Does the Wind Power Industry Threaten Marbled Murrelets or Do Marbled Murrelets Threaten the Wind Power Industry?

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Abstract: Green energy is being promoted by governments, industry, and environmentalists as a method of reducing greenhouse gas emissions and slowing global warming. Wind-based power is a rapidly growing area of green energy production throughout the world as improved turbine technology and green energy credits continue to lower costs of wind-based energy production. In Canada, wind farm projects exist in several provinces. No wind farms have been constructed in British Columbia, but dozens of projects are currently proposed. About 40 wind farms are projected to be built in British Columbia in the near future. Proposed and potential projects span the length of the coast, and could result in several thousand wind turbines being built on at-sea and inland sites.

The risk of bird mortality from collisions with wind turbines receives the most attention of all potential impacts associated with wind farms. Collision mortality is a cause of concern for the general public and government, even though most studies indicate that bird mortality rates are very low. In British Columbia, the threatened marbled murrelet (*Brachyramphus marmoratus*) is the highest profile bird species with a potential to be impacted by coastal wind farms. Due to the behavior, timing, location, and frequency of its flight patterns, the marbled murrelet could be at risk of colliding with wind turbines if they are located within the species' flight paths.

Developing sources of green energy and conserving marbled murrelet populations are both priorities for Environment Canada. Almost all farms proposed for coastal British Columbia seem to have potential to kill marbled murrelets. Can the wind power industry proceed to develop the wind-based energy potential of coastal British Columbia and avoid conflicts with marbled murrelet conservation, or will conservation concerns for marbled murrelets slow or stop development of the wind power industry? Both sides of this issue are discussed, and general mitigation measures are suggested.

Key Words: marbled murrelet, *Brachyramphus marmoratus*, wind farm, green energy, bird mortality, British Columbia

Introduction

Green energy is widely touted by governments, industry, and environmentalists as a method of reducing greenhouse gas emissions and global warming. Wind energy, a power source that essentially did not exist 20 years ago, has become the first green, renewable energy technology to achieve a commercial breakthrough, leaving solar energy far behind. Over the last two decades, there have been tremendous improvements in turbine technology and power delivery systems which have reduced the cost of producing electricity from about 30 cents to about 6 cents per kilowatt hour. Further improvements will continue to drive that cost downward as the industry expands. On a global basis, wind power capacity is increasing at a rate of 30% per year, and has increased 5 fold since 1995.

Wind farms come in several forms ranging from a single turbine designed to power a single home to utility-scale projects with hundreds or thousands of wind turbines producing hundreds of megawatts of power. Within this range are wind farms that are being developed for structures such as the Freedom Tower, the building that is replacing the World Trade Centre in New York. Constructed on top of the Freedom Tower, the world's first building-integrated wind farm will be a vertical turbine system that will produce 2.6 megawatts of power, a significant proportion of the building's power needs (Village Voice 2004).

The wind energy industry is booming around the world. The most intensive wind power developments have been constructed in Germany, the United States, Spain, Denmark, and Sweden. Denmark now produces 20% of its power from wind. In the United States, dozens of wind farms have been built, and a multitude of new projects have been proposed. In 2001, U.S.$1.7 billion was spent in the United States on wind turbine installation (National Geographic Today 2002). The United Kingdom has just announced plans for 15 offshore wind farms to help meet increasing electricity demands over the next two decades (USDE 2004).

In Canada, the use of wind to provide electricity lags far behind many other countries. For example, our production accounts for only 2% of Germany's capacity (CCAREC 2002). Washington State alone has almost as much wind power capacity as Canada (CCAREC 2002). The largest project in Canada is a 100-megawatt (1 megawatt can power 350 homes) wind farm in the Gaspé region of Quebec. The second largest concentration of wind farms is in the Pincher Creek area of southern Alberta. Gull Lake, Saskatchewan hosts a 15-megawatt wind farm. A single large turbine has been erected in Toronto, and small numbers of turbines occur elsewhere. There are vast areas in Canada, especially in Newfoundland, Cape Breton, Prince Edward Island, the Great Lakes coastline, the southern Prairie provinces, and coastal British Columbia (B.C.), which have viable wind resources.

