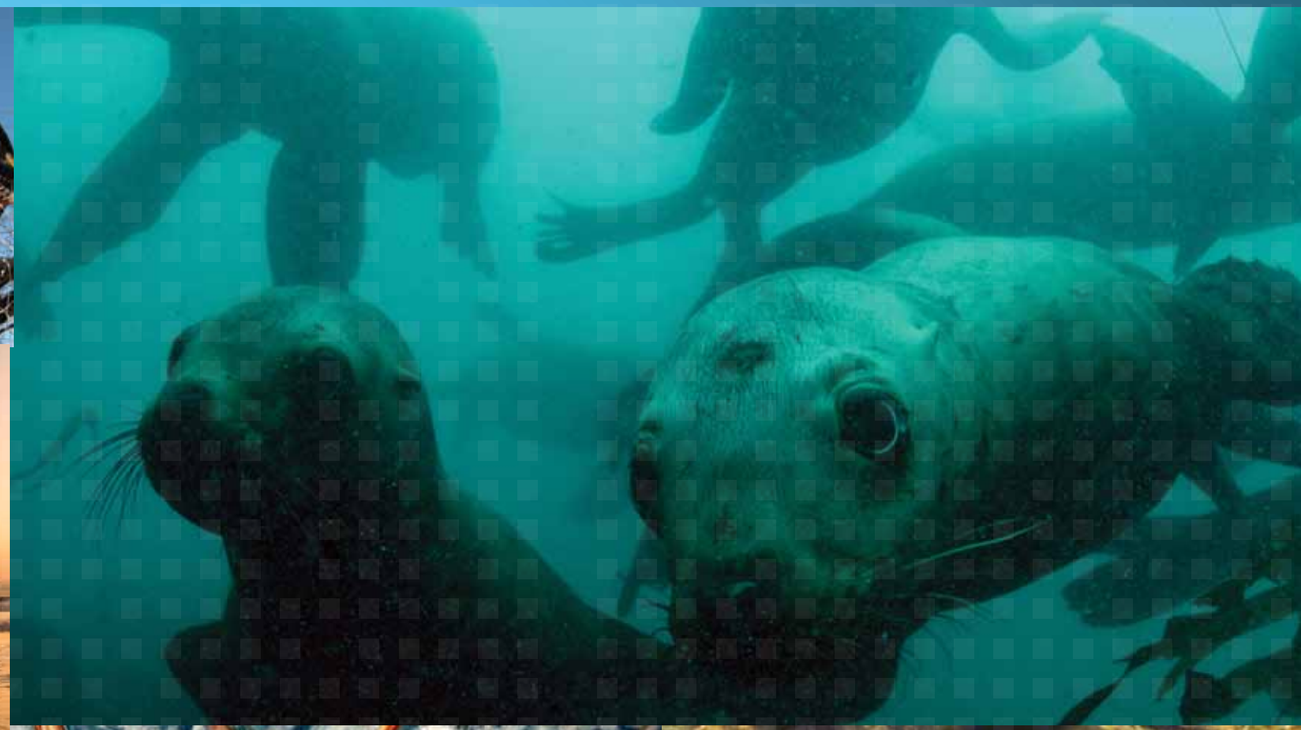
British Columbia
Marine Conservation Analysis

A Series of Marxan Scenarios for Pacific Canada

a report from the British Columbia Marine Conservation Analysis (BCMCA)





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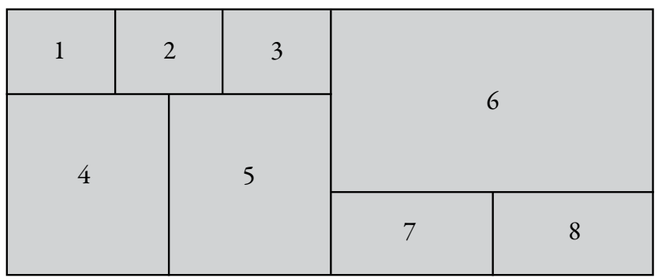

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acknowledgements

acknowledgements

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Current and former members and observers of the BCMCA Project Team are Susan Anderson Behn from Island and Approach First Nations Fisheries, Cheri Ayers from Hul'qumi'num Treaty Group, Natalie Ban from University of British Columbia (2006-2008) and James Cook University (from 2008, current), Julie Beaumont from Coastal First Nations, Karin Bodtker from Living Oceans Society*, Christopher Bos from Sport Fish Advisory Board, Tanya Bryan from Nature Conservancy of Canada (2008-2011)*, Kevin Conley from Fisheries and Oceans Canada, Ken Cripps from Coastal First Nations, Sarah Davies from Fisheries and Oceans Canada, Andrew Day from West Coast Vancouver Island Aquatic Management Board, Steve Diggon from West Coast Vancouver Island Aquatic Management Board (2007), Dana Haggarty from Hul'qumi'num Treaty Group, Christa Hrabok from British Columbia Ministry of Environment, Hilary Ibey from Fisheries and Oceans Canada, Steve Kachanoski from Ministry of Forests, Lands and Natural Resource Operations (from 2011, current), Kate Ladell from Living Oceans Society (2007) and Fisheries and Oceans Canada (2010 and current), Lynn Lee from Haida Oceans Technical Team, Sean MacConnachie from Fisheries and Oceans Canada, Greg MacMillan from Parks Canada, Murray Manson from Fisheries and Oceans Canada, Chris McDougall from Haida Oceans Technical Team, Dave Nicolson from Nature Conservancy of Canada (2006-2008)*, Miriam O from Fisheries and Oceans Canada, Manish Om Prakash from British Columbia Ministry of Environment, Craig Outhet from North Coast-Skeena First Nations Stewardship Society, Rob Paynter from British Columbia Integrated Land Management Bureau (2007) and Ministry of Forests, Lands and Natural Resource Operations (from 2011, current), Glen Rasmussen from Fisheries and Oceans Canada, Krista Royle from Living Oceans Society (2006) and Parks Canada (from 2007, current), Wayne Saito from BC Ministry of Environment, Charlie Short from British Columbia Integrated Land Management Bureau (2006 – 2010) and Ministry of Forests, Lands and Natural Resource Operations (from 2011, current), Karen Topelko from British Columbia Ministry of Environment, Bruce Turris from British Columbia Seafood Alliance, and Charlie Twaddle from British Columbia Ministry of Environment. **Thanks to the environmental non-governmental organizations (ENGOs) that supported representatives on the Project Team and generously contributed their knowledge: Canadian Parks and Wilderness Society, David Suzuki Foundation, Living Oceans Society, Nature Conservancy of Canada, Sierra Club BC, and World Wildlife Fund Canada.*

Current and former members and alternates of the BCMCA Human Use Data Working Group are Kim Barbero from British Columbia Marine Trades Association, Christopher Bos from Sport Fishing Advisory Board, Doug Daugert from Sport Fishing Advisory Board, Paula Galloway from British Columbia Salmon Farmers Association, Michelle James from Underwater Harvesters Association, Kim Johnson from Shell Canada, Les Kiss from Coast Forest Products Association, Jessica McIlroy from Ocean Renewable Energy Group, Jane McIvor from British Columbia Marine Trades Association, David Minato from British Columbia Salmon Farmers Association, Phillip Nelson from Council of Marine Carriers, Norm Penton from British Columbia Salmon Farmers Association, and Bruce Turris from British Columbia Seafood Alliance.

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Finally, we would like to acknowledge that the BCMCA was initiated in 2006 to address recommendations from a formal peer review of Living Oceans Society's Conservation Utility Analysis in 2005. We thank Living Oceans Society who, with the support of the Canadian Parks and Wilderness Society, David Suzuki Foundation, Nature Conservancy of Canada, Sierra Club BC, and World Wildlife Fund Canada, initiated the BCMCA and worked to assemble the initial Project Team.

"Thank you, all!"

introduction

introduction

The purpose of the BCMCA was to collaboratively identify marine *areas of high conservation* value and *areas important to human use* in Canada's Pacific Ocean and to make the resulting maps and documentation available to the marine planning community and others. This report describes our approach, documents results and contains maps that illustrate examples of results. The BCMCA used a decision support tool called Marxan to identify marine areas of high conservation value and to identify areas important to human use.

Identifying important areas involves compiling all available layers of mapped information (e.g., species, habitats, human uses) and processing these layers. The volume of data and computations required is overwhelming without the aid of computers and special software to handle the challenge. *Marxan* is a decision support tool *developed by the University of Queensland*, and has global recognition as one of the best tools to meet these challenges. Based on simple mathematics, Marxan uses the computer to search millions of potential *solutions* to find the best balance between costs and benefits. For example, a question commonly posed for Marxan is: which areas collectively contain a representative suite of species (e.g., 10% of the occurrence of 10 species) in the smallest possible footprint? In terms of the cost-benefit analogy, the benefit would be to identify a set of areas that together contain 10% of all the species. The cost would be related to the size of the overall footprint; the smaller the total area, the smaller the cost and the better the balance in the solution. Marxan is designed to test out different combinations of areas, or planning units, until it finds a combination that contains 10% of all the species and has the smallest footprint. Sometimes Marxan is unable to find a solution that contains enough of all the species, and, for example, one or more species might be underrepresented. However, in our experience Marxan more frequently found many different near-optimal solutions which can be compared for the species represented and areas included in each solution.

guidelines for use of BCMCA Marxan results

Open access to BCMCA products with appropriate and complete documentation is our goal. These guidelines were developed to help interested parties make the most of the BCMCA products and reduce inappropriate use. Because the Marxan scenarios were assembled for the purposes of the BCMCA project and to illustrate examples of "What if...?" Marxan analyses for British Columbia's marine planning community, they should not be interpreted as planning solutions. They were intended to illustrate Marxan's capability and flexibility.

- The results for each *scenario* were intended to meet the stated objectives for that scenario and should not be taken and presented out of that context.
- **The results of these ecological scenarios cannot and should not be presented or interpreted as identifying optimal Marine Protected Areas for the Canadian Pacific. If reserve or network design is your goal, then Marxan scenarios for that purpose must be designed by a planning process with overarching objectives and specific goals that suit the purpose of that process.**
- Stakeholder engagement in every marine planning process is important for many reasons. The fact that BCMCA products were collaboratively produced should not be viewed as a replacement for stakeholder engagement in any marine planning process that makes use of these products.
- Participation in the *BCMCA project team* or *human use working group* does not imply support or endorsement of any specific Marxan analysis results by participating organizations.
- Please review the section of this report titled "analysis limitations" for important limitations related to interpreting analysis results.

methods

steps taken to produce Marxan analyses

The BCMCA took these steps to produce examples of analyses using Marxan:

1. Identify overall objective and specific goals.

- The BCMCA had two overall objectives: to identify areas of high conservation value (ecological analyses), and to identify areas important to human use (human use analyses). The context within which these objectives were identified was unique for the BCMCA. We had no planning mandate, so we wanted to provide the results from example "*What if...?*" analyses to show British Columbia's marine planning community how they can use Marxan.
- The specific goal of all BCMCA analyses was to minimise the total area required to meet specific targets. (*Targets* are quantitative values set for each particular *feature* or mapped layer; e.g., 60% of eelgrass, seabird colonies, or recreational fishing areas.)

2. Identify features, obtain and map best-available data. *Features* are the spatial or mapped layers deemed important to be included in these analyses; e.g., specific species' habitats, general habitat types, seascape features, and areas of different human uses.

- Maps of all the ecological and human use features used in the BCMCA analyses are available in our *Marine Atlas and data library*. 169 ecological features were used in the ecological Marxan analyses, while 78 mapped human uses within six different use *sectors* were used in the human use Marxan analyses (Appendix 1, Tables 1 and 2).
- Ecological features and data were *recommended to the BCMCA* at a series of ecological *expert workshops*. Human use features were *developed in collaboration* with representatives of six sectors of human uses of the marine environment.

3. Divide the study area into *planning units*. The BCMCA chose 2 km by 2 km planning units (Figure 1) as a trade-off between the fine-scale detail available in some features and increasing analytical complexity that is a consequence of increasing the number of planning units.

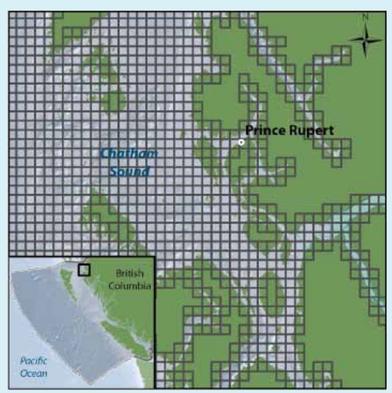


Figure 1. BCMCA planning units near Prince Rupert on the North Coast of British Columbia.

4. Tally the presence, absence, or amount of each feature in each planning unit in the *study area*. Using GIS tools, the BCMCA created a huge table to tell Marxan what was in each planning unit. This table shows, for example, how much eelgrass is in each planning unit, whether or not recreational crabbing takes place there, and if that planning unit is part of an estuary.

5. Set targets for every feature. Quantitative targets tell Marxan how much of each feature must be contained in an efficient *solution*, which is a combination of planning units that meets all targets. Marxan could choose all planning units (meaning the whole study area) and that 'solution' would meet all targets, but Marxan is trying to meet all targets efficiently, in the smallest total area or fewest total planning units.

- Ecological: Targets for ecological features were based on recommendations gathered at *expert workshops*. For each feature we requested that experts recommend a range of targets, spanning a minimum to a preferred amount, so that BCMCA could illustrate solutions for three "What if...?" *scenarios* using values at the low, middle, and high end of the expert recommended ranges (Table 1). For example, marine plant experts recommended that 30-80% (target range) of known bull kelp beds (the feature) be captured in Marxan solutions; therefore specific targets used in the low, medium, and high expert recommended scenarios were 30%, 55%, and 80% respectively. An unanticipated result of asking experts to recommend targets was that values differed greatly among ecological themes (e.g., recommended targets for seabirds differed from those for marine plants and invertebrates, etc). The BCMCA Project Team (PT) decided to illustrate solutions for three additional "What if...?" scenarios using consistent low, medium, and high targets for features in all ecological themes (Table 1). Targets for these scenarios were collaboratively set by the BCMCA Project Team after consulting best practices, peer-reviewed scientific literature and the advice of the ecological experts. In each scenario, each feature has its own target (Appendix 1, Table 1). Please note that target setting is not an exact science. Workshops were attended by regional species experts who drew upon their own experience and knowledge to recommend targets. In cases where targets were not recommended at the workshops, targets agreed upon by the PT were used.

Table 1. Ecological Marxan scenarios and targets used in each scenario.

Scenarios	Targets
Ecol 1 - Expert Low	Low end of ranges recommended by experts (ranges were given by feature): · low values vary from 10% to 100%
Ecol 2 - Expert Med	Middle of ranges recommended by experts (ranges were given by feature): · middle values vary between 18% and 100%
Ecol 3 - Expert High	High end of ranges recommended by experts (ranges were given by feature): · high values vary between 25% and 100%
Ecol 4 - PT Low	Low end of range identified by Project Team: 10% of representative features, 20% of special features
Ecol 5 - PT Med	Middle of range identified by Project Team: 20% of representative features, 40% of special features
Ecol 6 - PT High	High end of range identified by Project Team: 30% of representative features, 60% of special features

methods (cont'd)

steps taken to produce Marxan analyses (cont'd)

- Human Use: Targets for "What if...?" scenarios using human use data were identified collaboratively by the BCMCA *Human Use Data Working Group (HUWG)* (Table 2). The type of analyses and targets chosen by the HUWG were informed by a *Marxan experts workshop* held in May 2009. During the Marxan experts workshop, a new tool called Marxan with Zones was recommended for running analyses incorporating human use data. At that time the BCMCA decided it was not feasible to use Marxan with Zones due to the learning curve, lack of time and the unproven nature of the new tool. Instead, all the human use scenarios were designed to use Marxan to identify areas important to human use by exploring what happens to the footprint if uses were reduced. For example, to explore a reduction of commercial fisheries sector use by 5% in a Marxan analysis, we used a target of 95% for each of the commercial fisheries features (i.e., fisheries mapped). The results of this scenario showed the most efficient footprint that included 95% of the catch of each fishery. The metric used to measure 'use' varies by human use sector and feature (Appendix 1, Table 2).

Table 2. Human use Marxan scenarios and targets used in each scenario.

Scenarios	Human Use Sector	Targets
HU 1-5	Commercial Fisheries	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%
HU 6-10	Sport Fishing	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%
HU 11-15	Ocean Energy	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%
HU 16-20	Shipping and Transportation	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%
HU 21-25	Tenures	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%
HU 26-30	Tourism and Recreation	Overall reduction of sector use by 5%, 10%, 15%, 20%, 25%

6. **Run Marxan analyses with ecological data to identify areas of high conservation value.** The six different "What if...?" ecological scenarios were designed to identify areas of high conservation value. A scenario is a Marxan analysis with a unique set of features or targets. We varied targets among scenarios in our ecological analyses, but all the scenarios used the same set of ecological features. In each scenario, each feature has its own target (Appendix 1, Table 1).

   Marxan allows users to adjust a parameter which controls the size of the clumps of selected planning units that make up the solution. This parameter is called the *Boundary Length Modifier (BLM)* because the size of the clumps in a Marxan result is directly related to *total boundary length* (i.e., the sum of the perimeter of all the clumps). For example in Figure 2, the total boundary length of the small clumps in the middle panel (BLM=750) is much greater than the total boundary length of the large clumps in the right panel (BLM=2500). This is useful for marine planning because it gives analysts, managers and decision makers the option to consider a variety of spatial solutions that meet their analysis goals. A planning process or protected area design initiative would likely specify the preferred size of areas, or clumps, in the solutions to meet their specific goals. Since the BCMCA had no particular planning mandate, we ran each ecological scenario using three different values for the BLM parameter and we illustrate results for each to demonstrate this flexibility (Figure 2.)

Figure 2. Example Marxan results showing the effect of using different values for the Boundary Length Modifier (BLM) parameter. Darker areas are part of the combination of planning units selected by Marxan. Left panel shows no clumping (BLM = 0); middle panel shows medium clumping (BLM = 750); right panel shows high clumping (BLM = 2500).

7. **Run Marxan analyses with human use data to identify areas important to human use for each sector.** Five "What if...?" scenarios were run for each of six human use sectors to identify important areas for each sector, for a total of 30 different scenarios. The results for HU scenario 1, for example, explore what the commercial fishing footprint could look like if overall use were reduced by 5%. No ecological features were used in these scenarios. Scenarios for each sector used only those features pertaining to that sector's use of the marine environment (Appendix 1, Table 2). For each scenario the goal was to identify the areas important to that particular sector assuming a certain percentage reduction (Table 2) in each mapped use or feature. We did not adjust the Boundary Length Modifier or clumping parameter in the human use scenarios, but kept the value of this parameter constant (BLM=1000).

ecological scenario results

did Marxan meet the targets in the ecological scenarios?

Marxan met the targets in almost all of the scenarios. For example, if the target for eelgrass beds was 30%, at least 30% of eelgrass beds in the study area were contained somewhere in the combination of selected planning units (i.e., identified areas of high conservation value). In the ecological scenarios, 99% of the targets were met on average (Figure 3). The only exception was Scenario Ecol 3 – Expert high, which fulfilled only 95% of the targets (Figure 3). This scenario was not as successful as the others because a large number of targets were set at 100% (i.e., asking Marxan to find and select every instance of those features), as recommended at the ecological expert workshops. Because Marxan was also asked to select as little area as possible, it traded off fulfilling some targets to reduce the area selected.

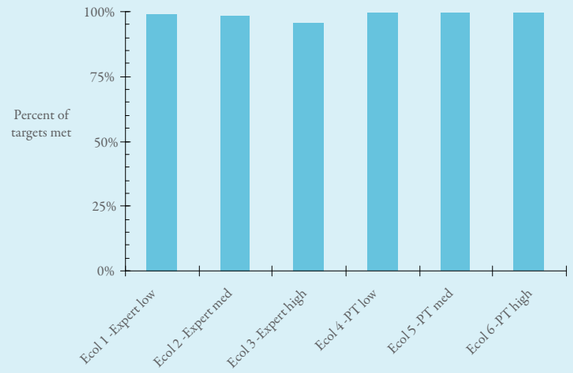


Figure 3. Percent of the targets that were met on average in each ecological Marxan scenario.

how did different targets affect Marxan results?

The percent of the study area covered by the solution increased as targets increased (Figure 4). Some of the features cover the whole study area, so it is logical to expect that the area covered by the solution is equal to or greater than the average target. For example, the whole study area is divided into ecosections and if the target for each ecosection is 30%, then Marxan must select at least 30% of the study area to meet the target for each ecosection.

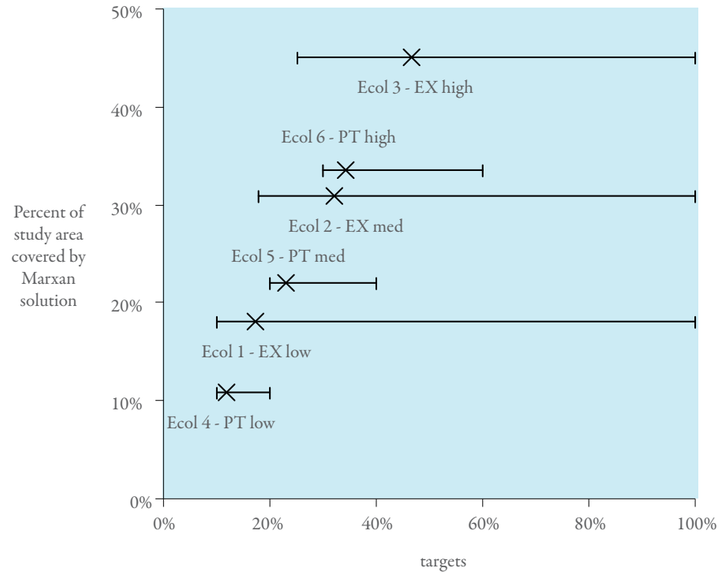


Figure 4. Percent of the study area covered by Marxan solutions and targets for each ecological scenario.
For each scenario, × signifies the average target and lines to the left and right indicate the lowest and highest targets used in that scenario.

ecological scenario results (cont'd)

how did different levels of clumping (BLM parameter) affect Marxan results?

As the level of clumping was increased in Marxan (i.e., BLM was increased), the size of the clumps identified as high conservation value got bigger (Figure 2). As the clumps got bigger, there were fewer of them in the solution and the total area of the solution increased slightly (Figure 5). The total boundary length (i.e., sum of the length of perimeters of all clumps) decreased as the level of clumping was increased. Total area of the solution and boundary length are important to planners and managers because if the selected areas were to receive enhanced management, longer boundaries and a greater number of small areas to actively manage tend to increase management challenges and costs. Obviously, there is a trade-off if the selected areas get too big, so it is useful for planners to have some control over this in Marxan analyses. This trade-off is also known as the edge-to-area ratio. In all our ecological scenarios, when the level of clumping was increased, the edge-to-area ratio decreased (Figure 6).

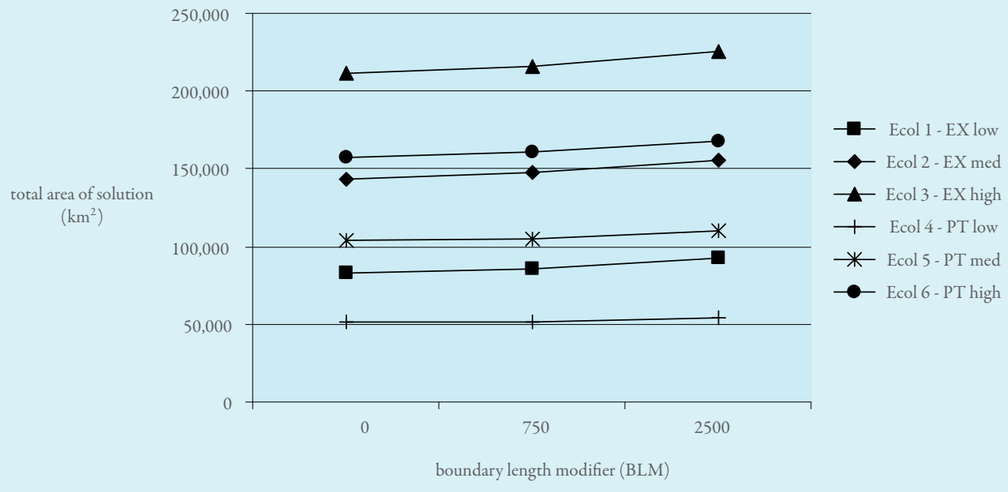


Figure 5. Total area of solution related to level of clumping, or boundary length modifier, for each ecological Marxan scenario.

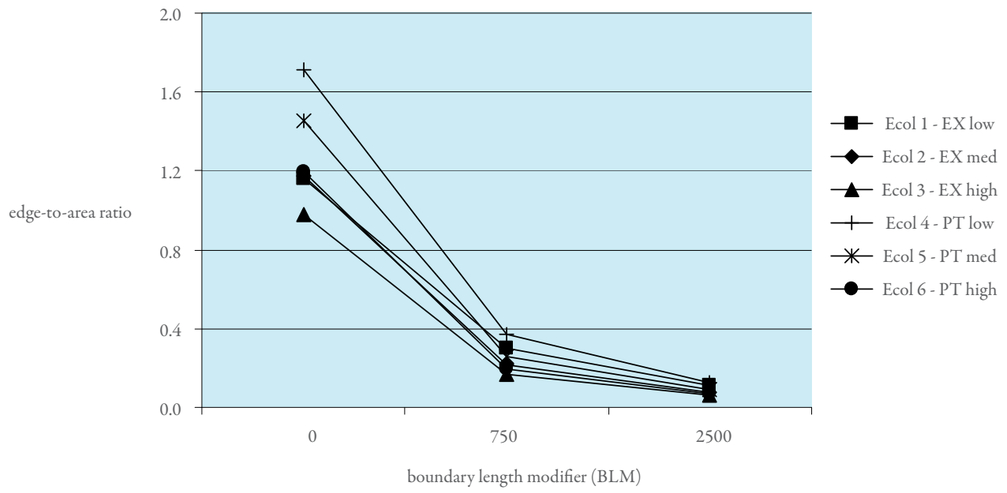


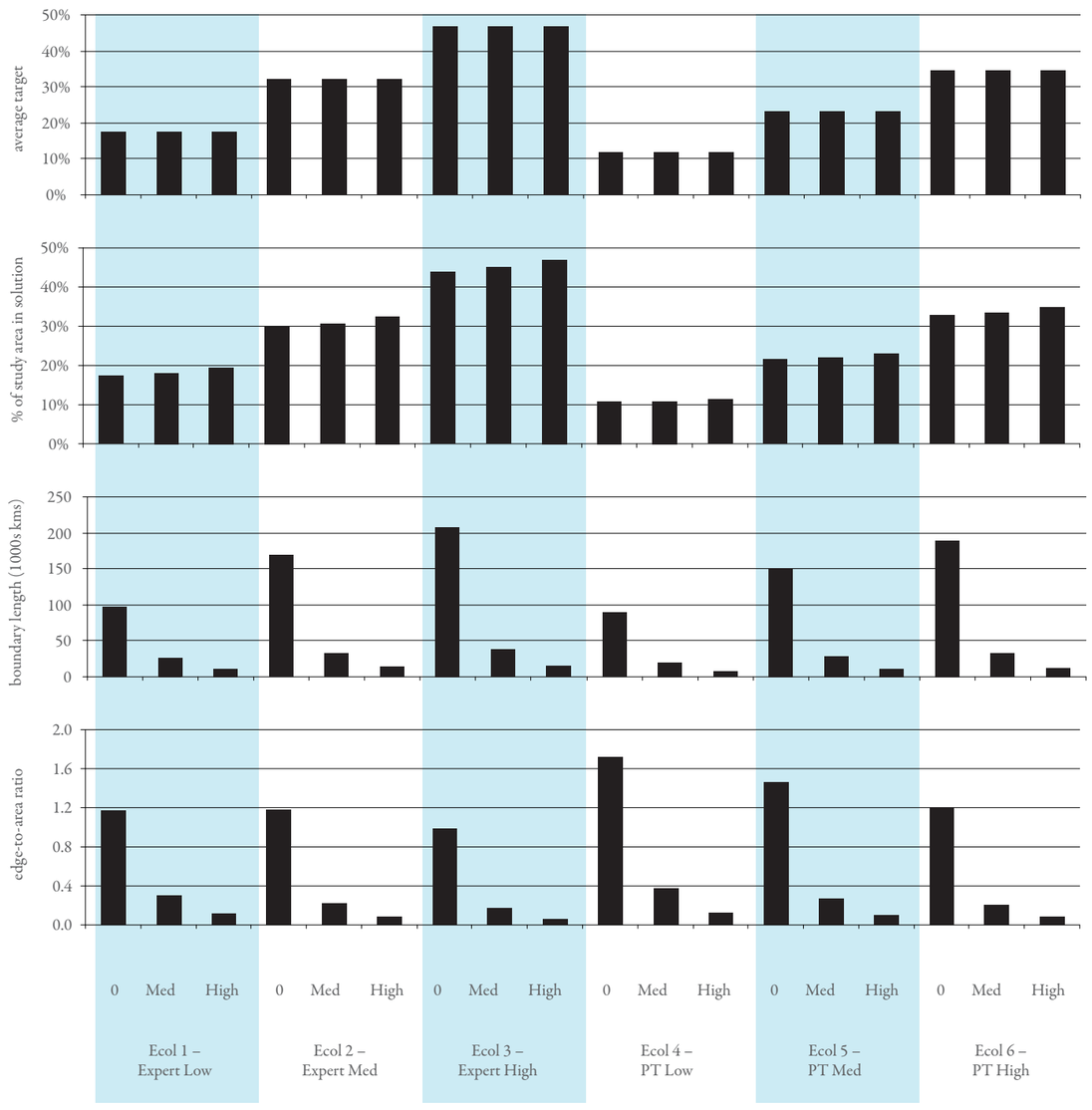
Figure 6. Edge-to-area ratio related to level of clumping, or boundary length modifier, for each ecological Marxan scenario.

comparing ecological scenarios

BCMCA ran a variety of ecological Marxan scenarios to provide the results from example "What if…?" analyses to show British Columbia's marine planning community how they can use Marxan. By studying how percent of the study area covered by the solution, total boundary length, and edge-to-area ratio are related to targets and level of clumping (Figure 7) planners can design scenarios to meet their goals.

