APPENDIX A:

SCOPING MATERIAL AND DISTRIBUTION LIST

Department of Energy
Golden Field Office
1617 Cole Boulevard
Golden, Colorado 80401-3393

September 20, 2010

TO: **Distribution List**

SUBJECT: **Notice of Scoping - University of Maine Deepwater Offshore Wind Test Site Gulf of Maine**

The U.S. Department of Energy (DOE) is proposing to award federal funding to the University of Maine (UMaine) to construct, deploy, and retrieve 1/3-scale floating wind turbines within the deepwater offshore wind test site (project) in the Gulf of Maine approximately two miles south of Monhegan Island. Details of the proposed project and its location are contained in the attachment to this Scoping Notice. Additional project information can be found at the UMaine DeepCwind Consortium website: http://www.deepcwind.org.

Pursuant to the requirements of the National Environmental Policy Act (NEPA), the Council on Environmental Quality regulations for implementing the procedural provision of NEPA (40 CFR Parts 1500-1508), and DOE's implementing procedures for compliance with NEPA (10 CFR 1021), DOE is preparing a draft Environmental Assessment (EA) to:

- Identify any adverse environmental effects that cannot be avoided should this proposed project be implemented.
- Evaluate viable alternatives to the proposed project.
- Describe the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.
- Characterize any irreversible and irretrievable commitments of resources that would be involved should this proposed project be implemented.

Potential Environmental Effects or Issues Identified for the Environmental Assessment

The EA will describe and analyze any potential impacts on the environment that would be caused by the project and will identify possible mitigation measures to reduce or eliminate those impacts. At a minimum, DOE will evaluate the potential impacts that may result to:

- Biological Resources, including avian species, bats, and marine mammals
- Water Resources
- The Acoustic Environment
- Ocean Use, including commercial fisheries and recreation
- Aesthetics
- Socioeconomics
- Cultural Resources

Development of a Reasonable Range of Alternatives

DOE is required to consider a reasonable range of alternatives to the proposed action during an environmental review. The definition of alternatives is governed by the "rule of reason". An EA must consider a reasonable range of options that could accomplish the agency's purpose and need while reducing environmental effects.

Reasonable alternatives are those that may be feasibly carried out based on environmental, technical, and economic factors.

The No Action Alternative will be addressed. The need for project redesign, or a project alternative, will be determined during the course of environmental review.

Public Scoping

The DOE is making this letter available to interested federal, state, and local agencies to provide information on issues to be addressed in the EA. Agencies are invited to identify the issues within their statutory responsibilities that should be considered in the EA. The general public is also invited to submit comments on the scope of the EA.

This letter and the draft EA, when it is available, will be posted in the DOE Golden Field Office online reading room: http://www.eere.energy.gov/golden/Reading_Room.aspx.

The DOE Golden Field Office welcomes your input throughout our NEPA process. Please submit your comments by October 5, 2010 to:

Department of Energy Golden Field Office
NEPA Division
Attn: Kurt Rautenstrauch
1617 Cole Boulevard
Golden, Colorado 80401

Or via email to:

Kurt.Rautenstrauch@go.doe.gov

Thank you for your participation in the NEPA process.

Sincerely,

Laura Margason

Laura Margason
NEPA Document Manager

Enclosure

Attachment

University of Maine Deepwater Offshore Wind Test Site
Proposed Project Description and Location

The U.S. Department of Energy (DOE) is proposing to provide federal funding to the University of Maine (UMaine) to perform research and development relating to floating offshore wind turbine platforms. The objective of this project is to experimentally validate coupled aeroelastic/hydrodynamic computer models developed by the National Renewable Energy Laboratory and others for floating offshore wind turbines.

The project proposed by UMaine is to design, fabricate, deploy, test, and retrieve of two 1/3-scale wind turbines on floating platforms. The turbines would measure approximately 100 feet from waterline to the hub, the rotor diameter would measure approximately 70 feet, and the total turbine height would be approximately 135 feet. The wind turbine platforms would be fabricated at a shipyard, or similar existing coastal facility, and towed to and moored within the University of Maine Deepwater Offshore Wind Test Site in the Gulf of Maine, shown in Figure 1, located approximately two miles south of Monhegan Island. The proposed project site was designated by the State of Maine as a result of comprehensive review of available information and numerous meetings with the public and interest groups, arising out of 2009 Maine legislation intended to encourage development of offshore wind energy off Maine's coast. The units may be moored at the project site during some or all of July through November of 2012 and during some or all of July through November of 2013. Retrieval of the units would occur following the deployment periods in both 2012 and 2013.

The focus of the testing would be to validate numerical models that predict how the turbine platforms would perform under various conditions of combined wind and wave loading. The wind turbine platforms would carry sensors and telemetry systems that would provide data to evaluate motion and structural performance of the floating turbine platforms under combined wind, wave, and environmental conditions. These data would be correlated with the corresponding data collected on an oceanographic buoy, already deployed at the site to evaluate the response of the floating turbine platforms to the wave forcing field. Motion of the platforms would also be correlated with tidal currents and winds. Environmental monitoring would occur during the deployments, including monitoring of bats and birds, marine life, and noise at the project site.

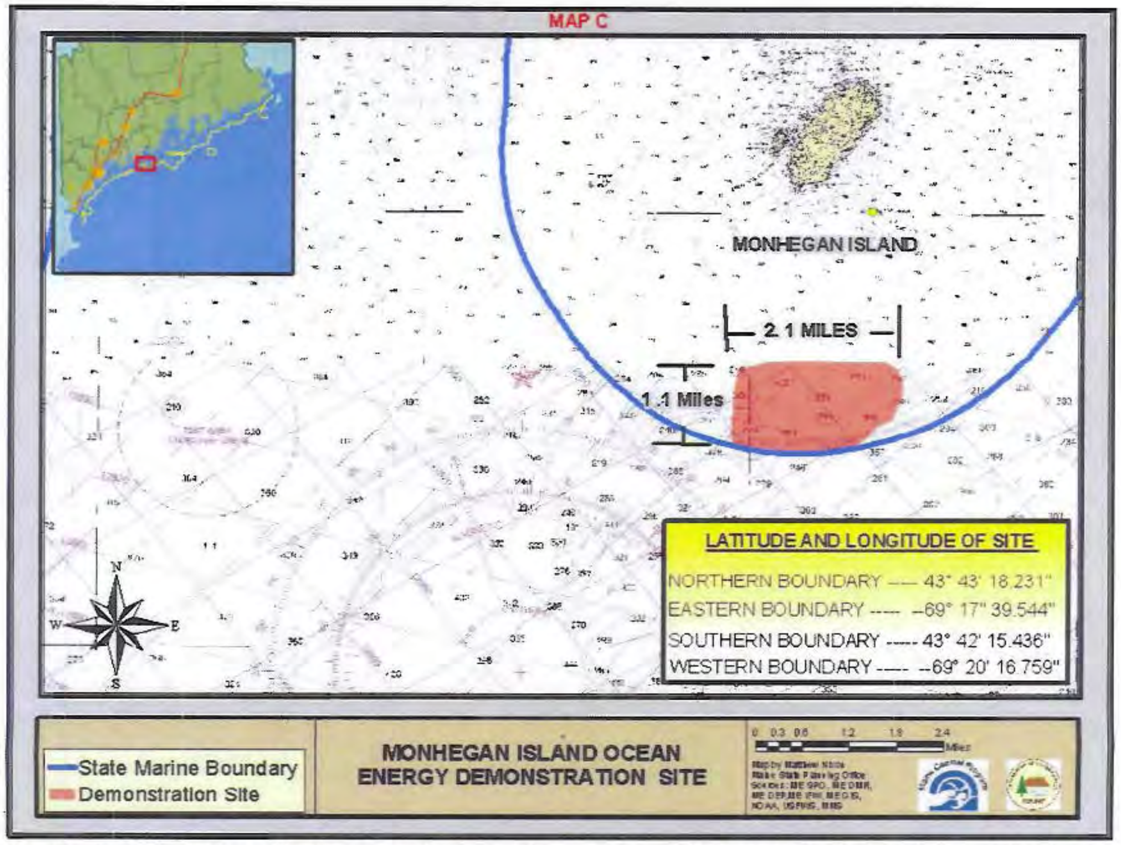

Figure 1 - Project Location. University of Maine Deepwater Offshore Wind Test Site, Off of Monhegan Island in the Gulf of Maine.

NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Univ. Maine Deepwater Offshore Wind Test Site
Gulf of Maine

The University of Maine is proposing to use federal funding from DOE to design, fabricate, and temporarily deploy two 1/3-scale floating wind turbines in the Gulf of Maine about two miles south of Monhegan Island. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at

http://www.eere.energy.gov/golden/Reading_Room.aspx.

Public comments on the NEPA process, proposed action and alternatives, and environmental issues will be accepted until October 5, 2010. Please send comments to Kurt Rautenstrauch, Department of Energy's Golden Field Office, 1617 Cole Blvd, Golden, CO 80401 or by email to kurt.rautenstrauch@goe.doe.gov.

NOTICE OF SCOPING

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Environmental Assessment
Univ. Maine Deepwater Offshore Wind Test Site
Gulf of Maine

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NOTICE OF SCOPING

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Environmental Assessment
Univ. Maine Deepwater Offshore Wind Test Site
Gulf of Maine

The University of Maine is proposing to use federal funding from DOE to design, fabricate, and temporarily deploy two 1/3-scale floating wind turbines in the Gulf of Maine about two miles south of Monhegan Island. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at

http://www.eere.energy.gov/golden/Reading_Room.aspx.

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NOTICE OF SCOPING

The U.S. Department of Energy (DOE) is requesting public input on the scope of environmental issues and alternatives to be addressed in the:

Environmental Assessment
Univ. Maine Deepwater Offshore Wind Test Site
Gulf of Maine

The University of Maine is proposing to use federal funding from DOE to design, fabricate, and temporarily deploy two 1/3-scale floating wind turbines in the Gulf of Maine about two miles south of Monhegan Island. An Environmental Assessment (EA) will be prepared by DOE pursuant to the requirements of the National Environmental Policy Act (NEPA). The notice of scoping and description of the proposed project is available for review at the DOE Electronic Public Reading Room at

http://www.eere.energy.gov/golden/Reading_Room.aspx.

