in the autumn, a Pearson Chi-square test shows a significant difference between the observation points (p=0.038). When this test compares Observation Points 4 and 5, the significance is greater (p=0.020), and stronger still when one combines the observations for Points 2 and 5, the two atop steep ridges, and compare them to Point 4, atop a gentler slope (p=0.006). The last analysis also shows a significant difference for the Common Raven at a 90% confidence level (p=.0.098).

This analysis suggests that soaring birds such as diurnal raptors, gulls, and corvids are more likely to be flying at blade height when the turbines are placed near steep cliff edges. In addition, the data suggest that Bald Eagles are the most likely to fly at blade height due both to vertical air flows and a higher flying altitude, with or without air current assistance.

Additional studies documenting the overall and seasonal abundance of raptors and corvids in the study area and more detailed behavioural studies at specific proposed turbine sites in the autumn of 2008 would further define the risks involved. Until additional research becomes available, serious consideration should be given to setting back wind turbines from steeply-inclined ridges where updrafts are most conducive for soaring. Again, the optimal set-back distance requires further study.

Since the field work was completed, the design of the wind turbines for the Glen Dhu site has changed, with the sweep of the turbine blades reaching down to 38 metres above the ground instead of 50 metres. This will put the flight paths of more soaring birds and small passerines at blade height than what is indicated by this study.

Displacement from Disturbance

Displacement from disturbance is an equivalent of habitat loss when during the construction and post-construction phase of wind farm development, the visual, noise, and vibration effects of the turbines and the disturbance created by construction and maintenance crews, their vehicles and machinery drive birds from the area (Drewitt and Langston 2006). Some preliminary evidence suggests that birds do not habituate to wind farm disturbance and that the effects actually become more pronounced over time (Stewart, Pullin, and Coles 2004). The extent of these impacts is best determined through a well-designed post-construction monitoring program.

Barrier Effects

The barrier effect is a result of wind farms causing birds to alter their flight paths to avoid wind turbines. This positive behaviour can become a negative impact when avoiding the turbine arrays can cause birds to lose too much energy or create stress.

The results of the diurnal passage surveys suggest that many passerine birds over the study area in the early morning are off-course or otherwise re-orienting to locate a migration corridor. After a night of migration, they may have a limited energy budget remaining to find a suitable landing location. For this and other reasons, the construction of wind turbines in clusters is considered one of the "best practices" of wind farm design and provides corridors for birds to fly through safely (Drewitt and Langston 2006).

The results of the diurnal passage survey also demonstrated that significant numbers of birds were flying in a westerly or easterly direction. Thus, there is further reason to construct turbines in clusters, rather than rows, especially rows perpendicular to an east-west axis.

Species of Concern

Table 33 list the species of birds for which their populations in Nova Scotia are considered by various conservation agencies to be at higher degrees of risk for serious decline or extirpation. Table 34 summarizes the status of these species of concern in the study area. The two species listed as "special concern" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), Peregrine Falcon and Rusty Blackbird were seen only once each in the study area in the autumn migration. The three species listed as "threatened" by COSEWIC were seen during the breeding season and will be discussed in more detail below. The other species listed as "yellow" by the Province of Nova Scotia or as a priority species by Partners in Flight involve largely habitat questions and will be dealt with in the next section of this assessment.

Chimney Swift

Two Chimney Swifts were seen together in flight in early July 2008 at the extreme southwest corner of the study area. Generally Chimney Swifts nest in towns or cities, and it is most likely these were foraging birds. While it is possible that Chimney Swifts will nest in large dead trees in mature forests, there is not enough evidence at this time to warrant a consideration of the possible impacts of a wind farm on this species.

Olive-sided Flycatcher

The Olive-sided Flycatcher was seen on 8 occasions during the spring migration and on 12 breeding point counts (see Figure 45). This suggests the species is fairly widespread in the study area in suitable nesting habitat; clearcuts and early successional forests. Photos of the breeding habitat of the Olive-sided Flycatcher in the study area can be seen in Figure 46.

The existence of large snags in clearcut or burned areas adjacent to forests (to build a nest) appears to be a critical component of this species' habitat (Altman and Sallabanks 2000). The causes of decline of this flycatcher are unknown and are puzzling since the availability of suitable habitat is increasing. Studies indicate that reproductive success is much less in clearcuts than in burnt over areas (Altman and Sallabanks 2000). It has been surmised that there is some critical factor lacking or present (like squirrel predation) in clearcuts compared to burnt areas.

Olive-sided Flycatchers feed from the top of a large snag and usually catch insects by flying outward horizontally or downward. Occasionally (about 17% of forays) they will fly upwards to catch prey (Altman and Sallabanks 2000).

Due to the unknown causes for the decline in the Olive-sided Flycatcher, it is difficult to assess the impact of a wind farm on its population in the study area. The construction of a wind farm should not negatively affect the habitat available to Olive-sided Flycatchers. Where wind turbines are placed in habitats suitable for this species, large snags should be cut down for at least 150 metres around their perimeter. This will help lessen the risk of collisions with rotating wind turbine blades.

Canada Warbler

The Canada Warbler was seen on four occasions. The first two were during the breeding season in 2007; one a single individual near Vamey's Lake and a pair in the southern portion of the study area (see map in Figure 47). In 2008, a male accompanied by a female was singing near the edge of Vamey's Lake in their spring migration period, and a single male in the exact same location as in 2007 in the southern portion of the study area.

The breeding habitat of the Canada Warbler is moist, mixed coniferous-deciduous forest, with a well developed understory, often near open water (Conway 1999). The breeding habitat of the Canada Warbler in the study area is shown in Figure 48.

The decline of Canada Warbler is believed to be related to the loss or degradation of nesting habitat (Conway 1999). The forestry practices aimed at reducing the deciduous component of Maritime forests have likely had a negative impact (Erskine 1992). Studies in New England and the Middle Atlantic States reported the Canada Warbler was one of the top five species most sensitive to forest fragmentation. At a more site-specific level, studies have shown that the clearing of brush and understory in forests, as well as grazing by ungulates, negatively affects their populations (Conway 1999).

The clearing of land for turbine construction is not likely to impact the Canada Warbler since turbines are built on higher ground, way from moist woodlands. The construction or improvement of roads and the construction of ancillary structures should avoid removing forest understory in wet areas. The wetlands and wet forests around Vamey's Lake and the wet forests in the southern section of the study area are the most promising habitat for the Canada Warbler. Wind farm development near these areas would most likely pose the greatest threat to existing populations of Canada Warbler or to their potential growth.

The problem of forest fragmentation is addressed in the next section.

Habitat Effects

This study shows repeatedly the importance of a variety of forest habitat types for bird populations. Cleared and early successional forest habitats with a high degree of edge are critical for many birds during the migration and breeding periods. Mid to late successional and mature coniferous forests are the preferred habitat of a number of the most common breeding birds. Deciduous forests may be essential as overwintering areas and provide the habitat of the first and fourth most abundant birds in the study area during the peak breeding period, Red-eyed Vireo and Ovenbird.

At this time, the greatest threat to the mature Sugar Maple-Yellow Birch-Beech hardwood forest and associated bird habitats on the Pictou-Antigonish Highlands is from harvesting for firewood. The local price per cord in the summer of 2008 for wood cut, split, and delivered is about 20% higher than at the same time last year. Thus, there is a strong likelihood of a continuing increase in hardwood harvest with further loss of mature forest habitat and more forest fragmentation. Given that wind farm development would take place in a variety of early to late successional forest areas, the loss of mature deciduous woodlands would likely be small, especially in comparison to forestry operations.

For those species listed as "Yellow" status by the Province of Nova Scotia or as a "Priority Species" by Partners in Flight, recovery depends on a broad, concerted effort by all forest users. This is the approach recommended by Partners in Flight (Rosenberg and Hodgman 2000). Their plan focuses on conserving and restoring the populations of the Canada Warbler and Black-throated Blue Warbler since in doing so, the situation of all other stable or declining species would improve as well. The elements of their plan are as follows:

• maintaining a balance of forest-age structures, including adequate amounts of mid-successional as well as late-successional forest

• ensuring long-term tree-species composition; i.e. prevent loss of particular species, such as hemlock, white pine, or beech, through disease or selective harvest

• ensuring adequate structural diversity, especially regarding understory components (shrubs, treefalls); monitor effects of natural disturbances (e.g. wind storms) as well as deer browsing and forestry practices

• setting maximum allowable levels of forest fragmentation due to forestry practices or planned development; e.g. do not allow any 10,000 km^2 landscape to fall below 70% forest cover

• identify and designate Bird Conservation Areas (BCA), within which long-term sustainability of priority bird populations is a primary management objective

This approach requires that industry, conservation groups, and First Nation, municipal, provincial, and federal governments intensify their efforts toward integrated management of the forest ecosystem over a sufficiently large area.

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The cover is a collage of photos taken by Bernard Burke, Anita Pouliot, and the author. All other photos and graphic materials are by the author unless otherwise noted.

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Figures

Figure 1. Location of Study Area (Outlined in Red)

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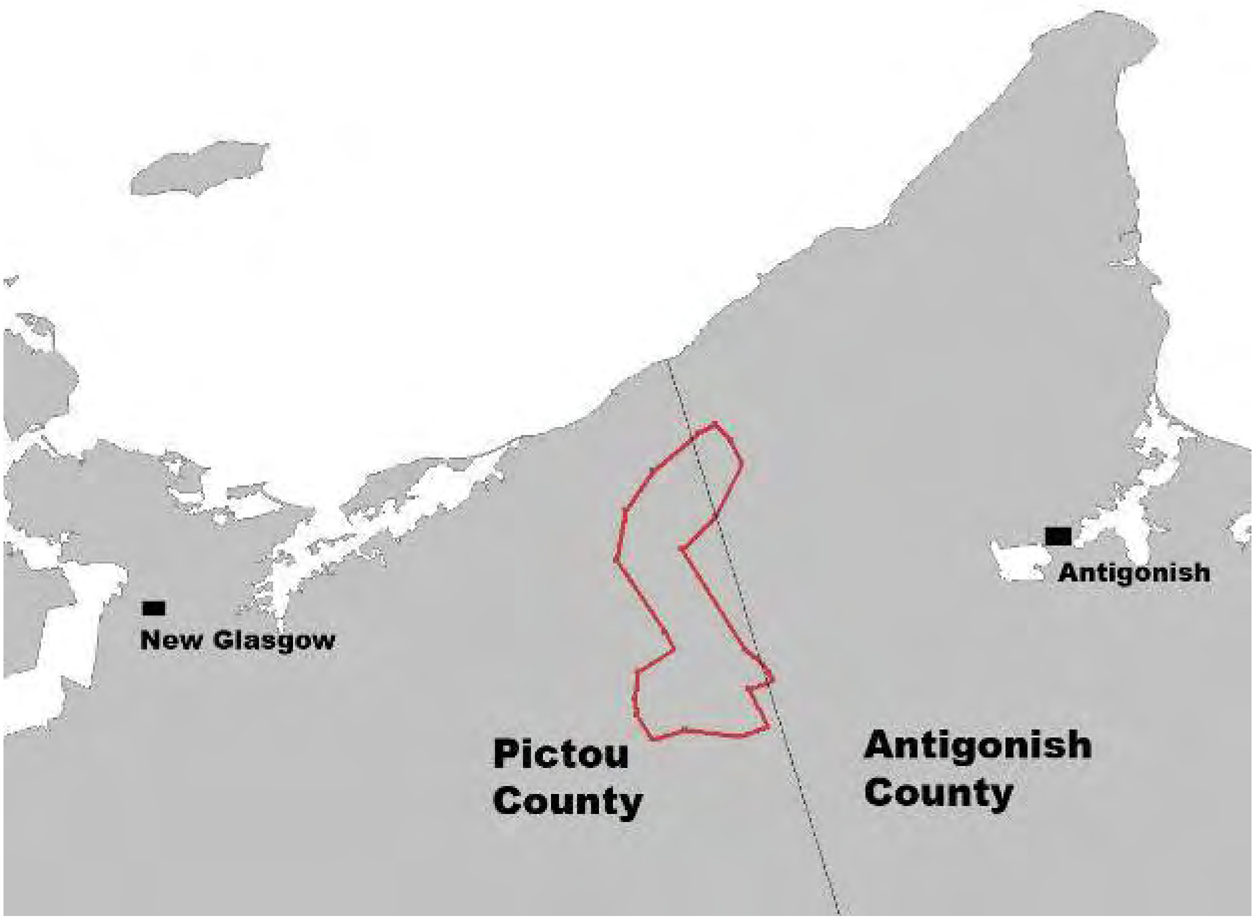

Figure 2. The Hollow or *Glen Dubh* (Dark Valley)

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Figure 3. View from Pictou-Antigonish Highlands towards the Northumberland Strait
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Figure 4. Fog Bank on Glen Dhu Wind Farm Site

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Figure 5. Mature Sugar Maple-Yellow Birch-Beech Woodland near the Glen Dhu Road

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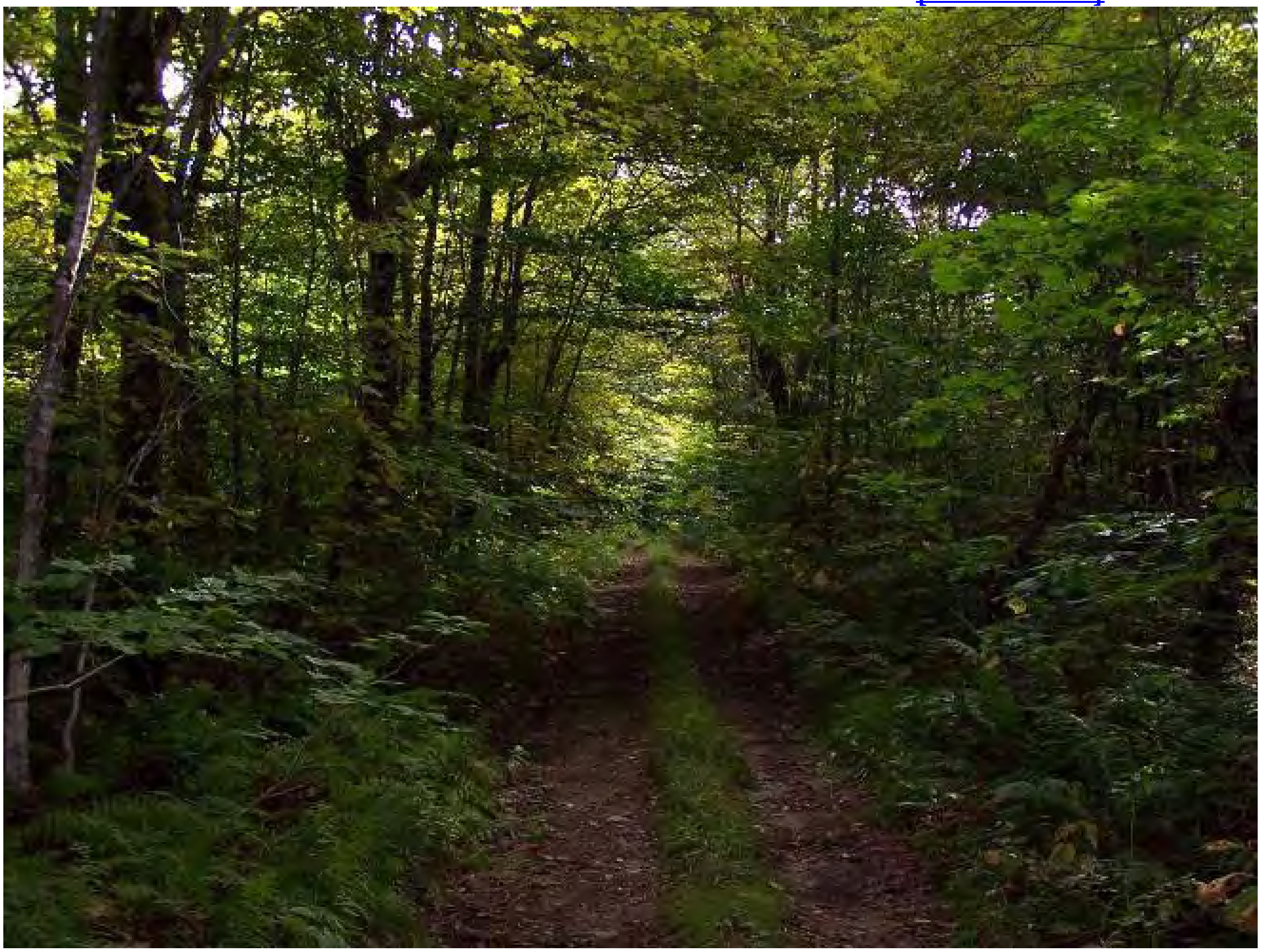

Figure 6. Clearcut Spruce Forest (Top) and Stack of Sugar Maple Logs for Firewood (Below)

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Figure 7. Cultural Infrastructure on the Glen Dhu Wind Farm Site

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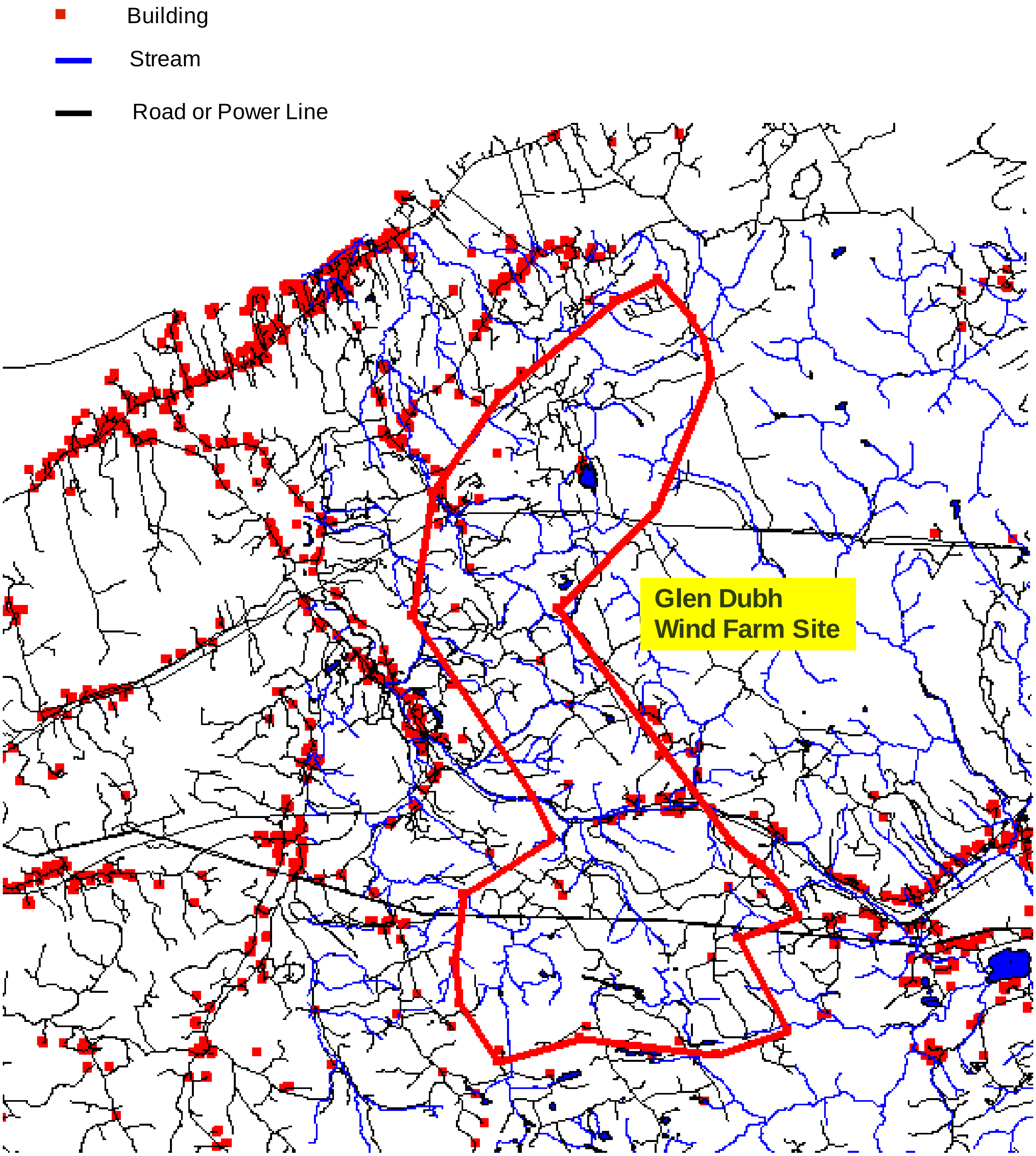

Figure 8. Human Ecological Footprint on the Pictou-Antigonish Highlands from Least (0) to Most Intense (100) Impact (Two Countries One Forest 2007)

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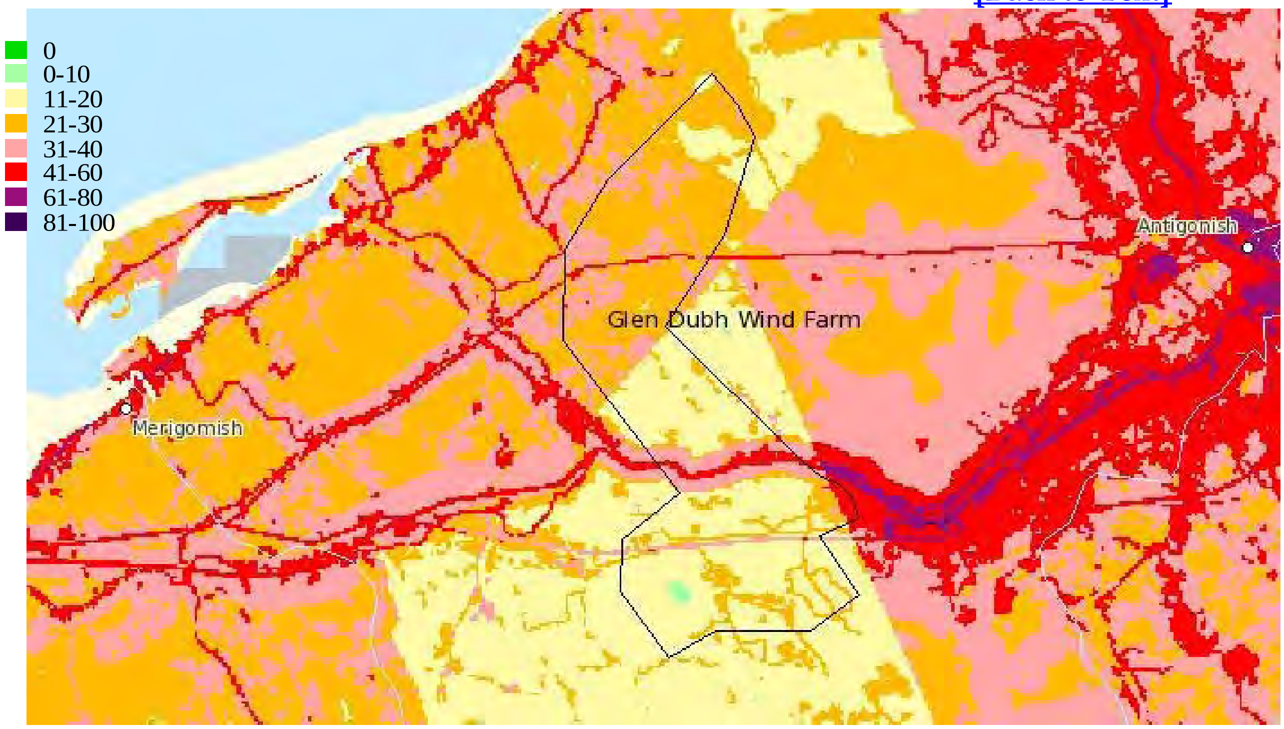

Figure 9. Location of Transects

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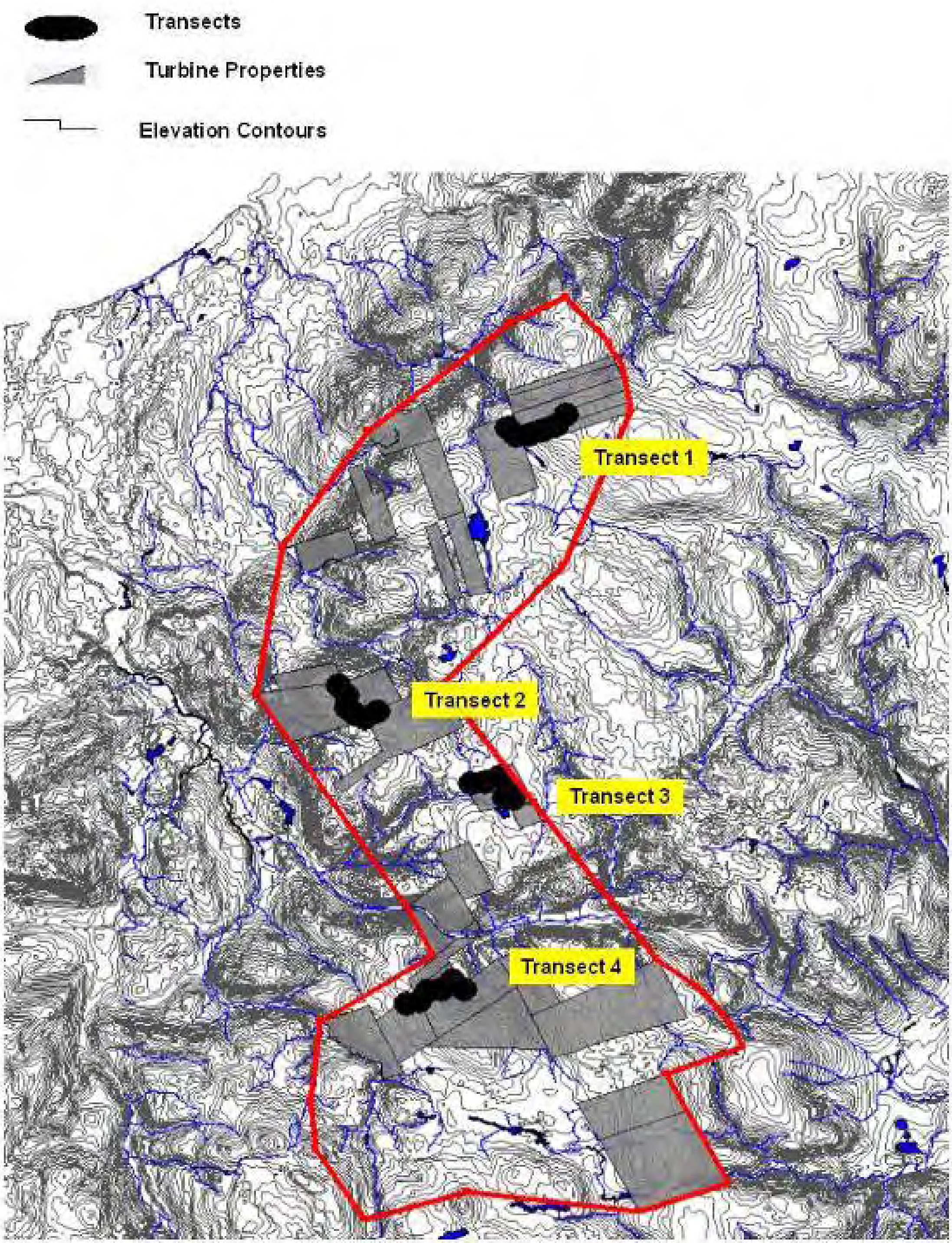


Figure 10. Mean Total Number of Birds per Transect at All Distances by 10-Day Period during Autumn Migration (With 95% confidence limits)

[Back to Text]

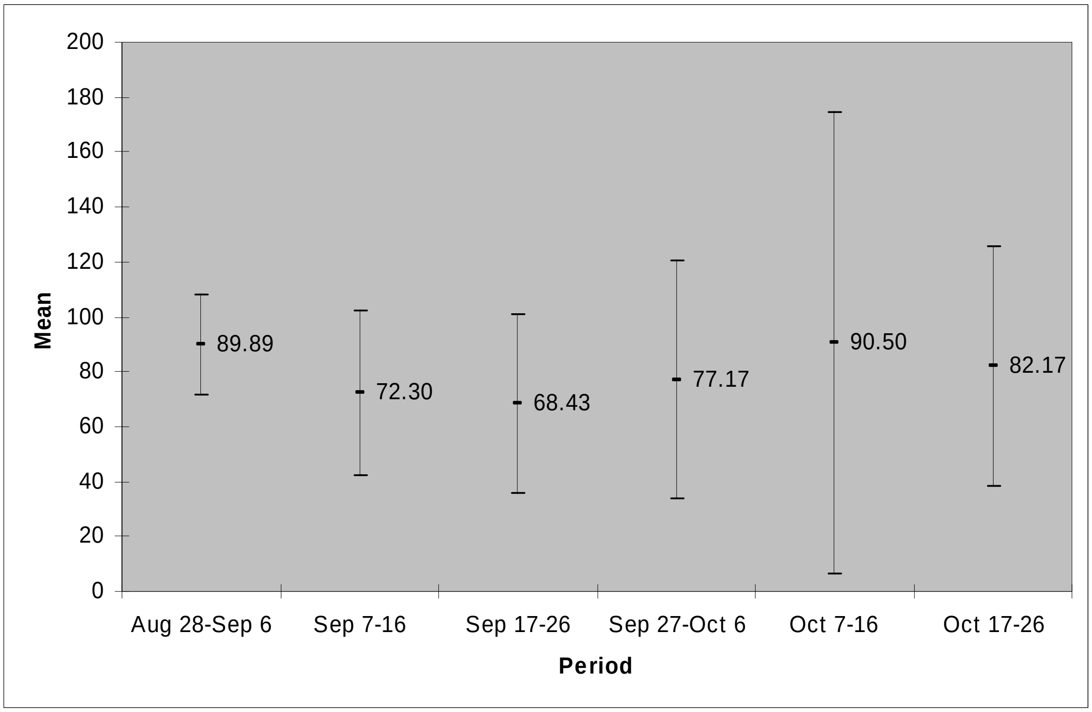


Figure 11. Mean Total Number of Birds per Transect Segment at < 50 m by 10-Day Period during Autumn Migration (With 95% confidence limits)

[Back to Text]

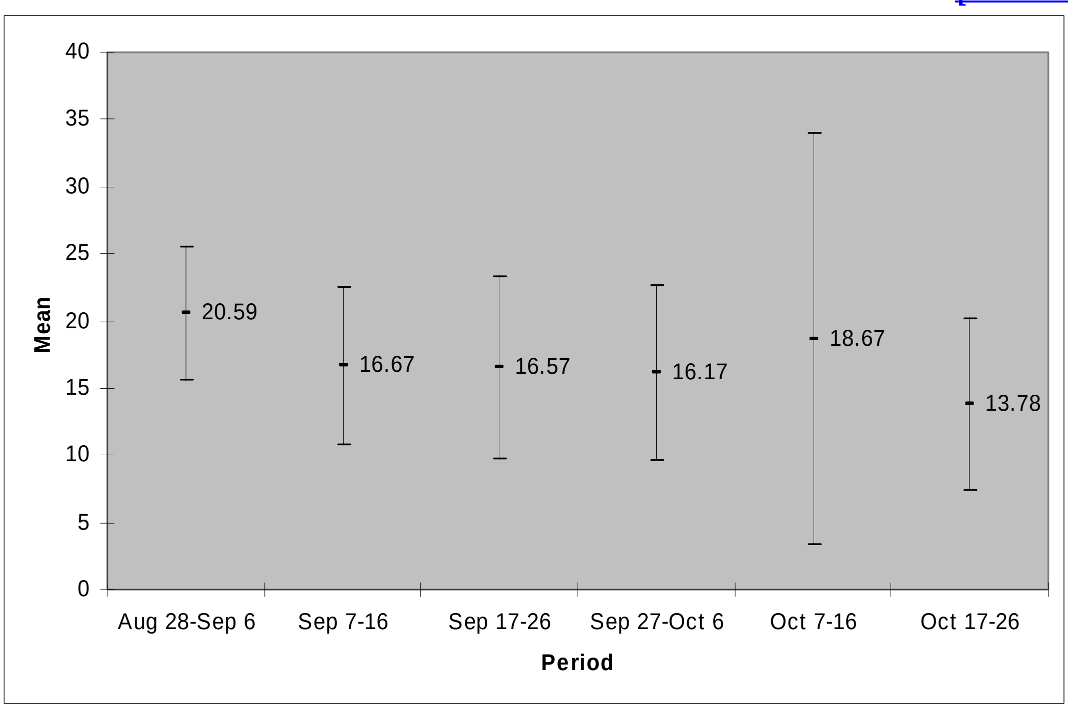


Figure 12. Mean Total Species of Birds per Transect at All Distances by 10-Day Period during Autumn Migration (With 95% confidence limits)

[Back to Text]

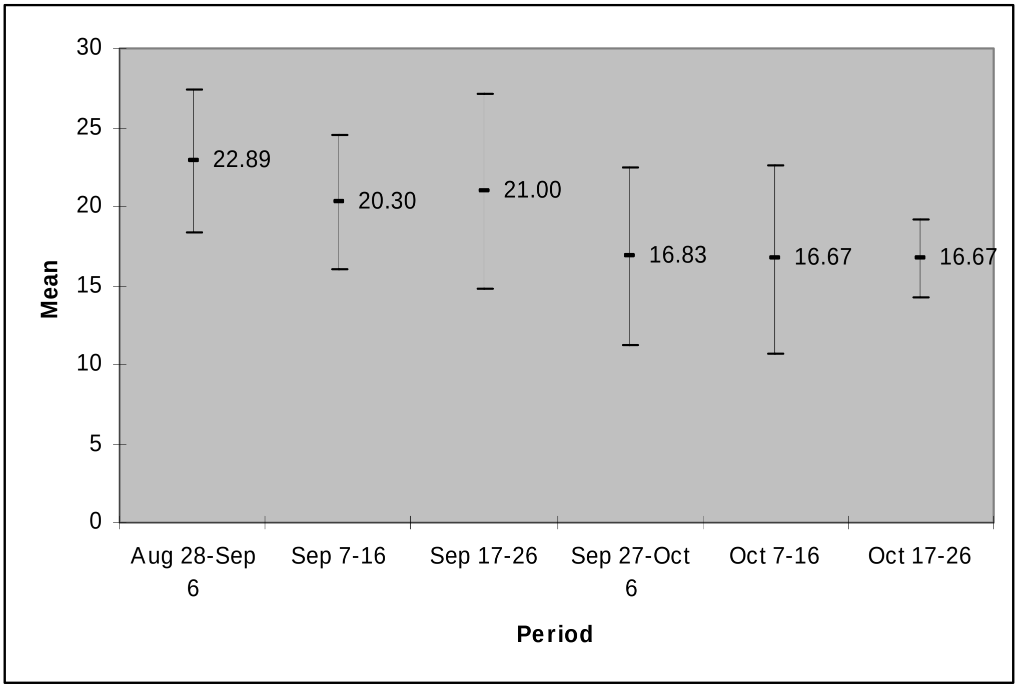


Figure 13. Mean Total Species of Birds per Transect Segment at <50 m by 10-Day Period during Autumn Migration (With 95% confidence limits)

[Back to Text]

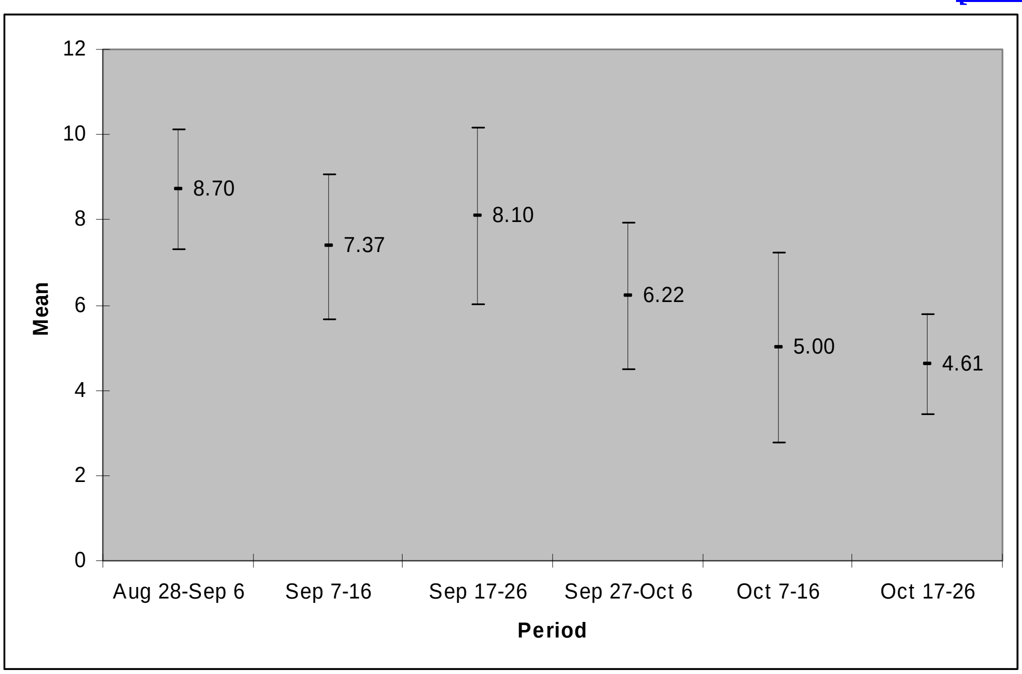


Figure 14. Mean Number of Birds by Species Demonstrating Statistically Significant Seasonal Patterns per Transect Segment <50 m by 10-Day Period during Autumn Migration

[Back to Text]

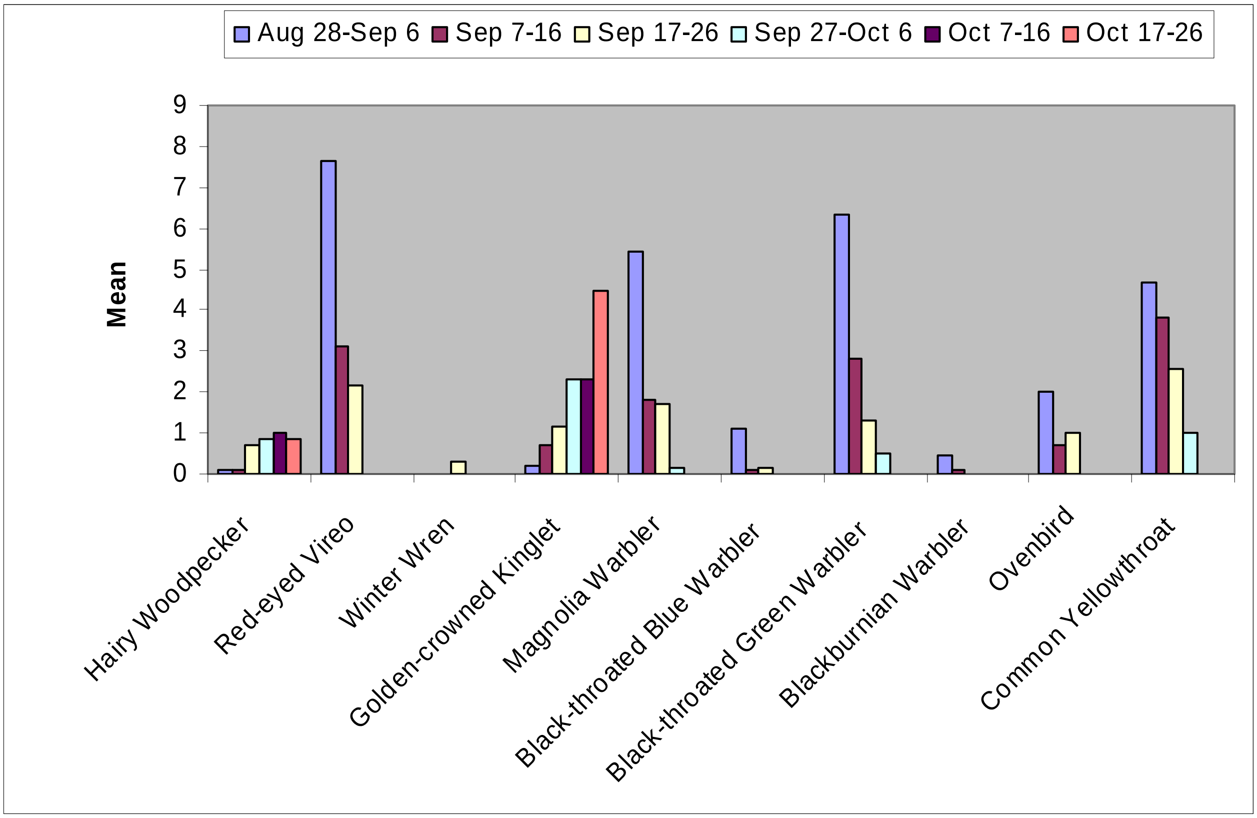


Figure 15. Mean Number of Birds by Species More Easily Detected at Distances >50 m and Demonstrating Statistically Significant Seasonal Patterns by 10-Day Period during Autumn Migration

[Back to Text]

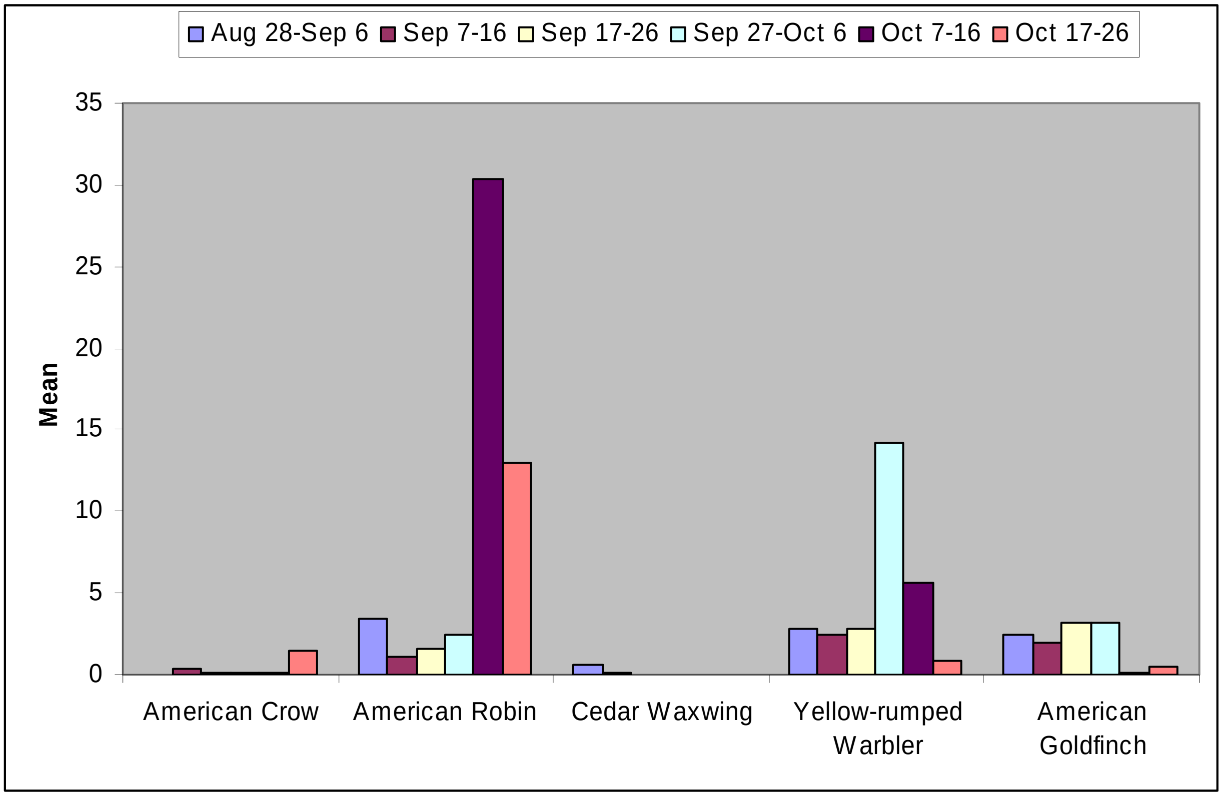


Figure 16. Radar Plot of Mean Total Birds, Wind Speed, and Wind Direction per Transect during Autumn Migration

[Back to Text]

