# Renewable ocean energy mapping workshop

## *Workshop Proceedings Report*

Workshop held
November 17th, 2008
Vancouver

**1st Draft Prepared by Neil Davis, BCMCA Human Use Coordinator, December 2008**
**Reviewed by workshop participants**
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BRITISH COLUMBIA
MARINE CONSERVATION ANALYSIS

## Workshop Summary

The BC Marine Conservation Analysis, in cooperation with the Ocean Renewable Energy Group, convened a workshop in November 2008 with industry representatives, scientists, and resource managers to develop a more comprehensive spatial representation of areas of interest to wave and tidal energy development on the BC coast. The areas are identified with the caveat that they are based on the participants' current understanding of available information. Workshop participants (1) reviewed existing maps illustrating wave and tidal energy potential, (2) developed criteria additional to energy potential that influence the potential of sites for energy capture developments, and (3) individually mapped the areas of interest or promise for energy development on the BC coast, assigning measures of relative importance to each area they mapped.

For existing maps illustrating energy resource potential, the key messages from the workshop and follow up discussions are:

1. These maps provide only a coarse indication of wave and tidal energy resources, and as such, cannot be used for planning purposes to predict where energy development may or should happen. They may be more useful for identifying areas where wave or tidal energy development will not happen. Finer scale, more detailed data is needed to inform where energy development may occur.
2. The accuracy of the wave energy data breaks down closer to shore, at water depths less than approximately 100 metres.
3. The tidal energy resources map provides a fairly representative picture of tidal resources at a regional spatial scale, but again, more detailed, local data is necessary; changes in flow and back eddies occur at very localised scales and have important implications for the potentially harvestable energy of a site.
4. Mean annual wave power (kW/m) is the most suitable unit to display for the wave energy resources map.
5. Annual energy production (Gigawatt hours per year) is the most suitable unit to display for the tidal energy resources map.
6. With respect to potential site development of tidal energy resources, it is important to note that developments around Vancouver Island can be arranged as a series of sites to provide a continuous daily supply of power.

Workshop participants identified numerous criteria that factor into their perspectives on the potential of sites for energy development. These criteria related to the proximity of support services and transmission infrastructure, the compatibility of energy projects with other environmental or socio-economic values in the site area, and physical site characteristics like substrate and proximity to land.

In mapping their areas of interest, participants emphasised that their mapping is based on a limited understanding of BC's ocean energy resources. Improved understanding, technological advances, and changing economic conditions are all likely to change which areas of the BC coast may be of interest for wave and tidal energy development in the future. Thus, planners, regulators, and other interest groups should not view the maps resulting from this workshop

as a definitive picture of the ocean energy sector's areas of interest. Rather, the maps provide a useful indication of current areas of interest that can serve as a source of guidance for planning and decision-making in the present and near future (5-10 years).

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# 1 Introduction

## 1.1 Report Objective and Workshop Overview

The objective of this document is to summarise feedback and recommendations from the Renewable Ocean Energy Mapping Workshop held in Vancouver on November 17th, 2008. The workshop was one of numerous spatial data review processes conducted with marine user groups as part of the British Columbia Marine Conservation Analysis (BCMCA) Project (described below). This particular workshop, convened with the cooperation of the Ocean Renewable Energy Group, focused on the wave and tidal energy sector in BC. Though no commercial wave or tidal energy capture operations currently exist on the BC coast, there is significant interest in the potential of these resources.

As a possible feature of the marine environment in the future, the BCMCA is interested in assembling the best available information about areas of interest to the wave and tidal energy sector. The intent of the workshop was to draw on the knowledge and expertise of industry representatives, scientists, and resource managers to develop a more comprehensive representation of areas of interest to wave and tidal energy development, as these areas are currently understood based on available information. More specifically, the workshop had three objectives:

1. Review existing spatial information illustrating wave and tidal resource potential to:
    a. identify gaps, limitations, and priority improvements or next steps for mapping areas of potential resource development;
    b. identify any additional key spatial questions related to this sector;
2. Identify criteria and site factors additional to energy resource potential that influence the potential of areas for wave and tidal energy development and discuss the implications of these factors for areas of development on the BC coast;
3. Generate maps of areas of interest/promise for wave and tidal energy development from each workshop participant and identify their relative importance as currently understood based on available information.

