Maryland Ornithological Society's Policy Statement on Alternative Energy Development in the State of Maryland
by
The MOS Ad Hoc Committee on Alternative Energy

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FOREWORD

Chairperson's Comments:

During autumn of 2008, the *Ad hoc* Committee on Alternative Energy was convened by the President of MOS, Dr. Wayne Bell, for the purpose of preparing a policy statement that could be used by the Society to allow for its participation as a well-prepared stakeholder in the development and deployment of alternative energy in the State of Maryland. What ensued was an in-depth discussion between members of the committee and other contributors on the potential impact of alternative energy technologies on bird health and bird habitat which culminated, over two years later, in the drafting of this document. While it is recognized that this policy statement is far from being complete, in that it does not discuss certain alternative energy modalities such as wind power, biomass and biofuels, this document represents a foundation on which MOS can anchor its discussions with other stakeholders involved in the deployment of alternative energy modalities in the State of Maryland.

As the development and deployment of alternative energy modalities in Maryland is a dynamic process, so too this policy statement must also be dynamic. In fact, this policy statement should be considered to be a "living document" that will be revised and/or appended, when necessary. For example, it is expected that before the end of 2011 an addendum addressing wind power will be added to this policy statement. The committee recognizes the contentious nature of the discussion regarding wind power in the birding and ornithology community and, therefore, has decided that it is prudent to further deliberate before issuing a document addressing wind power. The complexities of ridge-top, land and off-shore wind power will require a thoughtful assessment of the risks and benefits with regard to bird health and habitat.

This document is divided into two main sections, the Executive Summary and the in-depth discussions of the effect of each alternative energy modality on bird health and bird habitat. Following each in-depth discussion is a list of references and further reading material for the interested reader. It was the intention of the committee to not only provide a statement of policy, as is found in the Executive Summary of this document, but to also set this policy in an evidence-based framework so that a logical and well-informed discussion of the MOS policy on particular alternative energy modalities could be held with other stakeholders, including industry, government and other conservation societies.

It is my sincere hope that this document will serve as an important guide for the members of MOS as we actively engage in the conversation regarding Maryland's efforts to decrease our reliance on fossil fuels while responsibly deploying alternative energy technologies. As a community of avid birders and ornithologists, we must remain engaged in this process to ensure that the interests of birds, and the habitat that supports them, is always considered in the alternative energy conversation in Maryland.

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Maryland Ornithological Society Policy Statement on Alternative Energy Development in the State of Maryland
June 4, 2011

Executive Summary:

Since its inception in 1945, one of the central tenets of The Maryland Ornithological Society (MOS) has been to promote knowledge, appreciation and conservation of Maryland's avian species and the natural resources necessary for their support. Reaffirmed in 1998 by the MOS Board of Directors in the MOS Mission Statement, it is crucial that MOS apply this tenet to the current dialogue regarding the development of alternative energy sources in the State of Maryland.

To both decrease the acceleration of global climate change, caused, in part, by the combustion of fossil fuels, and to increase domestic energy security, Maryland, and the United States as a whole, have initiated parallel strategies to increase the production of energy from alternative sources. Maryland's Renewable Portfolio Standards (RPS), as this legal mandate is referred to, currently calls for 20% of the electricity to be sold in the State of Maryland to come from renewable sources that are installed within or adjacent to the PJM grid region by the year 2022. In addition, Maryland, through the Regional Greenhouse Gas Initiative (a cap and trade program) and the MD Energy Efficiency Resource Standards, has pledged to reduce CO_2 emissions associated with the electric industry as well as to decrease per capita use of electricity, within the next two decades. To meet these goals, robust development and deployment of alternative energy modalities will be necessary in the State of Maryland. As these goals will help to both mitigate the impact of global climate change and increase domestic energy security, MOS firmly supports the responsible development of alternative energy in the State of Maryland.

As is the case for classic forms of energy such as coal and petroleum, development and operation of alternative energy modalities in Maryland are expected to have an impact on birds and the natural resources required to support them. Accepting this fact, it is important that the development of alternative energy in Maryland is done in a manner that minimizes the impact on birds and their habitat. Therefore, MOS has developed this policy statement to provide clear guidance on the responsible development of alternative energy sources in Maryland.

Specifically, the following represents a summary of the official policy of the Maryland Ornithological Society, as approved by the MOS Board on June 4, 2011, regarding the development of alternative energy in the State of Maryland:

- MOS considers anthropogenic global climate change to be one of the greatest threats to avian health and habitat. Therefore, MOS considers the reduction of greenhouse gas emissions, as detailed by international bodies such as the U.N. Intergovernmental Panel on Climate Change, to be the ultimate action to protect avian health and habitat from the effects of global climate change.
- MOS considers prevention of habitat fragmentation and loss, protection for migratory and indigenous bird species, protection of ecosystem services and ecosystem health, and the preservation of Critical Habitats and Important Bird Areas to be critical elements of responsible energy development in the State of Maryland.
- MOS supports both a major reduction in Maryland's dependence on coal for the production of electricity and a transition to an energy profile which emphasizes

alternative energy sources that exert minimal or controllable impacts on bird health and bird habitat.