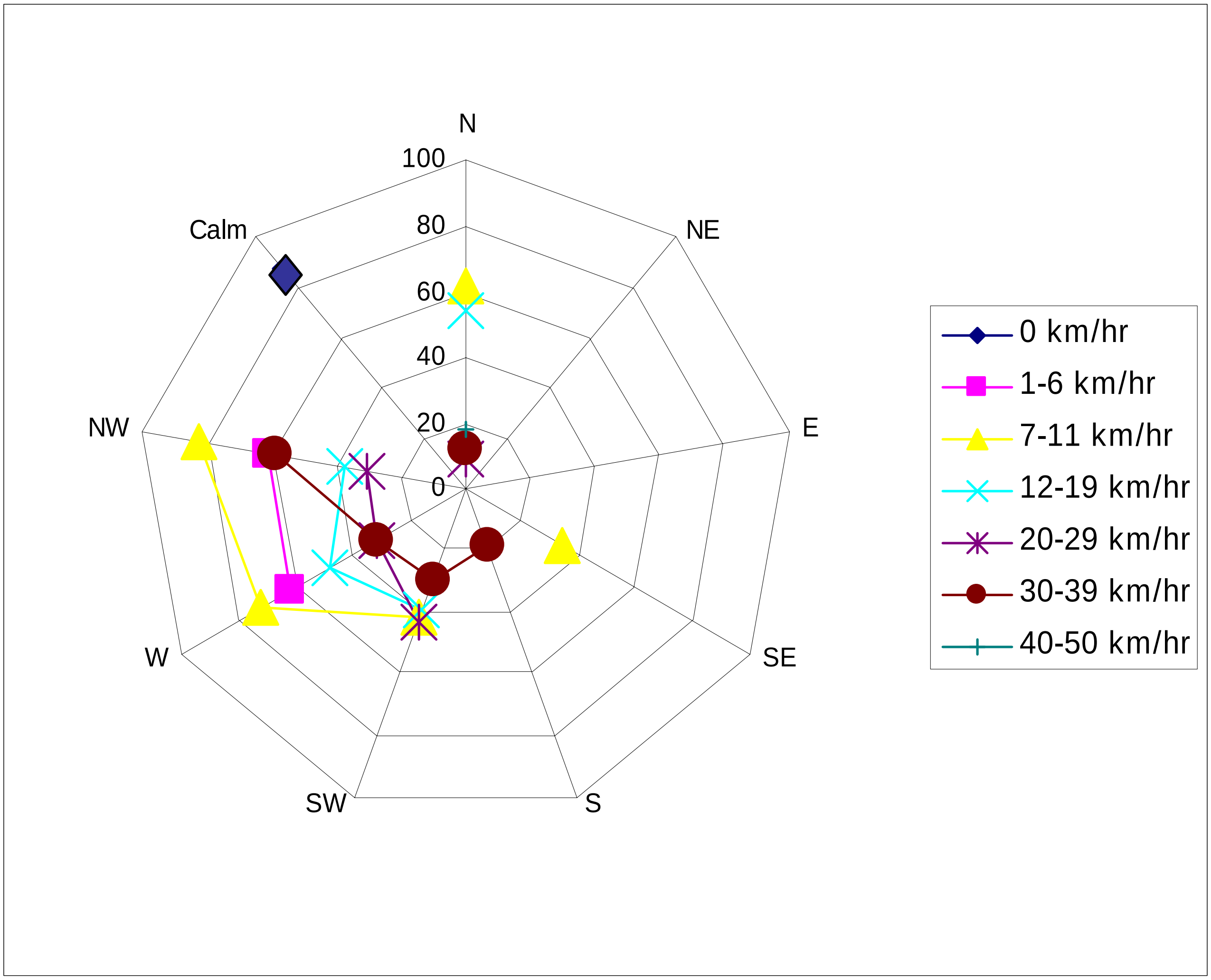
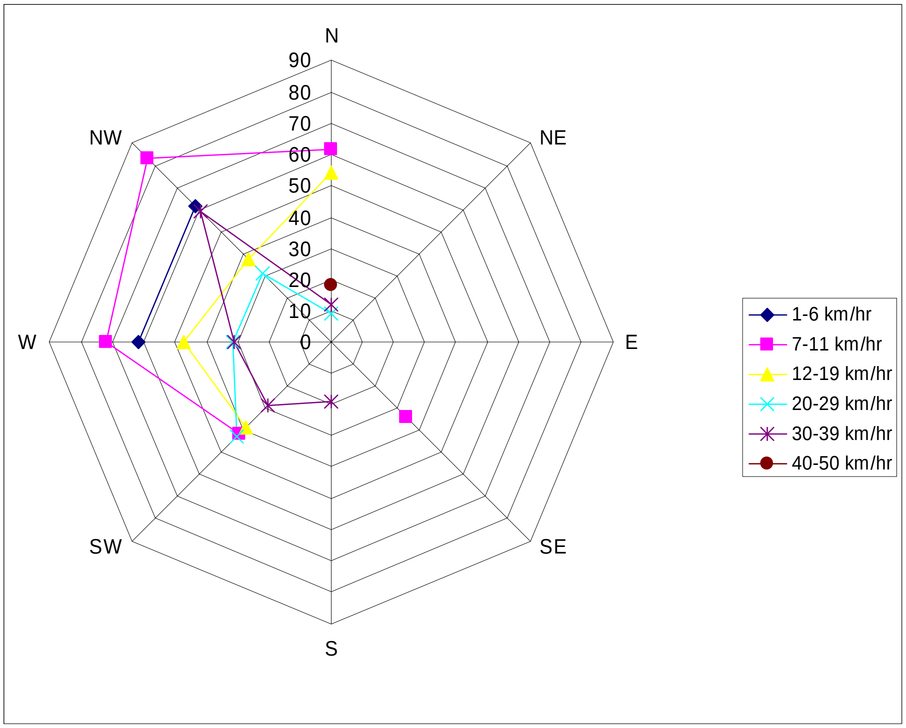


Figure 17. Radar Plot of Mean Total Birds, Wind Speed, and Wind Direction – Without "Calm" Direction – during Autumn Migration

[Back to Text]

A. Per Transect



B. Per Segment of Transects

[Back to Text]

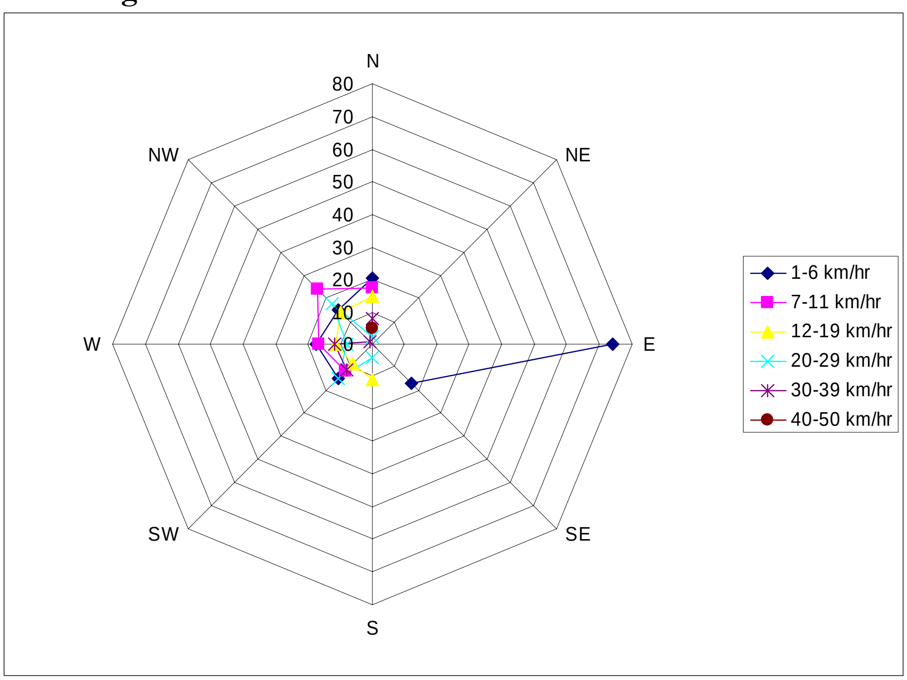


Figure 18. Forest Composition in Transect 1

[Back to Autumn Migration] [Back to Spring Migration]

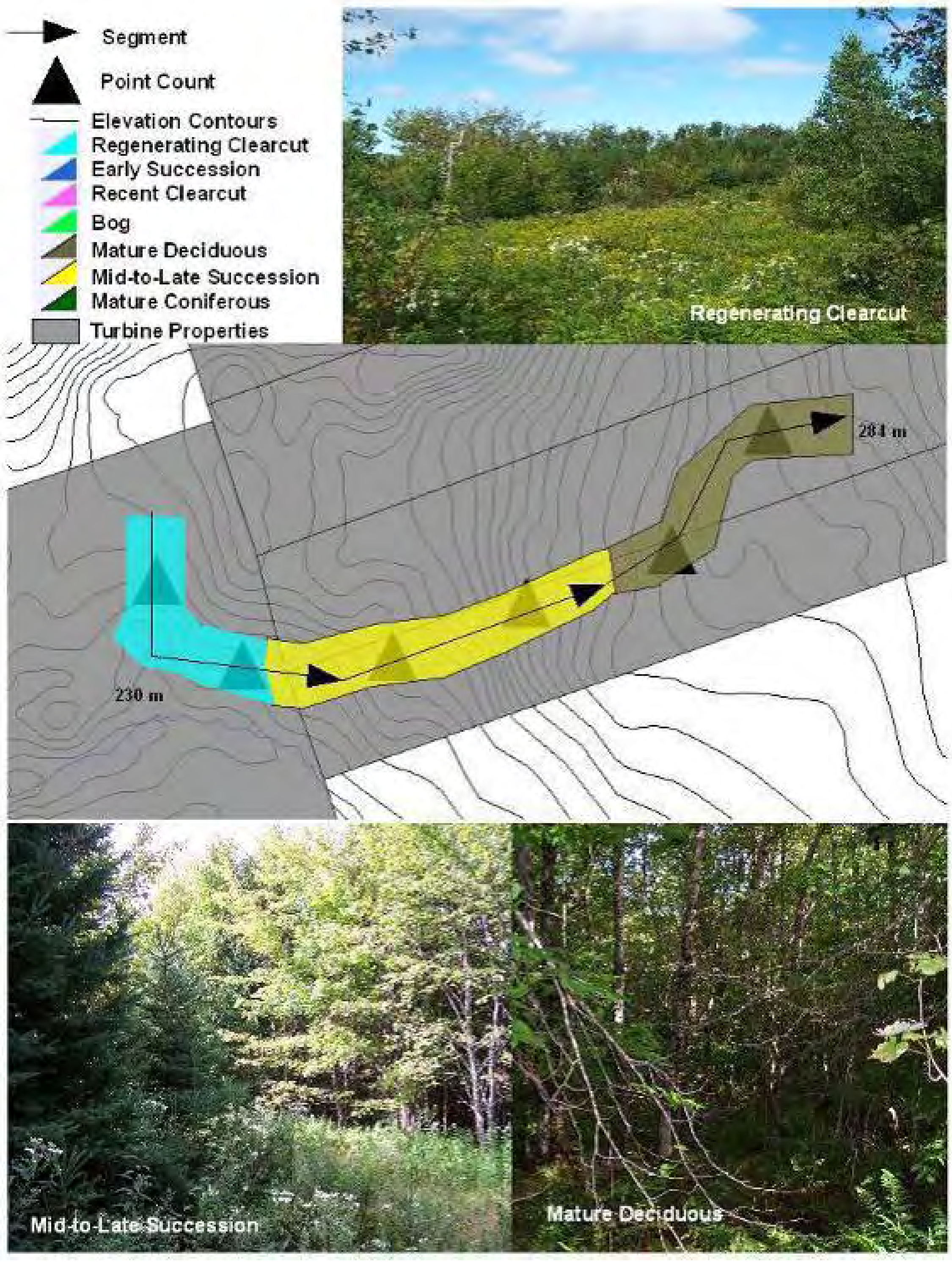


Figure 19. Forest Composition in Transect 2

[Back to Autumn Migration] [Back to Spring Migration]

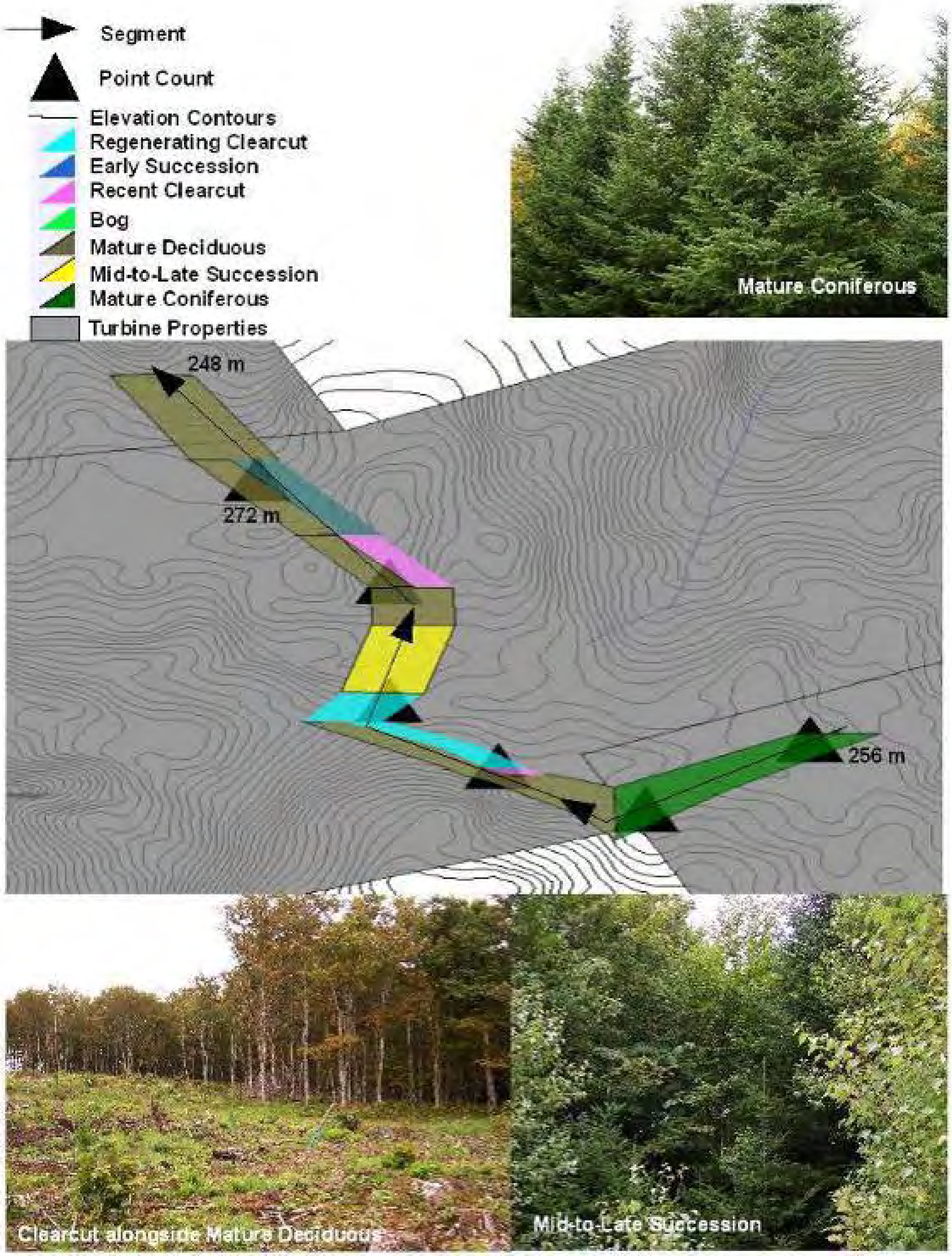


Figure 20. Forest Composition in Transect 3

[Back to Autumn Migration] [Back to Spring Migration]

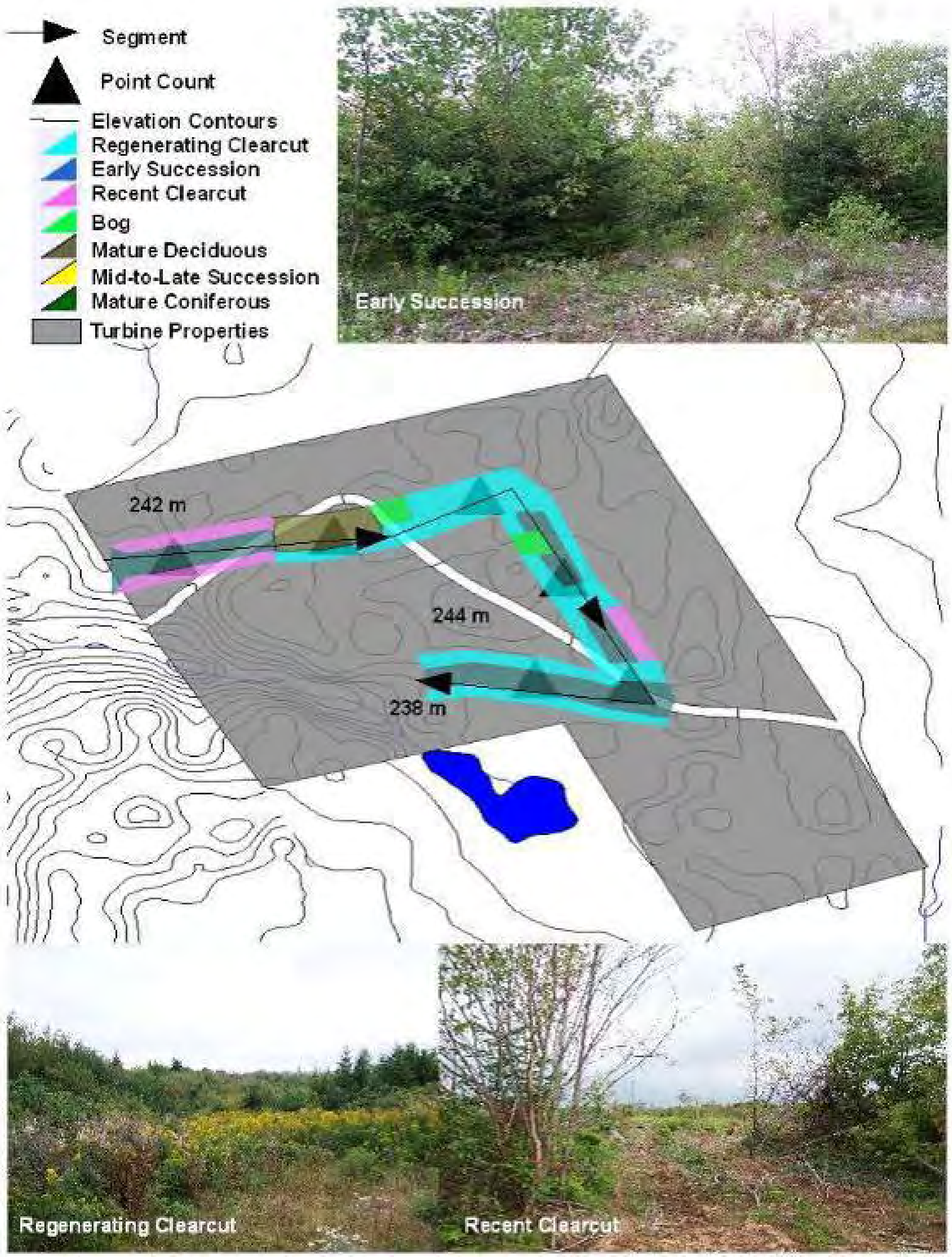


Figure 21. Forest Composition in Transect 4

[Back to Autumn Migration] [Back to Spring Migration]

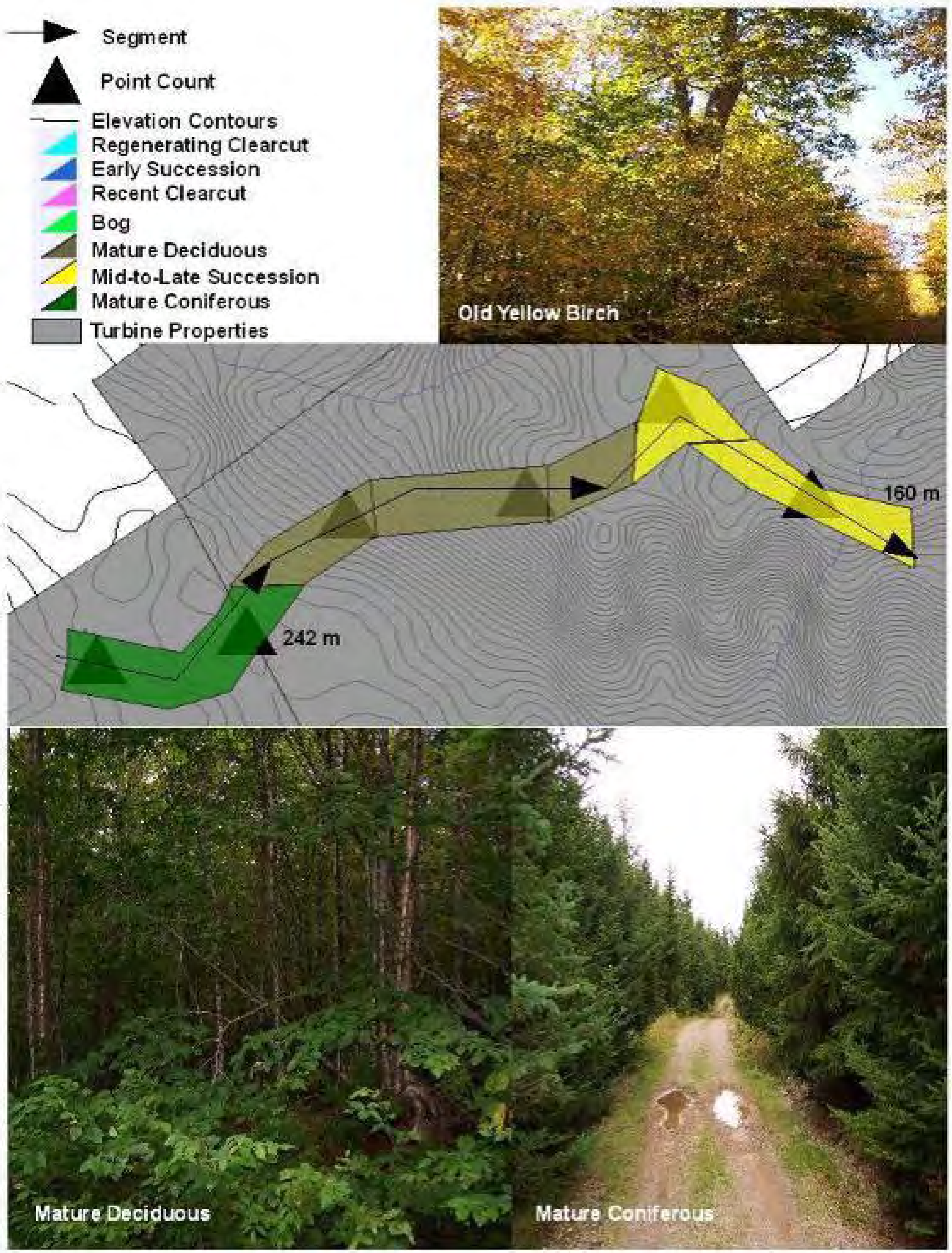


Figure 22. Location of Nocturnal Passage Listening Points

[Back to Autumn Migration] [Back to Spring Migration]

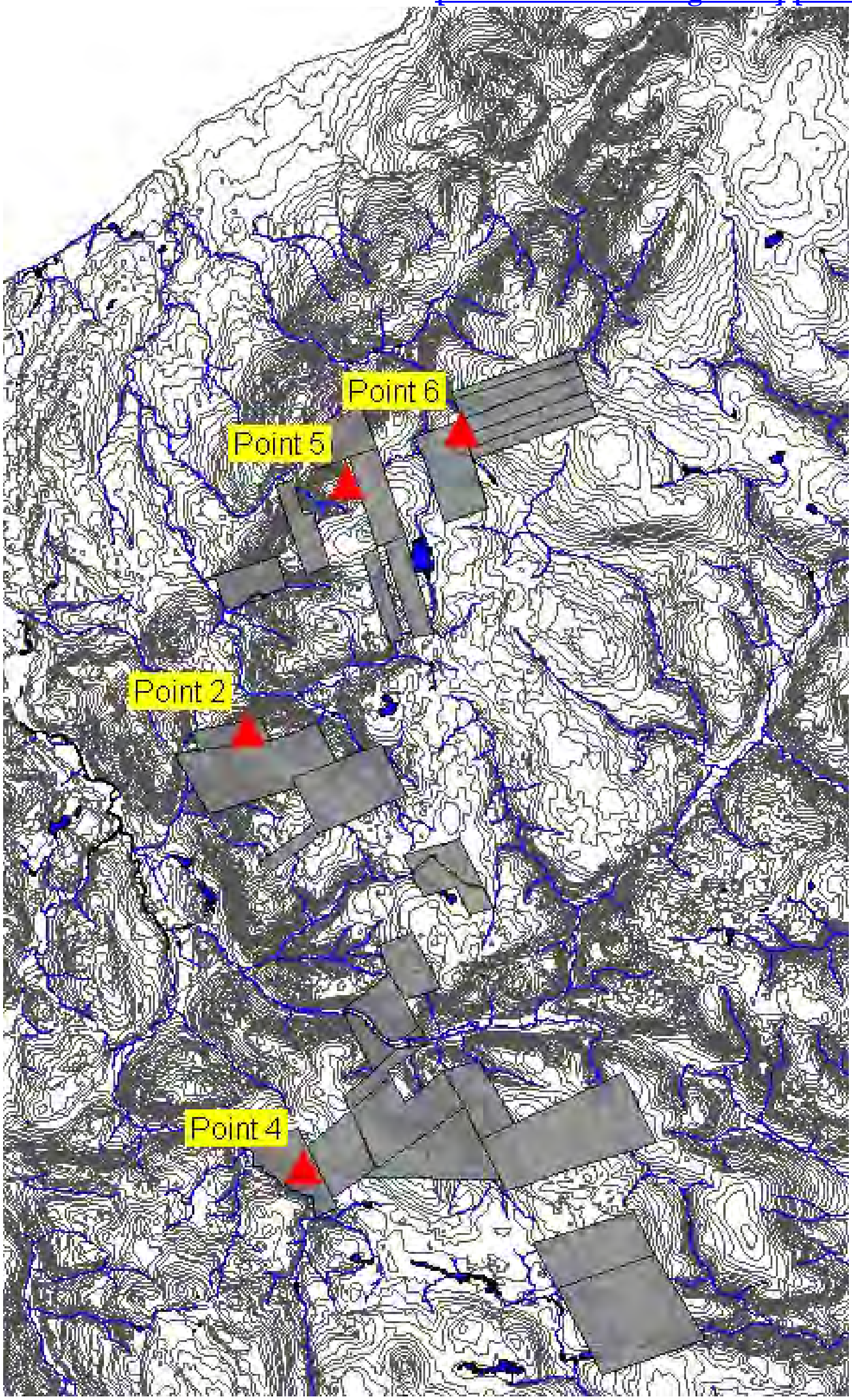
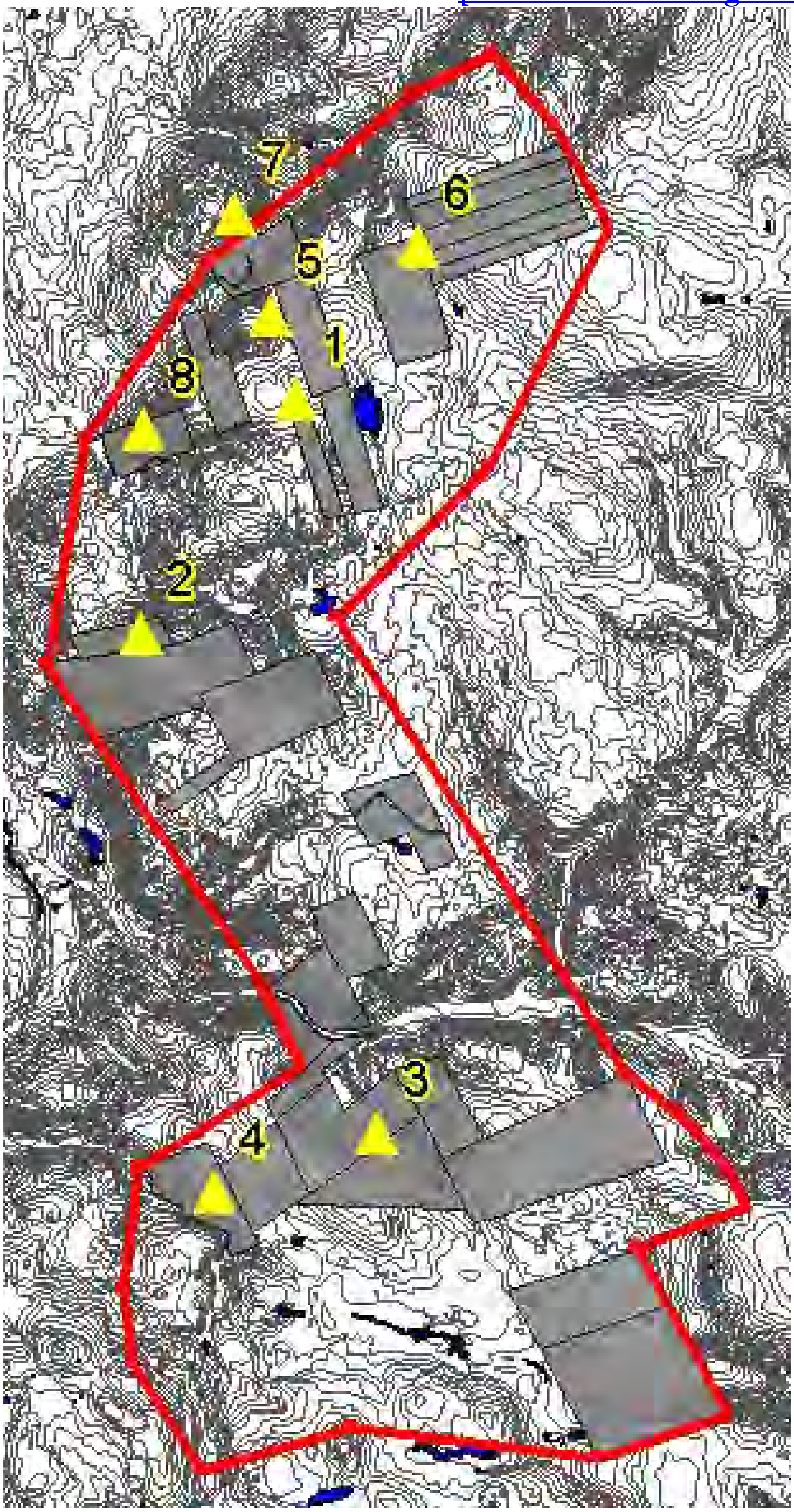


Figure 23. Location of Diurnal Passage Observation Points

[Back to Autumn Migration] [Back to Spring Migration]



Point 5

Point 2

Point 4

Figure 24. Flight Direction and Wind Direction for Woodpeckers and Small to Medium-sized Passerines Observed in Diurnal Passage during the Autumn Migration

[Return to Text]

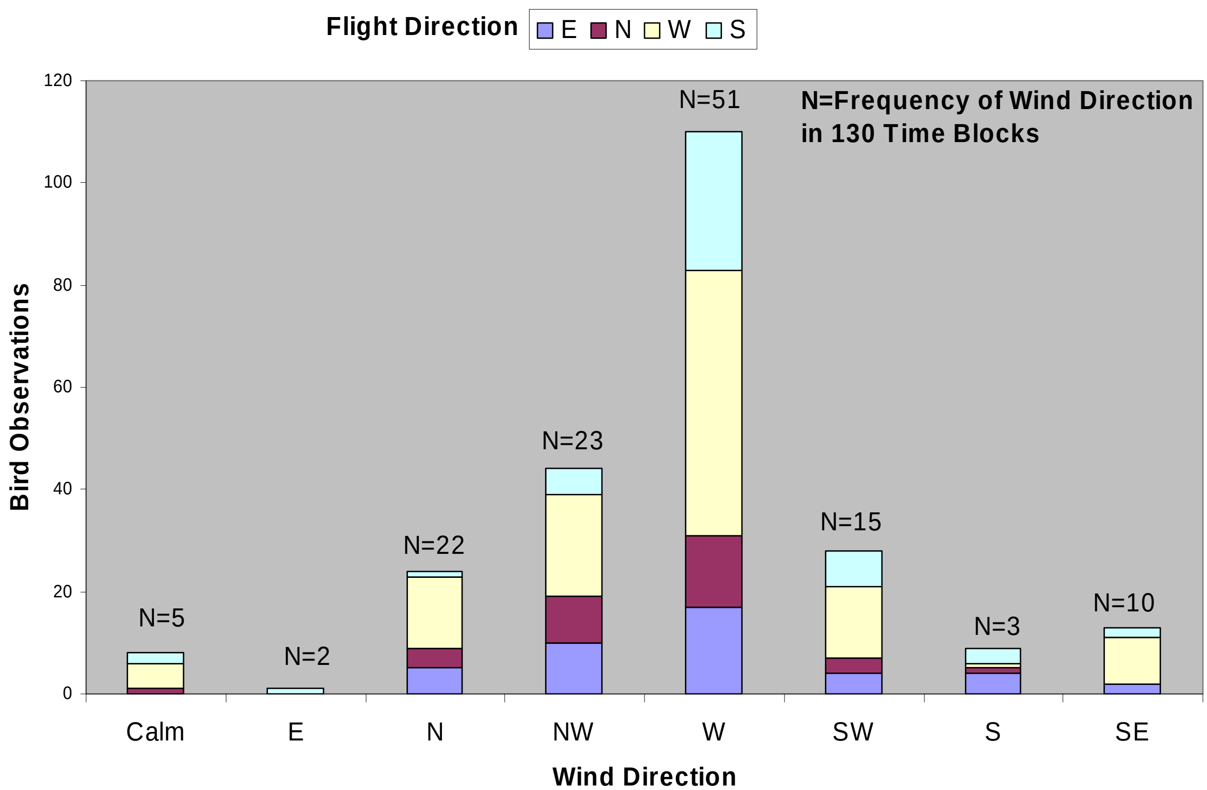


Figure 25. Flight Direction and Wind Speed for Woodpeckers and Small to Medium- sized Passerines Observed in Diurnal Passage during the Autumn Migration

[Back to Text]

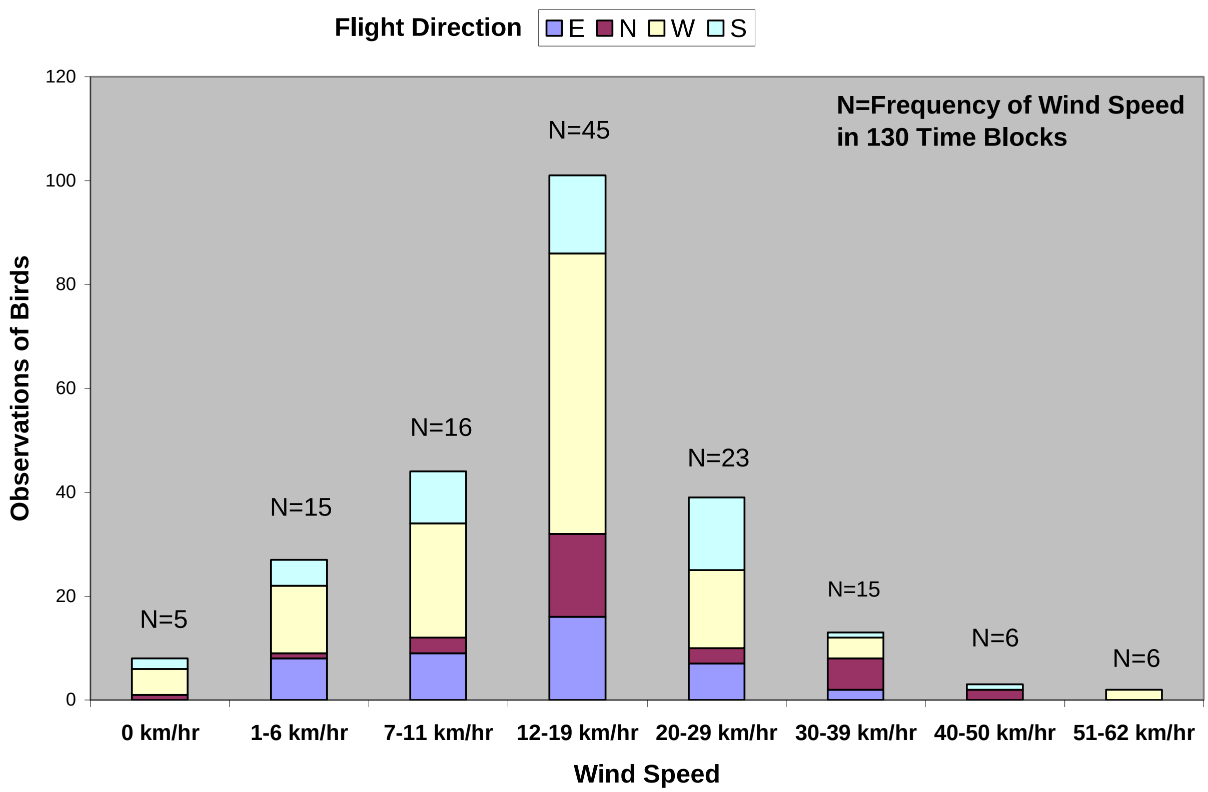


Figure 26. Location of Winter Standardized Area Counts

[Back to Text]

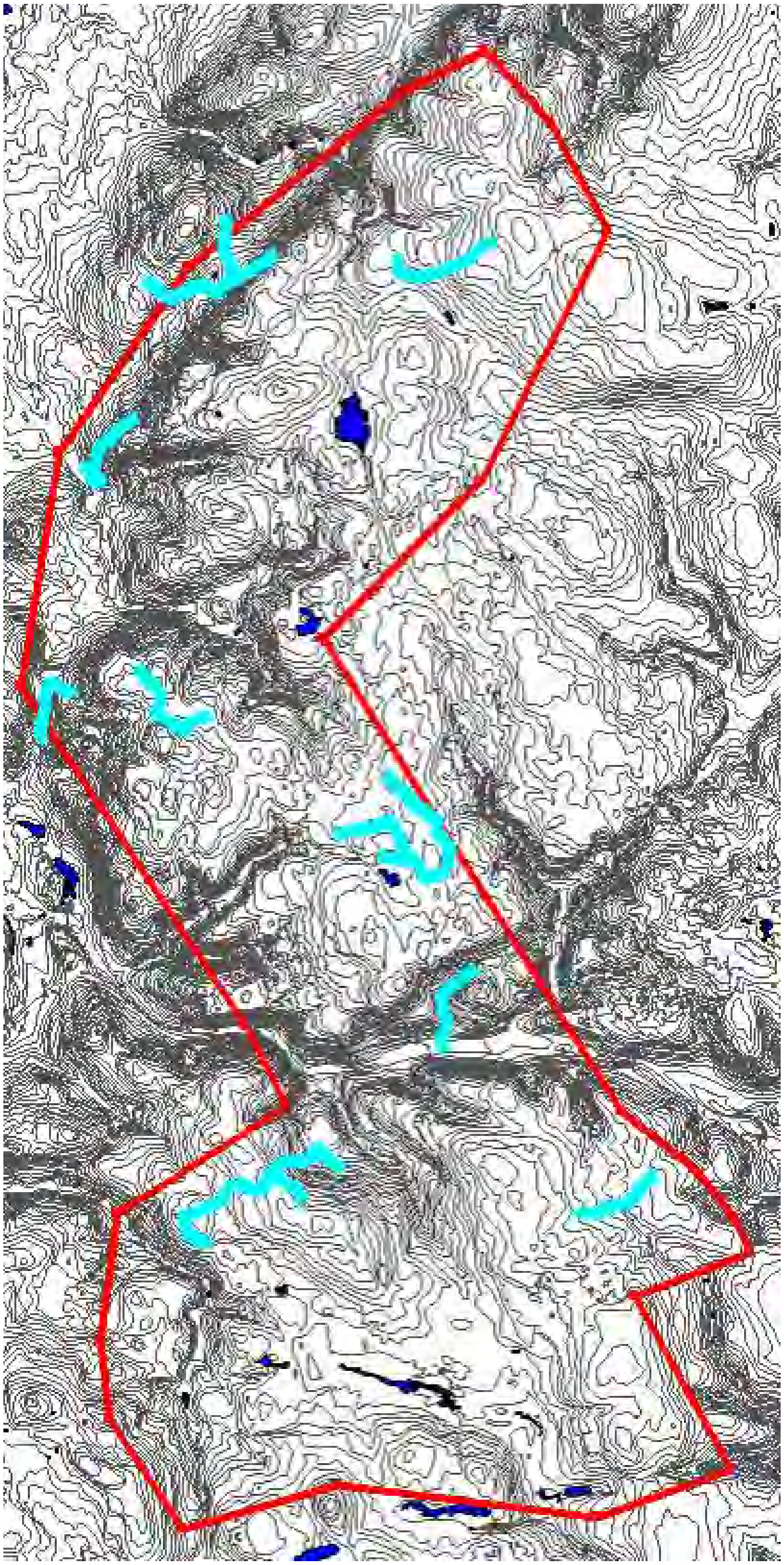


Figure 27. Mean Birds per Hectare by Habitat Type in Winter (With 95% confidence limits)

[Back to text]

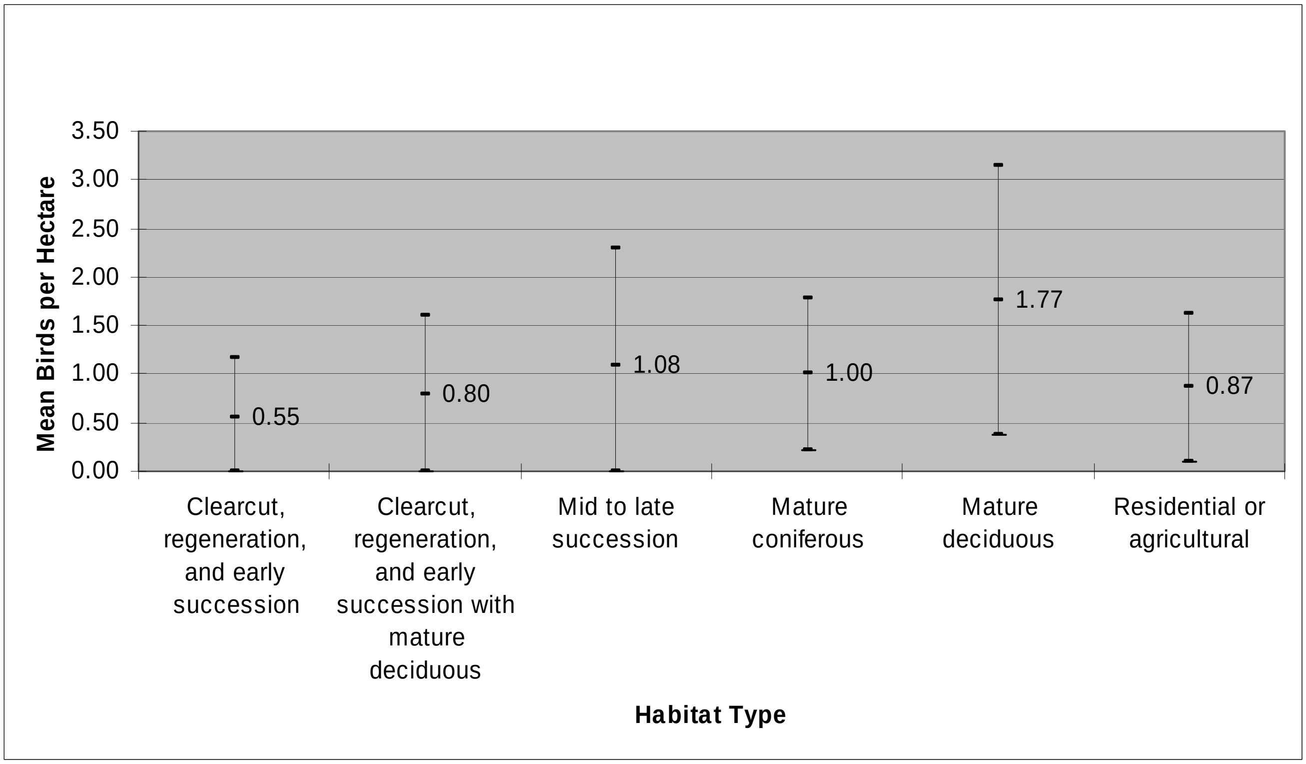


Figure 28. Mean Total Number of Birds per Transect at All Distances by 10-day Period during the Spring Migration (With 95% confidence limits)

[Back to Text]

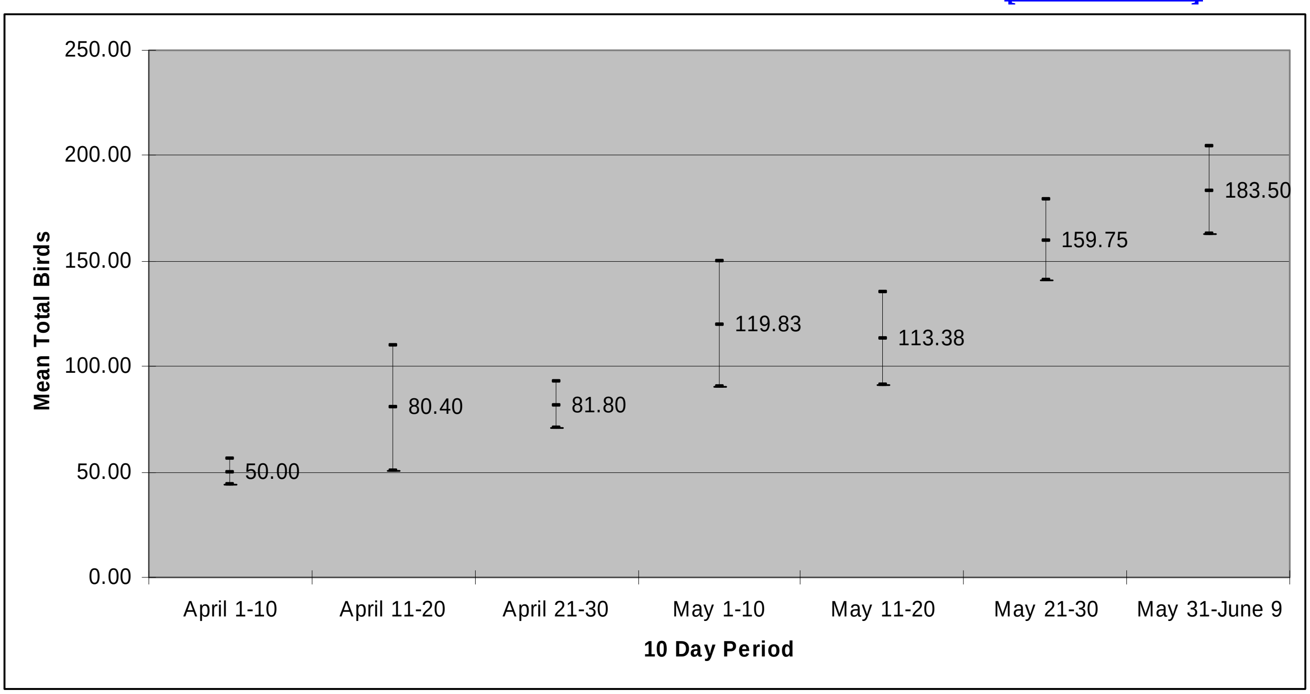


Figure 29. Mean Total Number of Birds per Transect at All Distances by 10-day Period without Breeding Birds during the Spring Migration (With 95% confidence limits)