Expected outcomes of the workshop were:

1. This report, summarising workshop participants' review feedback from the workshop, which would be circulated to participants for their review before being made publicly available;
2. A list of criteria and site factors additional to a site's energy potential that influence the potential of areas for wave and tidal energy development; and
3. A set of maps from each workshop participant showing areas of interest and their relative importance on the BC coast which could be summarised by the BCMCA for inclusion in the BCMCA atlas (see project background below).

## 1.2 BCMCA Project Background

The BC Marine Conservation Analysis (BCMCA) is a collaborative, BC coast-wide project that is assembling and analysing map-based data that can be used to support marine planning initiatives in BC, without advocating any particular planning outcomes. The overall goal of the

BCMCA is to identify marine areas of high conservation value and marine areas important to human use.

There are several marine planning initiatives underway or in preparatory stages in BC. The BCMCA project does not seek to replace these processes. Rather, the BCMCA is developing products that illustrate the spatial distribution of biological, ecological, oceanographic and human use values in BC's marine environment in order to inform discussions and decisions made within these planning initiatives.

The BCMCA was focused on two major products:

1) An atlas that illustrates known biophysical values and human uses in Canada's Pacific Ocean. This atlas was created from best available existing mapped data. Its purpose is to illustrate aspects of marine biology, ecology, oceanography, and human use relevant to a coast-wide scale.
2) A set of results from analyses using the Marxan[1] decision support tool. Results are documented from a range of scenarios, each with different sets of explicit objectives which inform the values put into Marxan parameters. Broadly, the analyses explore a range of "What if…?" scenarios designed to identify areas of high conservation value and areas important to each sector of human use based on data collated for the atlas.

Beginning in the fall of 2006, the BCMCA held a series of workshops in order to assemble the best available biological, ecological, and oceanographic data for the coast. Scientific experts were invited to the workshops to identify these data and make recommendations on the parameters for subsequent Marxan analyses. The BCMCA then obtained and collated 110 of the recommended datasets and prepared the features illustrated in the atlas and used in spatial analyses. Reports summarising expert workshops are available at the BCMCA website (www.bcmca.ca). All reports have undergone workshop participants' review before finalisation.

In 2008, the BCMCA identified six sectors of human use (i.e., commercial fisheries, recreational fisheries, ocean energy - wind, wave, tidal, oil, gas - , shipping and transportation, tenures, and recreation and tourism) and began assembling known human use data held by BCMCA project team organisations. Seeking advice and feedback from human use groups about the overall project, the BCMCA met with representative organisations and advisory boards and, based on feedback from these meetings initiated a Human Use Data Working Group. This group, with the cooperation and assistance of many individuals, reviewed approximately 100 human use datasets for accuracy and completeness. In a few cases data were improved by the BCMCA, and in all cases comments from reviewers are included as part of the atlas facing page information. The renewable ocean energy data are an example of where BCMCA funds were allocated to improve available data representing this sector's interest in the marine environment.

[1] www.uq.edu.au/marxan/

# 2 Workshop Summary

## 2.1 Attendees[2]

Neil Davis – BCMCA (Chair)
Jason Thompson – BCMCA (Minutes)

Jessica McIlroy – Ocean Renewable Energy Group
Michael Tarbotton – Triton Consultants
Brad Buckham – University of Victoria
Nigel Protter – Syncwave Systems
Ross Halliday – Natural Power
Adam Valair – Natural Power
Alex Tu – BC Hydro
James Elphick – Global Energy Horizons
Geoff Turner – BC Ministry of Energy, Mines, and Petroleum Resources
Darren Williams – Fisheries and Oceans Canada
Glen Rasmussen – Fisheries and Oceans Canada, BCMCA Project Team member

## 2.2 Workshop Components

### 2.2.1 Introductory BCMCA presentation

Neil Davis, BCMCA, presented an overview of the BCMCA project purpose and progress to date, and outlined the objectives of the workshop.

**Comments:**

- For the mapping being requested of participants, what happens if areas are not mapped now? Industry does not want to close off the possibility of energy development in additional areas if technology, the business environment, or other factors change. The wording of workshop objectives needs to reflect that the identification of areas in this workshop is based on limited knowledge, and that in the future, other areas may also be of interest. This mapping should not be interpreted by planners or regulators as definitive or set in stone. This is an emerging sector whose areas of interest are not fully understood.
    - N Davis: Maps from this workshop are intended to be a first cut at identifying areas of interest that can provide some guidance for planners and decision-makers. The human use maps in the BCMCA atlas will be accompanied by a summary of the review comments from the relevant user group so viewers can read the user group's commentary on the maps to inform their own perspectives. Viewers will also be able to link to this workshop report.