In 2001, the Canadian government established a 10-year $260 million incentive program for the wind power industry to encourage the development of wind power. About 1500 wind farms are projected to be built in Canada in the near future (CCAREC 2002). TransAlta Corp., the Alberta electrical utility, recently said it will invest up to $2 billion on wind farms over the next decade. In Manitoba, Shell Canada plans to build a 100-megawatt wind farm on southern farm lands (Winnipeg Free Press 2003).

No wind farms currently exist in British Columbia, but dozens are now proposed for the coast. Several at-sea wind farms have been proposed for sites such as James Island, Roberts Bank, Quadra Island, and off Graham Island. Many on-land wind farms have been proposed, mainly on the coast from central Vancouver Island north to Prince Rupert, but also in the interior in the Okanagan, Rocky Mountains, and other areas. About 40 wind farms, which will potentially include several thousand wind turbines in total, are projected to be built in British Columbia in the near future (CCAREC 2002). So make no mistake about it, the development of wind power in British Columbia and Canada is coming soon.

The coast of British Columbia, part of the Pacific Flyway, is home during various seasons to many millions of breeding seabirds, migrating and wintering waterfowl, migrating and breeding neotropical songbirds, and other migratory, wintering, and breeding birds. Some of these species have been designated as Species at Risk, and are protected by the federal *Species at Risk Act* (SARA). SARA is designed to protect wildlife at risk from becoming extirpated in the wild. All species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Threatened, Endangered, or Extirpated, including the marbled murrelet (*Brachyramphus marmoratus*), and their critical habitats, are covered by SARA. In addition, species on the B.C. Red List are covered by SARA.

Several concerns about wind farms are commonly expressed (e.g., Preserve Malpeque 2002 [Prince Edward Island]; Save Our Sound 2003 [Massachussetts]). Many concerns are related to aesthetics and impacts on lifestyle or property values; few people want to have their viewscape impeded by wind turbines. Other concerns include possible negative impacts to tourism, possible noise effects, possible collapse and malfunction of turbines, alienation of land for other uses, subsidies required to develop projects, and potential impacts to wildlife.

Wildlife issues are related mainly to potential bird and bat mortality from collisions with turbines and associated structures, alienation of habitats traditionally used by wildlife, and direct footprint effects or loss of habitat (NWCC 1999). The debate about the cumulative cost to wildlife from wind farms is heightening as more projects come on line and cumulative impacts are assessed. Potential risks to marbled murrelets are of especially high concern to regulatory agencies because marbled murrelets are the highest profile SARA-protected bird species on the B.C. coast.

Bird Mortality Risk from Wind Turbines: A Background

Avian mortality from collisions with wind turbines has been widely recognized as the most significant potential adverse impact to wildlife from wind farms (NWCC 1999; CCAREC 2002; Kingsley and Whittam 2002), although potential impacts on bats have recently been highlighted (Keeley et al. 2001; Windpower Monthly 2003). Concerns about turbine-related avian mortality stem largely from older generation wind farms in California and Spain where mortalities reported were relatively high and the species affected were of a high profile. The Altamont Pass, California wind farm has approximately 6500 wind turbines on 190 km^2 of rolling grassland east of San Francisco Bay (Hunt et al. 1998). Approximately 1500 birds are killed there annually, over half of which are raptors (overall rate of 0.23 fatalities/turbine/year [Thelander and Rugge 2001]).

At San Gorgonio Pass, California, a facility with 2700 turbines located along the Pacific migratory flyway, bird mortality was estimated at 3900–6900 fatalities annually (1.4 to 2.5 fatalities/turbine/year [McCrary et al. 1983]).

Reported mortality rates for birds at almost all wind farms are low, averaging 2.19 fatalities/turbine/year (Moorehead and Epstein 1985; PGEC 1986; Haussler 1988; BSA 1990; Orloff and Flannery 1992; Colson and Associates 1995; Anderson et al. 1998; NWCC 1999; Erickson et al. 2001, 2002, 2003; Johnson et al. 2002; Kingsley and Whittam 2002; Thomas 2003). Most studies seem to reach the same conclusion: impacts are not likely to be significant if wind turbines are located in areas of poor habitat and low bird densities, and in areas without significant populations of susceptible species of high conservation importance (Kingsley and Whittham 2001).