[Back to Text]

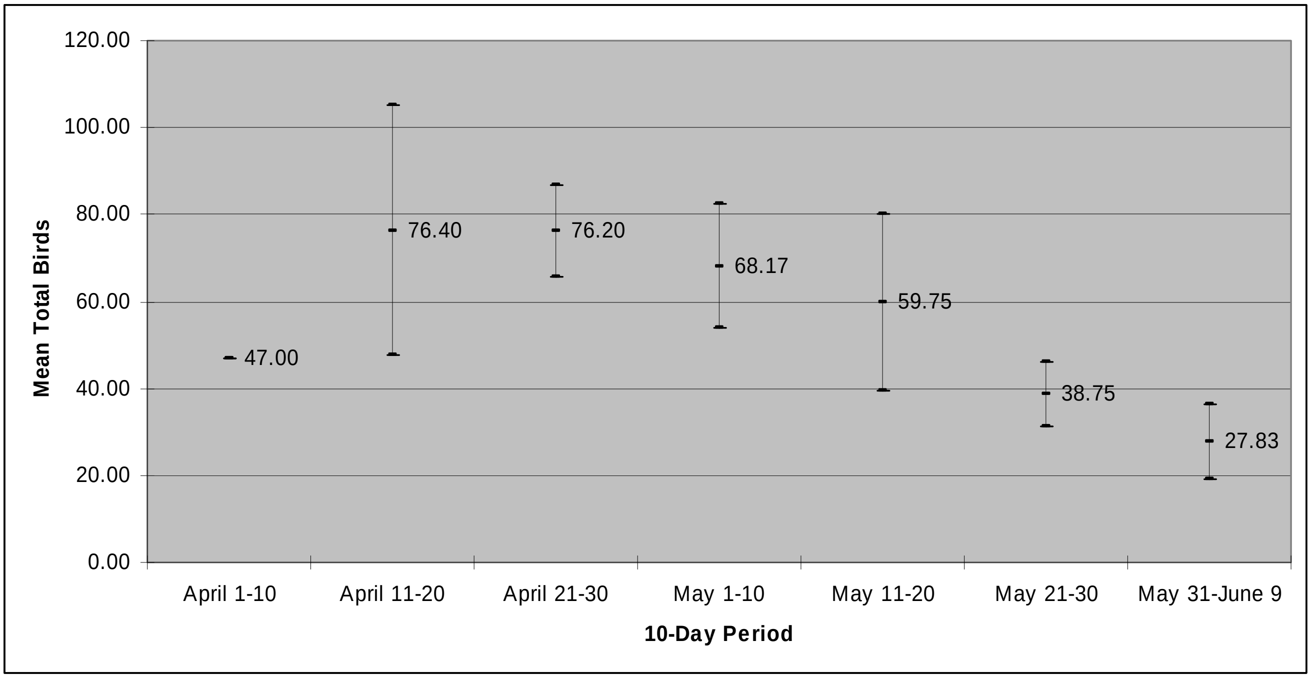


Figure 30. Mean Total Number of Birds per Transect Segment at <50m by 10-day Period without Breeding Birds during the Spring Migration (With 95% confidence limits)

[Back to Text]

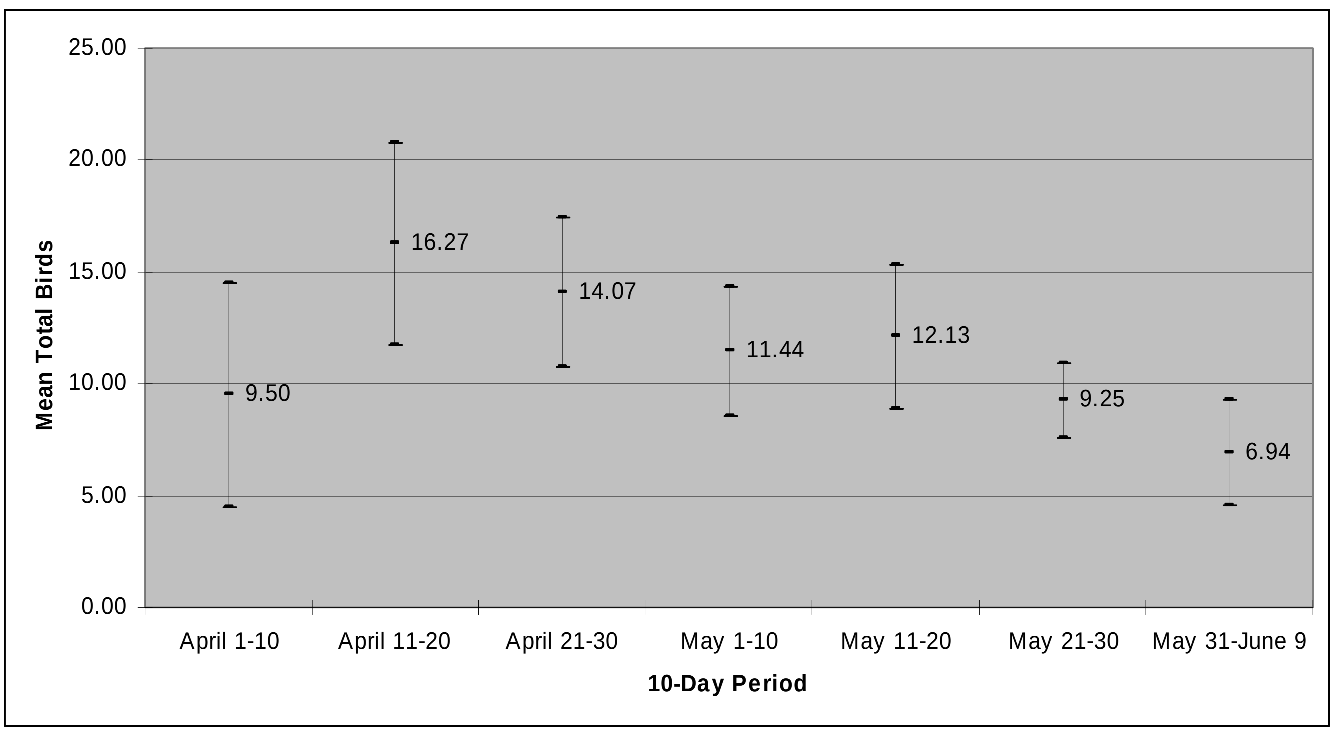


Figure 31. Mean Total Species of Birds by Transect at All Distances during the Spring Migration (With 95% confidence limits)

[Back to Text]

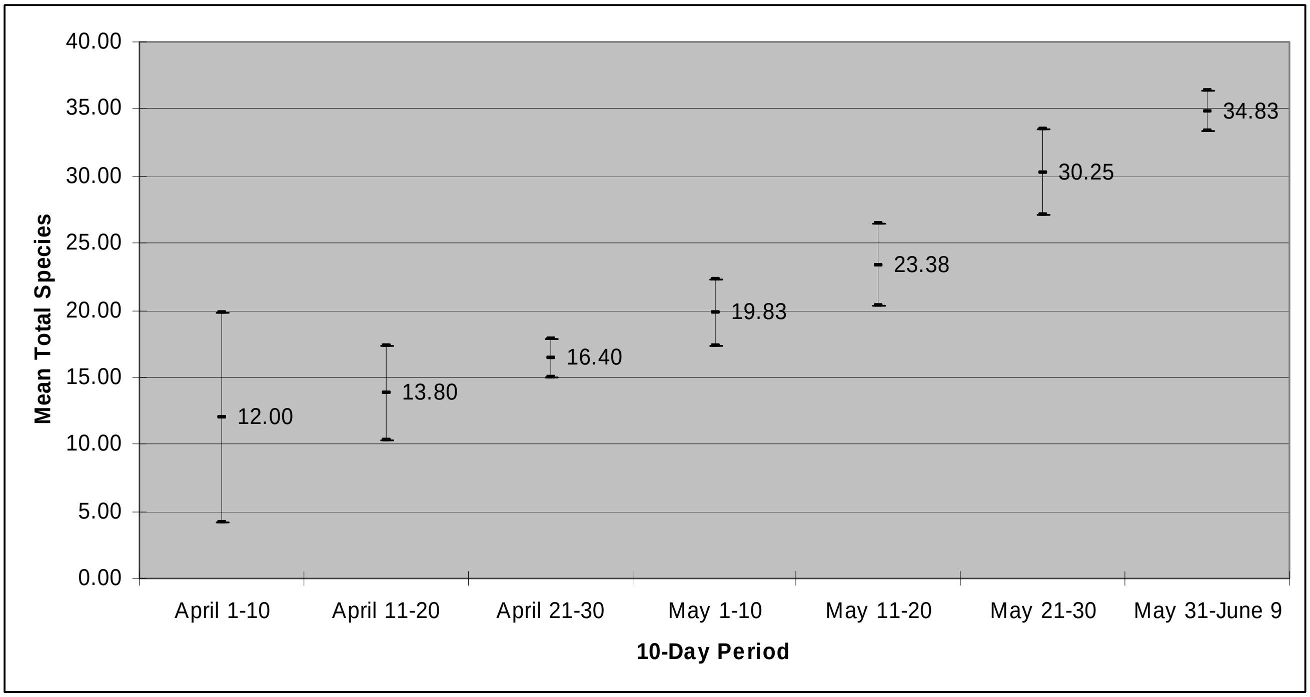


Figure 32. Means Total Species of Birds by Transect Segment at <50m without Breeders during the Spring Migration (With 95% confidence limits)

[Back to Text]

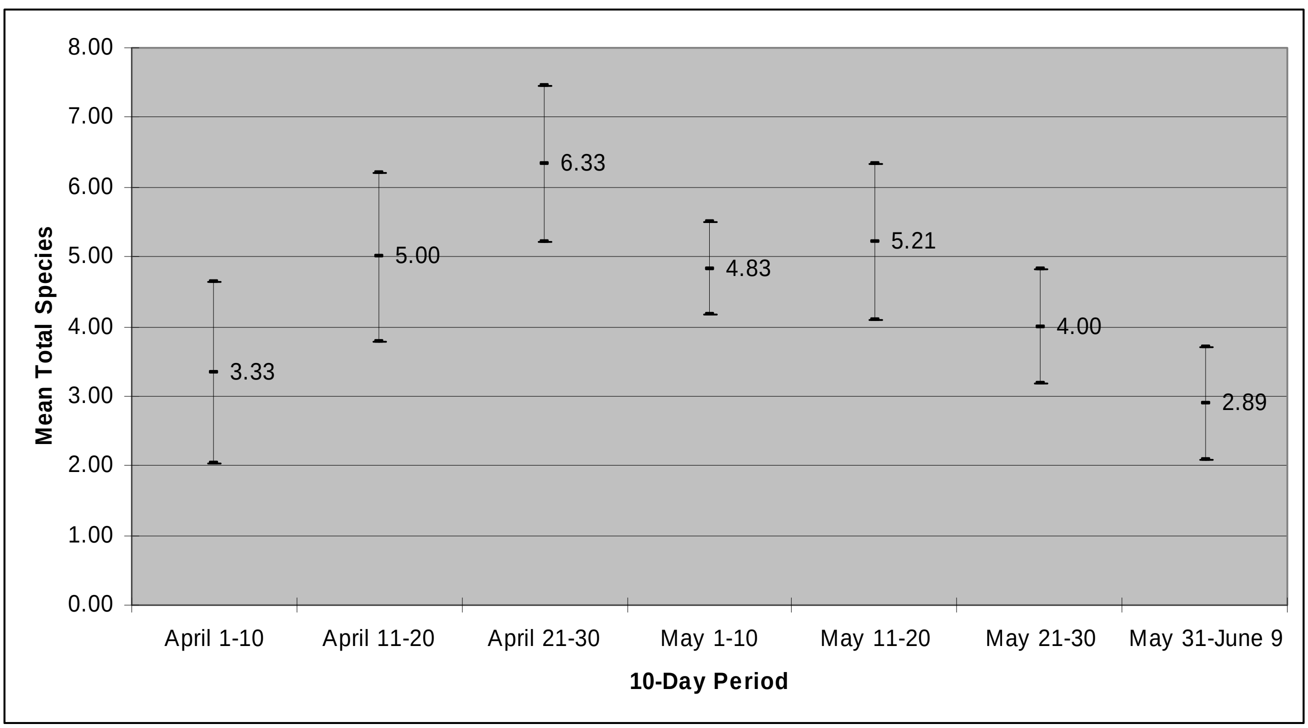
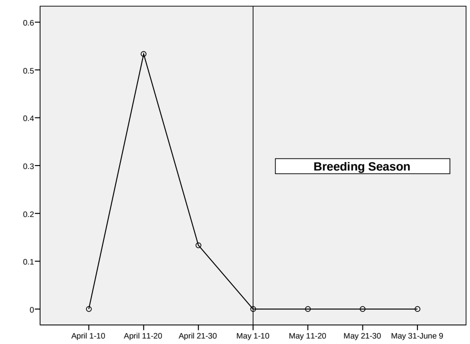


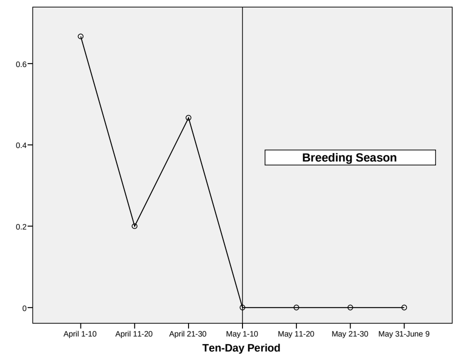
Figure 33. Species with Statistically Significant Seasonal Pattern for Transect Segments at <50m during Spring Migration (Breeding season to right of vertical line)

[Back to Text]

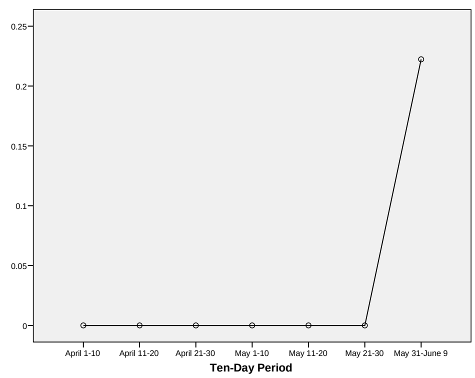
Ruffed Grouse



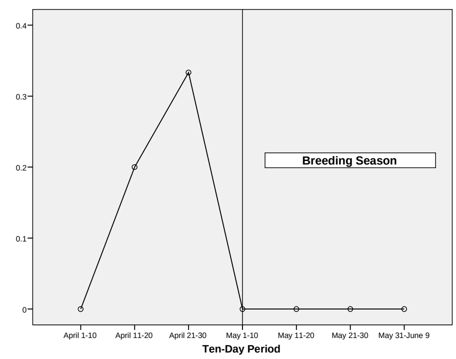
Hairy Woodpecker



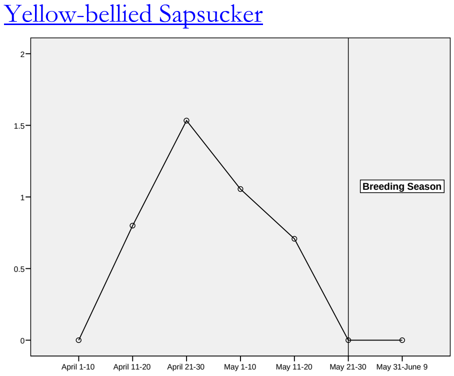
Ruby-throated Hummingbird



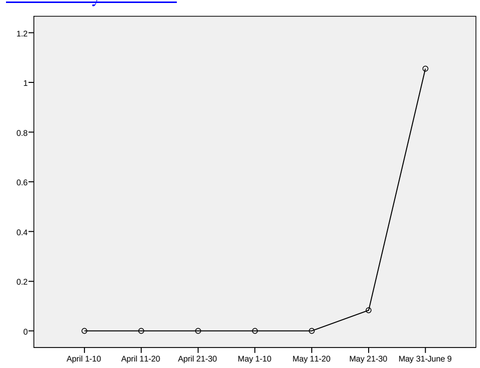
Northern Flicker



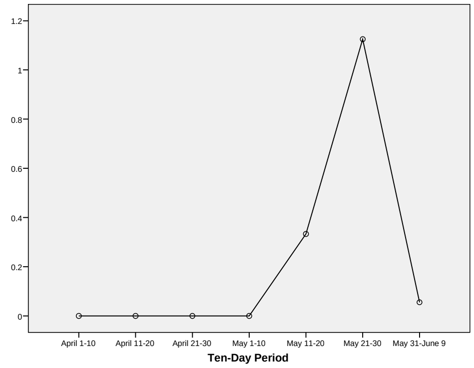
Yellow-bellied Sapsucker



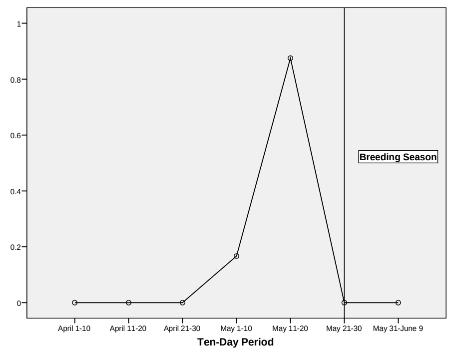
Alder Flycatcher



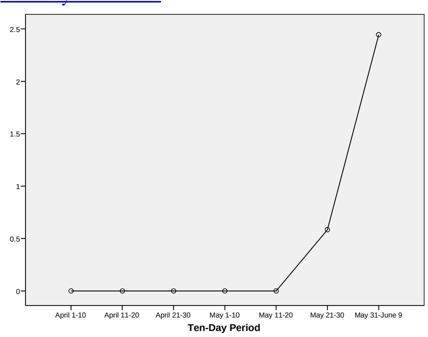
Least Flycatcher



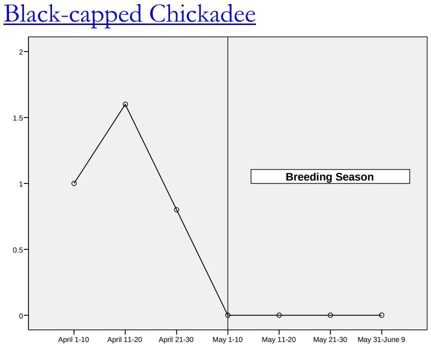
Blue-headed Vireo



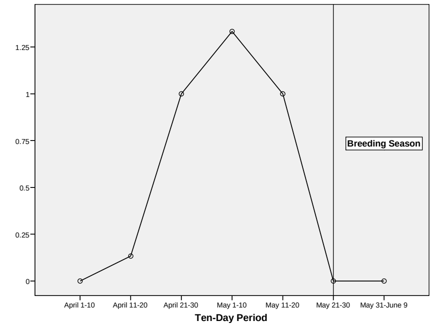
Red-eyed Vireo



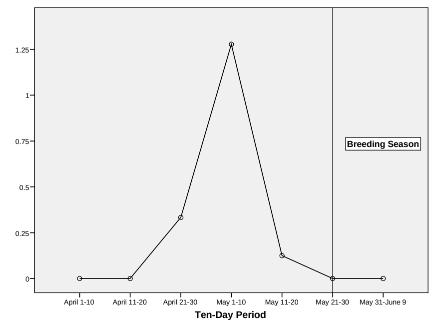
Black-capped Chickadee



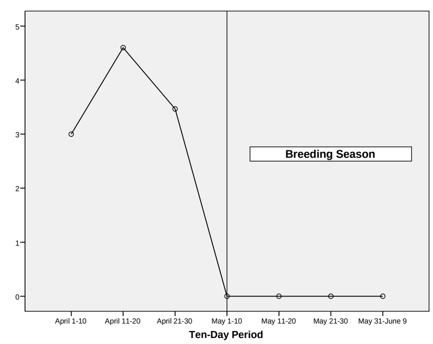
Ruby-crowned Kinglet



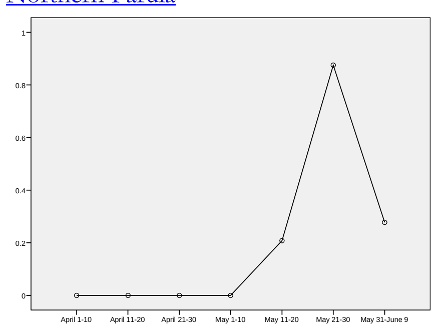
Hermit Thrush



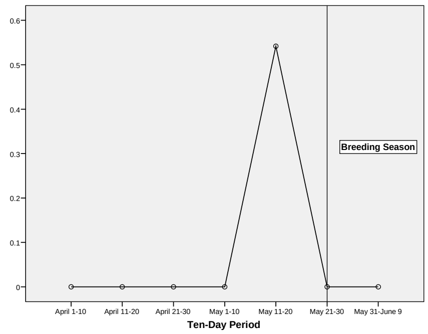
American Robin



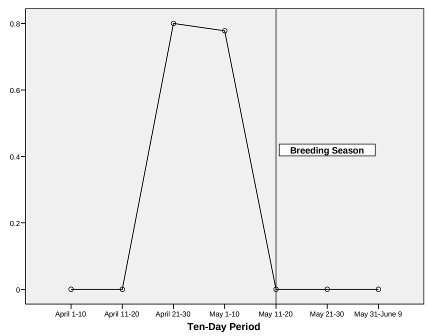
Northern Parula



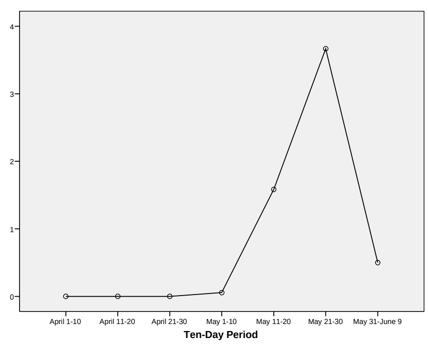
Magnolia Warbler



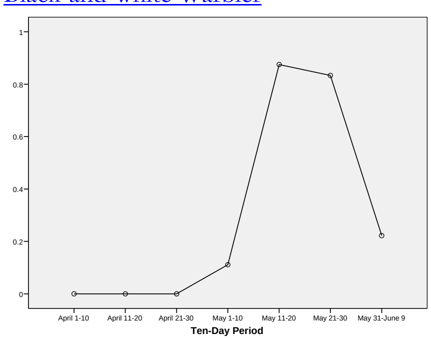
Yellow-rumped Warbler



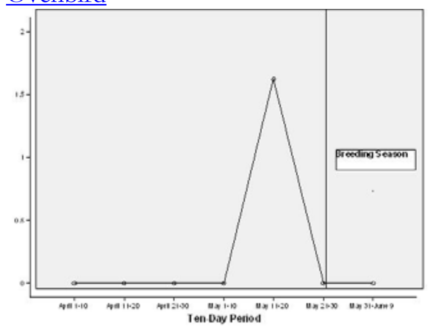
Black-throated Green Warbler



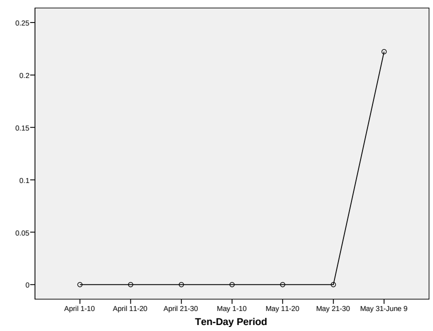
Black-and-white Warbler



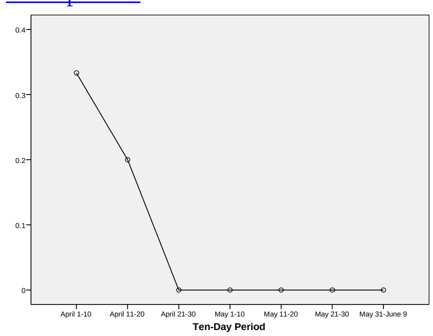
Ovenbird



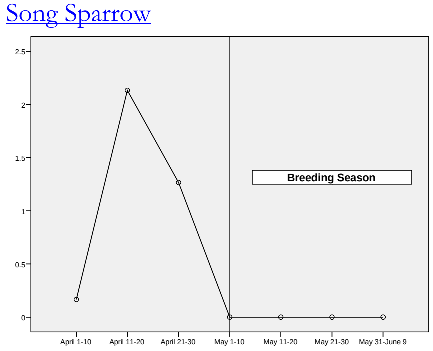
Mourning Warbler



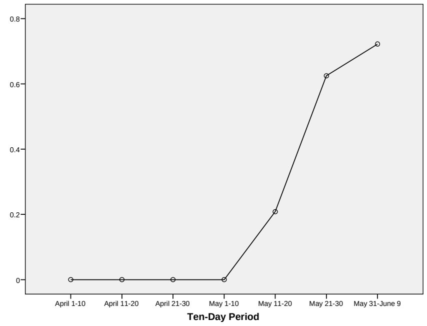
Fox Sparrow



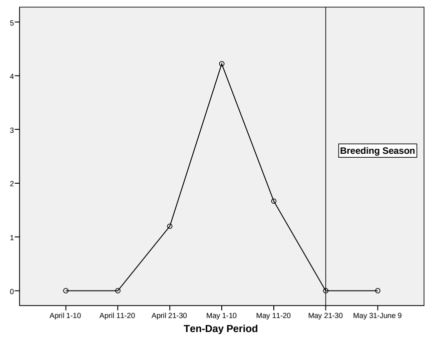
Song Sparrow



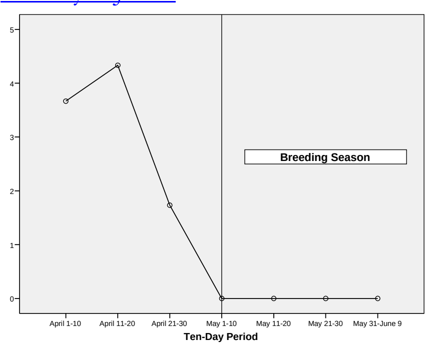
Lincoln's Sparrow



White-throated Sparrow



Dark-eyed Junco



Purple Finch

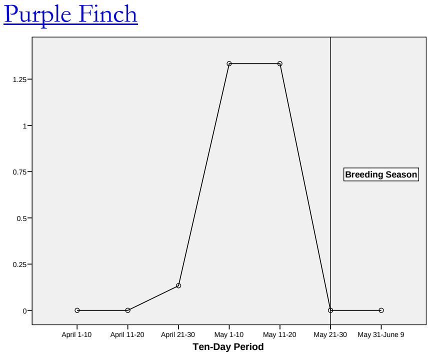


Figure 34. Mean Total Birds per Transect Segment at <50 m by Wind Direction and Speed for the Night before the Surveys during the Spring Migration

[Back to Text]

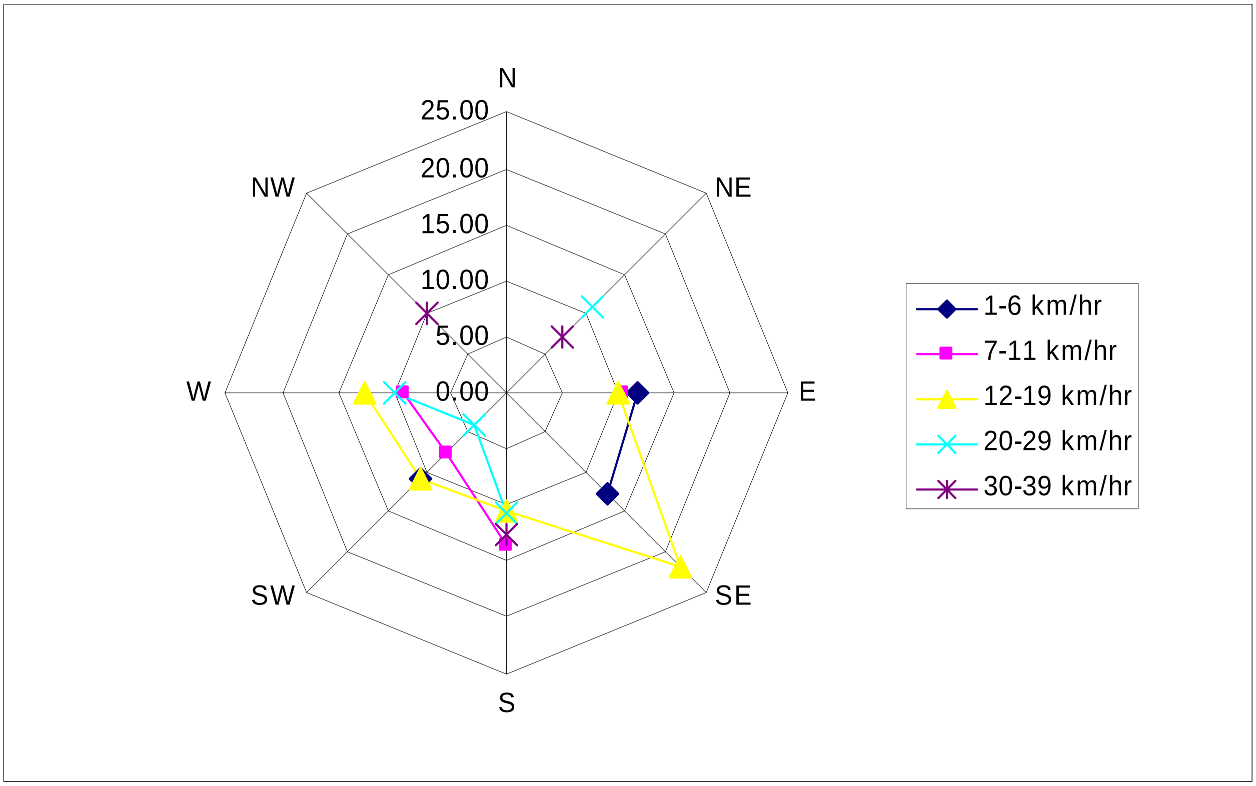


Figure 35. Mean Total Birds per Transect Segment at <50m by Habitat Type during the Spring Migration

[Back to Text]

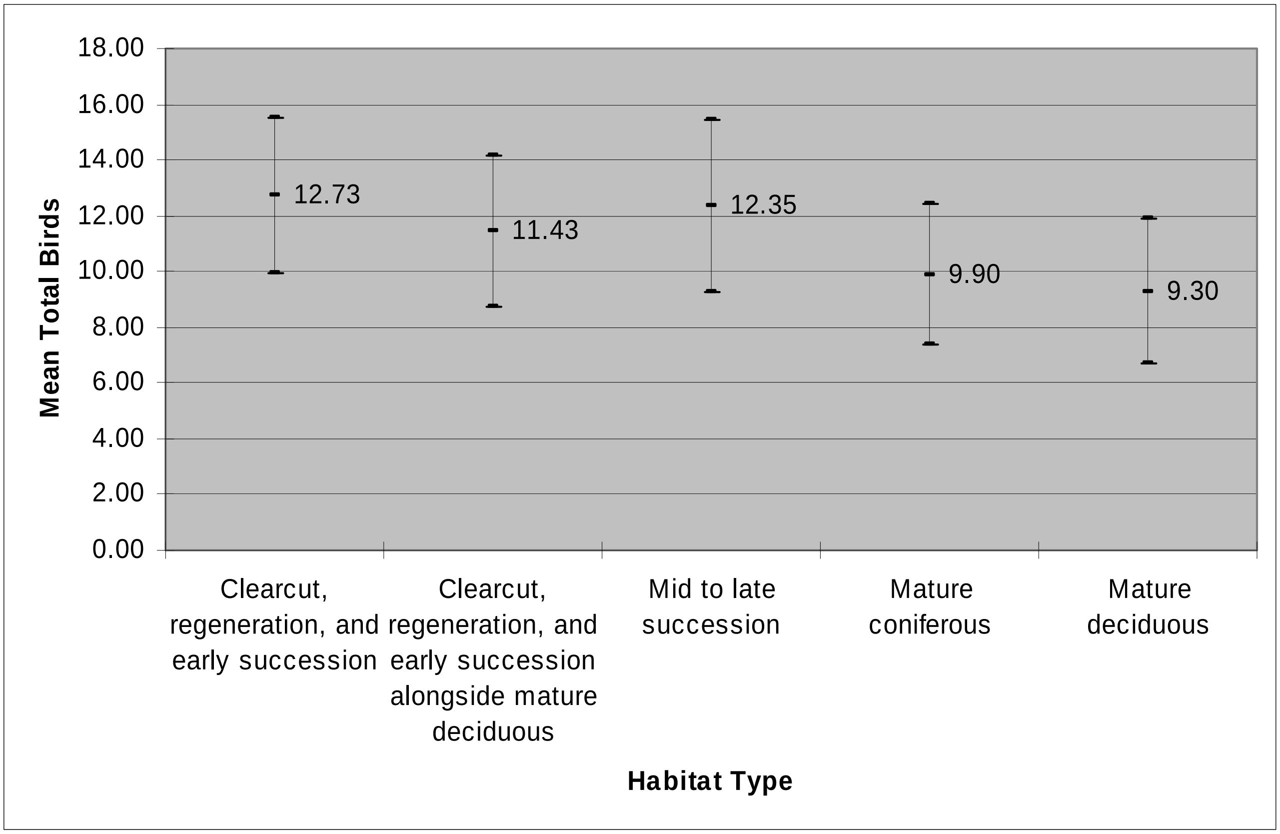


Figure 36. Least Square Means of Total Birds by Habitat Segments <50m by Habitat Type during the Spring Migration

[Back to Text]

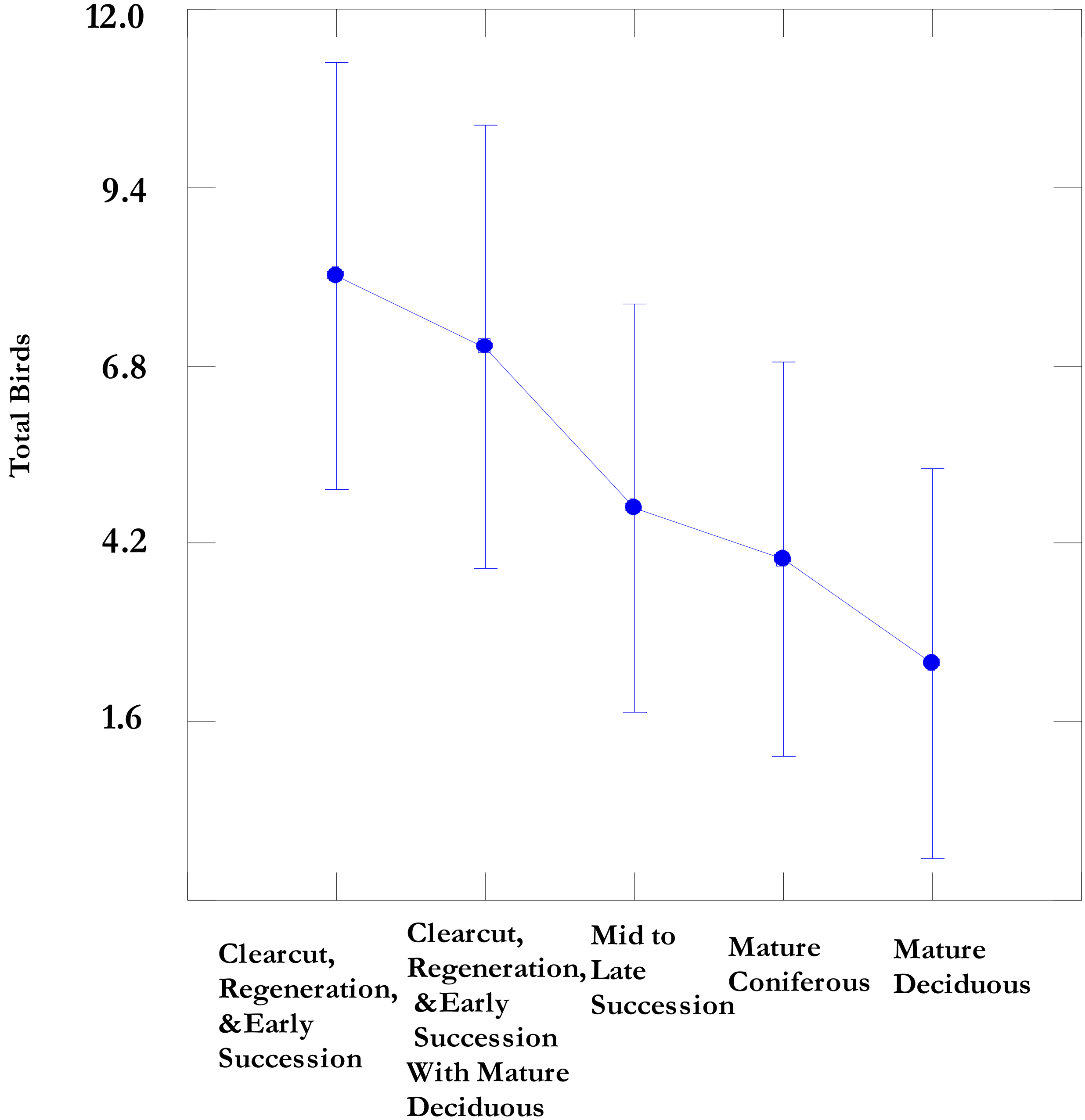


Figure 37. Mean Total Birds for Point Counts at All Distances by Habitat Type during the Spring Migration

[Back to Text]

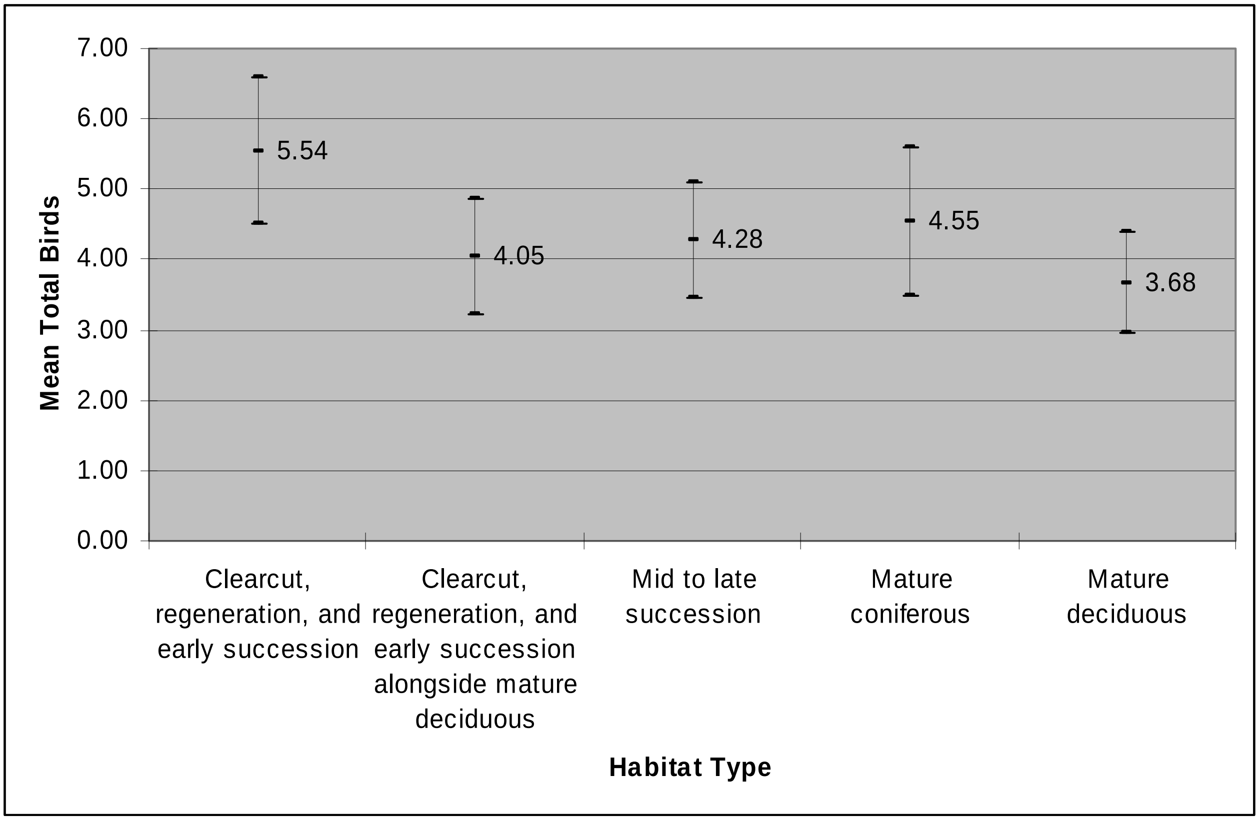


Figure 38. Area Search Routes for Crepuscular and Nocturnal Breeding Birds with Location of Birds Heard

[Back to Text]

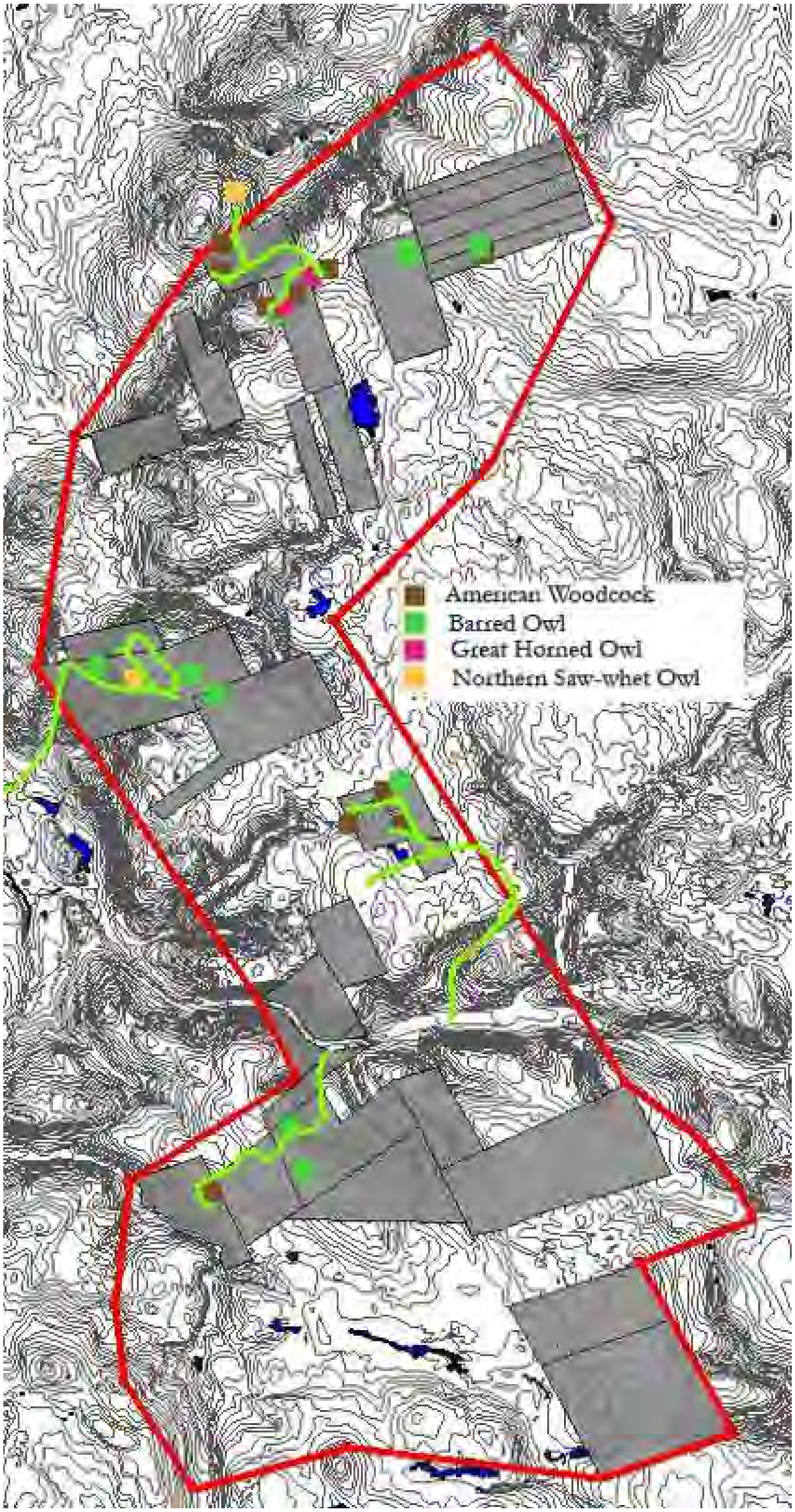


Figure 39. Mean Total Abundance of Early Breeders for Point Counts at All Distance by Habitat Type (With 95% confidence limits)

[Back to Text]