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Company	Title	Department	Last	First	Address Line 1	Address Line 2	City	State	Zip Code
Bureau of Parks and Lands			Prichard	Dan	18 Elkins Lane		Augusta	ME	04333-0022
Conservation Law Foundation		Maine Advocacy Center	Mahoney	Sean	14 Maine Street		Brunswick	ME	04011-2026
Dept. of Economic and Community Development			Trafton	Thaxter R.	59 State House Station		Augusta	ME	04333-0059
Federal Aviation Administration		FAA National Headquarters	Edgett-Baron	Sheri	800 Independence Avenue, SW	Room 400 East	Washington	DC	20591
Federal Emergency Management Agency			Sullivan	Jack	99 High Street	Sixth Floor	Boston	MA	02110
Governor's Office of Energy Independence & Security			Puser	Jennifer	22 State House Station		Augusta	ME	04333
Governor's Office of Energy Independence & Security			Kerry	John M.	23 State House Station		Augusta	ME	04333
Gulf of Maine Lobster Foundation, Inc.			Pelletier	Erin	P.O. Box 523		Kennebunk	ME	04043
Island Institute			Conkling	Philip	386 Main Street	P.O. Box 648	Rockland	ME	04841-0648
Land Use Regulation Commission		Maine Dept. of Conservation	Todd	Fred	19 Elkins Lane		Augusta	ME	04333-0023
Maine Audubon Society			Koffman	Ted	20 Gilsland Farm Road		Falmouth	ME	04105
Maine Coast Heritage Trust			Ireland	Thomas	1 Bowdoin Mill Island	Suite 201	Topsham	ME	04086
Maine Dept. of Environmental Protection	Acting Commissioner		Nagusky	Beth	28 Tyson Drive	17 State House Station	Augusta	ME	04333-0017
Maine Dept. of Inland Fisheries & Wildlife			Timpano	Steve	284 State Street	41 State House Station	Augusta	ME	04333-0041
Maine Dept. of Marine Resources			Mercer	Linda	194 McKown Point Road	P.O. Box 8	Boothbay Harbor	ME	04575
Maine Dept. of Marine Resources			Lapointe	George	21 State House Station		Augusta	ME	04333
Maine Dept. of Marine Resources		Bureau of Sea Run Fisheries and Habitat	Keliher	Patrick	172 State House Station		Augusta	ME	04333-0021
Maine Geological Survey		Maine Dept. of Conservation	Dickson	Stephen	Williams Pavilion	17 Elkins Lane	Augusta	ME	04333-0022
Maine Historic Preservation Commission			Shettleworth, Jr.	Earle	55 Capitol Street	65 State House Station	Augusta	ME	04333-0065
Maine Island Trail Association			Welch	Doug	58 Fore Street		Portland	ME	04101-4849
Maine Natural Areas Program		Dept. of Conservation	Docherty	Molly	17 Elkins Lane		Augusta	ME	04333-0093
Maine Port Authority			Henshaw	John H.	16 State House Station		Augusta	ME	04333-0016
Maine State Planning Office	Acting Director		Glidden	Tim	184 State Street	38 State House Station	Augusta	ME	04333
Maine State Planning Office		Maine Coastal Program	Leyden	Kathleen	187 State Street		Augusta	ME	04333
Monhegan Plantation Board of Assessors		Monhegan Town Office	Cash	Chris	260-A Monhegan Avenue	P.O. Box 322	Monhegan	ME	04852
Monhegan Plantation Power District			Thomson	Mathew	P.O. Box 127		Monhegan	ME	04852
National Park Service		Northeast Region, U.S. Custom House	Reidenbach	Dennis	200 Chestnut Street	Fifth Floor	Philadelphia	PA	19106
Natural Resources Council of Maine			Didishiem	Pete	3 Wade Street		Augusta	ME	04330
NOAA Fisheries		NMFS, Northeast Region	Higgins	John	69 Pemaquid Harbor Road		Pemaquid	ME	04558
NOAA Fisheries		NMFS, Maine Field Station	Murphy	Jeff	17 Godfrey Drive	Suite 1	Orono	ME	04473
NOAA Fisheries		NMFS, Northeast Region	Koyama	Kristen	55 Great Republic Drive		Gloucester	MA	01930
NOAA Fisheries		NMFS, Northeast Region	Colosi	Peter	56 Great Republic Drive		Gloucester	MA	01930
Office of the Governor			Tilberg	Karen	1 State House Station		Augusta	ME	04333-0001
Public Utilities Commission			Tannenbaum	Mitchell	18 State House Station		Augusta	ME	04333
Sierra Club - Maine Chapter			Woodsum	Karen	44 Oak Street	Suite 301	Portland	ME	04101
The Lobster Conservancy			Cowan	Diane	P.O. Box 235		Friendship	ME	004547-0235
The Nature Conservancy			Vickery	Barbara	14 Maine Street		Brunswick	ME	04011
U.S. Army Corps of Engineers		Maine Field Office	Clement	Jay	675 Western Avenue	Suite 3	Manchester	ME	04351
U.S. Coast Guard	Commander, Sector Northern NE		McPherson	Captain James B.	259 High Street		South Portland	ME	04106
U.S. Coast Guard		Energy/Facilities Branch	Beck	Ron	408 Atlantic Avenue		Boston	MA	02110
U.S. Dept. of the Interior		Office of the Solicitor	Hirschman	Daniel S.	1849 C Street, N.SW.	#MS6556	Washington	DC	20240-0001
U.S. Dept. of the Interior		Office of the Solicitor, Northeast Region	Tittler	Andrew	One Gateway Center	Suite 612	Newton	MA	02158
U.S. Dept. of the Interior		Bureau of Indian Affairs, Eastern Region	Kardatzke	Dr. James T.	545 Marriott Drive	Suite 700	Nashville	TN	37214
U.S. Dept. of the Navy	Director, Environmental Planning & Conservation Policy ODASN (E)		Egeland	Tom	1000 Navy Pentagon		Washington	DC	20350-1000
U.S. Environmental Protection Agency		New England Headquarters	Timmermann	Timothy	1 Congress Street, Suite 1100	Mail Code RAA	Boston	MA	02114-2023
U.S. Fish and Wildlife Service			Fefer	Stewart	4R Fundy Road		Falmouth	ME	04105
U.S. Fish and Wildlife Service		Maine Field Office	Nordstrom	Lori	1168 Main Street		Old Town	ME	04468
U.S. Fish and Wildlife Service		Regional Office	Moriarty	Marvin	300 Westgate Center Drive		Hadley	MA	01035-9589
Aroostook Band of Micmacs	Tribal Chief		Higgins	Victoria	7 Northern Road		Presque Isle	ME	04769
Houlton Band of Maliseet Indians	Tribal Chief		Commander	Brenda	88 Bell Road		Littleton	ME	04730
Passamaquoddy Tribe at Indian Township	Tribal Governor		Nichols	William	P.O. Box 301		Princeton	ME	04668
Passamaquoddy Tribe at Pleasant Point	Tribal Governor		Phillips-Doyle	Richard	P.O. Box 343		Perry	ME	04667
Penobscot Indian Nation	Tribal Chief		Francis	Kirk	12 Wabanaki Way		Indian Island	ME	04668

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

OCT - 1 2010

Kurt Rautenstraunch
Department of Energy
Golden Field Office
NEPA Division
1617 Cole Boulevard
Golden, Colorado 80401

RE: University of Maine Deepwater Offshore Wind Test Site

Dear Mr. Rautenstraunch:

This letter is in response to the U.S. Department of Energy's (DOE) September 20, 2010 Notice of Scoping concerning the proposed issuance of funds to the University of Maine (UM) to construct, deploy, and retrieve two 1/3-scale floating wind turbines in the Atlantic Ocean off the coast of Maine. Pursuant to the requirements of the National Environmental Policy Act (NEPA), DOE is preparing a draft Environmental Assessment (EA) that will describe and analyze any potential impacts on the environment that would be caused by the project and will identify possible mitigation measures to reduce or eliminate those impacts. The EA will also evaluate any viable alternatives to the proposed project. With the Notice of Intent, DOE requests state and federal resource agencies to identify any issues within their statutory responsibilities that should be addressed in the EA.

UM Deepwater Offshore Wind Test Site

The DOE is proposing to provide federal funding to UM to perform research and development relating to floating offshore wind turbine platforms. The objective of the project is to experimentally validate coupled aeroelastic/hydrodynamic computer models developed by the National Renewable Energy Laboratory and others for floating offshore wind turbines.

The project proposed by UM is to design, fabricate, deploy, test, and retrieve two, 1/3-scale wind turbines on floating platforms. The turbines would measure approximately 100 feet from the waterline to the hub, the rotor diameter would measure approximately 70 feet, and the total turbine height would be approximately 135 feet. The wind turbine platforms would be fabricated at a shipyard and towed to the site, which is located about 2 miles south of Monhegan Island. The units will be moored at the site for periods between July – November in 2012 and 2013.

National Marine Fisheries Service's Trust Resources

NOAA's National Marine Fisheries Service (NMFS) has federal statutory responsibility for protection, mitigation, and enhancement of marine and anadromous fish resources and marine mammals that may be directly affected by this project. Those authorities include protection of marine and anadromous fish and their habitat under the Magnuson-Stevens Fishery Conservation Act (16 USC 1801, et seq.); diadromous species under the Fish and Wildlife Coordination Act (16 USC 661, et seq.), marine mammals pursuant to the Marine Mammal Protection Act (16 USC 1361, et seq.) and threatened and endangered species under the Endangered Species Act of 1973, as amended (16 USC 460, et seq.). These same statutory authorities also obligate any Federal agency, including the DOE, to consult with NMFS before taking any action that might adversely affect NMFS trust resources.

The Atlantic Ocean in the vicinity Monhegan Island supports numerous Federally managed finfish, including Atlantic salmon (*Salmo salar*), Atlantic cod (*Gadus morhua*), winter flounder (*Pseudopleuronectes americanus*) Atlantic halibut (*Hippoglossus hippoglossus*) and sea herring (*Clupea harengus*). Several species of marine mammals are common residents or occasional visitors to these waters including gray seals, harbor seals, and harbor porpoise. Whales are also likely to occur seasonally near the project site. The construction and operation of the wind turbines proposed in the ocean may affect fish populations and marine mammals through disturbance/alteration of habitat and interaction with the off-shore facilities.

The Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon is listed as endangered under the ESA. The GOM DPS includes all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River. Included are all associated conservation hatchery populations used to supplement these natural populations; currently, such conservation hatchery populations are maintained at Green Lake National Fish Hatchery (GLNFH) and Craig Brook National Fish Hatchery (CBNFH). Atlantic salmon complete offshore migrations and may be seasonally present at the offshore wind test site.

Critical habitat has been designated for listed Atlantic salmon pursuant to section 4(b)(2) of the ESA. The critical habitat designation for the GOM DPS includes 45 specific areas occupied by Atlantic salmon at the time of listing that include approximately 19,571 km of perennial River, stream, and estuary habitat and 799 square km of lake habitat within the range of the GOM DPS and in which are found those physical and biological features essential to the conservation of the species. The entire occupied range of the GOM DPS in which critical habitat is designated is within the State of Maine. The project site is not located within designated critical habitat for the Atlantic salmon GOM DPS.