We also prepared an animation series of Marxan results to show how the spatial arrangement of solutions shifts as targets change or as the level of clumping changes. *View our animation series here.*

comparing ecological scenarios



Average target. Targets tell Marxan how much of each feature is required to meet the scenario goals. To optimise a solution, Marxan ensures that the target amounts of each feature are captured in selected areas and minimizes the total selected area. For each scenario, every feature has a target; the values shown here are the averages.

Percent of study area covered by the solution, or the total area of high conservation value in these scenarios, is influenced by targets and is slightly affected by the clumping level. Total area in scenario solutions ranges from 11% of the study area (approx 51,000 km^2) to 47% of the study area (approx 226,000 km^2).

Total boundary length is the sum of the length of perimeters or boundaries of all clumps in a solution. This is important to planners because if the selected areas (clumps in the solution) were to receive enhanced management, more boundaries tend to increase management challenges and cost.

Edge-to-area ratio is the total boundary length divided by the total area of the solution. This is important to planners because if the selected areas were to receive enhanced management, a configuration with fewer edges or boundaries (meaning a lower ratio) is easier and less costly to manage. Both the theory behind designing marine reserves and empirical studies support this.

Level of clumping (BLM parameter)

Scenario names (Med means medium, PT means Project Team)

Figure 7. Average targets, percent of study area covered by solutions, total boundary length, and edge-to-area ratio for each ecological Marxan scenario with each clumping level.

ecological data gaps and analysis limitations

ecological data gaps

Ecological features and data were *recommended to the BCMCA* at a series of ecological *expert workshops.* Experts at these workshops developed comprehensive wish-lists of all the features they would like to see available for analyses such as the BCMCA Marxan analyses. As expected, the BCMCA was not able to collate data to fulfill the complete list of recommended features. Roughly 150 were not created (Appendix 2). In many cases appropriate data do not exist, but in some cases data do exist but were not made available to the project. In addition some requested features would have required modeling or analysis work to create them and BCMCA did not have the capacity to make this happen. The types of features recommended but not created include:

- Pelagic habitat surrogates for zooplankton communities.
- Ephemeral oceanographic features such as gyres, eddies, upwelling zones, sea surface temperature fronts, and sea surface height gradients.
- Features that required modeling work such as potential or suitable habitats for eelgrass, fish communities, marine mammals, rocky and flat staging areas for migratory birds.
- 'Special' or unique habitats including subtidal glacial moraine, glacial refugium, vertical granite walls in fjords, persistent upwelling, rocky reefs, surge channels, caves, anoxic environments, juvenile fish habitat, spawning habitats, and adult rockfish habitat.
- Species without supporting data such as sandlance, sea otter in winter, and habitat for sixgill and basking sharks.
- Marine mammal distributions and observations.

Appendix 2 contains a detailed list with the reason why each feature was not created.

analysis limitations

Marxan has some limitations as a decision support tool.

- The *Marxan User's Manual* states that Marxan "is not designed to act as a stand-alone reserve design solution. Its effectiveness is dependent upon the involvement of people, the adoption of sound ecological principles, the establishment of scientifically defensible conservation goals and targets and the development and inclusion of quality spatial datasets."

- Marxan is limited in the ways costs can be represented. If the goal of an analysis is to meet certain targets while avoiding high cost areas, those high cost areas need to be defined by a single value in each planning unit. The user is not able to consider a range of costs simultaneously. For example, if the costs to be considered are socio-economic, Marxan requires users to combine all socio-economic costs into one value or layer of information. This is relatively straightforward if there is a single metric applicable to all (e.g., dollars) but not at all straightforward if each socio-economic feature has its own scale of relative value or intensity of use. The BCMCA used planning unit area as the cost in all the example scenarios; the goals of all the analyses we ran were to meet targets and minimize total area of the results. (Note that an extension of the Marxan software, *Marxan with Zones*, is recently available and allows users to allocate land and/or sea parcels to multiple zones each with their own targets, planning unit costs and biodiversity benefits. Users can now create zoning plans that meet a variety of conservation and human-use objectives while minimizing total cost of implementation.)

- Areas that lack data will not be chosen to be part of any result or solution, even though the gaps could be due to lack of survey effort rather than lack of important features or values. Also, the features that Marxan uses as input are static representations of a very dynamic environment. Each feature represents a snapshot in space and time, so that temporal or spatial variability cannot be addressed in a single scenario. The Marxan Good Practices Handbook expands on these limitations: "With Marxan it is difficult to consider:

    - objectives for which there are no or few spatial data;
    - ecological objectives that are not persistent in space and/or time;
    - resilience;
    - connectivity; and
    - ecological functions that are not spatially defined or persistent."

- The data used in these analyses for different features do not represent one consistent time period. Some data are older, even though they may be the best-available data, and datasets for different features used in a single analysis may have been compiled for different time periods. Data illustrated for some features may not reflect current or future reality in terms of the various measures of relative importance. Both ecological and human use features shift spatially over time due to ongoing changes in the environment and management.

- The *Marxan Good Practices Handbook* states: "Marxan can, like other tools, be misused and its outputs misinterpreted. While the use of Marxan as a decision support tool can facilitate stakeholder engagement it is not a magic bullet for participation and acceptance of the planning process. Marxan does not alleviate contextual issues, or pre-existing stakeholder and political conflicts."

BCMCA areas of high conservation value
Marxan scenario: Ecol 1 – EX low targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the low end of expert recommended ranges, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the second lowest average target (17%) and generated solutions that covered less than 20% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

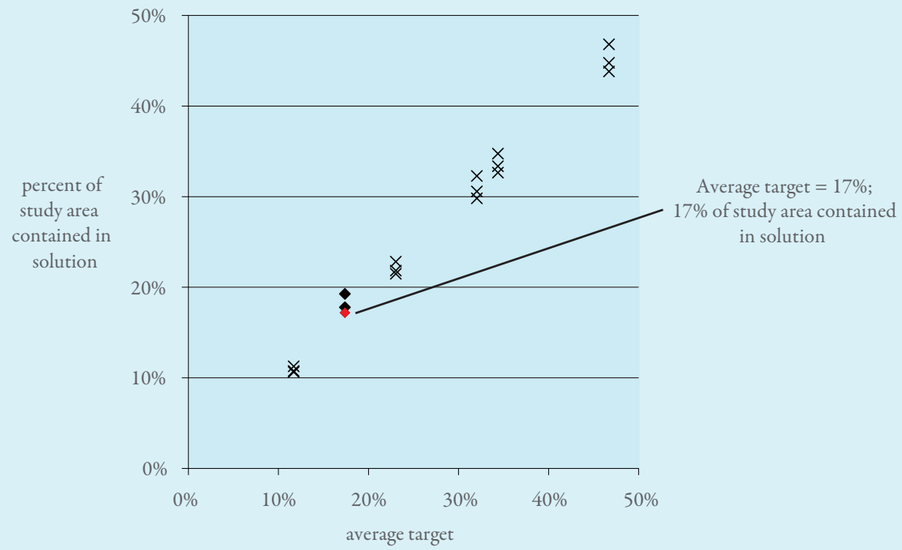


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

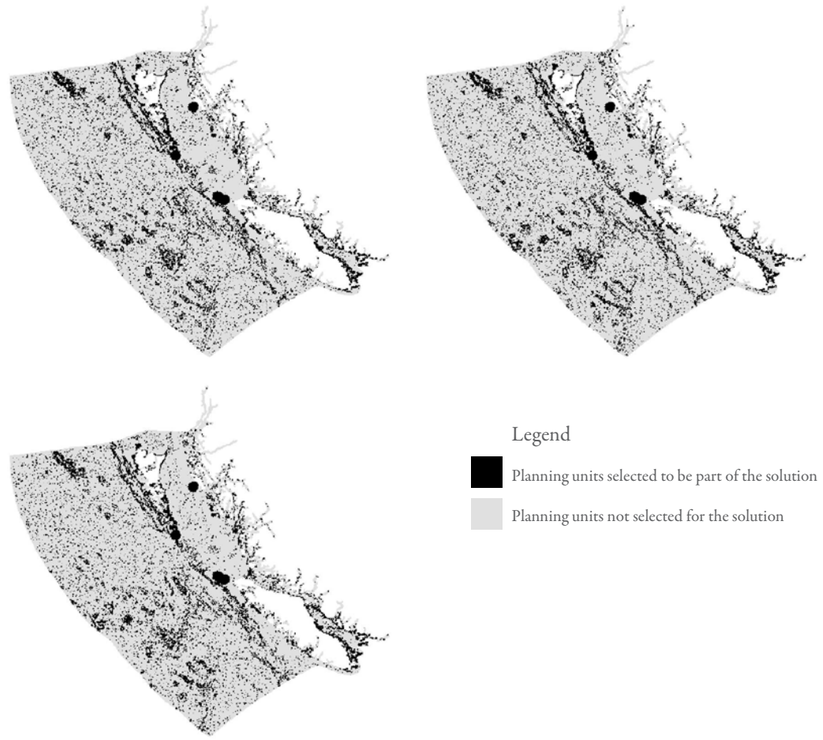
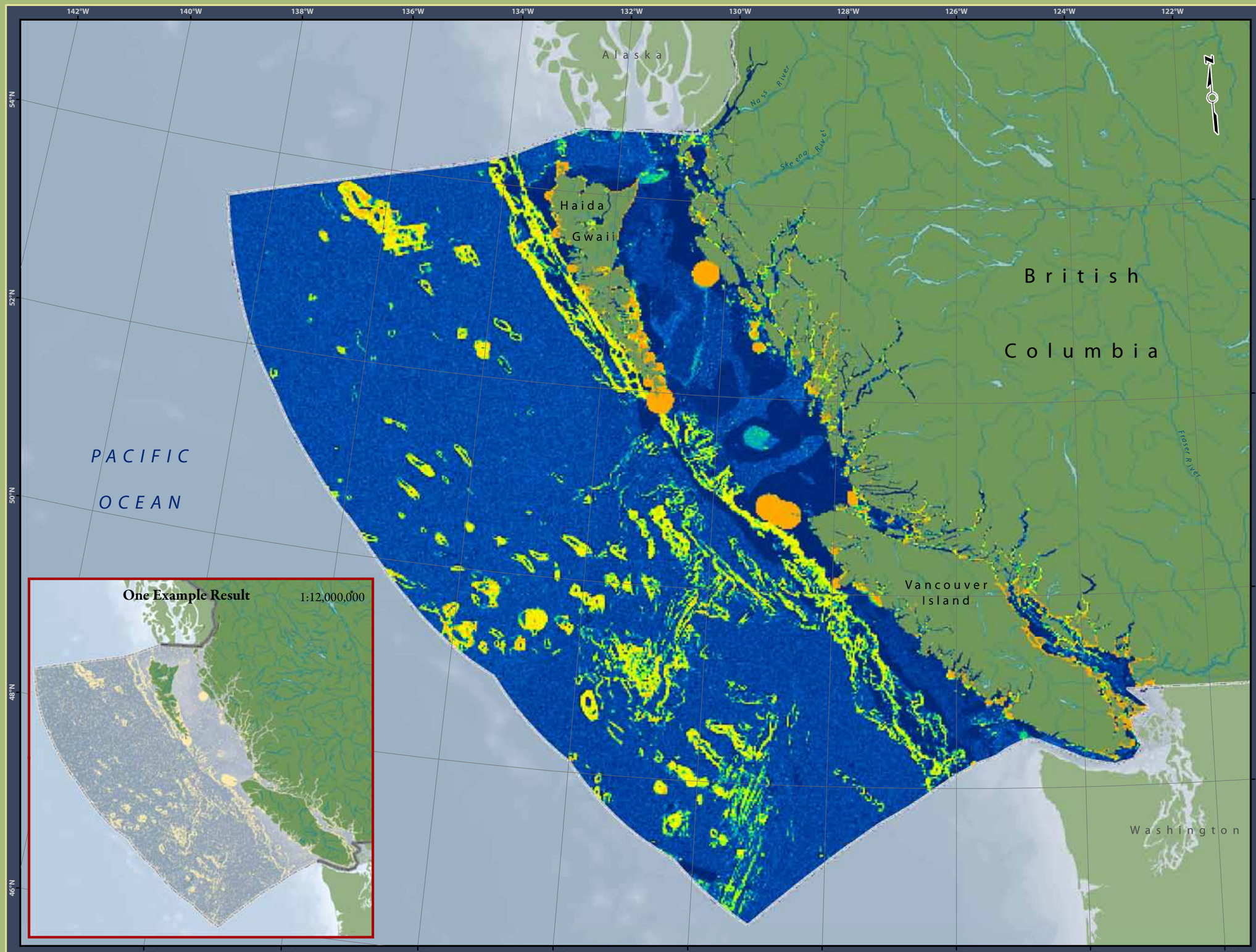


Figure 2. Three examples of results for Ecol 1 – EX low targets, no clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 1 - EX low targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet low targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution without constraint on size of clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 1 – EX low targets, medium clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the low end of expert recommended ranges, and to minimise the total area of the solution while aiming for medium sized clumps (i.e. Boundary Length Modifier, BLM = 750). This Marxan scenario, one of many run by the BCMCA, had the second lowest average target (17%) and generated solutions that covered less than 20% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

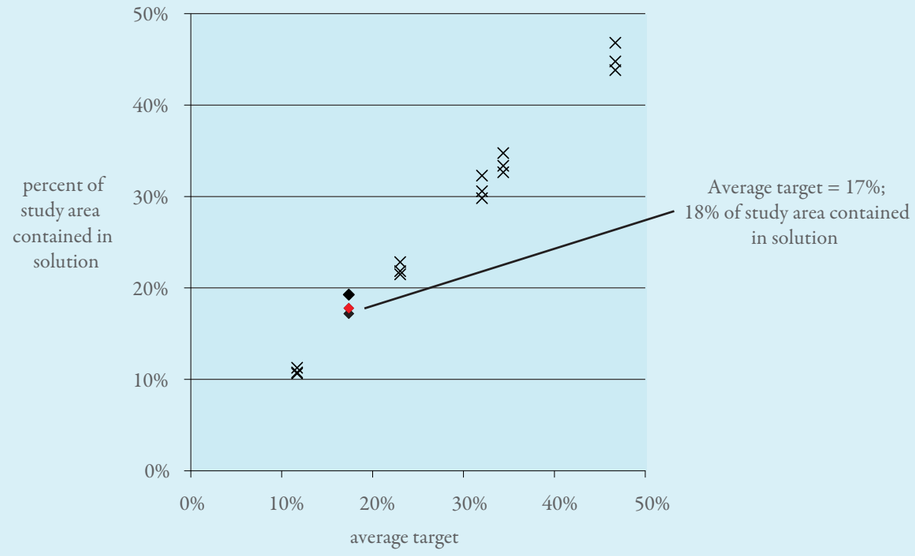


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

Figure 2. Three examples of results for Ecol 1 – EX low targets, medium clumping scenario.
The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 1 - EX low targets, medium clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet low targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution in moderately-sized clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

Alaska

Haida Gwaii

British Columbia

Vancouver Island

Washington

PACIFIC OCEAN

Nass River

Skeena River

Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

One Example Result 1:12,000,000

BCMCA areas of high conservation value
Marxan scenario: Ecol 1 – EX low targets, high clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the low end of expert recommended ranges, and to minimise the total area of the solution while aiming for large sized clumps (i.e. Boundary Length Modifier, BLM = 2500). This Marxan analysis, one of many run by the BCMCA, had the second lowest average target (17%) and generated solutions that covered less than 20% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

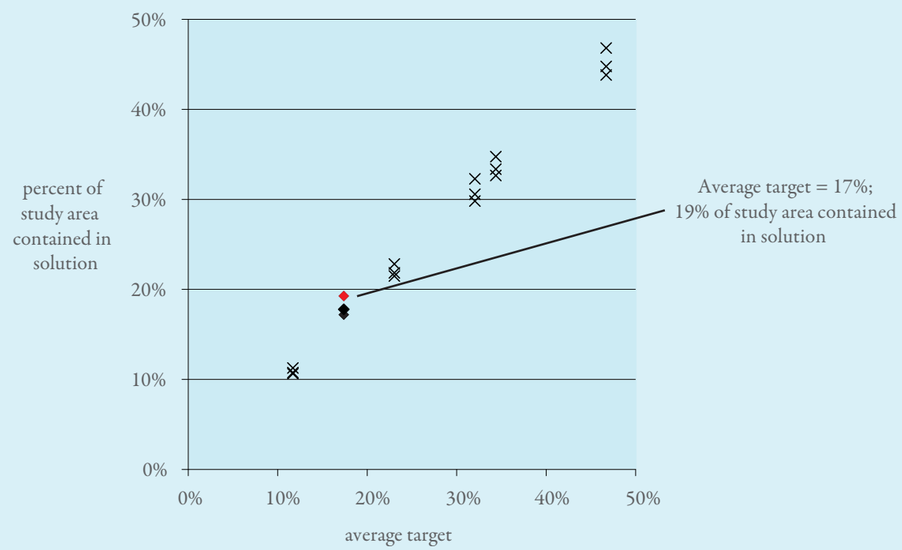


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimized, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

Figure 2. Three examples of results for Ecol 1 – EX low targets, high clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 1 - EX low targets, high clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet low targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution in large clumps or areas of high conservation value.

Data Sources:
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Base Data:
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Thematic Data:
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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

Alaska

Haida Gwaii

British Columbia

Vancouver Island

Washington

PACIFIC OCEAN

Nass River

Skeena River

Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

N

One Example Result 1:12,000,000

BCMCA areas of high conservation value
Marxan scenario: Ecol 2 – EX medium targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets in the middle of expert recommended ranges, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the third highest average target (32%) and generated solutions that covered 30% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

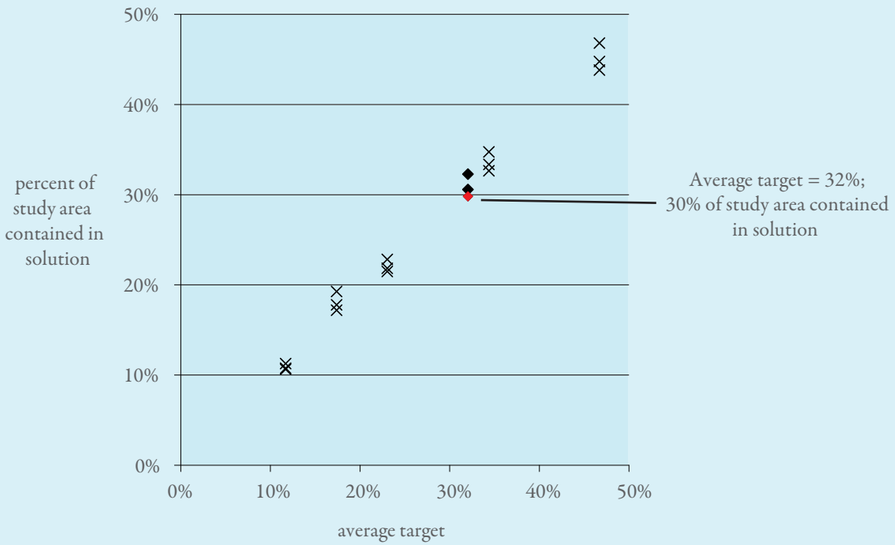

Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

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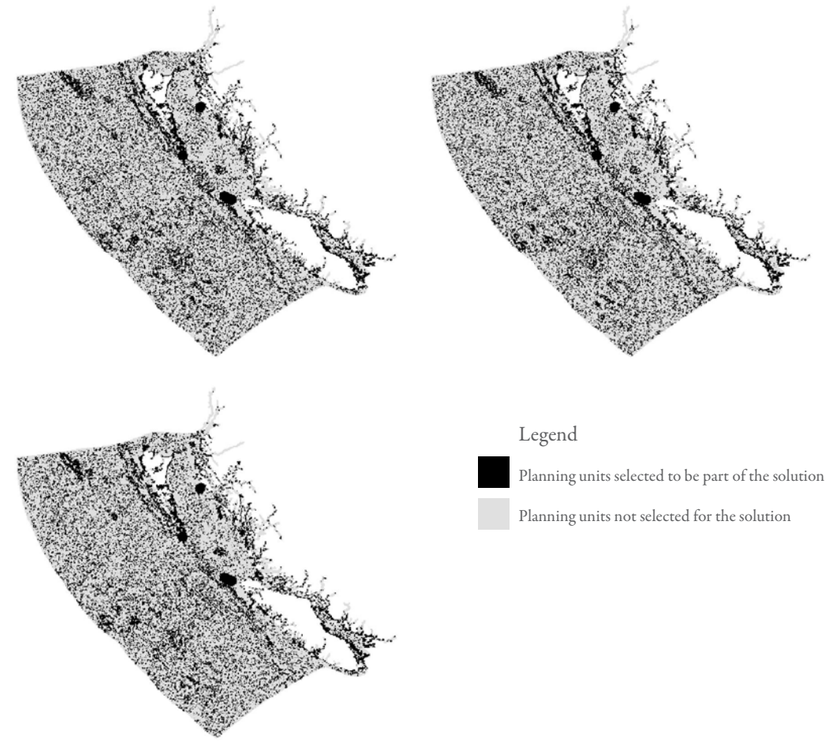
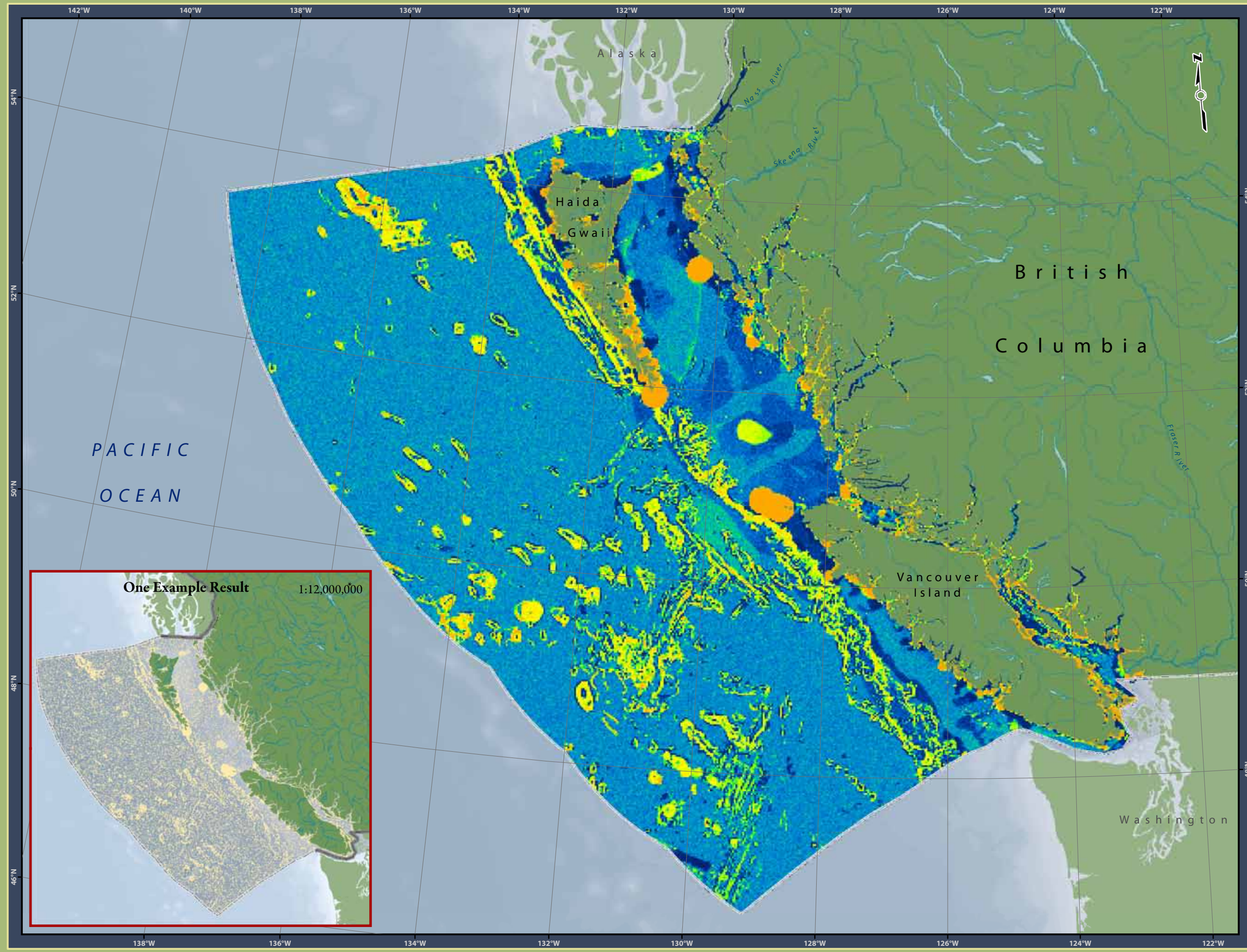


Figure 2. Three examples of results for Ecol 2 – EX medium targets, no clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 2 - EX med targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution without constraints on size of clumps or areas of high conservation value.

Data Sources:
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Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 2 – EX medium targets, medium clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets in the middle of expert recommended ranges, and to minimise the total area of the solution while aiming for medium sized clumps (i.e. Boundary Length Modifier, BLM = 750). This Marxan analysis, one of many run by the BCMCA, had the third highest average target (32%) and generated solutions that covered around 30% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

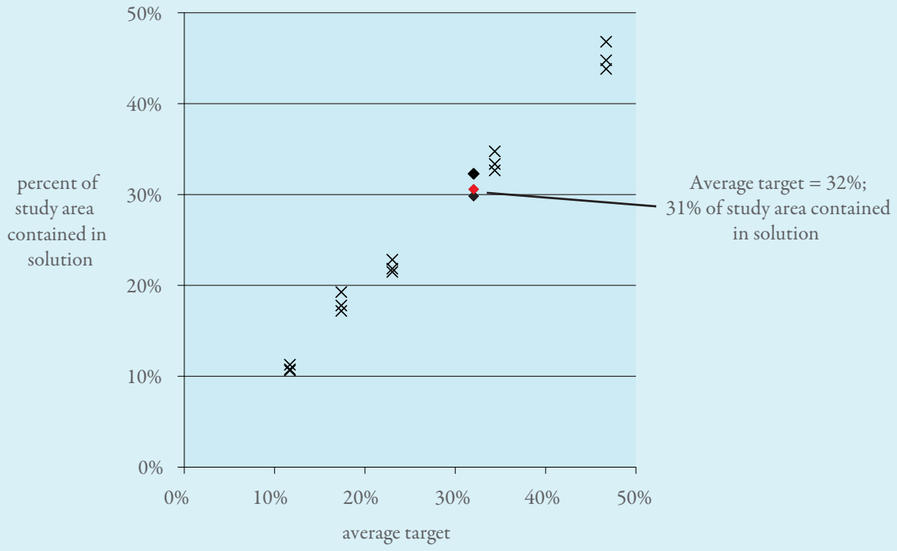

Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

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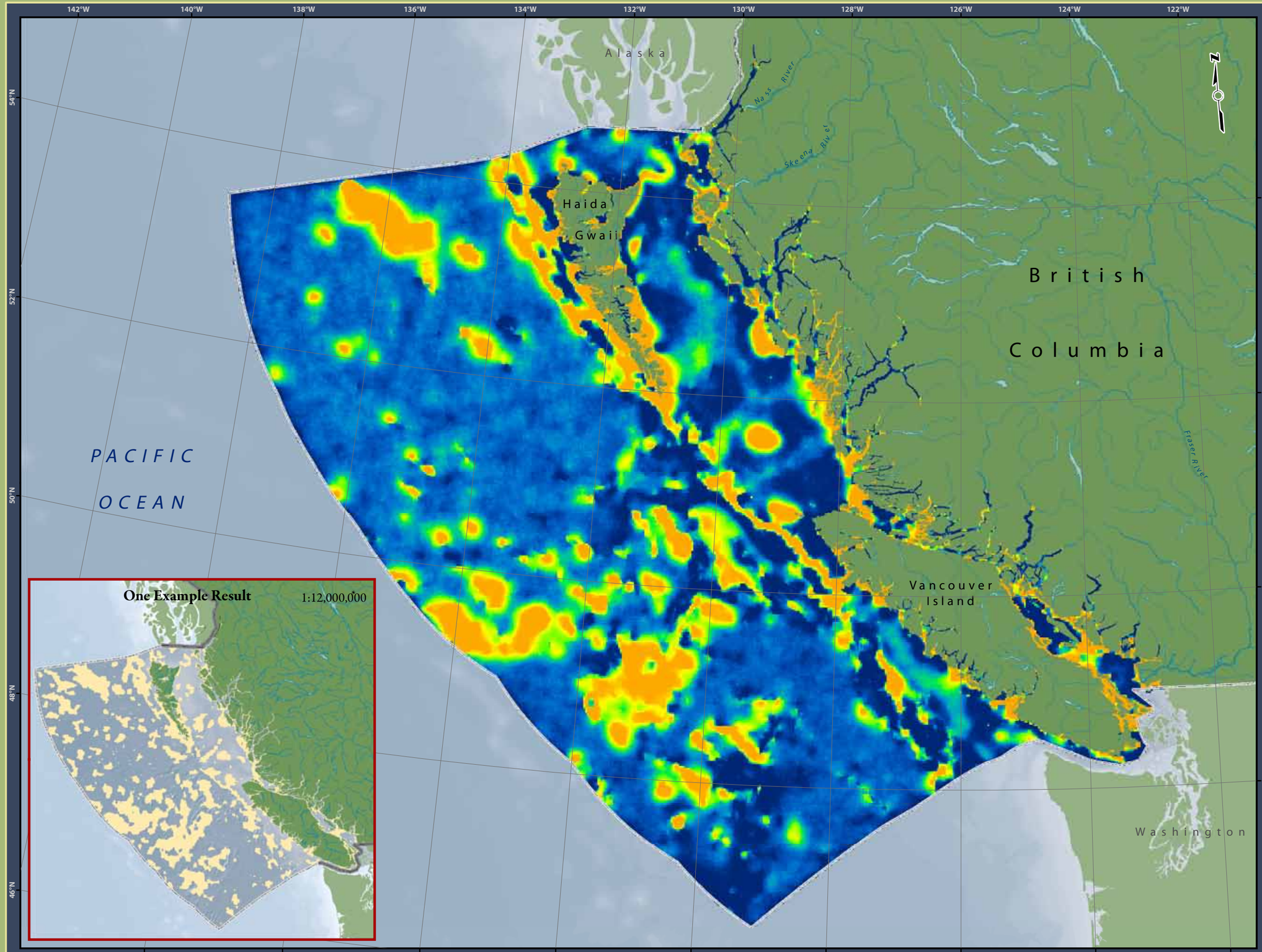
Figure 2. Three examples of results for Ecol 2 – EX medium targets, medium clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 2 - EX med targets, medium clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution in moderately-sized clumps or areas of high conservation value.