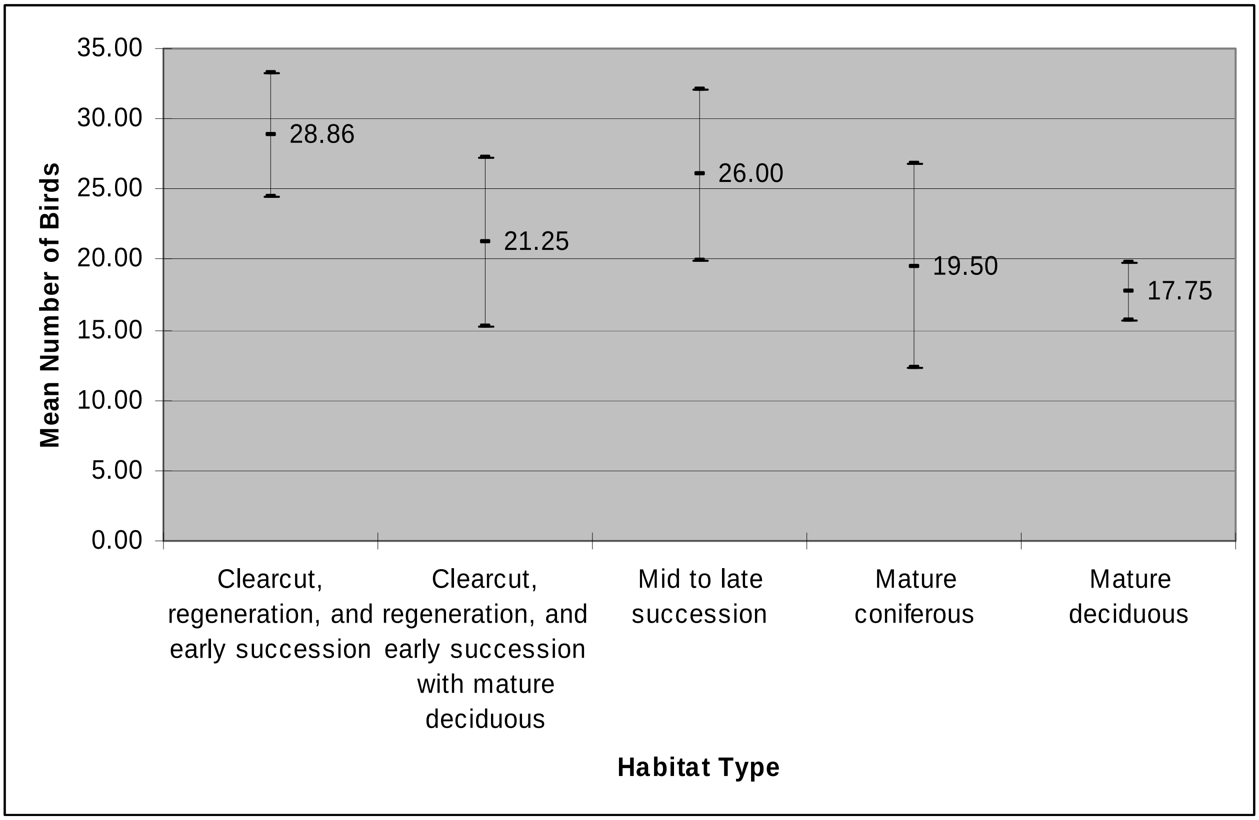


Figure 40. Mean Species Diversity of Early Breeders for Point Counts at All Distances by Habitat Type (With 95% confidence limits)

[Back to Text]

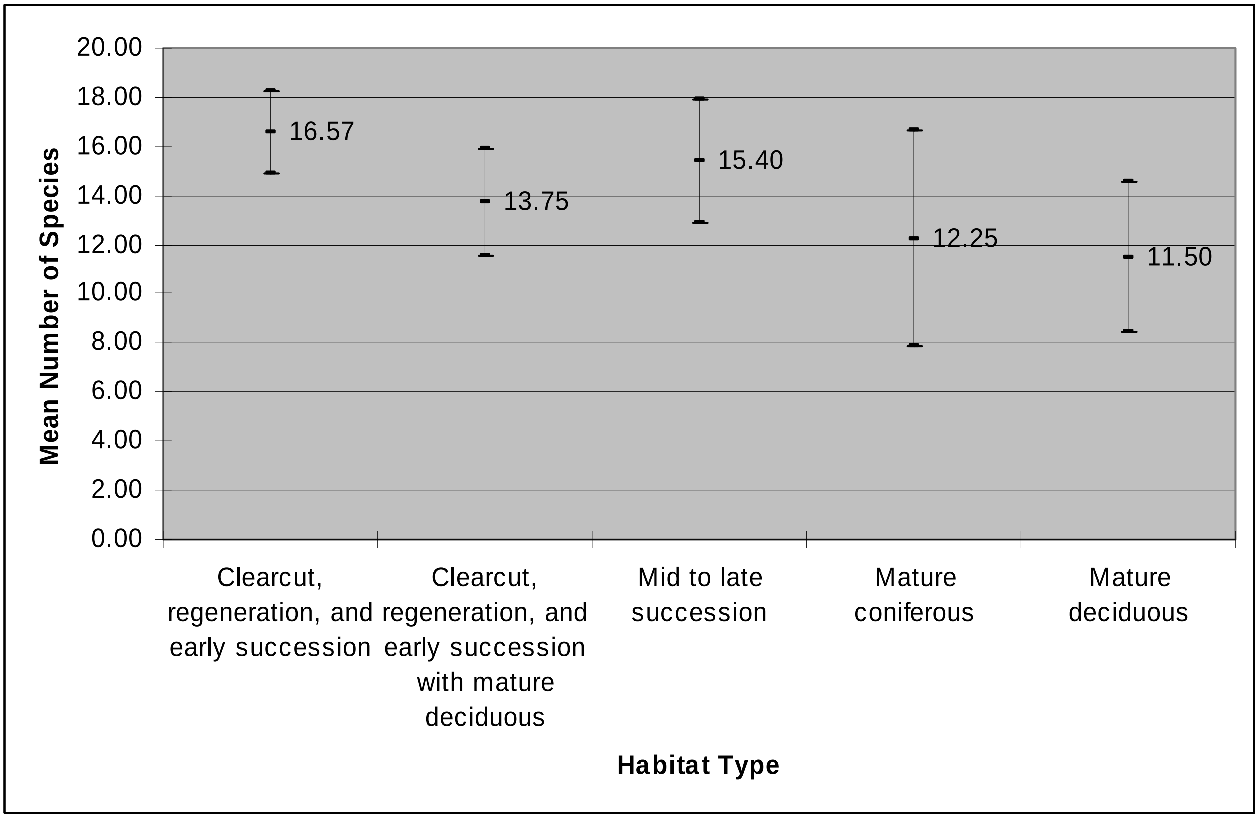


Figure 41. Location of Point Counts for the Peak Breeding Survey

[Back to Text]

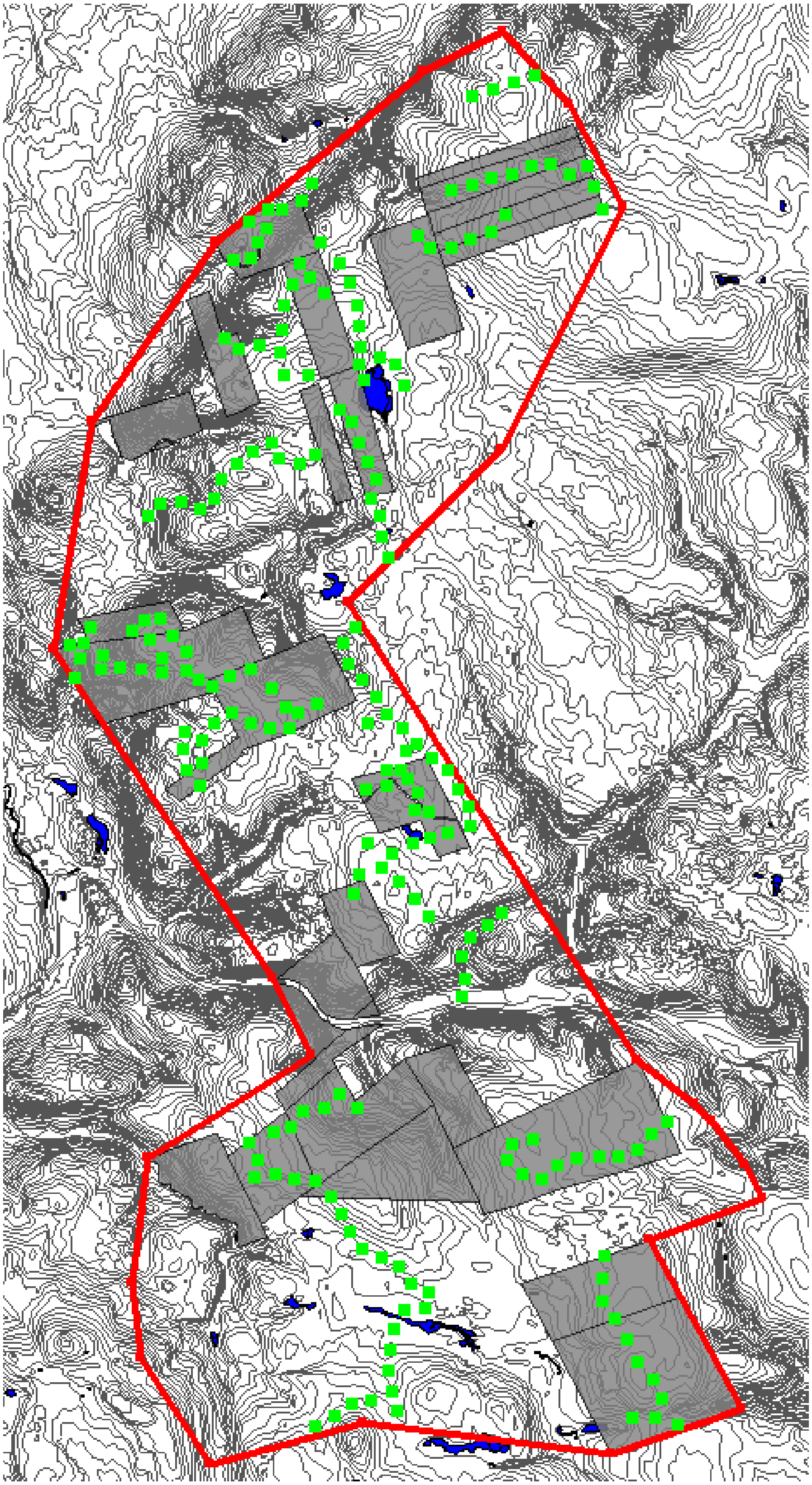


Figure 42. Mean Total Abundance of Peak Season Breeders for Point Counts at All Distance by Habitat Type (With 95% confidence limits)

[Back to Text]

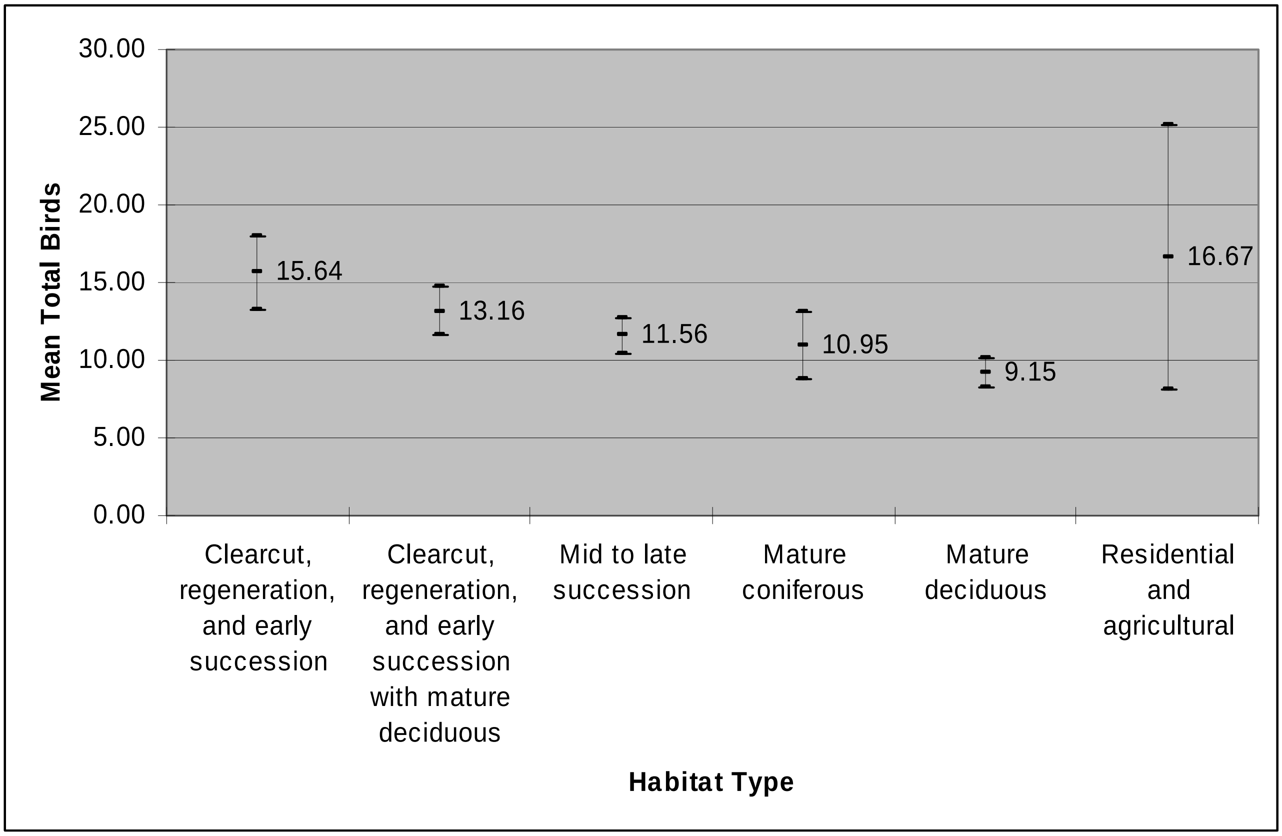


Figure 43. Mean Species Diversity of Peak Season Breeders for Point Counts at All Distances by Habitat Type (With 95% confidence limits)

[Back to Text]

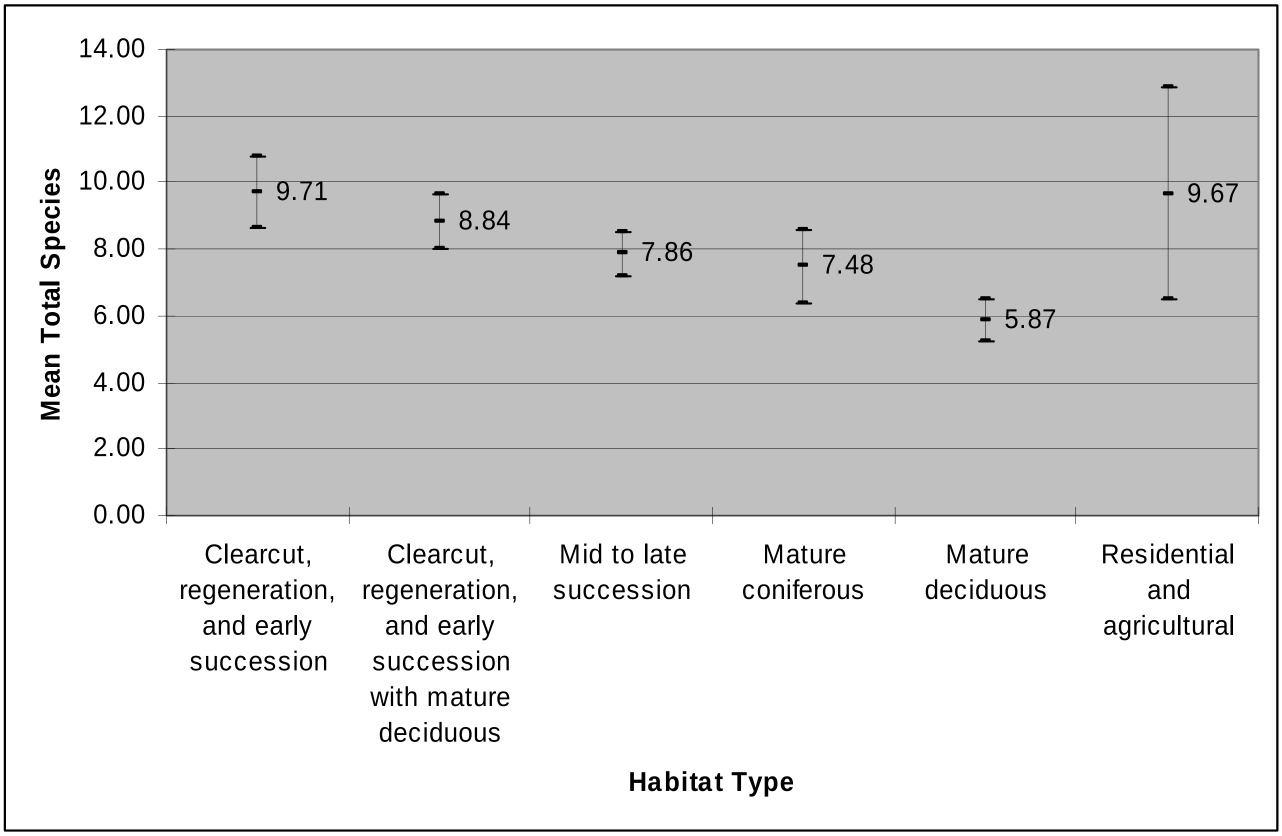
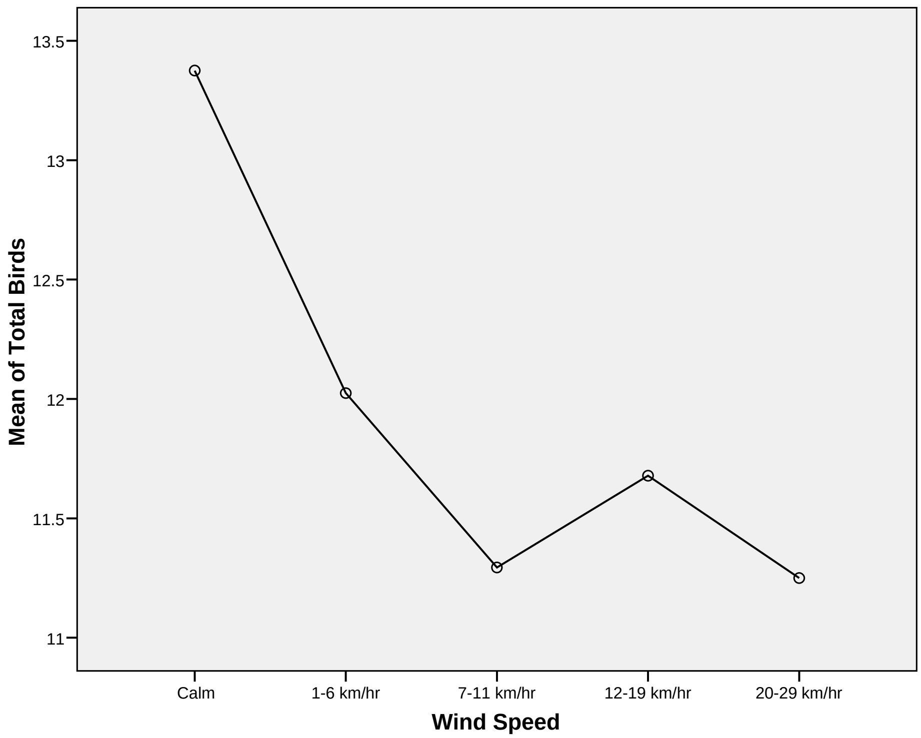
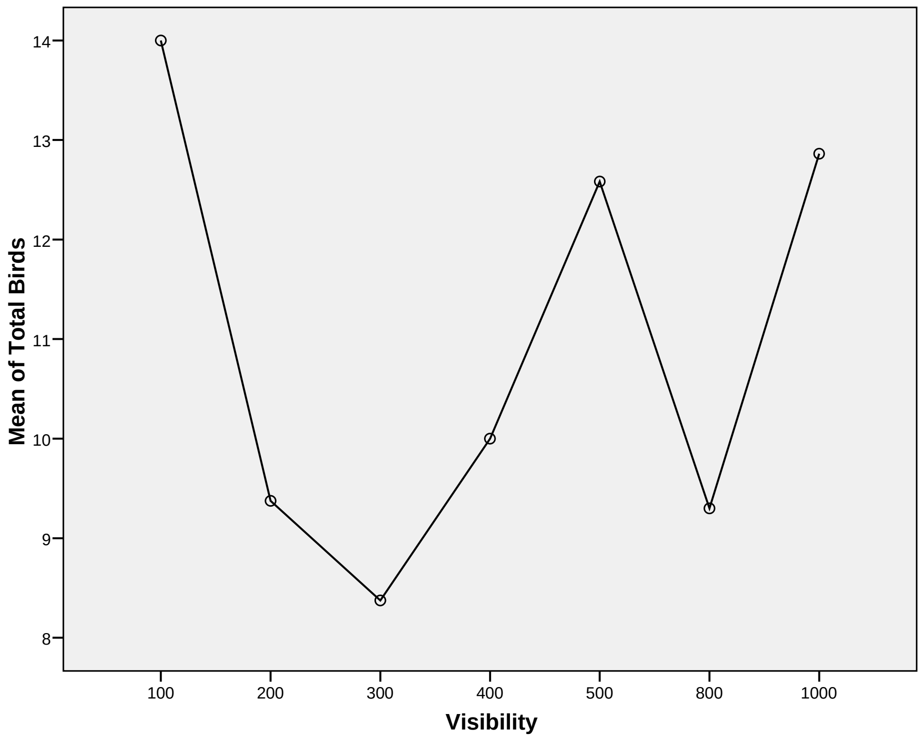
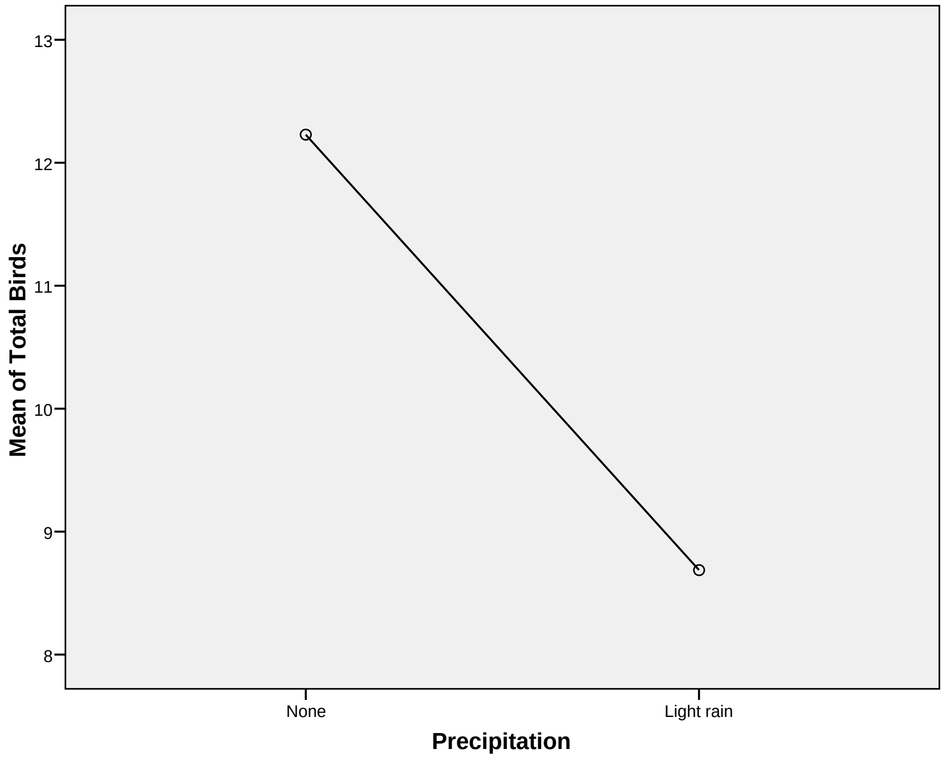


Figure 44. Effects of Weather and Time of Day on Mean Total Birds for Peak Breeding Point Counts

[Back to Text]






Mean of Total Birds
13
12
11
10
9
8
None
Light rain
Precipitation

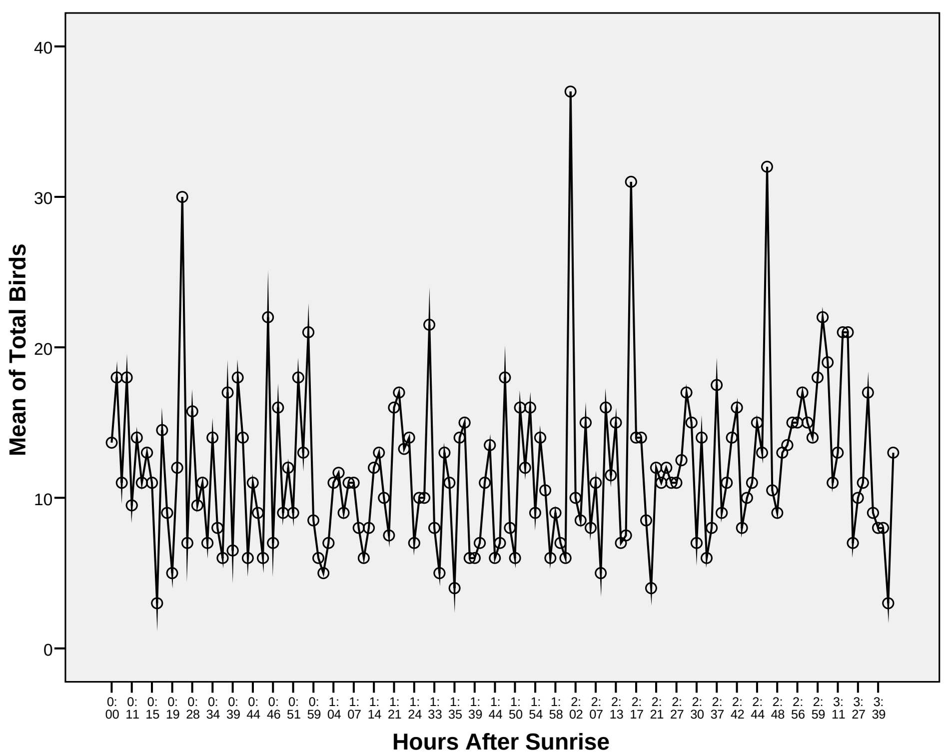

Mean of Total Birds
40
30
20
10
0
Hours After Sunrise

Figure 45. Map of Breeding Locations of Olive-sided Flycatcher

[Back to Text]

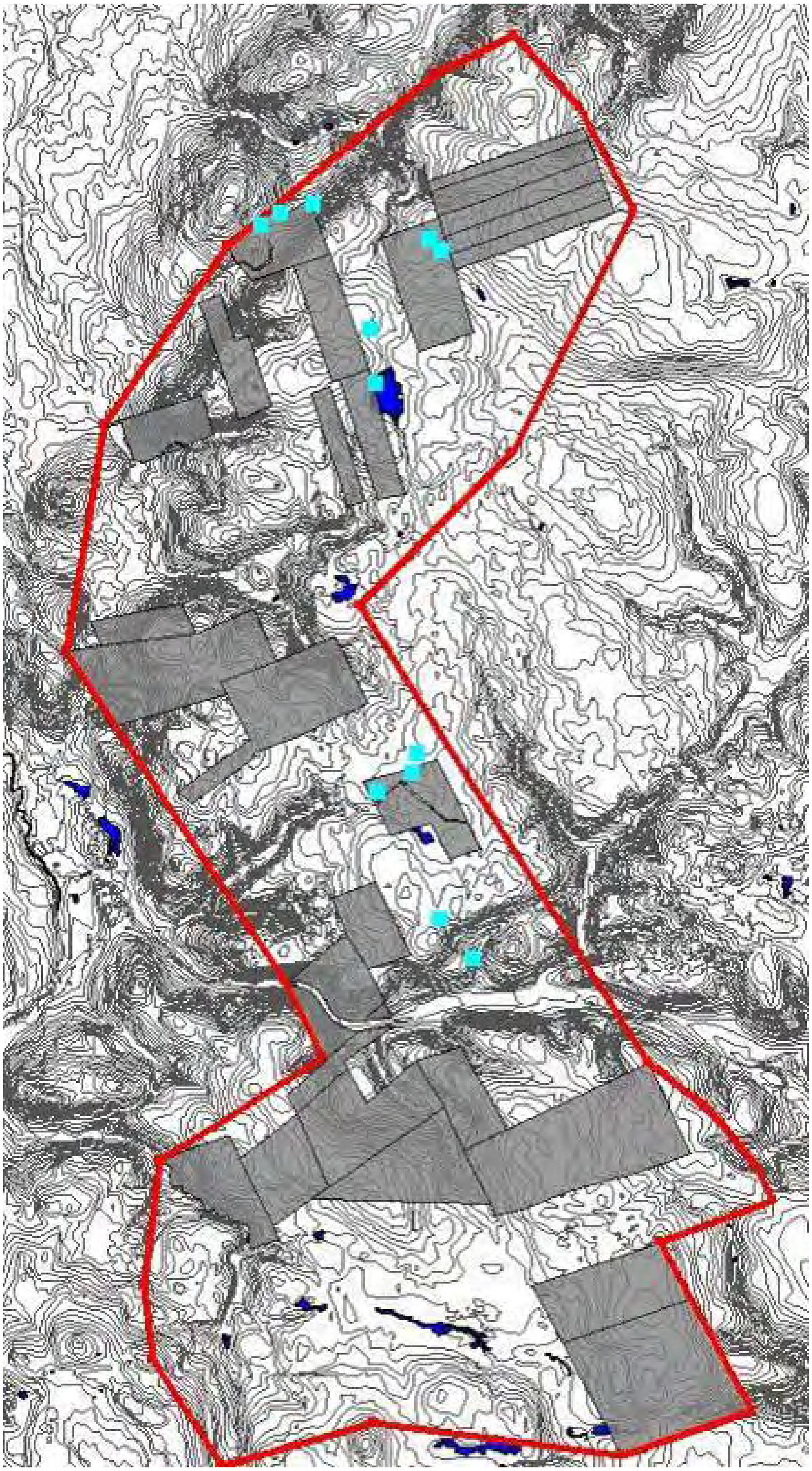


Figure 46. Habitat of Olive-sided Flycatcher in the Study Area

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Figure 47. Map of Sighting Locations of the Canada Warbler

[Back to Text]

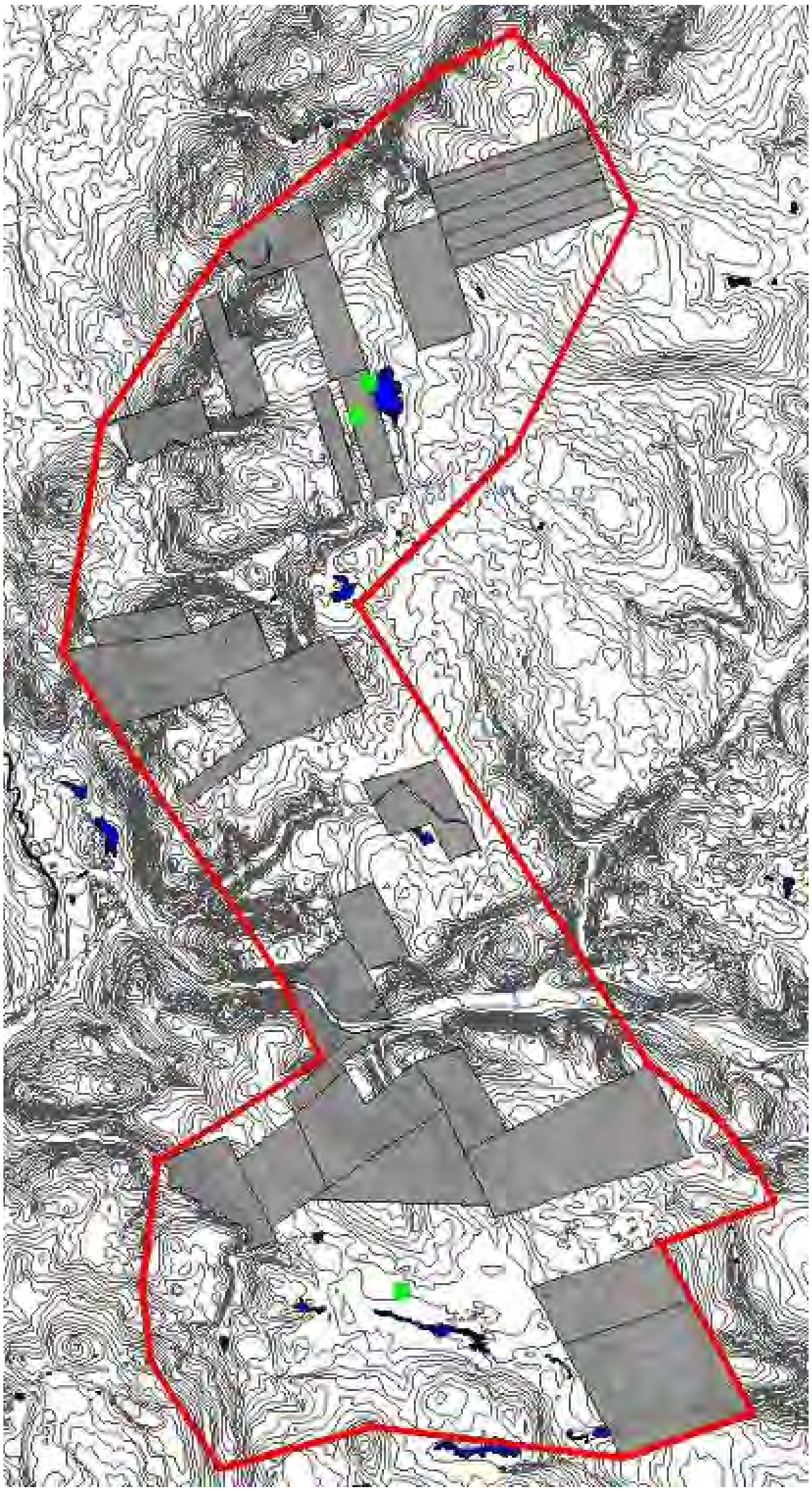

Figure 48. The Breeding Habitat of the Canada Warbler in the Study Area

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Tables

Table 1. Mean Number of Individual Species per Transect at All Distances by 10-Day Interval during the Autumn Migration

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	Aug 28-Sep 6	Sep 7-16	Sep 17-26	Sep 27-Oct 6	Oct 7-16	Oct 17-26	Total
Canada Goose	0.00	0.00	0.00	0.17	0.83	1.83	0.39
Ruffed Grouse	0.00	0.10	0.43	0.00	0.67	0.83	0.30
Double-crested Cormorant	0.00	0.90	0.00	0.00	0.00	0.00	0.20
Bald Eagle	0.00	0.00	0.00	0.00	0.50	0.17	0.09
Northern Harrier	0.00	0.10	0.00	0.00	0.00	0.00	0.02
Red-tailed Hawk	0.22	0.20	0.00	0.17	0.00	0.00	0.11
Sharp-shinned Hawk	0.33	0.60	0.29	0.00	0.33	0.00	0.30
American Kestrel	0.00	0.10	0.00	0.00	0.00	0.00	0.02
Merlin	0.00	0.00	0.00	0.17	0.00	0.00	0.02
Semipalmated Plover	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Solitary Sandpiper	0.00	0.20	0.00	0.00	0.00	0.00	0.05
Herring Gull	0.00	0.00	0.00	0.00	0.17	0.00	0.02
Barred Owl	0.11	0.00	0.00	0.00	0.17	0.00	0.05
Ruby-throated Hummingbird	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Belted Kingfisher	0.11	0.10	0.14	0.00	0.00	0.00	0.07
Downy Woodpecker	0.11	0.10	0.43	0.17	0.17	0.17	0.18
Hairy Woodpecker	0.22	0.70	1.14	1.83	1.67	1.50	1.07
Black-backed Woodpecker	0.00	0.00	0.14	0.00	0.00	0.00	0.02
Northern Flicker	4.44	2.80	2.29	0.67	0.17	0.00	2.02
Pileated Woodpecker	0.22	0.30	0.00	0.50	0.33	0.50	0.30
Alder Flycatcher	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Least Flycatcher	0.33	0.00	0.14	0.00	0.00	0.00	0.09
Northern Shrike	0.00	0.00	0.00	0.00	0.17	0.17	0.05
Blue-headed Vireo	0.78	1.60	1.29	0.00	0.00	0.00	0.73
Red-eyed Vireo	9.44	3.40	2.29	0.00	0.00	0.00	3.07
Gray Jay	0.00	0.20	0.14	0.17	0.17	0.50	0.18
Blue Jay	8.78	7.30	6.14	4.33	3.33	3.67	5.98
American Crow	0.00	0.40	0.14	0.17	0.17	1.50	0.36
Common Raven	2.44	3.80	3.71	3.17	7.67	5.17	4.14
Black-capped Chickadee	7.33	6.10	6.29	9.33	9.00	6.67	7.30
Boreal Chickadee	1.89	1.10	1.00	2.33	2.50	3.17	1.89
Red-breasted Nuthatch	3.00	3.40	1.43	1.00	0.50	0.17	1.84
White-breasted Nuthatch	0.00	0.10	0.29	0.00	0.17	0.00	0.09
Brown Creeper	0.00	0.10	0.14	0.00	0.00	0.33	0.09
Winter Wren	0.00	0.00	0.29	0.00	0.00	0.00	0.05
Golden-crowned Kinglet	0.22	0.70	1.14	2.33	2.33	4.50	1.64
Ruby-crowned Kinglet	0.89	1.90	2.86	3.50	2.83	0.00	1.93
Swainson's Thrush	0.11	0.10	0.14	0.00	0.00	0.00	0.07
Hermit Thrush	0.33	0.80	1.00	2.17	1.50	0.50	0.98
American Robin	3.44	1.10	1.57	2.50	30.33	13.00	7.45
Gray Catbird	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Bohemian Waxwing	0.00	0.00	0.00	0.00	0.33	0.33	0.09
Cedar Waxwing	0.56	0.10	0.00	0.00	0.00	0.00	0.14

Tennessee Warbler	0.33	0.00	0.00	0.00	0.00	0.00	0.07
Nashville Warbler	0.11	0.00	0.29	0.00	0.00	0.00	0.07
Northern Parula	2.00	0.60	0.43	0.17	0.00	0.00	0.64
Chestnut-sided Warbler	0.11	0.00	0.14	0.00	0.00	0.00	0.05
Magnolia Warbler	5.44	1.80	1.71	0.17	0.00	0.00	1.82
Cape May Warbler	0.22	0.00	0.00	0.00	0.00	0.00	0.05
Black-throated Blue Warbler	1.11	0.10	0.14	0.00	0.00	0.00	0.27
Yellow-rumped Warbler	2.78	2.40	2.86	14.17	5.67	0.83	4.39
Black-throated Green Warbler	6.33	2.80	1.29	0.50	0.00	0.00	2.20
Blackburnian Warbler	0.44	0.10	0.00	0.00	0.00	0.00	0.11
Palm Warbler	0.00	0.00	0.29	0.33	0.17	0.17	0.14
Bay-breasted Warbler	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Blackpoll Warbler	0.11	0.40	0.29	0.00	0.00	0.00	0.16
Black-and-White Warbler	0.67	0.50	0.43	0.00	0.00	0.00	0.32
American Redstart	0.44	0.00	0.00	0.00	0.00	0.00	0.09
Ovenbird	2.00	0.70	1.00	0.00	0.00	0.00	0.73
Mourning Warbler	0.33	0.20	0.00	0.00	0.00	0.00	0.11
Common Yellowthroat	4.67	3.80	2.57	1.00	0.00	0.00	2.36
Wilson's Warbler	0.11	0.00	0.00	0.00	0.00	0.00	0.02
Fox Sparrow	0.00	0.00	0.00	0.00	0.17	0.00	0.02
Song Sparrow	0.56	1.40	0.86	3.00	1.00	0.83	1.23
Lincoln's Sparrow	0.33	0.20	0.00	0.00	0.00	0.00	0.11
Swamp Sparrow	0.22	0.10	1.00	0.83	0.67	0.00	0.43
White-throated Sparrow	3.00	5.80	5.71	10.00	6.50	2.17	5.39
White-crowned Sparrow	0.00	0.00	0.14	0.00	0.17	0.00	0.05
Dark-eyed Junco	3.22	5.50	7.86	6.33	5.00	10.00	6.07
Red-winged Blackbird	0.00	0.00	0.00	0.00	0.00	0.17	0.02
Rusty Blackbird	0.00	0.00	0.00	0.00	0.33	0.00	0.05
Common Grackle	2.00	0.00	0.00	0.00	0.00	0.00	0.41
Red Crossbill	0.00	0.00	0.00	0.00	0.00	2.00	0.27
White-winged Crossbill	3.11	3.50	2.00	0.67	1.67	6.67	2.98
Pine Grosbeak	0.00	0.20	0.00	0.00	0.17	0.67	0.16
Purple Finch	1.33	1.40	1.29	2.17	1.33	0.83	1.39
Common Redpoll	0.00	0.00	0.00	0.00	0.00	0.83	0.11
Pine Siskin	0.56	0.30	0.14	0.00	0.33	0.83	0.36
American Goldfinch	2.44	1.90	3.14	3.17	0.17	0.50	1.95
Evening Grosbeak	0.00	0.20	0.00	0.00	1.17	11.00	1.70

Table 2. Mean Total Birds per Transect in the 50-m Band by Wind Direction and Speed during the Autumn Migration

[Back to Text]

WindSpeed	WindDirection									
	N	NE	E	SE	S	SW	W	NW	Calm	Total
0 km/hr									86.88	86.88
1-6 km/hr							61.50	61.00		61.25
7-11 km/hr	61.33			34.00		41.50	72.00	83.00		61.10
12-19 km/hr	54.00					39.00	47.00	37.33		42.00
20-29 km/hr	9.00					42.50	31.25	31.00		31.25
30-39 km/hr	12.00				19.00	29.00	31.00	59.00		30.29
40-50 km/hr	18.00									18.00
Total	39.57	0.00	0.00	34.00	19.00	39.33	44.33	54.44	86.88	51.89

Table 3. Percent Occurrence of Wind Direction and Speed Combinations per Transect during the Autumn Migration

[Back to Text]

WindSpeed	WindDirection									
	N	NE	E	SE	S	SW	W	NW	Calm	Total
0 km/hr									18.18	18.18
1-6 km/hr							4.55	4.55		9.09
7-11 km/hr	6.82			2.27		4.55	4.55	4.55		22.73
12-19 km/hr	2.27					2.27	2.27	6.82		13.64
20-29 km/hr	2.27					4.55	9.09	2.27		18.18
30-39 km/hr	2.27				2.27	2.27	6.82	2.27		15.91
40-50 km/hr	2.27									2.27
Total	15.91			2.27	2.27	13.64	27.27	20.45	18.18	100.00

Table 4. Habitat Types

[Back to Autumn Migration] [Back to Spring Migration]

Type No.	Type	Description	Primary Species	Secondary Species	No. of Point Counts	No. of Segments
1	Clearcut, Regenerating, and/or Early Succession	Disturbed by forestry practices in recent years	Spruce-Fir, Red Maple, Grey Birch, White Birch	Trembling Aspen, Pin Cherry	7	3
2	Clearcut, Regenerating and/or Early Succession alongside Mature Deciduous	Disturbed by forestry in recent years, surrounded on at least one side by mature deciduous forest	Spruce-Fir, Red Maple, Grey Birch, White Birch And Sugar Maple, Yellow Birch, Beech	Trembling Aspen, Pin Cherry And Striped Maple	4	3
3	Mid-to-Late Succession	A mixed age, mixed (coniferous and deciduous) forest	Spruce-Fir, Sugar Maple, Red Maple, Yellow Birch, White Birch	Grey Birch, Beech	5	2
4	Mature Coniferous	Conifers comprise greater than 75% of the trees with many of harvestable size	Spruce-Fir, Red Pine	Sugar Maple, Yellow Birch, Grey Birch	4	2
5	Mature Deciduous	Deciduous trees comprise greater than 75% of the trees and most are of harvestable size	Sugar Maple, Yellow Birch, Beech	Striped Maple, White Birch, Spruce-Fir	4	2

Table 5. Mean Total Birds in 50-m Band by Habitat Type for Segments and Point Counts during the Autumn Migration

[Back to Text]

Habitat Type	Segments	Point Counts
Clearcut, Regeneration, and Early Succession	25.00	3.83
Clearcut, Regeneration, and Early Succession with Mature Deciduous	14.88	2.16
Mid to Late Succession; Mixed Age and Mature Mixed Forest	15.14	2.47
Mature Coniferous	16.55	2.86
Mature Deciduous	12.09	1.61
Total	17.27	2.74

Table 6. Mean Total Species in 50-m Band by Habitat Type for Segments and Point Counts during the Autumn Migration

[Back to Text]

Habitat Type	Segments	Point Counts
Clearcut, Regeneration, and Early Succession	8.58	2.44
Clearcut, Regeneration, and Early Succession with Mature Deciduous	5.85	1.36
Mid to Late Succession; Mixed Age and Mature Mixed Forest	6.91	1.71
Mature Coniferous	7.55	1.93
Mature Deciduous	5.32	1.20
Total	6.90	1.82

Table 7. Mean Abundance of Species Showing Significant Habitat Relationships at the 95% Confidence Level and Their Associated Habitat Types at the 95% Confidence Level for Segments and Point Counts in the 50-m Band during the Autumn Migration

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	Clearcut, Regeneration, and Early Succession		Clearcut, Regeneration, and Early Succession with Mature Deciduous		Mid to Late Succession; Mixed Age and Mature Mixed Forest		Mature Coniferous		Mature Deciduous	
	Seg	PC	Seg	PC	Seg	PC	Seg	PC	Seg	PC
Downy Woodpecker	0.03		0.06		0.00		0.00		0.18	
Northern Flicker	0.70		0.15		0.00		0.05		0.00	
Red-eyed Vireo	0.48	0.03	0.61	0.18	0.91	0.20	0.36	0.02	1.95	0.30
Black-capped Chickadee	3.79		1.52		2.95		0.86		1.91	
Boreal Chickadee	1.06	0.12	0.15	0.03	0.55	0.04	1.27	0.27	0.50	0.00
White-breasted Nuthatch		0.00		0.05		0.00		0.00		0.00
Golden-crowned Kinglet	0.42	0.04	0.12	0.02	0.91	0.07	1.32	0.27	0.23	0.07
Ruby-crowned Kinglet	1.61	0.29	0.33	0.00	0.23	0.04	0.64	0.20	0.09	0.00
Hermit Thrush	0.30		0.03		0.41		0.32		0.68	
Yellow-rumped Warbler	0.45		0.55		0.27		1.18		0.14	
Palm Warbler	0.18		0.00		0.00		0.00		0.00	
Black-and-White Warbler	0.12		0.03		0.00		0.32		0.09	
Ovenbird	0.03		0.15		0.18		0.09		0.91	
Common Yellowthroat	2.12	0.45	0.67	0.05	0.18	0.02	0.36	0.02	0.00	0.00
Song Sparrow	1.15	0.23	0.90	0.05	0.50	0.05	0.09	0.00	0.00	0.00
Swamp Sparrow	0.42	0.12	0.06	0.02	0.09	0.00	0.00	0.00	0.00	0.00
White-throated Sparrow	3.15	0.61	2.06	0.25	0.55	0.11	1.68	0.32	0.05	0.00
Purple Finch	0.24		0.00		0.00		0.00		0.00	

Positively different from all four other habitat types at 95% level of probability

Positively different from three habitat types at 95% level of probability

Positively different from two habitat types at 95% level of probability

Positively different from one habitat type at 95% level of probability

Table 8. Mean Abundance of Species Showing Significant Habitat Relationships at the 95% Confidence Level and Their Associated Habitat Types at the 90% Confidence Level for Segments and Point Counts in the 50-m Band during the Autumn Migration

[Back to Text]

	Clearcut, Regeneration, and Early Succession		Clearcut, Regeneration, and Early Succession with Mature Deciduous		Mid to Late Succession; Mixed Age and Mature Mixed Forest		Mature Coniferous		Mature Deciduous	
	Seg	PC	Seg	PC	Seg	PC	Seg	PC	Seg	PC
Downy Woodpecker	0.03		0.06		0.00		0.00		0.18	
Northern Flicker	0.70		0.15		0.00		0.05		0.00	
Red-eyed Vireo	0.48	0.03	0.61	0.18	0.91	0.20	0.36	0.02	1.95	0.30
Black-capped Chickadee	3.79		1.52		2.95		0.86		1.91	
Boreal Chickadee	1.06	0.12	0.15	0.03	0.55	0.04	1.27	0.27	0.50	0.00
White-breasted Nuthatch		0.00		0.05		0.00		0.00		0.00
Golden-crowned Kinglet	0.42	0.04	0.12	0.02	0.91	0.07	1.32	0.27	0.23	0.07
Ruby-crowned Kinglet	1.61	0.29	0.33	0.00	0.23	0.04	0.64	0.20	0.09	0.00
Hermit Thrush	0.30		0.03		0.41		0.32		0.68	
Yellow-rumped Warbler	0.45		0.55		0.27		1.18		0.14	
Palm Warbler	0.18		0.00		0.00		0.00		0.00	
Black-and-White Warbler	0.12		0.03		0.00		0.32		0.09	
Ovenbird	0.03		0.15		0.18		0.09		0.91	
Common Yellowthroat	2.12	0.45	0.67	0.05	0.18	0.02	0.36	0.02	0.00	0.00
Song Sparrow	1.15	0.23	0.90	0.05	0.50	0.05	0.09	0.00	0.00	0.00
Swamp Sparrow	0.42	0.12	0.06	0.02	0.09	0.00	0.00	0.00	0.00	0.00
White-throated Sparrow	3.15	0.61	2.06	0.25	0.55	0.11	1.68	0.32	0.05	0.00
Purple Finch	0.24		0.00		0.00		0.00		0.00	

Positively different from all four other habitat types at 90% level of probability

Positively different from three habitat types at 90% level of probability

Positively different from two habitat types at 90% level of probability

Positively different from one habitat type at 90% level of probability

Table 9. Mean Abundance of Additional Species Showing Significant Habitat Relationships at the 95% Confidence Level and Their Associated Habitat Types at the 90% Confidence Level for Segments and Point Counts at All Distances during the Autumn Migration

[Back to Text]

	Clearcut, Regeneration, and Early Succession		Clearcut, Regeneration, and Early Succession with Mature Deciduous		Mid to Late Succession; Mixed Age and Mature Mixed Forest		Mature Coniferous		Mature Deciduous	
	Seg	PC	Seg	PC	Seg	PC	Seg	PC	Seg	PC
Red-tailed Hawk	0.00	0.05	0.12	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Pileated Woodpecker	0.24	0.08	0.09	0.00	0.00	0.00	0.09	0.05	0.00	0.00
Blue Jay	3.25	0.69	1.45	0.30	1.55	0.33	2.45	0.43	0.95	0.20
Common Raven	1.94	0.64	1.42	0.25	1.45	0.31	0.59	0.18	1.18	0.36
White-winged Crossbill	2.70	0.31	0.45	0.00	0.27	0.18	0.82	0.34	0.14	0.00
Pine Siskin	0.27	0.04	0.12	0.02	0.00	0.00	0.14	0.02	0.00	0.00

Cyan	Positively different from all four other habitat types at 95% level of probability
Green	Positively different from three habitat types at 95% level of probability
Orange	Positively different from two habitat types at 95% level of probability
Yellow	Positively different from one habitat type at 95% level of probability

Shading in table: Pileated Woodpecker Seg 0.24 (orange); Blue Jay Seg 3.25 and PC 0.69 (yellow); Common Raven Seg 1.94 (yellow), PC 0.64 (orange); White-winged Crossbill Seg 2.70 (yellow); Pine Siskin Seg 0.27 (orange).