- MOS supports an increase in the deployment of decentralized or "on-site" energy sources (e.g., structure-mounted solar panels, geothermal heat pumps) that would reduce the reliance on transmission wires.
- MOS expects that utility companies involved in the transmission of electricity via transmission wires to develop and adhere to an effective and comprehensive Avian Protection Plan (APP) as described by the Edison Electric Institute and US Fish and Wildlife Service.
- MOS considers nuclear power an acceptable energy source and fully supports the responsible expansion of the Calvert Cliffs Nuclear Power Plant.
- MOS does not consider centralized, industrial photovoltaic or concentrated solar power solar arrays to be acceptable sources of alternative energy in Maryland due to the large land area that would be required to compensate for the low insolation conditions that exist in Maryland. However, the use of residential photovoltaic or solar hot water systems that are mounted to existing structures is encouraged.
- MOS supports the installation and operation of closed loop and direct-return, open-loop ground-source heat pumps. Due to the potential for groundwater depletion, MOS does not support the use of open-loop ground-source heat pumps that contain a surface discharge component.
- MOS opposes the *de novo* construction of hydroelectric dams. However, the conversion of existing dams to hydroelectric power plants is considered a prudent use of these structures. MOS supports the responsible maintenance and relicensing of the Conowingo dam, due to the importance of the Conowingo reservoir as a habitat for bird species in Maryland.
- MOS supports the development of tidal and wave energy in Maryland with the caveat that concurrent research and monitoring programs on the impact of these technologies on bird health and bird habitat be implemented. MOS does not support the construction of tidal barrages and it is reluctant to support the construction of tidal fences and tidal lagoons.
- Until such time that vigorous recycling programs and per capita reduction in trash production result in a significant reduction in the deposition of municipal solid waste (MSW) to landfills, MOS supports the use of MSW as feedstock in responsibly-operated waste-to-energy programs in the state of Maryland.

Since the development and deployment of alternative energy modalities in the State of Maryland is expected to be a dynamic process, this document will be updated on a regular basis in order keep pace with the emerging environmental issues associated with alternative energy development, as they pertain to avian health and avian habitat. In addition, an addendum to this document detailing MOS's position on the development of wind power and generation of electricity from biomass will be issued by the end of 2011 or early 2012.

Introduction:

Energy generation is crucial to maintaining and improving the modern American lifestyle. Recently, however, a renewed dialogue has commenced in the United States on maintaining the production of plentiful and dependable energy by increasing our reliance on non-traditional or alternative forms of energy. This dialogue is mainly driven by a quest for domestic energy independence [1] and the crucial need for reduction of greenhouse gas (GHG) emissions, an established cause of global climate change [2]. While it is known that production of traditional fossil fuel-based energy often comes at great cost to our environment, it is expected that all alternative energy sources will also possess a spectrum of environmental impacts. Specifically, it is expected that birds and bird habitat will be impacted by the development of alternative energy sources.

In the absence of a comprehensive review of the impact of these alternative energy sources on Maryland birds and bird habitat, the Ad Hoc Committee on Alternative Energy was assembled by the Maryland Ornithological Society (MOS) in the Fall of 2008 to perform an in-depth examination of this issue. The intent of this committee was not to champion a specific form of alternative energy in the State of Maryland. Rather, it was the goal of the committee to objectively examine the current state of knowledge of the impact of alternative energy production on bird health and bird habitat. Specifically, the Committee focused on alternative energy sources that will be used to generate electricity in the State of Maryland. Although they are expected to have impacts on bird health and bird habitat, energy sources for transportation, such as biofuels, will not be reviewed in this policy statement. However, it is possible that a future addendum to this policy statement will address the issue of transportation fuels. In addition, due to the complexity of the issues surrounding their deployment, wind power and facilities that use biomass to generate electricity will also be addressed in a forthcoming addendum to this policy statement.

With the caveats listed previously, this policy statement serves as a review of the alternative energy modalities expected to be deployed in Maryland. In addition, it offers recommendations for the development of alternative energy sources for the production of electricity in the State of Maryland in a way that protects bird health and bird habitat.

Conservation:

The Maryland Ornithological Society (MOS) is a nonprofit, statewide organization of people who are interested in birds and nature. Founded in 1945 and incorporated in 1956 to promote the study and enjoyment of birds, MOS promotes knowledge of our natural world and fosters the appreciation and conservation of not only birds, but all natural resources. The Society also maintains a system of sanctuaries to encourage the conservation of birds and bird habitat, and records and publishes observations of bird life.

Because a central purpose of the Maryland Ornithological Society (MOS) is to promote knowledge, appreciation and study of birds and bird habitat, MOS therefore supports the conservation of birds, the protection of habitats of birds, and the conservation of natural resources necessary for their support.

MOS recognizes that the development of energy resources and the production of both traditional and alternative forms of energy have an inevitable impact upon the natural environment. As a general policy, MOS recommends that the development of both traditional and alternative energy sources be accomplished with the minimum impact possible to birds and the habitats of birds. MOS's conservation priorities for the protection of birds and bird habitats include but are not limited to:

- Prevention of habitat loss and habitat fragmentation--MOS has particular concern for the fragmentation of contiguous forests which lead to the degradation of forest interior bird habitat
- Protections for migratory and indigenous bird species—MOS has concern regarding both the direct and indirect environmental impacts of energy development and production on both migratory and indigenous species
- Protection of ecosystem services and ecosystem health—MOS supports the conservation of existing ecosystems including forest, grassland, riverine, estuarine, marine, and other ecosystems. Concerns extend to protection of water quality; air quality, vegetative health, prevention of invasive species, soils, and other components of ecosystems that contribute to the health and vitality of birds and the natural systems in which they live.
- Critical Habitats and Important Bird Areas--MOS believes that special caution should be taken in the development of traditional and alternative energy sources in areas of special concern for birds including but not limited to Critical Habitat areas and Important Bird Areas (IBA's), and in the development of any energy projects that would affect rare, threatened, or endangered species (RTE's), and other species in need of conservation, and for those bird species in habitats of special concern.

As a matter of policy, MOS supports the development of alternative energy sources, especially renewable energy sources, as a means of moving beyond dependence on fossil fuels. However, MOS recognizes that even the development of alternative energy sources may have negative environmental impacts on birds and bird habitat, and therefore takes the position that the net benefits to be gained by development of alternative and renewable energy sources over fossil fuel energy resources are not sufficient cause for relaxation or streamlining of environmental regulations or law.

Upon careful consideration of alternatives and upon cost/benefit analysis, MOS agrees that in some cases, carefully planned and monitored mitigation can ameliorate impacts of the development of alternative energy sources. MOS supports the mitigation of all negative impacts to the fullest extent possible.

