Washington Science Advisory Panel for Marine Spatial Planning

Review Comments on "An Approach for Mapping Ecologically Important Areas off the Washington Coast", ver. July 13, 2015

September 2015

Overview

The July 13 draft of the report, "An Approach for Mapping Ecologically Important Areas off the Washington Coast", by the Washington Department of Fish and Wildlife (Pierce *et al*., in prep.) was reviewed by seven members of the Washington Marine Spatial Planning (WAMSP) Science Panel. The Panel was encouraged by the authors' comprehensive approach to the challenge of mapping the diverse species and ecosystems along the outer Washington coast that would be affected by future energy development. The exceedingly diverse types, sources and extent of data on these resources will require an innovate approach to associate and analyze uniformly. Considering the many issues with data structure and availability, the current version of the report appears to develop a feasible framework for mapping.

Issues related to the use of the general additive spatial overlay analysis approaches are well known. The GIS application is used to produce new information by combining information from different sources that undergo some form of transformation and/or normalization into numeric classification; and then cartographically representing areas with high (or low) additive scores. This spatial analysis approach has a long history in integrating multiple thematic layers into a single composite layer, often intended for decision support (Carver 1991, Jankowski 1995). In doing so, questions concerning arise from the methods for producing weights for values within each thematic layer, and for assigning weights for combining layers. Besides concerns with the assignment of scores and weights, the accuracy of results depends upon the quality of the source data. Spatial "completeness" and "consistency" have long been noted as import factors in assessing data in spatial analysis (Burrough and McDonnell 1998).

The work reviewed here confronts these issues. In general the authors acknowledge the lack of consistency in the quality of the spatial data and the completeness in the spatial coverage of the data used in the analysis. Each data layer contributing to the analysis may have different spatial, temporal, and measurement "resolution" (the granularity of the data). However, the Panel identified a number of issues that inhibited their interpretation of both the approach and initial results, and make recommendations to be considered in revision for future versions.

Overview of Approach and Methods

- Overall, the Panel found the description of the approach tenable but difficult to interpret.
- There was considerable uncertainty among the Panel about where the current version of the (Ecological Important Area) EIA analysis fits into what are described as three components: 1. constructing the individual species and habitat based map layers; 2. overlaying the individual layers to display patterns of ecological importance across the layers; and, 3. comparing the overlays to alternative energy development scenarios. It would seem that the current version describes a (completed?) framework for #1, but the approach for #2 is only suggested and #3 is deferred to. Even #2 is conditioned by the observation that "We note that while the EIA maps do reveal some broad patterns, they are not intended to fulfill the specific task of identifying unique and sensitive areas that require extra conservation and protection on their own. We envision that our maps could be used for such a task if combined with other information and analyses."
- There is some lack of clarity about how the authors address spatial data modeling when the data for an individual theme does not map to the full spatial extent of the study area? In these conditions there is a likelihood that data layers with full spatial extent coverage will drive the overall assessment of the "Pattern of Importance" and uncertainty. For instance, Fig. 2 illustrates a cartographic representation of a spatial "DATA" pattern. This figure is labeled as the "count" of layers. Because there is variation in the count of data, does this mean that there is "missing data" for areas with less than 33 (the number of possible data layers), or are there places in space where the data tells us there is no observation of a specie and the cell is counted as "not being applied". There is a difference in "no spatial data" and spatial data that says "nothing is here".
- While not explicitly stated the authors use the concept of spatial homogeneity when considering a mapped region to be uniformly "valued" and therefore there are no "spatial objects" or differentiated regions to create a pattern. Spatial homogeneity is most often a question of "scale" (resolution or granularity) in the data. Before data themes are determined to "offer no spatial contrast" to a spatial pattern as the authors have done for some themes, the "scale" of the analysis must be fixed. The authors should consider how can information about spatial "heterogeneity" at finer scales (then that used in this analysis) be added to our understanding of ecologically important areas?
- That the report states "We do not provide discussion on the results at this time…" impedes the Panel's interpretation of their results even for the first of the three components (#1 above).
- Can appreciate the multifaceted team approach that this effort required, but it unfortunately translates into seemingly inconsistent analyses of individual datasets of species occurrences and related uncertainty.
- Although the authors acknowledge that this issue is deferred to later analyses or is outside their scope, it remains unclear how the results from the current

approach could support a decision support process for marine spatial planning (MSP) of alternative energy development.