Table 10. Hermit Thrush Nocturnal Passage Counts during the Autumn Migration
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Day	Month	Start Time	Listening Point	Elevation (m)	Night Wind Direction	Night Wind Speed (km/hr)	Current Wind Direction	Current Wind Speed	Temp.	Sound Count
3	9	530	2	200	SW	12-19	W	40-50	10	0
11	9	541	2	200	SE	12-19	SE	1-6	12	13
14	9	544	6	230	SW	7-11	Calm	0	1	79
15	9	546	2	200	S	12-19	SE	20-29	11	0
18	9	549	6	230	S	7-11	Calm	0	1	1
19	9	550	2	200	SW	7-11	W	12-19	7	5
23	9	555	6	230	SW	12-19	W	30-39	16	0
25	9	558	2	200	NW	30-39	NW	30-39	9	0
26	9	559	5	240	SW	12-19	W	20-29	18	4
1	10	605	6	230	SW	7-11	Calm	0	-3	89
5	10	610	4	210	W	12-19	NW	7-11	8	44
7	10	613	6	230	NW	20-29	NW	30-39	8	0
14	10	622	6	230	SW	7-11	Calm	0	2	57
18	10	627	4	210	W	12-19	Calm	0	1	12
19	10	629	6	230	S	7-11	Calm	0	-3	14
23	10	634	4	210	SW	12-19	SW	20-29	10	0

Table 11. Summary of Diurnal Passage of Raptors during the Autumn Migration
[Back to Text]

Species	Date Range	Time Range (hrs)	Median Time of Observation (hrs)	No. of Observations	% Time Blocks Observed	Mean No. Per Observation
Osprey	17 Sep - 3 Oct	1000-1200	1100	2	1.54%	1.00
Bald Eagle	29 Aug - 23 Oct	0830-1500	1130	29	16.92%	1.10
Northern Harrier	30 Aug	1000	1000	1	0.77%	1.00
Sharp-shinned Hawk	30 Aug - 15 Oct	0730-1600	0945	12	8.46%	1.17
Northern Goshawk	15 Oct	0800	0800	1	0.77%	1.00
Red-tailed Hawk	3 Sep - 10 Oct	0730-1500	1130	18	12.31%	1.11
American Kestrel	8 Sep - 17 Sep	1100-1330	1130	7	5.38%	1.14
Merlin	4 Oct	1300	1300	1	0.77%	1.00
Peregrine Falcon	6 Sep	1030	1030	1	0.77%	1.00

Table 12. Summary of the Diurnal Passage of Water Birds during the Autumn Migration

[Back to Text]

Species	Date Range	Time Range (hrs)	Median Time of Observation (hrs)	No. of Observations	% Time Blocks Observed	Mean No. Per Observation
Canada Goose	6 Sep	930	0930	1	0.77%	8.00
Duck sp.	12 Oct	0730	0730	1	0.77%	12.00
Double-crested Cormorant	8 Sep - 26 Sep	0730-1100	0800	3	2.31%	2.33
Herring Gull	14 Sep - 23 Oct	0800-1430	1100	7	4.62%	2.57
Great Black-backed Gull	6 Oct	0800	0800	1	0.77%	6.00

Table 13. Summary of the Diurnal Passage of Woodpeckers and Passerines during the Autumn Migration

[Back to Text]

Species	Date Range	Time Range (hrs)	Median Time of Observation (hrs)	No. of Observations	% Time Blocks Observed	Mean No. Per Observation
None	1 Oct - 20 Oct	0700-1400	0930	11	8.46%	0.00
Downy Woodpecker	31 Aug - 2 Oct	1000-1030	1015	2	1.54%	1.00
Hairy Woodpecker	18 Sep	1100-1100	1100	1	0.77%	1.00
Northern Flicker	10 Sep - 18 Oct	0730-1230	1030	6	3.85%	1.00
Pileated Woodpecker	18 Sep - 19 Oct	1100-1230	1100	3	2.31%	1.00
Northern Shrike	23 Oct	1000-1000	1000	1	0.77%	1.00
Blue-headed Vireo	2 Oct	1030-1030	1030	1	0.77%	1.00
Red-eyed Vireo	26 Sep	0830-0830	0830	1	0.77%	1.00
Gray Jay	23 Sep	1000-1000	1000	1	0.77%	1.00
Blue Jay	3 Sep - 23 Oct	0830-1630	1100	35	22.31%	1.29
Common Raven	30 Aug - 23 Oct	0730-1630	1030	86	43.08%	1.67
Black-capped Chickadee	17 Sep - 23 Oct	0730-1500	0945	8	6.15%	4.38
Boreal Chickadee	26 Sep	0830-0830	0830	1	0.77%	1.00
Red-breasted Nuthatch	26 Sep	0800-0800	0800	1	0.77%	1.00
White-breasted Nuthatch	2 Oct - 18 Oct	1030-1030	1030	2	1.54%	1.00
Golden-crowned Kinglet	26 Sep	0830-0830	0830	1	0.77%	2.00
Ruby-crowned Kinglet	26 Sep	0800-0830	0815	2	1.54%	1.00
American Robin	3 Sep - 23 Oct	0730-1530	1045	28	19.23%	3.57
American Pipit	3 Oct	1030-1030	1030	1	0.77%	1.00
Cedar Waxwing	5 Sep - 25 Sep	0900-1030	0945	2	0.77%	1.50
Nashville Warbler	26 Sep	0800-0800	0800	1	0.77%	1.00
Magnolia Warbler	26 Sep	0830-0830	0830	1	0.77%	2.00
Yellow-rumped Warbler	30 Aug - 11 Oct	0730-1230	1000	36	23.85%	1.61
Black-throated Green Warbler	31 Aug - 2 Oct	1030-1030	1030	1	0.77%	1.00
Palm Warbler	14 Oct	1030-1030	1030	1	0.77%	1.00
Warbler species	29 Aug - 6 Oct	0730-1130	0900	14	8.46%	1.50
Scarlet Tanager	19 Sep	1000-100	1000	1	0.77%	1.00
Lincoln's Sparrow	2 Oct	1030-1030	1030	1	0.77%	3.00
White-throated Sparrow	26 Sep -2 Oct	0830-1100	1030	3	2.31%	1.33
Dark-eyed Junco	29 Aug - 23 Oct	0730-1230	1030	20	15.38%	8.25
Rose-breasted Grosbeak	10 Sep	1130-1130	1130	1	0.77%	1.00
Bobolink	8 Sep	1000-1000	1000	1	0.77%	1.00
Red-winged Blackbird	22 Sep	0830-0830	0830	1	0.77%	1.00
Purple Finch	29 Aug - 19 Oct	0830-1300	1030	20	13.85%	1.30
Red Crossbill	15 Oct - 23 Oct	0730-1030	0800	3	2.31%	1.00
White-winged Crossbill	14 Sep - 19 Oct	0900-1130	1030	5	3.85%	2.60
Pine Siskin	19 Sep - 18 Oct	1000-1230	1045	4	3.08%	1.75
American Goldfinch	30 Aug - 23 Oct	0730-1130	1000	25	16.92%	2.08
Evening Grosbeak	29 Aug - 23 Oct	1030-1500	1115	4	3.08%	5.50
Passerine species	29 Aug - 23 Oct	0730-1630	1030	30	20.00%	1.80

Table 14. Matrix of Flight Direction and Wind Direction for Woodpeckers and Small to Medium-Sized Passerines in Diurnal Passage during the Autumn Migration

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		Wind Direction								
Species	Flight Direction	Calm	E	N	NW	W	SW	S	SE	Grand Total
Woodpeckers	E				2	1				3
	N				1					1
	W				2	1		1	1	5
	S				1	1	1			3
Woodpeckers Total					6	3	1	1	1	12
Blue Jay	E			2	1	7	1			11
	N	1		1			2			4
	W			4	4	5	1			14
	S	2				4				6
Blue Jay Total		3		7	5	16	4			35
American Robin	E				1	1		1	1	4
	N				2	1	1			4
	W	1		2	2	7	1		2	15
	S				1	1	2	1		5
American Robin Total		1		2	6	10	4	2	3	28
Warblers	?				2		3		1	6
	E			1	1	1	2			5
	N				2	2				4
	W	2		6	3	15	3		3	32
	S		1		1	4	1			7
Warblers Total		2	1	7	9	22	9		4	54
Finches	?		1	4	3	5	10	1		24
	E			1	1	3		1		6
	N			3	3	8		1		15
	W	1			2	3	4		1	11
	S			1	1	2		1		5
Finches Total		1	1	9	10	21	14	4	1	61
Other Passerines	?					2	1			3
	E			1	4	4	1	2	1	13
	N				1	3				4
	W	1		2	7	21	5		2	38
	S				1	15	3	1	2	22
Other Passerines Total		1		3	13	45	10	3	5	80
None	None	1		2	1	4	1		2	11
None Total		1		2	1	4	1		2	11
Grand Total		9	2	30	50	121	43	10	16	281

Table 15. Matrix of Flight Direction and Wind Speed for Woodpeckers and Small to Medium-Sized Passerines in Diurnal Passage during the Autumn Migration

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		Wind Speed								
Species	Flight Direction	0 km/hr	1-6 km/hr	7-11 km/hr	12-19 km/hr	20-29 km/hr	30-39 km/hr	40-50 km/hr	51-62 km/hr	Grand Total
Woodpeckers	E		2		1					3
	N			1						1
	W		2		1	2				5
	S		1	1		1				3
Woodpeckers Total			5	2	2	3				12
Blue Jay	E		1	4	4	2				11
	N	1			2		1			4
	W		4	7	1	1	1			14
	S	2	1	1	2					6
Blue Jay Total		3	6	12	9	3	2			35
American Robin	E		1	1	1	1				4
	N		1	1	2					4
	W	1		2	6	3	1		2	15
	S		1		2	1		1		5
American Robin Total		1	3	4	11	5	1	1	2	28
Warblers	?				2	3	1			6
	E			3	2					5
	N				2		1	1		4
	W	2	3	3	20	3	1			32
	S		1	4	1	1				7
Warblers Total		2	4	10	27	7	3	1		54
Finches	?		3	7	8	5	1			24
	E		2		1	3				6
	N			1	9	1	4			15
	W	1	1	4	2	3				11
	S				4		1			5
Finches Total		1	6	12	24	12	6			61
Other Passerines	?			1		2				3
	E		2	1	7	1	2			13
	N				1	2		1		4
	W	1	3	6	24	3	1			38
	S		1	4	6	11				22
Other Passerines Total		1	6	12	38	19	3	1		80
None	None	1	1		3		3	3		11
None Total		1	1		3		3	3		11
Grand Total		9	31	52	114	49	18	6	2	281

Table 16. Mean Birds per Hectare by Species and Habitat Type at < 50 m (Non-zero values in red) during the Winter

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	Clearcut, regeneration & early succession	Clearcut, regeneration & early succession with mature deciduous	Mid to late succession	Mature coniferous	Mature deciduous	Residential or agricultural	Total
Ruffed Grouse	0.00	0.00	0.01	0.00	0.03	0.00	0.01
Rock Pigeon	0.00	0.00	0.00	0.00	0.00	0.27	0.03
Barred Owl	0.00	0.00	0.00	0.00	0.03	0.00	0.01
Downy Woodpecker	0.00	0.00	0.00	0.11	0.16	0.00	0.05
Hairy Woodpecker	0.00	0.00	0.00	0.02	0.15	0.00	0.03
Gray Jay	0.10	0.00	0.00	0.04	0.00	0.00	0.03
Blue Jay	0.00	0.10	0.03	0.00	0.00	0.07	0.03
Black-capped Chickadee	0.32	0.40	0.39	0.23	1.13	0.53	0.47
Boreal Chickadee	0.03	0.00	0.00	0.38	0.00	0.00	0.09
Red-breasted Nuthatch	0.03	0.00	0.00	0.00	0.02	0.00	0.01
White-breasted Nuthatch	0.00	0.00	0.00	0.00	0.16	0.00	0.02
Golden-crowned Kinglet	0.07	0.05	0.01	0.22	0.08	0.00	0.08
Pine Grosbeak	0.00	0.25	0.61	0.00	0.00	0.00	0.17
Common Redpoll	0.00	0.00	0.02	0.00	0.00	0.00	0.01

Table 17. Species Observed by Habitat Type at >50 m or Flying during the Winter

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	Clearcut, regeneration, and early succession	Clearcut, regeneration, and early succession with mature deciduous	Mid to late succession	Mature coniferous	Mature deciduous	Residential or agricultural
Downy Woodpecker					X	
Hairy Woodpecker	X	X		X	X	
Pileated Woodpecker					X	
Gray Jay			X			
Blue Jay	X	X		X		X
Common Raven	X	X		X	X	X
American Crow			X	X	X	X
Black-capped Chickadee			X			
Pine Grosbeak		X	X	X		
White-winged Crossbill	X					
Common Redpoll		X	X	X		X
American Goldfinch	X					

Table 18. Mean Number of Each Species per Transect at All Distances by 10-day Period during the Spring Migration

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Species	April 1-10	April 11-20	April 21-30	May 1-10	May 11-20	May 21-30	May 31-June 9	Total
American Black Duck	0.00	0.00	0.00	0.17	0.25	0.13	0.00	0.10
Green-winged Teal	0.00	0.00	0.00	0.00	0.13	0.25	0.00	0.08
Ruffed Grouse	0.00	1.60	2.80	2.17	1.38	1.75	0.50	1.58
Common Loon	0.00	0.00	0.00	0.00	0.13	0.00	0.17	0.05
Red-tailed Hawk	0.00	0.20	0.00	0.17	0.00	0.13	0.33	0.13
Broad-winged Hawk	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.03
Sharp-shinned Hawk	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.08
American Kestrel	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.05
Merlin	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.03
Herring Gull	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.03
Mourning Dove	1.50	0.20	0.20	0.00	0.00	0.00	0.17	0.15
Barred Owl	0.00	0.20	0.60	0.17	0.00	0.00	0.00	0.13
Ruby-throated Hummingbird	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.15
Belted Kingfisher	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.03
Yellow-bellied Sapsucker	0.00	5.40	11.60	9.50	6.13	4.63	7.83	6.88
Downy Woodpecker	0.00	0.40	0.40	0.17	0.38	0.25	0.17	0.28
Hairy Woodpecker	4.50	2.20	3.20	2.33	2.50	1.75	3.50	2.63
Black-backed Woodpecker	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.03
Northern Flicker	0.00	2.80	7.40	6.50	2.88	2.63	3.00	3.80
Pileated Woodpecker	0.50	0.60	0.40	0.17	0.25	0.25	0.33	0.33
Olive-sided Flycatcher	0.00	0.00	0.00	0.00	0.00	0.50	0.50	0.18
Eastern Wood Pewee	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.05
Yellow-bellied Flycatcher	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.03
Alder Flycatcher	0.00	0.00	0.00	0.00	0.00	0.38	4.83	0.80
Least Flycatcher	0.00	0.00	0.00	0.00	1.13	3.63	5.67	1.80
Blue-headed Vireo	0.00	0.00	0.00	1.00	3.63	4.75	3.67	2.38
Red-eyed Vireo	0.00	0.00	0.00	0.00	0.00	2.25	12.00	2.25
Tree Swallow	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.03
Blue Jay	1.50	1.20	1.80	2.00	1.88	3.50	3.33	2.33
American Crow	1.00	1.60	0.40	1.33	0.13	0.13	0.50	0.63
Common Raven	2.00	1.80	1.40	1.83	1.25	1.63	1.17	1.53
Black-capped Chickadee	3.50	5.00	2.80	4.33	1.75	4.88	1.83	3.40
Boreal Chickadee	0.50	3.00	0.60	1.17	1.13	0.88	0.83	1.18
Red-breasted Nuthatch	0.00	0.00	0.00	0.17	0.00	0.13	0.17	0.08
White-breasted Nuthatch	1.00	0.20	0.60	0.00	0.25	0.13	0.00	0.23
Winter Wren	0.00	0.00	0.20	0.33	0.25	0.13	0.17	0.18
Golden-crowned Kinglet	0.00	0.20	0.00	0.33	0.13	0.00	0.00	0.10
Ruby-crowned Kinglet	0.00	0.40	4.80	8.83	6.00	3.50	4.00	4.48
Swainson's Thrush	0.00	0.00	0.00	0.00	0.00	0.75	2.67	0.55
Hermit Thrush	0.00	0.00	2.20	9.33	2.63	4.75	6.33	4.10
American Robin	16.00	25.60	17.60	15.17	9.13	10.00	16.83	14.83
Gray Catbird	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.03

Cedar Waxwing	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.03
Tennessee Warbler	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.10
Nashville Warbler	0.00	0.00	0.00	0.00	0.00	1.38	1.33	0.48
Northern Parula	0.00	0.00	0.00	0.00	1.13	3.50	4.17	1.55
Chestnut-sided Warbler	0.00	0.00	0.00	0.00	0.13	1.00	1.83	0.50
Magnolia Warbler	0.00	0.00	0.00	0.00	1.63	11.00	13.50	4.55
Black-throated Blue Warbler	0.00	0.00	0.00	0.00	0.38	0.75	1.00	0.38
Yellow-rumped Warbler	0.00	0.00	3.20	8.00	6.88	3.75	1.00	3.88
Black-throated Green Warbler	0.00	0.00	0.00	0.17	5.88	16.00	12.67	6.30
Blackburnian Warbler	0.00	0.00	0.00	0.00	0.13	1.00	0.67	0.33
Palm Warbler	0.00	0.00	0.20	0.50	0.38	0.63	0.17	0.33
Blackpoll Warbler	0.00	0.00	0.00	0.00	0.00	0.38	0.17	0.10
Black-and-White Warbler	0.00	0.00	0.00	0.33	2.63	3.13	2.83	1.63
American Redstart	0.00	0.00	0.00	0.00	0.13	0.75	4.17	0.80
Ovenbird	0.00	0.00	0.00	0.00	8.00	17.38	10.67	6.68
Mourning Warbler	0.00	0.00	0.00	0.00	0.00	0.00	1.17	0.18
Common Yellowthroat	0.00	0.00	0.00	0.00	0.75	5.50	7.33	2.35
Wilson's Warbler	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.03
Fox Sparrow	1.00	0.60	0.00	0.00	0.00	0.00	0.00	0.13
Song Sparrow	1.00	8.40	4.40	3.67	3.25	2.50	2.83	3.78
Lincoln's Sparrow	0.00	0.00	0.00	0.00	0.88	2.25	2.67	1.03
Swamp Sparrow	0.00	0.00	0.40	1.50	0.50	0.25	0.33	0.48
White-throated Sparrow	0.00	0.00	5.20	23.17	22.75	19.63	20.33	15.65
Dark-eyed Junco	11.50	14.20	5.40	5.83	4.38	5.63	3.17	6.38
Rose-breasted Grosbeak	0.00	0.00	0.00	0.00	0.00	0.25	0.17	0.08
Red-winged Blackbird	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.03
Common Grackle	0.50	2.60	0.40	0.83	0.13	1.13	0.83	0.90
Pine Grosbeak	1.00	0.40	0.00	0.00	0.13	0.00	0.00	0.13
Purple Finch	0.00	0.00	1.00	6.83	6.00	3.88	3.50	3.65
Common Redpoll	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.05
Pine Siskin	0.50	0.00	0.00	0.17	0.00	0.38	1.33	0.33
American Goldfinch	0.00	0.00	0.20	0.33	1.63	2.88	1.83	1.25
Evening Grosbeak	2.00	1.20	2.20	1.00	1.88	0.75	0.83	1.33

Table 19. Mean Total Birds per Transect Segment at <50m by Previous Night Wind Direction and Speed during the Spring Migration

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Wind Speed	N	NE	E	SE	S	SW	W	NW	Total
1-6 km/hr			11.67	12.67		10.67			11.57
7-11 km/hr			10.33		13.48	7.44	9.17		11.20
12-19 km/hr			10.00	22.00	10.56	10.73	12.50	10.00	12.46
20-29 km/hr		10.67				4.00	9.83		9.17
30-39 km/hr		7.00							7.00
Total		9.44	10.47	18.89	12.60	9.07	11.00	10.00	11.30

Table 20. Number of Transect Segments for Each Combination of Previous Night Wind Direction and Speed during the Spring Migration

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Wind Speed	N	NE	E	SE	S	SW	W	NW	Total
1-6 km/hr			3	3		3			9
7-11 km/hr			6		21	9	6		42
12-19 km/hr			6	6	9	15	12		48
20-29 km/hr		6				3	6	3	18
30-39 km/hr		3							3
Total		9	15	9	30	30	24	3	120

Table 21. Mean Abundance of Species Showing Significant Habitat Relationships at the 95% Confidence Level and Their Associated Habitat Types at the 95% Confidence Level for Transect Segments at <50m and Point Counts at All Distances during the Spring Migration

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	Clearcut, Regeneration, and Early Succession		Clearcut, Regeneration and Early Succession with Mature Deciduous		Mid to Late Succession; Mixed Age and Mature Mixed Forest		Mature Coniferous		Mature Deciduous	
Species	Seg <50m	PC All	Seg <50m	PC All	Seg <50 m	PC All	Seg <50m	PC All	Seg <50m	PC All
Northern Flicker		0.24		0.13		0.04		0.05		0.03
Alder Flycatcher		0.19 (orange)		0.00		0.02		0.03		0.00
Least Flycatcher		0.00		0.15		0.10		0.00		0.20
Blue-headed Vireo	0.07		0.10		0.30		0.05		0.60	
Red-eyed Vireo		0.09		0.35		0.10		0.03		0.13
Boreal Chickadee	0.17	0.06	0.17	0.00	0.05	0.02	1.10	0.40	0.00	0.00
Ruby-crowned Kinglet	0.43	0.30	0.17	0.05	0.90	0.40 (yellow)	1.15	0.40 (yellow)	0.54	0.18
Northern Parula	0.07	0.03	0.17	0.03	0.30	0.08	0.10	0.03	0.80	0.25
Black-throated Blue Warbler	0.03	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.50 (orange)	0.25
Black-throated Green Warbler		0.17		0.15		0.42		0.73		0.33
Blackburnian Warbler	0.00		0.00		0.40		0.05		0.20	
Palm Warbler	0.17		0.00		0.05		0.00		0.00	
Black-and-white Warbler		0.09		0.13		0.32 (orange)		0.03		0.03
Song Sparrow	1.50 (yellow)	0.49 (cyan)	0.03	0.05	0.15	0.04	0.15	0.00	0.00	0.00
Lincoln's Sparrow	1.00 (cyan)	0.26 (cyan)	0.07	0.00	0.00	0.02	0.05	0.00	0.00	0.00
Swamp Sparrow	0.33	0.09 (cyan)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White-throated Sparrow	2.60	1.01 (orange)	0.87	0.30	0.75	0.42	0.35	0.25	0.40	0.25

(cyan) Positively different from all four other habitat types at 95% level of probability
(green) Positively different from three habitat types at 95% level of probability
(orange) Positively different from two habitat types at 95% level of probability
(yellow) Positively different from one habitat type at 95% level of probability

Table 22. Nocturnal Passage Counts during the Autumn Migration

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Day	Month	Start Time	Listening Point	Elevation m	Night Wind Direction	Night Wind Speed km/hr	Current Wind Direction	Current Wind Speed km/hr	Temp.	Species	Sound Count
4	5	04:52	5	240	E	12-19	Calm	0	1	Hermit Thrush	6
8	5	04:46	5	240	S	7-11	Calm	0	5	Hermit Thrush	4
13	5	04:40	4	210	NE	20-29	NE	12-19	1	Passerine species	1
19	5	04:33	6	230	S	12-19	S	20-20	11	Hermit Thrush	3
26	5	04:27	5	240	S	12-19	SW	40-50	11	Passerine species	1

Table 23. Summary of Occurrence and Abundance of Birds in Diurnal Passage during the Spring Migration

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Species	Date Range	Time Range (hrs)	Median Time of Observation (hrs)	No. of Observations	% Time Blocks Observed	Mean No. Per Observation
Common Merganser	15-May	0854	0854	1	2.00%	2
Common Loon	13-May	0901	0901	1	2.00%	1
Double-crested Cormorant	28-May	0927	0927	1	2.00%	1
Great Blue Heron	07-Apr	0730	0730	1	2.00%	1
Osprey	19 Apr-17 May	0910-0954	0932	2	4.00%	1.50
Bald Eagle	8 Apr-26 May	0830-1116	1026	8	16.00%	1.00
Sharp-shinned Hawk	19 Apr-12 May	0848-0910	0910	3	6.00%	1.33
Northern Goshawk	18-May	0946	0946	1	2.00%	1.00
Red-tailed Hawk	19 Apr-3 Jun	0854-1300	0946	12	24.00%	1.08
American Kestrel	4 May-2 Jun	0902-1016	0929	4	8.00%	1.50
Hairy Woodpecker	25-May	0920-0957	0938	2	4.00%	1.00
Northern Flicker	2 May-18 May	0900-1614	0930	4	8.00%	1.00
Pileated Woodpecker	19 May-2 Jun	0901-0902	0901	2	4.00%	1.00
Tree Swallow	13-May	0901	0901	1	2.00%	1.00
Blue Jay	7 Apr-4 May	0900-0956	0928	2	4.00%	1.00
Common Raven	7 Apr-25 May	0730-1300	0953	17	34.00%	1.18
American Crow	21 Apr-28 May	0915-0927	0915	3	6.00%	2.67
American Robin	7 Apr-18 May	0730-1116	0842	8	16.00%	1.63
Savannah Sparrow	07-May	0940	0940	1	2.00%	1.00
Bobolink	28-May	0927	0927	1	2.00%	2.00
Common Grackle	7 Apr-18 May	0730-1016	0853	2	4.00%	3.50
Purple Finch	15 May-28 May	0854-0927	0910	2	4.00%	1.50
Common Redpoll	07-Apr	0900	0900	2	4.00%	1.00
Pine Siskin	13 May-20 May	0901-0907	0901	3	6.00%	1.00
American Goldfinch	13 May-30 May	0901-0957	0932	6	20.00%	1.33
Evening Grosbeak	21 Apr-24 May	0850-0924	0910	7	14.00%	1.14
Passerine species	8 May-4 Jun	0613-0957	0903	8	16.00%	2.38
None	16 Apr-6 Jun	0709-1131	0924	12	24.00%	0.00

Table 24. Flight Direction of Woodpeckers and Small to Medium Passerines in Diurnal Passage during the Spring Migration

[Back to Text]

Species	Undetermined	E	N	NE	NW	S	SE	W	Total
Hairy Woodpecker			1					1	2
Northern Flicker			1	1		1		1	4
Pileated Woodpecker		1						1	2
Tree Swallow		1							1
Blue Jay			1		1				2
American Robin		5		7			1		13
Savannah Sparrow				1					1
Bobolink			2						2
Common Grackle		4		3					7
Purple Finch	1	2							3
Common Redpoll	2								2
Pine Siskin	3								3
American Goldfinch	5				2	1			8
Evening Grosbeak	3			1			4		8
Passerine Species		14	1	2		1	1		19
Total	14	27	6	15	3	3	6	3	77

Table 25. Summary of Early Breeding Season by Species

[Back to Text]

Species	Breeding Start Week	Mean	Max.	Sum	Frequency	Rank
White-throated Sparrow	May 15	2.71	6	65	91.70%	1
American Robin	May 1	2.54	6	61	91.70%	2
Ovenbird	May 22	1.88	8	45	87.50%	3
Yellow-rumped Warbler	May 8	1.58	5	38	83.30%	4
Dark-eyed Junco	May 1	1.29	4	31	79.20%	5
Magnolia Warbler	May 22	1.21	4	29	75.00%	6
Blue Jay	May 1	1.17	5	28	62.50%	7
Black-capped Chickadee	May 1	1.13	3	27	70.80%	8
Hermit Thrush	May 15	0.96	3	23	66.70%	9
Yellow-bellied Sapsucker	May 22	0.79	2	19	66.70%	10
Song Sparrow	May 1	0.79	3	19	45.80%	11
Northern Flicker	May 1	0.75	2	18	54.50%	12
Common Raven	Mar 1	0.75	3	18	54.20%	13
Hairy Woodpecker	May 1	0.71	2	17	66.70%	14
Common Yellowthroat	May 22	0.71	3	17	45.80%	15
Blue-headed Vireo	May 22	0.63	2	15	41.70%	16
Purple Finch	May 22	0.54	2	13	41.70%	17
American Crow	April 8	0.46	2	11	41.70%	18
Ruffed Grouse	April 22	0.42	2	10	29.20%	19
Ruby-crowned Kinglet	May 8	0.38	2	9	33.30%	20
American Redstart	May 22	0.29	2	7	25.00%	21
Common Grackle	April 22	0.29	4	7	16.70%	22
Nashville Warbler	May 22	0.25	2	6	20.80%	23
Downy Woodpecker	May 8	0.17	1	4	16.70%	24
Pine Siskin	April 22	0.17	1	4	16.70%	25
Barred Owl	Mar 22	0.13	1	3	12.50%	26
Swainson's Thrush	May 22	0.13	1	3	12.50%	27
Palm Warbler	May 15	0.13	2	3	8.30%	28
American Kestrel	April 22	0.08	2	2	4.20%	29
Pileated Woodpecker	April 22	0.08	1	2	8.30%	30
Boreal Chickadee	May 15	0.08	1	2	8.30%	31
Swamp Sparrow	May 15	0.08	1	2	8.30%	32
American Black Duck	April 1	0.04	1	1	4.20%	33
Common Loon	May 8	0.04	1	1	4.20%	34
Red-tailed Hawk	April 15	0.04	1	1	4.20%	35
Merlin	May 15	0.04	1	1	4.20%	36
Black-backed Woodpecker	May 15	0.04	1	1	4.20%	37
Tree Swallow	May 8	0.04	1	1	4.20%	38
White-breasted Nuthatch	May 1	0.04	1	1	4.20%	39
Pine Grosbeak	May 15	0.04	1	1	4.20%	40

Table 26. Mean Abundance of Early Breeding Species Showing Significant Habitat Relationships and Their Preferred Habitat Types at the 95% Confidence Level for Point Counts at All Distances

[Back to Text]

Species	Clearcut, Regeneration, and Early Succession	Clearcut, Regeneration and Early Succession with Mature Deciduous	Mid to Late Succession; Mixed Age and Mature Mixed Forest	Mature Coniferous	Mature Deciduous
Northern Flicker	1.71	0.50	0.40	0.25	0.25
Blue-headed Vireo	0.14	0.50	1.40	0.00	1.25
Boreal Chickadee	0.00	0.00	0.00	0.50	0.00
American Redstart	0.00	0.25	0.40	0.00	1.00
Ovenbird	1.00	2.50	2.00	0.50	4.00
Common Yellowthroat	1.71	0.75	0.40	0.00	0.00
Song Sparrow	1.57	0.00	1.40	0.25	0.00
White-throated Sparrow	5.00	2.25	2.40	1.25	1.00
Dark-eyed Junco	1.00	2.00	2.20	0.50	0.75

(cyan)	Positively different from all four other habitat types at 95% level of probability
(green)	Positively different from three habitat types at 95% level of probability
(orange)	Positively different from two habitat types at 95% level of probability
(yellow)	Positively different from one habitat type at 95% level of probability

Table 27. Summary of Peak Breeding Season by Species

[Back to Text]

Species	Breeding Start Week	Mean	Max.	Sum	Frequency	Rank
Red-eyed Vireo	Jun-08	1.44	5	267	73.70%	1
White-throated Sparrow	May-15	1.25	8	256	57.40%	2
American Robin	May-01	1.12	5	229	60.80%	3
Ovenbird	May-22	1.00	6	204	59.30%	4
Black-throated Green Warbler	Jun-01	0.87	5	178	56.90%	5
Magnolia Warbler	May-22	0.52	3	106	39.20%	6
Swainson's Thrush	May-22	0.39	4	79	26.50%	7
Dark-eyed Junco	May-01	0.38	3	77	29.90%	8
Alder Flycatcher	Jun-08	0.40	4	75	24.70%	9
Hermit Thrush	May-15	0.36	4	74	27.90%	10
Common Yellowthroat	May-22	0.29	3	60	22.50%	11
American Redstart	May-22	0.28	3	57	23.50%	12
Ruby-crowned Kinglet	May-08	0.27	3	55	2.30%	13
Song Sparrow	May-01	0.24	4	48	13.70%	14
Black-and-white Warbler	Jun-01	0.24	2	48	22.10%	15
Yellow-bellied Sapsucker	May-22	0.23	2	47	19.60%	16
Least Flycatcher	Jun-01	0.23	3	46	15.20%	17
Blue-headed Vireo	May-22	0.20	2	40	17.20%	18
Blue Jay	May-01	0.19	3	39	13.20%	19
Mourning Warbler	Jun-15	0.23	3	37	17.20%	20
Yellow-rumped Warbler	May-08	0.18	4	36	12.30%	21
Northern Parula	Jun-01	0.17	2	34	14.20%	22
Hairy Woodpecker	May-01	0.14	2	28	12.70%	23
Purple Finch	May-22	0.13	2	27	12.30%	24
Black-capped Chickadee	May-01	0.12	2	25	10.30%	25
Cedar Waxwing	Jun-08	0.13	5	25	7.00%	26
Common Grackle	Apr-22	0.10	10	20	2.50%	27
Lincoln's Sparrow	Jun-08	0.09	2	17	8.10%	28
Chestnut-sided Warbler	Jun-01	0.08	3	16	6.90%	29
American Crow	Apr-08	0.07	4	14	5.40%	30
Swamp Sparrow	May-15	0.07	4	14	3.90%	31
Nashville Warbler	May-22	0.06	2	13	5.90%	32
White-winged Crossbill	Feb-01	0.06	12	12	0.50%	33
Northern Flicker	May-01	0.05	2	10	4.40%	34
Common Raven	Mar-01	0.04	2	9	3.40%	35
Olive-sided Flycatcher	Jun-08	0.05	1	9	4.80%	36
Yellow-bellied Flycatcher	Jun-15	0.06	1	9	5.50%	37
Boreal Chickadee	May-15	0.04	2	8	2.90%	38
Red-winged Blackbird	May-08	0.04	8	8	0.50%	39
Blackburnian Warbler	Jun-15	0.05	1	8	4.90%	40
American Goldfinch	Jun-22	0.08	2	8	6.30%	41
Gray Jay	Apr-01	0.03	4	7	1.50%	42
Tree Swallow	May-08	0.03	4	6	1.50%	43
Black-throated Blue Warbler	Jun-08	0.03	1	6	3.20%	44
Evening Grosbeak	Jun-15	0.04	2	6	3.10%	45

Winter Wren	May-22	0.02	1	4	2.00%	46
Eastern Wood-Pewee	Jun-08	0.02	1	4	2.20%	47
Pine Siskin	Apr-22	0.01	3	3	0.50%	48
Red-tailed Hawk	Apr-15	0.01	1	3	1.50%	49
Belted Kingfisher	May-22	0.01	1	3	1.50%	50
Northern Waterthrush	May-22	0.01	1	3	1.50%	51
Ruby-throated Hummingbird	Jun-08	0.02	1	3	1.50%	52
White-breasted Nuthatch	May-01	0.01	1	2	1.00%	53
Mourning Dove	May-15	0.01	1	2	1.00%	54
Yellow Warbler	May-22	0.01	2	2	0.50%	55
Bay-breasted Warbler	Jun-08	0.01	1	2	1.10%	56
Chimney Swift	Jun-15	0.01	2	2	0.60%	57
Pileated Woodpecker	Apr-22	0.00	1	1	0.50%	58
Common Loon	May-08	0.00	1	1	0.50%	59
Ring-necked Duck	May-15	0.00	1	1	0.50%	60
Spruce Grouse	May-08	0.00	1	1	0.50%	61
Wilson's Snipe	May-01	0.00	1	1	0.50%	62
Eastern Kingbird	Jun-01	0.00	1	1	0.50%	63
Red-breasted Nuthatch	May-15	0.00	1	1	0.50%	64
Tennessee Warbler	May-22	0.00	1	1	0.50%	65

Table 28. Mean Abundance of Peak Breeding Species Showing Significant Habitat Relationships and Their Preferred Habitat Types at the 95% Confidence Level for Point Counts at All Distances

[Back to Text]

Species	Clearcut, regeneration, and early succession	Clearcut, regeneration, and early succession with mature deciduous	Mid to late succession	Mature coniferous	Mature deciduous	Residential and agricultural
Red-eyed Vireo	0.95	1.74	1.20	0.53	2.20	1.00
White-throated Sparrow	2.79	1.61	1.22	0.81	0.34	1.00
American Robin	1.57	1.11	1.30	0.96	0.53	2.83
Ovenbird	0.39	1.13	0.73	0.57	1.94	0.00
Black-throated Green Warbler	0.75	0.61	1.02	2.05	0.51	0.33
Magnolia Warbler	0.68	0.34	0.75	1.10	0.04	0.17
Alder Flycatcher	1.52	0.44	0.28	0.37	0.00	0.67
Common Yellowthroat	0.71	0.68	0.11	0.05	0.06	0.50
American Redstart	0.21	0.34	0.23	0.05	0.47	0.00
Ruby-crowned Kinglet	0.50	0.00	0.38	0.52	0.09	0.33
Song Sparrow	0.82	0.32	0.06	0.05	0.00	1.33
Yellow-bellied Sapsucker	0.25	0.53	0.14	0.24	0.11	0.17
Least Flycatcher	0.00	0.55	0.11	0.00	0.38	0.00
Mourning Warbler	0.24	0.66	0.09	0.06	0.17	0.00
Yellow-rumped Warbler	0.18	0.00	0.28	0.57	0.00	0.17
Common Grackle	0.00	0.03	0.13	0.05	0.00	1.67
Chestnut-sided Warbler	0.21	0.18	0.02	0.00	0.00	0.33
Common Raven	0.00	0.05	0.02	0.00	0.09	0.33
Olive-sided Flycatcher	0.10	0.03	0.07	0.00	0.00	0.33
Yellow-bellied Flycatcher	0.00	0.00	0.11	0.18	0.00	0.00
Boreal Chickadee	0.00	0.00	0.06	0.19	0.00	0.00
American Goldfinch	0.36	0.13	0.03	0.00	0.00	0.33
Tree Swallow	0.00	0.00	0.02	0.00	0.02	0.67
Black-throated Blue Warbler	0.00	0.03	0.00	0.00	0.11	0.00
Red-tailed Hawk	0.04	0.00	0.02	0.00	0.00	0.17
Belted Kingfisher	0.00	0.03	0.00	0.00	0.02	0.17
Ruby-throated Hummingbird	0.00	0.00	0.00	0.11	0.02	0.00
Yellow Warbler	0.00	0.00	0.00	0.00	0.00	0.33
Ring-necked Duck	0.00	0.00	0.00	0.00	0.00	0.17

Positively different from all five other habitat types at 95% level of probability
Positively different from four other habitat types at 95% level of probability
Positively different from three habitat types at 95% level of probability
Positively different from two habitat types at 95% level of probability
Positively different from one habitat type at 95% level of probability

Table 29. Rank Comparison of Breeding Birds between Early Breeding and Peak Breeding Seasons

[Back to Text]

Species	Early Breeding Rank	Equivalent Peak Breeding Rank
White-throated Sparrow	1	1
American Robin	2	2
Ovenbird	3	3
Yellow-rumped Warbler	4	15
Dark-eyed Junco	5	6
Magnolia Warbler	6	4
Blue Jay	7	14
Black-capped Chickadee	8	18
Hermit Thrush	9	7
Yellow-bellied Sapsucker	10	12
Song Sparrow	11	11
Northern Flicker	12	23
Common Raven	13	24
Hairy Woodpecker	14	16
Common Yellowthroat	15	8
Blue-headed Vireo	16	13
Purple Finch	17	17
American Crow	18	20
Ruffed Grouse	19	
Ruby-crowned Kinglet	20	10
American Redstart	21	9
Common Grackle	22	19
Nashville Warbler	23	22
Downy Woodpecker	24	
Pine Siskin	25	27
Barred Owl	26	
Swainson's Thrush	27	5
Palm Warbler	28	
American Kestrel	29	
Pileated Woodpecker	30	30
Boreal Chickadee	31	25
Swamp Sparrow	32	21
American Black Duck	33	
Common Loon	34	31
Red-tailed Hawk	35	28
Merlin	36	
Black-backed Woodpecker	37	
Tree Swallow	38	26
White-breasted Nuthatch	39	29
Pine Grosbeak	40	