[2] Participatory mapping was also provided by Russell Stothers from Clean Current Power Systems.

### 2.2.2 DFO planning presentation

Darren Williams from Fisheries and Oceans Canada (DFO), Oceans Policy and Planning Branch in Ottawa presented DFO's approach to Integrated Oceans Management planning, highlighting risk analysis and management among their current priorities. Planning challenges related to ocean energy, such as the limited knowledge of this sector and the lack of a federal regulatory framework, were also discussed.

**Comments:**

- What is the direction DFO is taking on regional strategic environmental assessment?
    - D. Williams: DFO is trying to integrate the consideration of multiple uses and ecological values in a way that allows strategic environmental assessment to help guide industry development in a rational, planned way.
- Is Ecosystem-Based Management (EBM) a DFO policy?
    - D. Williams: EBM is a principle in legislation. D. Williams can provide a weblink that explains DFO's definition of EBM.

### 2.2.3 Review of existing spatial data

Neil Davis presented maps of existing data that have been assembled by the BCMCA to the workshop participants. These maps were:

- Maps of wave and tidal energy resource potential developed by Triton Consultants and the National Research Council Canadian Hydraulics Centre; and
- A map of tidal and wave energy investigative permit locations from the BC Integrated Land Management Bureau.

The workshop participants were asked to review existing spatial data maps and comment on:

- The quality of data used to generate the map;
- How the information was displayed:
    - Which attributes of energy should be displayed - e.g., power density, power potential, etc;
    - How power classes should be broken down for display;
- The accuracy and resolution of the map;
- The completeness of the map;
- Caveats about the map;
- Using resource potential to illustrate potential use; and
- Any additional subjects important to the spatial representation of wave and tidal energy areas of interest.

**<u>Wave Power</u>**

Map title: Mean annual wave power (winter season).

- Two versions of this map exist: a map of the point locations in the northeast Pacific where wave power is modelled, and a map with a contoured, continuous surface of wave power derived from the point locations modeled. Analogous maps for the summer season also exist.
- The maps are based on results of a wind-wave hindcast model

- The model draws on data from sites (buoys) with > 300 days of good records;
- Mean wave power for each site is calculated for each month in the year; and
- Model resolution: .25° x .25° grid for NE Pacific.

**Comments:**

- Data for this map originated from the Wavewatch 3 (WW3) model
  - This is numerically created data (WW3 is a wave model developed by Hendrik Tolman, NOAA).
  - The map is based on approximately 7 years of data.
  - Triton downloads this data every 3 months.
- This is not "bankable" data. That is, it is much too coarse to be used as information to support appeals for financial investments in ocean energy projects.
  - The way to make this data more "bankable" is to take buoy measurements and tune the data in the model for a specific site, accounting for local bathymetry etc.
  - There is room for improvement on how to estimate wave height.
  - To move towards the information necessary for implementing an energy project, two finer scale steps are required for building on this coarse model. First, a series of publicly funded buoys should be placed at strategic spots along the coast within 20 km of shore in consultation with industry. These buoys should be placed in generic areas that will give clean data and allow for extrapolation and correlation. Then, developers will have to do site specific data collection with their own buoy for several years.
  - Take this large scale data and apply it to bathymetry to focus in on sites. There are established techniques to take this data and apply it to smaller scale and specific locations.
- Are wave energy investors an audience for this atlas? Because the information is not detailed or reliable enough.
  - N. Davis: this atlas is intended more for marine planning, so the audiences include governments and user groups or stakeholders with an interest in marine planning.
- The accuracy of this wave data breaks down significantly as you get closer to shore.
- How do we define "closer to shore" in this context?
  - For water depths less than 100m you would want to start using a local model in addition to the Wavewatch 3 data.
- It is not a question of quality with this existing map and associated data – it is good for what it is, but it is not fine grained enough for planning purposes.
  - Use the contour map for the atlas rather than map with a grid of points.
  - If the BCMCA is using this existing dataset, they need to add the caveats described above regarding the data and the breakdown of data accuracy in nearshore areas (less than 100m water depth).
- This dataset does not give a good indication of where wave energy development might occur because of its coarse resolution and the rapid advancement of technologies within the industry.