Several species of endangered whales are found seasonally off the coast of Maine and may be present near the Monhegan Island test site. North Atlantic right whales (*Eubalaena glacialis*) are most likely to occur in these waters during the summer and fall. Humpback whales (*Megaptera novaeangliae*) feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States and are likely to be found off the coast of Maine during this time period. Fin whales (*Balaenoptera physalus*) are also present off the coast of Maine during the warmer months. Sei (*Balaenoptera borealis*) and Sperm (*Physter macrocephalus*) whales are also seasonally present in New England waters but are typically found in deeper offshore waters.

Listed sea turtles are occasionally present in Maine waters. The most abundant sea turtle in Maine waters is the Federally endangered leatherback sea turtles (*Dermochelys coriacea*). Threatened loggerhead sea turtles (*Caretta caretta*) may also be occasionally present near the project site. The presence of these species is limited to the summer months.

Under Section 7(a)(2) of the ESA, each Federal agency is required to insure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of any endangered species or threatened species. As such, the DOE should initiate Section 7 consultation for the project prior to issuing funds to evaluate the potential impact of the proposed project on listed species that may occur in the action area, including Atlantic salmon, whales and sea turtles.

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are distributed along the entire East Coast of the United States and have been designated a Candidate Species by NMFS. The best available scientific information indicates that Atlantic sturgeon occur in several river systems in Maine and in Canada (e.g., the Penobscot, Kennebec, Androscoggin and Saint John) and may occur in the action area. In 2006, NMFS initiated a status review for this species to determine if listing as threatened or endangered under the ESA is warranted. The Status Review report is available at: http://www.nero.noaa.gov/prot_res/CandidateSpeciesProgram/AtlSturgeonStatusReviewReport.pdf. NMFS is currently considering the information presented in the 2007 Status Review Report to determine if any listing action pursuant to the ESA is warranted at this time. A listing determination, and, if listing is warranted, any accompanying proposed rule(s), is expected to be published by NMFS in Fall 2010. As a candidate species, Atlantic sturgeon receives no substantive or procedural protection under the ESA; however, NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on Atlantic sturgeon from any proposed project. Please note that if the species is proposed for listing, the conference provisions of the ESA become applicable (see 50 CFR 402.10(e)).

Additionally, under the Magnuson-Stevens Fishery Conservation Act (MSA) the waters off Monhegan Island have been designated as Essential Fish Habitat (EFH) for fifteen federally managed fish species, including red and white hake (*Urophycis chuss* and *U. tenuis)* and those species previously mentioned above. Under the 1996 Amendments (PL 104-267) to the MSA (16 U.S.C § 1801 et seq. (1998)), the DOE is required to consult with NMFS if the DOE's action or proposed action that it funds, permits, or undertakes, may adversely impact any EFH. The Amendments broadly define EFH as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". Under the MSA, the DOE is obligated to consult with NMFS concerning this matter.

As noted previously, the waters of Monhegan Island support numerous other diadromous fish species including American shad, river herring, rainbow smelt, Atlantic tomcod, striped bass, sea lamprey, and American eel. Pursuant to the Fish and Wildlife Coordination Act (16 USC 661, et seq.), the DOE is required to consult with NMFS if an action modifies a water body. The DOE is required to consider recommendations from NMFS to prevent loss of and damage to fish and wildlife resources.

All marine mammals receive protection under the Marine Mammal Protection Act (MMPA) of 1972, as amended. The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. The MMPA established a Federal responsibility to conserve marine mammals with management vested in the Department of Interior for sea otter, walrus, polar bear, dugong, and manatee and Department of Commerce for cetaceans (e.g., whales, dolphins, porpoises) and pinnipeds (e.g., seals). NMFS may issue permits under MMPA Section 104 to persons, including federal agencies such as the DOE, that authorize the taking of specific species of marine mammals. As previously indicated, several marine mammals including gray seals, harbor seals, harbor porpoise, and whales could be affected by the proposed project. As such, NMFS recommends that DOE and/or the University of Maine coordinate with NMFS Office of Protected Resources' Permits, Conservation and Education Division (301-713-2332) to determine if any MMPA authorization is necessary for the proposed action.

Conclusion

We encourage the DOE and the applicant to work with NMFS as project plans become more developed to identify and evaluate the potential for impacts to the species under NMFS' jurisdiction. Additionally, NMFS recommends that the EA include an analysis of likely impacts to the NOAA trust resources identified above. This analysis should include an assessment of impacts to the benthic habitat at the project site as well as the potential for species such as large whales or sea turtles to interact with or become entangled in the mooring system. Informal discussions can greatly facilitate consultation if a decision is made to file a development application at a later stage. NMFS should be consulted early in the planning process for our advice on impact assessment studies. Should you have any questions regarding these comments, please contact Jeff Murphy at (207)866-7379 at our Maine Field Station.

Sincerely,

Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

cc: Norm Dube, MDMR
Wendy Mahaney, USFWS
Daly, F/PR
Boelke, F/NER3
Crocker, F/NER4

File Code: Sec 7 tech assist 2010 – DOE UM offshore wind test site

Subject: Wind power project

AMServiceURLStr: https://Slingshot.hdrinc.com/CFSS/control?view=services/FTService

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From: Edie Caldwell [mailto:edie@edithcaldwell.com]
Sent: Tuesday, October 05, 2010 4:04 AM
To: krautenstrauch@jason.com
Subject: Wind power project

From: Edie Caldwell <edie@edithcaldwell.com>
Date: October 5, 2010 5:58:46 AM EDT (CA)
To: kurt-rautenstrauch@go.doe.gov
Subject: Wind power project

Dear Mr. Rautenstrauch,

I shall not go into the reasons now, but I wanted to let you know that I am totally opposed to the offshore wind turbines being in the Gulf of Maine.

With kind regards to you,

Edie Caldwell
Rockport

Subject: Comments on Monhegan test site
Attachments: MLA_Monhegan Test Site_2010-Oct.pdf

AMServiceURLStr: https://Slingshot.hdrinc.com/CFSS/control?view=services/FTService

From: patrice.f.mccarron@gmail.com [mailto:patrice.f.mccarron@gmail.com] **On Behalf Of** Patrice McCarron (MLA)
Sent: Tuesday, October 05, 2010 8:00 AM
To: krautenstrauch@jason.com
Subject: Comments on Monhegan test site

Please find the attached comments from the Maine Lobstermen's Association on the offshore wind test site off Monhegan Island.

Thank you for your consideration.

--
Patrice McCarron, Executive Director
Maine Lobstermen's Association
21 Western Ave # 1, Kennebunk, ME 04043
207-967-4555 (Office) * 207-205-4544 * 866-407-3770 (Fax)

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Lobstermen's Association, Inc.
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Phone: 207-967-4555 • Fax: 866-407-3770
www.mainelobstermen.org

Department of Energy Golden Field Office
NEPA Division
Attn: Kurt Rautenstrauch
1617 Cole Boulevard
Golden, CO 80401

October 4, 2010

The Maine Lobstermen's Association (MLA), an industry-based fishing organization representing the interests of the Maine lobster industry, is submitting comments in response to the Notice of Scoping for the University of Maine to construct, deploy, and retrieve 1/3 scale floating wind turbines at a deepwater offshore wind test site off Monhegan Island in the Gulf of Maine.

The Maine lobster industry landed nearly 80 million pounds of lobster in 2009, valued at $228 million. Maine's 5,500 commercial lobstermen contribute nearly $1 billion to the state's coastal economy each year.

The MLA has been a close observer of the state of Maine's efforts to become a leader in ocean wind energy by establishing 5 GW of ocean energy by 2030. While we support the state's goal of energy independence from foreign oil, the MLA believes that wind development should proceed with caution and only with full consideration of local community and environment impacts.

The Monhegan Test Site was selected through a careful process which included extensive community outreach and meetings with stakeholders. The MLA strongly urges that the Department of Energy continue to reach out to the effected parties to ensure that all economic, social and environmental concerns are well understood.

Lobstering is the economic backbone of Maine's coastal communities, and the residents of Monhegan are highly dependent upon lobstering. It is imperative that the environmental impacts of the proposed offshore wind development are understood for lobster and other marine species, as well as habitat impacts. It is equally important that fishing patterns for both lobster and other fisheries are well understood. The community must be closely consulted to ensure that all of the economic consequences of potentially removing areas of bottom from their local fishery are understood. Commercial fishing is both an economic livelihood for

Maine's islands and coastal communities, but it is also a way of life. The value of this heritage must be considered.

The MLA continues to cautiously support the development of offshore wind energy along the coast of Maine, but it must be done in a way that is sensitive to our environment, economy and heritage. It is essential to minimize any economic and social dislocation, through outreach and close consultation with effected communities, resulting from ocean energy development projects.

Thank you for your consideration of these comments.

Sincerely,

Patrice McCarron
Executive Director

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

October 4, 2010

Kurt Rautenstrauch
Department of Energy's Golden Field Office
1617 Cole Blvd.
Golden, Colorado 80401

Re: Scoping Comments for Environmental Assessment—University of Maine Deepwater Offshore Wind Test Site, Gulf of Maine

Dear Mr. Rautenstrauch:

In accordance with our responsibilities under Section 309 of the Clean Air Act and the National Environmental Policy Act (NEPA), the Environmental Protection Agency (EPA) has reviewed the Department of Energy (DOE) notice of scoping for an Environmental Assessment (EA) for the proposed University of Maine Deepwater Wind Offshore Wind Test Site. The proposed project includes the design, fabrication and deployment of two one-third scale floating wind turbines in the Gulf of Maine approximately two miles south of Monhegan Island.

EPA requests that the following issues be addressed in the DOE EA to be developed for the test site:

- Fish and shellfish use of the project area, along with any related and fishing and shellfishing; impacts during construction and operation on fish/shellfish as well as fishing activities;
- Habitat characterization of proposed mooring footprint (helix anchors or mooring blocks);
- Consideration of the impacts of alternative mooring designs, depending on substrate conditions;
- Impacts from scouring and sediment deposition associated with moorings;
- If cables will be deployed to anchor the turbines, the EA should characterize benthic habitat and expected impacts along the footprint of the cable corridor;
- If an electricity transmission cable will be installed as part of the project the EA should describe the impacts of laying the cable on the seafloor and at landfall to intertidal or subtidal habitats such as salt marsh, eelgrass, etc.;
- Construction and operation noise effects to marine life including marine mammals;

- Impacts associated with project maintenance, including method, and frequency, of turbine blade washing, and vessel trips;
- How the results of studies on the one-third scale project will be extrapolated to assess the potential impacts of a scaled-up project.

Thank you for the opportunity to offer scoping comments. Please contact me at 617-918-1025 with any comments or questions.