Table 30. Breeding Status of Birds in the Study Area (Legend Below)

[Back to Text]

Species	Observed	Possible Breeding	Probable Breeding	Confirmed Breeding
Wood Duck		H		
American Black Duck			T	
Green-winged Teal		H		
Ring-necked Duck			P	
Common Merganser			A	
Ruffed Grouse			T	
Spruce Grouse		H		
Common Loon	X			
Great Blue Heron	X			
Bald Eagle		H		
Osprey		H		
Northern Goshawk			T	
Red-tailed Hawk			A	
Broad-winged Hawk		H		
American Kestrel			T	
Merlin		H		
Herring Gull	X			
Wilson's Warbler		S		
American Woodcock			T	
Black-billed Cuckoo		S		
Mourning Dove		S		
Great Horned Owl		S		
Barred Owl			T	
Northern Saw-whet Owl		S		
Chimney Swift		H		
Ruby-throated Hummingbird		H		
Belted Kingfisher		H		
Yellow-bellied Sapsucker				FY
Downy Woodpecker			T	
Hairy Woodpecker				DD
Black-backed Woodpecker		H		
Northern Flicker			T	
Pileated Woodpecker			T	
Olive-sided Flycatcher			T	
Eastern Wood Pewee			T	
Yellow-bellied Flycatcher		S		
Alder Flycatcher			T	
Least Flycatcher			T	
Eastern Kingbird		H		
Blue-headed Vireo				DD
Red-eyed Vireo				CF
Gray Jay				FY
Blue Jay			T	
American Crow			T	
Common Raven			T	
Tree Swallow				AE

Black-capped Chickadee			CF
Boreal Chickadee		T	
Red-breasted Nuthatch		T	
White-breasted Nuthatch		T	
Winter Wren		T	
Golden-crowned Kinglet	S		
Ruby-crowned Kinglet		D	
Swainson's Thrush			FY
Hermit Thrush			CF
American Robin			CF
Cedar Waxwing		T	
European Starling			FY
Tennessee Warbler	S		
Nashville Warbler		T	
Northern Parula			CF
Yellow Warbler		T	
Chestnut-sided Warbler			CF
Magnolia Warbler			CF
Cape May Warbler			FY
Black-throated Blue Warbler			CF
Yellow-rumped Warbler			CF
Black-throated Green Warbler			CF
Blackburnian Warbler		T	
Palm Warbler		T	
Bay-breasted Warbler	H		
Black-and-White Warbler		T	
American Redstart			CF
Ovenbird			CF
Northern Waterthrush	S		
Mourning Warbler			CF
Common Yellowthroat			DD
Canada Warbler		P	
Rose-breasted Grosbeak	S		
Chipping Sparrow	S		
Song Sparrow			FY
Lincoln's Sparrow			CF
Swamp Sparrow		T	
White-throated Sparrow			FY
Dark-eyed Junco			FY
Red-winged Blackbird	H		
Common Grackle			CF
Pine Grosbeak	H		
Purple Finch			NB
White-winged Crossbill	H		
Pine Siskin	H		
American Goldfinch		T	
Evening Grosbeak		T	

Breeding Codes

OBSERVED (Ob):

X - Species observed in its breeding season (no breeding evidence)

POSSIBLE (Po):

H - Species observed in its breeding season in suitable nesting habitat

S - Singing male(s) present, or breeding calls heard, in suitable nesting habitat in breeding season

PROBABLE (Pr):

P - Pair observed in suitable nesting habitat in nesting season

T - Permanent territory presumed through registration of territorial song, or the occurrence of an adult bird, at the same place, in breeding habitat, on at least two days a week or more apart, during its breeding season

D - Courtship or display, including interaction between a male and a female or two males, including courtship feeding or copulation

V - Visiting probable nest site

A - Agitated behaviour or anxiety calls of an adult

B - Brood Patch on adult female or cloacal protuberance on adult male

N - Nest-building or excavation of nest hole by wrens and woodpeckers

CONFIRMED (Conf):

NB - Nest-building or carrying nest materials, for all species except wrens and woodpeckers

DD - Distraction display or injury feigning

NU - Used nest or egg shells found (occupied or laid within the period of the survey)

FY - Recently fledged young (nidicolous species) or downy young (nidifugous species), including incapable of sustained flight

AE - Adults leaving or entering nest site in circumstances indicating occupied nest

FS - Adult carrying faecal sac

CF - Adult carrying food for young

NE - Nest containing eggs

NY - Nest with young seen or heard

Table 31. Species of Birds Flying at 50-125 m above the Observation Point at All Diurnal Passage Observation Points during the Autumn Migration

[Back to Text]

		Passed Through Swept Area		
Species	Data	No	Yes	Grand Total
Osprey	N	1	1	2
	%	50.00%	50.00%	100.00%
Bald Eagle	N	18	11	29
	%	62.07%	37.93%	100.00%
Sharp-shinned Hawk	N	8	4	12
	%	66.67%	33.33%	100.00%
Red-tailed Hawk	N	12	6	18
	%	66.67%	33.33%	100.00%
American Kestrel	N	5	2	7
	%	71.43%	28.57%	100.00%
Merlin	N		1	1
	%	0.00%	100.00%	100.00%
Peregrine Falcon	N		1	1
	%	0.00%	100.00%	100.00%
Herring Gull	N	5	2	7
	%	71.43%	28.57%	100.00%
Common Raven	N	67	19	86
	%	77.91%	22.09%	100.00%
American Robin	N	24	4	28
	%	85.71%	14.29%	100.00%
American Pipit	N		1	1
	%	0.00%	100.00%	100.00%
Yellow-rumped Warbler	N	29	2	31
	%	93.55%	6.45%	100.00%
Warbler Species	N	11	2	13
	%	84.62%	15.38%	100.00%
Bobolink	N		1	1
	%	0.00%	100.00%	100.00%
Passerine Species	N	27	2	29
	%	93.10%	6.90%	100.00%
Total N		207	59	266
Total %		77.82%	22.18%	100.00%

Table 32. Observations of Bald Eagle and Common Raven Flying at 50-125 m above the Observation Point at Points 5, 2, and 4 during the Autumn Migration

[Back to text]

			Passed Swept Area		
Species	Observation Point	Data	No	Yes	Grand Total
Bald Eagle	5	N	9	6	15
		%	60.00%	40.00%	100.00%
	2	N	4	2	6
		%	66.67%	33.33%	100.00%
	4	N	5	3	8
		%	62.50%	37.50%	100.00%
Bald Eagle N			18	11	29
Bald Eagle %			62.07%	37.93%	100.00%
Common Raven	5	N	28	10	38
		%	73.68%	26.32%	100.00%
	2	N	6	4	10
		%	60.00%	40.00%	100.00%
	4	N	31	5	36
		%	86.11%	13.89%	100.00%
Common Raven N			65	19	84
Common Raven %			77.38%	22.62%	100.00%
Total N			83	30	113
Total %			73.45%	26.55%	100.00%

Table 33. The Status of Species of Concern by Conservation Agency (Legend below)

[Back to Text]

Species	COSEWIC Status	SARA Status	NSESA Status	DNR Status	PIF Priority Species
Spruce Grouse					X
Common Loon				Yellow	
Northern Goshawk				Yellow	
Peregrine Falcon	Special Concern	Threatened	Vulnerable	Red	
American Woodcock					X
Chimney Swift	Threatened		Endangered	Yellow	
Olive-sided Flycatcher	Threatened			Yellow	X
Gray Jay				Yellow	
Boreal Chickadee				Yellow	
Chestnut-sided Warbler					X
Cape May Warbler					
Black-throated Blue Warbler					X
Blackburnian Warbler					X
Bay-breasted Warbler					X
Canada Warbler	Threatened			Yellow	X
Bobolink				Yellow	
Rusty Blackbird	Special Concern			Yellow	
Red Crossbill					X

Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
Endangered = A wildlife species that is facing imminent extirpation or extinction

Threatened = A wildlife species likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction

Special Concern = A wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats

Species at Risk Act - Federal (SARA)
Classifications the same as for COSEWIC

Nova Scotia Endangered Species Act (NSESA)
Vulnerable = A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events

Partners in Flight (PIF)
Priority Species = A species may be considered a priority for several different reasons, including global threats to the species, high concern for regional or local populations, or responsibility for conserving large or important populations of the species.

Table 34. Status of Species of Concern in the Study Area

[Back to Text]

Species	Status in Study Area
Spruce Grouse	Observed once in breeding season, breeding status=possible
Common Loon	Observed in flight only; 3 observations in the spring and twice in the breeding season; breeding status=possible
Northern Goshawk	One observation in autumn; 2 observations in breeding season; breeding status=probable
Peregrine Falcon	One observation in autumn
American Woodcock	10 flight display sites found in breeding season; nocturnal passage descent noted on four occasions in autumn; breeding status=probable
Chimney Swift	One observation in breeding season; breeding status=possible
Olive-sided Flycatcher	8 observations during spring migration; 12 observations during breeding period; breeding status=probable
Gray Jay	5 observations in autumn; 3 observations in winter, 1 observation in spring, 3 observations in breeding period; breeding status=confirmed
Boreal Chickadee	Numerous observations in all seasons; uncommon to common inhabitant of late successional and mature coniferous forest
Chestnut-sided Warbler	Common spring and fall migrant; uncommon to common breeder in early successional forest; breeding status=confirmed
Cape May Warbler	One family group seen in late May 2007; breeding status=confirmed
Black-throated Blue Warbler	Uncommon autumn and spring migrant; uncommon breeder in mature deciduous; breeding status=confirmed
Blackburnian Warbler	Uncommon migrant in autumn and spring, uncommon to common breeder in late successional forest; breeding status=probable
Bay-breasted Warbler	Uncommon migrant in autumn, rare in breeding season with two observations; breeding status=possible
Canada Warbler	Seen on two occasions in breeding season of 2007 including one pair; adult male seen at same location of pair in 2008. Another pair seen in spring migration; breeding status=probable
Bobolink	Seen once in diurnal passage in both autumn and spring
Rusty Blackbird	One observation in autumn
Red Crossbill	3 observations in autumn diurnal passage

Update to Baseline Study

Glen Dhu Wind Energy – Phase 2 Lands

Breeding Bird Survey 2010

By:

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For:

Shear Wind Inc.

April 2011

Introduction

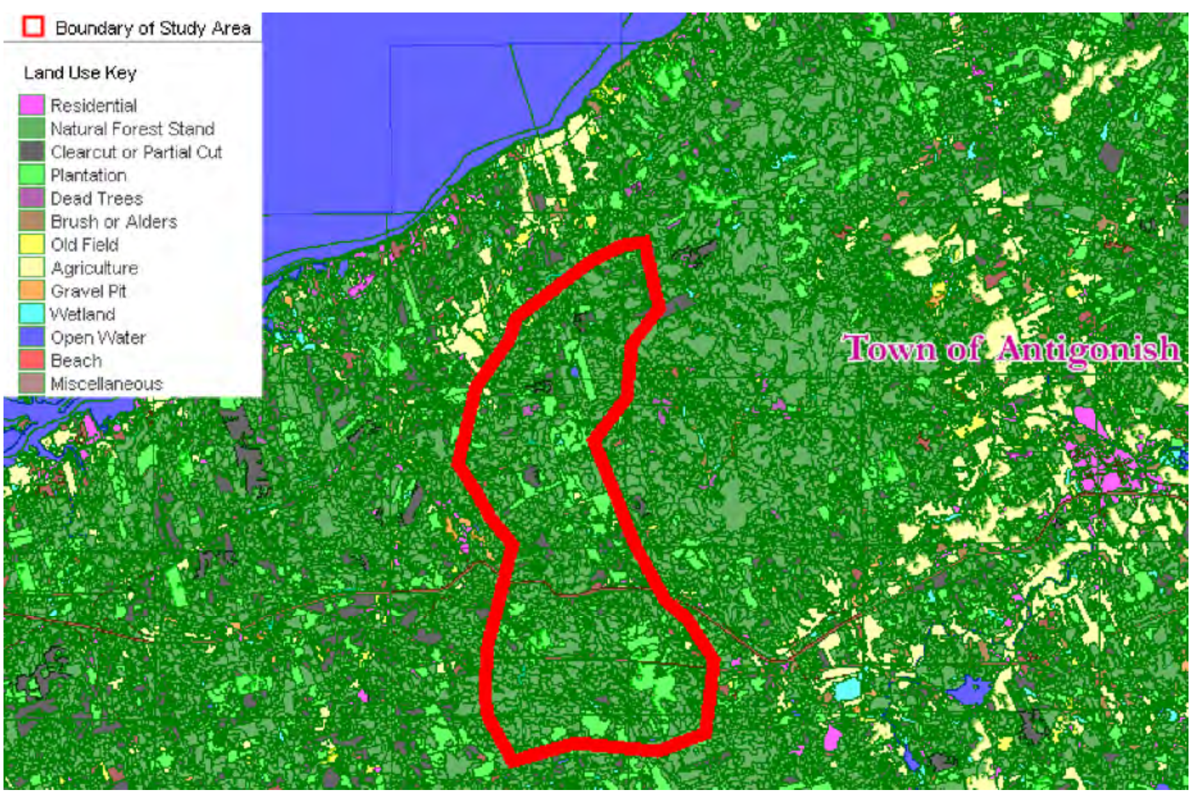
This document reports on a breeding bird survey conducted in 2010 on lands proposed for the development of Phase 2 of Glen Dhu Wind Energy by Shear Wind Inc. Phase 1 was completed in March 2011 with the construction of 27 turbines; each having a capacity of 2.3 megawatts.

A baseline study was conducted for both phases in 2007-2008 with follow-up studies carried out in 2009-2010 for the Phase 1 lands (Kearney 2007, 2008, 2009; 2010a; 2010b; 2011). In addition, a repetition of the baseline breeding bird survey for Phase 2 lands was carried out in 2010. The findings of this 2010 study are presented here along with a preliminary comparison with changes since 2008 on Phase 2 and Phase 1 lands .

Location of Study Area

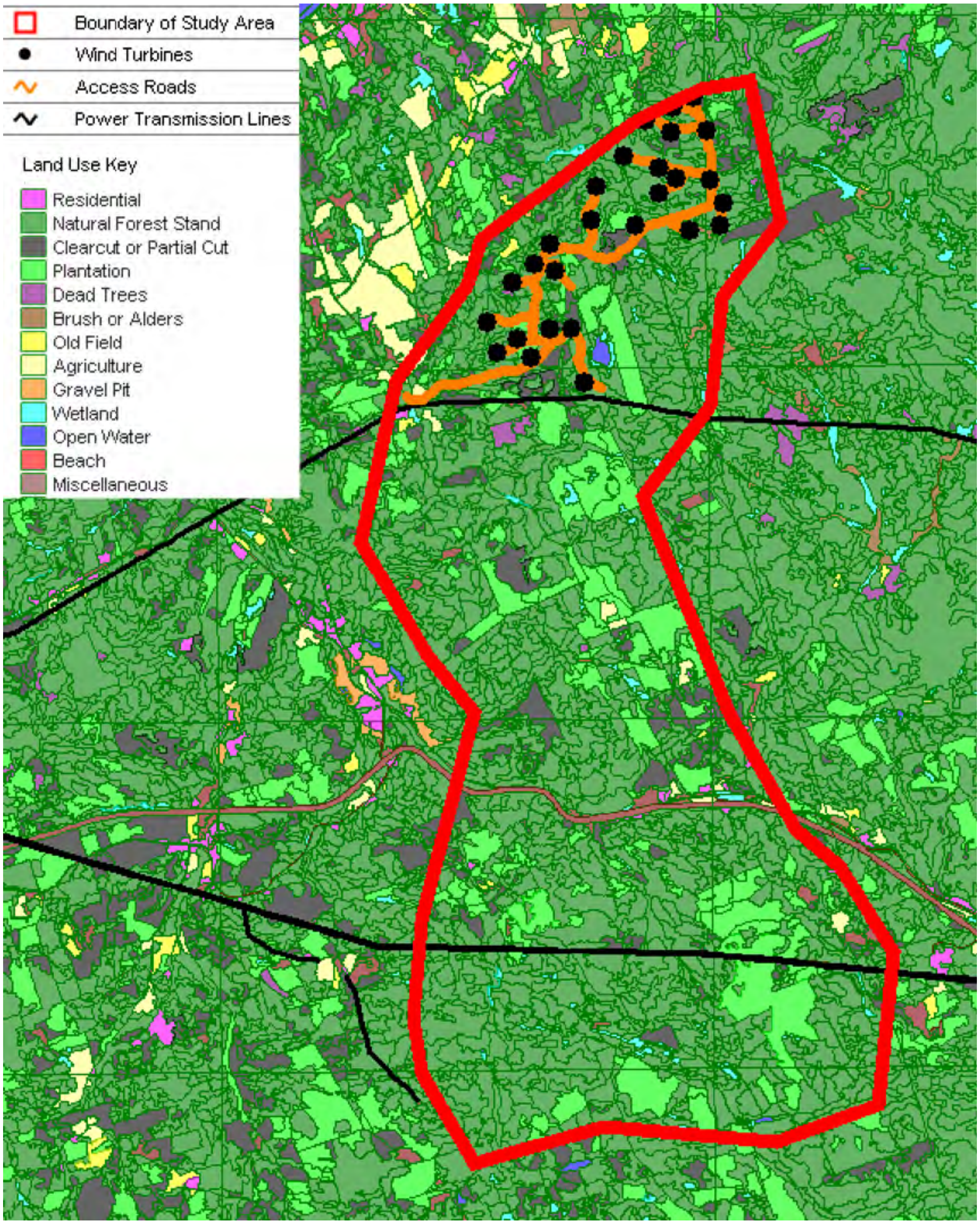
The location of the study area in the Pictou-Antigonish Highlands of Nova Scotia is shown in Figure 1.

Figure 1: Location of Study Area



As shown in Figure 2, the study area consists of forested lands, covering approximately 4,050 hectares. Phase 1 lands are those above the northernmost power transmission line where 27 wind turbines and access roads have been constructed. The Phase 2 lands are below this area.

Figure 2: Phase 1 and Phase 2 Lands



Methodology

The survey of breeding birds in 2010 consisted of three parts; 1) nocturnal monitoring survey, 2) early breeding point counts, and 3) peak season point counts.

Nocturnal surveys were conducted following the Guidelines for Nocturnal Owl Monitoring in North America published by Bird Studies Canada (Takats et al. 2001). These surveys focused on the following species that have been detected in the study area: American Woodcock, Barred Owl, Great Horned Owl, and Saw-whet Owl. Surveys took place on five nights from 15 April to 4 May 2010.

The breeding season point counts followed the protocols established by the Canadian Wildlife Service for assessing the impact of wind turbines on birds (Environment Canada 2007). The point counts were 10 minutes in duration and recorded birds in the distance categories from the observer of <50 metres, 50-100 metres, >100 metres, and flying overhead.

Forty early breeding point counts were conducted from 6 to 19 May 2010. These point counts along with an additional one hundred and eighty-five peak season point counts were surveyed again from 3 to 29 June 2010. The location of the total one hundred and twenty-five point counts surveyed in the early and peak breeding seasons are shown in Figure 3. The eighty point counts conducted on Phase 1 lands in 2010 are also shown in Figure 3.

Notes were taken on the breeding status of each species observed and classified as to whether they were possible, probable, or confirmed breeders, using the criteria developed for the Maritimes Breeding Bird Atlas. Species of special conservation concern, identified in the baseline study, were monitored during the surveys. In addition, habitat changes since the baseline study was recorded at each of the point counts stations.

Habitat Change

Of the total 125 point counts surveyed in 2010, 123 were surveyed in 2008 during the baseline study. The degree of habitat change between 2008 and 2010 was evaluated for every point count that was surveyed in both years. Virtually all the changes in habitat on the Phase 2 lands were due to forestry operations of grading and widening forestry roads or from the harvest of the forest.

Figure 3: Location of Breeding Point Count

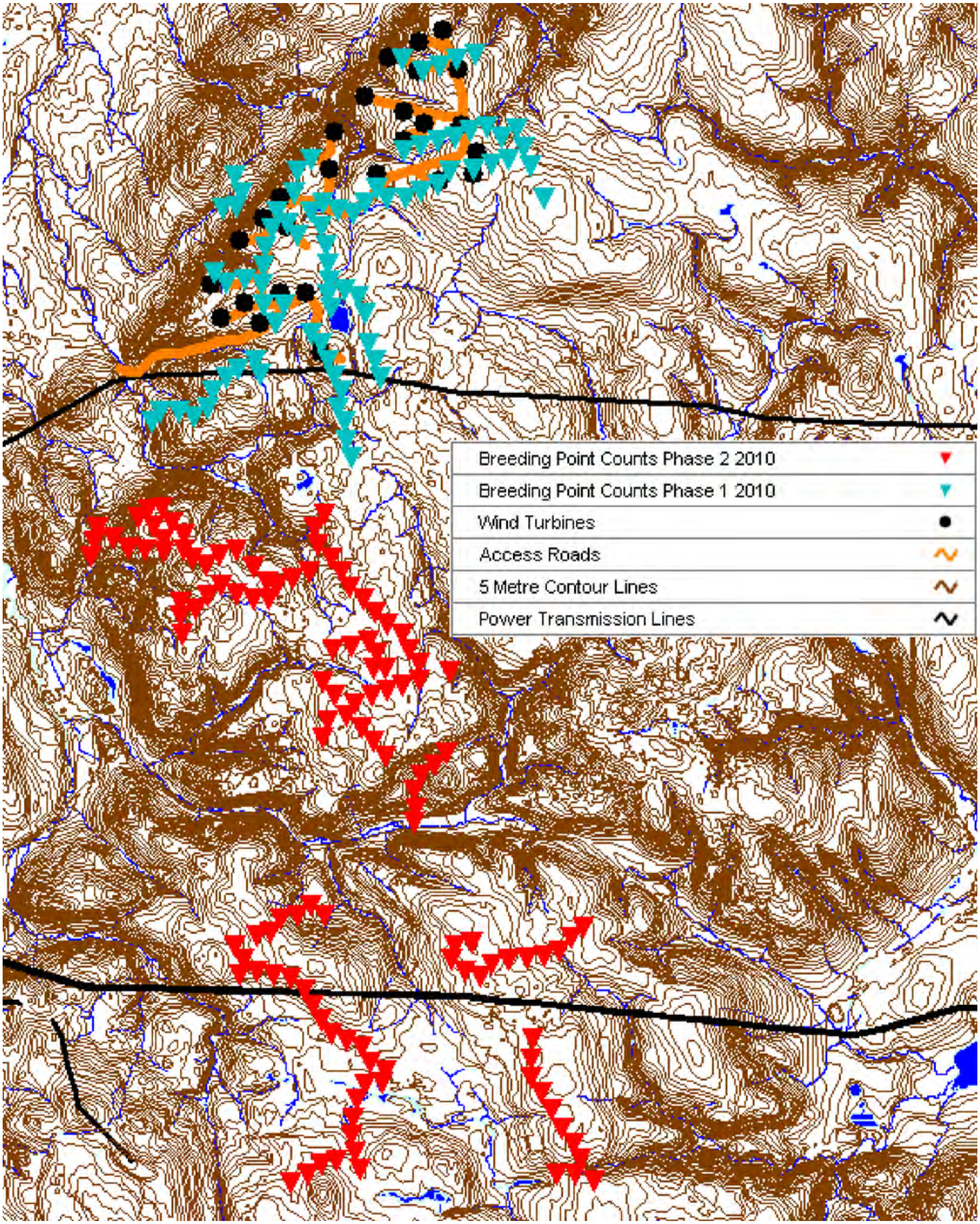
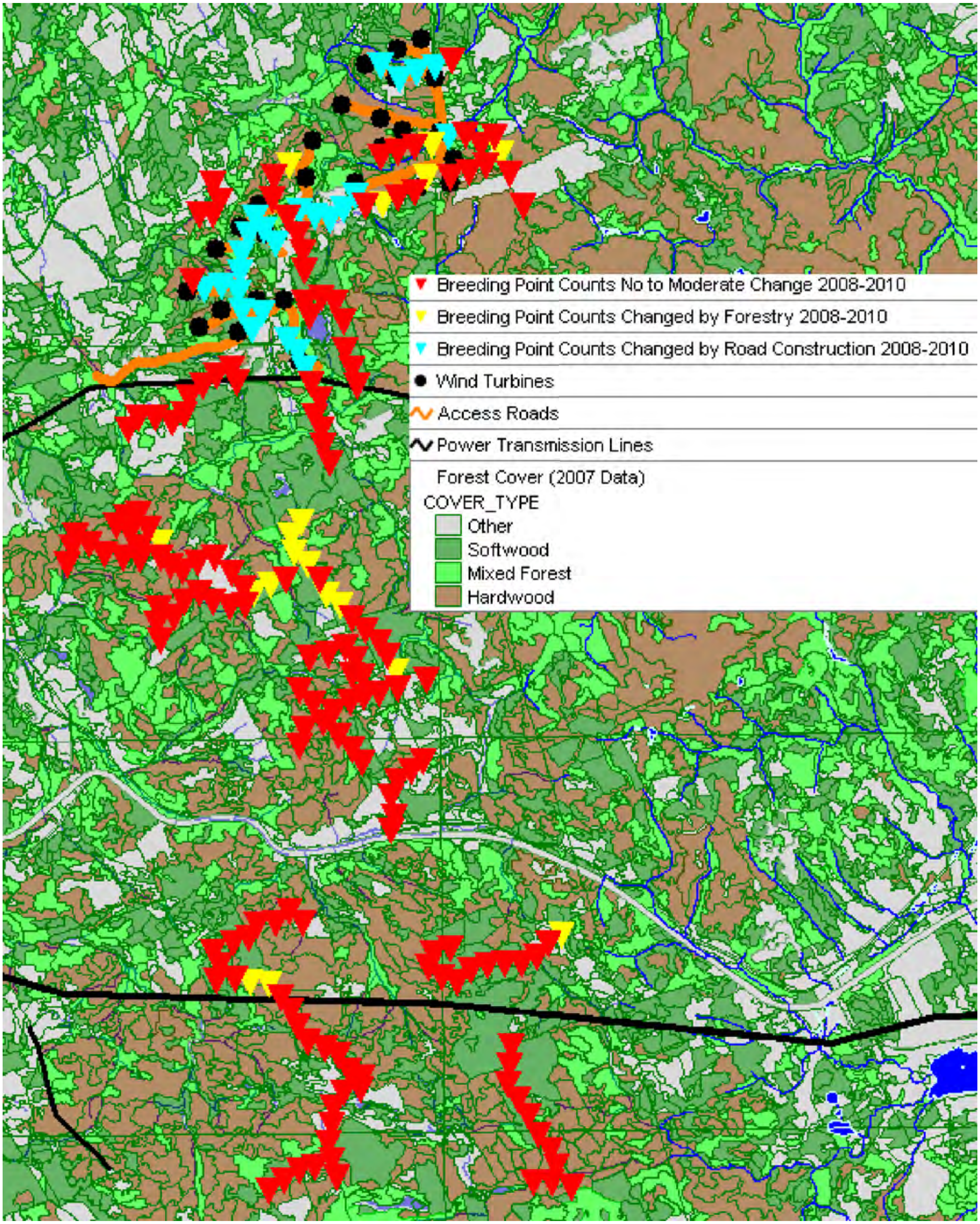


Table 1: Degree of Habitat Changes since Baseline Study with Code Legend

Degree of Habitat Change			Legend			
Change Code	**2008 to 2010**	**%**	*Code*	*Name*	*Description*	*Example*
0	92	**74.80**	0	No change	No disturbance	Looks the same as last year
1	5	**4.07**	1	Small change	Noticeable disturbance	Grading of forestry road
2	13	**10.57**	2	Moderate change	Change that might affect bird habitat	Widening of forestry road
3	12	**9.76**	3	Substantial change	Change having a definite affect on bird habitat	Clearcut part of habitat
4	1	**0.81**	4	Total change	Total or near total disturbance of habitat	Clearcut all or most of habitat
Total	123	**100.00**	Total	Total	Total surveyed in both 2008 & 2010	Any point count surveyed in both 2008 & 2010

Thus, for 75% of the point counts on Phase 2 lands, there was no change from 2008 to 2010. Small to moderate changes in habitat were found at 15% of the point counts. Substantial or total change, due to forest harvesting, occurred at 11% of the point counts. These changes in habitat are shown graphically in Figure 4. Point counts demonstrating substantial or total change due to forestry are marked in yellow. This figure also shows the habitat changes on the Phase 1 lands between 2008 and 2010. Here the changes are due both to forestry and the road construction needed for wind turbine development. Point counts exhibiting substantial or total change due to road construction are shown in aqua blue. More information on the Phase 1 lands can be found in Kearney (2011).

Figure 4: Habitat Changes



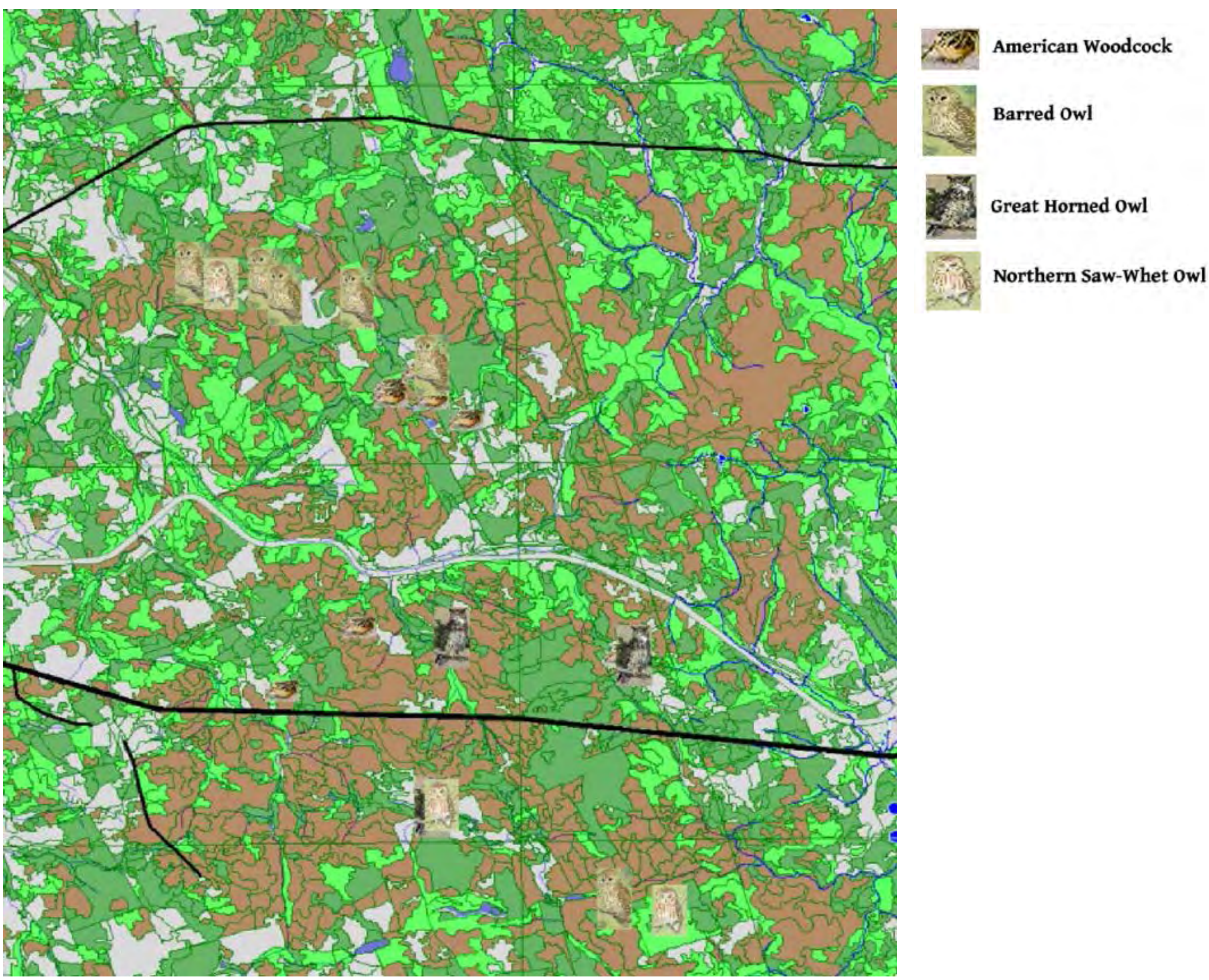
Results of Nocturnal Surveys

The results of the nocturnal surveys on Phase 2 lands conducted in 2008 and 2010 are displayed in Table 2. The location of all the nocturnal birds seen in both 2008 and 2010 are shown in Figure 5.

Table 2: Results of Nocturnal Surveys on Phase 2 Lands

Species	*2008*	*2010*
American Woodcock	4	4
Barred Owl	4	2
Great Horned Owl	0	3
Northern Saw-whet Owl	1	2

Figure 5: Location of Nocturnal Breeders on Phase 2 Lands, 2008-2010



Results of the Early Breeding Bird Surveys

The early breeding bird surveys were conducted differently in 2010 than in 2008. The early breeding point counts in 2008 consisted of repetitions of the 6 point counts along 4 transects once to twice a week in April and May. Three of these transects were on Phase 2 lands and one on Phase 1 lands. In 2010, early breeding point counts were more evenly distributed over the entire study area (Phase 1 and 2) but were carried out only once during the month of May.

Repetitions of single point counts, as in 2008, give a more accurate assessment of the birds breeding on a particular site but at the expense of effort that could go to wider geographical coverage. Wide geographical coverage with a greater number of point counts, as in 2010, presents a more accurate “big picture” perspective but with a less precise assessment of the birds at each point count station. Thus the two methodologies employed in 2008 and 2010 complement each other.

Another factor affecting a comparison of the 2008 and 2010 data is that early breeding point counts were carried out over a longer time period in 2008, from April 8 to June 2 compared to May 1 to 19 in 2010. In both years, only those species whose breeding season had commenced were counted on any particular date. Breeding dates were drawn from the data of the Maritimes Breeding Bird Atlas website (http://www.mba-aom.ca/).

Table 3 shows a ranking of the abundance of early breeding birds in 2008 on the Phase 2 lands. The five most abundant early breeding birds were American Robin, White-throated Sparrow, Ovenbird, Yellow-rumped Warbler, and Black-capped Chickadee. The mean number of American Robins and the White-throated Sparrows at each point count station was identical at 2.72. However, the American Robin was seen at 100% of the 18 point count stations compared to 94% for the White-throated Sparrow.

Table 4 shows the ranking of the abundance of early breeding birds on Phase 2 lands in 2010. The five most abundant birds were White-throated Sparrow, American Robin, Yellow-rumped Warbler, Hermit Thrush, and Dark-eyed Junco. Differences in the mean number of birds, frequency at point count stations, and total diversity largely represents the differences in the methodologies of the two years, 2008 and 2010, rather than declines or increases in abundance.

Table 3: Abundance Indices of Early Breeding Birds on Phase 2 Lands in 2008

Species	N	R	Max	Mean	Sum	% N	Rank
American Robin	18	6	6	2.72	49	100.0	1
White-throated Sparrow	18	3-4	6	2.72	49	94.4	2
Ovenbird	18	2-3	8	2.06	37	88.9	3
Yellow-rumped Warbler	18	5	4	1.28	23	77.8	4
Black-capped Chickadee	18	6	3	1.22	22	77.8	5
Magnolia Warbler	18	2-3	4	1.22	22	72.2	6
Dark-eyed Junco	18	6	3	1.22	22	77.8	7
Hermit Thrush	18	3-4	3	1.17	21	77.8	8
Blue Jay	18	6	5	1.11	20	55.6	9
Yellow-bellied Sapsucker	18	2-3	2	0.78	14	61.1	10
Northern Flicker	18	6	2	0.78	14	61.1	11
Common Yellowthroat	18	2-3	2	0.72	13	50.0	12
Song Sparrow	18	6	2	0.72	13	44.4	13
Hairy Woodpecker	18	6	2	0.67	12	61.1	14
Common Raven	18	9	3	0.67	12	44.4	15
Blue-headed Vireo	18	2-3	2	0.61	11	38.9	16
Purple Finch	18	2-3	2	0.61	11	50.0	17
American Crow	18	9	2	0.50	9	44.4	18
Ruffed Grouse	18	7	2	0.39	7	27.8	19
Ruby-crowned Kinglet	18	5	2	0.33	6	27.8	20
American Redstart	18	2-3	2	0.33	6	27.8	21
Common Grackle	18	7	4	0.33	6	16.7	22
Nashville Warbler	18	2-3	2	0.28	5	22.2	23
Downy Woodpecker	18	5	1	0.22	4	22.2	24
Pine Siskin	18	7	1	0.22	4	22.2	25
American Kestrel	18	7	2	0.11	2	5.6	26
Barred Owl	18	9	1	0.11	2	11.1	27
Boreal Chickadee	18	3-4	1	0.11	2	11.1	28
Swainson's Thrush	18	2-3	1	0.11	2	11.1	29
American Black Duck	18	9	1	0.06	1	5.6	30
Common Loon	18	5	1	0.06	1	5.6	31
Red-tailed Hawk	18	8	1	0.06	1	5.6	32
Merlin	18	5	1	0.06	1	5.6	33
Pileated Woodpecker	18	7	1	0.06	1	5.6	34
Tree Swallow	18	5	1	0.06	1	5.6	35
White-breasted Nuthatch	18	6	1	0.06	1	5.6	36
Swamp Sparrow	18	3-4	1	0.06	1	5.6	37
Pine Grosbeak	18	5	1	0.06	1	5.6	38
Black-backed Woodpecker	18	5	0	0.00	0	0.0	39

Palm Warbler	18	3-4	0	0.00	0	0.0	40
N=Number of Point Count Stations; R=Number of Repetitions; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.							

Table 4: Abundance Indices of Early Breeding Birds on Phase 2 Lands in 2010

Species	N	R	Max	Sum	Mean	% N	Rank
White-throated Sparrow	12	1	4	19	1.58	67.7	1
American Robin	39	1	7	61	1.56	61.5	2
Yellow-rumped Warbler	34	1	4	21	0.62	35.3	3
Hermit Thrush	12	1	2	7	0.58	50.0	4
Dark-eyed Junco	39	1	3	14	0.36	25.6	5
Northern Flicker	39	1	1	13	0.33	33.3	6
Hairy Woodpecker	39	1	3	11	0.28	20.5	7
Black-capped Chickadee	39	1	4	10	0.26	15.4	8
Blue Jay	39	1	3	7	0.18	12.8	9
Ruffed Grouse	39	1	2	6	0.15	12.9	10
American Crow	39	1	2	5	0.13	10.3	11
Pileated Woodpecker	39	1	2	5	0.13	10.3	12
Song Sparrow	39	1	1	4	0.10	10.3	13
Golden-crowned Kinglet	34	1	1	2	0.06	5.9	14
Common Grackle	39	1	1	2	0.05	5.1	15
Common Raven	39	1	1	2	0.05	5.1	16
Downy Woodpecker	34	1	1	1	0.03	2.9	17
Brown Creeper	34	1	1	1	0.03	2.9	18
American Kestrel	39	1	1	1	0.03	2.6	19
N=Number of Point Count Stations; R=Number of Repetitions; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.							

Results of Peak Breeding Surveys

Peak breeding point counts were conducted on Phase 2 lands from 4 June to 3 July 2008 and from 3 to 29 June 2010. The 2008 survey consisted of 130 point count stations while the 2010 survey had 125. However for those species commencing their breeding period later than the first week of June, the number of point counts that included an analysis of those species ranged between 59 and 118. For all peak breeding point counts there was only one count per season (no repetitions). The results of the peak breeding bird surveys are shown in Table 5 and Table 6.

Table 5: Abundance Indices of Peak Breeding Birds on Phase 2 Lands in 2008.

Species	N	Max	Sum	Mean	% N	Rank
Red-eyed Vireo	118	4	165	1.398	69.5	1
Ovenbird	130	1	151	1.162	62.3	2
American Robin	130	5	132	1.015	55.4	3
White-throated Sparrow	130	7	122	0.938	50.0	4
Black-throated Green Warbler	130	4	105	0.808	55.4	5
Magnolia Warbler	130	3	55	0.423	31.5	6
Hermit Thrush	130	4	53	0.408	29.2	7
Swainson's Thrush	130	4	52	0.400	26.2	8
Dark-eyed Junco	130	3	42	0.323	26.9	9
American Redstart	130	3	42.0	0.323	26.9	10
Alder Flycatcher	118	3	29	0.246	16.9	11
Black-and-White Warbler	130	2	31	0.238	22.3	12
Yellow-bellied Sapsucker	130	2	30	0.231	20.0	13
Blue-headed Vireo	130	2	29	0.223	18.5	14
Common Yellowthroat	130	3	29	0.223	18.5	15
Mourning Warbler	100	3.000	21.0	0.21	14.0	16
Blue Jay	130	3	27	0.208	13.1	17
Ruby-crowned Kinglet	130	2	27	0.208	20.0	18
Least Flycatcher	130	3	26	0.200	14.6	19
Golden-crowned Kinglet	130	2	24	0.185	17.7	20
Song Sparrow	130	3	20	0.154	10.0	21
Yellow-rumped Warbler	130	4	20	0.154	10.8	22
Hairy Woodpecker	130	2	19	0.146	13.8	23
Northern Parula	130	2	16	0.123	10.8	24
Purple Finch	130	1	13	0.100	10.0	25
White-winged Crossbill	130	12	12	0.090	0.1	26
Black-capped Chickadee	130	2	10	0.077	6.2	27
Yellow-bellied Flycatcher	100	1	7	0.070	7.0	28
Common Grackle	130	7	9	0.069	2.3	29
Nashville Warbler	130	2	8	0.062	5.4	30
Red-winged Blackbird	130	8	8	0.062	0.8	31

American Crow	130	4	8	0.060	3.8	32
Evening Grosbeak	100	2	6	0.060	5.0	33
Cedar Waxwing	118	3	7	0.059	3.4	34
Lincoln's Sparrow	118	2	7	0.059	5.1	35
Chestnut-sided Warbler	130	1	7	0.054	5.4	36
Common Raven	130	2	6	0.050	3.8	37
Gray Jay	130	4	6	0.050	1.5	38
Black-throated Blue Warbler	118	1	5	0.042	4.2	39
Swamp Sparrow	130	2	5	0.038	2.3	40
Northern Flicker	130	1	5	0.038	3.8	41
Olive-sided Flycatcher	118	1	4	0.034	3.4	42
American Goldfinch	59	1	2	0.034	3.4	43
Blackburnian Warbler	100	1	3	0.030	3.0	44
Ruby-throated Hummingbird	118	1	3	0.025	2.5	45
Eastern Wood Pewee	118	1	3	0.025	2.5	46
Pine Siskin	130	3	3	0.023	0.8	47
Red-tailed Hawk	130	1	3	0.020	2.3	48
Chimney Swift	100	2	2	0.020	1.0	49
Canada Warbler	118	1	2	0.017	1.7	50
Bay-breasted Warbler	118	1	2	0.017	1.7	51
Belted Kingfisher	130	1	2	0.015	1.5	52
Yellow Warbler	130	2	2	0.015	0.8	53
Northern Waterthrush	130	1	2	0.015	1.5	54
Common Loon	130	1	1	0.008	0.8	55
Spruce Grouse	130	1	1	0.008	0.8	56
Mourning Dove	130	1	1	0.008	0.8	57
Red-breasted Nuthatch	130	1	1	0.008	0.8	58
Tennessee Warbler	130	1	1	0.008	0.8	59
Brown Creeper	130	1	1	0.008	0.8	60
Eastern Kingbird	130	1	1	0.008	0.8	61
Tree Swallow	130	1	1	0.008	0.8	62

N=Number of Point Count Stations; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

Table 6: Abundance Indices of Peak Breeding Birds on Phase 2 Lands in 2010

Species	N	Max	Sum	Mean	% N	Rank
Red-eyed Vireo	118	4	190	1.590	82.9	1
American Robin	125	6	169	1.355	66.1	2
White-throated Sparrow	125	6	154	1.242	51.6	3
Ovenbird	125	5	149	1.161	66.1	4
Black-throated Green Warbler	125	5	100	0.806	58.1	5
Hermit Thrush	125	4	78	0.621	40.3	6
Magnolia Warbler	125	3	73	0.589	43.5	7
Dark-eyed Junco	125	4	69	0.560	38.7	8
Ruby-crowned Kinglet	125	3	64	0.516	37.1	9
Swainson's Thrush	125	3	44	0.355	26.6	10
American Redstart	125	4	44	0.347	27.4	11
Common Yellowthroat	125	2	40	0.323	24.2	12
Alder Flycatcher	118	4	30	0.256	17.9	13
Mourning Warbler	64	2	14	0.219	18.7	14
Purple Finch	125	2	26	0.210	20.2	15
Least Flycatcher	125	5	28	0.210	14.5	16
Blue Jay	125	3	24	0.194	10.5	17
Black-and-White Warbler	125	1	22	0.177	17.7	18
Song Sparrow	125	3	19	0.153	11.3	19
Yellow-rumped Warbler	125	2	18	0.145	11.3	20
Northern Parula	125	1	17	0.137	13.7	21
Northern Flicker	125	3	17	0.137	10.5	22
Black-capped Chickadee	125	4	17	0.137	8.9	23
Blue-headed Vireo	125	2	17	0.137	12.1	24
Yellow-bellied Sapsucker	125	1	15	0.121	12.1	25
American Crow	125	4	15	0.120	6.5	26
Hairy Woodpecker	125	1	14	0.113	11.3	27
Chestnut-sided Warbler	125	1	10	0.081	8.1	28
Common Grackle	125	3	10	0.081	5.6	29
Common Raven	125	2	10	0.080	6.4	30
Yellow-bellied Flycatcher	64	1	5	0.078	7.8	31
Lincoln's Sparrow	118	1	9	0.077	7.7	32
Evening Grosbeak	64	2	4	0.063	3.1	33
White-winged Crossbill	125	6	7	0.060	1.6	34
Pileated Woodpecker	125	1	7	0.056	5.6	35
Nashville Warbler	125	2	6	0.048	4.0	36
Ruby-throated Hummingbird	118	2	5	0.043	3.4	37
Rusty Blackbird	125	2	5	0.040	2.4	38
Pine Siskin	125	4	5	0.040	1.6	39

European Starling	125	4	4	0.032	0.8	40
Swamp Sparrow	125	2	4	0.032	2.4	41
Golden-crowned Kinglet	125	1	4	0.032	3.2	42
Downy Woodpecker	125	1	4	0.032	3.2	43
Winter Wren	125	1	3	0.024	2.4	44
Northern Waterthrush	125	1	3	0.024	2.4	45
Boreal Chickadee	125	1	3	0.024	2.4	46
Wilson's Snipe	125	2	3	0.024	1.6	47
Gray Jay	125	1	3	0.020	2.4	48
Rose-breasted Grosbeak	125	1	2	0.016	1.6	49
Red-breasted Nuthatch	125	1	2	0.016	1.6	50
Blackburnian Warbler	64	1	1	0.016	1.6	52
Bay-breasted Warbler	118	1	1	0.009	0.9	53
Yellow Warbler	125	1	1	0.008	0.8	54
Mourning Dove	125	1	1	0.008	0.8	55
Sharp-shinned Hawk	125	1	1	0.008	0.8	56
Pine Grosbeak	125	1	1	0.008	0.8	57
Belted Kingfisher	125	1	1	0.008	0.8	58
Savannah Sparrow	125	1	1	0.008	0.8	59

N=Number of Point Count Stations; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

The Red-eyed Vireo was the most abundant peak breeding bird species in both 2008 and 2010. The remaining six most common birds on Phase 2 lands in both years was American Robin, White-throated Sparrow, Ovenbird, Black-throated Green Warbler, Hermit Thrush, and Magnolia Warbler.