Data Sources:
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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

May 9, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 2 – EX medium targets, high clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets in the middle of expert recommended ranges, and to minimise the total area of the solution while aiming for large sized clumps (i.e. Boundary Length Modifier, BLM = 2500). This Marxan analysis, one of many run by the BCMCA, had the third highest average target (32%) and generated solutions that covered around 30% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

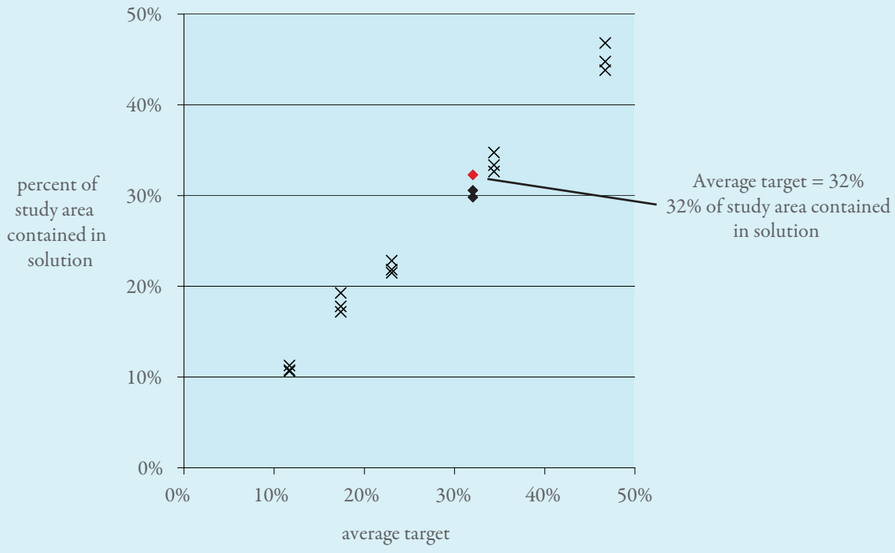

Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

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Figure 2. Three examples of results for Ecol 2 – EX medium targets, high clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 2 - EX med targets, high clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution in large clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

One Example Result 1:12,000,000

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River
N
142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

BCMCA areas of high conservation value
Marxan scenario: Ecol 3 – EX high targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of expert recommended ranges, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the highest average target (47%) and generated solutions that covered less than 50% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

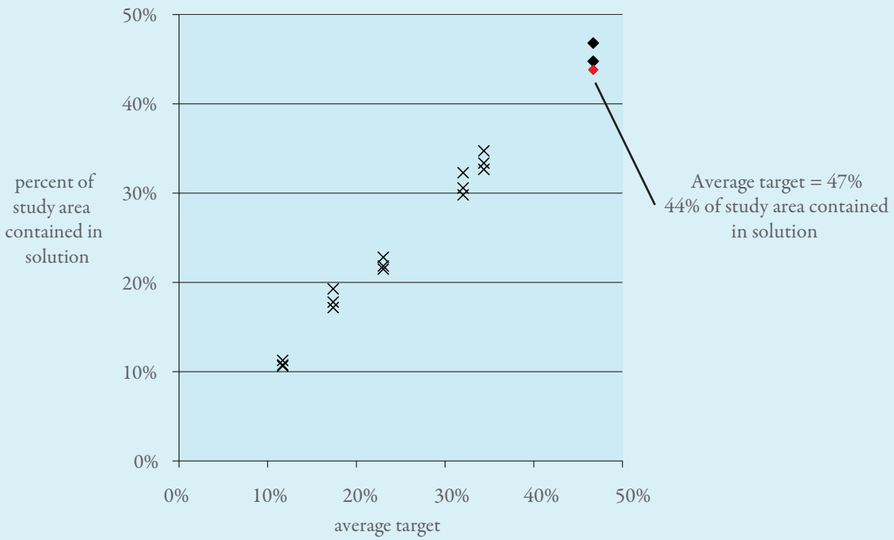


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

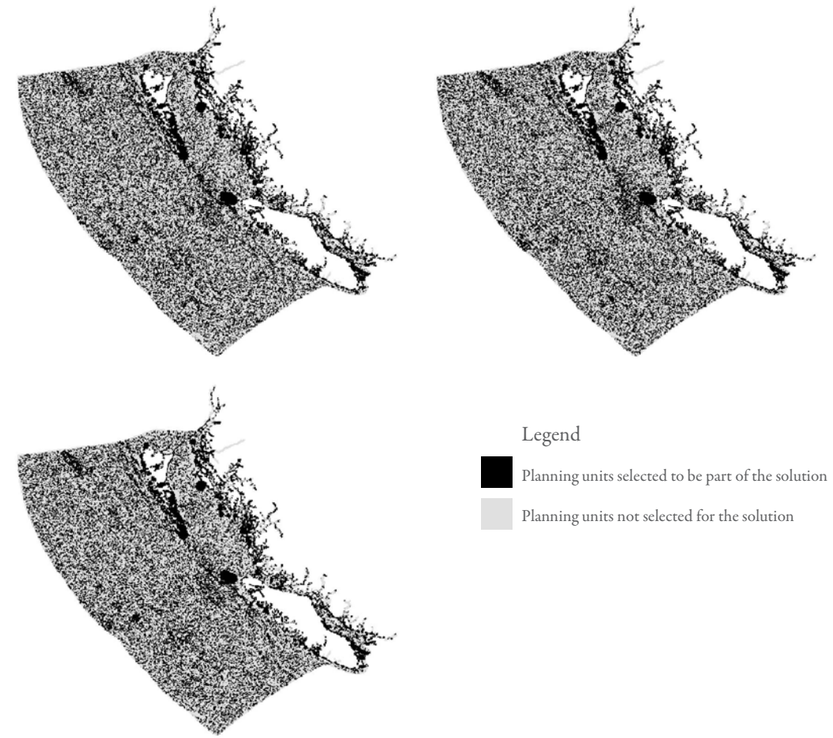
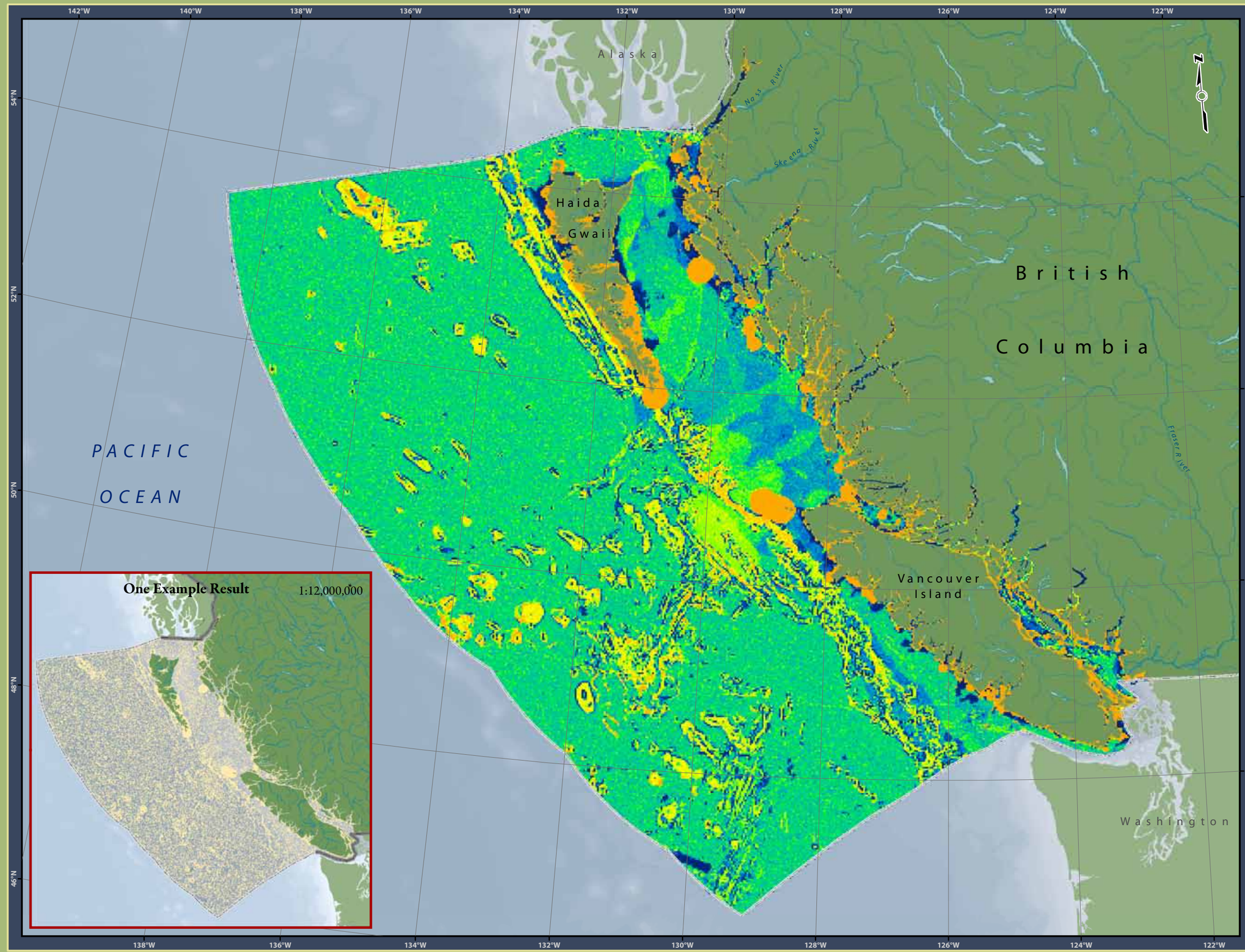


Figure 2. Three examples of results for Ecol 3 – EX high targets, no clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 3 - EX high targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet high targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution without constraint on size of clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 3 – EX high targets, medium clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of expert recommended ranges, and to minimise the total area of the solution while aiming for medium sized clumps (i.e. Boundary Length Modifier, BLM = 750). This Marxan analysis, one of many run by the BCMCA, had the highest average target (47%) and generated solutions that covered less than 50% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

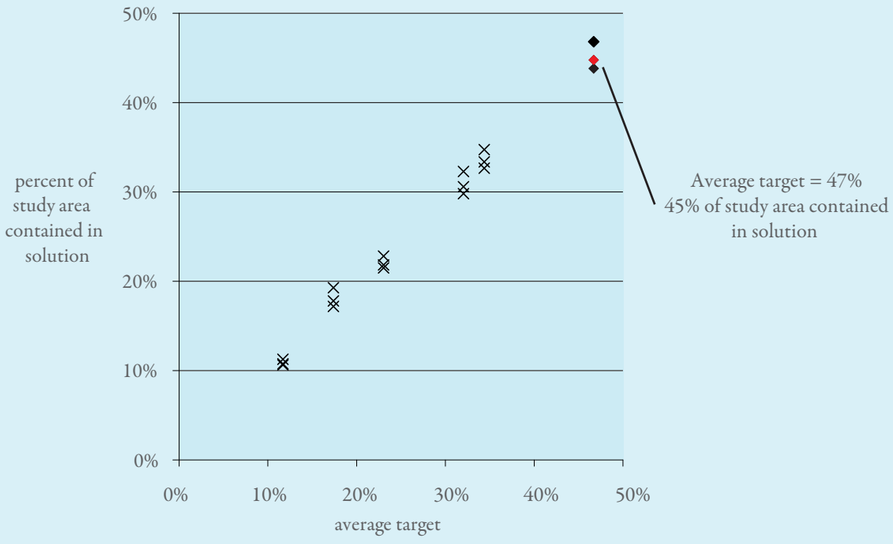


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

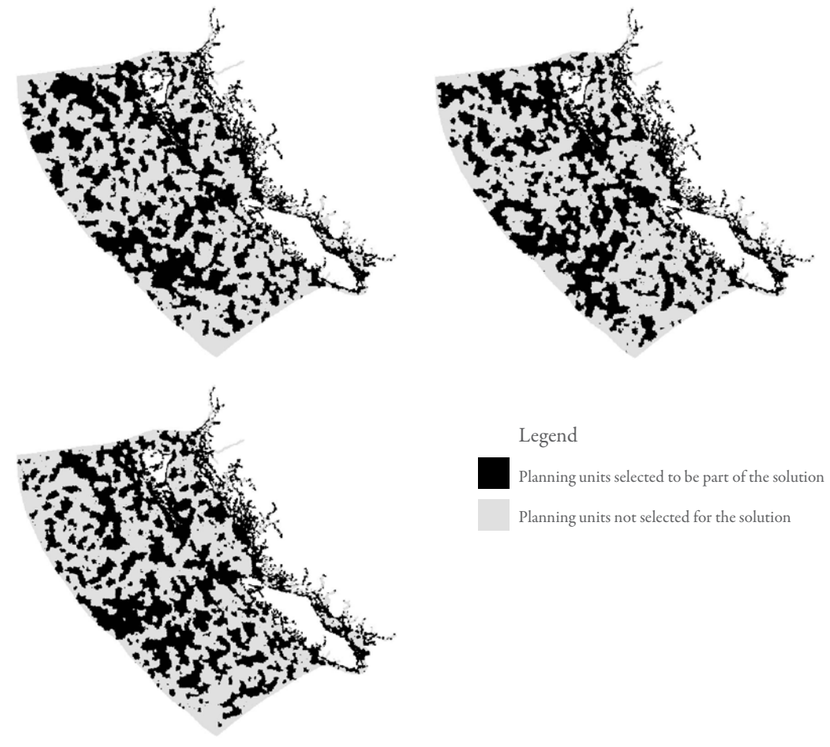


Figure 2. Three examples of results for Ecol 3 – EX high targets, medium clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 3 - EX high targets, medium clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet high targets recommended by experts at BCMCA ecological workshops and minimize the total area of the solution in moderately-sized clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

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Thematic Data:
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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

One Example Result 1:12,000,000

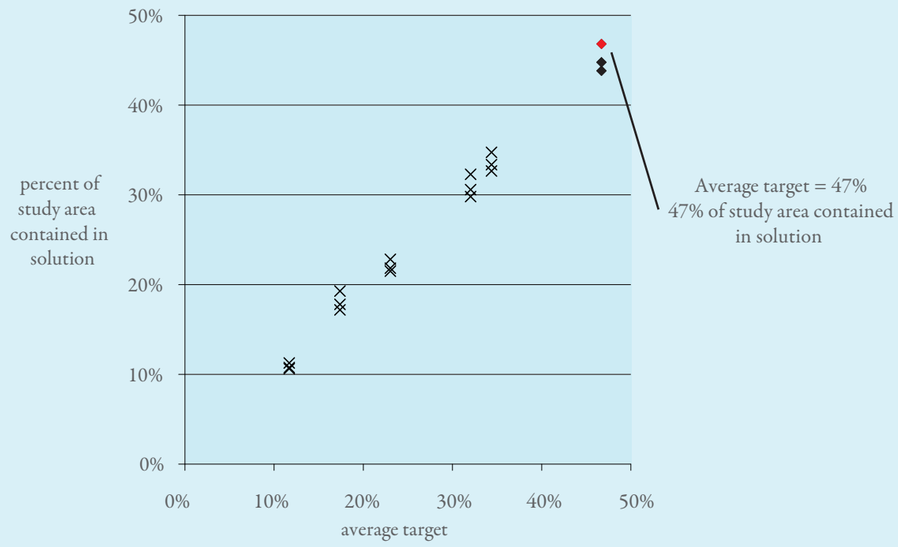
Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

BCMCA areas of high conservation value
Marxan scenario: Ecol 3 – EX high targets, high clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of expert recommended ranges, and to minimise the total area of the solution while aiming for large sized clumps (i.e. Boundary Length Modifier, BLM = 2500). This Marxan analysis, one of many run by the BCMCA, had the highest average target (47%) and generated solutions that covered less than 50% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.



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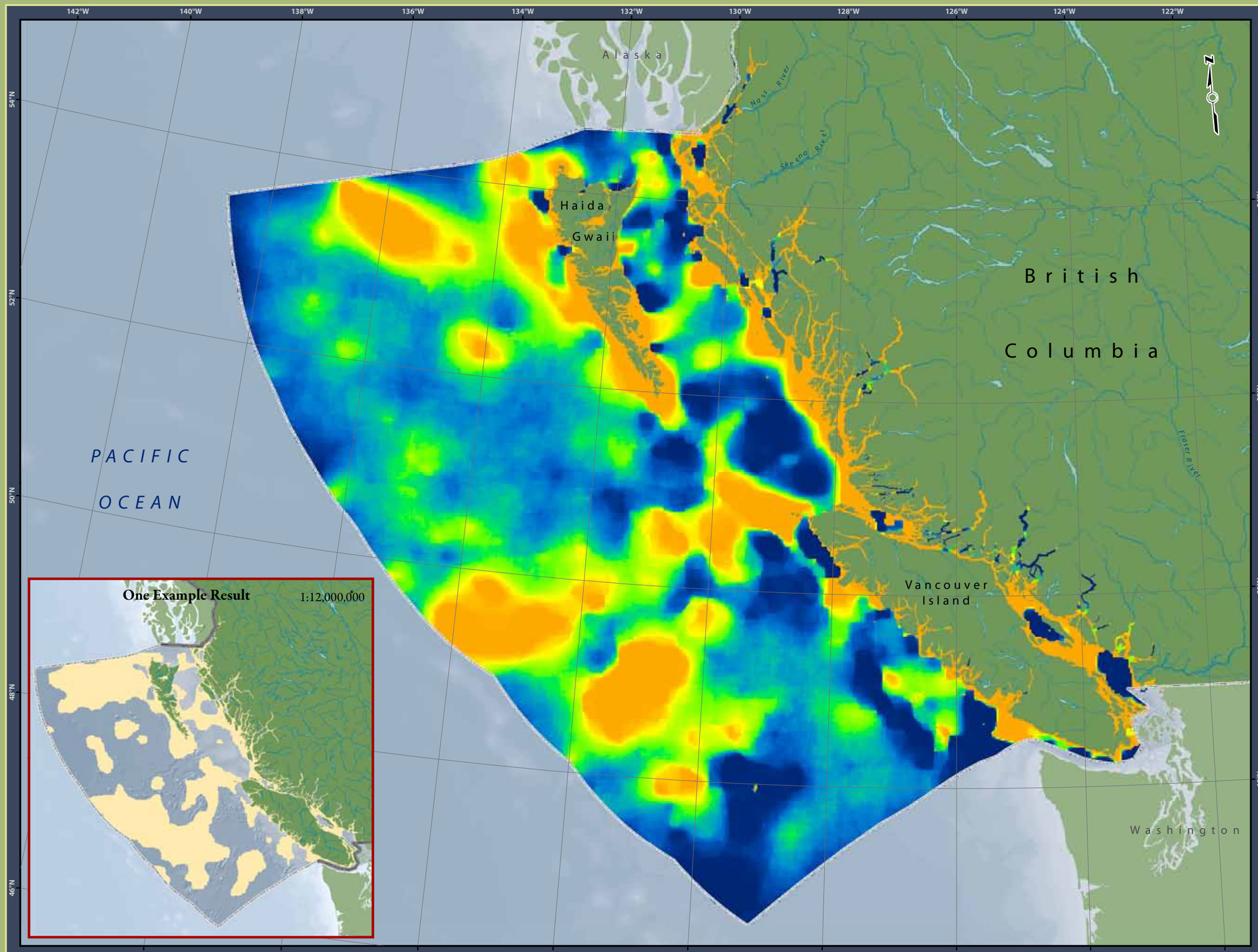

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 3 - EX high targets, high clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
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Prepared for:

BC Marine Conservation Analysis

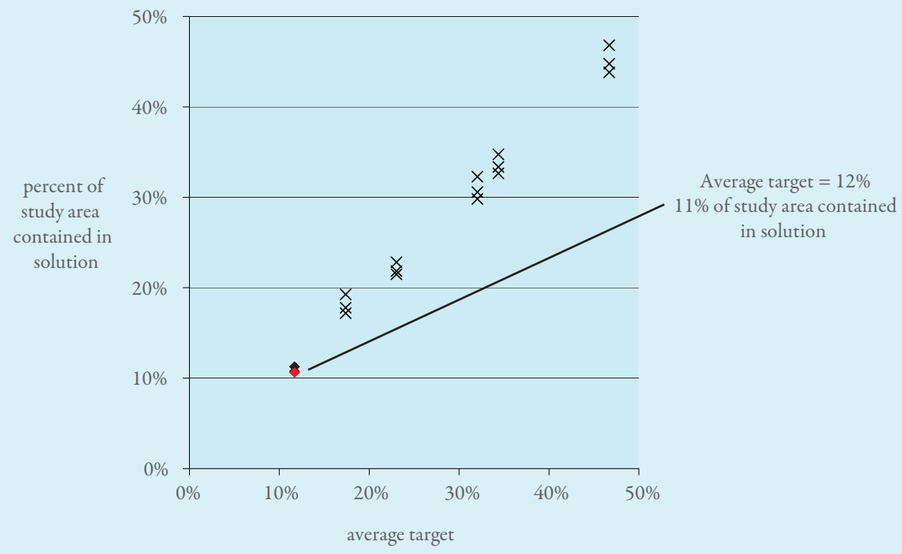
Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 4 – PT low targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the low end of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the lowest average target (12%) and generated solutions that covered around 10% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.



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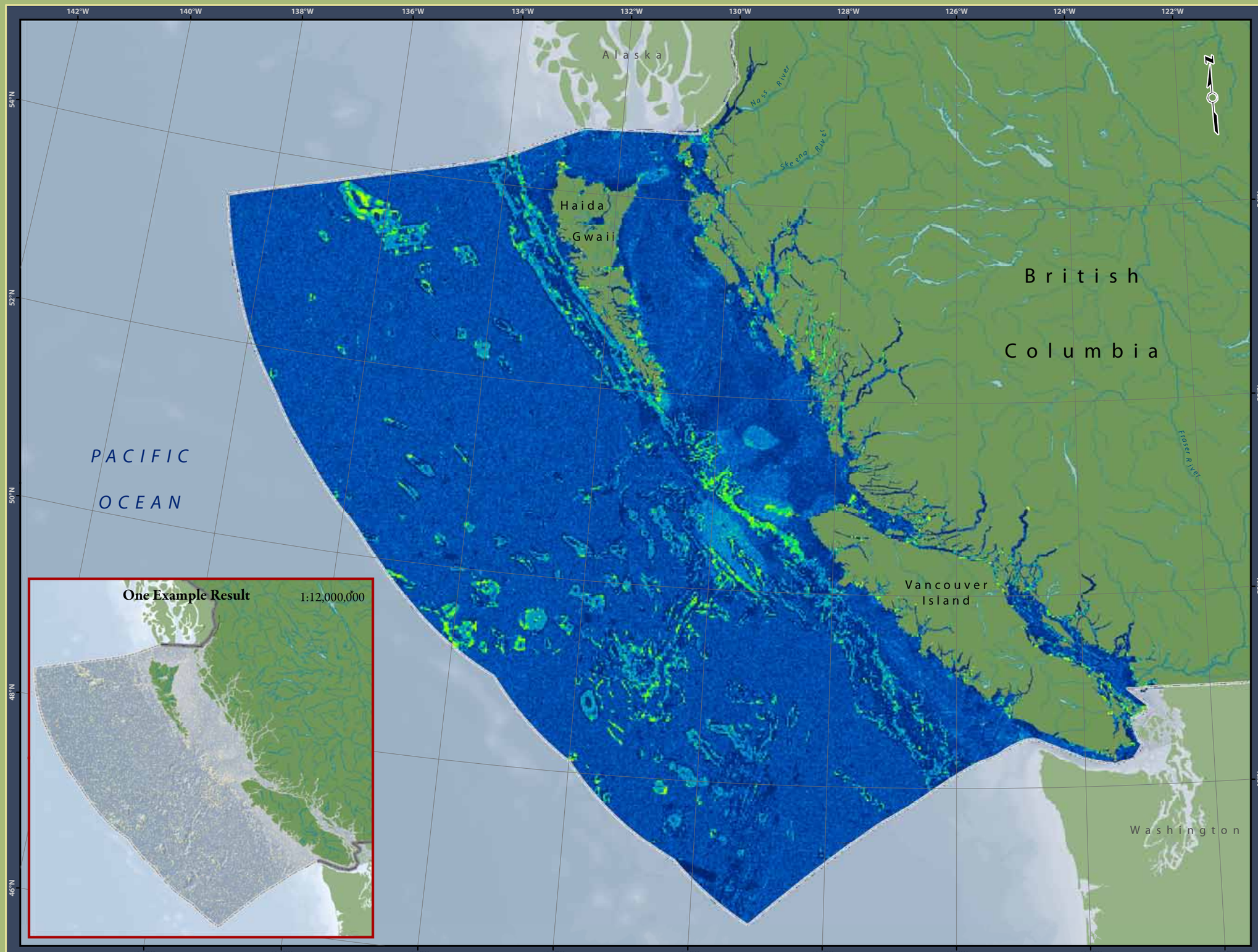

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 4 - PT low targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
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Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

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April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 4 – PT low targets, medium clumping

What if...?

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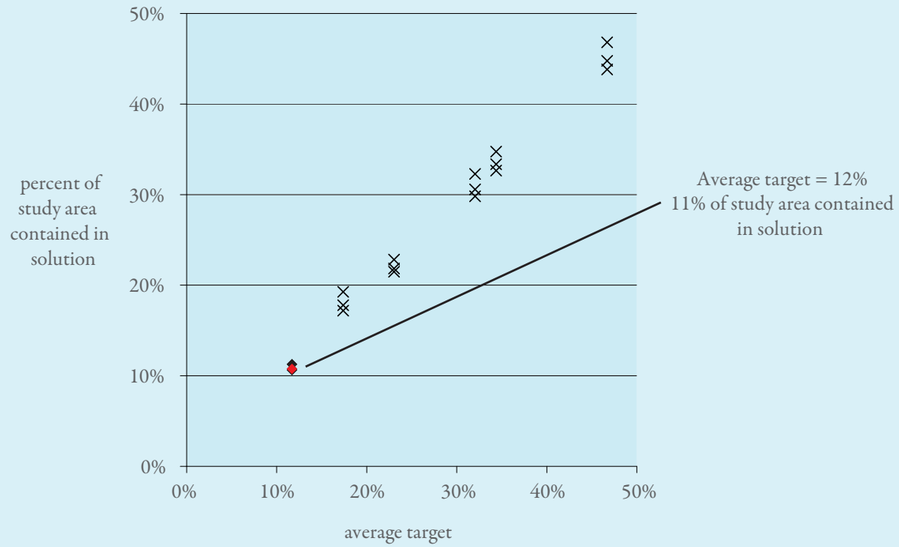

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BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 4 - PT low targets, medium clumping in solution

Legend

Selection frequency over 100 runs

Areas in one example result

Notes:
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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

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Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

One Example Result 1:12,000,000

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

BCMCA areas of high conservation value
Marxan scenario: Ecol 4 – PT low targets, high clumping

What if...?