Sincerely,

Timothy Timmermann
Office of Environmental Review

Subject: Scoping - University of Maine Deepwater Offshore Wind Test Site, Gulf of Maine. Part 1 of 2
Attachments: ea_oceanwind_pbw_101810.pdf; ea_oceanwind_pbw_101810.docx; brostrom_jms_2008.pdf; brostrom_huber_emails_july_aug_2010.pdf

AMServiceURLStr: https://Slingshot.hdrinc.com/CFSS/control?view=services/FTService

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From: Ron Huber [mailto:coastwatch@gmail.com]
Sent: Monday, October 18, 2010 12:27 AM
To: krautenstrauch@jason.com
Subject: Scoping - University of Maine Deepwater Offshore Wind Test Site, Gulf of Maine. Part 1 of 2

Dear Mr Rautenstrauch

Attached are our scoping comments regarding the environmental assessment of the effect of the Department of Energy funding the University of Maine Deepwater Offshore Wind Test Site
Also attached are pdf files of documents referenced, cited or alluded to in our comments for addition into the record of the preparation of the environmental assessment. Additional reference documents are being sent by separate email.

Please contact me If you have any difficulty downloading these documents or have any adidtional questions. My telephone # is 207-691-7485. Or you may reach me by return email

Ron Huber

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Ron Huber
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Penobscot Bay Watch

POB 1871, Rockland ME 04841

October 18, 2010

Department of Energy Golden Field Office
NEPA Division
Attn: Kurt Rautenstrauch
116117 Cole Boulevard
Golden, Colorado 80403

Re: Scoping - University of Maine Deepwater Offshore Wind Test Site, Gulf of Maine

Dear Mr. Rautenstrauch

Penobscot Bay Watch is a citizens association dedicated since 1993 to protecting and restoring the living marine resources of Penobscot Bay and the greater Gulf of Maine. Our oversight includes discharge licenses and major development initiatives in Penobscot Bay and surrounding waters, including proposals for industrial ports in upper Penobscot Bay and offshore energy facilities such as those proposed off Monhegan Island and beyond. To that end we participate in state and federal permitting and licensing processes as appropriate.

We are writing in response to the Department of Energy's Notice of Scoping for An Environmental Assessment of the effect of funding the University of Maine Deepwater Offshore Wind Test Site. The Department of Energy (DOE) has invited comment from the interested public to supply information that will aid the department in determining whether the proposed action warrants issuance of a Finding of No Significant Impact, or requires preparation of an Environmental Impact Statement.

Having reviewed the complete record of information used by the Maine Bureau of Parks and Lands in its decision making process designating the site under present consideration, as well as numerous other sources of information about the resources at risk, we strongly believe that sufficient uncertainties exist, both onsite and offsite, to warrant preparation of an environmental impact statement prior to the Department of Energy making a final decision as to whether the Monhegan site if the most appropriate of the alternatives. Given the facts, we do not believe that it remotely possible for the Department to decide otherwise without making a mockery of NEPA.

While the amount of funding is not specified in the notice, over the past year and a half, the University of Maine *"has been awarded nearly $40 million in funding to pursue research in deepwater offshore wind energy technology," according to* Elizabeth Viselli of the University of Maine's DeepCWind Consortium. At least twenty million dollars of that are the subject of this Environmental Assessment , if not all forty millions.

We note that, while the public notice describes the proposal to "construct, deploy. and retrieve 1//3-scale floating wind turbines within the deepwater offshore wind test site", the University of Maine states that these funds also "will be used to build, deploy and test a full-scale prototype of a 5 megawatt floating wind turbine" source: Elizabeth Viselli.

Unless the DOE will specifically disallow these funds to be used for that second purpose, then the impact of the deploying and testing (i.e. operation) of the full sized floating turbine must also be factored into this Environmental Assessment.

SCOPE OF REVIEW

We ask that the DOE consider as broad a geographic scope as possible.

1. Impacts to both the two square mile footprint of the demonstration test site and to the ill-defined but foreseeable footprint of the site farther offshore where the full-sized floating wind turbine will be deployed as part of this expenditure of DOE funds.

2. Impacts to the Eastern Maine Coastal Current, the Western Maine Coastal Current and other existing oceanographic structure of the Gulf of Maine that will be impacted by deployment of the test and full sized floating turbines.

3. Impacts to Gulf of Maine lobster larvae migration from alterations in existing Gulf of Maine current dynamics caused by deployment of floating deepwater wind turbines in hydrodynamically sensitive areas.

4 Impacts to Gulf of Maine nutrient flows and to overall seasonally significant geographic concentrations of finfisheries, due to alterations in existing Gulf of Maine current dynamics and alterations in thermal structure of the water column of the footpring of floating deepwater turbines.

5. Impacts to irreplaceable scenic resources of state and national significance from deploying this test project off of Monhegan Island, as opposed far lesser impacts from deploying in one of the other two locations chosen by the state of Maine as deepwater test areas, but relegated to later development, if at all.

6. Impacts to Atlantic puffins and other seabirds known and documented to overfly the area of the proposed wind test site off Monhegan.

7. Impacts to land birds known and documented as seasonally migrating through the location off Monhegan proposed for the University of Maine's deepwater wind site

AT ISSUE

Below we will describe general and site specific issues of unavoidable adverse impacts, followed by citations and excerpts or complete copies of relevant peer reviewed research, followed by information gathered by competent bird naturalists, that is worthy of consideration in the Department's Environmental Assessment.

1. Unavoidable adverse impacts of artificially modified ocean wind on oceanic processes. Winds play in key role in many natural marine processes, including the natural Ekman Transport of energy from air to water; ocean surface circulation (particularly at gyres); vertical water motion; mixing of upper ocean layers; upwelling of deep, often nutrient-rich, anoxic waters to the surface, and downwelling of oxygen rich waters to the lower water column

The operation of an ocean windfarm's turbines creates an in-situ forced 1 meter/day upwelling process in the water column beneath that facility. *(1) Brostrom 2008*

By artificially and continuously impacting the natural Ekman Transport within the windturbine complex's energy footprint, ocean windfarms, by their very nature as moored or monopiled in-place energy *sinks*, appear to act as anthropogenically generated artificial gyres, capable of generating eddies and other perturbations of the water column and nearby water currents, with implications for additional

The Gulf of Maine's marine ecosystem has evolved and adapted to seasonally predictable gyres and eddies. The addition of year-round in-place artificial gyres to the hydrodynamics of the Gulf of Maine is highly likely to have discernable impacts on its surface water characteristics and currents, with consequences for transport of lobster larvae and those of other animal species, as well as for the timing of Gulf of Maine phytoplankton blooms.

It is the duty of the Department of Energy to determine the significance of those impacts and those consequences before setting out any locations for development of offshore renewable energy .

2. Unavoidable adverse impacts to a nationally significant scenic Monhegan viewshed.

Lobster Cove on the southern tip of Monhegan, possesses nationally significant scenic resources. It is reachable only by pedestrian footpath and is one of the most popular destinations for day tripping tourists visiting the island,. It is also a place of pilgrimage for generations of fine artists, who annually in their hundreds paint the views of and from Lobster Cove, where the deep waters of the Gulf of Maine are cut by the granite shieldwall of the continent, and by barely glimpsed archipelagoes far to south'ard. The deep dark of the Atlantic ocean, and the clear starfields, presentlyclaim the night here.

The proposed deployment of prototype small and full sized wind turbines at this site for an indefinite number of years and renewals will unavoidably adversely impact this nationally significant viewshed:

During the daytime, the turning blades will modify the optical experience of dawn, from numerous places on the island, and throughout the day will command the visual attention of all who gaze to the south upon the Gulf of Maine viewscape, including those visiting publicly-accessible Lobster Cove, artist and casual tourist alike.

At night the safety lights atop the turbines, blinking and occasionally flared by the passing blades, will similarly command the attention of those viewing the evening skies and starshed south of Monhegan.

It is not known what the sonic impact of the prototype turbines will be on the public and the artists enjoying Lobster Cove, however, sonic pollution both in the audible spectrum and "infrasound" are problems that challenge people living similar distances from landbased wind.

3. Unavoidable adverse impacts to a unique island bird population and to an internationally nationally significant migratory bird route along the Atlantic Seaboard.

Birds living on or transiting Monhegan - and the site where the full scale 5 megawatt ocean wind turbine will be deployed, if outside the Monhegan test center's waters - will be adversely impacted if the project's wind turbines are funded, built, deployed and operated. Birds have been counted off Monhegan and other outer Penobscot Bay islands since the 1940s

Lobster Cove, the public beach on Monhegan whose nationally significant scenic viewshed is reachable only by pedestrian footpath, is also very popular as a location for ornithologists desiring to count migrating birds heading north or south in great numbers during the same times of year that the prototype windturbines would be deployed - summer and autumn.

Maine Bureau of Parks and Lands erroneously concluded in its decision approving the Monhegan Deepwater Test Area that little impact was likely to birds from development and operation of this project. That decision is under review by Maine Superior Court

To the contrary, however, the records of recent and historic professional and amateur ornithologists experienced with the bird life of Monhegan and the waters south of the island show a very heavy use of the island and those waters by a large number of residential and migratory bird species.

* Bird sitings on Monhegan. September 14 to September 28, 2010 . Bryan Pfeiffer professional bird naturalist, author and consultant, identified 122 bird species during a visit to Monhegan from September 14th to September 28, 2010. (List below)

* Maine eBird, sponsored by Audubon and Cornell Laboratory of Ornithology, recorded 202 bird species during 2009 & 2010. (List below.)

* Bird sitings on Monhegan, July2 2010 to October 16, 2010 These are primarily from Lobster Cove, the public beach on Monhegan whose nationally significant scenic viewshed includes the location slated for the proposed Monhegan Deepwater Wind Test Area. Migrating birds heading south along the atlantic flyway pass over Penobscot Bay then stop at Monhegan in great numbers during the times of year that the prototype windturbines would be deployed - summer and autumn.

They were made by ornithologist Tom Magarian and submitted by him to the Maine-Bird online forum & archive. (List below) Magarian is a professional ornithologist who works with New Jersey Audubon. He has been tasked to carry out radar sitings of birds off Lobster Cove, Monhegan. The visual observations he recorded (see below) are a supplement to those readings, by this highly qualified individual. His email address: tmagarian@alumni.unity.edu

Because the funds being released by Department of Energy will be used to build, deploy and test both one or more 1/3 scale test prototypes, *and* "*a full-scale prototype of a 5 megawatt floating wind turbine*", according to Elizabeth Viselli of the University of Maine-led DeepCwind Consortium, the environmental assessment needs to acknowledge the potential impacts of both size turbines on birds.

Nothing is known about the proposed location for deploying the full scale 5 megawatt floating turbine. Neither the Bureau of Parks and Lands designation of the deepwater wind test area off Monhegan, nor the enabling law MRSA 12 §1868. Identification of offshore wind energy test areas" limit the size of prototypes that may be deployed in the test center's waters. However, the expectation among Monhegan residents is that deployment will be limited there to 1/3 sized prototypes, not full sized ones.