Statistical analyses were conducted to determine significant differences in the mean numbers of each species on Phase 2 Lands between 2008 and 2010. For comparative purposes, statistical analyses were also made for Phase 1 Lands. The results are given in Table 7.

The data indicates that the means of bird species at point counts do not have equal variances or have normal distributions. However the Welsh and Brown-Forsythe tests are parametric tests considered quite robust in this situation. The Wilcoxon-Mann-Whitney Test is a non-parametric test that was also used to supplement the former two methods. Only those species that showed significant differences between 2008 and 2010 using both parametric and non-parametric tests are given in Table 7.

Table 7: Tests of Significant Changes in Abundance from 2008-2010

	Phase 2 Lands						Phase 1 Lands					
		Mean		p-value				Mean		p-value		
Species	Trend	2008	2010	W	BF	WMW	Trend	2008	2010	W	BF	WMW
Mourning Dove							Increase	0.01	0.212	0.001	0.000	0.000
Northern Flicker	Increase	0.04	0.14	0.025	0.025	0.037	Increase	0.070	0.230	0.036	0.015	0.005
Ruby-crowned Kinglet	Increase	0.21	0.52	0.000	0.000	0.001						
Golden-crowned Kinglet	Decrease	0.18	0.03	0.000	0.000	0.000	Decrease	0.360	0.040	0.000	0.000	0.000
Hermit Thrush	Increase	0.41	0.62	0.042	0.042	0.040	Increase	0.28	0.78	0.001	0.001	0.001
American Robin	Increase	1.02	1.35	0.036	0.036	0.034						
Black-throated Green Warbler							Decrease	0.99	0.59	0.024	0.033	0.021
Dark-eyed Junco	Increase	0.34	0.56	0.009	0.009	0.021	Increase	0.47	0.79	0.001	0.001	0.039
Purple Finch	Increase	0.10	0.21	0.020	0.020	0.022	Increase	0.11	0.33	0.016	0.015	0.015
W= Welsh Test, BF=Brown-Forsythe Test, WMW=Wilcoxon-Mann-Whitney Test												

Four species had increased significantly on both Phase 1 and Phase 2 lands from 2008 to 2010. These were Northern Flicker, Hermit Thrush, Dark-eyed Junco, and Purple Finch. Two species increased significantly only on Phase 2 Lands, the Ruby-crowned Kinglet and American Robin, and one species only on Phase 1 lands, the Mourning Dove. One species decreased significantly on both Phase 1 and Phase 2 lands, the Golden-crowned Kinglet. One species decreased significantly only on Phase 1 lands, the Black-throated Green Warbler.

From this analysis it can be seen that the point counts on the Phase 2 lands can serve as a control group in the analysis of changes on Phase 1 lands until construction occurs on Phase 2 lands. For example, the increase in Mourning Doves on Phase 1 lands is likely the result of wind farm construction which created cleared land suitable for this species while the decrease in Black-throated Green Warblers could be the result of the losses in forest habitat, especially softwood habitat in that area. On the other hand, increases or decreases that occurred on both Phase 1 and Phase 2 lands likely indicate broader regional trends.

Breeding Status

The breeding status of bird species on the Phase 2 and Phase 1 lands is shown in Table 8. The status classifications are those used by the Maritimes Breeding Bird Atlas, http://www.mba-aom.ca. In total, between 2007 and 2010, 93 breeding species were found in the study area of which 35 are confirmed breeders, 31 are probable breeders, and 27 are possible breeders.

Table 8: Breeding Status of Bird Species in the Study Area 2007-2010 (with hyperlinks to species information)

Species	Status	Species	Status
Wood Duck	Possible	Winter Wren	Probable
American Black Duck	Probable	Golden-crowned Kinglet	Possible
Green-winged Teal	Possible	Ruby-crowned Kinglet	Probable
Ring-necked Duck	Probable	Swainson's Thrush	Confirmed
Common Merganser	Probable	Hermit Thrush	Confirmed
Ruffed Grouse	Confirmed	American Robin	Confirmed
Spruce Grouse	Possible	Cedar Waxwing	Confirmed
Bald Eagle	Possible	European Starling	Confirmed
Osprey	Possible	Tennessee Warbler	Possible
Northern Goshawk	Probable	Nashville Warbler	Probable
Red-tailed Hawk	Probable	Northern Parula	Confirmed
Broad-winged Hawk	Possible	Yellow Warbler	Probable
American Kestrel	Probable	Chestnut-sided Warbler	Confirmed
Merlin	Possible	Magnolia Warbler	Confirmed
Wilson's Snipe	Possible	Cape May Warbler	Confirmed
American Woodcock	Probable	Black-throated Blue Warbler	Confirmed
Black-billed Cuckoo	Possible	Yellow-rumped Warbler	Confirmed
Mourning Dove	Probable	Black-throated Green Warbler	Confirmed
Great Horned Owl	Possible	Blackburnian Warbler	Probable
Barred Owl	Probable	Palm Warbler	Probable
Northern Saw-whet Owl	Possible	Bay-breasted Warbler	Possible
Chimney Swift	Possible	Black-and-White Warbler	Probable
Ruby-throated Hummingbird	Possible	American Redstart	Confirmed
Belted Kingfisher	Confirmed	Ovenbird	Confirmed
Yellow-bellied Sapsucker	Confirmed	Northern Waterthrush	Possible
Downy Woodpecker	Confirmed	Mourning Warbler	Confirmed
Hairy Woodpecker	Confirmed	Common Yellowthroat	Confirmed
Black-backed Woodpecker	Possible	Wilson's Warbler	Possible
Northern Flicker	Confirmed	Canada Warbler	Probable
Pileated Woodpecker	Probable	Rose-breasted Grosbeak	Probable
Olive-sided Flycatcher	Probable	Chipping Sparrow	Possible
Eastern Wood Pewee	Probable	Savannah Sparrow	Possible
Yellow-bellied Flycatcher	Possible	Song Sparrow	Confirmed

Alder Flycatcher	Probable	Lincoln's Sparrow	Confirmed
Least Flycatcher	Probable	Swamp Sparrow	Confirmed
Eastern Kingbird	Possible	White-throated Sparrow	Confirmed
Blue-headed Vireo	Confirmed	Dark-eyed Junco	Confirmed
Red-eyed Vireo	Confirmed	Red-winged Blackbird	Possible
Gray Jay	Confirmed	Rusty Blackbird	Confirmed
Blue Jay	Probable	Common Grackle	Confirmed
American Crow	Probable	Pine Grosbeak	Possible
Common Raven	Probable	Purple Finch	Confirmed
Tree Swallow	Confirmed	White-winged Crossbill	Possible
Black-capped Chickadee	Confirmed	Pine Siskin	Possible
Boreal Chickadee	Probable	American Goldfinch	Probable
Red-breasted Nuthatch	Probable	Evening Grosbeak	Probable
White-breasted Nuthatch	Probable		

Species of Special Conservation Concern

This section deals with two categories of birds deemed of special conservation concern. The first are three species classified as sensitive to human activities by the Nova Scotia Department of Natural Resources; the Northern Goshawk, Gray Jay, and Boreal Chickadee. The second category is those species listed in Schedule 1 of Canada's *Species at Risk Act* (SARA). These include the Chimney Swift (threatened), Olive-sided Flycatcher (threatened), Canada Warbler (threatened), and Rusty Blackbird (Special Concern).

The Northern Goshawk has not been detected during a breeding point count but it is a probable breeder on Phase 2 lands where it has been seen during spring diurnal passage counts. A total of 9 Gray Jays have been seen on breeding point counts on Phase 2 lands in 2008 and 2010 combined, with a mean of 0.02 per point count. A total of 32 Boreal Chickadees have been seen on breeding point counts on Phase 2 lands in 2008 and 2010 combined, with a mean of 0.07 per point count.

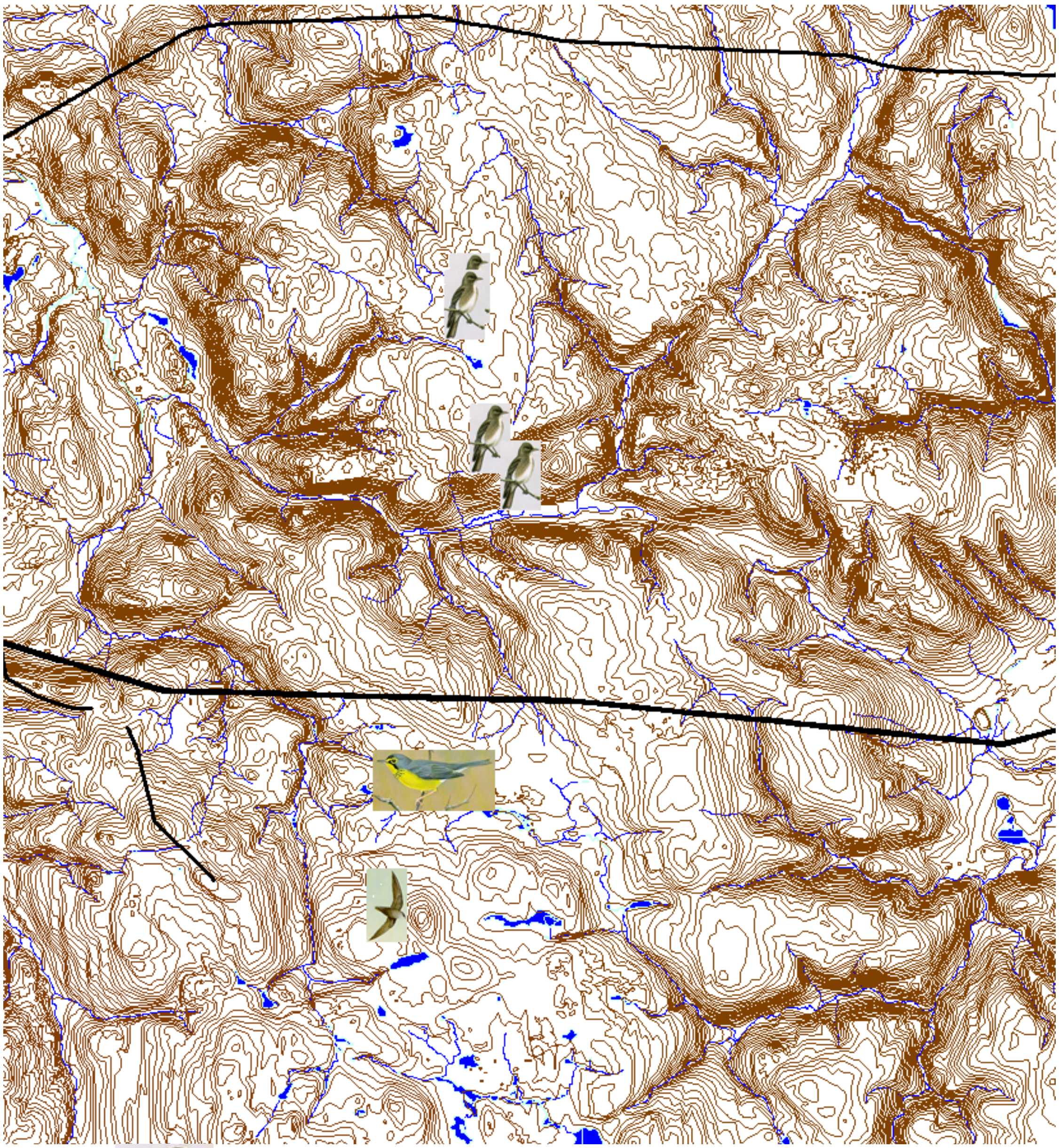
The Chimney Swift is a possible breeding bird on Phase 2 lands where a pair of birds was seen on one occasion in 2008 (see Figure 6) but none in 2010.

Olive-sided Flycatchers were possible breeders in four locations on Phase 2 lands in 2008 (see Figure 6) while none were seen there in 2010.

A pair of Canada Warbler (probable breeder) was seen in 2008 on Phase 2 lands but not in 2010 (see Figure 6).

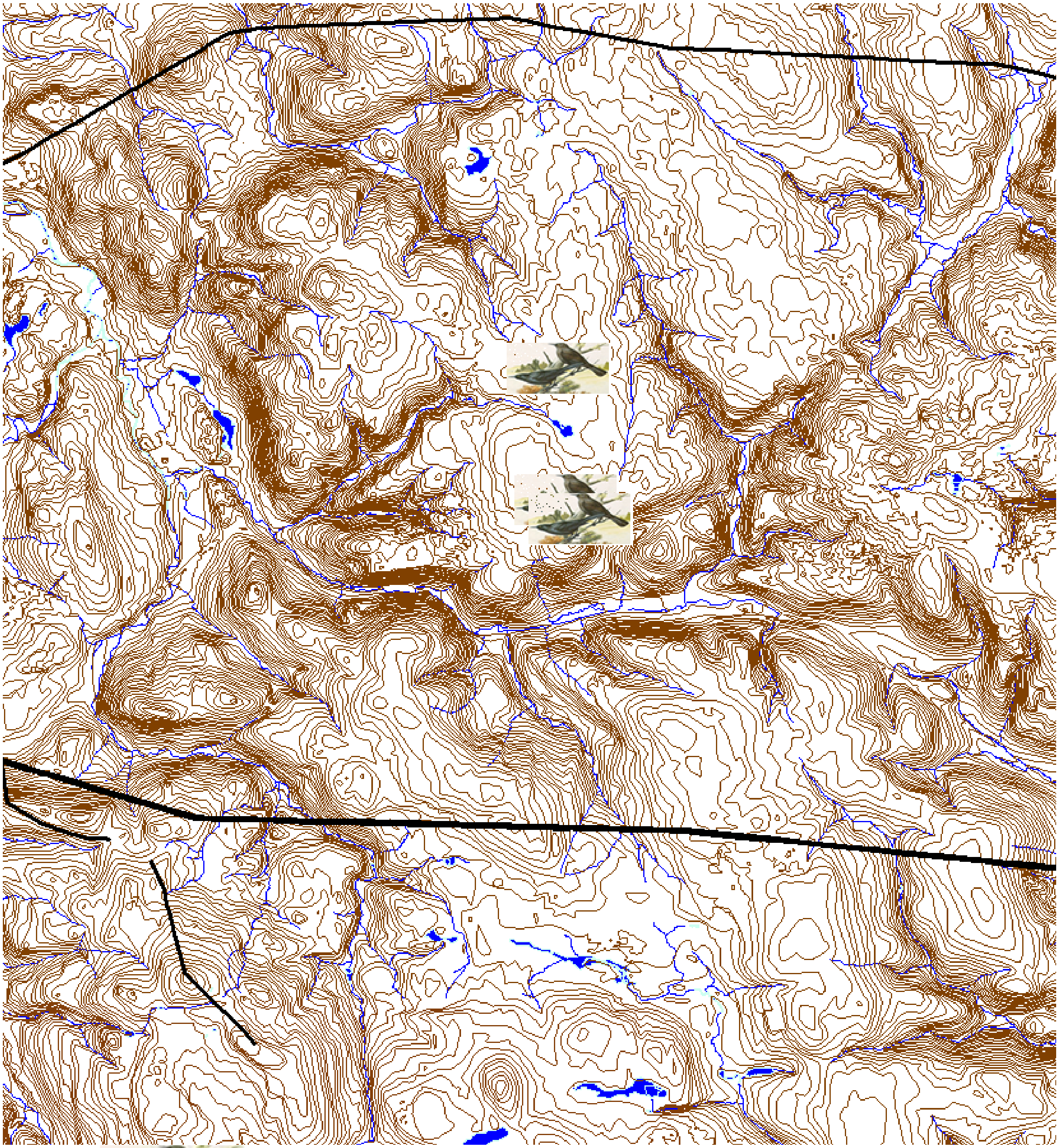
Rusty Blackbirds were not seen in 2008 but were seen at three point counts in 2010 including one pair carrying food to a nest, making it a confirmed breeder (see Figure 7).

Figure 6: Location of SARA Listed Species on Phase 2 Lands in 2008



Legend:  **Olive-sided Flycatcher**  **Canada Warbler**  **Chimney Swift**

Figure 7: Location of SARA Listed Species on Phase 2 Lands in 2010



Legend:  **Rusty Blackbird (male & female)**

Conclusion

The updating of the Glen Dhu Wind Energy baseline study with the breeding bird survey on Phase 2 lands provides a valuable expansion of the data available for this area. The 2010 study showed little change in breeding bird populations between 2008 and 2010 with the abundance of all species remaining the same or increasing with the exception of one species.

Similarly this 2010 study demonstrated that there was no widespread change in forest habitat since 2008 on Phase 2 land with 79% of the point counts showing no to slight change and 11% substantial to total change. As shown in Figure 4, there was one major clearcut in the northeast section of the Phase 2 lands with a few much smaller cuttings scattered throughout the area. This relatively small degree of habitat change for breeding birds would equally apply to migrating birds in stop-over and winter residents.

The breeding status of birds on the Phase 2 lands will be further updated in 2011 and will be especially useful as a control area for the post-construction monitoring of the Phase 1 lands.

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Cover Photo: Black-throated Green Warbler by Bernard Burke, used with permission.

Update to Baseline Study

Glen Dhu Wind Energy – Phase 2 Lands

Breeding Bird Survey 2011

Red-eyed Vireo at Nest

By:

John Kearney

John F. Kearney & Associates

For:

Shear Wind Inc.

November 2011

Introduction

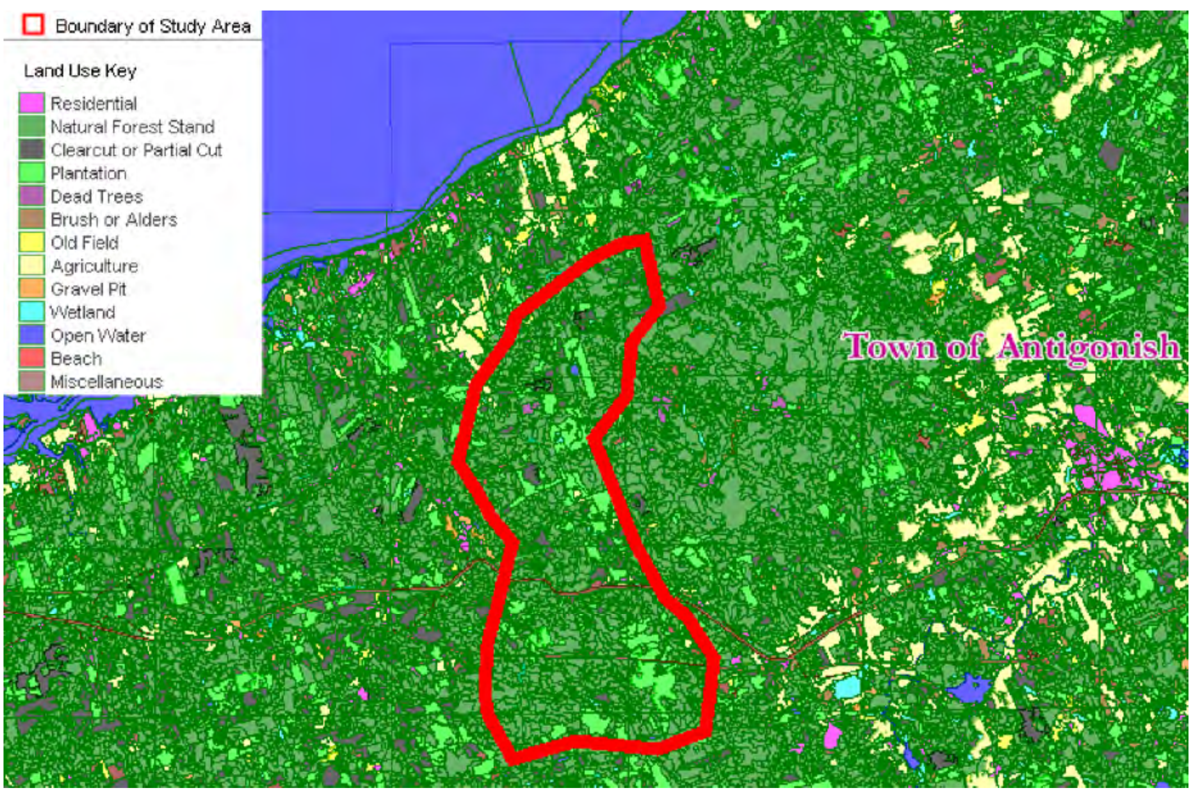
This document reports on a breeding bird survey conducted in 2011 on lands proposed for the development of Phase 2 of Glen Dhu Wind Energy by Shear Wind Inc. Phase 1 was completed in March 2011 with the construction of 27 turbines; each having a capacity of 2.3 megawatts.

A baseline study was conducted for both phases in 2007-2008 with follow-up studies carried out in 2009-2010 for the Phase 1 lands (Kearney 2007, 2008, 2009; 2010a; 2010b; 2011). In addition, a repetition of the baseline breeding bird survey for Phase 2 lands was carried out in 2010 (Kearney 2011) and in 2011. The findings of the 2011 study are presented here along with a comparison with changes since 2008 on Phase 2 lands.

Location of Study Area

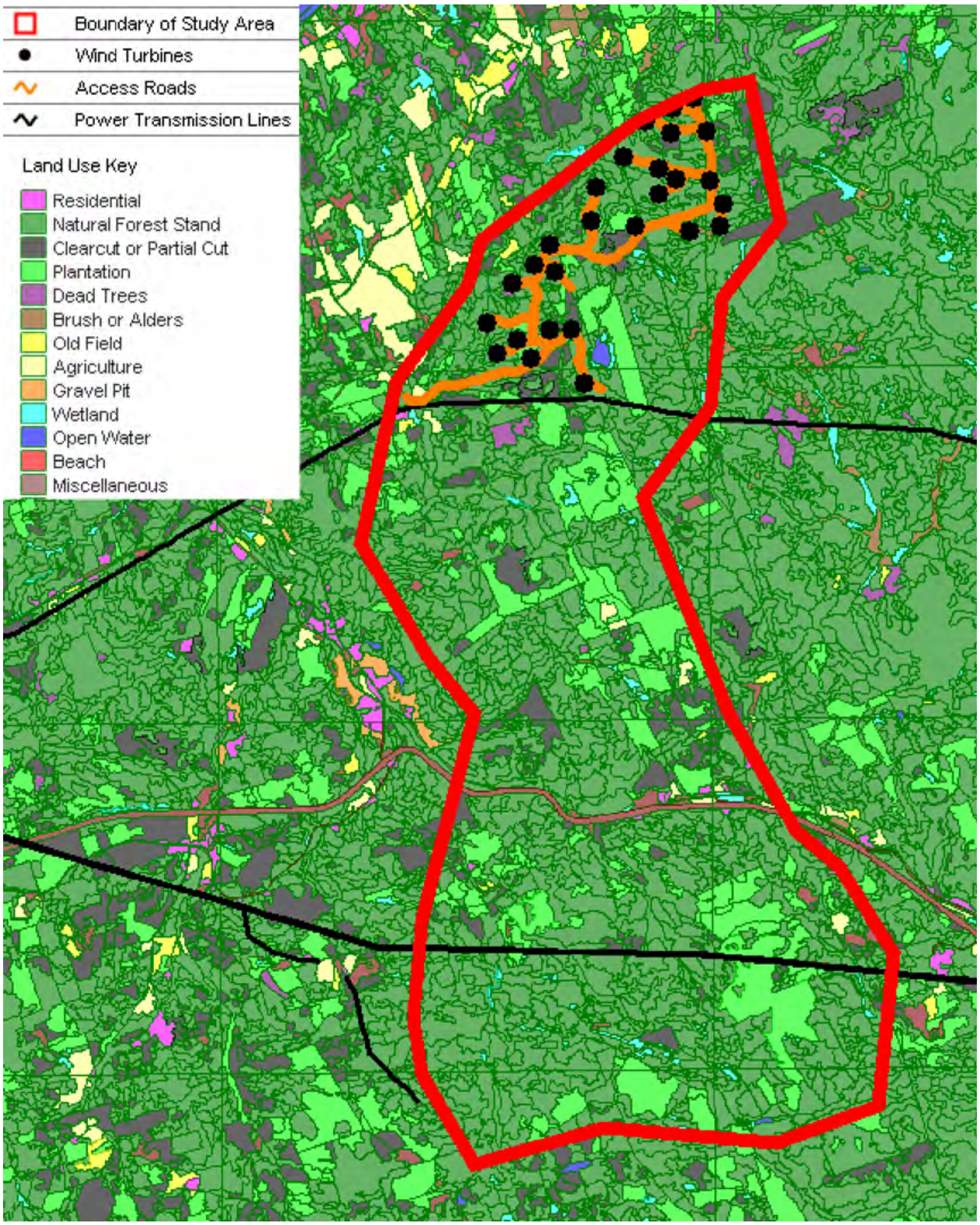
The location of the study area in the Pictou-Antigonish Highlands of Nova Scotia is shown in Figure 1.

Figure 1: Location of Study Area



As shown in Figure 2, the study area consists of forested lands, covering approximately 4,050 hectares. Phase 1 lands are those above the northernmost power transmission line where 27 wind turbines and access roads have been constructed. The Phase 2 lands are below this area.

Figure 2: Phase 1 and Phase 2 Lands



Methodology

The survey of breeding birds in 2011 consisted of three parts; 1) nocturnal monitoring survey, 2) early breeding point counts, and 3) peak season point counts.

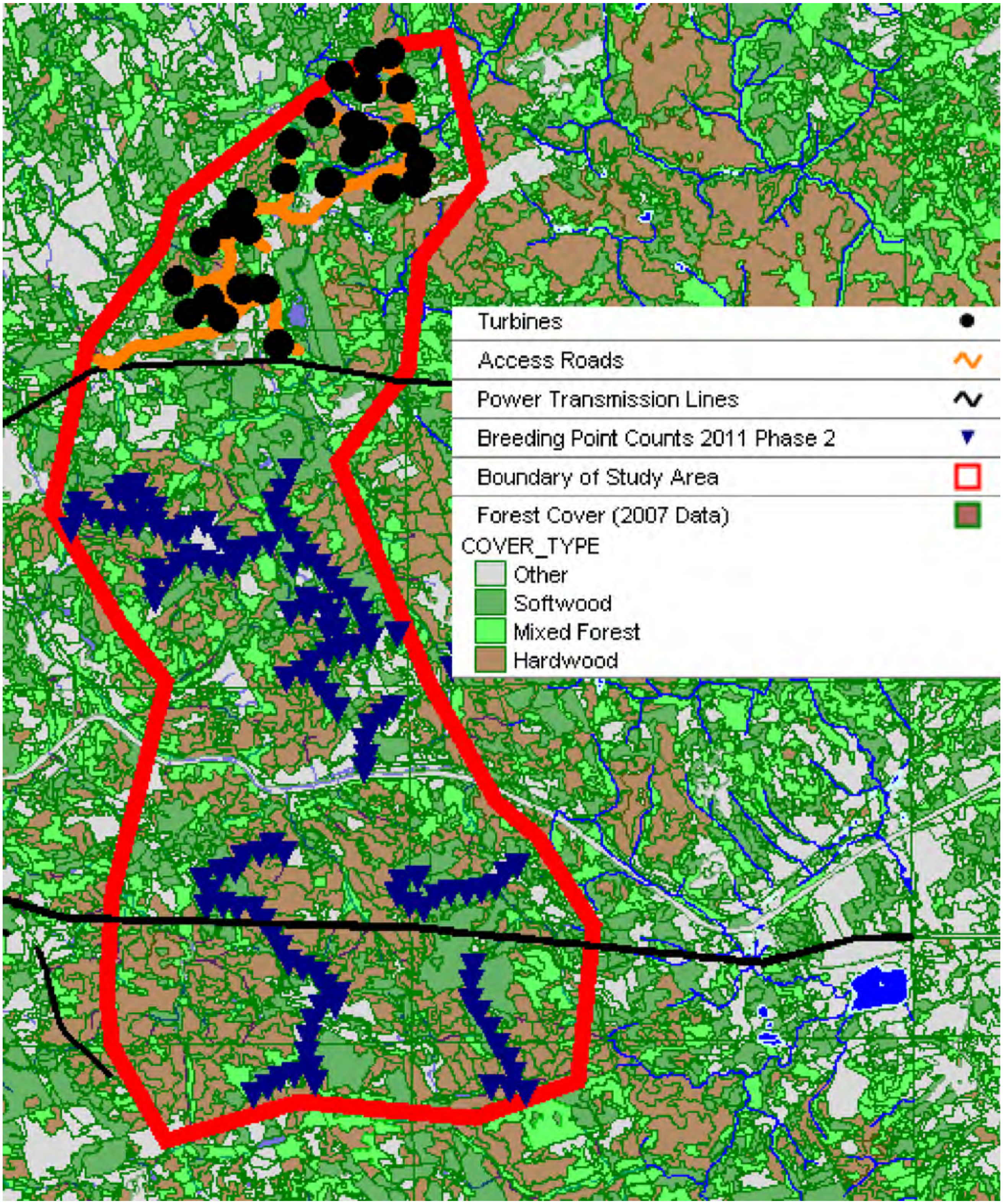
Nocturnal surveys were conducted following the Guidelines for Nocturnal Owl Monitoring in North America published by Bird Studies Canada (Takats et al. 2001). These surveys focused on the following species that have been detected in the study area: American Woodcock, Barred Owl, Great Horned Owl, and Saw-whet Owl. Due to the frequency of rain and high winds during the 2011 breeding season, only one nocturnal survey was successfully completed (May 14).

The breeding season point counts followed the protocols established by the Canadian Wildlife Service for assessing the impact of wind turbines on birds (Environment Canada 2007). The point counts were 10 minutes in duration and recorded birds in the distance categories from the observer of <50 metres, 50-100 metres, >100 metres, and flying overhead.

Twenty-one early breeding point counts were conducted from 6 to 17 May 2011. These point counts along with an additional one hundred and six peak season point counts were surveyed again from 7 June to 3 July 2011. The location of the total one hundred and twenty-seven point counts surveyed in the early and peak breeding seasons are shown in Figure 3.

Notes were taken on the breeding status of each species observed and classified as to whether they were possible, probable, or confirmed breeders, using the criteria developed for the Maritimes Breeding Bird Atlas. Species of special conservation concern, identified in the baseline study, were monitored during the surveys. In addition, habitat changes since the baseline study was recorded at each of the point counts stations.

Figure 3: Location of 127 Breeding Point Counts on Phase 2 Lands 2011



Habitat Change

Of the total 127 point counts surveyed in 2011, 120 were surveyed in both 2008 and 2010, 2 in 2011 and 2008 only, 1 in 2010 and 2011 only, and 4 only in 2011. An additional 2 point counts were classified as to habitat in 2007 during the pre-assessment and surveyed in 2011. The degree of habitat change between 2007 and 2011 was evaluated for every point count that was surveyed in at least one year prior to 2011. Virtually all the changes in habitat on the Phase 2 lands were due to forestry operations of grading and widening forestry roads or from the harvest of the forest.

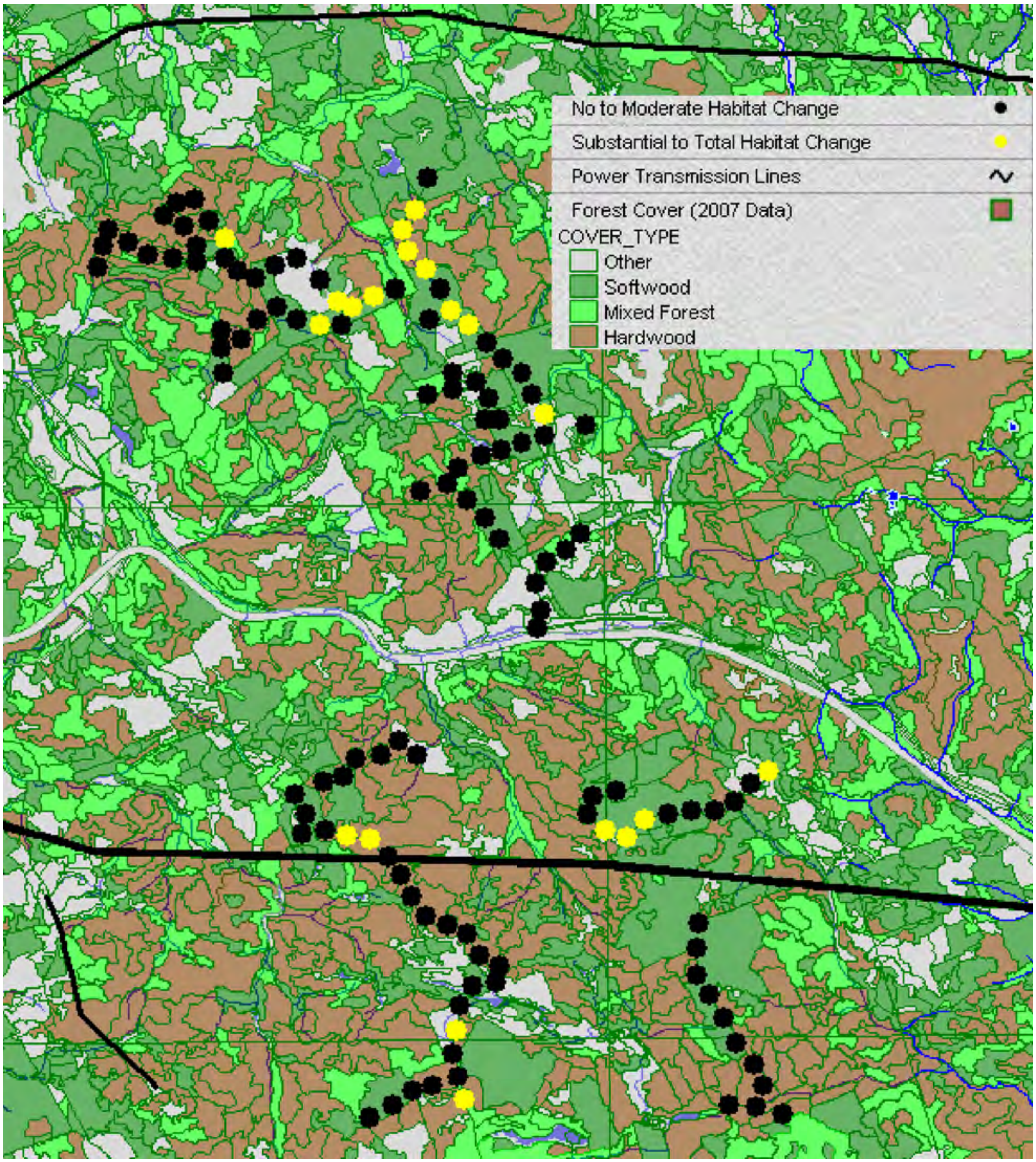
Table 1: Degree of Habitat Changes since Baseline Study with Code Legend

Degree of Habitat Change			Legend			
Change Code	2007 to 2011	%	*Code*	*Name*	*Description*	*Example*
0	81	64.8	0	No change	No disturbance	Looks the same as last year
1	11	8.8	1	Small change	Noticeable disturbance	Grading of forestry road
2	13	10.4	2	Moderate change	Change that might affect bird habitat	Widening of forestry road
3	19	15.2	3	Substantial change	Change having a definite effect on bird habitat	Clearcut part of habitat
4	1	0.8	4	Total change	Total or near total disturbance of habitat	Clearcut all or most of habitat
Total	125	100.00	Total	Total	Total surveyed in both 2007-2010 & 2011	Any point count surveyed in 2007-2010 and 2011

As shown in Table 1, for 65% of the point counts on Phase 2 lands, there was no change in habitat from 2008 to 2010. Small to moderate changes in habitat were found at 19% of the point counts. Substantial or total change, due to forest harvesting, occurred at

16% of the point counts. These changes in habitat are shown graphically in Figure 4. Point counts demonstrating substantial or total change due to forestry are marked in yellow.

Figure 4: Habitat Changes on Phase 2 Lands due to Forestry Practices between 2007 and 2011.



Results of Nocturnal Surveys

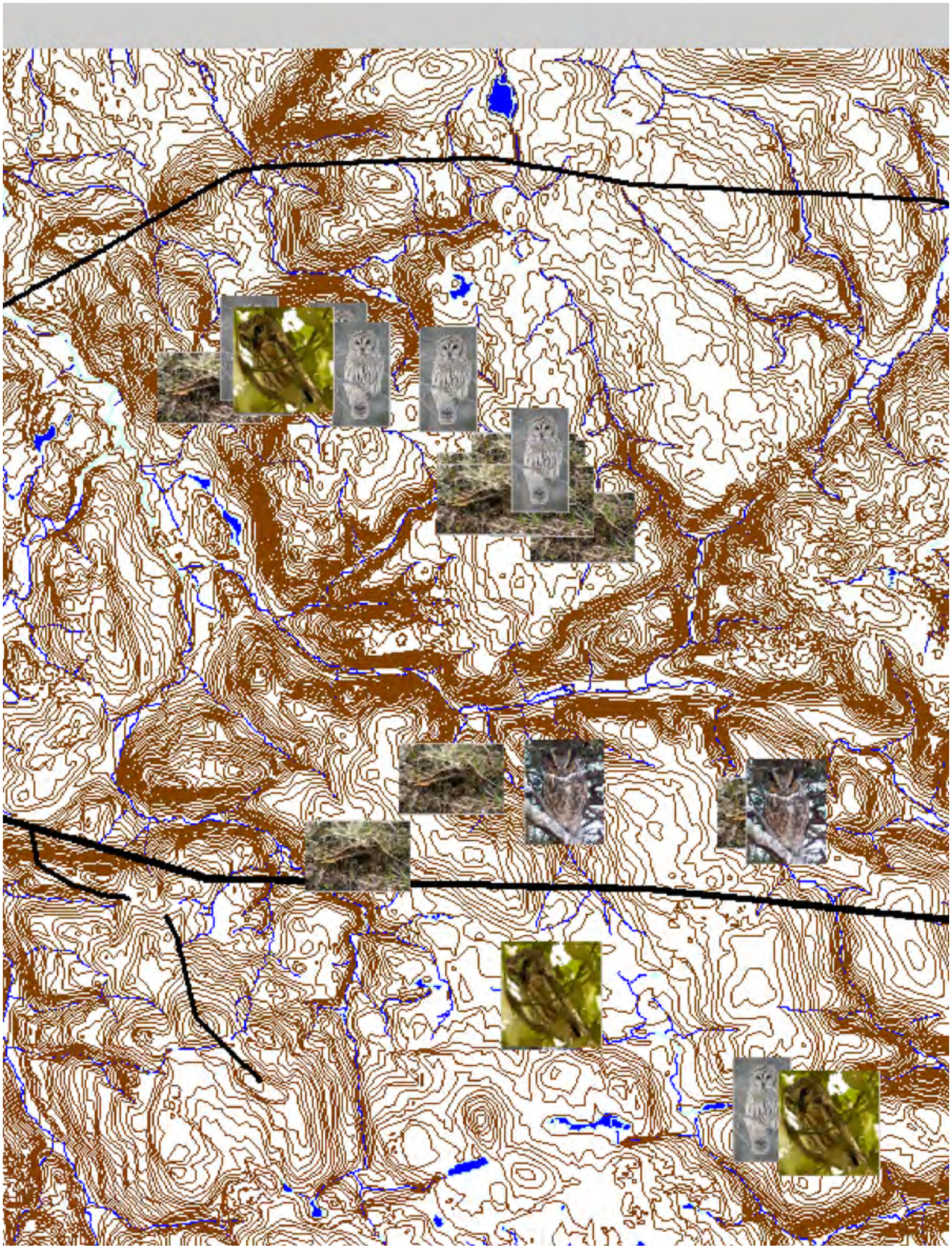
The results of the nocturnal surveys on Phase 2 lands conducted in 2008, 2010 and 2011 are displayed in Table 2. The location of all nocturnal birds seen in those years is presented in Figure 5.

Table 2: Results of Nocturnal Surveys on Phase 2 Lands

Species	*2008*	*2010*	*2011*
American Woodcock	4	4	2
Barred Owl	4	2	1
Great Horned Owl	0	3	0
Northern Saw-whet Owl	1	2	0

Great Horned Owl

Figure 5: Location of Nocturnal Breeders on Phase 2 Lands, 2008-2011



American Woodcock Barred Owl Great Horned Owl Northern Saw-whet Owl

Results of the Early Breeding Bird Surveys

The early breeding bird surveys were conducted differently in all three years, 2008, 2010, and 2011. The early breeding point counts in 2008 consisted of repetitions of 18 point counts along 3 transects; with one to two transects surveyed each week in April and May. In 2010, 39 early breeding point counts were more evenly distributed over the entire Phase 2 lands, but included those on the 2008 transects, and were carried out only once during the month of May. In 2011, the early breeding transects were done once on the 18 point counts of the three transects (and a very small number in other areas).

Repetitions of single point counts, as in 2008, give a more accurate assessment of the birds breeding on a particular site but at the expense of effort that could go to wider geographical coverage. Wide geographical coverage with a greater number of point counts, as in 2010, presents a more accurate "big picture" perspective but with a less precise assessment of the birds at each point count station. The 2011 early breeding survey is representative of a kind of less expensive follow-up survey that might be conducted regularly as part of a study of long-term trends.

Another factor affecting a comparison of the 2008 with 2010 and 2011 data is that early breeding point counts were carried out over a longer time period in 2008, from April 8 to June 2 compared to May 1 to 19 in 2010-2011. In all three years, only those species whose breeding season had commenced were counted on any particular date. Breeding dates were drawn from the data of the Maritimes Breeding Bird Atlas website (http://www.mba-aom.ca/).

Table 3 shows a ranking of the abundance of early breeding birds in 2008 on the Phase 2 lands. The five most abundant early breeding birds were American Robin, White-throated Sparrow, Ovenbird, Yellow-rumped Warbler, and Black-capped Chickadee. The mean number of American Robins and the White-throated Sparrows at each point count station was identical at 2.72. However, the American Robin was seen at 100% of the 18 point count stations compared to 94% for the White-throated Sparrow.

Table 3: Abundance Indices of Early Breeding Birds on Phase 2 Lands in 2008

Species	N	R	Max	Mean	Sum	% N	Rank
American Robin	18	6	6	2.72	49	100.0	1
White-throated Sparrow	18	3-4	6	2.72	49	94.4	2
Ovenbird	18	2-3	8	2.06	37	88.9	3
Yellow-rumped Warbler	18	5	4	1.28	23	77.8	4
Black-capped Chickadee	18	6	3	1.22	22	77.8	5
Magnolia Warbler	18	2-3	4	1.22	22	72.2	6
Dark-eyed Junco	18	6	3	1.22	22	77.8	7
Hermit Thrush	18	3-4	3	1.17	21	77.8	8
Blue Jay	18	6	5	1.11	20	55.6	9
Yellow-bellied Sapsucker	18	2-3	2	0.78	14	61.1	10
Northern Flicker	18	6	2	0.78	14	61.1	11
Common Yellowthroat	18	2-3	2	0.72	13	50.0	12
Song Sparrow	18	6	2	0.72	13	44.4	13
Hairy Woodpecker	18	6	2	0.67	12	61.1	14
Common Raven	18	9	3	0.67	12	44.4	15
Blue-headed Vireo	18	2-3	2	0.61	11	38.9	16
Purple Finch	18	2-3	2	0.61	11	50.0	17
American Crow	18	9	2	0.50	9	44.4	18
Ruffed Grouse	18	7	2	0.39	7	27.8	19
Ruby-crowned Kinglet	18	5	2	0.33	6	27.8	20
American Redstart	18	2-3	2	0.33	6	27.8	21
Common Grackle	18	7	4	0.33	6	16.7	22
Nashville Warbler	18	2-3	2	0.28	5	22.2	23
Downy Woodpecker	18	5	1	0.22	4	22.2	24
Pine Siskin	18	7	1	0.22	4	22.2	25
American Kestrel	18	7	2	0.11	2	5.6	26
Barred Owl	18	9	1	0.11	2	11.1	27
Boreal Chickadee	18	3-4	1	0.11	2	11.1	28
Swainson's Thrush	18	2-3	1	0.11	2	11.1	29
American Black Duck	18	9	1	0.06	1	5.6	30
Common Loon	18	5	1	0.06	1	5.6	31
Red-tailed Hawk	18	8	1	0.06	1	5.6	32
Merlin	18	5	1	0.06	1	5.6	33
Pileated Woodpecker	18	7	1	0.06	1	5.6	34
Tree Swallow	18	5	1	0.06	1	5.6	35
White-breasted Nuthatch	18	6	1	0.06	1	5.6	36
Swamp Sparrow	18	3-4	1	0.06	1	5.6	37
Pine Grosbeak	18	5	1	0.06	1	5.6	38
Black-backed Woodpecker	18	5	0	0.00	0	0.0	39

Palm Warbler	18	3-4	0	0.00	0	0.0	40

N=Number of Point Count Stations; R=Number of Repetitions; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

Table 4 shows the ranking of the abundance of early breeding birds on Phase 2 lands in 2010. The five most abundant birds were White-throated Sparrow, American Robin, Yellow-rumped Warbler, Hermit Thrush, and Dark-eyed Junco. Differences in the mean number of birds, frequency at point count stations, and total diversity largely represents the differences in the methodologies of the two years, 2008 and 2010, rather than declines or increases in abundance.