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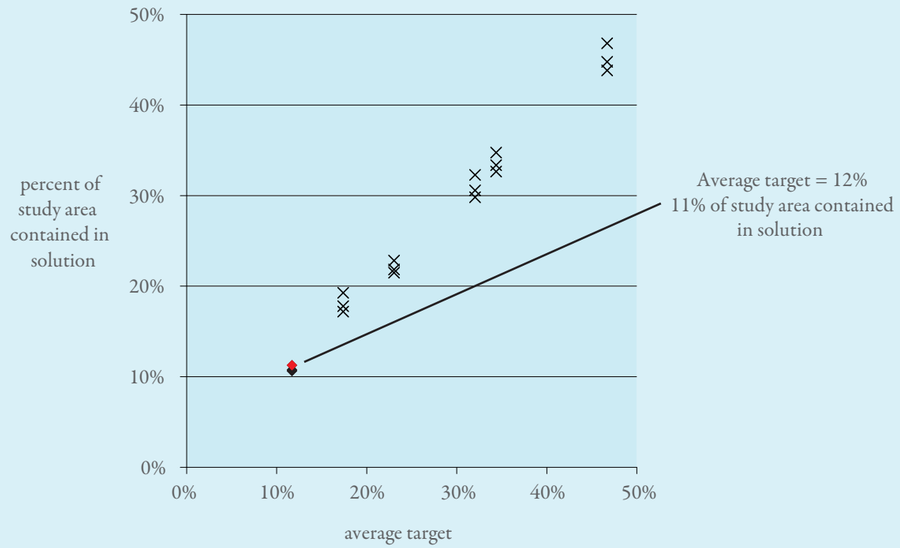

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Figure 2. Three examples of results for Ecol 4 – PT low targets, high clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

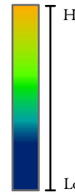
Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 4 - PT low targets, high clumping in solution

Legend

Selection frequency over 100 runs



Areas in one example result

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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
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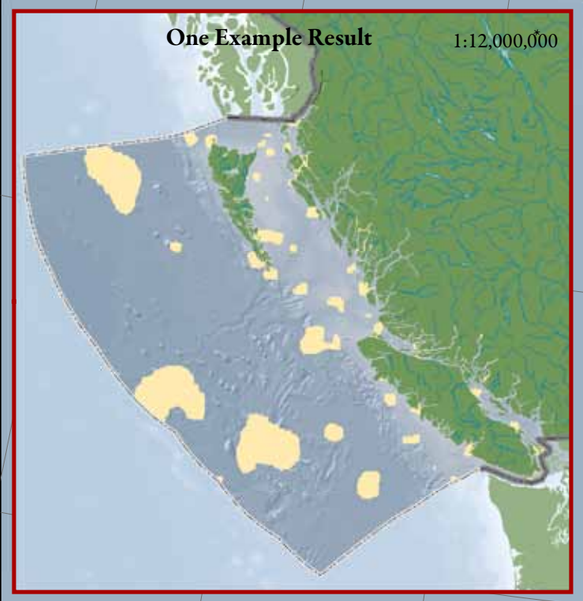
Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

May 9, 2011



Alaska
Haida Gwaii
British Columbia
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Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River
142°W
140°W
138°W
136°W
134°W
132°W
130°W
128°W
126°W
124°W
122°W
54°N
52°N
50°N
48°N
46°N

BCMCA areas of high conservation value
Marxan scenario: Ecol 5 – PT medium targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets in the middle of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the third lowest average target (23%) and generated solutions that covered less than 30% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

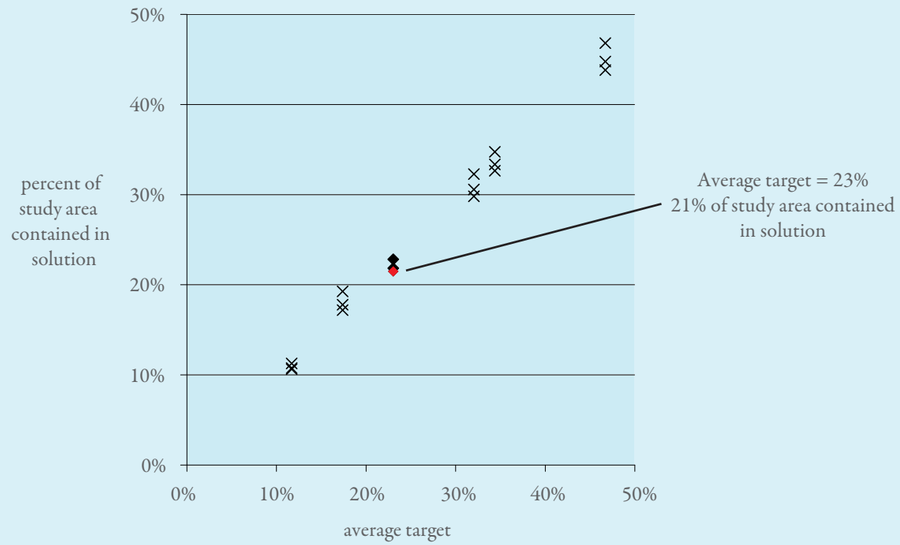

Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

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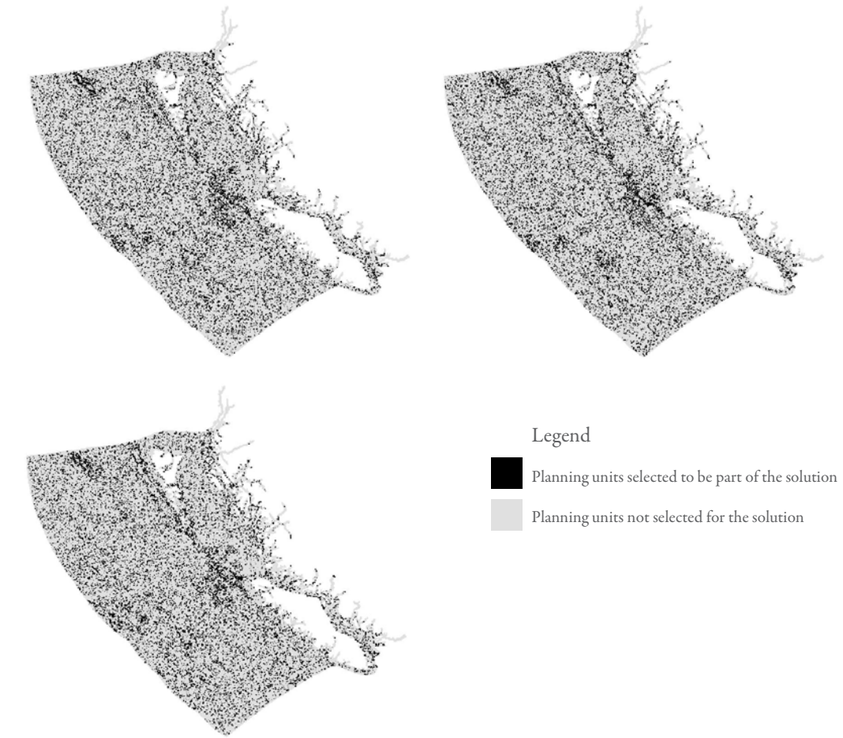
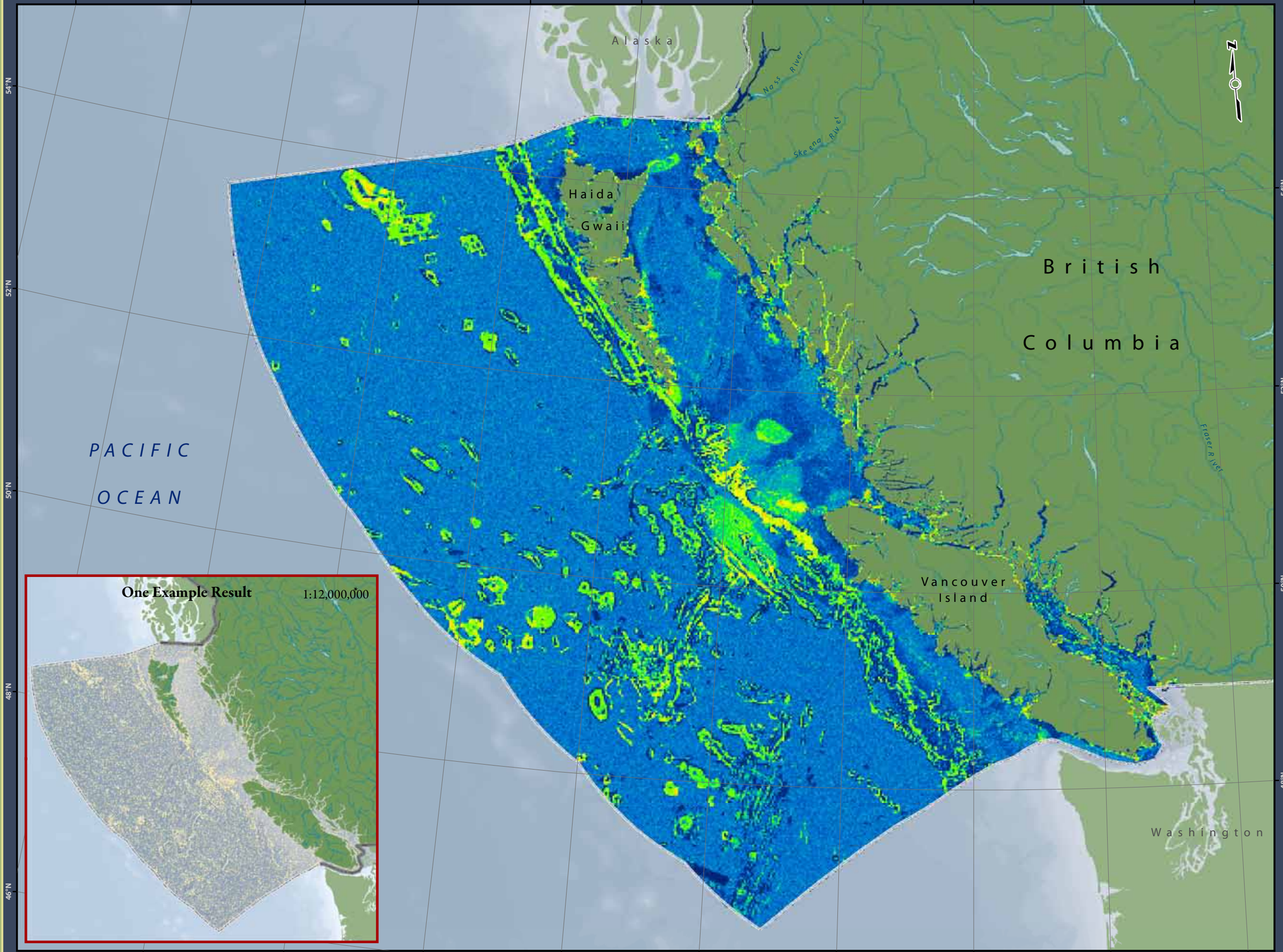


Figure 2. Three examples of results for Ecol 5 – PT medium targets, no clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 5 - PT med targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by the BCMCA Project Team and minimize the total area of the solution without constraints on size of clumps or areas of high conservation value.

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Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

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Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 5 – PT medium targets, medium clumping

What if...?

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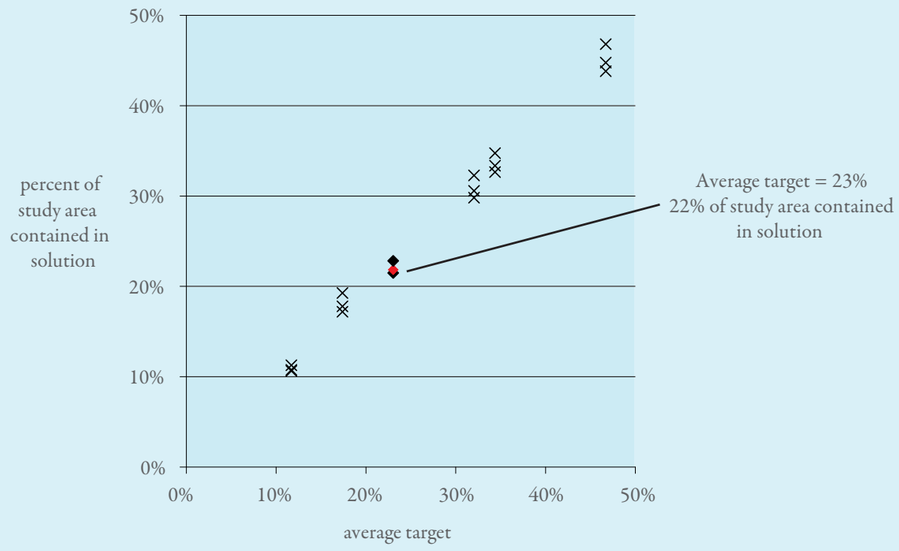

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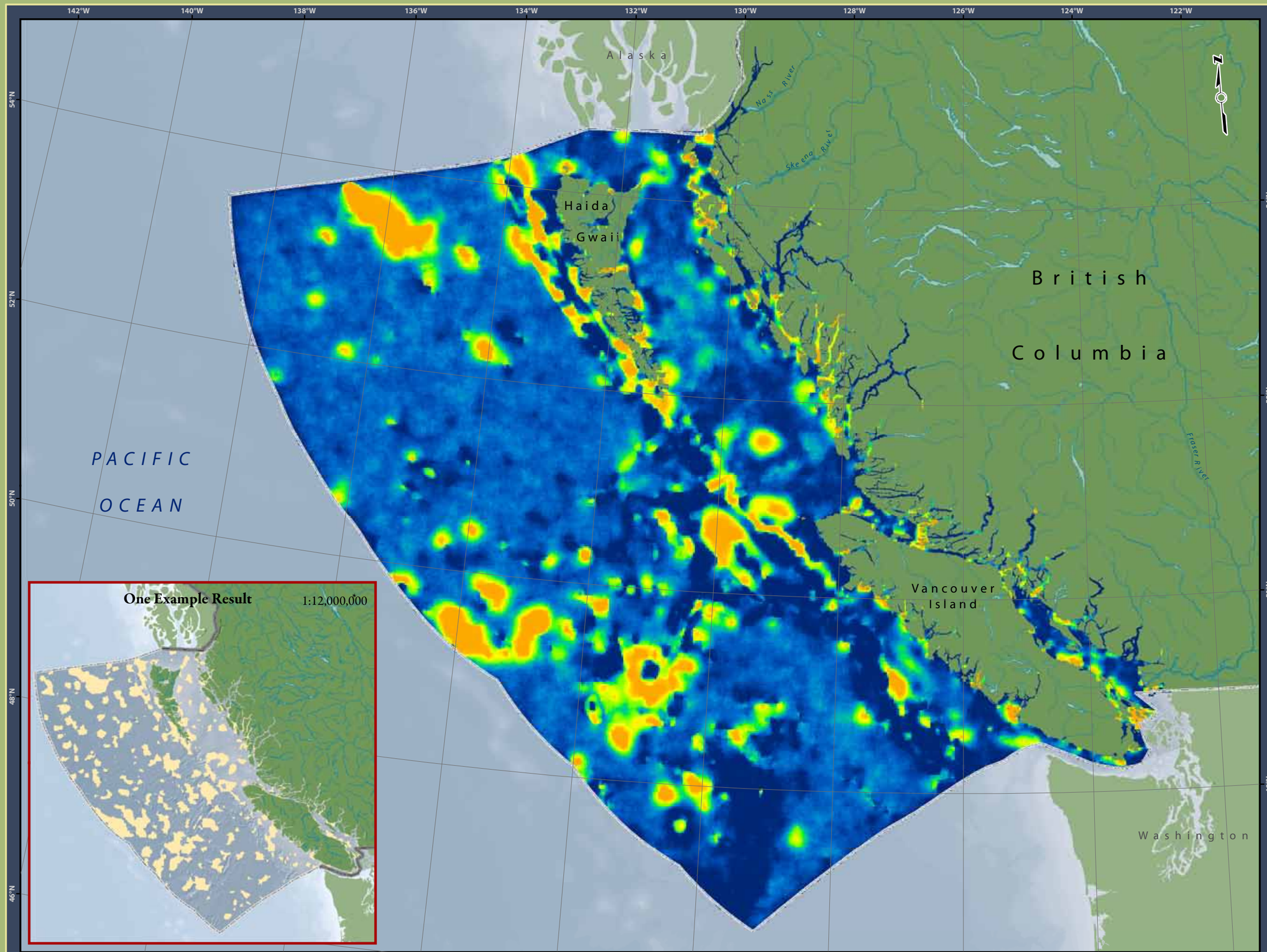
Figure 2. Three examples of results for Ecol 5 – PT medium targets, medium clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 5 - PT med targets, medium clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by the BCMCA Project Team and minimize the total area of the solution in moderately-sized clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 5 – PT medium targets, high clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets in the middle of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while aiming for large sized clumps (i.e. Boundary Length Modifier, BLM = 2500). This Marxan analysis, one of many run by the BCMCA, had the third lowest average target (23%) and generated solutions that covered less than 30% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

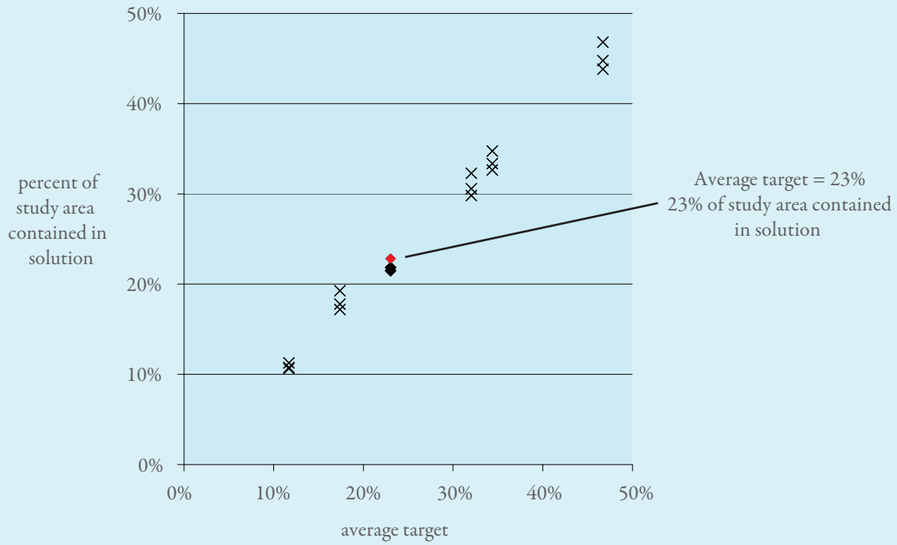


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

Figure 2. Three examples of results for Ecol 5 – PT medium targets, high clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 5 - PT med targets, high clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet medium targets recommended by the BCMCA Project Team and minimize the total area of the solution in large clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

One Example Result 1:12,000,000

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

BCMCA areas of high conservation value
Marxan scenario: Ecol 6 – PT high targets, no clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while not constraining clump size (i.e. Boundary Length Modifier, BLM = 0). This Marxan analysis, one of many run by the BCMCA, had the second highest average target (34%) and generated solutions that covered less than 40% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

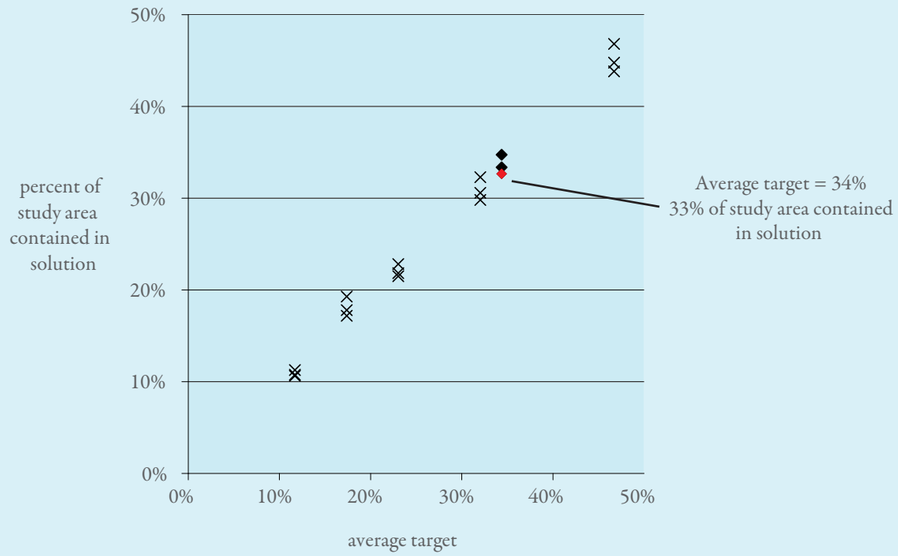


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

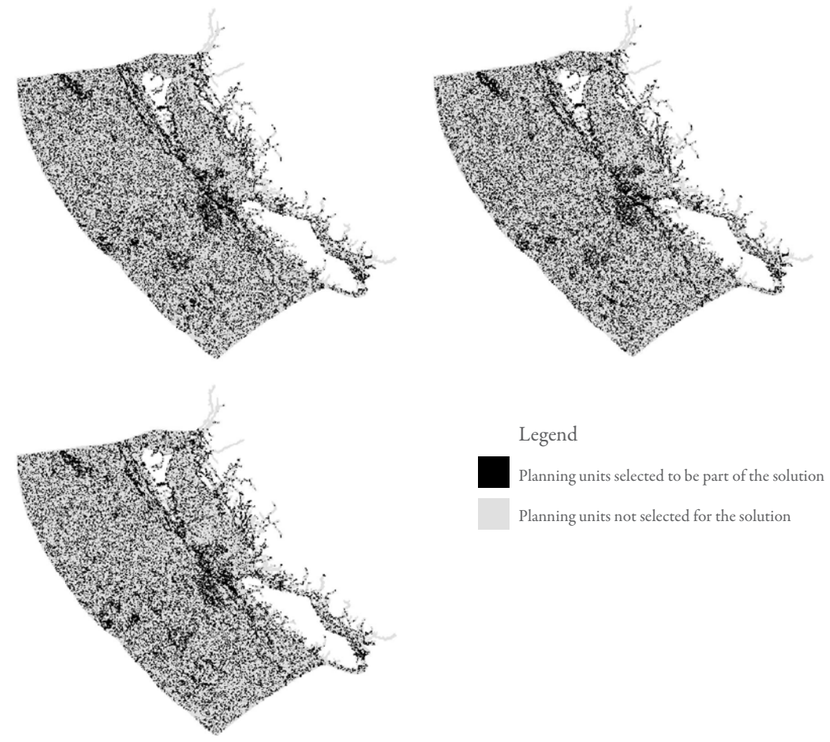
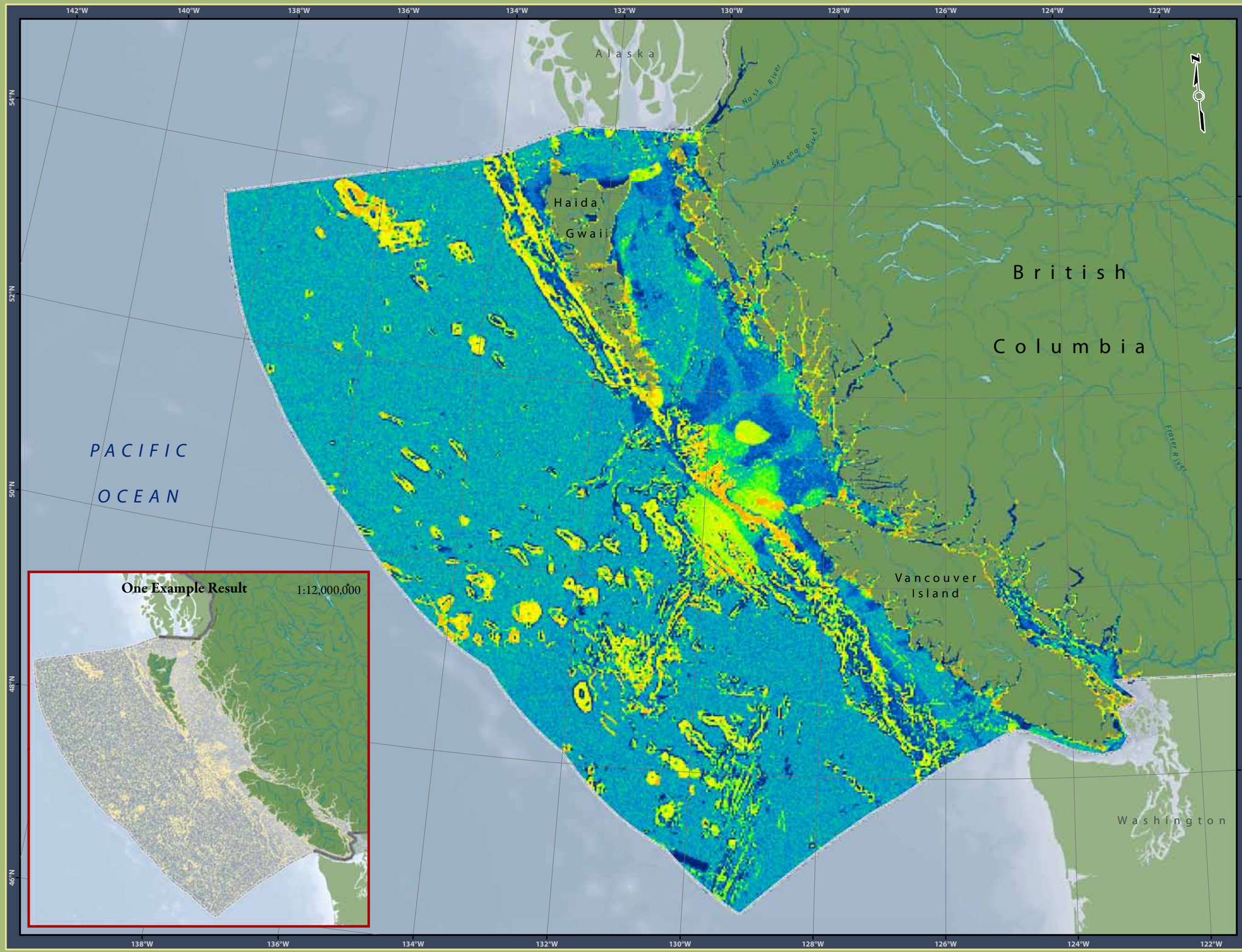


Figure 2. Three examples of results for Ecol 6 – PT high targets, no clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.



BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 6 - PT high targets, no clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet high targets recommended by the BCMCA Project Team and minimize the total area of the solution without constraints on size of clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

BCMCA areas of high conservation value
Marxan scenario: Ecol 6 – PT high targets, medium clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while aiming for medium sized clumps (i.e. Boundary Length Modifier, BLM = 750). This Marxan analysis, one of many run by the BCMCA, had the second highest average target (34%) and generated solutions that covered less than 40% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

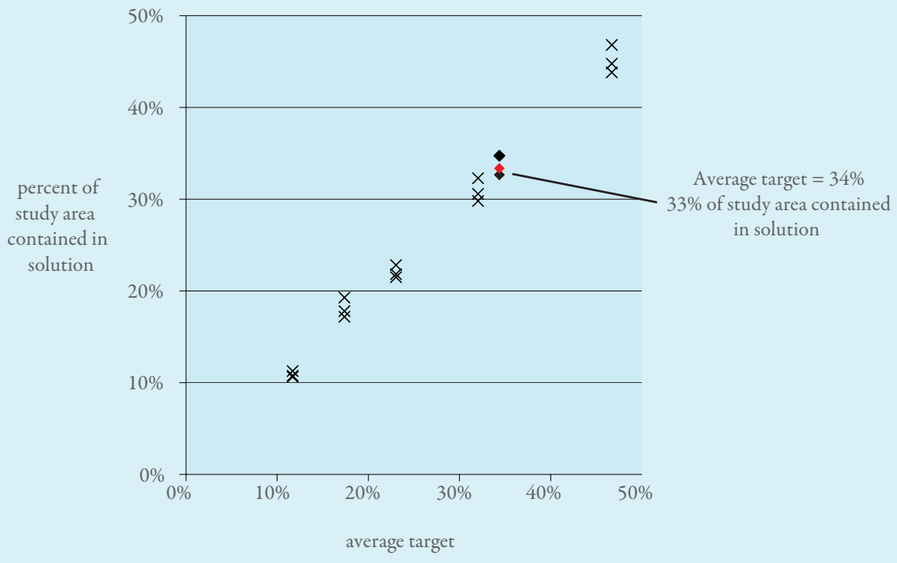


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

Figure 2. Three examples of results for Ecol 6 –PT high targets, medium clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 6 - PT high targets, medium clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet high targets recommended by the BCMCA Project Team and minimize the total area of the solution in moderately-sized clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.
May 9, 2011

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

One Example Result 1:12,000,000

BCMCA areas of high conservation value
Marxan scenario: Ecol 6 – PT high targets, high clumping

What if...?

We asked Marxan to select areas containing all of the ecological features, using targets at the high end of ranges recommended by the BCMCA project team, and to minimise the total area of the solution while aiming for large sized clumps (i.e. Boundary Length Modifier, BLM = 2500). This Marxan analysis, one of many run by the BCMCA, had the second highest average target (34%) and generated solutions that covered less than 40% of the study area (Figure 1). Please read the previous sections in this report for information to help interpret these results.