Unless the University proposes to renege on its informal agreement with the Monhegan community to limit deployments off their island to 1/3 sized prototypes, it will have to either choose one of the other two wind test areas, or consider some hitherto undisclosed location elsewhere. If so, then a range of alternative locations needs to be selected, examined and ranked, prior to final determination and the releasing of funds to the University of Maine, as construction and deployment of this full size windturbine will take place only with the authorization of the DOE funds under present consideration.

4. Unavoidable adverse impacts to Fisheries

Direct impacts upon commercial and recreational fisheries and pleasure sailors include the exclusion zone directly around each windturbine, as well as, for fishers with bottom tending gear, cable areas and other seafloor installations of the wind project.

Direct impacts to important fishing feeding and breeding and nursery areas, if turbines are deployed there. Indirect impacts by deploying windturbines in migratory pathways of fish, shellfish or prey species, due to the upwelling and thermal modification of ocean hydrology per *Brostrom 2008* and other researchers cited in above.

In summary, because deployment of a full scale 5 megawatt floating turbine is a reasonably anticipated outcome of the DOE releasing these funds, the adverse impacts that it could likely have on birds and fish inside and outside the immediate footprint of the offshore test area needs to be considered. The Environmental Assessment will be deficient if it does not acknowledge and include the reasonably foreseeable impacts to managed and protected resources.

Viable alternatives to the proposed project.

The state of Maine identified eight sites in Maine state waters as potentially appropriate for hosting Maine's Offshore Wind Energy Test Areas. These sites were winnowed down to three locations in 2009; of those three, the easternmost site, two miles south of Monhegan, was chosen on December 14, 2009 to host the Maine Offshore Wind Research Center.

The state's decision to locate the Offshore Wind Research Center off Monhegan is being contested in Maine Superior Court as of October 18, 2010. The petitioner suggests that the Bureau of Parks and Lands has underemphasized likely impacts to Monhegan scenic and bird resources, due to a pre-made decision to locate the University of Maine deepwater test site off Monhegan Island for logistical reasons.

The Department of Energy has an opportunity to reexamine the record of the BPL's decision, coupled with and tempered by additional information that extends the Bureau's overly narrow definition of scenic , fishery and avian resources at risk to one more consistent with natural resource conservation and scenic resource preservation standards under federal law.

Irreversible and irretrievable commitments of resources.

Because the project being considered for funding by the Department of Energy would build and deploy floating renewable energy facilities that would be anchored or moored in place, irreversible and irretrievable commitments of resources will be far fewer than those of fixed monopile wind turbines, such as those approved off southern Massachusetts.

Should the site prove unsuitable due to unacceptable adverse impacts to living and/or non living marine resources. the floating facilities can be towed to different locations or returned to shore, for, maintenance, modification or recycling.

Conclusion. We strongly believe that sufficient uncertainties exist, both onsite and offsite, of the nature and extent of the adverse impacts of this project to warrant preparation of an environmental impact statement prior to the Department of Energy making a final decision as to whether the Monhegan site is the most appropriate of the alternatives. Given the facts, we do not believe it possible for the Department to decide otherwise.

We ask that the DOE consider as broad a geographic scope as possible. that it consider:

1. Impacts to both the two square mile footprint of the demonstration test site and to the ill-defined but foreseeable footprint of the site farther offshore where the full-sized floating wind turbine will be deployed as part of this expenditure of DOE funds.

2. Impacts to the Eastern Maine Coastal Current, the Western Maine Coastal Current and other existing oceanographic structure of the Gulf of Maine that will be impacted by deployment of the test and full sized floating turbines.

3. Impacts to Gulf of Maine lobster larvae migration from alterations in existing Gulf of Maine current dynamics caused by deployment of floating deepwater wind turbines in hydrodynamically sensitive areas.

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See attachments, below.

Sincerely

Ron Huber

Ron Huber
Penobscot Bay Watch

Attachments (pdf files)

* On the influence of large wind farms on the upper ocean circulation by Goram Brostrom, Norwegian Meteorology Institute. 2008

* Goram Brostrom. August 2010 . Personal communication
* Weather response to a large wind turbine array D. B. Barrie and D. B. Kirk-Davidoff University of Maryland Department of Atmospheric and Oceanic Science, Atmos. Chem. Phys. Discuss.: 29 January 2009
* Potential climatic impacts and reliability of very large-scale wind farms 2009" by C. Wang and R. G. Prinn
* Bird sitings off Monhegan's Lobster Cove, July 2, to October 16, 2010, _by Audubon ornithologist Tom Magarian
* Maine eBird Monhegan listings 2009-2010. Cornell Laboratory & Audubon
* Bird Observations, Monhegan, September 2010 Bird naturalist Bryan Pfeiffer
* Notes on a Fall Migration at Matinicus Rock, 1949 Rosario Mazzeo
* Gulf of Maine Circulation
* Gulf of Maine Fishing Grounds

Journal of Marine Systems 74 (2008) 585–591

Contents lists available at ScienceDirect

Journal of Marine Systems

journal homepage: www.elsevier.com/locate/jmarsys

On the influence of large wind farms on the upper ocean circulation

Göran Broström

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ARTICLE INFO

Article history:
Received 21 May 2007
Received in revised form 25 April 2008
Accepted 2 May 2008
Available online 15 May 2008

Keywords:
Wind farm
Wind forcing
Upwelling
Ocean dynamics

ABSTRACT

Large wind farms exert a significant disturbance on the wind speed in the vicinity of the installation and in this study we outline the oceanic response to the wind wake from a large wind farm placed in the ocean. We find that the size of the wind wake is an important factor for the oceanic response to the wind farm. We show through simple analytical models and idealized numerical experiments that a wind speed of 5–10 m/s may generate upwelling/downwelling velocities exceeding 1 m/day if the characteristic width of the wind wake is of the same size or larger than the internal radius of deformation. The generated upwelling is sufficiently enough that the local ecosystem will most likely be strongly influenced by the presence of a wind farm.

1. Introduction

It is predicted that large open-water wind farms will become much more frequent in the decades to come (Archer and Jacobson, 2003, 2005; Henderson et al., 2003; Kooijman et al., 2003; Hasager et al., 2006). There are certain advantages with oceanic wind farms, not least the higher wind speeds and locations away from densely populated areas. On the negative side are large costs of establishing and maintaining wind farms out in the open water (Byrne and Houlsby, 2003), wave forces on the structures, disturbance of ship traffic, and environmental effects among others.

Although there are a number of plans and studies for large wind farms in the open ocean the environmental consequence are not well known and much of the literature is in a so called gray form represented by reports, theses etc. Presently, the environmental focus has mainly been on the direct consequences of the solid structures of the wind farm on the oceanic environment. The establishment of solid structures will probably act as artificial reefs creating new highly productive areas in the sea. Other possible environmental consequences may be the impact of electric cables on the fish migrations (Branover et al., 1971; Wiltschko and Wiltschko, 1995), effects of sound generated by the power plant on the fauna (Sand and Karlsen, 1986; Karlsen, 1992; Knudsen et al., 1992; Karlsen et al., 2004; Hastings and Popper, 2005), shadowing from the wind mills, and bird and bat collisions with the wind mills (Tucker, 1996a,b; Garthe and Hüppop, 2004; Wiggelinkhuizen et al., 2006). There is probably also an influence of the wind farm on the local climate (Baidya Roy and Pacala, 2004; Rooijmans, 2004) as well as on the global climate if wind farms become abundant (Keith et al., 2004).

In this study we outline how the presence of a large wind farm, which changes the wind stress at the sea surface, affects the upper ocean response to wind forcing. Using general theoretical arguments we show that large wind farms may have a direct, and strong, impact on the circulation pattern around the installation. In particular, if the wind farm is large enough variations in the wind will create upwelling and downwelling patterns around the wind farm through divergence in the Ekman transport. The main theoretical description is based on the so called reduced gravity model, which describes the dynamics of a buoyant layer on top of a dense stagnant layer. The theoretical framework follows standard derivations used in the geophysical fluid dynamics (Gill, 1982; Pedlosky, 1987) and the analysis shows that the oceanic response is more sensitive to the curl of the wind stress than to the wind stress itself. In the open ocean, the curl of the wind stress is usually relatively small as the gradients in the wind forcing are set by the scale of atmospheric low-pressure systems, which are much larger than the corresponding dynamical scales of the ocean. The presence of a wind farm

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doi:10.1016/j.jmarsys.2008.05.001

will generate an unnaturally strong horizontal shear in the wind stress, which creates a large curl of the wind stress that causes a divergence/convergence in the upper ocean. We find that the impact on the ocean currents will increase with the size of the wind farm, and when the size is comparable with the internal radius of deformation (or internal Rossby radius) we expect to find a circulation, and an associated upwelling pattern, to be excited by the wind farm. Using a simple example we show that a wind speed of 5–10 m/s can induce an upwelling exceeding 1/m day. It is well known that upwelling can have significant impact on the local ecosystem (e.g., Okkonen and Niebauer, 1995; Valiela, 1995; Botsford et al., 2003; Dugdale et al., 2006). Thus, as upwelling of nutrient rich deep water represent the main source of nutrients during summer in most oceanic areas it is likely that the upwelling induced by a wind farm will imply an increased primary production, which may affect the local ecosystem.

There are some notable similarities between the proposed upwelling process and some natural upwelling systems generated by divergence in the Ekman transport due to wind curls at coastal boundaries (Dugdale et al., 2006; Fennel and Lass 2007) or the marginal ice zone (MIZ) (Røed and O'Brian, 1983; Okkonen and Niebauer, 1995; Fennel and Johannessen, 1998). For the present scenario, the MIZ studies are probably most relevant: Røed and O'Brian (1983) estimated upwelling velocities of order 5 m/day for reasonable wind speeds while Okkonen and Niebauer (1995) invoked upwelling velocities of up to 8 m/day, which were seen to fuel an extensive bloom in the MIZ.

In Section 2, the basic equations that describe the structure of the oceanic response to wind forcing in the vicinity of a wind farm are outlined. Some dynamical features of these equations are described in Section 3, while Section 4 is devoted to discussion of the results.

2. Basic equations

In this section we will outline some simple equations that describe a buoyant surface layer on top of a stagnant deep layer; these equations are very similar to the equations describing the barotropic flow and are generally referred to as the reduced gravity model, or a 1 1/2 layer model. The model is based on integration over the active upper layer and is thus two-dimensional; vertical velocity is manifested as a vertical movement of the pycnocline and is thus included implicitly. It should be remembered that certain conditions must be fulfilled for the reduced gravity model to be valid; the reasonableness of these assumptions can be questioned for the outlined scenarios. However, the reduced gravity model highlights a number of processes that may be important in the vicinity of large wind farms, and the primary aim of the present study is to outline the basic response of the upper ocean to a large wind farm, not to describe these processes in detail.