Primary Comments

Lack of Clear Definition of Ecological Importance Indicated by Selected Spatial Data

- The narrative does not provide an explicit operational definition of 'ecological importance' and the diverse data infer several different interpretations
- The result is an apparent lack of 'methodologically informative' ranks that can be explicitly related to resource susceptibility and vulnerability to alternative energy development. In some cases, the choice of resource data is scientifically justifiable but much less so in other cases. The Panel recognizes that this very often reflects the (lack of or incomplete) availability of appropriate data, but in other cases it seemed to be a case of just use a "handy dataset". See several examples, below.
- Definitions of the categorical ranks should at least have some narrative translation, e.g., what does a "1" mean vs a "3"
- Uncertainty rankings are not consistently assessed among datasets. Two datasets have an additional "9" rank for special cases and the meaning of that rank appears to vary.

Scientifically Ambiguous and Inconsistent Ranking of EIA and Uncertainty

- How does each analysis (and mapping) unit – the hexagon – arrive at a sensitivity value for data quality and completeness?
- Ranks appear to be somewhat ad hoc and inconsistent. In the discussion of individual layers, the use of merged or concatenated importance and uncertainty scores was not obvious and was not explained at the outset. There is a helpful, general explanation only on page 31; however, beyond the explanation to help understand the maps, the reasons for using that approach should be stated as well.
- It is often unclear how species scores were used to define the hexagon score. Was the highest score for any species chosen as the score for a hexagon?
- One illustrative example is that for many resources uncertainty is represented by statistical variability (coefficient of variation; confidence interval) of the data and in many another cases it is represented by the quality and completeness of the data, e.g., for Sea Otter, Seabird Colonies, Seal and Sea Lion Haulouts, Snowy Plover Nesting Areas, etc.
- Incorporating more consistency in ranking uncertainty should information on how much the scores, or the data underlying the scores, varied among years where there were multi-year datasets.
- In final application, are the minimum importance score maps at all helpful, especially given the inconsistency in uncertainty criteria? The vast majority of the study area may be deemed important if more species and habitat data were made available.

Problems with Analytical Approach to Spatial Data Overlays

- How do the authors address the likelihood that certain data layers can drive the overall assessment of ecological importance or uncertainty?
- Is there an appropriate sensitivity analysis to investigate this possible effect and its impact on interpretation
- There is some question whether the minimum importance score maps are at all helpful, especially given the inconsistency in uncertainty criteria. The vast majority of the study area may be deemed important if more species and habitat data were made available.
- From the perspective that the marine landscape (seascape) exhibits structure (pattern) which constrains and controls the function, both ecologically and culturally in that system, the mapping of important areas could also be understood by noting significant regionalization (patchiness and fragmentation) of data over the extent of the study area (Kupfer 2012, Hinchey et.al. 2008).

Interpreting Process from Pattern rather than the Pattern as Truth

- With the exception of Groundfish Species-Habitat Associate Models, almost all the resource maps use the basic data as the ultimate EIA pattern ("truth"), albeit often with numerous caveats. Conversely, much of the scientific approaches to MSP extrapolate limited resource data to broader spatial domains using well documented spatial distributions of marine physical features (e.g., bathymetry, as in the Groundfish Species-Habitat Associate Models; water structure such as gyres; etc.). The Panel appreciates the fact that this is a scale of analysis that is likely beyond the scope of the WDFW MSP responsibilities and resources, but it would be important to distinguish where this may be possible for future, more intensive analysis?
- An example where the "truth" of EIA patterns are derived somewhat questionably from limited data is the Coastal Intertidal Forage Fish Spawning Sites. These data are derived from monthly sampling for two years (October 2012-October 2014) using a rigorous, proven protocols. However, it is recognized that forage fish spawning is exceedingly patchy, episodic and not spatially consistent, and will spawn on estuarine beaches as well as outer coast beaches. It is scientifically uncertain whether these data capture the potential spawning sites for all the candidate forage fish that may spawn on the recognized "possible spawning habitat" beaches. More rigorous mapping of the criteria for "possible spawning habitat" beaches might be more representative of forage fish susceptibility.
- The majority of data used in this analysis comes from mid-shelf species and habitats. Thus the most obvious patterns in synthesis maps are related to mid-shelf biodiversity hotspots, specifically at the ecotone along the shelf-edge. Nearshore patterns appear to be unresolved.