Table 4: Abundance Indices of Early Breeding Birds on Phase 2 Lands in 2010

Species	N	R	Max	Sum	Mean	% N	Rank
White-throated Sparrow	12	1	4	19	1.58	67.7	1
American Robin	39	1	7	61	1.56	61.5	2
Yellow-rumped Warbler	34	1	4	21	0.62	35.3	3
Hermit Thrush	12	1	2	7	0.58	50.0	4
Dark-eyed Junco	39	1	3	14	0.36	25.6	5
Northern Flicker	39	1	1	13	0.33	33.3	6
Hairy Woodpecker	39	1	3	11	0.28	20.5	7
Black-capped Chickadee	39	1	4	10	0.26	15.4	8
Blue Jay	39	1	3	7	0.18	12.8	9
Ruffed Grouse	39	1	2	6	0.15	12.9	10
American Crow	39	1	2	5	0.13	10.3	11
Pileated Woodpecker	39	1	2	5	0.13	10.3	12
Song Sparrow	39	1	1	4	0.10	10.3	13
Golden-crowned Kinglet	34	1	1	2	0.06	5.9	14
Common Grackle	39	1	1	2	0.05	5.1	15
Common Raven	39	1	1	2	0.05	5.1	16
Downy Woodpecker	34	1	1	1	0.03	2.9	17
Brown Creeper	34	1	1	1	0.03	2.9	18
American Kestrel	39	1	1	1	0.03	2.6	19

N=Number of Point Count Stations; R=Number of Repetitions; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

Table 5 summarizes the data for 2011. Again American Robin and White-throated Sparrow were the two most abundant species, followed by Northern Flicker, Yellow-rumped Warbler, and Hermit Thrush.

Table 5: Abundance Indices of Early Breeding Birds on Phase 2 Lands in 2011

Species	N	R	Max	Sum	Mean	%N	Rank
American Robin	21	1	6	50	2.38	85.71%	1
White-throated Sparrow	9	1	3	8	0.89	44.44%	2
Northern Flicker	21	1	4	15	0.71	52.38%	3
Yellow-rumped Warbler	15	1	2	9	0.60	46.67%	4
Hermit Thrush	9	1	3	5	0.56	33.33%	5
Song Sparrow	21	1	3	8	0.38	19.05%	6
Ruffed Grouse	21	1	1	5	0.24	23.81%	7
Dark-eyed Junco	21	1	2	5	0.24	14.29%	8
Hairy Woodpecker	21	1	2	3	0.14	9.52%	9
Blue Jay	21	1	1	2	0.10	9.52%	10
Bald Eagle	21	1	2	2	0.10	4.76%	11
European Starling	21	1	2	2	0.10	4.76%	12
Downy Woodpecker	15	1	1	1	0.07	6.67%	13
Black-capped Chickadee	21	1	1	1	0.05	4.76%	14
American Crow	21	1	1	1	0.05	4.76%	15

N=Number of Point Count Stations; R=Number of Repetitions; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

Therefore, while different survey methods were used in all three years to analyze early breeding bird populations and gave quite different results in terms of the mean number of birds of each species at point count stations, the relative abundance of each species remains fairly constant from one year to the next. As shown in Table 6, from 2008 to 2011, American Robin and White-throated Sparrow ranked either #1 or #2 in abundance among early breeding birds. The Yellow-rumped Warbler ranged between #3 and #4, Hermit Thrush from #4 to #6, Dark-eyed Junco from #5 to #8, Hairy Woodpecker from #7 to #10, and Blue Jay from #7 to #10. Other species were more variable and this trend may reflect their more variable status in the study area or changes in population. For example, the Northern Flicker varied from #3 to #8, Black-capped Chickadee from #4 to #14, Song Sparrow from #6 to #10, and Ruffed Grouse from #7 to #19. This analysis ignores the "late" early breeding warblers, like Ovenbird and Magnolia Warbler, which were included by conducting surveys in the last week of May in 2008.

Table 6: Comparison of Abundance Indices of the Ten Most Common Early Breeding Birds on Phase 2 Lands, 2008-2011, for Species Commencing Breeding by the Third Week of May

	2008							2010							2011						
Species	N	R	Max	Sum	Mean	%N	Rank	N	R	Max	Sum	Mean	%N	Rank	N	R	Max	Sum	Mean	%N	Rank
American Robin	18	6	6	49	2.7	100	1	39	1	7	61	1.6	62	2	21	1	6	50	2.4	86	1
White-throated Sparrow	18	3-4	6	49	2.7	94	2	12	1	4	19	1.6	68	1	9	1	3	8	0.9	44	2
Yellow-rumped Warbler	18	5	4	23	1.3	78	3	34	1	4	21	0.6	35	3	15	1	2	9	0.6	47	4
Hermit Thrush	18	3-4	3	21	1.2	78	6	12	1	2	7	0.6	50	4	9	1	3	5	0.6	33	5
Dark-eyed Junco	18	6	3	22	1.2	78	5	39	1	3	14	0.4	26	5	21	1	2	5	0.2	14	8
Northern Flicker	18	6	2	14	0.8	61	8	39	1	1	13	0.3	33	6	21	1	4	15	0.7	52	3
Blue Jay	18	6	5	20	1.1	56	7	39	1	3	7	0.2	13	9	21	1	1	2	0.1	10	10
Hairy Woodpecker	18	6	2	12	0.7	61	10	39	1	3	11	0.3	21	7	21	1	2	3	0.1	10	9
Black-capped Chickadee	18	6	3	22	1.2	78	4	39	1	4	10	0.3	15	8	21	1	1	1	0.1	5	14
Song Sparrow	18	6	2	13	0.7	44	9	39	1	1	4	0.1	10	13	21	1	3	8	0.4	19	6
Ruffed Grouse	18	7	2	7	0.4	28	19	39	1	2	6	0.2	13	10	21	1	1	5	0.2	24	7

Results of Peak Breeding Surveys

Peak breeding point counts were conducted on Phase 2 lands from 4 June to 3 July 2008, from 3 to 29 June 2010, and from 7 June to 3 July 2011. The 2008 survey consisted of 130 point count stations, the 2010 survey had 125, and 2011 had 127. However for those species commencing their breeding period later than the first week of June, the number of point counts that included an analysis of those species ranged between 59 and 120. For all peak breeding point counts there was only one count per season (no repetitions). The results of the peak breeding bird surveys are shown in Tables 7-9.

Table 7: Abundance Indices of Peak Breeding Birds on Phase 2 Lands in 2008.

Species	N	Max	Sum	Mean	% N	Rank
Red-eyed Vireo	118	4	165	1.398	69.5	1
Ovenbird	130	1	151	1.162	62.3	2
American Robin	130	5	132	1.015	55.4	3
White-throated Sparrow	130	7	122	0.938	50.0	4
Black-throated Green Warbler	130	4	105	0.808	55.4	5
Magnolia Warbler	130	3	55	0.423	31.5	6
Hermit Thrush	130	4	53	0.408	29.2	7
Swainson's Thrush	130	4	52	0.400	26.2	8
Dark-eyed Junco	130	3	42	0.323	26.9	9
American Redstart	130	3	42.0	0.323	26.9	10
Alder Flycatcher	118	3	29	0.246	16.9	11
Black-and-White Warbler	130	2	31	0.238	22.3	12
Yellow-bellied Sapsucker	130	2	30	0.231	20.0	13
Blue-headed Vireo	130	2	29	0.223	18.5	14
Common Yellowthroat	130	3	29	0.223	18.5	15
Mourning Warbler	100	3.000	21.0	0.21	14.0	16
Blue Jay	130	3	27	0.208	13.1	17
Ruby-crowned Kinglet	130	2	27	0.208	20.0	18
Least Flycatcher	130	3	26	0.200	14.6	19
Golden-crowned Kinglet	130	2	24	0.185	17.7	20
Song Sparrow	130	3	20	0.154	10.0	21
Yellow-rumped Warbler	130	4	20	0.154	10.8	22
Hairy Woodpecker	130	2	19	0.146	13.8	23
Northern Parula	130	2	16	0.123	10.8	24
Purple Finch	130	1	13	0.100	10.0	25
White-winged Crossbill	130	12	12	0.090	0.1	26
Black-capped Chickadee	130	2	10	0.077	6.2	27
Yellow-bellied Flycatcher	100	1	7	0.070	7.0	28
Common Grackle	130	7	9	0.069	2.3	29
Nashville Warbler	130	2	8	0.062	5.4	30
Red-winged Blackbird	130	8	8	0.062	0.8	31
American Crow	130	4	8	0.060	3.8	32
Evening Grosbeak	100	2	6	0.060	5.0	33
Cedar Waxwing	118	3	7	0.059	3.4	34
Lincoln's Sparrow	118	2	7	0.059	5.1	35
Chestnut-sided Warbler	130	1	7	0.054	5.4	36
Common Raven	130	2	6	0.050	3.8	37
Gray Jay	130	4	6	0.050	1.5	38
Black-throated Blue Warbler	118	1	5	0.042	4.2	39

Swamp Sparrow	130	2	5	0.038	2.3	40
Northern Flicker	130	1	5	0.038	3.8	41
Olive-sided Flycatcher	118	1	4	0.034	3.4	42
American Goldfinch	59	1	2	0.034	3.4	43
Blackburnian Warbler	100	1	3	0.030	3.0	44
Ruby-throated Hummingbird	118	1	3	0.025	2.5	45
Eastern Wood Pewee	118	1	3	0.025	2.5	46
Pine Siskin	130	3	3	0.023	0.8	47
Red-tailed Hawk	130	1	3	0.020	2.3	48
Chimney Swift	100	2	2	0.020	1.0	49
Canada Warbler	118	1	2	0.017	1.7	50
Bay-breasted Warbler	118	1	2	0.017	1.7	51
Belted Kingfisher	130	1	2	0.015	1.5	52
Yellow Warbler	130	2	2	0.015	0.8	53
Northern Waterthrush	130	1	2	0.015	1.5	54
Common Loon	130	1	1	0.008	0.8	55
Spruce Grouse	130	1	1	0.008	0.8	56
Mourning Dove	130	1	1	0.008	0.8	57
Red-breasted Nuthatch	130	1	1	0.008	0.8	58
Tennessee Warbler	130	1	1	0.008	0.8	59
Brown Creeper	130	1	1	0.008	0.8	60
Eastern Kingbird	130	1	1	0.008	0.8	61
Tree Swallow	130	1	1	0.008	0.8	62

N=Number of Point Count Stations; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.

Table 8: Abundance Indices of Peak Breeding Birds on Phase 2 Lands in 2010

Species	N	Max	Sum	Mean	% N	Rank
Red-eyed Vireo	118	4	190	1.590	82.9	1
American Robin	125	6	169	1.355	66.1	2
White-throated Sparrow	125	6	154	1.242	51.6	3
Ovenbird	125	5	149	1.161	66.1	4
Black-throated Green Warbler	125	5	100	0.806	58.1	5
Hermit Thrush	125	4	78	0.621	40.3	6
Magnolia Warbler	125	3	73	0.589	43.5	7
Dark-eyed Junco	125	4	69	0.560	38.7	8
Ruby-crowned Kinglet	125	3	64	0.516	37.1	9
Swainson's Thrush	125	3	44	0.355	26.6	10

American Redstart	125	4	44	0.347	27.4	11
Common Yellowthroat	125	2	40	0.323	24.2	12
Alder Flycatcher	118	4	30	0.256	17.9	13
Mourning Warbler	64	2	14	0.219	18.7	14
Purple Finch	125	2	26	0.210	20.2	15
Least Flycatcher	125	5	28	0.210	14.5	16
Blue Jay	125	3	24	0.194	10.5	17
Black-and-White Warbler	125	1	22	0.177	17.7	18
Song Sparrow	125	3	19	0.153	11.3	19
Yellow-rumped Warbler	125	2	18	0.145	11.3	20
Northern Parula	125	1	17	0.137	13.7	21
Northern Flicker	125	3	17	0.137	10.5	22
Black-capped Chickadee	125	4	17	0.137	8.9	23
Blue-headed Vireo	125	2	17	0.137	12.1	24
Yellow-bellied Sapsucker	125	1	15	0.121	12.1	25
American Crow	125	4	15	0.120	6.5	26
Hairy Woodpecker	125	1	14	0.113	11.3	27
Chestnut-sided Warbler	125	1	10	0.081	8.1	28
Common Grackle	125	3	10	0.081	5.6	29
Common Raven	125	2	10	0.080	6.4	30
Yellow-bellied Flycatcher	64	1	5	0.078	7.8	31
Lincoln's Sparrow	118	1	9	0.077	7.7	32
Evening Grosbeak	64	2	4	0.063	3.1	33
White-winged Crossbill	125	6	7	0.060	1.6	34
Pileated Woodpecker	125	1	7	0.056	5.6	35
Nashville Warbler	125	2	6	0.048	4.0	36
Ruby-throated Hummingbird	118	2	5	0.043	3.4	37
Rusty Blackbird	125	2	5	0.040	2.4	38
Pine Siskin	125	4	5	0.040	1.6	39
European Starling	125	4	4	0.032	0.8	40
Swamp Sparrow	125	2	4	0.032	2.4	41
Golden-crowned Kinglet	125	1	4	0.032	3.2	42
Downy Woodpecker	125	1	4	0.032	3.2	43
Winter Wren	125	1	3	0.024	2.4	44
Northern Waterthrush	125	1	3	0.024	2.4	45
Boreal Chickadee	125	1	3	0.024	2.4	46
Wilson's Snipe	125	2	3	0.024	1.6	47
Gray Jay	125	1	3	0.020	2.4	48
Rose-breasted Grosbeak	125	1	2	0.016	1.6	49
Red-breasted Nuthatch	125	1	2	0.016	1.6	50
Blackburnian Warbler	64	1	1	0.016	1.6	52
Bay-breasted Warbler	118	1	1	0.009	0.9	53
Yellow Warbler	125	1	1	0.008	0.8	54

Mourning Dove	125	1	1	0.008	0.8	55
Sharp-shinned Hawk	125	1	1	0.008	0.8	56
Pine Grosbeak	125	1	1	0.008	0.8	57
Belted Kingfisher	125	1	1	0.008	0.8	58
Savannah Sparrow	125	1	1	0.008	0.8	59
N=Number of Point Count Stations; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.						

Table 9: Abundance Indices of Peak Breeding Birds on Phase 2 Lands in 2011

Species	N	Max	Sum	Mean	%N	Rank
Ovenbird	127	5	174	1.37	66.9	1
Red-eyed Vireo	120	5	158	1.32	71.7	2
American Robin	127	6	123	0.97	48.8	3
White-throated Sparrow	127	7	121	0.95	39.4	4
Black-throated Green Warbler	127	6	109	0.86	51.2	5
Magnolia Warbler	127	3	78	0.61	37.8	6
Hermit Thrush	127	3	66	0.52	38.6	7
Swainson's Thrush	127	3	56	0.44	33.1	8
Dark-eyed Junco	127	3	56	0.44	35.4	9
Ruby-crowned Kinglet	127	2	48	0.38	31.5	10
Mourning Warbler	99	2	33	0.33	28.3	11
Alder Flycatcher	120	4	37	0.31	19.2	12
American Redstart	127	3	37	0.29	21.3	13
Common Yellowthroat	127	4	34	0.27	18.9	14
Black-and-White Warbler	127	1	24	0.19	18.9	15
Blue-headed Vireo	127	2	22	0.17	16.5	16
Northern Parula	127	2	20	0.16	15.0	17
Purple Finch	127	3	19	0.15	11.8	18
Song Sparrow	127	3	18	0.14	8.7	19
Chestnut-sided Warbler	127	2	17	0.13	12.6	20
Least Flycatcher	127	4	15	0.12	6.3	21
American Crow	127	4	14	0.11	7.1	22
American Goldfinch	82	2	8	0.10	7.3	23
Yellow-rumped Warbler	127	2	10	0.08	7.1	24
Black-capped Chickadee	127	2	8	0.06	5.5	25
Lincoln's Sparrow	120	2	7	0.06	4.2	26
Yellow-bellied Sapsucker	127	1	7	0.06	5.5	27
Blue Jay	127	2	7	0.06	4.7	28

Boreal Chickadee	127	1	7	0.06	5.5	29
Northern Flicker	127	1	6	0.05	4.7	30
Common Grackle	127	2	6	0.05	3.9	31
Yellow-bellied Flycatcher	99	2	4	0.04	3	32
Hairy Woodpecker	127	1	5	0.04	3.9	33
Northern Waterthrush	127	1	5	0.04	3.9	34
Pileated Woodpecker	127	1	4	0.03	3.1	35
Gray Jay	127	1	4	0.03	3.1	36
Chimney Swift	99	3	3	0.03	1	37
Ruffed Grouse	127	1	3	0.02	2.4	28
Red-tailed Hawk	127	1	3	0.02	2.4	39
Belted Kingfisher	127	1	3	0.02	2.4	40
Common Raven	127	2	3	0.02	1.6	41
Nashville Warbler	127	1	3	0.02	2.4	42
Yellow Warbler	127	3	3	0.02	0.8	43
Blackburnian Warbler	99	1	2	0.02	2	44
Olive-sided Flycatcher	120	1	2	0.02	1.7	45
Bay-breasted Warbler	120	1	2	0.02	1.7	46
European Starling	127	1	2	0.02	1.6	47
Downy Woodpecker	127	1	1	0.01	0.8	48
Red-breasted Nuthatch	127	1	1	0.01	0.8	49
Golden-crowned Kinglet	127	1	1	0.01	0.8	50
Savannah Sparrow	127	1	1	0.01	0.8	51
Swamp Sparrow	127	1	1	0.01	0.8	52
Rose-breasted Grosbeak	127	1	1	0.01	0.8	53
Pine Siskin	127	1	1	0.01	0.8	54
N=Number of Point Count Stations; Max=Maximum Number Seen on Any Point Count; Mean=Average Seen per Point Count Station; Sum=Total Seen on All Point Counts Combined; %N=Percentage of Point Count Stations Where Species Was Seen; Rank=Abundance Rank Based on Mean.						

As summarized in Table 10, The Red-eyed Vireo was the most abundant peak breeding bird species in both 2008 and 2010 but the Ovenbird took over that position in 2011. The next seven most common birds on Phase 2 lands from 2008 to 2011 were American Robin, White-throated Sparrow, Black-throated Green Warbler, Magnolia Warbler, Hermit Thrush, Swainson's Thrush, and Dark-eyed Junco.

In the peak breeding surveys, the mean number of birds seen of each species at the point counts is often similar from one year to the next, and the relative abundance of these species, as seen in their ranking, is similar between years.

Table 10: Comparison of Abundance Indices of the Most Common Peak Breeding Birds on Phase 2 Lands, 2008-2011

	2008						2010						2011					
Species	N	Max	Sum	Mean	% N	Rank	N	Max	Sum	Mean	% N	Rank	N	Max	Sum	Mean	%N	Rank
Red-eyed Vireo	118	4	165	1.40	70	1	118	4	190	1.59	83	1	120	5	158	1.32	72	2
Ovenbird	130	1	151	1.16	62	2	125	5	149	1.16	66	4	127	5	174	1.37	67	1
American Robin	130	5	132	1.02	55	3	125	6	169	1.36	66	2	127	6	123	0.97	49	3
White-throated Sparrow	130	7	122	0.94	50	4	125	6	154	1.24	52	3	127	7	121	0.95	39	4
Black-throated Green Warbler	130	4	105	0.81	55	5	125	5	100	0.81	58	5	127	6	109	0.86	51	5
Magnolia Warbler	130	3	55	0.42	32	6	125	3	73	0.59	44	7	127	3	78	0.61	38	6
Hermit Thrush	130	4	53	0.41	29	7	125	4	78	0.62	40	6	127	3	66	0.52	39	7
Swainson's Thrush	130	4	52	0.40	26	8	125	3	44	0.36	27	10	127	3	56	0.44	33	8
Dark-eyed Junco	130	3	42	0.32	27	9	125	4	69	0.56	39	8	127	3	56	0.44	35	9
Ruby-crowned Kinglet	130	2	27	0.21	20	18	125	3	64	0.52	37	9	127	2	48	0.38	32	10
American Redstart	130	3	42	0.32	27	10	125	4	44	0.35	27	11	127	3	37	0.29	21	13
Alder Flycatcher	118	3	29	0.25	17	11	118	4	30	0.26	18	13	120	4	37	0.31	19	12
Common Yellowthroat	130	3	29	0.22	19	15	125	2	40	0.32	24	12	127	4	34	0.27	19	14
Black-and-White Warbler	130	2	31	0.24	22	12	125	1	22	0.18	18	18	127	1	24	0.19	19	15
Mourning Warbler	100	3	21	0.21	14	16	64	2	14	0.22	19	14	99	2	33	0.33	28	11
Yellow-bellied Sapsucker	130	2	30	0.23	20	13	125	1	15	0.12	12	25	127	1	7	0.06	6	27
Blue-headed Vireo	130	2	29	0.22	19	14	125	2	17	0.14	12	24	127	2	22	0.17	17	16
Blue Jay	130	3	27	0.21	13	17	125	3	24	0.19	11	17	127	2	7	0.06	5	28
Purple Finch	130	1	13	0.10	10	25	125	2	26	0.21	20	15	127	3	19	0.15	12	18
Least Flycatcher	130	3	26	0.20	15	19	125	5	28	0.21	15	16	127	4	15	0.12	6	21
Golden-crowned Kinglet	130	2	24	0.19	18	20	125	1	4	0.03	42	None	127	1	1	0.01	1	50
Song Sparrow	130	3	20	0.15	10	21	125	3	19	0.15	11	19	127	3	18	0.14	9	19
Yellow-rumped Warbler	130	4	20	0.15	11	22	125	2	18	0.15	11	20	127	2	10	0.08	7	24
Hairy Woodpecker	130	2	19	0.15	14	23	125	1	14	0.11	11	27	127	1	5	0.04	4	33
Northern Parula	130	2	16	0.12	11	24	125	1	17	0.14	14	21	127	2	20	0.16	15	17

Northern Flicker	130	1	5	0.04	4	41	125	3	17	0.14	11	22	127	1	6	0.05	5	30
Black-capped Chickadee	130	2	10	0.08	6	27	125	4	17	0.14	9	23	127	2	8	0.06	6	25
Chestnut-sided Warbler	130	1	7	0.05	5	36	125	1	10	0.08	8	28	127	2	17	0.13	13	20
American Crow	130	4	8	0.06	4	32	125	4	15	0.12	7	26	127	4	14	0.11	7	22

To accurately detect significant differences in the abundance of breeding birds, statistical methods are required. Since it is unlikely, when comparing point count results, that the mean number of birds has a normal distribution or equal variances, a variety of statistical tests are required to find significant differences when they exist. The analysis of each species was subject to five statistical tests and each species had to have shown a significant change at the 95% confidence level in each test in order to be included in Table 11. These tests are the parametric tests of Analysis of Variance (ANOVA), Welch Test, Brown-Forsythe Test, Tamhane's T2 Pairwise Comparison, and the non-parametric Wilcoxon-Mann-Whitney Test.

Table 11: Species Demonstrating a Statistically Significant Change in Abundance between 2008 and 2011

	Mean			Change		p-Value				
Species	**2008**	**2010**	**2011**	**Trend**	**in Rank**	**ANOVA**	**W**	**BF**	**T**	**WMW**
Yellow-bellied Sapsucker	0.23	0.12	0.06	-	13=>27	0.001	0.001	0.001	0.001	0.001
Hairy Woodpecker	0.15	0.11	0.04	-	23=>33	0.019	0.006	0.018	0.140	0.006
Blue Jay	0.21	0.19	0.06	-	17=>28	0.039	0.006	0.039	0.028	0.018
Golden-crowned Kinglet	0.19	0.03	0.01	-	20=>50	0.000	0.000	0.000	0.000	0.000
Ruby-crowned Kinglet	0.21	0.51	0.38	+	18=>10	0.000	0.000	0.000	0.000	0.021

ANOVA=Analysis of Variance, W=Welch Test, BF=Brown-Forsythe Test, T=Tamhane's T2 Pairwise Comparison, WMW=Wilcoxon-Mann-Whitney Test

This suite of tests indicated that the Yellow-bellied Sapsucker, Hairy Woodpecker, Blue Jay, and Golden-crowned Kinglet were declining in the years 2008 to 2011. Only the Ruby-crowned Kinglet was indicated as increasing.

The non-parametric tests alone showed a few other species with increasing trends from 2008 to 2011. These were Boreal Chickadee (mean of 0.00 => 0.06, p=0.007), Chestnut-sided Warbler (mean of 0.05 =>0.13, p=0.040), and Mourning Warbler (mean of

0.21=>0.33, p=0.032). At the same time, the non-parametric tests alone showed two species with declining trends, Cedar Waxwing (0.06=>0.00, p=0.043) and Black-throated Blue Warbler (0.04=>0.00, p=0.024).

The declines of the four species described in Table 11 are of some concern. They are all species ranked in the top 10 to 25 bird species in the forest ecosystem of the region in the peak breeding surveys. The Hairy Woodpecker, an early breeder, is ranked between 7 and 14 in the early breeding surveys. The causes for these declines are not known but this trend should be further studied. The woodpecker species, in particular, are considered "keystone" forest species since they provide nesting holes for other species and, in the case of Yellow-bellied Sapsucker, sap wells where other birds forage for sap and the insects attracted to it. It should also be noted that the three other forest woodpecker species, the Downy Woodpecker, the Pileated Woodpecker, and the Northern Flicker all showed declines in abundance between 2010 and 2011 but not to extent that could be demonstrated as statistically significant.

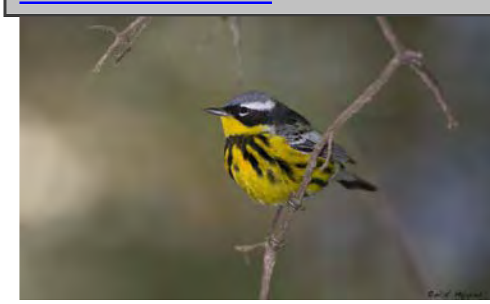
Breeding Status

The breeding status of bird species in the study area (including both the Phase 2 and Phase 1 lands) is shown in Table 12. The status classifications are those used by the Maritimes Breeding Bird Atlas, http://www.mba-aom.ca. In total, between 2007 and 2011, 93 breeding species were found in the study area of which 35 are confirmed breeders, 31 are probable breeders, and 27 are possible breeders.

Table 12: Breeding Status of Bird Species in the Study Area 2007-2011 (with hyperlinks to species information)

Species	Status	Species	Status
Wood Duck	Possible	Winter Wren	Probable
American Black Duck	Probable	Golden-crowned Kinglet	Possible
Green-winged Teal	Possible	Ruby-crowned Kinglet	Probable
Ring-necked Duck	Probable	Swainson's Thrush	Confirmed
Common Merganser	Probable	Hermit Thrush	Confirmed
Ruffed Grouse	Confirmed	American Robin	Confirmed
Spruce Grouse	Possible	Cedar Waxwing	Confirmed
Bald Eagle	Possible	European Starling	Confirmed
Osprey	Possible	Tennessee Warbler	Possible

Northern Goshawk	Probable	Nashville Warbler	Probable
Red-tailed Hawk	Probable	Northern Parula	Confirmed
Broad-winged Hawk	Possible	Yellow Warbler	Probable
American Kestrel	Probable	Chestnut-sided Warbler	Confirmed
Merlin	Possible	Magnolia Warbler	Confirmed
Wilson's Snipe	Possible	Cape May Warbler	Confirmed
American Woodcock	Probable	Black-throated Blue Warbler	Confirmed
Black-billed Cuckoo	Possible	Yellow-rumped Warbler	Confirmed
Mourning Dove	Probable	Black-throated Green Warbler	Confirmed
Great Horned Owl	Possible	Blackburnian Warbler	Probable
Barred Owl	Probable	Palm Warbler	Probable
Northern Saw-whet Owl	Possible	Bay-breasted Warbler	Possible
Chimney Swift	Possible	Black-and-White Warbler	Probable
Ruby-throated Hummingbird	Possible	American Redstart	Confirmed
Belted Kingfisher	Confirmed	Ovenbird	Confirmed
Yellow-bellied Sapsucker	Confirmed	Northern Waterthrush	Possible
Downy Woodpecker	Confirmed	Mourning Warbler	Confirmed
Hairy Woodpecker	Confirmed	Common Yellowthroat	Confirmed
Black-backed Woodpecker	Possible	Wilson's Warbler	Possible
Northern Flicker	Confirmed	Canada Warbler	Probable
Pileated Woodpecker	Probable	Rose-breasted Grosbeak	Probable
Olive-sided Flycatcher	Probable	Chipping Sparrow	Possible
Eastern Wood Pewee	Probable	Savannah Sparrow	Possible
Yellow-bellied Flycatcher	Possible	Song Sparrow	Confirmed
Alder Flycatcher	Probable	Lincoln's Sparrow	Confirmed
Least Flycatcher	Probable	Swamp Sparrow	Confirmed
Eastern Kingbird	Possible	White-throated Sparrow	Confirmed
Blue-headed Vireo	Confirmed	Dark-eyed Junco	Confirmed
Red-eyed Vireo	Confirmed	Red-winged Blackbird	Possible
Gray Jay	Confirmed	Rusty Blackbird	Confirmed
Blue Jay	Probable	Common Grackle	Confirmed
American Crow	Probable	Pine Grosbeak	Possible
Common Raven	Probable	Purple Finch	Confirmed
Tree Swallow	Confirmed	White-winged Crossbill	Possible
Black-capped Chickadee	Confirmed	Pine Siskin	Possible
Boreal Chickadee	Probable	American Goldfinch	Probable
Red-breasted Nuthatch	Probable	Evening Grosbeak	Probable
White-breasted Nuthatch	Probable		



Magnolia Warbler

Species of Special Conservation Concern

This section deals with two categories of birds deemed of special conservation concern. The first are three species classified as sensitive to human activities by the Nova Scotia Department of Natural Resources; the Northern Goshawk, Gray Jay, and Boreal Chickadee. The second category is those species listed in Schedule 1 of Canada's *Species at Risk Act* (SARA). These include the Chimney Swift (threatened), Olive-sided Flycatcher (threatened), Canada Warbler (threatened), and Rusty Blackbird (Special Concern).

The Northern Goshawk has not been detected during a breeding point count but it is a probable breeder on Phase 2 lands where it has been seen during spring diurnal passage counts. A total of 13 Gray Jays have been seen on breeding point counts on Phase 2 lands in 2008, 2010 and 2011 combined, with a mean of 0.03 per point count. A total of 41 Boreal Chickadees have been seen on breeding point counts on Phase 2 lands in 2008, 2010, and 2011 combined, with a mean of 0.11 per point count.

The Chimney Swift is a possible breeding bird on Phase 2 lands where a pair of birds was seen on one occasion in 2008 (see Figure 6), none in 2010, and again in the same place in 2011 (see Figure 8) when 3 birds were seen.

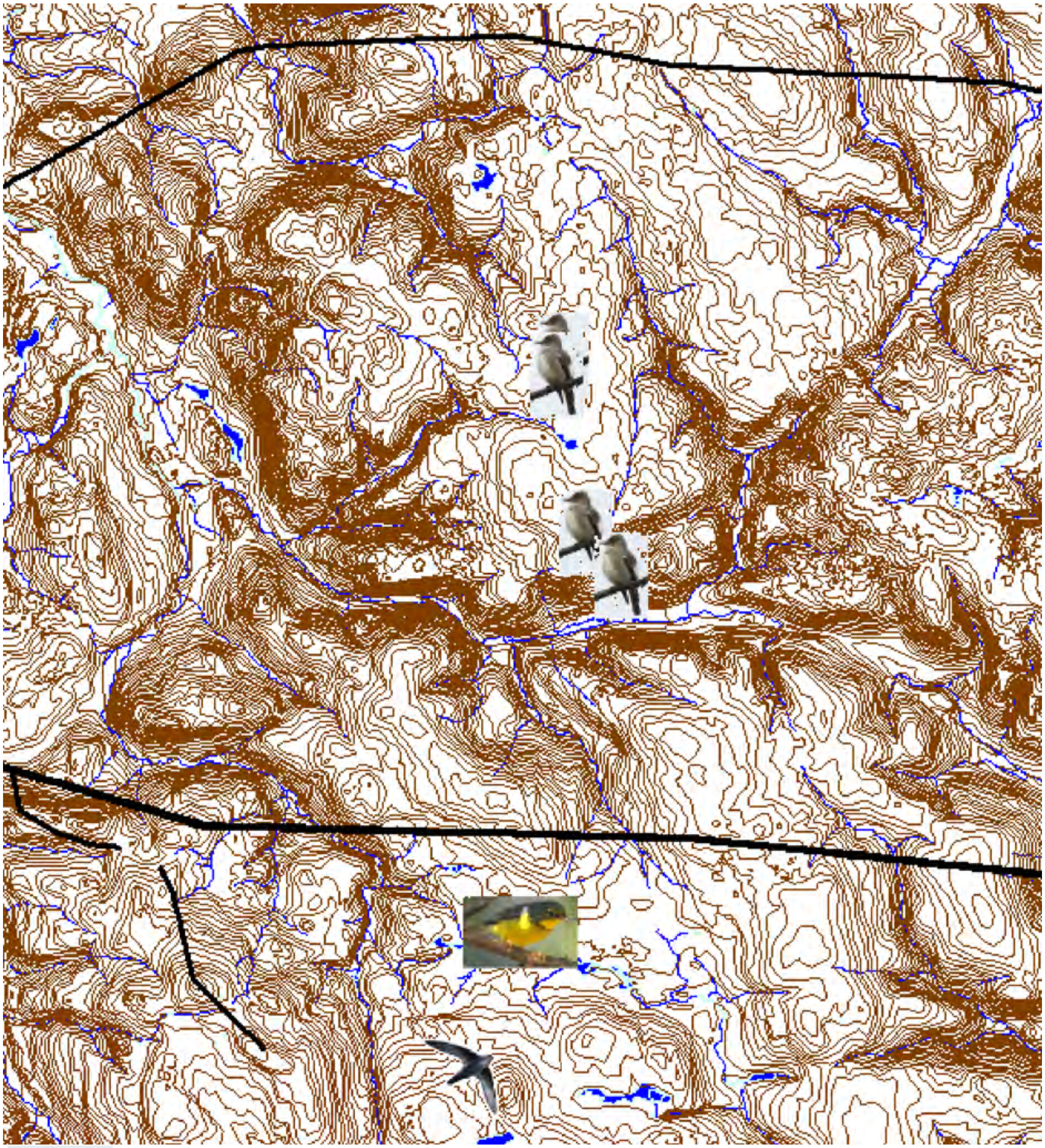
Olive-sided Flycatchers were possible breeders in four locations on Phase 2 lands in 2008 (see Figure 6), none were seen there in 2010, and 3 in 2011 (see Figure 8).

A pair of Canada Warbler (probable breeder) was seen in 2008 on Phase 2 lands but not in 2010 or 2011(see Figure 6).

Rusty Blackbirds were not seen in 2008 but were seen at three point counts in 2010 including one pair carrying food, making it a confirmed breeder (see Figure 7). Then in 2010, no Rusty Blackbirds were seen on the Phase 2 lands.

For those point counts where Canada Warblers, Rusty Blackbirds, or Olive-sided Flycatchers were seen in one year and not in a subsequent year, extra trips were made to those point counts and in some cases, recordings of their vocalizations were played.

Figure 6: Location of SARA Listed Species on Phase 2 Lands in 2008



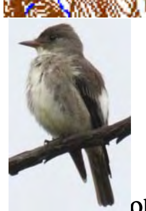
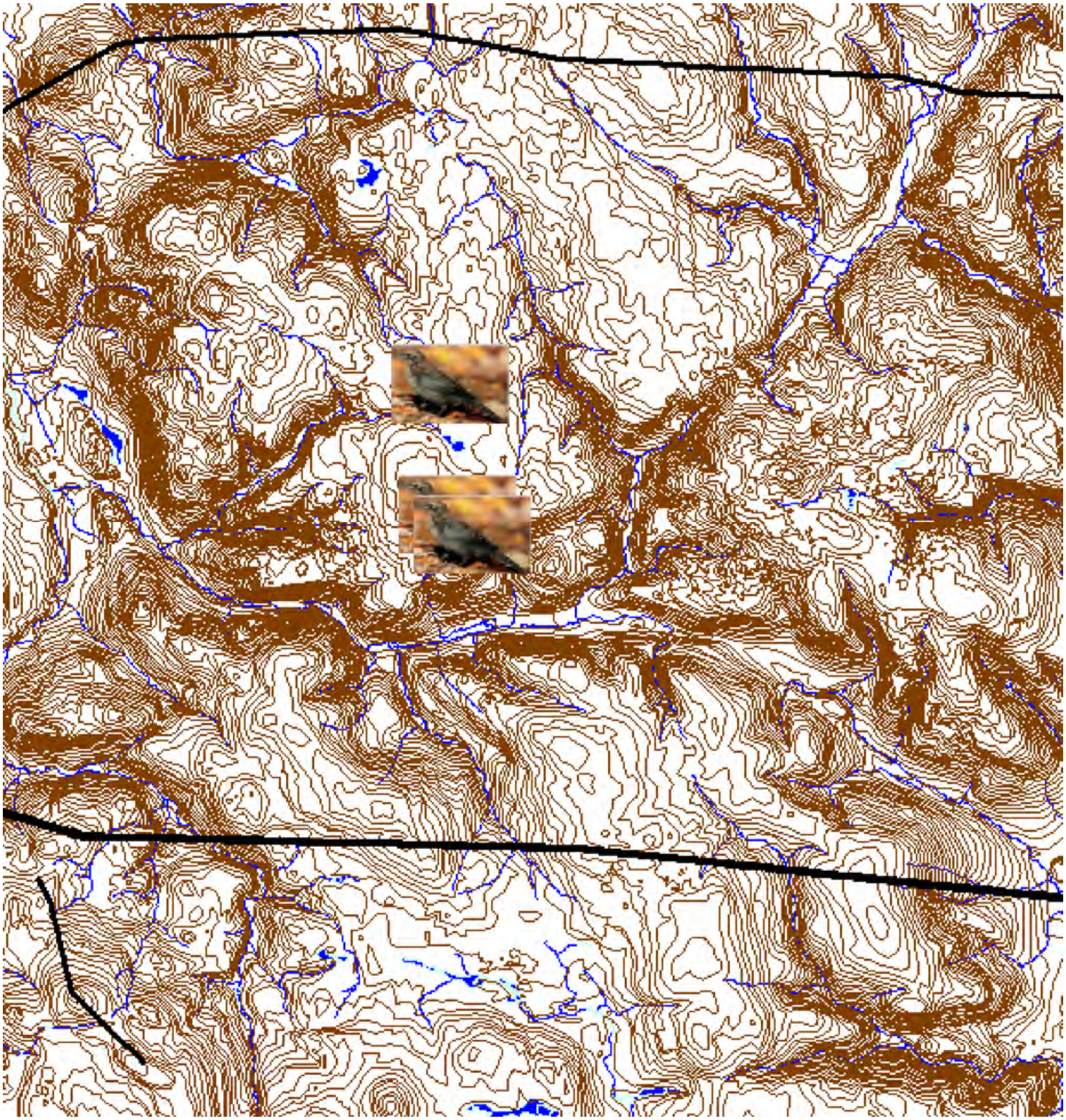
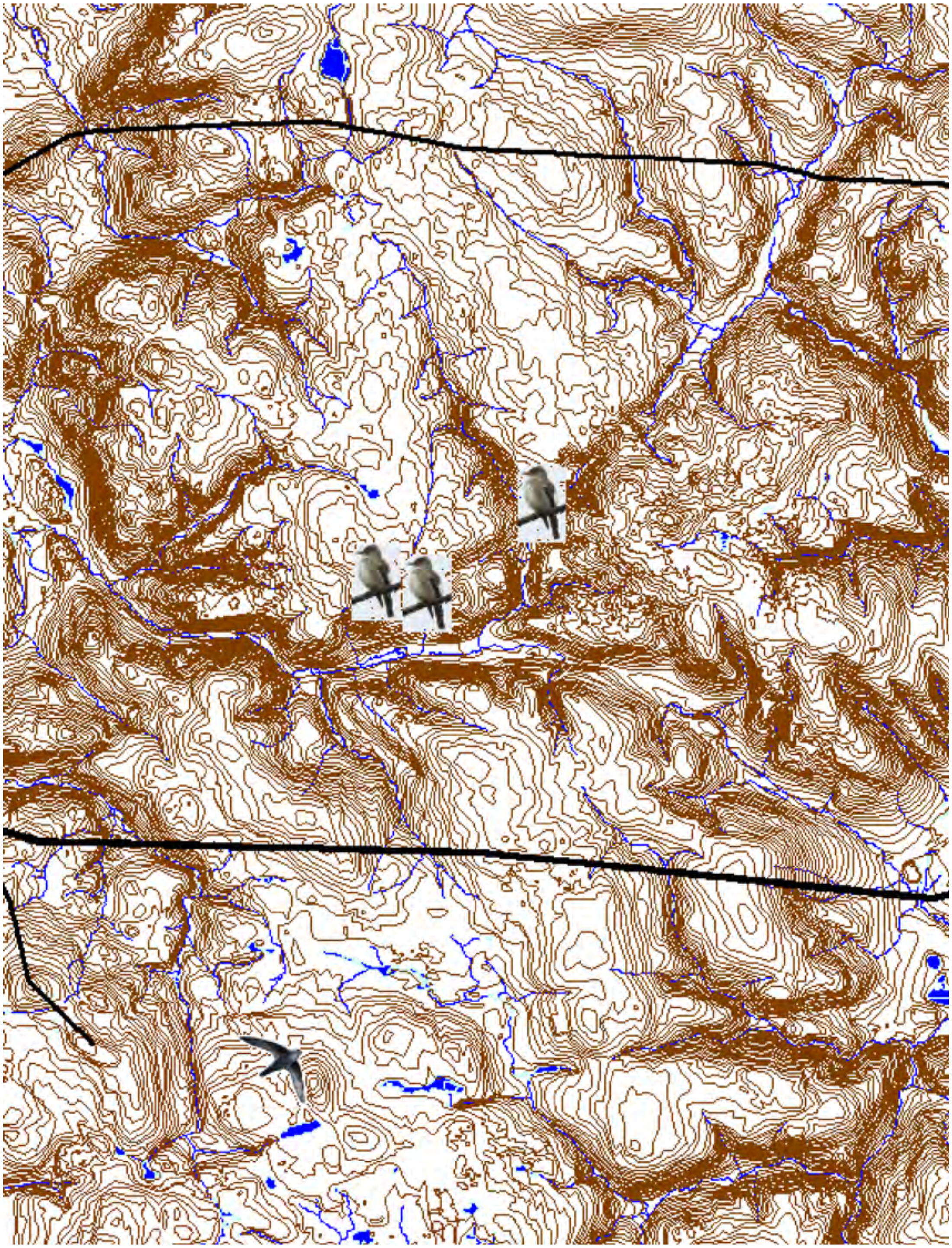
 Olive-sided Flycatcher  Canada Warbler  Chimney Swift

Figure 7: Location of SARA Listed Species on Phase 2 Lands in 2010



**Rusty Blackbird**

Figure 8: Location of SARA Listed Species on Phase 2 Lands in 2011



 **Olive-sided Flycatcher**  **Chimney Swift**

Conclusion

The updating of the Glen Dhu Wind Energy baseline study of 2007-2008 with the breeding bird surveys on Phase 2 lands in 2010 and 2011 provides a valuable expansion of the data available for this area. For the most part, the follow-up studies show little changes in the breeding bird populations of the Phase 2 lands with a few important exceptions.

The decline in woodpecker species from 2008 to 2011 warrants further study to confirm this finding, to study its possible causes if the trend is confirmed, and to explore possible remedial actions. It is recommended that desktop studies be conducted to determine if data from other sources support similar trends in adjacent areas or similar habitats and that construction and post-construction studies continue the breeding bird surveys on the Phase 2 lands in future years. In addition, since some woodpeckers are a particularly early breeding species, it is recommended that early breeding bird surveys be started in mid-April to better gauge the abundance of territorial woodpeckers when they are most detectable by their calls and drumming.

The combined follow-up studies in 2010 and 2011 also show that over one-third (35%) of the habitat of point count conducted in 2007 and 2008 had been affected by forestry by the time of the 2011 breeding bird season through road grading, construction, and tree harvesting. Of those point counts, 16% had been substantially or totally altered by clear-cutting.

In terms of wind energy development, the data from these two follow-up studies the Phase 2 lands will provide important control data in the analysis of the current Glen Dhu Wind Energy facility on the Phase 1 lands. This analysis will be the subject of a report to be completed in early in 2012.

Yellow-bellied Sapsucker

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