2.1. Form and strength of wind drag

The form and strength of the perturbations in the wind stress is the basic driving mechanism of this study. The wind stresses used in this study are in the x-direction and the wind farm creates a disturbance that is strongest in the y-direction. We will consider two simple forms of the wind stress: 1) A wind stress that is homogenous in the x-direction such that analytical solutions can be found and 2) a wind wind-stress pattern having a more realistic two-dimensional form. The stresses are given by

$$\begin{aligned} \tau_x &= \tau_{x0} - \Delta\tau_x e^{-(2y/L)^2}, \\ \tau_x &= \tau_{x0} - \Delta\tau_x e^{-(2y/(0.8L+0.2x))^2} \; max \quad \left(e^{-(1-x)/L} x/L, 0\right), \end{aligned} \qquad (1a, b)$$

where τ_{x0} is the wind stress outside the influence of the wind farm, $\Delta\tau_x$ reflect the change in the wind stress induced by the wind farm, and L is the characteristic size of the wind farm. For the more realistic scenario we assume that the wind deficit is zero at the upwind end of the wind farm, reaches a maximum at the end of the farm and declines downwind from the farm with a characteristic length scale L. We also assume that the width of the wind deficit increases in the downwind direction, as expected from turbulent mixing and meandering of the wake. The shapes of the proposed wind stresses are shown in Fig. (1), and follow loosely results from recent studies (Barthelmie et al., 2003; Corten and Brand, 2004; Corten et al., 2004; Hegberg et al., 2004; Christiansen and Hasager, 2005; Hasager et al., 2006). However, it should

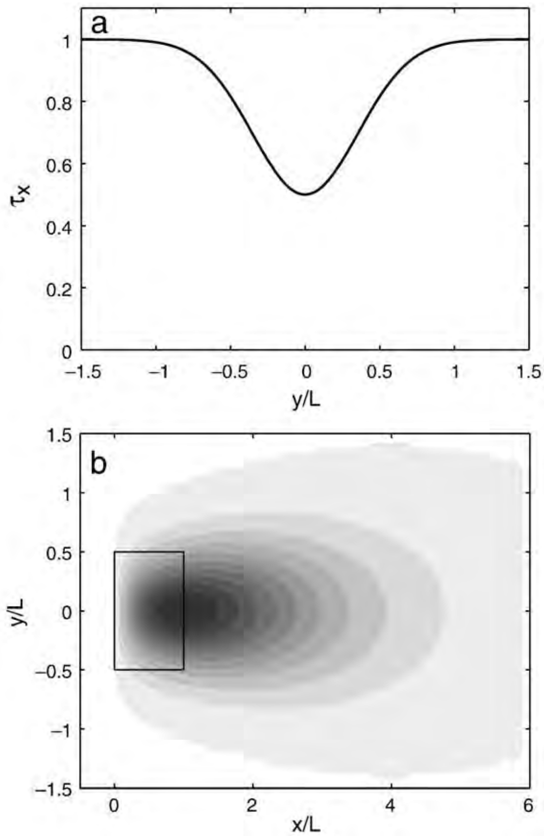

Fig. 1. The wind-stress deficit used in this study. a) Cross section of the one one-dimensional case used for analytical studies and b) map of the more realistic wind-stress deficit, where also the extent of the wind farm is displayed by a black line.

be noted that further investigations focusing on the wind stress at the sea surface are required for more accurate predictions, and specifications, of how a large wind farm influence the wind stress at the sea surface.

2.2. Basic shallow water equations

Let us consider an ocean that rotates with the angular speed $f/2$, where f is the Coriolis parameter, and having an active upper layer with thickness h and density $\rho-\Delta\rho$ overlying an infinitely deep passive layer with density ρ. The horizontal coordinates are x and y; the vertical coordinate is z, which is zero at the sea surface and positive upwards. The bottom of the active layer is located at $z=-h(x,y)$ while the free surface is located at $z=0$ according to the rigid lid approximation (see Fig. 2).

The flow in the active upper layer can be described by integrating the Navier-Stokes and continuity equations from the bottom of the active layer to the surface, and by applying the hydrostatic approximation. Neglecting the non-linear terms for simplicity (although it should be recognized that they are in general not negligible), the linear reduced gravity equations in transport form become

$$\begin{aligned}
&\frac{\partial U}{\partial t}-fV = -g'h_0\frac{\partial h}{\partial x}+\frac{1}{\rho}\tau_x,\\
&\frac{\partial V}{\partial t}+fU = -g'h_0\frac{\partial h}{\partial y}+\frac{1}{\rho}\tau_y,\\
&\frac{\partial h}{\partial t}+\left(\frac{\partial U}{\partial x}+\frac{\partial V}{\partial y}\right) = 0,
\end{aligned} \qquad (2a–c)$$

where U and V are the mass transports in x and y directions, respectively, $g'=g\Delta\rho/\rho$ is the reduced gravity, h_0 is the initial thickness of the upper layer and we will assume that h_0=const, τ_x, $\tau_y=(\tau_x^S-\tau_x^B,\tau_y^S-\tau_y^B)$ are the stresses acting on the water column where τ_x^S, τ_y^S, are the surface stresses and τ_x^B, τ_y^B are the stresses at the bottom of the active layer (τ_x^B, τ_y^B are assumed to be zero in this study). An important assumption for the reduced gravity model is that the bottom layer should be deep and stagnant; furthermore, the amplitude in h must be small: These assumptions may be questionable for wind farms placed in

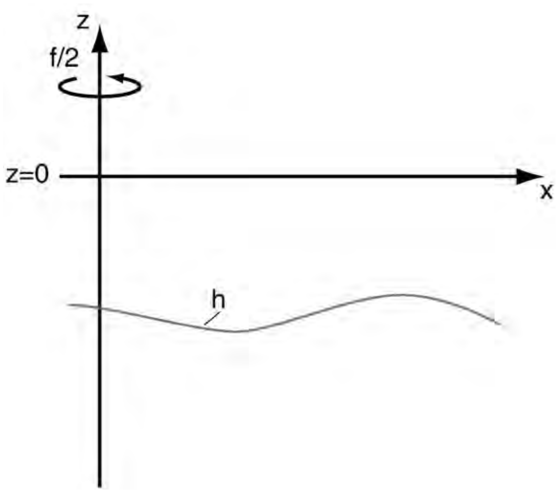

Fig. 2. Schematic picture of the geometric settings used in this study.

relatively shallow water. As a final remark it may seem strange that the gradient of the slope at the lower boundary appears to induce a force in the upper layer; the force comes really from the sloping surface and the slope in the lower layer only removes the pressure gradient from the surface down into the stagnant deep layer. However, the changes in the surface elevation are small and can be neglected in the remaining analysis, and this is the rigid lid approximation.

2.3. General equation for h

The response of the thickness of the upper layer to wind forcing is the key feature in the reduced gravity model. If the thickness of the upper layer is known, the velocities of the system are easily calculated. After some manipulations of Eq. (2) we find (Gill, 1982; Pedlosky, 1987)

$$\frac{\partial}{\partial t}\left[\left(\frac{\partial^2}{\partial t^2}+f^2\right)h-\nabla\cdot(gh_0\nabla h)\right] = -\frac{f}{\rho}curl(\tau)-\frac{1}{\rho}\frac{\partial}{\partial t}\nabla\cdot\tau. \qquad (3)$$

Eq. (3) is very general and describes an extensive set of phenomena where the reduced gravity approximation is valid. A normal problem in using this equation is to find appropriate boundary conditions (Gill, 1982; Pedlosky, 1987); for the reduced gravity model we will simply assume that $h=h_0$ at the boundaries or that it is bounded at infinity.

In the following analysis we will neglect fast transients such that the second order time derivative in Eq. (3) can be neglected (i.e., we neglect internal gravity waves, the geostrophic adjustment process and all processes for small time $t<f$). Furthermore we assume that the wind forcing is constant and neglect the last term. It is convenient to use non-dimensional variables and we thus introduce the scales $t=t'f^{-1}$, $(x,y)=(x',y')L$, and $h=h'\Delta\tau/f\rho L$: We have (dropping the primes on the non-dimensional variables)

$$\frac{\partial}{\partial t}(h-a^2\nabla^2h) = -curl\left(\frac{\tau}{\Delta\tau}\right), \qquad (4)$$

where $a=\sqrt{g'h_0}/fL$ is a non-dimensional number (here considered as constant) identified as the internal radius of deformation, or the internal Rossby radius, divided by the size of the wind farm. Eq. (4) is easily integrated in time such that

$$(h-h_0)-a^2\nabla^2(h-h_0) = -tcurl\left(\frac{\tau}{\Delta\tau}\right), \qquad (5)$$

where h_0 is the initial non-dimensional depth of the pycnocline. For the one-dimensional case there exists an analytical solution whereas we solve this equation numerically for two dimensions. The important lesson to be learnt from Eq. (5) is that the depth of the pycnocline changes linearly in time, i.e., $(h-h_0)/t$ has a self-similar solution, and that the rate depends linearly on the strength of the wind-stress curl.

3. Some dynamical features of the equations

3.1. Analytical time-dependent solution for zonal wind forcing

In this section we aim at finding some analytical results. To highlight the ocean response to wind forcing we consider a wind distribution in the form of a Gaussian, as outlined by Eq. (1a). From Eq. (5) we find that

$$(h{-}h_0){-}a^2\frac{\partial^2}{\partial y^2}(h{-}h_0) = -t\frac{1}{\Delta\tau_x}\frac{\partial\tau_x}{\partial y}. \tag{6}$$

To obtain the full structure of the solution it is necessary to also solve an inhomogeneous Helmholtz equation. Assuming that the wind stress has a Gaussian distribution (Eq. (1a)), and by requiring that the solution is bounded at infinity we find the following solution

$$\begin{aligned} h(t,y){-}h_0 =\, & t\frac{\sqrt{\pi}}{16a^2}e^{-\frac{1}{8a^2}}\left[e^{\frac{2y}{a}}\left(1-erfc\left(\frac{1}{4a}+2y\right)\right)\right. \\ & \left.-e^{-\frac{2y}{a}}\left(1-erfc\left(\frac{1}{4a}+2y\right)\right)\right] \end{aligned} \tag{7}$$

where erfc is the error function. The disturbance of the upper layer thickness thus increases linearly with time and is proportional to the magnitude of the wake. Due to the dynamics of the geostrophic adjustment process the signal has a form that depends on the non-dimensional parameter a (Fig. 3) (again a is a measure of how large the internal deformation radius is compared to the size of the wind farm). If the variation in wind has a length scale that is much larger than the internal deformation radius the form of the disturbance is fully governed by the form of the wind curl (as seen by setting $a=0$ in Eq. (6)). However, if the structure of the wind field is of the same, or smaller, dimension than the internal deformation radius the ocean responds by distributing the signal over an area with a characteristic width corresponding to the internal deformation radius. It should also be noted that the amplitude of the signal becomes smaller for large values of a^2.