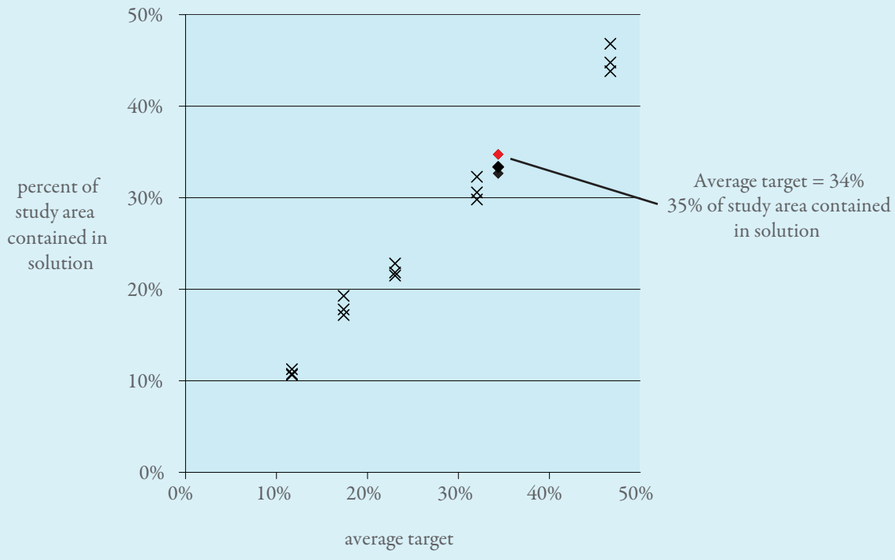


Figure 1. Average target and area of solution for this scenario (red diamond) compared to others

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution or the result for a single run (Figure 2). All of the selected areas in any one example have equal conservation value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs, as shown in the main map on the facing page. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. The areas shown in orange in the map on the facing page are those areas that were selected most often and can be considered 'areas of high conservation value'. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or due to a few rarer species present in an area. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare.

Figure 2. Three examples of results for Ecol 6 – PT high targets, high clumping scenario. The BCMCA generated 100 different examples of results for this scenario. The spatial pattern of selected planning units in each of the examples is slightly different.

BCMCA Analysis

Ecological Marxan Results

Areas of High Conservation Value

Scenario: Ecol 6 - PT high targets, high clumping in solution

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The goal of this scenario was to meet high targets recommended by the BCMCA Project Team and minimize the total area of the solution in large clumps or areas of high conservation value.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

April 20, 2011

One Example Result 1:12,000,000

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

Alaska

Haida Gwaii

British Columbia

Vancouver Island

Washington

PACIFIC OCEAN

Nass River

Skeena River

Fraser River

results for human use marxan analyses

The goal for the human use Marxan analyses was to identify areas important to each of six sectors of human use in the marine environment. The BCMCA designed these scenarios in collaboration with representatives of the six Human Use Working Group (HUWG) sectors and ran all the scenarios that were designed.

During the period December 2011 to February 2012, the BCMCA provided web-hosted presentations to review and discuss the results of the human use Marxan scenarios with the sector representatives as follows:

- recreational fisheries (December 14 2011),
- ocean energy (December 14 2011),
- shipping and transportation (December 16 2011),
- tourism and recreation (January 5 2012),
- tenures (January 17 and February 1 2012), and
- commercial fisheries (February 17 2012).

All of the sectors identified reasons that the results did not represent a comprehensive and accurate view of marine areas important to their sector. The most common concern was that some of the input data lacked information on relative value. As a result, although analyses were designed to identify areas important to human users, with little or no relative value information in the datasets, Marxan uses data density to determine areas of importance and human use representatives found the results lacking validity. After consideration of draft facing page material and mapped results, two of the sectors agreed to make the results public, contingent on accurate documentation of their comments and caveats.

Sector representatives provided these specific reasons for not publishing human use Marxan results in this report:

- The results do not *adequately* illustrate important areas for Ocean Energy from the point of view of the non-renewable energy sector. Some of the mapped features are spatially broad and lacking fine scale detail as to relative importance. Therefore, the analyses are not able to differentiate relative importance across broad areas and the results are not informative or useful with respect to areas important for non-renewable Ocean Energy. In fact some of the most prospective areas for non-renewable energy were *left out of* the results in some scenarios.
- The BC Salmon Farming Association (BCSFA) membership does not endorse the BCMCA to publish the tenures Marxan results in the larger Marxan report because membership in the salmon farming companies cannot endorse BCMCA products which may be ultimately used by BC marine spatial planning projects to limit and ultimately affect the sustainability of the sector.
- The data included in the Sport Fishing maps is only indicative of the presence or absence of effort in the areas identified, and lacks parameters that indicate the frequency of use, social importance, or economic value of the recreational fishery (individual harvest) in any given area. These data limitations could result in misleading outputs from MARXAN analysis, such that a proposed reduction in area does not represent a proportional impact on the recreational fishery.

results for human use marxan analyses (cont'd)

Results for the commercial fisheries sector and the shipping and transportation sector can be found in the next pages of this report. Please interpret these with care and with full consideration of the comments and caveats on the facing pages. These results are presented as examples and are meant to be instructional.

did Marxan meet the targets in the human use scenarios?

Yes, Marxan met all the targets 100% of the time.

how did different targets affect Marxan results?

As expected, when targets decrease, the total area in the Marxan results decreases. Please see the charts on the facing pages following for specific values.

Areas important for Commercial Fisheries (please see comments & caveats)
Marxan scenario HU 1: Reduction of Commercial Fisheries footprint by 5%

What if...?

We asked Marxan to select areas containing at least 95% of each of the features related to commercial fisheries and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 95% of the total catch in each fishery feature is contained in the solution. Solutions for this analysis covered 56% of the study area (Figure 1), while the total footprint of all the commercial fishery features covers 89% of the study area.

Please read the previous sections in this report for information to help interpret these results.

35 commercial fisheries (features) were targeted in this analysis:

Chinook Salmon (Gillnet)	Chinook Salmon (Seine)	Chinook Salmon (Troll)
Chum Salmon (Gillnet)	Chum Salmon (Seine)	Chum Salmon (Troll)
Coho Salmon (Gillnet)	Coho Salmon (Seine)	Coho Salmon (Troll)
Dungeness Crab	Geoduck	Green Sea Urchin
Groundfish (Trawl)	Halibut	Humpback Shrimp
Krill	Pink Salmon (Gillnet)	Pink Salmon (Seine)
Pink Salmon (Troll)	Pink Shrimp	Prawn
Red Sea Urchin	Rockfish (Hook and Line) - ZN	Roe Herring (Gillnet)
Roe Herring (Seine)	Sablefish (Longline)	Sablefish (Trap)
Sardine	Schedule II	Sea Cucumber
Shrimp (Trawl)	Sidestripe Shrimp	Sockeye Salmon (Gillnet)
Sockeye Salmon (Seine)	Sockeye Salmon (Troll)	

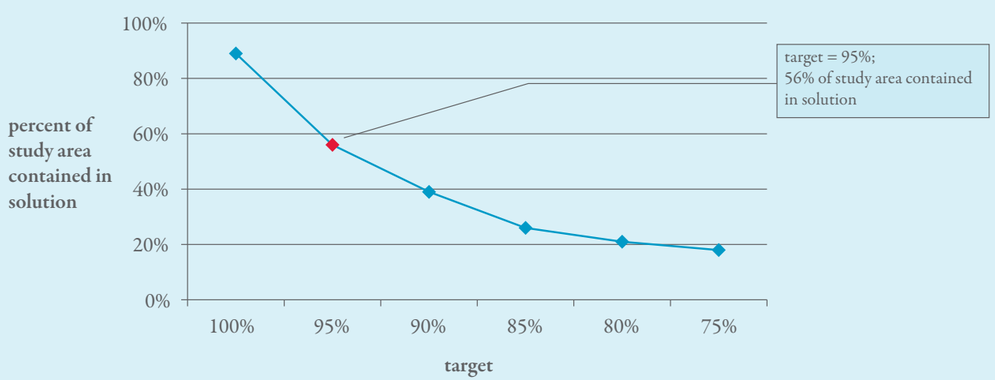


Figure 1. Target and area of solution for this scenario (red diamond) compared to other commercial fisheries scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for commercial fisheries'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 95%.

reviewers

- BC Seafood Alliance, Herring Conservation and Research Society, Underwater Harvesters Association.

comments

- **The results are misleading because total catch, the metric used to represent each fishery, is not a good measure of relative importance in all cases. No one proxy for importance works; neither value, nor catch, nor effort, nor cost works. Availability also plays a role, as does the ecosystem management structure. Therefore, the blue areas in the results maps cannot accurately be interpreted as "not important" to commercial fisheries.**
  - For example in the groundfish (trawl) data, total catches for midwater trawl and for rockfish dwarf the catch for some other species groups. Since the catch by species groups targeted by different fishermen is not differentiated, the Marxan results do not capture areas important to each different component of the groundfish fishery.
  - As a second example, catch may be transferable between areas for some fisheries, while for others a particular area can be the virtually irreplaceable (i.e. some stocks are migratory and some are not). Those irreplaceable areas may not be identified as important based on the total catch metric.
  - Neither are operational costs factored into the analysis. Costs may vary across space, and total catch does not account for that.

caveats

- Each one of the fisheries was targeted equally, meaning that no relative importance was assigned amongst the fisheries despite the range of catch each fishery represents.
- The data used in these analyses for different fisheries do not represent one consistent time period. They reflect past fishery catches and may not reflect current or future reality in terms of total area fished or catch abundance as measures of relative importance. Areas fished and relative value change due to ongoing changes in the environment and management.
- Data for many fisheries were screened to meet confidentiality requirements; therefore overall area of use shown is an underestimate of total area used.
- Areas of relative importance to these commercial fisheries should not be directly interpreted in economic terms or as representative of biological value, diversity or abundance.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Areas Important for Commercial Fisheries

Scenario: HU 1 - 5% reduction of sector footprint (measured in total catch)

Legend

Selection frequency over 100 runs

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 95% of the total catch mapped for each of the 35 commercial fishing features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

May 5, 2011

One Example Result 1:12,000,000*

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River
142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

Areas important for Commercial Fisheries (please see comments & caveats)
Marxan scenario HU 2: Reduction of Commercial Fisheries footprint by 10%

What if...?

We asked Marxan to select areas containing at least 90% of each of the features related to commercial fisheries and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 90% of the total catch in each fishery feature is contained in the solution. Solutions for this analysis covered 39% of the study area (Figure 1), while the total footprint of all the commercial fishery features covers 89% of the study area.

Please read the previous sections in this report for information to help interpret these results.

35 commercial fisheries (features) were targeted in this analysis:

Chinook Salmon (Gillnet)	Chinook Salmon (Seine)	Chinook Salmon (Troll)
Chum Salmon (Gillnet)	Chum Salmon (Seine)	Chum Salmon (Troll)
Coho Salmon (Gillnet)	Coho Salmon (Seine)	Coho Salmon (Troll)
Dungeness Crab	Geoduck	Green Sea Urchin
Groundfish (Trawl)	Halibut	Humpback Shrimp
Krill	Pink Salmon (Gillnet)	Pink Salmon (Seine)
Pink Salmon (Troll)	Pink Shrimp	Prawn
Red Sea Urchin	Rockfish (Hook and Line) - ZN	Roe Herring (Gillnet)
Roe Herring (Seine)	Sablefish (Longline)	Sablefish (Trap)
Sardine	Schedule II	Sea Cucumber
Shrimp (Trawl)	Sidestripe Shrimp	Sockeye Salmon (Gillnet)
Sockeye Salmon (Seine)	Sockeye Salmon (Troll)	

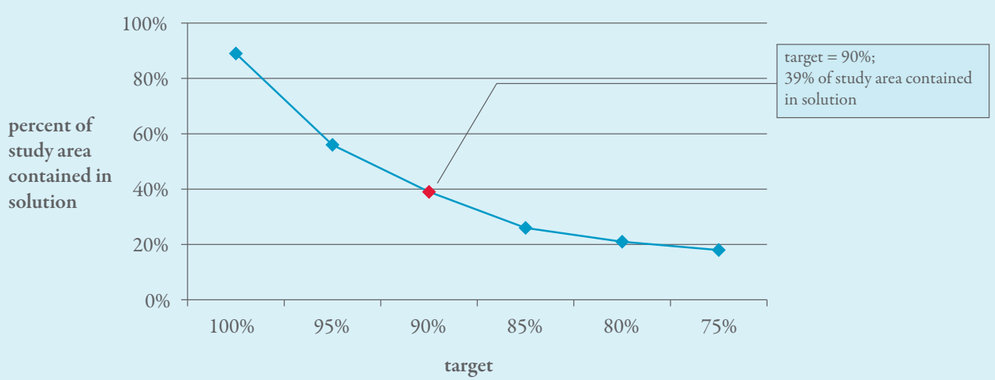


Figure 1. Target and area of solution for this scenario (red diamond) compared to other commercial fisheries scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for commercial fisheries'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 90%.

reviewers

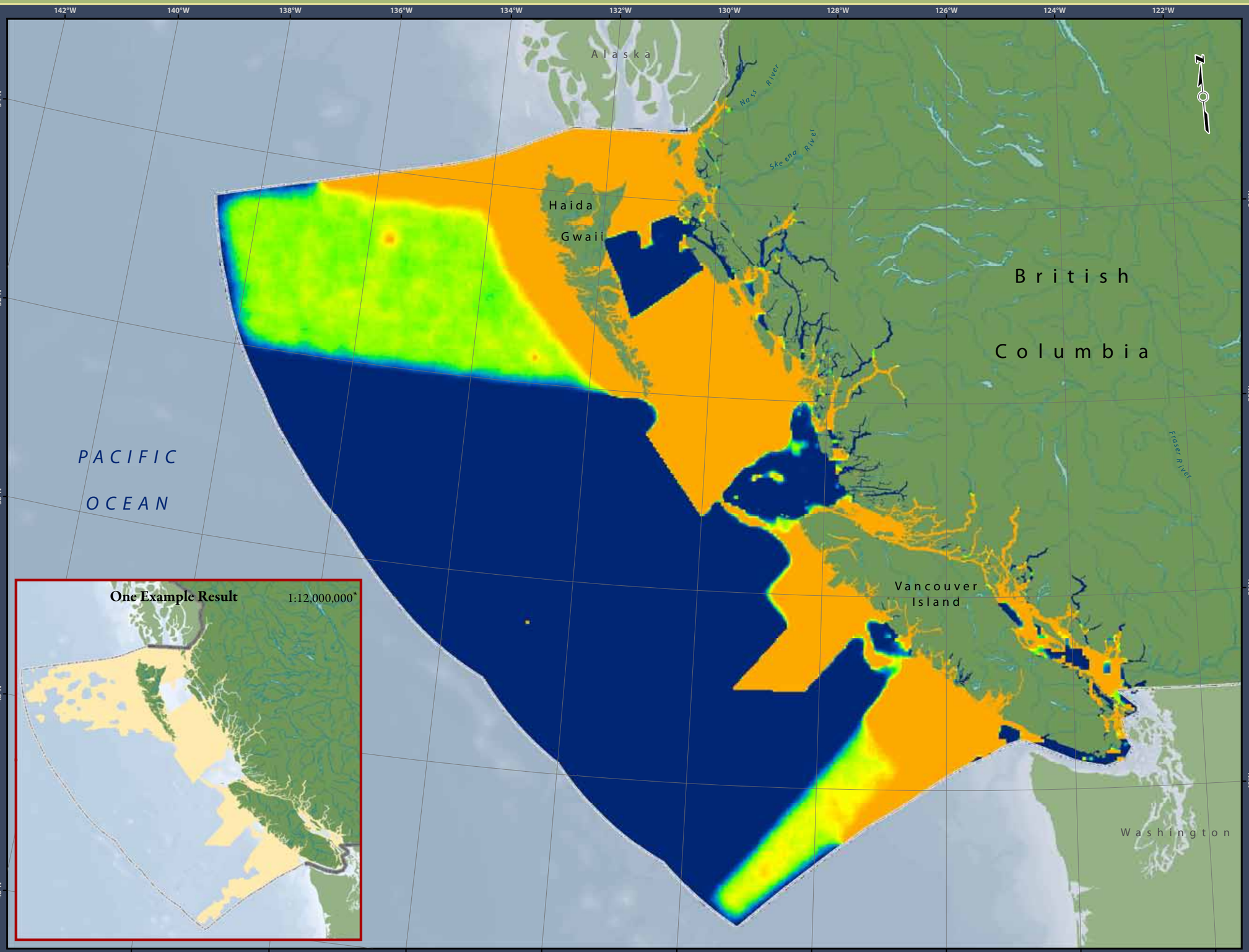
- BC Seafood Alliance, Herring Conservation and Research Society, Underwater Harvesters Association

comments

- **The results are misleading because total catch, the metric used to represent each fishery, is not a good measure of relative importance in all cases. No one proxy for importance works; neither value, nor catch, nor effort, nor cost works. Availability also plays a role, as does the ecosystem management structure. Therefore, the blue areas in the results maps cannot accurately be interpreted as "not important" to commercial fisheries.**
  - **For example in the groundfish (trawl) data, total catches for midwater trawl and for rockfish dwarf the catch for some other species groups. Since the catch by species groups targeted by different fishermen is not differentiated, the Marxan results do not capture areas important to each different component of the groundfish fishery.**
  - **As a second example, catch may be transferable between areas for some fisheries, while for others a particular area can be the virtually irreplaceable (i.e. some stocks are migratory and some are not). Those irreplaceable areas may not be identified as important based on the total catch metric.**
  - **Neither are operational costs factored into the analysis. Costs may vary across space, and total catch does not account for that.**

caveats

- Each one of the fisheries was targeted equally, meaning that no relative importance was assigned amongst the fisheries despite the range of catch each fishery represents.
- The data used in these analyses for different fisheries do not represent one consistent time period. They reflect past fishery catches and may not reflect current or future reality in terms of total area fished or catch abundance as measures of relative importance. Areas fished and relative value change due to ongoing changes in the environment and management.
- Data for many fisheries were screened to meet confidentiality requirements; therefore overall area of use shown is an underestimate of total area used.
- Areas of relative importance to these commercial fisheries should not be directly interpreted in economic terms or as representative of biological value, diversity or abundance.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.



BCMCA Analysis

Human Use Marxan Results

Areas Important for Commercial Fisheries

Scenario: HU 2
10% reduction of sector footprint
(measured in total catch)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 90% of the total catch mapped for each of the 35 commercial fishing features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 3, 2012

Areas important for Commercial Fisheries (please see comments & caveats)
Marxan scenario HU 3: Reduction of Commercial Fisheries footprint by 15%

What if...?

We asked Marxan to select areas containing at least 85% of each of the features related to commercial fisheries and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 85% of the total catch in each fishery feature is contained in the solution. Solutions for this analysis covered 26% of the study area (Figure 1), while the total footprint of all the commercial fishery features covers 89% of the study area.

Please read the previous sections in this report for information to help interpret these results.

35 commercial fisheries (features) were targeted in this analysis:

Chinook Salmon (Gillnet)	Chinook Salmon (Seine)	Chinook Salmon (Troll)
Chum Salmon (Gillnet)	Chum Salmon (Seine)	Chum Salmon (Troll)
Coho Salmon (Gillnet)	Coho Salmon (Seine)	Coho Salmon (Troll)
Dungeness Crab	Geoduck	Green Sea Urchin
Groundfish (Trawl)	Halibut	Humpback Shrimp
Krill	Pink Salmon (Gillnet)	Pink Salmon (Seine)
Pink Salmon (Troll)	Pink Shrimp	Prawn
Red Sea Urchin	Rockfish (Hook and Line) - ZN	Roe Herring (Gillnet)
Roe Herring (Seine)	Sablefish (Longline)	Sablefish (Trap)
Sardine	Schedule II	Sea Cucumber
Shrimp (Trawl)	Sidestripe Shrimp	Sockeye Salmon (Gillnet)
Sockeye Salmon (Seine)	Sockeye Salmon (Troll)	

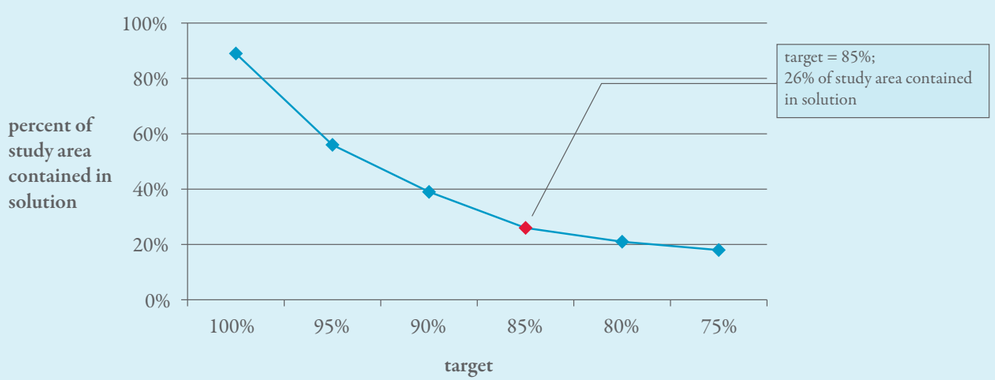


Figure 1. Target and area of solution for this scenario (red diamond) compared to other commercial fisheries scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for commercial fisheries'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 85%.

reviewers

- BC Seafood Alliance, Herring Conservation and Research Society, Underwater Harvesters Association

comments

- **The results are misleading because total catch, the metric used to represent each fishery, is not a good measure of relative importance in all cases. No one proxy for importance works; neither value, nor catch, nor effort, nor cost works. Availability also plays a role, as does the ecosystem management structure. Therefore, the blue areas in the results maps cannot accurately be interpreted as "not important" to commercial fisheries.**
  - **For example in the groundfish (trawl) data, total catches for midwater trawl and for rockfish dwarf the catch for some other species groups. Since the catch by species groups targeted by different fishermen is not differentiated, the Marxan results do not capture areas important to each different component of the groundfish fishery.**
  - **As a second example, catch may be transferable between areas for some fisheries, while for others a particular area can be the virtually irreplaceable (i.e. some stocks are migratory and some are not). Those irreplaceable areas may not be identified as important based on the total catch metric.**
  - **Neither are operational costs factored into the analysis. Costs may vary across space, and total catch does not account for that.**

caveats

- Each one of the fisheries was targeted equally, meaning that no relative importance was assigned amongst the fisheries despite the range of catch each fishery represents.
- The data used in these analyses for different fisheries do not represent one consistent time period. They reflect past fishery catches and may not reflect current or future reality in terms of total area fished or catch abundance as measures of relative importance. Areas fished and relative value change due to ongoing changes in the environment and management.
- Data for many fisheries were screened to meet confidentiality requirements; therefore overall area of use shown is an underestimate of total area used.
- Areas of relative importance to these commercial fisheries should not be directly interpreted in economic terms or as representative of biological value, diversity or abundance.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Areas Important for Commercial Fisheries

Scenario: HU 3
15% reduction of sector footprint
(measured in total catch)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 85% of the total catch mapped for each of the 35 commercial fishing features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 3, 2012

One Example Result 1:12,000,000*

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

Areas important for Commercial Fisheries (please see comments & caveats)
Marxan scenario HU 4: Reduction of Commercial Fisheries footprint by 20%

What if...?

We asked Marxan to select areas containing at least 80% of each of the features related to commercial fisheries and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 80% of the total catch in each fishery feature is contained in the solution. Solutions for this analysis covered 21% of the study area (Figure 1), while the total footprint of all the commercial fishery features covers 89% of the study area.

Please read the previous sections in this report for information to help interpret these results.

35 commercial fisheries (features) were targeted in this analysis:

Chinook Salmon (Gillnet)	Chinook Salmon (Seine)	Chinook Salmon (Troll)
Chum Salmon (Gillnet)	Chum Salmon (Seine)	Chum Salmon (Troll)
Coho Salmon (Gillnet)	Coho Salmon (Seine)	Coho Salmon (Troll)
Dungeness Crab	Geoduck	Green Sea Urchin
Groundfish (Trawl)	Halibut	Humpback Shrimp
Krill	Pink Salmon (Gillnet)	Pink Salmon (Seine)
Pink Salmon (Troll)	Pink Shrimp	Prawn
Red Sea Urchin	Rockfish (Hook and Line) - ZN	Roe Herring (Gillnet)
Roe Herring (Seine)	Sablefish (Longline)	Sablefish (Trap)
Sardine	Schedule II	Sea Cucumber
Shrimp (Trawl)	Sidestripe Shrimp	Sockeye Salmon (Gillnet)
Sockeye Salmon (Seine)	Sockeye Salmon (Troll)	

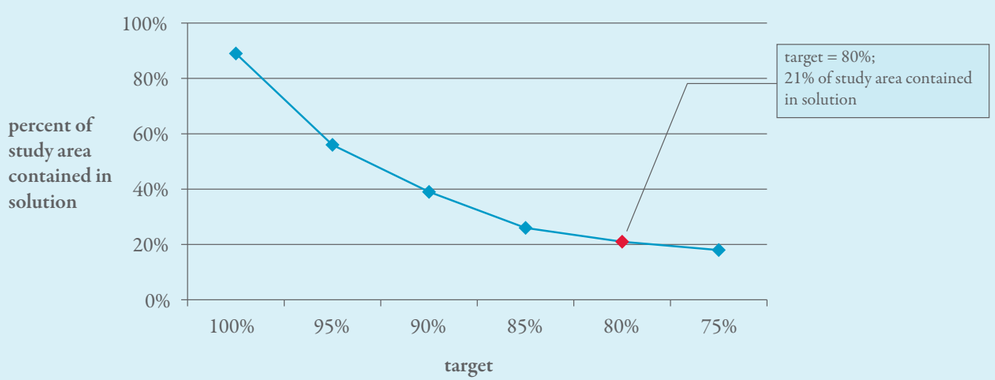


Figure 1. Target and area of solution for this scenario (red diamond) compared to other commercial fisheries scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for commercial fisheries'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 80%.

reviewers

- BC Seafood Alliance, Herring Conservation and Research Society, Underwater Harvesters Association

comments

- **The results are misleading because total catch, the metric used to represent each fishery, is not a good measure of relative importance in all cases. No one proxy for importance works; neither value, nor catch, nor effort, nor cost works. Availability also plays a role, as does the ecosystem management structure. Therefore, the blue areas in the results maps cannot accurately be interpreted as "not important" to commercial fisheries.**
  - **For example in the groundfish (trawl) data, total catches for midwater trawl and for rockfish dwarf the catch for some other species groups. Since the catch by species groups targeted by different fishermen is not differentiated, the Marxan results do not capture areas important to each different component of the groundfish fishery.**
  - **As a second example, catch may be transferable between areas for some fisheries, while for others a particular area can be the virtually irreplaceable (i.e. some stocks are migratory and some are not). Those irreplaceable areas may not be identified as important based on the total catch metric.**
  - **Neither are operational costs factored into the analysis. Costs may vary across space, and total catch does not account for that.**

caveats

- Each one of the fisheries was targeted equally, meaning that no relative importance was assigned amongst the fisheries despite the range of catch each fishery represents.
- The data used in these analyses for different fisheries do not represent one consistent time period. They reflect past fishery catches and may not reflect current or future reality in terms of total area fished or catch abundance as measures of relative importance. Areas fished and relative value change due to ongoing changes in the environment and management.
- Data for many fisheries were screened to meet confidentiality requirements; therefore overall area of use shown is an underestimate of total area used.
- Areas of relative importance to these commercial fisheries should not be directly interpreted in economic terms or as representative of biological value, diversity or abundance.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Areas Important for Commercial Fisheries

Scenario: HU 4
20% reduction of sector footprint
(measured in total catch)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 80% of the total catch mapped for each of the 35 commercial fishing features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 3, 2012

Alaska

Haida Gwaii

British Columbia

Vancouver Island

Washington

PACIFIC OCEAN

Nass River

Skeena River

Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

One Example Result 1:12,000,000*

Areas important for Commercial Fisheries (please see comments & caveats)
Marxan scenario HU 5: Reduction of Commercial Fisheries footprint by 25%

What if...?

We asked Marxan to select areas containing at least 75% of each of the features related to commercial fisheries and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 75% of the total catch in each fishery feature is contained in the solution. Solutions for this analysis covered 18% of the study area (Figure 1), while the total footprint of all the commercial fishery features covers 89% of the study area.

Please read the previous sections in this report for information to help interpret these results.