Questionable Selection of Data Sources Relative to Susceptibility and Vulnerability

- The lack of a clear definition and consistency in interpreting “ecological importance” appears to be based predominantly on data availability, rather than resource susceptibility and vulnerability to potential alternative energy development impacts
- For instance, in many instances the most vulnerable and uniquely (spatially) susceptible resources are early life history stages or reproductively isolated/rare concentrations. However, except for mapped resources such as Seabird Colonies, Seal and Sea Lion Haulouts, and Snowy Plover Nesting Areas, there is no consideration for susceptibility and vulnerability in either data selection or the EIA ranking. Similarly, this does not appear to be represented in the Uncertainty ranks.
- Just one example of an inappropriate data source is that of salmon, which is represented by the (late sub-adult/adult) life history state that is perhaps least susceptible/vulnerable compared to early life history stages during their initial ocean migration/residence (not to mention estuarine migration/residence; see below). The authors use the Genetic Stock Identification (GSI) study of Chinook salmon caught in Washington’s ocean troll fishery (Moran *et al.* 2013). Not only are these data likely biased by all the factors that dictate spatially heterogeneous of fish in a commercial fishery, but is just concentrated in ocean waters north of Willapa Bay during only May-September. And, it is particularly unclear what the relevance or importance of the genetic data, unless it relates to spatial distinction of the occurrence of ESA stocks, which is not represented in the analysis. Conversely, the voluminous data of juvenile salmon (as well as a plethora of other fish species) collected by NOAA and GLOBEC studies in transects along the entire Washington coast (not to mention California to Alaska), as encompassed in data represented by Brodeur *et al.* (2007), Morris *et al.* (2007), Daly *et al.* (2012, 2014), Yu *et al.* (2012) and many other associated information sources.
- Method and data choices were made that may be entirely reasonable, but not necessarily the only options, or the justification is not clear. Those driving decisions, rationales or challenges should be spelled out more explicitly, especially those that are present across multiple layers. In particular:
    - The issue of the choice of a hexagonal mapping unit is one that we discussed at both meetings. I think the consensus was that it has precedent and is not unreasonable, but it's also not obvious to a wide audience and not overwhelmingly compelling. It has pros and cons. But most of all, the rationale behind that choice, and some possible disadvantages (mostly pragmatic ones) should be described. That's not done in the text.
    - An organization of the layers into 3 groups is used in Table 2, and to a lesser extent in Figs. 3-5. It's also briefly alluded to in the text. Is this grouping something that could be developed further and maybe help facilitate an approach for a weighted combination of the individual layers? Otherwise, the choice of the 33 layers seems highly arbitrary, especially without a robust discussion or scheme guiding the selection of layers.

- A more consistent approach should be used to address the varying spatial coverage of the different layers (especially when combined).

Interpretation of "Hotspots" and "Coldspots"

- "Hotspots" and "coldspots" are misleading from the standpoints that there is considerable inconsistency in terms of data spatial coverage and data uncertainty that has nothing to do with ecological importance but would indicate so in the overlay method.
- As the authors explore means of standardizing the "hotspot" and "coldspot" views in their analysis, the use of pattern analysis and descriptive Geostatistics is a meaningful method for identifying significant distributions of spatial clustering (Getis and Ord, 1992, Elith and Leathwick, 2009). The geostatistical approach refers to a "hotspot" and "coldspot" in the context to neighboring features, rather than a "high" score at a unique location. From this perspective a feature with a high value is interesting, but may not be significant within the context of neighboring features.
- Would this inconsistency be addressed by standardizing the score by the number of data layers within the corresponding hexagon?