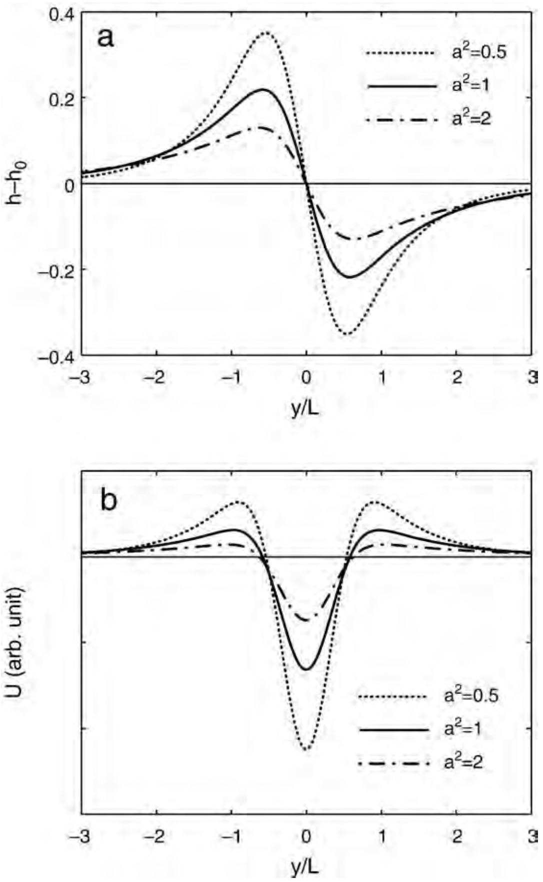

Fig. 3. a) The form of the disturbance in thickness of the upper layer and b) the geostrophic velocity for various number of the a^2 parameter (here the wind forcing is given by $\tau_x=e^{-(2y)^2}$).

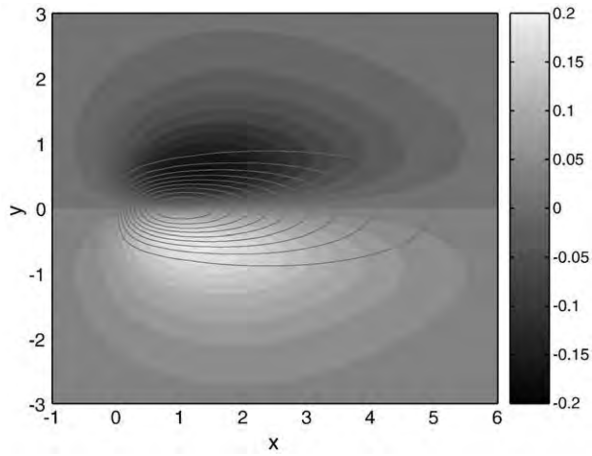

Fig. 4. The spatial structure of the disturbance in thickness of the upper layer for $a^2=1$ and $t=1$. Gray lines represent the wake in the wind forcing.

3.2. More general time-dependent numerical solution

In two dimensions it is more difficult to find analytical solutions and we rely on numerical solutions using the self adapting finite element technique implemented in FEMLAB® package, the relative tolerance was set to 10^{-6} and two refinements of the grid were made (the self adaptation implies that the resolution will depend on the parameter a^2). It should be remembered that the linear solution predicts that the shape of the response is self-similar and will not change in

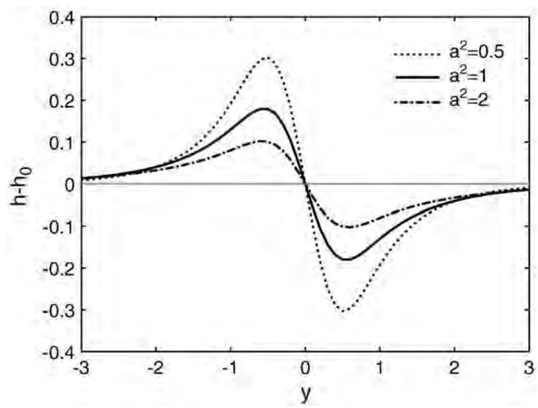

Fig. 5. Section of the disturbance in thickness of the upper layer at the downwind end of the wind farm.

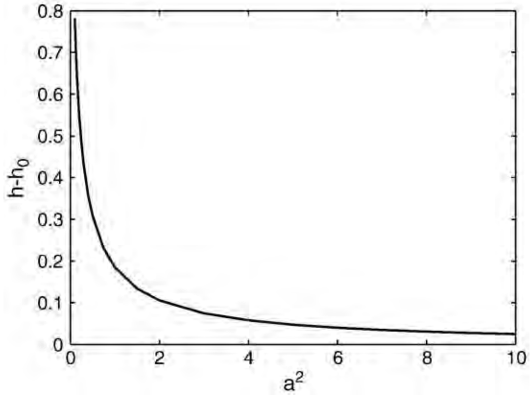

Fig. 6. The maximum amplitude of the disturbance in thickness of the upper layer as a function of a^2.

time and we evaluate the solution at $t=1$ (Fig. 4). From Fig. (5) we see that the pycnocline will rise on the southern side of the wind farm and will be depressed on the northern side. The ocean response follows the wind pattern to a large degree, although the signal covers a slightly larger area than the wind wake as expected from the geostrophic adjustment process.

The spatial response depends critically on the deformation radius, and cross sections of the pycnocline position at $x=1$ (at the downwind end of the wind farm) are displayed in Fig. (5); for $a^2=1$ the amplitude is about 25% of the amplitude for small a^2. Apparently, the geostrophic adjustment process mixes the positive and negative response appearing on each side of the wind wake such that the magnitude of the response becomes weaker. It is a notable feature that the response for increasing value of a^2 becomes wider as well. A key parameter for the environmental influence is the strength of the upwelling and the maximum value of the pycnocline height as a function of a^2 is shown in Fig. (6). Again we see that the amplitude of the response decreases rapidly with a^2, showing that a key parameter for the ocean response is the physical size of the wind wake.

Inserting $f=1.2\cdot10^{-4}$ s^{-1}, $h_0=10$ m, $\Delta\rho=2$ kg/m^3, we find that the internal radius of deformation is 3.7 km and using $L=5$ km we find $a^2\approx0.54$, which implies that there should be an important signal from a 5 km wide wind farm on the upwelling pattern. The upwelling velocity can be estimated from the horizontal shear in the wind wind-stress times the spatial distribution/influence of the response as outlined in Figs. (5) and (6), and we thus expect the maximum upwelling velocity to be roughly $\Delta\tau_x/(\rho fL)\cdot0.3\approx1$ m/day for the case with $\Delta\tau_x=0.025$ N/m^2, and $a^2\approx0.54$. It should be noted that this only gives a very rough estimate of the upwelling velocity. When the disturbances grow larger it is expected that non-linear terms, lower-layer motions, and bottom friction become important. Anyway, the predicted upwelling velocity

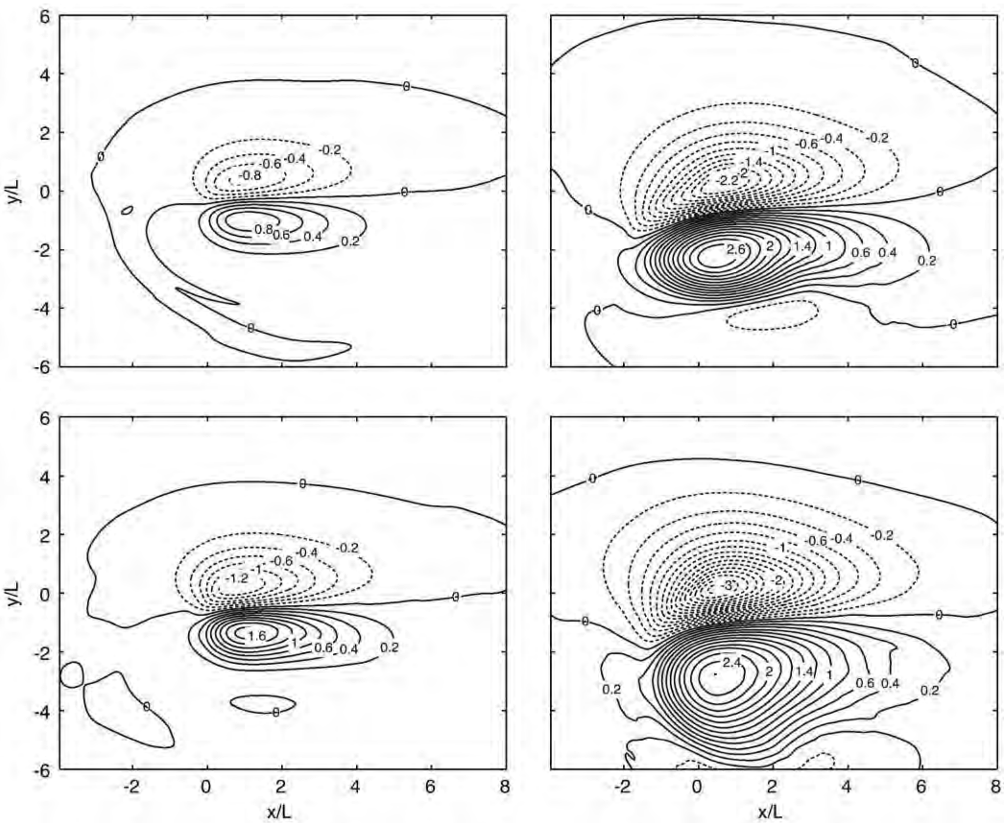

Fig. 7. The spatial structure of the disturbance in the mixed layer depth after 1 day (left panels) and 5 days (right panels) for wind forcing $\tau_{x0}=0.05$ N/m^2, $\Delta\tau_x=0.025$ N/m^2 (upper panels), and $\tau_{x0}=0.1$ N/m^2, $\Delta\tau_x=0.05$ N/m^2, (lower panels).

would provide a very strong forcing on the ecosystem in the vicinity of the wind farm during typical summer situations.

3.3. Results from a general circulation model

We end this section by showing results from some simple experiments carried out with the MITgcm general circulation model (Marshall et al., 1997a,b), which provides a non-linear as well as a full three-dimensional solution; we use the model in its hydrostatic mode although it has non-hydrostatic capability. To describe mixing in the upper ocean we apply the KPP turbulence mixing scheme (Large et al., 1994). We here assume that $L=5$ km and that the ocean is 20 m deep, and we apply no slip condition at the bottom (notably the KPP model will calculate the velocity at the first grid point according to a quadratic law). The temperature is 10 °C below −10 m and is 20 °C above −10 m, and we use a linear equation of state such that $\rho=\rho_0(1-\alpha T)$, where $\rho_0=1000$ kg m^{-3} and $\alpha=2\cdot10^{-4}$ K^{-1}. $f=1.2\cdot10^{-4}$ is taken as constant. The horizontal resolution is 200 m and the domain stretches from $x=-5L$ to $15L$ and from $y=-10L$ to $10L$, and we apply periodic boundary conditions. In the vertical we use 0.5 m resolution. The wind is applied instantaneously to an ocean at rest.