Wind Farms and Bird Mortalities: A Relative Perspective

The potential risk of bird mortality from wind turbines should be kept in perspective. Studies at most wind farms have detected minimal or very low levels of mortality (Moller and Poulsen 1984; Kirtland 1985; NWCC 1999; Erickson et al. 2001, 2002, 2003; Johnson et al. 2002; Kingsley and Whittam 2002; Thomas 2003). The total annual avian mortality has been estimated at being in the 'low thousands' (Kerlinger 2001), but this would be expected to increase as numbers of turbines increase. If all of the United State's annual electricity demand of approximately 770 gigawatts was met with wind power, it could be extrapolated that turbines would cause 4.4 million bird deaths annually (Bradley 1997). This estimate is dwarfed by estimates for other collision-associated bird mortalities: vehicles, 60–80 million/year; buildings, 100 million to 1 billion/year; power lines, up to 174 million/year; and communication towers, 4–5 million/year (Erickson et al. 2001; Kerlinger 2001). In addition, bird mortalities by feral and domestic outdoor cats were estimated on the order of hundreds of millions of birds per year (ABC 2001; Kerlinger 2001). One study estimated that in Wisconsin alone, annual bird mortality by rural cats ranged from 7.8 to 217 million birds/year (Coleman and Temple 1995).

There are no reports of single event mass kills of birds at any wind farm anywhere in the world (Erickson et al 2003). In contrast, mass kills are regularly reported from communications towers. In one recent example, 5000–10,000 songbirds were killed in one night at a communications tower site in Kansas (USFWS 1999).

It is generally agreed that the effect of mortality caused by wind farms is probably not significant to populations unless the individual birds killed belong to an endangered species (Ultrasystems, Inc. 1985; ABAG 1987; Crockford 1992; Howell and Noone 1994; Colson and Associates 1995, NWCC 1999; Erickson et al. 2002; Kingsley and Whittam 2002); however, if populations are very small or localized, negative impacts have the potential to significantly affect populations.

Key Factors Associated with Potential Bird Mortality at Wind Farms

Several factors influence the potential for bird mortality to occur at wind farms: location or siting, scale or size of the project, turbine design (tower design, tower height, blade size and rotation speed), turbine arrangement, lighting requirements, and others.

Location

The location of the wind farm site is the key factor influencing the rate of bird collision mortality. The consensus is that wind farms should avoid important bird areas such as sanctuaries for endangered species, wetlands, hunting areas for raptors, staging areas for migrants, or other areas frequented by large concentrations of birds (Lawrence and Strojan 1980; Medsker 1982; McCrary et al. 1983; Sadler et al. 1984; Colson and Associates 1995; Erickson et al. 2002; Kingsley and Whittam 2001, 2002). If endangered species are exposed to risks from wind farms, then the potential impacts on those species will likely be more severe than for more common species (Kingsley and Whittam 2002).

Scale

Logically, larger facilities will have greater potential impacts than smaller facilities. Increasing the number of turbines at a site increases the collision risk for birds and bats, regardless of location (Kingsley and Whittam 2002).

Turbine Design

Modern large turbines with slower rpms (12–20 rpm) have proven to have much lower rates of bird strike mortality than older generation, high-rpm (50–200 rpm) turbines (Erickson et al. 2002). High levels of raptor mortality reported for two wind farms in California, described briefly above, were mainly the result of large numbers of high-rpm turbines being placed in areas of high raptor use (Orloff and Flannery 1996). These studies continue to be cited, erroneously, as key evidence of environmental costs associated with current wind farm projects (e.g., LA Times 2003), even though improved turbine technology and improved knowledge of siting issues have solved most of the factors associated with those high rates of mortality.