35 commercial fisheries (features) were targeted in this analysis:

Chinook Salmon (Gillnet)	Chinook Salmon (Seine)	Chinook Salmon (Troll)
Chum Salmon (Gillnet)	Chum Salmon (Seine)	Chum Salmon (Troll)
Coho Salmon (Gillnet)	Coho Salmon (Seine)	Coho Salmon (Troll)
Dungeness Crab	Geoduck	Green Sea Urchin
Groundfish (Trawl)	Halibut	Humpback Shrimp
Krill	Pink Salmon (Gillnet)	Pink Salmon (Seine)
Pink Salmon (Troll)	Pink Shrimp	Prawn
Red Sea Urchin	Rockfish (Hook and Line) - ZN	Roe Herring (Gillnet)
Roe Herring (Seine)	Sablefish (Longline)	Sablefish (Trap)
Sardine	Schedule II	Sea Cucumber
Shrimp (Trawl)	Sidestripe Shrimp	Sockeye Salmon (Gillnet)
Sockeye Salmon (Seine)	Sockeye Salmon (Troll)	

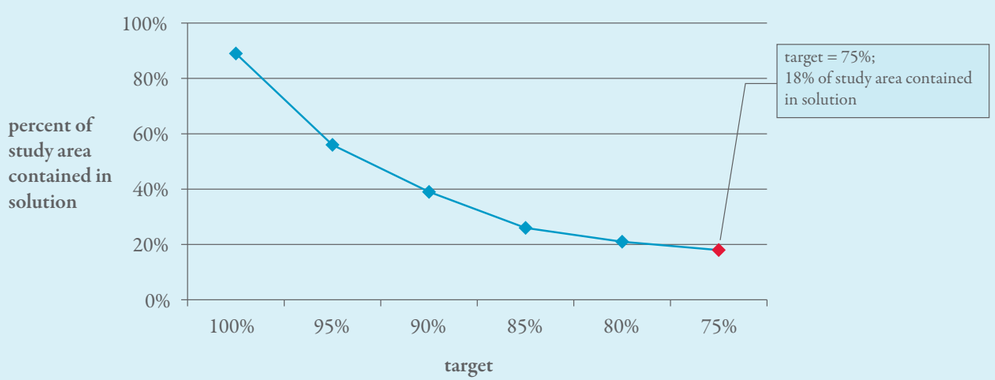


Figure 1. Target and area of solution for this scenario (red diamond) compared to other commercial fisheries scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for commercial fisheries'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 75%.

reviewers

- BC Seafood Alliance, Herring Conservation and Research Society, Underwater Harvesters Association

comments

- **The results are misleading because total catch, the metric used to represent each fishery, is not a good measure of relative importance in all cases. No one proxy for importance works; neither value, nor catch, nor effort, nor cost works. Availability also plays a role, as does the ecosystem management structure. Therefore, the blue areas in the results maps cannot accurately be interpreted as "not important" to commercial fisheries.**
  - **For example in the groundfish (trawl) data, total catches for midwater trawl and for rockfish dwarf the catch for some other species groups. Since the catch by species groups targeted by different fishermen is not differentiated, the Marxan results do not capture areas important to each different component of the groundfish fishery.**
  - **As a second example, catch may be transferable between areas for some fisheries, while for others a particular area can be the virtually irreplaceable (i.e. some stocks are migratory and some are not). Those irreplaceable areas may not be identified as important based on the total catch metric.**
  - **Neither are operational costs factored into the analysis. Costs may vary across space, and total catch does not account for that.**

caveats

- Each one of the fisheries was targeted equally, meaning that no relative importance was assigned amongst the fisheries despite the range of catch each fishery represents.
- The data used in these analyses for different fisheries do not represent one consistent time period. They reflect past fishery catches and may not reflect current or future reality in terms of total area fished or catch abundance as measures of relative importance. Areas fished and relative value change due to ongoing changes in the environment and management.
- Data for many fisheries were screened to meet confidentiality requirements; therefore overall area of use shown is an underestimate of total area used.
- Areas of relative importance to these commercial fisheries should not be directly interpreted in economic terms or as representative of biological value, diversity or abundance.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

Alaska

Nass River

Skeena River

Haida Gwaii

British Columbia

PACIFIC OCEAN

Vancouver Island

Fraser River

Washington

BCMCA Analysis

Human Use Marxan Results

Areas Important for Commercial Fisheries

Scenario: HU 5
25% reduction of sector footprint
(measured in total catch)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 75% of the total catch mapped for each of the 35 commercial fishing features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 3, 2012

Areas important for Shipping and Transportation (please see comments & caveats)
Marxan scenario HU 16: Reduction of Shipping and Transportation footprint by 5%

What if...?

We asked Marxan to select areas containing at least 95% of each of the features related to shipping and transportation and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 95% of the relative intensity in each shipping and transportation feature is contained in the solution. Solutions for this analysis covered 47% of the study area (Figure 1), while the total footprint of all the shipping and transportation features covers 90% of the study area.

Please read the previous sections in this report for information to help interpret these results.

17 shipping and transportation features were targeted in this analysis:

Ferry Routes - High Use	Ferry Routes - Low Use
Ferry Routes - Moderate Use	Ferry Routes - Very High Use
Ferry Routes - Very Low Use	Ferry Terminals
Summer (Bulk) Carrier Vessel Density	Summer Cruise Vessel Density
Summer Fishing Vessel Density	Summer Tanker Vessel Density
Summer Tug Vessel Density	Tow Boat Reserves
Winter (Bulk) Carrier Vessel Density	Winter Cruise Vessel Density
Winter Fishing Vessel Density	Winter Tanker Vessel Density
Winter Tug Vessel Density	

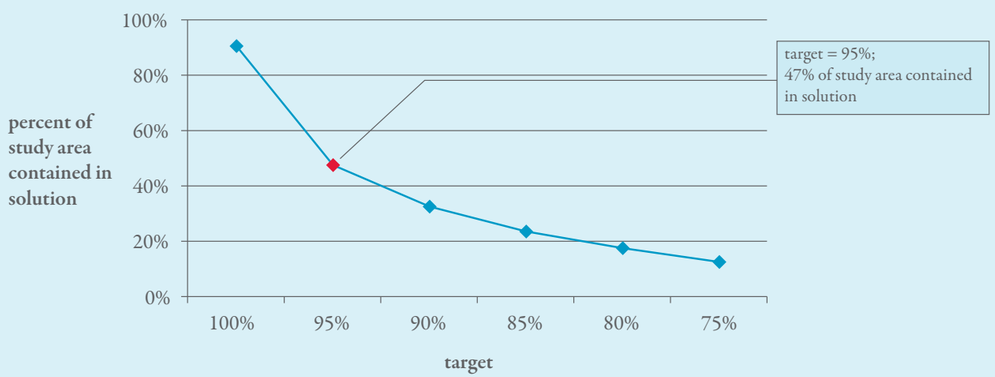


Figure 1. Target and area of solution for this scenario (red diamond) compared to other shipping and transportation scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for shipping and transportation'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 95%.

reviewers

- Phillip Nelson, Council of Marine Carriers

reviewer comments

- Density feature maps do not accurately illustrate individual vessel tracks (i.e. real vessels do not appear and disappear in mid-ocean). Therefore, the veracity of this collation of data is doubtful and the maps can be somewhat misleading.
- Parts of some vessel routes have been omitted (by Marxan) in these analyses results, while other portions of the same route have been included. Therefore the results do not accurately illustrate areas important for shipping and transportation.

caveats

- A number of ferry routes are not portrayed in the ferry route data set, due to lack of data and are therefore not accounted for in this analysis (for details see *feature map caveats*).
- Each one of the features was targeted equally, meaning that no relative importance was assigned amongst the features. Relative densities within vessel density features were based on a single year of observations (2007), but densities do vary significantly annually.
- Vessel density data coverage does not go beyond the Canadian EEZ, thus tracks end there.
- Tanker routes in and out of Kitimat were changed in 2009 (see *feature map facing page*) and this analysis does not take that change into account.
- The data used reflect past use levels and may not reflect current or future reality.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Shipping and Transportation (See comments and caveats)

Scenario: HU 16
5% reduction of sector footprint
(measured in relative intensity of use)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 95% of the relative intensity of use mapped for each of the 17 shipping and transportation features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 24, 2012

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

One Example Result 1:12,000,000*

Areas important for Shipping and Transportation (please see comments & caveats)
Marxan scenario HU 17: Reduction of Shipping and Transportation footprint by 10%

What if...?

We asked Marxan to select areas containing at least 90% of each of the features related to shipping and transportation and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 90% of the relative intensity in each shipping and transportation feature is contained in the solution. Solutions for this analysis covered 32% of the study area (Figure 1), while the total footprint of all the shipping and transportation features covers 90% of the study area.

Please read the previous sections in this report for information to help interpret these results.

17 shipping and transportation features were targeted in this analysis:

Ferry Routes - High Use	Ferry Routes - Low Use
Ferry Routes - Moderate Use	Ferry Routes - Very High Use
Ferry Routes - Very Low Use	Ferry Terminals
Summer (Bulk) Carrier Vessel Density	Summer Cruise Vessel Density
Summer Fishing Vessel Density	Summer Tanker Vessel Density
Summer Tug Vessel Density	Tow Boat Reserves
Winter (Bulk) Carrier Vessel Density	Winter Cruise Vessel Density
Winter Fishing Vessel Density	Winter Tanker Vessel Density
Winter Tug Vessel Density	

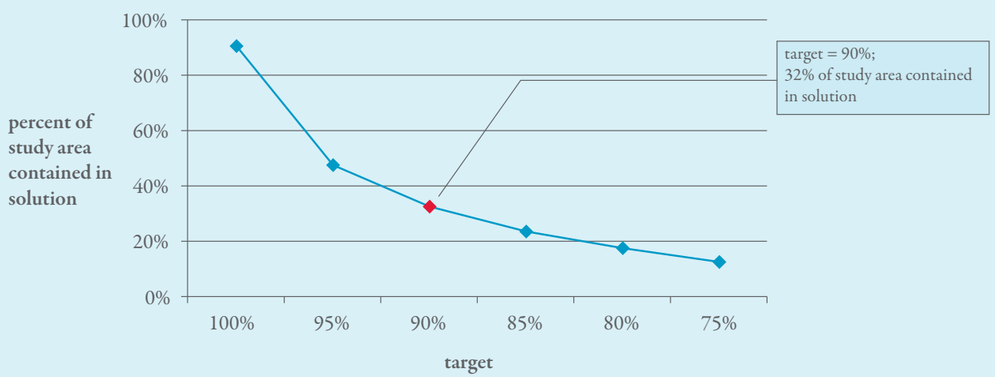


Figure 1. Target and area of solution for this scenario (red diamond) compared to other shipping and transportation scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for shipping and transportation'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 90%.

reviewers

- Phillip Nelson, Council of Marine Carriers

reviewer comments

- **Density feature maps do not accurately illustrate individual vessel tracks (i.e. real vessels do not appear and disappear in mid-ocean). Therefore, the veracity of this collation of data is doubtful and the maps can be somewhat misleading.**
- Parts of some vessel routes have been omitted (by Marxan) in these analyses results, while other portions of the same route have been included. Therefore the results do not accurately illustrate areas important for shipping and transportation.

caveats

- A number of ferry routes are not portrayed in the ferry route data set, due to lack of data and are therefore not accounted for in this analysis (for details see *feature map caveats*).
- Each one of the features was targeted equally, meaning that no relative importance was assigned amongst the features. Relative densities within vessel density features were based on a single year of observations (2007), but densities do vary significantly annually.
- Vessel density data coverage does not go beyond the Canadian EEZ, thus tracks end there.
- Tanker routes in and out of Kitimat were changed in 2009 (see *feature map facing page*) and this analysis does not take that change into account.
- The data used reflect past use levels and may not reflect current or future reality.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Shipping and Transportation (See comments and caveats)

Scenario: HU 17
10% reduction of sector footprint
(measured in relative intensity of use)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 90% of the relative intensity of use mapped for each of the 17 shipping and transportation features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres

0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 24, 2012

Alaska

Haida Gwaii

British Columbia

Vancouver Island

Washington

PACIFIC OCEAN

Nass River

Skeena River

Fraser River

N

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W

54°N 52°N 50°N 48°N 46°N

54°N 52°N 50°N 48°N

One Example Result 1:12,000,000*

Areas important for Shipping and Transportation (please see comments & caveats)
Marxan scenario HU 18: Reduction of Shipping and Transportation footprint by 15%

What if...?

We asked Marxan to select areas containing at least 85% of each of the features related to shipping and transportation and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 85% of the relative intensity in each shipping and transportation feature is contained in the solution. Solutions for this analysis covered 23% of the study area (Figure 1), while the total footprint of all the shipping and transportation features covers 90% of the study area.

Please read the previous sections in this report for information to help interpret these results.

17 shipping and transportation features were targeted in this analysis:

Ferry Routes - High Use	Ferry Routes - Low Use
Ferry Routes - Moderate Use	Ferry Routes - Very High Use
Ferry Routes - Very Low Use	Ferry Terminals
Summer (Bulk) Carrier Vessel Density	Summer Cruise Vessel Density
Summer Fishing Vessel Density	Summer Tanker Vessel Density
Summer Tug Vessel Density	Tow Boat Reserves
Winter (Bulk) Carrier Vessel Density	Winter Cruise Vessel Density
Winter Fishing Vessel Density	Winter Tanker Vessel Density
Winter Tug Vessel Density	

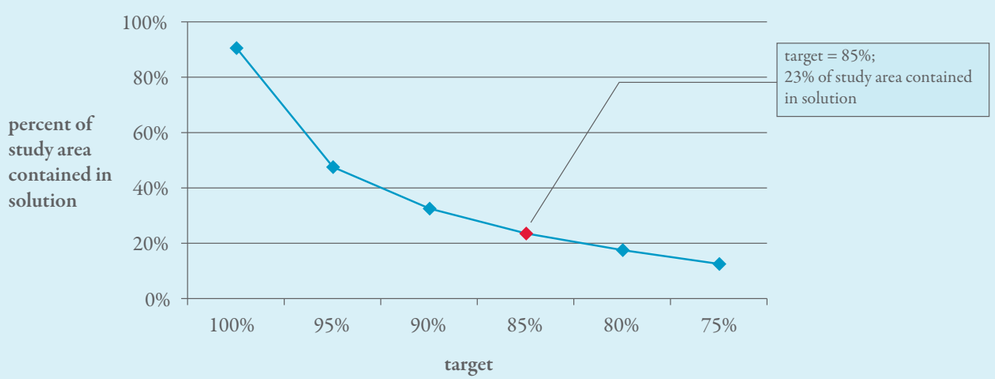


Figure 1. Target and area of solution for this scenario (red diamond) compared to other shipping and transportation scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for shipping and transportation'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 85%.

reviewers

- Phillip Nelson, Council of Marine Carriers

reviewer comments

- **Density feature maps do not accurately illustrate individual vessel tracks (i.e. real vessels do not appear and disappear in mid-ocean). Therefore, the veracity of this collation of data is doubtful and the maps can be somewhat misleading.**
- Parts of some vessel routes have been omitted (by Marxan) in these analyses results, while other portions of the same route have been included. Therefore the results do not accurately illustrate areas important for shipping and transportation.

caveats

- A number of ferry routes are not portrayed in the ferry route data set, due to lack of data and are therefore not accounted for in this analysis (for details see *feature map caveats*).
- Each one of the features was targeted equally, meaning that no relative importance was assigned amongst the features. Relative densities within vessel density features were based on a single year of observations (2007), but densities do vary significantly annually.
- Vessel density data coverage does not go beyond the Canadian EEZ, thus tracks end there.
- Tanker routes in and out of Kitimat were changed in 2009 (see *feature map facing page*) and this analysis does not take that change into account.
- The data used reflect past use levels and may not reflect current or future reality.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

Human Use Marxan Results

Shipping and Transportation (See comments and caveats)

Scenario: HU 18
15% reduction of sector footprint
(measured in relative intensity of use)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 85% of the relative intensity of use mapped for each of the 17 shipping and transportation features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 24, 2012

Alaska
Nass River
Skeena River
Haida Gwaii
British Columbia
Fraser River
PACIFIC OCEAN
Vancouver Island
Washington

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N

One Example Result 1:12,000,000*

Areas important for Shipping and Transportation (please see comments & caveats)
Marxan scenario HU 19: Reduction of Shipping and Transportation footprint by 20%

What if...?

We asked Marxan to select areas containing at least 80% of each of the features related to shipping and transportation and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 80% of the relative intensity in each shipping and transportation feature is contained in the solution. Solutions for this analysis covered 17% of the study area (Figure 1), while the total footprint of all the shipping and transportation features covers 90% of the study area.

Please read the previous sections in this report for information to help interpret these results.

17 shipping and transportation features were targeted in this analysis:

Ferry Routes - High Use	Ferry Routes - Low Use
Ferry Routes - Moderate Use	Ferry Routes - Very High Use
Ferry Routes - Very Low Use	Ferry Terminals
Summer (Bulk) Carrier Vessel Density	Summer Cruise Vessel Density
Summer Fishing Vessel Density	Summer Tanker Vessel Density
Summer Tug Vessel Density	Tow Boat Reserves
Winter (Bulk) Carrier Vessel Density	Winter Cruise Vessel Density
Winter Fishing Vessel Density	Winter Tanker Vessel Density
Winter Tug Vessel Density	

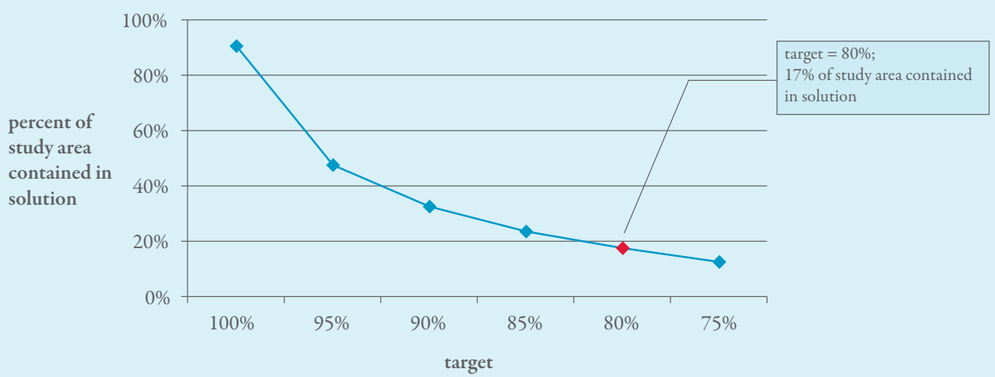


Figure 1. Target and area of solution for this scenario (red diamond) compared to other shipping and transportation scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for shipping and transportation'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 80%.

reviewers

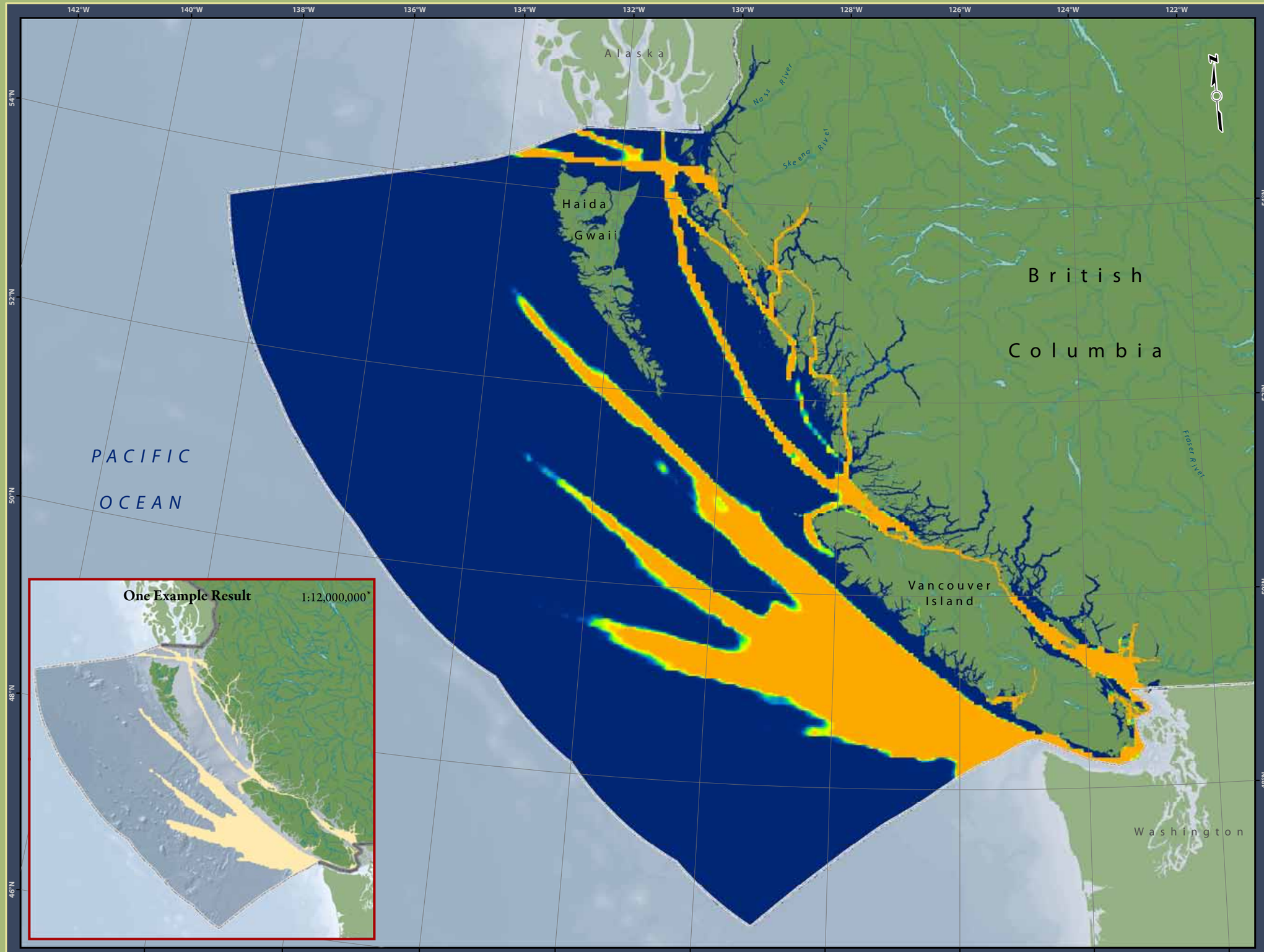
- Phillip Nelson, Council of Marine Carriers

reviewer comments

- **Density feature maps do not accurately illustrate individual vessel tracks (i.e. real vessels do not appear and disappear in mid-ocean). Therefore, the veracity of this collation of data is doubtful and the maps can be somewhat misleading.**
- Parts of some vessel routes have been omitted (by Marxan) in these analyses results, while other portions of the same route have been included. Therefore the results do not accurately illustrate areas important for shipping and transportation.

caveats

- A number of ferry routes are not portrayed in the ferry route data set, due to lack of data and are therefore not accounted for in this analysis (for details see *feature map caveats*).
- Each one of the features was targeted equally, meaning that no relative importance was assigned amongst the features. Relative densities within vessel density features were based on a single year of observations (2007), but densities do vary significantly annually.
- Vessel density data coverage does not go beyond the Canadian EEZ, thus tracks end there.
- Tanker routes in and out of Kitimat were changed in 2009 (see *feature map facing page*) and this analysis does not take that change into account.
- The data used reflect past use levels and may not reflect current or future reality.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.



BCMCA Analysis

Human Use Marxan Results

Shipping and Transportation (See comments and caveats)

Scenario: HU 19
20% reduction of sector footprint
(measured in relative intensity of use)

Legend

Selection frequency over 100 runs

High (100%)

Low (0%)

Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 80% of the relative intensity of use mapped for each of the 17 shipping and transportation features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *

* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.

February 24, 2012

Areas important for Shipping and Transportation (please see comments & caveats)
Marxan scenario HU 20: Reduction of Shipping and Transportation footprint by 25%

What if...?

We asked Marxan to select areas containing at least 75% of each of the features related to shipping and transportation and to minimise the total area of the solution. This Marxan analysis, one of many run by the BCMCA, successfully met all the targets, meaning that at least 75% of the relative intensity in each shipping and transportation feature is contained in the solution. Solutions for this analysis covered 12% of the study area (Figure 1), while the total footprint of all the shipping and transportation features covers 90% of the study area.

Please read the previous sections in this report for information to help interpret these results.

17 shipping and transportation features were targeted in this analysis:

Ferry Routes - High Use	Ferry Routes - Low Use
Ferry Routes - Moderate Use	Ferry Routes - Very High Use
Ferry Routes - Very Low Use	Ferry Terminals
Summer (Bulk) Carrier Vessel Density	Summer Cruise Vessel Density
Summer Fishing Vessel Density	Summer Tanker Vessel Density
Summer Tug Vessel Density	Tow Boat Reserves
Winter (Bulk) Carrier Vessel Density	Winter Cruise Vessel Density
Winter Fishing Vessel Density	Winter Tanker Vessel Density
Winter Tug Vessel Density	

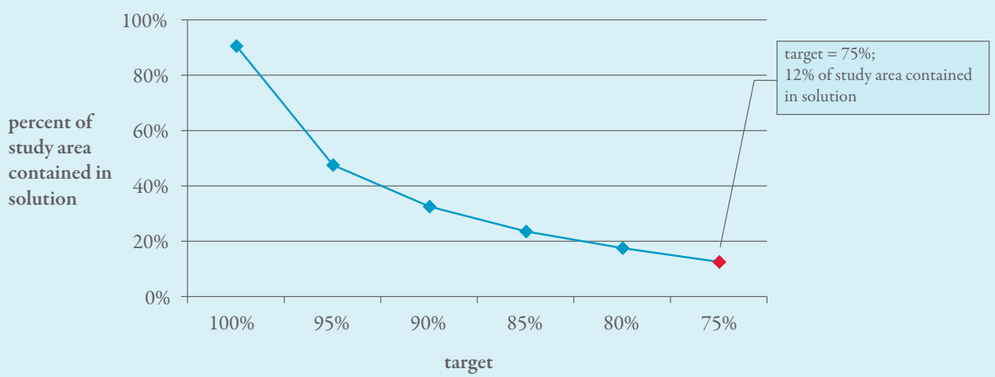


Figure 1. Target and area of solution for this scenario (red diamond) compared to other shipping and transportation scenarios.

Each time Marxan is run using identical features, targets, and parameter values, Marxan generates a slightly different result because it has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the solution with the lowest overall score. As Marxan does this, it makes some randomised choices about which planning units to include in each new combination for comparison, so solutions may differ slightly. We ran Marxan 100 times and generated 100 different examples of solutions for every "What if...?" scenario.

Best practice for presenting results of Marxan analyses advises showing results in two formats. The first is an example of a solution for a single run (inset map on facing page). All of the selected areas in any one example have equal value for the goals set. The second format, called selection frequency, shows how often each planning unit was selected to be part of the solution over a number of runs (main map on the facing page). Selection frequency can be interpreted as a measure of irreplaceability, which can be equated with high importance. The areas shown in orange in the map on the facing page are those areas that were selected most often and are therefore considered 'areas important for shipping and transportation'. Most of the area of the solution is orange because there is little spatial flexibility in the solution due to the high target of 75%.

reviewers

- Phillip Nelson, Council of Marine Carriers

reviewer comments

- **Density feature maps do not accurately illustrate individual vessel tracks (i.e. real vessels do not appear and disappear in mid-ocean). Therefore, the veracity of this collation of data is doubtful and the maps can be somewhat misleading.**
- Parts of some vessel routes have been omitted (by Marxan) in these analyses results, while other portions of the same route have been included. Therefore the results do not accurately illustrate areas important for shipping and transportation.

caveats

- A number of ferry routes are not portrayed in the ferry route data set, due to lack of data and are therefore not accounted for in this analysis (for details see *feature map caveats*).
- Each one of the features was targeted equally, meaning that no relative importance was assigned amongst the features. Relative densities within vessel density features were based on a single year of observations (2007), but densities do vary significantly annually.
- Vessel density data coverage does not go beyond the Canadian EEZ, thus tracks end there.
- Tanker routes in and out of Kitimat were changed in 2009 (see *feature map facing page*) and this analysis does not take that change into account.
- The data used reflect past use levels and may not reflect current or future reality.
- Please refer to individual feature atlas pages for additional caveats related to the datasets.

BCMCA Analysis

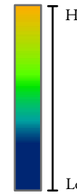
Human Use Marxan Results

Shipping and Transportation (See comments and caveats)

Scenario: HU 20
25% reduction of sector footprint
(measured in relative intensity of use)

Legend

Selection frequency over 100 runs



Areas in one example result

Notes:
- The selection frequency refers to the number of times each 2 km x 2 km grid cell was selected to be part of the result.
- The Marxan goal of this scenario was to include at least 75% of the relative intensity of use mapped for each of the 17 shipping and transportation features and minimize the total area of the result.

Data Sources:
See the appendices of the BCMCA Marxan Analyses Report (2011) for a complete list.

Base Data:
ESRI Base Data, GeoBase, GeoBC, NOAA, Natural Resources Canada, USGS, Washington State Government

Thematic Data:
For more information on feature data, analysis methods, and caveats for use of these results, please see facing page and BCMCA Marxan Analyses Report (2011).

Projection: BC Albers NAD83

0 25 50 75 100 125 150
Kilometres
0 25 50 75
Nautical Miles

1:4,250,000 *
* Written scales are approximate and are based on a 11 x 17 inch paper size.

Prepared for:

BC Marine Conservation Analysis

Map template by Caslys Consulting Ltd.
February 24, 2012

Alaska
Haida Gwaii
British Columbia
Vancouver Island
Washington
PACIFIC OCEAN
Nass River
Skeena River
Fraser River

142°W 140°W 138°W 136°W 134°W 132°W 130°W 128°W 126°W 124°W 122°W
54°N 52°N 50°N 48°N 46°N
N.54 N.52 N.50 N.48

One Example Result 1:12,000,000*

marxan glossary

The definitions included here are relevant to the context of the BC Marine Conservation Analysis (BCMCA) project's use of these terms. Some definitions do not necessarily apply more broadly.

Areas important to human use – areas that are important to marine user groups. The BCMCA project team invited user groups to help identify the areas that are important to them. Areas selected to be part of the solution for a human use Marxan analysis are called areas important for a particular human use sector. There is no measure to compare relative importance among sectors partly because the measurement of use differs among sectors.

Areas of high conservation value - areas that are important for effectively representing and conserving marine biodiversity. Areas selected to be part of the solution for an ecological Marxan analysis are called areas of high conservation value.

Biodiversity - the variety of species and ecosystems on earth and the ecological processes of which they are a part, including ecosystem, species and genetic diversity components.