To visualize the ocean response to the wind forcing we define the following quantity

$$\Delta H_{\mathrm{ml}} = h_0 - \frac{1}{T_{\mathrm{U}}-T_{\mathrm{B}}}\int_{-H}^{0}(T-T_{\mathrm{B}})dz, \tag{8}$$

where $h_0=10$ m is the initial position of the thermocline, $(T_{\mathrm{U}}, T_{\mathrm{B}})=(20,10)$ °C is the initial temperature of the upper and lower layers, respectively. The right-hand side of Eq. (6) will essentially measure the depth of the 10 °C isotherm, and subtracting this from the initial position of the 10 °C isotherm ΔH_{ml} will measure the amount of upwelling at a certain location.

The distributions of ΔH_{ml} after 1 resp. 5 days and a wind stress corresponding roughly to a wind speed 5 and 7.5 m/s (using a drag coefficient of $1.5\cdot10^{-3}$) are displayed in Fig. (7). The initial magnitude of the upwelling/downwelling is on the order of 0.8 m/day for the weak wind case, and is about 1.5 m/day for the strong wind case (Fig. 7a, c) in rough agreement with the theoretical estimates presented in Section 3.2 (i.e., 1 m/day and 2 m/day, respectively). However, after some time, say 2–3 days, the response becomes weaker, this weakening being most evident in the strong wind-forcing case. Most likely, non-linear effects become important as the amplitude of the disturbance grows. (The Rossby number (U/Lf) that measures the importance of non-linear terms relative to the Coriolis force is of order unity for $U=0.6$ m/s, furthermore the movements of the pycnocline are not negligible; we thus expect that the non-linear terms are important, but they do not dominate the system). Internal friction may be important but due to weak velocities in the lower layer we do not expect bottom friction to be important. Furthermore, it is clear from the numerical experiments that the shape of the disturbance changes and become wider with time.

Another striking property of the numerical model solution is that the response tends to become asymmetric with time, which is not predicted by the linear model. Notably, the depression of the pycnocline is wider and by smaller amplitude than the response in the upwelling sector. A possible explanation is that the upwelling leads to a cyclonic circulation while the downwelling generates an anti-cyclonic circulation. It is known in geophysical fluid dynamics that there are certain differences between cyclonic and anti-cyclonic eddies. However, an analysis of the dipole structure seen in these experiments is beyond the scope of the present study.

4. Results and discussion

The demand for electric power has stimulated many plans for constructing large off-shore wind-power plants. However, there have only been a few studies on the environmental impact of these wind farms on the oceanic environment; most available studies describe the direct effects of the wind mill constructions, noise and shadowing from the installations, and the possible influence of electric cables on the marine life. In this study we outline a possible environmental influence of the wind farms that, to our knowledge, has not previously been described in any detail in the scientific literature. More specifically, the wind farms may influence the wind pattern and hence force an upper ocean divergence. This will in turn influence the upwelling pattern, thereby changing, for instance, the temperature structure and availability of nutrients in the vicinity of the wind farm.

The basic oceanic response depends on the reduction in the wind stress at the sea surface, both in magnitude and the size of the affected area. From a literature review it appears that these quantities have not yet been studied in sufficiently detail to provide a reliable description of these features. Most studies of wind-farm influence on the wind focuses on the wind structure within the farm and how it will affect the efficiency of the wind farm. However, the far-reaching wind deficit and the wind stress at the sea surface have not been subjected to in substantial investigations. Thus, it is probably necessary with complementing studies of these issues before accurate estimates of the influence on the upper ocean physics can be established. Here, it should also be underlined that the size of the wind farm is a very important factor and that the oceanic response rapidly becomes much stronger when the size of the wind farm becomes larger than the internal radius of deformation.

Examples of how divergence of the wind causes upwelling in the ocean are when winds blow along a coast, over an island, or along the MIZ (Gill, 1982; Røed and O'Brian, 1983; Okkonen and Niebauer, 1995; Valiela, 1995; Botsford et al., 2003; Dugdale et al., 2006). With a wind-driven transport directed out from the coast the water that is transported out from the coast will be replaced by water from deeper layers through upwelling. These types of systems and the ecosystem response to the upwelling of nutrient rich, but also plankton poor, deep water have been studied extensively (Valiela, 1995; Botsford et al., 2003; Dugdale et al., 2006). However, there is an important difference between the upwelling forced along a coast and the type of upwelling that may be forced by large wind farms. In the coastal upwelling case, the presence of land implies that the ecosystem properties cannot be supplied from upstream condition; the wind-farm induced upwelling on the other hand, has an important upstream import of water that carries the properties of the ecosystem. The situation along the MIZ is probably more relevant but has not been studied to the same degree; one difference here is that the position of MIZ change with time and reacts to the wind forcing while a wind farm has a fixed position.

We have not outlined the barotropic response in this study; this response is somewhat different but needs to be addressed. To the lowest order approximation the geostrophic balance inhabits vertical movements and the flow follows depth contours, or more specifically closed f/H contours. The basic steady state balance is characterized by a state where the net divergence over a closed f/H contour due to wind forcing is balanced by the net divergence induced by the Ekman layer at the bottom (Walin, 1972; Dewar, 1998; Nøst and Isachsen, 2003). It should be noted that the divergence of the wind field is generally small given the large size of atmospheric low-pressure systems. Accordingly, the wind tends to generate relatively weak barotropic signals around depth contours having small horizontal scales (say 100 km). The presence of a wind farm may create a substantial divergence of the wind field in the immediate vicinity of the wind farm. If the farm is placed close to a sloping bottom it is thus possible that the wind farm may provide a substantial additional forcing of the barotropic-current system in an ocean area. However, more studies using realistic systems are needed before it is possible to judge the strength of this forcing mechanism. Furthermore, if a substantial part of an enclosed or semi-enclosed ocean area is subject to wind farms there may be a measurable affect on the major basin-scale circulation and the associated pathways of nutrients.

Acknowledgements

Prof. Peter Lundberg provided valuable help on an early version of this manuscript. Two anonymous reviewers also provided insightful comments that improved the readability and impact of the manuscript. The model simulations were performed on the climate computing resource 'Tornado' operated by the National Supercomputer Centre at Linköping University. Tornado is funded with a grant from the Knut and Alice Wallenberg foundation.

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from Gøran Broström <goranb@met.no>
to Ron Huber <coastwatch@gmail.com>
date Thu, Aug 19, 2010 at 8:38 AM
subject Re: Ocean windfarm - hydrology and climate question.
hide details 8:38 AM (3 hours ago)

Hi Ron
Thanks for your letter. I am not sure I have a clear answer to you. I think that further studies are needed for more realistic situations. However, I have not been able to work any more on this subject altough I am still interested in what a large wind farm may impact the ocean currents.

I do think large wind farms can potentially have a relatively large impact on the local oceanographic conditions. I say potentially because it has not yet been proven yet. Thing that should be investigated may be:

1. Will the wind farms increase the upwelling in the area? If so, how will the nutrient levels and primary production be affected by the increased nutrient levels? Will the risks for toxic algae blooms increase?

2. Will the induced changes in wind stresses (or more specifically, the large increase in wind stress curl) give rise to a changing current system in the area? Will this affect local transport mechanism for e.g., plankton, larvae and sediment. Will the new current pattern influence wave climate in nearby areas and the nearby coast. What is the extent of the induced current system (if barotropic motions are excited there is a possible remote affect from the wind farms).

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For our question concerning Lobster larvaes I think that the transport of these may change. However, without really knowing I would say that the wind farms will not affect Lobster production in a negativ way. The possibility of increased primary production will probably take out any negative impacts on larvae transport but I really do not know.

My phone number to my office is (+47) 22963348. I work late monday to wendsday so call me if you have any qustions. Unfortenately, I am not aware of any other simiar studies.

Sincerely
Göran

Ocean Wind Energy Extraction and Climate

Following is an email from Ron Huber to Norwegian meteorologist Goran Brostrom inquiring about the impact of ocean wind energy extraction and ocean climate, and Dr Brostrom's emailed response.

----

from Ron Huber <coastwatch@gmail.com>
to Göran Broström <goran.brostrom@met.no>
date Tue, Jul 20, 2010 at 11:34 AM
subject Ocean windfarm - hydrology and climate question.

Göran Broström,
Norwegian Meteorological Institute,
Postboks 43 Blindern, N-0313 Oslo, Norway.

Dear Dr Broström,

My organization, Penobscot Bay Watch, is trying to understand the possible effect of ocean windfarms on local and regional climate. The Gulf of Maine may soon join other coastal oceans in hosting large scale ocean windfarms. We have read with great interest your 2008 paper: "On the influence of large wind farms on the upper ocean circulation", and an English translation of your commentary "Windmills at sea will affect the climate" of 2008.

Now we are seeking additional research examining the actual or potential effects ocean windfarms can have on coastal currents.

As you may know the United States' Gulf of Maine region has committed to large scale ocean wind farming. There are plans for deepwater floating wind turbines to be anchored 30 to 80 kilometers offshore of Maine, and shallow water farms set into the seafloor in shallower regions. No ocean windmills of either kind have been built yet in the Gulf of Maine

Doctor Brostrom, what are the questions that we need to ask and seek answers for, when considering what possible impacts should be examined during the review process for these offshore windfarms?

For example, Penobscot Bay's lobster fishery is very productive, but it is very dependent on the Eastern Maine Coastal Current transporting

lobster larvae to this bay at a precise season. Is it possible that the very large arrays of ocean windmills proposed for the Gulf of Maine by both the United States and Canada could have any accelerating or delaying effect, or thermal diverting effect upon such local ocean currents?

It is difficult to predict precise number of windturbines proposed, as the development is still in planning. Because ocean windfarming is still in a planning stage for the Gulf of Maine region, we would like to ensure that those windfarms that are emplaced here have as little impact on the Gulf of Maine's hydrology and meteorology as possible. Any information you can share that we can bring to the considerations would be most gratefully appreciated. If there are other researchers studying the effect of ocean windfarming on the regional environment that you can recommend, that too would be welcomes..

Sincerely

Ron Huber
Penobscot Bay Watch
POB 1871. Rockland Maine 04841
e: coastwatch@gmail.com
tel: 207-691-7485
web: www.penbay.org

2. Gøran Brostrøm replies to Ron Huber

from Gøran Brostrøm <goranb@met.no>
to Ron Huber <coastwatch@gmail.com>
date Thu, Aug 19, 2010 at 8:38 AM
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