Lighting

Numerous studies have proven that lights on tall towers can attract and cause the death of many birds. Lights attract birds, especially songbirds, and mass kills of thousands have been documented, mainly at communications towers (Kemper 1996; USFWS 1999); however, no mass mortalities have been documented at wind farms (Kingsley and Whittam 2002, Erickson et al. 2003). Birds are more responsive to red and infrared spectrums than to white light. Under conditions of poor visibility, blinking red marker lights appear to disorient birds, perhaps because they simulate stars, which birds use as navigational cues (Ugoretz 2001). Typically, birds navigate by orienting themselves at right angles to lights, which produces the circling masses of birds observed around lighted towers, as reported by Kemper (1996) and others.

Transport Canada requires that any obstruction more than 90 m above ground level within two nautical miles of a Visual Flight Rules route be marked with a flashing red beacon mounted at the highest practical point (Kingsley and Whittam 2002). To reduce nocturnal mortalities of birds, the U.S. Fish and Wildlife Service (2000) recommends that solid red or pulsing red lights be avoided, that white or red strobe lights be used, and that intensity of strobes and number of lights be minimized. The risk of lights attracting flying birds will be minimized if the least number of lights with the least attractive characteristics (colour and intensity) to birds that are allowed by Transport Canada are used.

Marbled Murrelet

In British Columbia, one species, the marbled murrelet, is the highest profile bird species that has potential to be impacted by coastal wind farms. Marbled murrelets nest throughout most of coastal British Columbia (Campbell et al. 1990), and their numbers are estimated to range from 55,000 to 78,000 (Burger 2002). The species has been listed as Threatened by COSEWIC (2004), and is red-listed in British Columbia (B.C. CDC 2004), mainly because its population is assumed to be declining due to the harvesting of old-growth forests which the species depends on for nesting habitat. Other threats to the species include oiling at sea, increased predation rates at nests due to habitat fragmentation, and global warming. A Marbled Murrelet Recovery Team is in place in Canada, and recovery actions are underway (Canadian Marbled Murrelet Recovery Team 2003).

Risk Factors for Marbled Murrelets

Since birds are known to collide with turbines, it is logical to assume that turbines present a risk to marbled murrelets. Because adult survivorship is the main driver of murrelet population stability (Nelson 1997; Burger 2002), the potential loss of adult murrelets is of particular conservation concern, especially when considering the cumulative effects associated with a new mortality risk.

Marbled murrelets are unique among seabirds because they nest in trees in old-growth forests and forage at sea (Nelson 1997). Marbled murrelets make regular flights from nesting areas to foraging areas throughout the year, but there are strong peaks in movements during the breeding season, mainly May through July (Manley et al. 1992; Rodway et al. 1993; Nelson 1997).

Murrelets tend to fly up coastal inlets, then access inland areas through valleys or gaps in ridgelines. Near their nesting stands, they tend to fly low over the forest canopy, often circling before entering the canopy (Nelson 1997). These flights would, at times, be within a height zone (30–100 m) that would coincide with the height of turbine blade rotation.

Marbled murrelets are among the fastest birds that fly over forests in coastal British Columbia. Their flight speeds over the forest are usually greater than 70 km/hr, and regularly exceed 100 km/hr when flying downhill (Burger 2001); consequently, they might be less likely than slower-flying forest birds to avoid collisions with towers and transmission lines. Additionally, flights to and from nesting areas occur mainly near dawn and dusk with peak activity occurring well before sunrise (Manley et al. 1992; Burger 2001) when light levels are low. Ridgetops are frequently enshrouded in cloud, mist, or drizzle, which would further reduce visibility of the turbines.

Possible Mitigating Factors for Marbled Murrelets

Marbled murrelets apparently have good vision under low light levels since they can access nests in high forest canopies in low light conditions and in fog and rain. This behavioral trait likely gives murrelets some ability to avoid turbines and other solid structures. Although it is not known if murrelets can detect rotating turbine blades, it seems likely they could do so to some extent given the slow rpm of the turbine blades. It is less likely that murrelets could detect associated transmission lines because the lines are thin and difficult to see. Additionally, marbled murrelets are unlikely to nest on ridges or plateaus proposed for most wind farms as these sites are usually either logged or have small stunted trees.