In addition, as a matter of conservation policy, MOS supports the promotion of sustainable development strategies including but not limited to, the development of eco-districts; promotion of sustainable, livable communities strategies; development of public/private partnerships that result in land conservation, employment of adaptation and mitigation strategies to address climate change conditions, land use plans that promote protection of natural resources and conservation of birds and bird habitat; and formation of strategic and regional partnerships with other local, state, regional, and national conservation organizations.

MOS notes that although this Policy Statement is intended to primarily address the development of alternative energy in Maryland, the conservation ethics and policy positions of MOS regarding the protection of birds and bird habitat and the conservation of natural resources know no geographical boundaries.

MOS fully supports programs that encourage energy conservation measures by individuals, businesses, and government entities. MOS supports the principle that every individual, family, business, and government agency can adopt simple, available techniques to reduce power use, thereby improving energy conservation and reducing demand at the same time.

Simple practical measures include, but are not limited to, those practiced in the home such as turning off lights, idle machinery, and other equipment; drying clothes on a rack or line; limiting driving by combining errands, sharing rides, telecommuting, using public transportation, and other energy conserving measures. Families and businesses can reduce energy demand by improving building insulation; insulating water heaters; and installing energy-efficient windows as well as by replacing inefficient lighting, appliances, computer monitors, and other devices with more energy-efficient substitutes.

MOS supports land conservation strategies that will increase energy efficiency and contribute to more livable, sustainable communities. Planting trees and shrubs to protect buildings from temperature extremes, increasing urban forest canopy cover, day-lighting strategies, and application of energy conservation techniques in the design and construction of new buildings or refurbishing of existing structures.

This is just a sampling of conservation suggestions; many more methods have been published online by the U.S. Department of Energy (http://www.energysavers.gov), the U.S. Environmental Protection Agency (http://www.fueleconomy.gov), Baltimore Gas and Electric Company (http://www.bgehome.com/energy_saving_center.php), the US Green Building Council (http://www.usgbc.org/), the Sustainable Sites Initiative (http://www.sustainablesites.org/), and many other organizations and government entities.

Decreasing Our Dependence on Coal:

Greater than 60% of the electricity consumed in Maryland is produced through the combustion of traditional fossil fuels, such as coal (60%), natural gas (5%) and oil (0.5%), in power plants situated in the State of Maryland and neighboring states [3]. While coal is an efficient and reliable source of energy, its combustion contributes to the generation of regional and global environmental problems. There are three main characteristics of coal that impact on bird health and habitat, 1) mining techniques, 2) coal combustion emissions and 3) disposal of remaining ash. Although only 35% of coal produced in the Mid-Atlantic region is via surface mining techniques [4], such as mountain top removal, this activity has resulted in destruction of critical habitat for birds such as the Cerulean Warbler [5]. However, it is important to recognize that not all mining activities have permanently negative impacts on bird habitat. Specifically, reclaimed strip mines have provided for restoration of nesting habitat for the Golden-winged Warbler and Henslow's Sparrows. Second, coal combustion emissions are known to cause regional environmental problems, such as acid rain, ground level ozone and mercury dispersal, and global problems, such as global climate change [2, 6]. These regional and global effects precipitated by the emissions of fossil fuel combustion, such as coal, are known threats to bird habitat and health [7-10]. Finally, the material which remains after the combustion of coal consists of toxic components, such as heavy metals, that are known to negatively impact health. Although there are few studies specifically examining the impact of coal ash on bird health, these toxic remnants of coal combustion are concentrated and stored in impoundments that are susceptible to groundwater seepage and bursting which may pose a threat to waterways and other habitat [11-12]. It is clear from these examples that the impact of the use of coal for energy production on bird health and bird habitat is substantial. Therefore, MOS supports both a major reduction in Maryland's dependence on coal for the production of electricity and a transition to an energy profile which emphasizes alternative energy sources that exert minimal impacts on bird health and bird habitat. MOS does recognize, however, that the transition from coal will not be immediate due to the need for an acceptable alternative to coal for supplying the base load in our electricity supply. Therefore, as the conversion of methane (the main component of natural gas) to CO_2 via combustion is known to reduce the greenhouse gas potential of methane, MOS cautiously supports the use of natural gas as a transitional fossil fuel to supply the base load of electricity during the gradual elimination of coal as a the primary fossil fuel used in the power plants that supply the State of Maryland with electricity. However, MOS will not support the harvesting of natural gas via hydraulic fracturing until such time that it can be demonstrated in peer reviewed studies that this technique can be performed with minimal impact on groundwater quality and without significant depletion of surface water resources.

Current attempts to mitigate some of the more detrimental effects of coal as an energy source have been proposed. For example, coal-fired power plants with carbon capture and storage (CCS) technology have been proposed as a possible method for reducing the emission of carbon dioxide, a potent greenhouse gas [13]. Since this technology is new, there has been little assessment of its potential impact on birds and bird habitat. While this technology may decrease GHG emissions from coal-fired power plants, it does not address the impact that coal mining practices and the disposal of coal ash have on birds and bird habitat. Therefore, it is obvious that the traditional sources of fossil fuel-based energy, such as coal, will continue to significantly impact bird health and bird habitat, even if emission mitigation technology is deployed in an attempt to develop "clean coal". The result of this is the real need to develop and implement alternative energy sources that possess a minimum impact on birds and bird habitat while simultaneously solving the significant need for a reduction in GHG emissions and providing a reliable source of energy to the residents of Maryland. Furthermore, the increasing call for legislation to control GHG emissions though state and national legislation will inevitably create a fertile market for alternative energy deployment in the United States. Therefore, it is important to understand and work to minimize the impact of these alternative energy sources on bird health and bird habitat before they are deployed in the State of Maryland.