Estuaries Punted

- The authors "exclude all estuaries from our main analysis because mapping key areas within estuaries would require finer-scale resolution than current data can support" despite the fact that the biome ("habitat type") structure of Washington's coastal estuaries are classified and mapped at appropriate resolution for an ecological assessment they have described for the coast's open waters.
- The authors note that estuaries are known to be of the highest ecological importance without going through their process for mapping ecologically important areas. What factors were used to determine that estuaries are important, and can that method be applied to other areas?
- If the analysis were to consider the susceptibility/vulnerability of particularly ecologically important species/life history stages/resources (see above), certain biomes could be mapped as particularly sensitive for species that are uniquely dependent on estuaries. The data exists (National Wetland Inventory [NWI], for instance) and the resource knowledge

Assessment of Data Gaps

- Despite MSP law stipulating "identifying gaps in existing information" and recommending "a strategy for acquiring science", there is no comprehensive assessment of critical data gaps other than incidentally within some of the individual resource sections; this really demands a detailed recommendation.
- The approach used in this report makes use of only wwo out of thirty-three "non-animal" layers. What other "non-animal" data themes would be useful? Would ocean circulation patterns, regions of upwelling, regions with repeated observations of algal blooms, or seafloor roughness be useful?

Secondary Comments

Provide Scientific Literature or Other Technical Documentation of their Basic Approach

- It would really help acceptance of their approach and methodology if scientific/technical literature citations were provided for the “models” they drew on?

Difficulty in Interpreting Ecological Importance Priorities when Dynamic Range of Indicator Metrics are Narrow and Uniform (Helen)

- Is it feasible (likely in later phase) to group data layers based on sensitivity to various types of alternative energy development?

Inconsistencies and Contradictions Need to be Resolved

- Report needs a thorough review to catch inconsistencies and contradictions in methods, assumptions and interpretations.

Recommendations

1. A greater degree of unity and consistency in the approaches used is needed. The general section currently is partly an introduction and method description, and partly a set of disposable instructions for reviewers (the panel). Overall, it's not clearly laid out as a part of the final product and need to be developed to become an important component of the product, in addition to the individual layers. Otherwise, the selection of layers and data used to develop the layers appears to be arbitrary and idiosyncratic, especially to those readers who are not marine ecologists. Given the individuality of the datasets, much of the inconsistency is understandable, but the reader needs to understand that there is some logic to the process of selection and analysis.
2. Introduce a clear definition of “ecological importance” that is uniformly represented by spatial data.
3. Consider expanding multivariate categorical ranking system beyond EIA and Uncertainty, e.g., by distinguishing data completeness, variance, quality, resource sensitivity/vulnerability (much of which is inconsistently rolled into Uncertainty rank).
4. Contemplate analyzing or classifying areas (individual cells, or groupings by environmental data?) for their “uniqueness”, although the EIA or Uncertainty scores may still be low?
5. It may be very informative to stratify this analysis by coarse scale habitats or some synthesis of data foot prints. Consider the subsystems in the Coastal and Marine Ecological Classification Standard (CMECS) for strata, since they seem to correspond with data availability. Stratification, especially for the hotspots and cold spot maps, will likely provide greater resolution to distinguish hexagons among similar habitats, and especially nearshore habitats.

6. Table 2 identifies the data layers used and notes the survey methods (logbooks, aerial, transects, etc.) in their creation. The “appendix” – or descriptions of the individual map layers – offers good insight into the data source and processing, but does not always speak to the “process” of representing the data spatially. This is not unusual at this level of analysis, but some reference to the nature of the original geographic data might be useful (such as unique or repeated point or line observations, hand digitized polygons, interpolated surfaces, etc.)
7. Fig 1 could potentially be very useful and a powerful explanatory tool, but it's currently very crowded. The distinction in colors and intent between the "Hexagon Zonal Association" and the "WDFW Strata Regions" is confusing; the last 3 colors and names in each of those groupings seem identical across groupings. Including ShoreZone symbology in the same map makes the map harder to read (though that might be improved with better cartography). The outer boundary of the MSP Study Area is never explained in the text or the map; I assume it's the EEZ boundary? Could focusing on the hotspot and cold spot maps, but calling them something different, which provide more resolved patterns, be more helpful? If categorical ranks for uncertainty were to be separated (e.g., #2), the difference between data completeness, quality, etc. would be more distinguishable.
8. The synthesis maps do not identify which resources generate the specific scores. One can determine the species and habitats contributing to the values within each hexagon by looking at the individual maps, but that is challenging. The discussed and planned online tool (Fig. 6) should provide this information.
9. If additional time/funding is provided, suggest looking into incorporating relative contributions of each hexagon to management goals established for each species, resource and habitat. This is a significant undertaking, but this analysis has accomplished a lot of the upfront processing legwork. A viable option would be a Marxan analysis.
10. Don’t create a map that you don’t want anyone to look at!

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