Risk Factors for Industry

Opposition to wind farms near urban areas, mainly due to NIMBY (Not in My Back Yard) attitudes, has led to development proposals being made for remote areas that have relatively few birds; however, marbled murrelets and other species at risk may occur in those areas. More than 60 Important Bird Areas have been established on the British Columbia coast, some of which span hundreds of square kilometers (Bird Studies Canada 2004). The establishment of these areas, and the presence of existing parks and ecological reserves on the B.C. coast has meant that many windy, remote areas are essentially not available for the construction of wind farms.

Marbled murrelets are arguably the highest profile bird species on the British Columbia coast. Concern for the species dominates regulatory agency concern for wildlife at many proposed land-based wind farms. Under SARA, killing of listed species by a corporate entity can result in legal prosecution and fines of up to $1 million. Legal liability for contravention of the Act remains untested, and uncertainties around this issue provide considerable concern for industry.

The Conundrum

Developing sources of green energy and conserving marbled murrelet populations are both priorities for Environment Canada. The negative effects on future bird populations of not adopting alternate renewable energy strategies, such as wind power, are potentially enormous. Global climate change is predicted to result in countless bird deaths through large-scale alteration of breeding habitats (Gates 1993), and has, indeed, been cited as a cause of decline of some seabird populations, including some in British Columbia (e.g., Hipfner et al. 2002). Additionally, traditional migratory stopovers could be affected by climate change if bird migration periods are no longer synchronized with maximum food production times.

No wind farms currently exist within the marbled murrelet's core range, so there are no studies to refer to regarding their effects on the species. Almost all proposed wind farm projects in coastal British Columbia could potentially lead to increased mortality of marbled murrelets because the planned developments occur within the species' range. Current environmental assessments of proposed coastal wind farms focus much of their attention on marbled murrelets (e.g., Beauchesne and Cooper 2003; Cooper et al. 2003; Cooper 2004). Can the wind power industry proceed to develop the wind energy potential of coastal British Columbia and not suffer consequences under the *Species at Risk Act*? Uncertainties around this issue and the Act provide considerable concern for industry.

How the Wind Industry Can Minimize Risk to Marbled Murrelets and All Birds

Potential risks to marbled murrelets and other birds from the development of wind farms can be minimized through the following measures:

- locating wind farms away from concentrations of birds, including marbled murrelets, to reduce potential risk of mortalities;
- avoiding areas with important numbers of bird species at risk;
- avoiding locations with significant marbled murrelet flight paths and adjacent nesting habitat;
- implementing other mitigation measures such as using the most appropriate turbine design, minimizing lighting, concentrating turbines to increase visibility, and routing transmission lines below ridgelines and below treetop level;
- monitoring actual impacts to marbled murrelets and using adaptive management strategies to reduce risks to them; and
- using existing clearcut or barren ridges rather than clearing old forests to build wind farms.

How the Regulatory Agencies Can Promote Bird Conservation and Green Energy

Regulatory agencies can promote both bird conservation and the development of green energy through following measures:

- protecting bird populations, marbled murrelets, and other species at risk from unwarranted risk;
- reconciling the global need for green energy alternatives to fossil fuels with acceptable levels of risk to marbled murrelets and other birds;
- identifying wind resource areas that can be targeted for development of wind farms, similar to the 'working forest' policy for the forest industry in British Columbia;
- clarifying their intent with respect to the *Species at Risk Act* by asking questions such as "Do studies and decisions conducted in good faith by industry during the Environmental Impact Assessment process provide industry with some measure of defence if marbled murrelets and other species at risk are inadvertently killed by industrial developments?"; and
- establishing thresholds for unacceptable risk, and providing industry with firm numbers or rates of mortality that might trigger legal action so that industry can evaluate their business risk.

Conclusions

Wind farms need to be built and monitored to determine the actual risk of mortality they pose to marbled murrelets. Special monitoring techniques may be necessary to accurately estimate impacts to murrelets. Results of monitoring studies can then be used to predict potential impacts of future wind farms on the species. A cumulative effects assessment of potential coast-wide mortality associated with wind farms can then be made, and, hopefully, feasible management regimes can be implemented that will allow wind farm projects to proceed without significant impacts to marbled murrelet populations.

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