Transmission Towers and Transmission Wires:

Currently, a great majority of the electricity produced in and for the State of Maryland is done at centralized power plants such as coal-fired power plants, nuclear power plants and hydroelectric dams. The State of Maryland imports a significant amount of its electricity (25% in 2008). Inherent in the production of electricity by centralized sources is the necessity to distribute this power via electricity transmission lines supported by transmission towers. These transmission towers and transmission lines are a major source of bird mortality with tens of thousands of birds per year killed by these manmade structures [14, 15]. Although voluntary guidelines for the protection of birds from power line-related injury and mortality do exist [15], generation of electricity by decentralized or on-site sources such as roof mounted solar panels, may, over time, decrease the need for transmission lines and, thereby, decrease the risk to birds. However, the addition of centralized alternative energy sources to the energy profile of Maryland may also require an increase in reliance on these transmission wires. Therefore, as discussed in the following sections of this policy statement, MOS supports an increase in the deployment of decentralized or "on-site" energy sources (e.g., structure-mounted solar panels and geothermal heat pumps) that would reduce the reliance on transmission wires. This would be expected to reduce the impact of energy transmission on bird health and bird habitat. Additionally, in the cases where transmission wires are necessary for the delivery of electricity, such as to urban areas, MOS expects the utility companies involved in the transmission of the electricity to develop and adhere to an effective Avian Protection Plan (APP), as described by the Edison Electric Institute and US Fish and Wildlife Service [15]. Electricity suppliers in Maryland, such as Baltimore Gas and Electric (BGE), Southern Maryland Electric Cooperative and PEPCO, have adopted comprehensive Avian Protection Plans.

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Nuclear Power:

Unlike coal-fired or other fossil fuel power plants which generate the heat required to turn steam turbines by oxidation or burning of carbon rich materials, nuclear power plants generate the heat required to turn similar electricity-generating turbines by relying on the fission, or splitting, of the uranium atom. Since there is no oxidation of carbon-containing fuels in a nuclear power plant, there is virtually no emission of CO_2 resulting from the operation of a nuclear power plant. This characteristic, coupled with its low impact on land use [1], makes nuclear power an ideal choice for reducing GHG emissions while producing a consistent source of electricity [2].

The Calvert Cliffs Nuclear Power Plant (CCNPP), functioning since 1977 with a generation capacity of greater than 1,700 MW [3], supplied over 30% of the electricity generated by power plants within the State of Maryland during 2008 [4]. Although it is the only nuclear power plant functioning in Maryland, CCNPP is licensed to continue operations through the year 2036. Additionally, a recent proposal to build a third reactor at the Calvert Cliffs site, which would add an additional 1,600 MW of electricity generating capacity, was submitted to the US Nuclear Regulatory Commission for consideration [5]. The construction of this proposed reactor is supported by Maryland environmental groups such as the Maryland Conservation Council because of its relatively low impact on wildlife and wildlife habitat, when compared to other sources of alternative energy such as wind, solar and biomass [6]. Although their impact on bird health and habitat will not be addressed in this policy statement, mainly due to their recent arrival on the market, miniature nuclear power sources such as the 10 megawatt Toshiba/ Westinghouse 4S Nuclear Power Plant may represent a decentralized source of nuclear energy in the future [7].

As with any energy source, impacts on bird health and bird habitat can be expected at nuclear power plants. Components and characteristics of nuclear power plants that may impact on bird health and bird habitat are, uranium mining, plant construction, cooling towers, cooling water intake and discharge, radioactive waste disposal, and radiological accident.

While there are currently no active uranium mining operations in the State of Maryland, it is important to consider the impact of this critical component of nuclear power plant operation on migrating and resident birds that may be affected by mining operations. The closest uranium deposit to the State of Maryland is the estimated 110 million pounds of uranium in the Coles Hill deposit in Pittsylvania County, VA [8]. This deposit is not currently being mined but explorations into the feasibility of mining this deposit are underway. A more likely source of fuel for nuclear power plants would be expected to come from decommissioned nuclear warheads. Specifically, 50% of the fuel rods installed since the 1990's in all nuclear reactors in the United States (accounting for 10% of the US electricity generation over this period) were created from reprocessed Soviet and US nuclear warheads via programs such as Megatons to Megawatts [9,10]. Furthermore, the New START treaty, signed by Russia and the United States in 2010, will allow for a continued use of decommissioned warheads in this program [11]. Since Megatons to Megawatts reduces the threat of nuclear destruction while simultaneously providing nuclear power, MOS rigorously supports the continuation of the Megatons to Megawatts program.

A detailed analysis regarding land use for the construction of nuclear power plants and other alternative energy sources has been performed by the Maryland Conservation Council. This study [1], demonstrates that when normalized by power output, one nuclear power plant would use 61-fold less land than a wind power plant, ~230-fold less land than a solar power array and

~7000-fold less land required to grow the fuel for a biomass-fired power plant. Combined with its low impact on total land requirements, the land immediately surrounding nuclear power plants may provide suitable habitat for some species of birds. The American Bird Conservancy (ABC) states in their policy statement on nuclear power [12] that the area surrounding nuclear plants and the cooling ponds have developed into habitats amenable to multiple bird species such as Osprey, Peregrine Falcons, Bald Eagles, Red-cockaded Woodpeckers, Eastern Bluebirds, Wood Ducks, American Kestrels, Wild Turkeys and Ring-necked Pheasant.

Cooling towers, an integral component of nuclear power plants, have been shown to cause bird mortality, mainly due to collision [13]. Songbirds, such as kinglets, warblers and finches, top the list of bird deaths due to collisions at cooling towers, while gulls and ducks were shown to mainly avoid these structures [13]. However, the authors of this study admit that the incidents of collision-induced mortality are highly variable and may be due mainly to improper lighting of the cooling towers, suggesting that these deaths are preventable. Also, when viewed in the context of bird deaths precipitated by collisions with tall buildings (97.5 to 975 million) and lighted communication towers (5 to 50 million/year), the number of birds killed by collision with nuclear power plant cooling towers per year (estimated to be 6,200/year in the US) is minimal [14-16].

An important requirement for the successful operation of a nuclear power plant is an abundant supply of water to cool the reactor. In the current design of nuclear reactors used in the United States, the coolant water never comes in direct contact with the radioactive source. Therefore, the coolant water that is discharged from a nuclear power plant is not radioactive [17]. However, concentrations of heavy metals and salts as well as temperature of the water can be increased in cooling water discharge. Although there are few studies examining the impact of discharge water on the health of birds, impacts on aquatic species and aquatic habitat from water discharge is known to occur [18]. Water intake systems have been documented to result in significant bird mortality. Specifically, it has been documented that diving ducks, such as Lesser Scaup, have become entrained in the water intakes of a nuclear power plant [19].