- Also, no one should assume that the areas of highest wave energy are the best for wave energy development as this is not always the case.
- For mapping purposes, show all seasons or an annual average rather than a seasonal average for winter or summer as these are drastically different from one another and could be misleading.
- Given the level of detail, what is the most appropriate unit of measurement for map display?
    - Agree with current unit: annual wave power in kW/m (getting into other units such as wave direction, will just confuse users at this level).
    - Maybe add wave period?
    - Wave energy is not linear like wind energy or water flow in a river, so interpreting sites of interest or promise is more difficult.
    - Based on the current level of resolution, the divisions/power classes presented in the map legend are appropriate. Any finer division of classes would go beyond the resolution of the model on which the map is based.

**Tidal Power**

Map title: Tidal energy potential.

- Map developed by Triton Consultants and the National Research Council Canadian Hydraulics Centre, based on the results of models built by Triton.
- The map identifies tidal energy hotspots on the BC coast as point locations.
- Triton used Canadian Sailing Directions to identify sites with currents, then consulted charts to estimate width and depth of flow.
- Then they created a bathymetry mesh of nodes specifying water depth and bottom roughness.

**Comments:**

- Tidal energy that is significant enough to harvest is generally in narrows.
- In the above data, some estimates of mean power density were established.
- High potential is based on the U-cubed value (the cube of flow velocity), however there can be low velocities associated with high U-cubed.
- One main area is the focus of most tidal energy interests: Discovery Passage area.
    - Seymour Narrows is the largest.
- Change the units of measurement on the tidal map for the atlas to annual energy production (Gigawatt hours per year). Energy is a more useful unit of measurement than power for most audiences.
- Change how the tidal sites are displayed so that sites with larger energy production are represented by larger dots on the map (i.e., the size of the dot reflects the size of the energy production).
- The map of mean power potential tells nothing about the practicality of any capture devices being installed on these sites.
- Next steps to build on these data would be to perform some modelling in more specific localised areas. Triton has done some work in Discovery Passage. They realised there are very subtle differences in flow across a cross section of a passage. Back

eddies are also very important to the harvestable energy production potential of sites, and this is not captured by this tidal map.

- These maps give a good indication of where to look for potential sites of tidal energy development. The clustering of sites at a regional spatial scale is fairly representative. Much more detailed studies are required on localised scales before energy projects can be realised.
- Local flow structure may be absolutely critical in design – it's all about the spatial spread in flow, both in vertical and horizontal dimensions.
- The divisions of power classes in the map legend are probably appropriate.
- The group is more prepared to discuss areas of interest in tidal than in wave energy.
- Important questions remain about what happens to tidal flows if power is removed with energy capture technology. None of the modelling used to generate these maps has taken into account the effect of taking power out of a tidal system via some installation of a power apparatus.
- Providing some background about resource use for each map in the BCMCA atlas would be useful.
    - N. Davis: this has been done for DFO's Eastern Scotian Shelf Integrated Management area atlas and the BCMCA is currently considering including similar information in the BCMCA atlas.

### 2.2.4 Site characteristics influencing areas of potential development

Neil Davis invited workshop participants to identify the site characteristics beyond the energy potential of a site that would influence which areas of the BC coast are more or less promising for wave and tidal energy development. The characteristics presented here are intended to be general in nature rather than site specific. Not all workshop participants necessarily agreed with all characteristics. Characteristics are not listed here in any priority order.

**Site Characteristics listed by participants:**

- Proximity to electricity infrastructure (this does not necessarily exclude communities on diesel power)
    - Sites that are closer to infrastructure are more desirable.
- Water depth
    - Water depth must be sufficient at tidal sites to submerge energy capture infrastructure.
- Existing Industry
    - Shipping lanes, heavily transited areas, fishing grounds, and other navigable water designations may be less suitable sites for energy developments.
- Obstruction of animal movements
    - Tidal sites in narrow passages may obstruct the movement of marine mammals. Sites where this is possible are likely less suitable for energy developments.
- First Nations and local community support
    - Areas where there is support from adjacent First Nations and local communities are more suitable for energy development.