Boundary Length Modifier (BLM) – a Marxan parameter or variable which controls the size of the clumps of selected planning units that make up a solution. This parameter is called the Boundary Length Modifier because the size of the clumps is directly related to total boundary length (i.e., the sum of the perimeter of all the clumps). For example, the total boundary length of a solution with small clumps (lower BLM) is much greater than the total boundary length of a solution with large clumps (higher BLM). This parameter is useful for marine planning because it gives analysts, managers and decision makers the option to consider a variety of spatial solutions that meet their analysis goals. A planning process or protected area design initiative would likely specify a preferred size of clumps to meet their specific goals.

Conservation - the protection, maintenance and rehabilitation of biodiversity, allowing for the sustainable utilization of species and ecosystems, and the natural resources they provide.

Conservation planning – the exercise of identifying areas important for meeting conservation objectives (e.g., biodiversity representation within a defined region) and then designing management measures to ensure that those conservation objectives are met (the BCMCA is helping with the first half of this exercise – identifying important areas).

Ecosystem - is a dynamic complex of plant, animal and microorganism communities and their abiotic environment, all interacting as a functional unit in an area.

Edge-to-area ratio (Marxan context) - is the total boundary length divided by the total area of a Marxan solution. This is important to planners because if the selected areas in a Marxan solution were to receive enhanced management, a configuration with fewer edges or boundaries (meaning a lower ratio) is easier and less costly to manage. Both the theory behind designing marine reserves and empirical studies support this.

Expert workshops - The BCMCA organized five workshops where experts on an ecological theme (e.g., marine mammals, marine birds) were invited to participate. At these workshops, experts identified sources of the best available ecological data for the BCMCA atlas and spatial analyses, and made recommendations to help define the parameters for analyses.

Features (Marxan context) - are the spatial or mapped layers to be included in Marxan analyses. Features include broad ecological units such as ecosections, species habitats such as foraging areas around seabird colonies, oceanographic features such as areas with high tidal currents, and areas of human use focus such as commercial or sport fishing areas. Ecological features were *recommended to the BCMCA* at a series of ecological expert workshops and human use features were *developed in collaboration* with representatives of six sectors of human uses of the marine environment.

Feature count map (also called a Richness map) - a map that results from laying multiple feature maps on top of one another and counting the number of features that occur in each planning unit. These maps show ecologically rich areas or areas where multiple human uses overlap, and they can also be used to identify data poor areas. *(View ecological feature count map)*

Human Use Data Working Group (HUWG) – a committee of user group representatives that provides advice to the project team about the preparation and use of human use data in the BCMCA project.

Marxan – is a decision support tool *developed by the University of Queensland*, and has global recognition as one of the best tools to meet the challenge of identifying areas of high conservation value or areas important to human use given the computational complexity in doing so. Marxan is frequently used more specifically as a reserve design tool to help identify potential protected areas, but it is a flexible tool and BCMCA's use is more general.

marxan glossary (cont'd)

Planning unit (Marxan context) - The building blocks of Marxan are the parcels of land or water that are compared to one another – these parcels are called planning units, or sometimes called analysis units. The amount of each feature present in each planning unit is recorded and used in Marxan analyses. Marxan selects a combination of planning units to be included in a solution. The BCMCA used planning units that measure 2 km by 2 km and cover the Canadian Pacific Exclusive Economic Zone (EEZ), for a total of 120, 499 planning units.

Planning unit cost (Marxan context) - The individual 'cost' of each planning unit. The 'cost' can reflect any relative economic, social or ecological measure and is sometimes referred to as a suitability measure (i.e., how 'suitable' is each planning unit for meeting the objectives of any specific Marxan scenario?). In all the BCMCA analyses, the cost of each planning unit is equal to its area, meaning that all planning units have the same cost.

Richness map (also called a feature count map) – a map that results from laying multiple feature maps on top of one another and counting the number of features that occur in each planning unit. These maps show ecologically rich areas or areas where multiple human uses overlap, and they can also be used to identify data poor areas. *(View Richness map of all ecological features)*

Scenario (Marxan context) – a Marxan analysis with a unique set of features or targets. Marxan can be run multiple times within a scenario to generate a suite of example results. The BCMCA ran Marxan 100 times for each scenario.

Sector – the term that refers to the broad groups of human users in BC's marine environment that have been identified by the BCMCA. The sectors are (1) commercial fishing, (2) sport fishing, (3) ocean energy, (4) tourism and recreation, (5) shipping and marine transportation, and (6) marine and foreshore tenures. Each sector may consist of multiple distinct user groups.

Selection frequency map – one of two formats often used to illustrate the results of a Marxan analysis. Selection frequency refers to the number of times each planning unit was selected to be part of the solution over a number of runs. Selection frequency can be interpreted as a measure of irreplaceability, which is often equated with conservation value or conservation utility. However, it should be noted that higher selection frequency might be due to many features overlapping in an area, or a few rarer species present in an area, or features in an areas that were given high targets. Lower selection frequency may indicate locations of widespread features which are equally ecologically important but not as rare as others which drive Marxan to repeatedly select the same planning units.

Solution (Marxan context) – a combination of planning units selected by Marxan to meet all the targets and constraints of a scenario. Each time Marxan is run, a solution is generated that meets all of the targets for the lowest cost. The BCMCA ran Marxan 100 times for each scenario. An example result is equivalent to a single solution from one of the runs in a scenario and a map illustrating an example result is one of two formats often used to illustrate Marxan results. There are many possible solutions with different spatial patterns for any Marxan scenario.

Spatial analyses – the process of deriving new information through the assembly and interpretation of existing spatial or mapped data. BCMCA ran two types of spatial analyses:

1. Identification of areas of high conservation value (using ecological data only)
2. Identification of areas important to six different human use sectors (using human use data only)

Target (Marxan context) - A quantitative value that defines how much of a particular feature is required to meet the goals or objectives of a Marxan scenario. Each feature in each scenario has a target (e.g., the target for eelgrass beds in Scenario Ecol 1 is 50%, the target for seamounts in Scenario Ecol 1 is 20%, etc.).

Total boundary length - the sum of the perimeters of all the clumps or selected areas in a Marxan solution. Boundary length is important to planners because if the selected areas were to receive enhanced management, more boundaries tend to increase management challenges and cost.

User group – a more specific term than sector, used to refer to a set of human users that essentially all participate in the same marine activity (e.g., halibut fishing or industrial shipping or sea kayaking). There may be numerous user groups within a sector and there may be multiple representative bodies for any given user group.

frequently asked questions

Question: Why are there multiple examples of results for each scenario? If the features used are the same why does Marxan come up with many different solutions?

Answer: Marxan has a random element to it. Marxan compares millions and millions of possible combinations of planning units, scores each as to whether targets are met and costs are minimised, then chooses the combination with the best score. As Marxan does this, it makes some randomised choices about which planning units to include, so solutions usually differ slightly. The more constrained a problem is (e.g., higher targets with higher level of clumping), the more similar all the solutions will be. It is advantageous for planning processes to be able to consider many equally efficient spatial solutions for any one problem.

Question: How can I tell what values or features are present in any particular area in a solution? Planners considering different solutions need to know why any particular area was selected to be part of a solution and what uses or values exist within it.

Answer: This type of information can be made available but is not part of the information that the BCMCA is currently presenting. The BCMCA is illustrating examples of results for hypothetical "What if...?" scenarios. Any planning process designing analyses to meet specific objectives could ask the analyst to provide a detailed list of the features present in each area that is part of a solution.

Question: What is the relationship between *selection fequency* for any ecological scenario and the ecological *feature count map* that illustrates the number of ecological features occurring in each planning unit of the study area? I would have guessed (incorrectly) that more features would equate to greater conservation value but this is obviously not the case.

Answer: All the selected areas in any one example Marxan result have equal conservation value. They represent a good solution to the problem or scenario only when considered all together. Higher selection frequency does mean that a planning unit has been chosen more frequently to be part of a solution, but that may be because one or two rare species occur there or because many common features co-occur there. The features count map tells us how many features overlap in every planning unit and is therefore complimentary to the selection frequency of a Marxan scenario. By considering both maps a planner can see if any particular area of high conservation value has many features or just a few that are perhaps rare.

Question: Why did the BCMCA not run Marxan analyses using both ecological and human use data in the same scenario? (i.e., in BCMCA's Strategy and Action Plan, Jan. 2009, the second goal of the planned analyses was to "identify areas of high conservation value that minimize overlap with areas important to human use (using ecological and human use data).")

Answer: The BCMCA is a collaboratively run project and our goals evolved over time. After the Marxan tool was introduced to the Human Use Working Group (HUWG) and they had a chance to review much of the human use data, neither the idea of combining all uses into one cost layer nor the idea of running a single analysis that targeted all types of human uses received the support of the HUWG. The main reason cited was the variation in metrics, or measures of use, and quality among human use datasets (i.e., data varied from quantified use to presence/absence to potential future areas of use). This variation makes combining all human use data sets into a single index of importance or value challenging, and also questions the usefulness of running analyses that target different types of data equally.

Question: Why did the BCMCA not run Marxan analyses to "identify areas of high conservation value by incorporating additional marine reserve design principles (e.g., maximising connectivity, minimizing edge-to-area ratio)"? as stated in BCMCA's Strategy and Action Plan, Jan. 2009.

Answer: The BCMCA is a collaboratively run project and our goals evolved over time. We did collaboratively draft a Marxan scenario options document which outlines our scenario design plans, including some objectives related to incorporating marine reserve design principles. These scenarios were deemed a lower priority than providing a set of relatively basic example scenarios. We have not run more specific reserve design scenarios to date. Please feel free to email us (*info@bcmca.ca*) with ideas for additional example scenarios.

Question: Did the BCMCA run a scenario where current marine protected areas and designated Areas of Interest were 'locked-in' as part of the solution? Why or why not?

Answer: No. Although this is commonly done as part of a planning process, the BCMCA does not have a planning mandate and therefore we did not run this type of scenario. It is more appropriate that decision makers involved in a planning process make these kinds of scenario design decisions, as they are related to specific planning objectives.

Question: Why do the entire *Hecate Strait sponge reefs* not show up as areas of high conservation value in the results of ecological Marxan scenarios?

Answer: Sponge reefs were targeted at 10%, 20%, and 30% in each of the low, medium, and high target scenarios, respectively. These targets were met, such that a portion of the sponge reefs feature is contained in the selected areas, or areas of high conservation value, for each ecological Marxan example result. At the invertebrate experts' workshop, experts preferred not to recommend targets for features, meaning Project Team targets were adopted for these features in the expert scenarios. Project Team screening criteria for 'special' features excluded the sponge reefs because they have no official endangered status. Thus they were targeted similarly to all other representation features.

appendix 1. feature lists

Table 1. Ecological features, target used in each ecological Marxan scenario, special or representational status of feature, and rationale for status. PT stands for Project Team, and med for medium.

Ecological Theme	Ecological Feature	Target by scenario							
		Ecol 1-Expert low	Ecol 2-Expert med	Ecol 3-Expert high	Ecol 4-PT low	Ecol 5-PT med	Ecol 6-PT high	Representational or special feature, rational if special	Unit of measure in planning units
Fish	Herring Spawn shoreline targeted by 6 mportance classes	10%	20%	30%	10%	20%	30%	representational	presence/absence of importance class
Fish	Salmon Stream Suitability / Classification	10%	20%	30%	10%	20%	30%	representational	production potential of juvenile fish (normalised)
Fish and Invertebrates	Mean CPUE from trawl observer data, 2004 - Feb. 2010	10%	20%	30%	10%	20%	30%	representational	kg / hour (normalised)
Fish and Invertebrates	Observed catch density from groundfish trawl surveys - 2003-2009 - by year	10%	20%	30%	10%	20%	30%	representational	kg / km^2 (normalised)
Fish and Invertebrates	Observed catch density from shrimp trawl surveys - 2004-2009 - by year	10%	20%	30%	10%	20%	30%	representational	kg / km^2 (normalised)
Fish and Invertebrates	Richness index from groundfish trawl surveys - 2003-2009 - by year	10%	20%	30%	10%	20%	30%	representational	count of spp (normalised)
Fish and Invertebrates	Richness index from shrimp trawl surveys - 2004-2009 - by year	10%	20%	30%	10%	20%	30%	representational	count of spp (normalised)
Fish and Invertebrates	Richness index from trawl observer data, 2004 - Feb. 2010	10%	20%	30%	10%	20%	30%	representational	count of spp (normalised)
Invertebrates	Coral occurrences in trawl observer data	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Corals caught in groundfish trawl surveys	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Intertidal invertebrate habitat surrogate - Mudflats adjacent to estuaries	10%	20%	30%	10%	20%	30%	representational	linear metres of shoreline
Invertebrates	Intertidal invertebrate habitat surrogate - Rock platform submerged at high tides	10%	20%	30%	10%	20%	30%	representational	linear metres of shoreline
Invertebrates	Intertidal invertebrate habitat surrogate - Rock substrate with high current	10%	20%	30%	10%	20%	30%	representational	linear metres of shoreline
Invertebrates	Intertidal invertebrate habitat surrogate - Sandy Substrate in the Intertidal Zone	10%	20%	30%	10%	20%	30%	representational	linear metres of shoreline
Invertebrates	Selected corals *(Lophelia pertusa, Stylaster campylecus, Primnoa willeyi)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Selected crustaceans *(Balanus glandula, Balanus nubilus, Ampelisca sp., Neotrypaea californiensis)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Selected echinoderms *(Stronglyocentrotus purpuratus, Amphiodia periercta)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Selected molluscs *(Vermetus compactus, Crassadoma gigantean, Mytilus californianus, Penitella penita)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Selected segmented worms *(Eudistylia vancouveri, Phyllochaetopterus prolifica, Dodecaceria fewkesi, Serpula columbiana)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Selected sponges *(Aphrocallistes vastus, Heterochone calyx)*	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Sponge occurrences I - groundfish trawl surveys	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Sponge occurrences II - trawl fishery observer data	10%	20%	30%	10%	20%	30%	representational	presence/absence
Invertebrates	Sponge Reefs	10%	20%	30%	10%	20%	30%	representational	area covered, m^2
Marine Birds	American Wigeon Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Ancient Murrelet - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Ancient Murrelet - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Ancient Murrelet - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Theme	Ecological Feature	Target by scenario: Ecol 1- Expert low	Ecol 2- Expert med	Ecol 3- Expert high	Ecol 4 - PT low	Ecol 5 - PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Marine Birds	Ancient Murrelet winter	50%	62.5%	75%	20%	40%	60%	special; BC Blue listed	avg. birds/km² (normalised)
Marine Birds	At-sea Marbled Murrelet density	70%	85%	100%	20%	40%	60%	special; high expert target & listed spp	avg. birds/km² (normalised)
Marine Birds	At-sea marine bird density	10%	20%	30%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	At-sea nationally and globally listed seabird species occurrences	20%	40%	60%	20%	40%	60%	special; all listed spp	avg. birds/km² (normalised)
Marine Birds	Bald eagle winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Barrow's Goldeneye Winter	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Black Oystercatcher - medium breeding site	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km²
Marine Birds	Blue-winged Teal Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Bonaparte's gull autumn	40%	50%	60%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Bonaparte's gull spring	40%	50%	60%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Brandt's Cormorant - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Brandt's Cormorant - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Brandt's Cormorant Winter	15%	22.5%	30%	20%	40%	60%	special; BC Red listed	avg. birds/km² (normalised)
Marine Birds	Brant Spring Staging	75%	87.5%	100%	20%	40%	60%	special; high expert target	avg. birds/km² (normalised)
Marine Birds	Brant Winter	75%	87.5%	100%	20%	40%	60%	special; high expert target	avg. birds/km² (normalised)
Marine Birds	Bufflehead	20%	30%	40%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	California gull Winter	15%	32.5%	50%	20%	40%	60%	special; BC Blue listed	avg. birds/km² (normalised)
Marine Birds	Canada Goose	10%	17.5%	25%	20%	40%	60%	special; BC Red listed	avg. birds/km² (normalised)
Marine Birds	Cassin's Auklet - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Cassin's Auklet - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Cassin's Auklet - small colony	80%	90%	100%	20%	40%	60%	special;high expert target	area covered by near-colony foraging, m²
Marine Birds	Cassin's Auklet Foraging habitat	20%	40%	60%	20%	40%	60%	special; BC Blue listed	avg. modeled density (normalised)
Marine Birds	Common Goldeneye Winter	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Common Loon Winter Habitat	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Common Merganser	20%	30%	40%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Common Murre - large colony	100%	100%	100%	20%	40%	60%	special;high expert target	area covered by near-colony foraging, km²
Marine Birds	Common Murre - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km²

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Theme	Ecological Feature	Target by scenario: Ecol 1- Expert low	Ecol 2- Expert med	Ecol 3 - Expert high	Ecol 4 - PT low	Ecol 5- PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Marine Birds	Common murre winter	25%	37.5%	50%	20%	40%	60%	special; BC Red listed	avg. birds/km^2 (normalised)
Marine Birds	Double-crested Cormorant - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Double-crested Cormorant - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Double-crested Cormorant - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Double-crested Cormorant Winter	15%	22.5%	30%	20%	40%	60%	special; BC Blue listed	avg. birds/km^2 (normalised)
Marine Birds	Eurasian Wigeon Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Gadwall Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Glaucous-winged Gull - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Glaucous-winged Gull - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Glaucous-winged Gull - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km^2
Marine Birds	Glaucous-winged gull winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Great Blue Heron Nests and Foraging Areas	100%	100%	100%	20%	40%	60%	special; BC Blue listed	near-nest foraging area, m^2
Marine Birds	Great Blue Heron Winter	30%	40%	50%	20%	40%	60%	special; BC Blue listed	avg. birds/km^2 (normalised)
Marine Birds	Green-winged Teal Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Harlequin Duck Spring Staging	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Harlequin Moulting	75%	82.5%	90%	20%	40%	60%	special; high expert target	avg. birds/km^2 (normalised)
Marine Birds	Harlequin Winter	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Herring Gull Winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Hooded Merganser	20%	30%	40%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Horned Grebe	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Horned Puffin - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Long-tailed Duck Winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Mallard Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Marbled Murrelet winter	20%	40%	60%	20%	40%	60%	special; BC Red listed	avg. birds/km^2 (normalised)
Marine Birds	Mew Gull Winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Northern Pintail Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Northern Shoveler Winter	20%	35%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Theme	Ecological Feature	Target by scenario: Ecol 1- Expert low	Ecol 2- Expert med	Ecol 3- Expert high	Ecol 4- PT low	Ecol 5 - PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Marine Birds	Pacific Loon Winter	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Pelagic Cormorant	15%	22.5%	30%	20%	40%	60%	special; BC Red listed	avg. birds/km² (normalised)
Marine Birds	Pelagic Cormorant - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Pelagic Cormorant - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Pelagic Cormorant - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Peregrine falcon nesting	90%	95%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Birds	Pigeon Guillemot - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Pigeon Guillemot - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Red breasted merganser	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Red-necked Grebe	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Red-throated Loon Winter Habitat	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Rhinoceros Auklet - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Rhinoceros Auklet - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Rhinoceros Auklet - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Rhinoceros Auklet Foraging habitat	10%	20%	30%	10%	20%	30%	representational	avg. modeled density (normalised)
Marine Birds	Sandhill Crane Observations	10%	20%	30%	10%	20%	30%	representational	presence/absence
Marine Birds	Scaup species winter	40%	57.5%	75%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Scoter species pre-migration staging	50%	62.5%	75%	10%	20%	30%	representational; surf scoter is BC blue listed but others are not	avg. birds/km² (normalised)
Marine Birds	Scoter species winter	25%	37.5%	50%	10%	20%	30%	representational; surf scoter is BC blue listed but others are not	avg. birds/km² (normalised)
Marine Birds	Semipalmated Plover nests	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Birds	Shorebird staging areas - flat	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Birds	Shorebird staging areas - rocky	10%	20%	30%	10%	20%	30%	representational	presence/absence
Marine Birds	Storm Petrels - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Storm Petrels - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Storm Petrels - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m²
Marine Birds	Thayer's Gull Winter	15%	22.5%	30%	10%	20%	30%	representational	avg. birds/km² (normalised)
Marine Birds	Thick-billed Murre - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, km²

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Theme	Ecological Feature	Target by scenario: Ecol 1- Expert low	Ecol 2 - Expert med	Ecol 3- Expert high	Ecol 4- PT low	Ecol 5- PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Marine Birds	Trumpeter Swan Winter - point	25%	37.5%	50%	10%	20%	30%	representational	count of birds (normalised)
Marine Birds	Trumpeter Swan Winter - polygon	25%	37.5%	50%	10%	20%	30%	representational	avg. birds/km^2 (normalised)
Marine Birds	Tufted Puffin - large colony	100%	100%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Tufted Puffin - medium colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Tufted Puffin - small colony	80%	90%	100%	20%	40%	60%	special; high expert target	area covered by near-colony foraging, m^2
Marine Birds	Tundra Swan Winter	25%	37.5%	50%	20%	40%	60%	special; BC Blue listed	avg. birds/km^2 (normalised)
Marine Birds	Western Grebe	40%	50%	60%	20%	40%	60%	special; BC Red listed	avg. birds/km^2 (normalised)
Marine Mammals	California Sea Lions - haulouts	30%	45%	60%	10%	20%	30%	representational	near haulout foraging area, m^2
Marine Mammals	Chlorophyll	10%	20%	30%	10%	20%	30%	representational	avg. mg/m^3
Marine Mammals	Harbour Seals haulouts, targeted by Ecosection	10%	20%	30%	10%	20%	30%	representational	near haulout foraging area, m^2
Marine Mammals	Sea Otter - habitat and range	20%	35%	50%	10%	20%	30%	representational; spp of specialconcern	area, m^2
Marine Mammals	Steller Sea Lions - haulouts	30%	45%	60%	10%	20%	30%	representational	near haulout foraging area, m^2
Marine Mammals	Steller Sea Lions - rookeries	100%	100%	100%	20%	40%	60%	special; high expert target	near rookery foraging area, m^2
Marine Plants	Bull Kelp Bioband, targeted by Ecosection	30%	55%	80%	20%	40%	60%	special; high expert target	linear metres of shoreline
Marine Plants	Bull Kelp beds, targeted by Ecosection	30%	55%	80%	20%	40%	60%	special; high expert target	area, m^2
Marine Plants	Ditch grass - *Ruppia spp.*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Eelgrass *(Zostera marina)* polygons, targeted by Ecosection	50%	75%	100%	20%	40%	60%	special; high expert target	area, m^2
Marine Plants	Eelgrass Bioband, targeted by Ecosection	50%	75%	100%	20%	40%	60%	special; high expert target	linear metres of shoreline
Marine Plants	Estuaries, targeted by relative importance	50%	75%	100%	20%	40%	60%	special; high expert target	area, m^2
Marine Plants	Feather boa kelp - *Egregia menziesii*	12%	26%	40%	10%	20%	30%	representational	presence/absence
Marine Plants	General Kelp, targeted by Ecosection	30%	55%	80%	20%	40%	60%	special; high expert target recommended for all kelps	area, m^2
Marine Plants	Giant perennial kelp - *Macrocystis pyrifera* observations	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Giant Kelp Bioband, targeted by Ecosection	50%	65%	80%	20%	40%	60%	special; high expert target	linear metres of shoreline
Marine Plants	Giant Kelp beds, targeted by Ecosection	50%	65%	80%	20%	40%	60%	special; high expert	target area, m^2
Marine Plants	Important Algal Habitats - Boulder/Cobble floor	30%	30%	30%	10%	20%	30%	representational	linear metres of shoreline
Marine Plants	Important Algal Habitats - Mudflats/estuarine	30%	30%	30%	10%	20%	30%	representational	linear metres of shoreline
Marine Plants	Important Algal Habitats - Rocky intertidal - highly exposed (surge)	30%	30%	30%	10%	20%	30%	representational	linear metres of shoreline

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Themelow	Ecological Feature med	Target by scenario: Ecol 1- Expert low	Ecol 2- Expert med	Ecol 3- Expert high	Ecol 4- PT low	Ecol 5- PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Marine Plants	Important Algal Habitats - Rocky intertidal - semiwave exposed	30%	30%	30%	10%	20%	30%	representational	linear metres of shoreline
Marine Plants	Important Algal Habitats - Rocky intertidal - sheltered	30%	30%	30%	10%	20%	30%	representational	linear metres of shoreline
Marine Plants	Priority Eelgrass Habitat	100%	100%	100%	20%	40%	60%	special; high expert	target area, m^2
Marine Plants	Rare algae - *Antithamnion kylinii*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Arthrocardia silvae*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Codium ritteri*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Cystoseira*, targeted by Ecosection	1 occurrence	1 occurrence	1 occurrence	10%	20%	30%	representational	presence/absence
Marine Plants	Rare algae - *Desmarestia tortuosa*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Dictyoneurum californicum*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Eisenia arborea*, targeted by Ecosection	1 occurrence	1 occurrence	1 occurrence	10%	20%	30%	representational	presence/absence
Marine Plants	Rare algae - *Hollenbergia nigricans*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Laminaria farlowii*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Laminaria longipes*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Laminaria sinclairii*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Lithothrix spp.*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Phycodrys riggii*	100%	100%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Postelsia palmaeformis*	20 occurrences	20 occurrences	20 occurrences	4 occurrences	9 occurrences	13 occurrences	special; high expert target (i.e., 20 of 22 occurrences)	presence/absence
Marine Plants	Rare algae - *Pterygophora californica*	30%	30%	30%	10%	20%	30%	representational	presence/absence
Marine Plants	Rare algae - *Rhodolith spp.*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Tayloriella abyssalis*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Tayloriella divaricata*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Thuretellopsis peggiana*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Tokidaea chilkatensis*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Rare algae - *Whidbeyella cartilaginea*	30%	65%	100%	20%	40%	60%	special; high expert target	presence/absence
Marine Plants	Salt Marsh Bioband, targeted by Ecosection	50%	75%	100%	20%	40%	60%	special; high expert target	linear metres of shoreline
Marine Plants	Surfgrass Bioband, targeted by Ecosection	50%	75%	100%	20%	40%	60%	special; high expert target	linear metres of shoreline
Physical Representation	Benthic Classes: 64 unique classes each targeted by Ecosection	10%	25%	40%	10%	20%	30%	representational	area, m^2

appendix 1. feature lists (cont'd)

Table 1. (cont'd)

Ecological Themelow	Ecological Feature med	Target by scenario: Ecol 1- Expert low	Ecol 2- Expert med	Ecol 3- Expert high	Ecol 4- PT low	Ecol 5- PT med	Ecol 6- PT high	Representational or special feature, rational if special	Unit of measure in planning units
Physical Representation	Coastal Classes: 32 unique classes, each targeted by Ecosection	10%	25%	40%	10%	20%	30%	representational	linear metres of shoreline
Physical Representation	Ecosections: 12 ecosections	10%	25%	40%	10%	20%	30%	representational	area, m^2
Physical Representation	High Rugosity (seabed roughness)	55%	60%	65%	20%	40%	60%	special; unique physical feature	area, m^2
Physical Representation	Hydrothermal vents	25%	50%	75%	20%	40%	60%	special; unique physical feature	vent field count
Physical Representation	Oceanographic Regions: 16 regions	10%	25%	40%	10%	20%	30%	representational	area, m^2
Physical Representation	Seamounts	20%	40%	60%	20%	40%	60%	special; unique physical feature	presence/absence
Physical Representation	Shorezone exposure classes: 6 classes, each targeted by Ecosection	10%	25%	40%	10%	20%	30%	representational	linear metres of shoreline
Physical Representation	Tidal Current	40%	60%	100%	20%	40%	60%	special; unique physical feature & high expert target	area, m^2

Table 2. Human use sector, features and metric of use for each feature

Human Use sector	Human Use feature	metric of use (unit of measure in planning units)
Commercial Fisheries	Chinook Salmon (gillnet)	total fish caught, 2001-2007
Commercial Fisheries	Chinook Salmon (seine)	total fish caught, 2001-2007
Commercial Fisheries	Chinook Salmon (troll)	total fish caught, 2001-2007
Commercial Fisheries	Chum Salmon (gillnet)	total fish caught, 2001-2007
Commercial Fisheries	Chum Salmon (seine)	total fish caught, 2001-2007
Commercial Fisheries	Chum Salmon (troll)	total fish caught, 2001-2007
Commercial Fisheries	Coho Salmon (gillnet)	total fish caught, 2001-2007
Commercial Fisheries	Coho Salmon (seine)	total fish caught, 2001-2007
Commercial Fisheries	Coho Salmon (troll)	total fish caught, 2001-2007
Commercial Fisheries	Dungeness Crab	total pounds caught, 2000-2004
Commercial Fisheries	Geoduck	total pounds caught, 2000-2005
Commercial Fisheries	Green Sea Urchin	total pounds caught, 2000-2005
Commercial Fisheries	Groundfish Trawl	total kilograms, 1996-2004
Commercial Fisheries	Halibut	total pounds caught, 1991-2006

appendix 1. feature lists (cont'd)

Table 2. (cont'd)