Finally, the issue of radiological waste disposal is currently one of great debate. While properly isolated and contained radiological waste would be expected to have no impact on birds and bird habitat, migration of the radiological waste from the storage site or accidental release of radiological waste could impact bird health and habitat. For example, studies in barn swallows and mallards have demonstrated that birds accessing radioactive leaching ponds do possess elevated and quantifiable levels of radioisotopes in their feathers, internal organs and eggs (in the case of swallows) [20, 21]. Therefore, MOS expects that nuclear waste generated from the production of nuclear power will be properly isolated and contained to prevent the exposure of birds and other animals, including man.

Overall the generation of electricity by nuclear power, like other sources of power generation, has the potential for impacting bird health and habitat. However, measures such as monitoring and control of uranium mine tailings, proper lighting of cooling towers, improving the design of water intakes at power plants and responsible handling and disposal of radiological waste would be expected to decrease the impact of this power source on bird health and bird habitat. If these or similar measures for decreasing the impact of nuclear power on bird health and bird habitat are considered and incorporated into the paradigm for generation of electricity by nuclear power in the State of Maryland, MOS would consider nuclear power an acceptable alternative energy source.

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Solar Power:

Harvesting the energy contained in solar radiation and converting it to electricity, a process known as solar power generation, can be achieved directly by the use of photovoltaics (PV) or indirectly by concentrating solar power (CSP) systems [1,2]. Both of these methods of solar power generation are currently used in either large, centralized arrays such as industrial PV or CSP power plants [3,4] or in smaller, residential arrays such as roof-mounted photovoltaic and solar hot water systems [5,6]. Taking advantage of the physical phenomenon discovered by Edmond Becquerel in 1839 known as the "photoelectric effect", PVs produce an electric current when light energy is absorbed by the semiconductor material (usually silicon) from which they are constructed [1]. CSP systems, on the other hand, use a large array of mirrored surfaces to reflect and focus the solar radiation onto a collector which uses the thermal radiation and/ or focused sunlight to generate electricity. Similar to the generation of electricity by nuclear power plants, fossil fuels are not involved in either the conversion of solar radiation to electricity via the photoelectric effect or the reflection and focusing of solar radiation in CSP systems, making these systems desirable for mitigating global climate change. In fact, generation of electricity by these methods are considered to have low CO_2 output (~ 28 fold lower for PV) when compared to coal-fired power plants [7, 8, 9]. Unlike nuclear power, however, large tracts of land (> 230 fold more land per MW than is required for a 1600 MW nuclear power plant) are required for the construction of centralized arrays for industrial PV and CSP plants [10], creating the potential for the disruption of wildlife habitat.

Mainly due to its latitude and lower incident solar radiation levels (insolation), the overall potential in Maryland for electricity generation by centralized arrays of PV (4-5 kWh/m2/day) and CSP (2-3 kWh/m2/day) is considered to be suboptimal (≤ 5 kWh/m2/day) [11,12]. As a result, the land mass required in Maryland to build a centralized solar power plant with a similar output to one in the Southwestern US (6-8 kWh/m^2/day) would be significantly greater on an acre by acre basis. Within the State of Maryland, there are no centralized solar arrays that are currently producing electricity for distribution [13]. However, University of Maryland Eastern Shore is in the process of constructing a 2.1 MW, 20 acre PV system for supplementing the electricity needs of the school [14]. While centralized solar power arrays are uncommon in Maryland, state and federal government grants and tax incentives for the installation of residential solar power systems have been made available [15, 16]. Unlike centralized arrays that are meant for the production of electricity for distribution, these arrays are meant to supplement the electricity needs of residences and businesses and thereby reduce the need for grid-supplied electricity. Since these PV and solar water heater arrays are erected on existing structures, there is no additional land mass required for their usage. In comparison with centralized solar power arrays, the impact on wildlife habitat is minimal when deployed in this manner.

As was already stated, centralized solar power arrays require large areas of land in order to function. In addition, these tracts of land must be kept clear of tall vegetation in order to prevent the obstruction of the sunlight. Therefore, land areas dedicated to the construction and operation of centralized solar arrays for electricity distribution would be devoid of trees and large shrubs thereby decreasing the amount of suitable habitat for birds. Specifically, it has been calculated by the Maryland Conservation Council that over 70,000 acres of land (>110 square miles or almost 1% of the land area of Maryland) would be required for the construction of a large number of solar arrays necessary to equal the annual electricity output of the proposed 1600 MW additional nuclear reactor at the Calvert Cliffs nuclear power plant [10]. Along with the large area of land required for a centralized solar array, other hazards to bird health such as the potential for collision with free standing structures associated with the array and the potential for burns from the focused solar radiation in CSP arrays [17]. Data regarding the incidence of collisions and burns caused by centralized solar arrays are not abundant, but the American Bird Conservancy estimates the impact of centralized solar arrays on local bird mortality to be minimal [17]. Furthermore, the probability of collision with a smaller array installed upon an existing structure, such as a residence, would be no greater than the probability of a collision with the existing structure.

Overall, it is quite clear that the largest impact of centralized solar arrays would be the significant loss of habitat for birds and other wildlife. Therefore, while MOS would not consider centralized solar arrays an acceptable source of alternative energy, the generation of electricity by smaller, residential solar arrays mounted to existing structures would be considered acceptable if these arrays do not require additional land mass to be used beyond what is already used for the existing structure.