- The content of existing plans that have marine components or implications for marine use
    - Existing plans may enable or hinder ocean energy development if they entail use designations or regulations for marine or coastal areas.
- Proximity to significant ports or rail lines
    - Sites closer to transportation infrastructure are advantageous as some energy infrastructure is large and challenging to transport.
- Distance offshore
    - For the foreseeable future, sites closer to shore are cheaper.
- Environmental / ecological considerations
    - Environmentally sensitive marine areas may be less suitable for energy development. This may also apply to coastal sites where power transmission infrastructure from ocean energy projects comes ashore.
- Visual quality concerns
    - Visual quality concerns among adjacent communities around the in-water infrastructure or the power transmission infrastructure (e.g., power lines) may pose challenges for ocean energy projects.
- Geological features and substrate requirements
    - Geological features and substrates can affect the costs of developing sites differentially according to the specific technologies installed at the site.
- Proximity to servicing
    - Energy sites closer to hubs of materials and skilled labour are more desirable.

### 2.2.5 Identification of Areas of Interest

This portion of the workshop invited workshop participants to map areas of interest/promise for wave and tidal energy development. Neil Davis explained that the mapping exercise is based on a method that has been used elsewhere in BC and in California. He showed sample maps from the processes where this mapping method was used. A similar use of this mapping method is described in the peer-reviewed literature[3].

The Workshop participants were asked to:

1. Draw polygons on marine charts indicating areas of potential development on the BC coast;
2. Identify whether the polygons were for tidal or wave energy development; and
3. Spend $100 among all polygons to indicate their relative importance.
    - Higher amounts = areas of more interest/promise

[3] Scholz, A., K. Bonzon, R. Fujita, N. Benjamin, N. Woodling, P. Black, and C. Steinback. 2004. *Participatory socioeconomic analysis: Drawing on fishermen's knowledge for marine protected area planning in California*. Marine Policy **28**(4)**:**335-349.

**Comments:**

- This is a useful exercise, but it needs to be noted that areas of interest will change based on many interrelated factors including advancements in technology, evolving population centres, global warming, energy prices, etc.
- To mitigate the potential misuse of these maps, this workshop should state that it aims to identify areas with energy potential on a 5-10 year time horizon.
- The BCMCA also needs to solicit mapping input from other industry members not present at this workshop to develop a more representative and complete picture of areas of interest or promise.

N. Davis: Are there any caveats or provisos worth adding about the existing maps, or the maps participants have just created, which have not already been mentioned today?

- No comments from participants.

## 3 Next Steps

A number of next steps were discussed at the workshop. First, the BCMCA agreed to follow up with industry representatives not present at the workshop to solicit their mapping of areas of interest. The BCMCA also made clear their commitment to summarise the workshop proceedings in a report which would be circulated to participants for their review before the report would be made publicly available. The BCMCA will also digitise participants' maps and create a coastwide GIS map illustrating their areas of interest. Individual participant's maps will not be circulated beyond the BCMCA project or made publicly available. Each participant will have the opportunity to review their map. Following the map review, all participants' maps will be overlaid to create a summary map which will be made publicly available and included in the BCMCA atlas. No objections were made to this plan for information sharing.

# 4 Appendix

## 4.1 Final Workshop Agenda



## Renewable ocean energy mapping workshop

*Agenda*

November 17th, 2008
12:30 – 4:30 pm
SFU Harbour Centre, 515 West Hastings, Vancouver
Room 1500, Main floor

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Co-chairs: Neil Davis (BCMCA), Jessica McIlroy (OREG)
Minutes: Jason Thompson (BCMCA)

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**12:30 Meeting opening (*all*)**
- Co-chair introductory remarks
- Group introductions
- Review of agenda

**12:55 BCMCA presentation (*Neil Davis, BCMCA*)**
- Introduction to the BCMCA and its progress to date
- Purpose of workshop, what is expected of workshop participants, and what will be done with participants' input (i.e. how it can be used and how participants would like to see mapping efforts shared)
- How products of data review may be of benefit to participants

**1:20 DFO presentation (*Darren Williams, DFO Oceans Policy and Planning Branch*)**
- A DFO perspective on marine planning
- The utility of spatial information representing areas of interest to renewable ocean energy

**1:45 Review of data assembled to date (*all*)**

- Summary of wave and tidal resource potential datasets assembled by the BCMCA and where they came from (BCMCA)
- Comments on existing data re: accuracy, comprehensiveness, gaps, suggested improvements (participants)
- Recommended additional data (participants)

**2:45 Break**

**3:00 Identification of areas of interest (*participants*)**

- Identifying factors that make areas suitable for potential development
- Mapping areas of interest
- Assigning relative importance to areas of interest

**3:45 Wrap up tasks *(all)***

- Comments on how workshop mapping results should be used, interpreted (participants)
- Data sharing arrangements (all)
- Next steps (BCMCA)

**4:30 Meeting close**