Human Use sector	Human Use feature	metric of use (unit of measure in planning units)
Commercial Fisheries	Humpback Shrimp	total pounds caught, 1997-2004
Commercial Fisheries	Krill	total pounds caught, 2000-2004
Commercial Fisheries	Pink Salmon (gillnet)	total fish caught, 2001-2007
Commercial Fisheries	Pink Salmon (seine)	total fish caught, 2001-2007
Commercial Fisheries	Pink Salmon (troll)	total fish caught, 2001-2007
Commercial Fisheries	Pink Shrimp	total pounds caught, 1997-2004
Commercial Fisheries	Prawn	total pounds caught, 2001-2004
Commercial Fisheries	Red Sea Urchin	total pounds caught, 2000-2005
Commercial Fisheries	Rockfish Hook and Line (ZN)	total kilograms, 1993-2004
Commercial Fisheries	Roe Herring (gillnet)	total metric tonnes, 1989 - 2008
Commercial Fisheries	Roe Herring (seine)	total metric tonnes, 1989 - 2008
Commercial Fisheries	Sablefish (longline)	total kilograms, 1996-2004
Commercial Fisheries	Sablefish (trap)	total kilograms, 1996-2004
Commercial Fisheries	Sardine	total metric tonnes, 2001 - 2008
Commercial Fisheries	Schedule II	total kilograms, 1996-2004
Commercial Fisheries	Sea Cucumber	total pounds caught, 2000-2005
Commercial Fisheries	Shrimp Trawl	total pounds caught, 1996-2004
Commercial Fisheries	Sidestripe Shrimp	total pounds caught, 1997-2004
Commercial Fisheries	Sockeye Salmon (gillnet)	total fish caught, 2001-2007
Commercial Fisheries	Sockeye Salmon (seine)	total fish caught, 2001-2007
Commercial Fisheries	Sockeye Salmon (troll)	total fish caught, 2001-2007
Ocean Energy	Offshore Exploratory Wells	known presence
Ocean Energy	Offshore Petroleum Tenures - Federal - Canadian Forest Oil	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Federal - Chevron	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Federal - Exxon/Mobil	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Federal - Shell	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Federal - Suncor (formerly Petro-Canada)	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Provincial - Conoco Phillips/Dynamic Oil	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Provincial - Haida Resources Ltd.	area, km^2
Ocean Energy	Offshore Petroleum Tenures - Provincial - Offshore Oil & Gas Corp.	area, km^2
Ocean Energy	Oil and Gas Prospectivity targeted by relative exploration potential	area, km^2
Ocean Energy	Renewable Energy Tenures - ocean energy investigative permits	area, km^2
Ocean Energy	Renewable Energy Tenures - transmission lines	linear kilometres
Ocean Energy	Renewable Energy Tenures - wind energy investigative permits	area, km^2
Ocean Energy	Tidal Energy Areas of Interest targeted by relative importance	area, km^2
Ocean Energy	Wave Energy Areas of Interest targeted by relative importance	area, km^2
Ocean Energy	Wind Energy Potential targeted by relative mean wind energy potential	area, km^2
Shipping and Transportation	Carrier Vessel Density Summer 2007	relative density of transit through a planning unit
Shipping and Transportation	Carrier Vessel Density Winter 2007	relative density of transit through a planning unit
Shipping and Transportation	Cruise Vessel Density Summer 2007	relative density of transit through a planning unit
Shipping and Transportation	Cruise Vessel Density Winter 2007	relative density of transit through a planning unit
Shipping and Transportation	Ferry Routes targeted by relative intensity of use	linear metres
Shipping and Transportation	Ferry Terminals	area, m^2
Shipping and Transportation	Fishing Vessel Density Summer 2007	relative density of transit through a planning unit
Shipping and Transportation	Fishing Vessel Density Winter 2007	relative density of transit through a planning unit
Shipping and Transportation	Tanker Vessel Density Summer 2007	relative density of transit through a planning unit
Shipping and Transportation	Tanker Vessel Density Winter 2007	relative density of transit through a planning unit
Shipping and Transportation	Tow Boat Reserves	area, m^2
Shipping and Transportation	Tug Vessel Density Summer 2007	relative density of transit through a planning unit
Shipping and Transportation	Tug Vessel Density Winter 2007	relative density of transit through a planning unit
Sport (Recreational) Fishing	Anadromous Fish	area, m^2
Sport (Recreational) Fishing	Crab	area, m^2
Sport (Recreational) Fishing	Groundfish	area, m^2
Sport (Recreational) Fishing	Prawn and Shrimp	area, m^2

appendix 1. feature lists (cont'd)

Table 2. (cont'd)

Human Use sector	Human Use feature	metric of use (unit of measure in planning units)
Tenures	Aquaculture - Finfish	area, m^2
Tenures	Aquaculture - Shellfish	area, m^2
Tenures	Commercial & Industrial Uses - Energy Production	area, m^2
Tenures	Commercial & Industrial Uses - Commercial Uses	area, m^2
Tenures	Commercial & Industrial Uses - Industrial Uses	area, m^2
Tenures	Log Handling & Storage	area, m^2
Tenures	Residential Marine - Floating Cabin	area, m^2
Tenures	Residential Marine - Floating Community	area, m^2
Tenures	Residential Marine - Private Moorage	area, m^2
Tenures	Residential Marine - Strata Moorage	area, m^2
Tenures	Utilities - Cathodic Site/Anode Beds	area, m^2
Tenures	Utilities - Electric Power Line	area, m^2
Tenures	Utilities - Gas and Oil Pipeline	area, m^2
Tenures	Utilities - Miscellaneous	area, m^2
Tenures	Utilities - Sewer/Effluent Line	area, m^2
Tenures	Utilities - Telecommunication Line	area, m^2
Tenures	Utilities - Water Line	area, m^2
Tourism and Recreation	Anchorages - Safe Boat Haven	known presence
Tourism and Recreation	Anchorages - Other	known presence
Tourism and Recreation	Campsite - Access Point	known presence
Tourism and Recreation	Campsite - Alternate	known presence
Tourism and Recreation	Campsite - Day Destination or Day Use	known presence
Tourism and Recreation	Campsite - Primary	known presence
Tourism and Recreation	Campsite - Other, Potential or Commercial	known presence
Tourism and Recreation	Commercial Recreational Tenure - Community Outdoor Recreation	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Ecotourist Lodge	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Fish Camp	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Guided Nature Viewing	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Guided Saltwater Recreation	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Miscellaneous	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Multiple Use	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Private Camp	area, m^2
Tourism and Recreation	Commercial Recreational Tenure - Tidal Sports Fishing Camp	area, m^2
Tourism and Recreation	Dive Site - Boat-based	known presence
Tourism and Recreation	Dive Site - Shore-based	known presence
Tourism and Recreation	Dive Site - Unknown	known presence
Tourism and Recreation	Environmental Tenure - Ecological Reserve	area, m^2
Tourism and Recreation	Environmental Tenure - Fish and Wildlife Management	area, m^2
Tourism and Recreation	Environmental Tenure - Protected Area Strategy	area, m^2
Tourism and Recreation	Environmental Tenure - Protection and Conservation	area, m^2
Tourism and Recreation	Environmental Tenure - UREP and Recreation Reserve	area, m^2
Tourism and Recreation	Marinas and Coastal Facilities - Coastal Ecotourism Lodge	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Fishing Lodge	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Floating Fishing Lodge	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Harbour Authority or Public Wharf	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Harbour Authority with Marine Fuel Services	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Marina	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Marina with Marine Fuel Services	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Marine Fuel Services	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Private Marine or Yacht Club or Yacht Sales	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Transport Canada Public Wharf	known presence
Tourism and Recreation	Marinas and Coastal Facilities - Transport Canada Public Wharf with Marine Fuel Services	known presence
Tourism and Recreation	Recreational Boating Routes targeted by relative intensity of use	linear metres
Tourism and Recreation	Sea Kayaking Routes targeted by relative intensity of use	linear metres

appendix 2.

Ecological features recommended but not created

Recommended feature	Reason feature was not created
Marine Birds: Pelagic Seabirds	
Northern Fulmar	Data Gap
Haida Gwaii Marbled Murrelet - At sea	A single at-sea feature was created for Marbled Murrelet to be consistent with the at-sea features created for all marine birds and listed marine birds
North Coast Marbled Murrelet - At sea	
Central Coast Marbled Murrelet - At sea	
South Coast Marbled Murrelet - At sea	
West Coast Marbled Murrelet - At sea	
East Coast Marbled Murrelet - At sea	
Haida Gwaii Marbled Murrelet - population indices long term surveys (radar)	The radar data identify terrestrial nest sites and an appropriate means of correlating the terrestrial data with the marine environment was not determined. In addition, data were not available for all regions.
North Coast Marbled Murrelet - population indices long term surveys (radar)	
Central Coast Marbled Murrelet - population indices long term surveys (radar)	
South Coast Marbled Murrelet - population indices long term surveys (radar)	
West Coast Marbled Murrelet - population indices long term surveys (radar)	
East Coast Marbled Murrelet - population indices long term surveys (radar)	
At-sea diversity or richness index	Time constraints precluded adapting this feature when the decision was made to use 2 km x 2 km planning units for both the nearshore and offshore areas
Sandlance (forage fish as a proxy for seabird distribution)	Data Gap
Seamounts, steep sided banks, canyons (shelf break and other)	Banks, canyons and the shelf break were not explicitly created but should be captured by the high rugosity feature. The high rugosity feature was not reviewed with the intent to inform banks and canyons important for seabirds. Seamounts were mapped.
Eddies	Duplicate feature (Cetaceans; Invertebrates); Data gap
Salmon escapement at estuaries	Salmon productivity information was tied to river mouths
Marine Birds: Nearshore Birds *(Note: features that identified multiple species were split out into separate features for each species with the exception of the scaup and scoter features)*	
Bald Eagle nesting	Data Gaps
Marine Birds: Shorebirds	
Staging areas (migratory) (habitat model)	Experts decided that data do not adequately represent habitat
Tidal flats	Somewhat encompassed in the sandy staging areas feature
Rocky habitat with offshore rocks or piers or very complex shoreline	Data gap

Recommended feature	Reason feature was not created
Marine Plants: Canopy Kelp	
Nereocystis leutkeana habitat	Resources not available for habitat modeling work
Macrocystis integrifolia habitat	Resources not available for habitat modeling work
Alaria fistulosa	Data gap
Marine Plants: Algae	
Rare - *Dictyoneuropsis reticulata* (Phylum Phaeophyta). (Saunders) Smith 1942	Feature combined with Dictyoneurum feature
Rare - *Cumathamnion sympodophyllum* (Phylum Rhodophyta). Wynne et Daniels 1966	Data gap
Rare - *Tokidademdron bullatum* (Phylum Rhodophyta). (Gardner) Wynne 1983	Data gap
Special habitats: Whiffen Spit, Cape Palmerston, Brooks Peninsula	Data gap; No feedback received during data review on the best way to map the features
Special habitats: Subtidal glacial moraine	Data gap; No feedback received during data review on the best way to map the features
Special habitats: Vertical granite walls (fjords) e.g. Kynoch Inlet	Data gap; No feedback received during data review on the best way to map thefeatures
Special habitats: Special upwelling with unique features (e.g. Cape St. James) - persistent	Data gap; No feedback received during data review on the best way to map the features
Marine Plants: Vascular Marine Plants	
Salt marsh	Combined with estuary feature
Eelgrass potential habitat	Resources not available for habitat modeling work
Marine Mammals: Cetaceans	
Southern Resident Killer Whale - Distribution	Data requests were not successful
Southern Resident Killer Whale - Abundance	Data requests were not successful
Southern Resident Killer Whale - Suitable Habitat	Data requests were not successful; critical habitat was mapped
Southern Resident Killer Whale - Realized Habitat	Data requests were not successful; critical habitat was mapped
Northern Resident Killer Whale - Abundance	Data requests were not successful
Northern Resident Killer Whale - Suitable Habitat	Data requests were not successful; critical habitat was mapped
Northern Resident Killer Whale - Realized Habitat	Data requests were not successful; critical habitat was mapped
Transient Killer Whale - Distribution	Data may exist, but were not made available to the BCMCA
Transient Killer Whale - Abundance	Data may exist, but were not made available to the BCMCA
Transient Killer Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Transient Killer Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Offshore Killer Whale - Distribution	Data may exist, but were not made available to the BCMCA
Offshore Killer Whale - Abundance	Data may exist, but were not made available to the BCMCA
Offshore Killer Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Offshore Killer Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
False Killer Whale - Distribution	Data may exist, but were not made available to the BCMCA
False Killer Whale - Abundance	Data may exist, but were not made available to the BCMCA

appendix 2. (cont'd)

Ecological features recommended but not created

Recommended feature	Reason feature was not created
False Killer Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
False Killer Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Sperm Whale - Distribution	Data may exist, but were not made available to the BCMCA
Sperm Whale - Abundance	Data may exist, but were not made available to the BCMCA
Sperm Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Sperm Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Humpback Whale - Abundance	Data may exist, but were not made available to the BCMCA
Humpback Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Humpback Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Fin Whale - Abundance	Data may exist, but were not made available to the BCMCA
Fin Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Fin Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Sei Whale - Distribution	Data may exist, but were not made available to the BCMCA
Sei Whale - Abundance	Data may exist, but were not made available to the BCMCA
Sei Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Sei Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Northern Right Whale - Distribution	Data may exist, but were not made available to the BCMCA
Northern Right Whale - Abundance	Data may exist, but were not made available to the BCMCA
Northern Right Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Northern Right Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Blue Whale - Distribution	Data may exist, but were not made available to the BCMCA
Blue Whale - Abundance	Data may exist, but were not made available to the BCMCA
Blue Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Blue Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Minke Whale - Abundance	Data may exist, but were not made available to the BCMCA
Minke Whale - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Minke Whale - Realized Habitat	Data may exist, but were not made available to the BCMCA
Beaked Whales (Baird's, Cuvier's, Stejnerger's, Hubb's) - Distribution	Data may exist, but were not made available to the BCMCA
Beaked Whales (Baird's, Cuvier's, Stejnerger's, Hubb's) - Abundance	Data may exist, but were not made available to the BCMCA
Beaked Whales (Baird's, Cuvier's, Stejnerger's, Hubb's) - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Beaked Whales (Baird's, Cuvier's, Stejnerger's, Hubb's) - Realized Habitat	Data may exist, but were not made available to the BCMCA
Pacific White-sided Dolphin - Abundance	Data may exist, but were not made available to the BCMCA
Pacific White-sided Dolphin - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Pacific White-sided Dolphin - Realized Habitat	Data may exist, but were not made available to the BCMCA
Dall's Porpoise - Abundance	Data may exist, but were not made available to the BCMCA
Dall's Porpoise - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Dall's Porpoise - Realized Habitat	Data may exist, but were not made available to the BCMCA
Harbour Porpoise - Abundance	Data may exist, but were not made available to the BCMCA
Harbour Porpoise - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Harbour Porpoise - Realized Habitat	Data may exist, but were not made available to the BCMCA
Risso's Dolphin - Distribution	Data may exist, but were not made available to the BCMCA
Risso's Dolphin - Abundance	Data may exist, but were not made available to the BCMCA
Risso's Dolphin - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Risso's Dolphin - Realized Habitat	Data may exist, but were not made available to the BCMCA
Northern Right Whale Dolphin - Distribution	Data may exist, but were not made available to the BCMCA
Northern Right Whale Dolphin - Abundance	Data may exist, but were not made available to the BCMCA
Northern Right Whale Dolphin - Suitable Habitat	Data may exist, but were not made available to the BCMCA
Northern Right Whale Dolphin - Realized Habitat	Data may exist, but were not made available to the BCMCA
Areas of upwelling or high productivity	Data gap
Sea Surface Temperature (SST) Fronts	Data gap
Eddies	Duplicate feature (Invertebrates; Pelagic Seabirds); Data gap
Slope	Included as part of the Benthic Classes feature
Depth	Included as part of the Benthic Classes feature
Sea Surface Height Gradients	Data gap
Rocky Reefs	Data gap
Seamounts, canyons	Seamounts mapped, canyons included as part of the Benthic Classes feature

appendix 2. (cont'd)

Ecological features recommended but not created

Recommended feature	Reason feature was not created
Marine Mammals: Pinnipeds and Mustelids	
Sea Otter - Winter Habitat	Data gap
Harbour Seal - Foraging Habitat	Data may exist, but were not made available to the BCMCA
California Sea Lions - Rookeries	Rookeries are not found in British Columbia
Northern Fur Seal - Foraging Areas	Data gap
Northern Fur Seal - Offshore Habitat	Data gap; Pup habitat mapped
Elephant Seal - Foraging Habitat	Data gap; Distribution mapped
Marine Invertebrates: Invertebrate Foundation Species and Invertebrate Communities	
Intertidal: Protected surge channels	Data gap
Intertidal: Exposed surge channels	Data gap
Intertidal: Surge channels in caves	Data gap
Subtidal: Rock walls with high current velocities	Data gap
Subtidal: Rock tops of seamounts	Data gap
Subtidal: Cobble, high tidal velocities in channels	Data gap
Subtidal: Sand with high tidal currents in constricted areas	Data gap
Subtidal: Alongshore currents	Data gap
Gyres	Data gap
Eddies	Duplicate feature (Cetaceans; Pelagic Seabirds); Data gap
Upwelling Zones	Duplicate feature (Cetaceans); Data gap
Sea Surface Temperature (SST) Fronts	Duplicate feature (Cetaceans); Data gap
Sea Surface Height Gradients	Duplicate feature (Cetaceans); Data gap
Marine Invertebrates: Rare and Endangered Invertebrate Species and Unique Habitats	
Rare and endangered species locations, populations	Data gap
Unique Habitats: Intertidal/subtidal caves	Data gap
Unique Habitats: Historical wreck/artifical reefs	Human use feature

Recommended feature	Reason feature was not created
Unique Habitats: Abyssal plain	Included as part of the Benthic Classes feature
Unique Habitats: Fjord walls	Data gap; High rugosity feature identified fjord walls
Unique Habitats: Anoxic environments	Data gap
Unique Habitats: High silicates throughout water column including surface	Data gap
Unique Habitats: Strong tidal currents in high (oceanic) salinity water	Data gap
Unique Habitats: Very warm surface water	Data gap
Unique Habitats: Very cold surface/subsurface water	Data gap
Unique Habitats: Moderately strong tidal currents in high salinity water in intertidal	Data gap
Marine and Anadromous Fish: Anadromous and Pelagic Fish	
Spawning/holding areas	Data gap; Estuaries were mapped
Rearing/juvenile staging areas	Data gap
Nearshore habitats and spawning areas	Data gap
Spawning areas for forage species	Data gap
Intermediate and sub-adult nearshore habitat	Data gap
Offshore adult pelagic habitat	Data gap
Rare/uncommon species at international, national and local scales	Data gap
Locations / habitat for SARA listed species	Data gap; Basking shark observations mapped
Marine and Anadromous Fish: Groundfish and Demersal Fishes	
Rockfish habitat (juvenile)	Data gap
Rockfish habitat (adult)	Data gap
Rockfish habitat (spawning)	Data gap
Total fish biomass (based on surveys not commercial catches)	Data gap; species richness and catch density mapped from survey datasets
Known habitat of Sixgill and Basking sharks	Basking shark observations mapped
Frontier areas/untrawled areas	Untrawled areas mapped from survey datasets
Spawning area of broadcast spawners	Data gap

appendix 3. data sources

Table 1. Ecological data sources

Ecological Theme	Data Source
Fish	Fisheries and Oceans Canada - Cumulative Herring Spawn Habitat Index
Fish	University of Montana, Flathead Biological Station - Watershed based estimates of salmon productivity and mouth of salmon bearing streams
Fish and Invertebrates	Fisheries and Oceans Canada, Marine Ecosystem and Aquaculture Division, Shellfish Section - Shrimp Trawl Surveys
Fish and Invertebrates	Fisheries and Oceans Canada, Pacific Region, Science Branch, Groundfish Section - Groundfish Trawl Observer Data
Fish and Invertebrates	Fisheries and Oceans Canada, Pacific Region, Science Branch, Groundfish Section - Groundfish Trawl Surveys
Invertebrates	Fisheries and Oceans Canada, Pacific Region, Science Branch, Groundfish Section - Groundfish Trawl Observer Data
Invertebrates	Fisheries and Oceans Canada, Pacific Region, Science Branch, Groundfish Section - Groundfish Trawl Surveys
Invertebrates	Natural Resources Canada - Hexactinellid Sponge Reefs
Invertebrates	Province of British Columbia - Shorezone Mapping System
Invertebrates	Royal British Columbia Museum - Invertebrate Specimen Records
Marine Birds	Alan Burger - Southwest Vancouver Island Shelf Surveys
Marine Birds	Alan Burger - Trevor Channel Transects
Marine Birds	BC Conservation Data Centre - Peregrine falcon nesting, inventory, or element occurrence records
Marine Birds	Bernard Schroeder - Marbled Murrelet Surveys
Marine Birds	Bird Studies Canada - BC Coastal Waterbird Survey
Marine Birds	British Columbia Breeding Bird Atlas - Semipalmated Plover observations
Marine Birds	British Columbia Conservation Data Centre - non-sensitive element occurrences - pelagic birds
Marine Birds	Capital Regional District - Harbours Atlas
Marine Birds	Environment Canada (Canadian Wildlife Service) - BC Ferry Surveys
Marine Birds	Environment Canada (Canadian Wildlife Service) - British Columbia Seabird Colony Inventory
Marine Birds	Environment Canada (Canadian Wildlife Service) - Burrard Inlet Environmental Action Plan: Winter Bird Surveys
Marine Birds	Environment Canada (Canadian Wildlife Service) - Cassin's Auklet Telemetry Data, 1999-2001
Marine Birds	Environment Canada (Canadian Wildlife Service) - Coastal Waterbird Inventory
Marine Birds	Environment Canada (Canadian Wildlife Service) - Marine Bird Areas of Interest
Marine Birds	Environment Canada (Canadian Wildlife Service) - Marine Bird Database
Marine Birds	Environment Canada (Canadian Wildlife Service) - Moulting Sea Duck Survey
Marine Birds	Environment Canada (Canadian Wildlife Service) - Pelagic Seabird Surveys
Marine Birds	Environment Canada (Canadian Wildlife Service) - Rhinoceros Auklet Telemetry Data, 2002
Marine Birds	Environment Canada (Canadian Wildlife Service) - Shorebird staging areas

Ecological Theme	Data Source
Marine Birds	Environment Canada (Canadian Wildlife Service) - Triennial Swan Surveys
Marine Birds	Environment Canada (Canadian Wildlife Service) - West Coast Vancouver Island Waterbird Survey
Marine Birds	Laskeek Bay Conservation Society - Laskeek Bay Surveys
Marine Birds	Parks Canada - Great Blue Heron nest sites
Marine Birds	Parks Canada - Nesting Seabird Colonies
Marine Birds	Parks Canada - Semipalmated Plover Nesting Coastline
Marine Birds	Parks Canada - West Coast Trail Surveys
Marine Birds	Raincoast Conservation Foundation - Sandhill Crane observations
Marine Mammals	Fisheries and Oceans Canada - Harbour Seal haulouts
Marine Mammals	Fisheries and Oceans Canada - Modeled Optimum Sea Otter Habitat
Marine Mammals	Province of British Columbia - California Sea Lion haulouts
Marine Mammals	Province of British Columbia - Harbour Seal haulouts
Marine Mammals	SciTech Environmental Consulting - Spring Chlorophyll Concentration Climatology: 2003-2006
Marine Mammals	University of British Columbia, Marine Mammal Research Unit - Steller Sea Lion sites
Marine Mammals	Wendy Szaniszlo - California Sea Lion Haulouts
Marine Plants	British Columbia Conservation Data Centre - Algae element occurrences
Marine Plants	Capital Regional District - Harbours Atlas
Marine Plants	Community Mapping Network - Eelgrass Surveys
Marine Plants	Cynthia Durance - *Ruppia* observations
Marine Plants	Fisheries and Oceans Canada - Eelgrass Surveys
Marine Plants	Living Oceans Society - Merged Eelgrass Datasets
Marine Plants	Living Oceans Society - Merged Kelp Datasets
Marine Plants	Louis Druehl - *Macrocystis pyrifera* Observation
Marine Plants	Michael Coon - *Macrocystis pyrifera* Observation
Marine Plants	Pacific Estuary Conservation Program - Estuaries
Marine Plants	Parks Canada - Haida Gwaii Marine Plants
Marine Plants	Parks Canada - Pacific Rim Confidence Weighted Abundance Rasters
Marine Plants	Parks Canada (via the Ocean Biogeographic Information System) - *Egregia* point locations
Marine Plants	Province of British Columbia - Eelgrass Surveys

appendix 3. data sources (cont'd)

Table 1. Ecological data sources

Ecological Theme	Data Source
Marine Plants	Province of British Columbia - Kelp Surveys
Marine Plants	Province of British Columbia - Shorezone Mapping System
Marine Plants	Province of British Columbia - Shorezone Mapping System - Bioband
Marine Plants	Province of British Columbia/Canadian Wildlife Service (Environment Canada) - Sensitive Ecosystem Inventory
Marine Plants	University of British Columbia Herbarium - Algae specimen records
Marine Plants	University of British Columbia Herbarium - *Egregia* specimen records
Marine Plants	University of British Columbia Herbarium - *Ruppia specimen* records
Physical Representation	Fisheries and Oceans Canada - Endeavour Vent Zones and Marine Protected Area Boundary
Physical Representation	Fisheries and Oceans Canada - Institute of Ocean Sciences
Physical Representation	InterRidge Vents Database, Version 2.0
Physical Representation	Living Oceans Society - Bathymetry data
Physical Representation	Marine Conservation Biology Institute (MCBI) and the Commission for Environmental Cooperation - Baja to Bering Sea (B2B) Study, Version 1.1 CD
Physical Representation	Marine Geoscience Data System - Bathymetry data
Physical Representation	Natural Resouces Canada - Bathymetry data
Physical Representation	Natural Resources Canada - Canadian National Geographic Names Registry
Physical Representation	Parks Canada - Benthic Habitat Classification
Physical Representation	Parks Canada - Oceanographic Regions
Physical Representation	Parks Canada - Rugosity Analysis
Physical Representation	Province of British Columbia - BC Marine Ecological Classification - Substrate data
Physical Representation	Province of British Columbia - Ecosections
Physical Representation	Province of British Columbia - Shorezone Mapping System
Physical Representation	Seamounts Online: University of California

Table 2. Human use data sources

Sector	Data Source
Commercial Fisheries	Fisheries and Oceans Canada, Shellfish Stock Assessment Harvest Log Database, Pacific Biological Station - Catch and effort grids
Commercial Fisheries	Fisheries and Oceans Canada, Groundfish Stock Assessment Harvest Log Database, Pacific Biological Station - Catch and effort grids
Commercial Fisheries	International Pacific Halibut Commission (IPHC) - IPHC statistical areas
Commercial Fisheries	Fisheries and Oceans Canada, Conservation Biology Section, Pacific Biological Station - Herring Gillnet Catchpoints
Commercial Fisheries	Fisheries and Oceans Canada, Conservation Biology Section, Pacific Biological Station - Herring Openings (separate files by year for 1989-2008)
Commercial Fisheries	Fisheries and Oceans Canada, Conservation Biology Section, Pacific Biological Station - Herring Seine Catchpoints
Commercial Fisheries	Fisheries and Oceans Canada, Sardine Harvest Log Database, Pacific Biological Station - Sardine fishery catch grid and presence
Commercial Fisheries	Fisheries and Oceans Canada - Salmon Gillnet catch and effort (separate files by year for 2001-2007)
Commercial Fisheries	Fisheries and Oceans Canada - Salmon Seine catch and effort (separate files by year for 2001-2007)
Commercial Fisheries	Fisheries and Oceans Canada - Salmon Troll catch and effort (separate files by year for 2001-2007)
Ocean Energy	Province of BC, Ministry of Energy, Mines and Petroleum Resources, Offshore Oil and Gas Branch - Federal tenures
Ocean Energy	Province of BC, Ministry of Energy, Mines and Petroleum Resources, Offshore Oil and Gas Branch - Provincial tenures
Ocean Energy	Province of BC, Ministry of Energy, Mines and Petroleum Resources, Offshore Oil and Gas Branch - Exploratory Wells
Ocean Energy	BC Marine Conservation Analysis - Oil and Gas Prospectivity
Ocean Energy	Province of British Columbia, GeoBC - TANTALIS Crown Tenures database
Ocean Energy	BC Marine Conservation Analysis - Tidal Energy Areas of Interest
Ocean Energy	BC Marine Conservation Analysis - Wind Energy Areas of Interest
Ocean Energy	Environment Canada - Canadian Wind Energy Atlas
Shipping and Transportation	BC Marine Conservation Analysis - Ferry Routes
Shipping and Transportation	Province of British Columbia, GeoBC - TANTALIS Crown Tenures database
Shipping and Transportation	Canadian Coast Guard / Environment Canada (Canadian Wildlife Service) - Vessel traffic density summer 2007
Shipping and Transportation	Canadian Coast Guard / Environment Canada (Canadian Wildlife Service) - Vessel traffic density winter 2007
Shipping and Transportation	Transport Canada Pacific Region, Marine Branch, Navigable Waters Protection Division - Tow Boat Reserves
Sport (Recreational) Fishing	BC Marine Conservation Analysis - Sport Fishing Data (anadromous fish, crab, groundfish, and prawn and shrimp)
Tenures	Province of British Columbia, GeoBC - Aquaculture tenures
Tenures	Province of British Columbia, GeoBC - TANTALIS Crown Tenures database
Tourism and Recreation	BC Marine Conservation Analysis - Marinas and Coastal Facilities
Tourism and Recreation	BC Marine Conservation Analysis - Anchorages
Tourism and Recreation	BC Marine Conservation Analysis - Recreational Boating Routes
Tourism and Recreation	BC Marine Conservation Analysis - Sea Kayaking Routes
Tourism and Recreation	BC Marine Conservation Analysis - Campsites and Kayak Use Sites
Tourism and Recreation	BC Marine Conservation Analysis - Scuba Dive Sites

British Columbia
Marine Conservation Analysis

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