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Geothermal Power and Geothermal Heating/Cooling:

Below the Earth's surface lies a reservoir of geothermal energy that can be harnessed to both generate electricity (Geothermal Power) and provide temperature control in residential structures (Geothermal Heating/Cooling). Geothermal energy consists of heat trapped inside the Earth from the planet's formation, heat generated from the natural radioactive decay of isotopes found inside the Earth and the heating of the ground from the sun [1, 2]. This energy radiates from the internal regions of the Earth to its surface and, in regions of high geothermal energy concentrations, such as areas of the United States west of the continental divide [3], can be harvested to generate electricity by heating water to create the steam necessary to turn electricity-generating steam turbines [1, 2]. While the construction of centralized geothermal power plants for the generation of electricity may be feasible in the Western areas of the United States where this geothermal energy is abundant, this is not primarily the case for the Mid-Atlantic area of the United States [3]. However, a sufficient geothermal energy gradient does exist in Maryland to allow for the construction of geothermal heat pump systems, also known as ground-source heat pumps, for use in heating and cooling residential structures [4]. Similar to the workings of the electric heat pump system that is widely used in Maryland for residential temperature control, a ground-source heat pump takes advantage of the principles of heat exchange to either heat or cool a residence. However, unlike the electric heat pump that exchanges heat between the residential structure and the atmosphere, a ground-source heat pump exchanges heat between the residence and the ground via a system of pipes installed beneath the surface of the area surrounding the structure [5]. It is estimated that, in Maryland, installation of a ground-source heat pump system could decrease the annual use of residential electricity by 30-40% [1]. In addition, since geothermal energy and heating/cooling systems do not require the combustion of fossil fuels, the amount of CO_2 released by the operation of these systems is minimal (0.2 lb/kWh) when compared to coal (2.1 lb/kWh), oil (2.0 lb/kWh) or natural gas (1.3 lb/kWh) combustion [1].

Since the operation of a geothermal power plant in the State of Maryland is not feasible due to the low abundance of geothermal energy in the Mid-Atlantic area [3], the impact of these plants on the health and habitat of Maryland's birds will not be discussed here. However, for the interested reader, several references which discuss the environmental impact of geothermal power plants are provided [6-8]. Regarding geothermal or ground-source heat pumps, the overall environmental impact, and thus effect on birds and bird habitat, of these systems in comparison with geothermal energy production is minimal and depends on the type of heat pump (open or closed loop) used [9-10]. As stated earlier, in a ground-source heat pump system, heat is exchanged with the ground surrounding the residential structure by a system of in-ground pipes that create a loop. In the open loop system, which is simpler, cheaper and has a greater potential for environmental impact than the closed loop system, water is drawn from a groundwater aquifer through the series of underground pipes and is discharged into the same aquifer via a second well (direct return) or to a body of surface water (surface discharge) [5]. The environmental impact of the open loop system can include ground water depletion when designed with a surface discharge component [10]. In the closed loop system, a system of pipes containing a relatively non-toxic fluid capable of heat exchange (usually a mixture of water and propylene glycol or water and potassium acetate) is installed as a closed system [5, 10, 11]. This style of geothermal heat pump does not require the use of ground water and, besides the temporary disturbance of the ground surrounding the residence during the installation of the pipe system, would not be expected to result in any additional long term loss of habitat beyond the developed area used for the residential structure. As far as the impact of geothermal heat pumps on bird health is concerned, there is minimal information available regarding this topic. Therefore, the full extent of ground-source heat pump systems on bird health is not fully characterized, but would be expected to be minimal.

Overall, it is clear that Maryland does not have the adequate geothermal energy reservoirs to support the operation of geothermal power plants. Maryland does, however, have ideal conditions for the installation and operation of residential geothermal or ground-source heat pump systems. Although the design of open loop ground-source heat pump systems may result in habitat degradation and water depletion when designed with a surface water discharge component, the design of “direct return” open loop geothermal heat pump systems and closed loop geothermal heat pump systems are anticipated to have minimal impact upon bird health and bird habitat in Maryland. Therefore, MOS considers the installation and operation of “direct return” open loop and closed loop geothermal heat pump systems acceptable, as long as the installation and operation of these systems do not result in long term disruption of habitat beyond what was already developed for the existing residential structure. In addition, MOS also encourages further research on the impact of these ground-source heat pump systems on bird health.

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Hydropower:

Power sources that harness the kinetic energy of moving water and convert it to usable sources of energy are known collectively as hydropower [1]. Although hydroelectric dams are considered by many to be the prototypic source of hydropower, energy modalities that harvest the kinetic energy contained in waves and tides are also sources of hydropower.

Hydroelectric dams are structures that are built across flowing rivers to create an impoundment of water upstream which allows for conversion of the kinetic energy in the flowing water to electricity as the water is released to the downstream side of the dam and across the blades of electric turbines. As of December, 2009, approximately 7% of all net electricity generated in the United States was from conventional hydroelectric sources such as hydroelectric dams [2]. However, hydroelectricity comprised over 20% of the electricity generation from non-fossil fuel sources (the remaining coming from nuclear sources) and almost 65% of the electricity generated from non-nuclear, non-fossil sources. A similar profile is observed in Maryland where hydroelectricity provides approximately 5% of the State's electricity, the majority of which is produced by the Conowingo hydroelectric plant on the Susquehanna River [3]. This energy source comprises almost 25% of the non-fossil fuel sources and greater than 80% of the alternative non-nuclear, non-fossil sources used to generate electricity in Maryland. Therefore, traditional hydroelectric power is a considerable source of alternative non-nuclear, non-fossil energy in the United States and Maryland. Non-traditional hydroelectric sources of energy such as harvesting the energy in waves and tides are not currently in widespread use in the United States or Maryland, but there is great interest in developing these potential sources of energy due to the greater predictability (i.e. tidal vs. wind or solar) and availability in coastal areas [4-6].

As with all other sources of energy, hydropower, whether in the form of hydroelectric, tidal or wave energy, is known to exert varying impacts on both aquatic and terrestrial habitat used by birds. In the instance of hydroelectric dam operations, loss of continuity for movement of aquatic fauna, disruption of sediment flow and upstream and downstream impacts on water flow and water chemistry have been documented [7-9]. Many of these factors have the potential for altering bird habitat [7]. Even more dramatic than operation of hydroelectric plants, *de novo* construction has proven to possess a great potential for destruction of habitat, as seen in the construction of the O'Shaughnessy dam which lead to the deliberate flooding and destruction of the Hetch Hetchy Valley of Yosemite National Park [10]. However, not all impacts of hydroelectric dams are negative. For example, the Conowingo reservoir, formed by the impounded waters just upstream of the Conowingo Dam, is known to provide an important habitat for gulls, waterfowl and raptors in Northern Maryland [11]. In addition, many of the adverse outcomes due to operation of a hydroelectric plant can be lessened or mitigated altogether [12]. Overall, the impact of hydroelectric dams on the river and terrestrial environment, which includes bird habitat, is complex. Therefore, construction, major renovation or even the relicensing process for existing dams, should include both a comprehensive assessment of the environmental impact of the dam and the necessary mitigation measures to reduce the impact of the dam on the health of the upstream and downstream river and its associated areas. These measures would ensure that the impact of the operation and/or construction of the hydroelectric plant on bird habitat are taken into consideration. As far as regulation of hydropower in the United States is concerned, the Federal Energy Regulatory Commission (FERC), an independent regulatory agency within the Department of Energy, has the responsibility to oversee the licensing of hydroelectric facilities, monitor environmental matters regarding hydroelectric plants and provide permits for the development of tidal power [13]. As such, FERC is currently in receipt of notices to file a relicensing application for operation of the Conowingo dam by Excelon Generation Company (the current license expires in 2014) and a licensing application for conversion of the Jennings Randolph Dam on the Potomac River in Garrett County, Maryland to a hydroelectric power plant for operation by Fairlawn Hydroelectric [14]. It is the expectation of MOS that a comprehensive assessment of the impact of these licensing actions upon bird health and bird habitat will be a part of the licensing process for both projects. Furthermore, it is suggested that MOS monitor the progress of these and other hydroelectric projects to ensure that the process will indeed include assurances for protection of both bird health and bird habitat.

Although tidal power and wave power modalities have not been commercially deployed in Maryland as of April 2010 [15], the Chesapeake Bay is a body of water that is under great tidal and ocean wave influence and, therefore, may have great potential for the generation of tidal and wave power. Currently, there are many technologies in development for harvesting the energy contained in the tides such as tidal turbines, tidal fences, tidal barrages, tidal lagoons and underwater electric kites (UEK) [6, 16-19]. Of these technologies, tidal barrages, essentially a dam constructed across an entire estuary, are known to have the greatest impact on estuaries and the birds that rely on this habitat [17, 18]. Therefore, MOS would not support the construction of a tidal barrage in Maryland or the Chesapeake Bay. Tidal lagoons, which capture a portion of the water contained in high tide to turn turbines during the release of this water at low tide [6], may be an acceptable alternative to tidal barrages due to the fact that the entire estuary is not under the influence of the lagoon. However, further research on the impact of tidal lagoons on estuaries and the birds that rely on them is required before MOS would fully support the construction of tidal lagoons as an energy source in Maryland. Although tidal fences have less impact on estuaries, the movement of large marine fauna is known to be affected [20]. Therefore, MOS would be reluctant to support the construction of tidal fences in the Chesapeake Bay unless significant evidence suggested a minimal impact on the fauna of the Chesapeake Bay. Tidal turbines act in a similar manner to wind turbines except for the fact that the blades of the turbine are submerged under water and are driven by the movement of water. The Underwater Electric Kite (UEK), developed by UEK Systems of Annapolis, Maryland, is a specialized form of tidal turbine which was designed to minimize the known impact on fish associated with the operation of tidal turbines. Currently there are plans to test the functionality and impact of the UEK in the Indian River Inlet in Delaware [21]. Overall the impact of tidal turbines and the UEK on birds, especially diving seabirds, has not been extensively studied but is thought to be minimal [16]. Therefore, MOS would cautiously support the development of this form of tidal energy but only if coupled with a comprehensive monitoring and research program that assesses the impact of this technology on bird health and bird habitat. Due to the little information available on the impact of the construction and operation of wave energy systems, MOS recommends that research into the impact of these systems on bird health and bird habitat be performed before deployment of this technology into the waters of Maryland.

In summary, MOS encourages the responsible development and operation of hydropower sources in the State of Maryland that have been demonstrated to possess limited impact on bird health and bird habitat. While MOS opposes the *de novo* construction of new dams for development of hydroelectric power in Maryland, MOS would consider the conversion of existing dams to hydroelectric power plants (i.e. Jennings Randolph Dam in Garrett County) a prudent use of these structures. In addition, MOS supports the responsible maintenance and relicensing of existing hydroelectric power plants, such as the Conowingo hydroelectric plant, due to the important habitat that these dams provide for bird species in Maryland [11]. MOS also supports the development of tidal and wave energy in Maryland with the caveat that concurrent research and monitoring programs on the impact of these technologies on bird health and bird habitat be implemented. MOS does not support the construction of tidal barrages and is reluctant to support the construction of tidal fences and tidal lagoons in the waters of Maryland without further research on the potential impact of these technologies on bird health and bird habitat. Given that facilities are implemented responsibly and with consideration for bird health and bird habit, MOS considers hydropower an important and necessary source of energy for the development of Maryland's alternative energy portfolio.

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Waste-to Energy:

Municipal solid waste (MSW), also known as trash, is defined by the U.S. Environmental Protection Service (USEPA) as "durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes" [1]. It is estimated that the people of the United States produce over 250 million tons of trash annually (4.5 lbs/person/day) with only 33% of this waste being recycled or composted [2]. Although the majority of the remaining waste is deposited in landfills (54% of total waste), a portion of the trash that is not recycled is converted into energy (13%) in a process known as waste-to-energy (WTE). In the WTE process, MSW is combusted to create heat which is used to generate the steam required to operate steam-driven electric turbines. With available space for safe landfill disposal of MSW becoming increasingly unavailable and the generation of MSW predicted to increase, the conditions are amenable for diverting a larger amount of MSW to WTE plants. This is indeed the case in Maryland where several WTE projects have either been proposed or are in the process of being built [3,4]. Given the increased interest in this form of alternative energy, it is important to identify and understand the risks and benefits of WTE plants to both bird health and bird habitat. With regard to the avian population of Maryland, these areas of concern are the effects of WTE on habitat, air and water.

As is the case for other centralized alternative energy plants, it is a fact that construction of WTE plants require the clearing and development of land. Therefore, it is crucial that the placement of WTE facilities minimize or avoid the disruption of important or fragile habitat. It is important to recognize, however, that the amount of land space required for the construction of a WTE plant, based on MW of power produced per acre of land, is reasonable when compared to the land requirements for a solar or wind power plant. For example, the Wheelabrator Baltimore WTE power plant (previously known as Baltimore RESCO) is located on approximately 12 acres of developed land just outside of Baltimore city, near the intersection of I-95, I-295 and I-395 [5,6]. This plant, which has been running since 1985, operates 24 hours a day, 7 days a week to convert 2,250 tons/day of MSW into electricity (60 MW capacity or enough electricity for 68,000 homes) and steam, which is used in the downtown heating loop [5,7]. When normalized to energy generated per acre of land use, the Baltimore Wheelabrator WTE is similar in its energy-production-to-land-use ratio (5 MW/acre) to a nuclear power plant (4.8 MW/acre) and is considerably more efficient in land use than a centralized solar (0.02 MW/acre) or wind (0.17 MW/acre) power plant [8]. Furthermore, the Wheelabrator WTE plant requires approximately 50-fold less land than the Alpha Ridge Landfill in Howard County [9], thereby demonstrating a much more efficient land use for the disposal of MSW. Overall, it is clear that if built in a manner that avoids the disruption of critical habitat, WTE plants are among the most efficient in generating energy when normalized to the land area required for operation.

While WTE plants are among the most efficient of the alternative energy sources with respect to land use, the fact that these plants generate electricity by the combustion of MSW is of potential concern to bird health. Specifically, combustion of MSW has the potential for the release of particulate matter, nitrogen oxides, sulfur dioxides, and hazardous air pollutants (mercury, furans, dioxins); similar to the emissions profile of a coal-fired power plant. However, like coal-fired power plants, many of the WTE plants employ emission reduction technologies [10]. In a head to head comparison, it has been estimated that the emission of nitrogen oxides and oxides of sulfur by WTE plants is 65% and 30% lower, respectively, than coal-fired power plants [11]. Similar to coal-fired power plants, however, WTE power plants emit the greenhouse gas, carbon dioxide (CO_2). As stated earlier in this document, the contribution of CO_2 to anthropogenic global climate change and the negative impact of climate change on birds are well recognized by MOS [12, 13]. However, an important difference between the emission of CO_2 from WTE plants and that of coal-fired plants is that the CO_2 emitted from WTE plants is the result of a diversion of MSW from landfills where it would normally be degraded by microorganisms to methane, a greenhouse gas with a much greater heat-trapping potential than CO_2 [12]. The emission of CO_2 from coal-fired power plants, however, results in the liberation of previously sequestered carbon that would not have otherwise been liberated and, therefore, results in a proportionally greater contribution to GHG emissions than emissions from WTE plants [11, 14]. Although not ideal, energy can be produced from the methane released during the degradation of MSW in landfills, a process known as landfill-gas-to-energy [14]. This process is known to be 10-fold less efficient than conversion of MSW to energy in a WTE plant [14]. Plans to use this technology at the Alpha Ridge Landfill in Howard County, MD are in place [15]. Along with handling the emissions associated with WTE plants, there is also a requirement to deal with the residues of the combustion process [10, 14]. There are two principal solid residues from thermal treatment systems: the bottom ash, which is the solid remainder of the waste feedstock after processing; and the Flue Gas Treatment (or Air Pollution Control) residues from the air pollution control process. Recycling of the bottom ash from WTE plant into construction applications reduces the quantity requiring landfill disposal. Metals not reclaimed in the initial recycling process may be recovered from the subsequent ash for a total reclamation of over 90% [14]. An alternative way to deal with the residual ash is vitrification. In vitrification the resulting ash is mixed with sand and melted. The compound formed is a glassy substance that is virtually non-reactive. Ultimately, it is important for proper control and disposal of the WTE-generated ash in order to avoid an impact of this material on bird health and bird habitat.

Since the water used to generate the steam to turn turbines in a WTE plant does not come into contact with the MSW to be burned, the major concern as to the effect of WTE power plants on water is not chemical or trash contamination. Rather, the discharge of cooling water used to maintain an optimal operating temperature may be of potential concern. Although the potential for a deleterious effect of the elevated temperature of discharged cooling water on bird health and bird habitat is similar to that seen with the discharge of cooling waters from nuclear power plants, there is little evidence that this is a major problem for bird health or bird habitat. In fact, WTE plants have found ingenious uses for the cooling water discharge. For example, the Wheelabrator Baltimore WTE plant uses the plant's cooling water to operate an aquaculture center which releases approximately 5,000 juvenile large-mouth bass, yellow perch and rock fish into the rivers of Maryland every autumn [5]. Other creative uses for cooling water from WTE plants in Maryland include the 900-foot-long cooling water discharge channel from the Montgomery County Resource Recovery Facility in Dickerson, Maryland, which empties into the Potomac River; it became the Dickerson Whitewater Course, a canoe and kayak training facility for the 1992 Olympic Games. While cooling water discharge systems have been used for interesting purposes, the lack of information on this discharge with respect to bird health and bird habitat suggests that further research and monitoring is required. Given the reduction in GHG and other pollutants, the reduction in land devoted to landfill, and assuming an appropriate selection of site and proper control of emissions and ash, on balance, the impact of WTE on the avian population of Maryland would be expected to be minor. Therefore, until such time that vigorous recycling programs and per capita reduction in trash production result in a significant reduction in the deposition of municipal solid waste (MSW) to landfills, MOS supports the use of MSW as feedstock in responsibly-operated waste-to-energy programs in the state of Maryland.

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