ECOSYSTEM TYPOLOGY A WIND FARM SITING TOOL

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Abstract

The Rhode Island Coastal Resource Management Council (CRMC) has been leading an Ocean Special Area Management Plan (SAMP) effort, that will result in zoning the state coastal waters to accommodate offshore wind farms. In earlier work, we approached offshore wind farm siting as an optimization problem, considering wind resources and technological constraints. In this study, we introduce ecological constraints, within the conceptual framework of ecosystem services, and explore their effect using spatial multivariate statistical analysis (Principal Component and Cluster Analyses; PCCA). This yields an ecological typology, or a zoning, of the coastal area based on ecological variables. The method is extended to provide a more synthetic typology of ecosystem services by integrating, besides ecological services, food provisioning and recreation. The application of PCCA to the SAMP coastal area provides a regionalization of the area into sub-ecosystems described by their: (1) dominant species, (2) biodiversity, summarized by biodiversity and richness indices, (3) resilience to wind farm impact, and (4) fisheries activity. The methodology allows zoning the SAMP ecosystem into homogeneous sub-regions and identifying the most sensitive sub-regions to potential wind farm impact. Combining ecosystem services typologies with technological constraints and wind resources, provides a methodology to identify optimal wind farm siting areas. The method, although tested for the SAMP area is location independent.

Objective

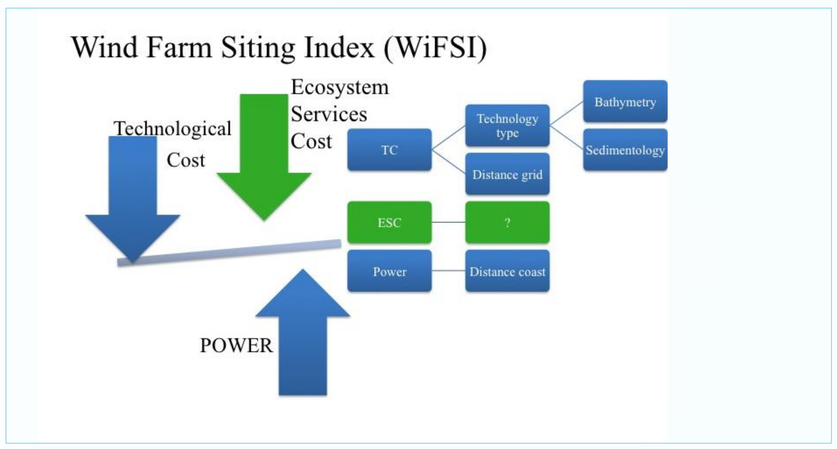
To provide a macro-scale wind farm siting conceptual framework and methodology including ecosystem services constraints.

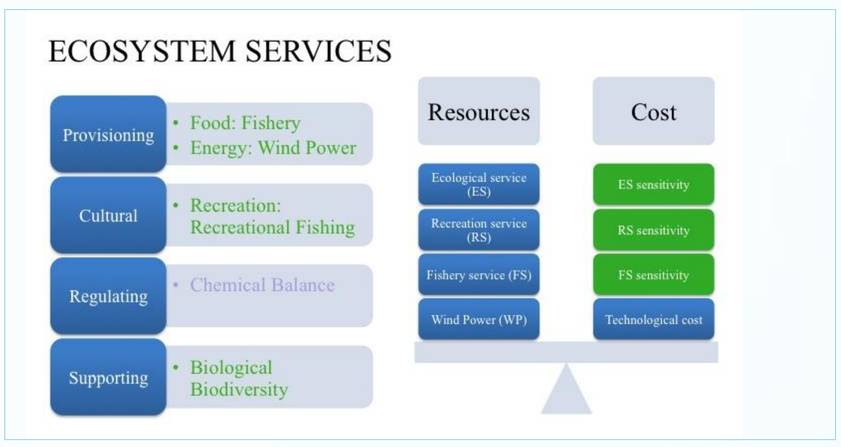
Conceptual framework

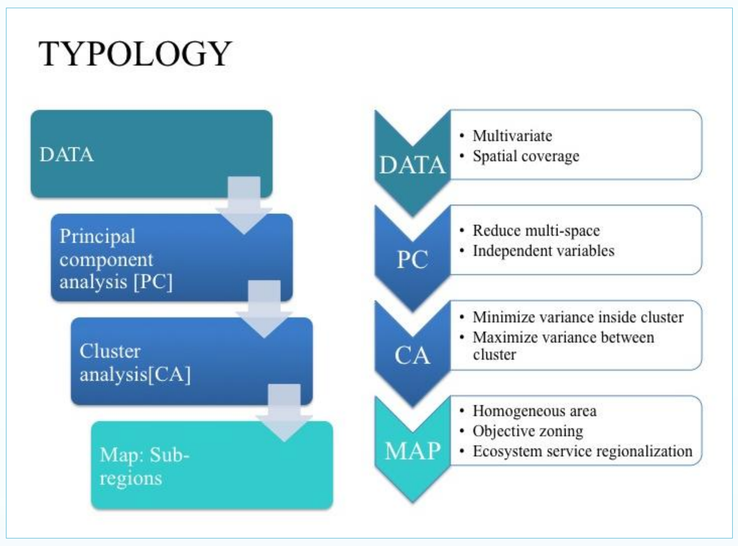
Ecosystem Based Management Approach (EBM)
Ecosystem services: services the ecosystem provides to human

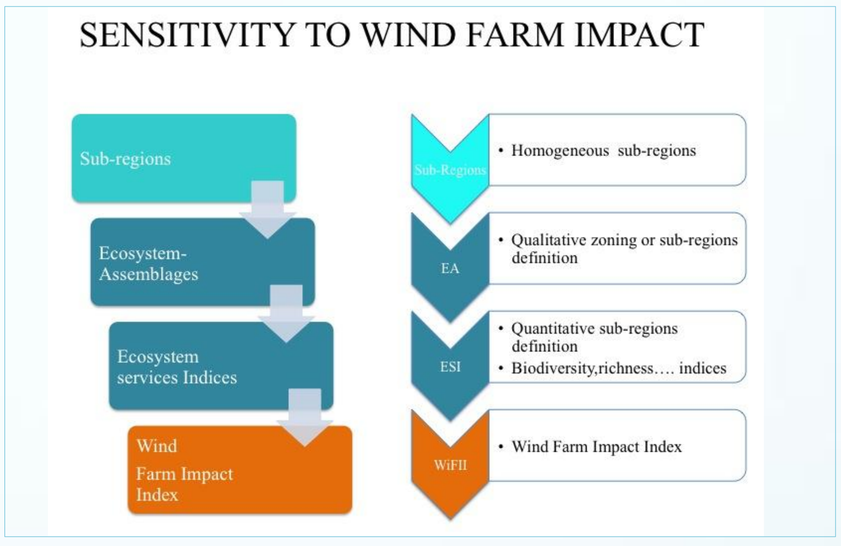
Methodology

1. **Ecosystem services data base**
   Fish and mammals species , fisheries data etc…are interpolated on a relevant spatial grid .
2. **Ecosystem services Typology**
   Multivariate statistical analysis: principal component and cluster analyses identify homogeneous ecosystem services sub-regions.
3. **Wind Farm Impact Index (WiFII)**
   All species are assigned two sensitivity impact coefficients, one associated with the construction phase and the other operation/ maintenance.
   A wind farm impact index is developed for each sub-regions
4. **Technological development Index(TDI)**
   A contour map of the Technology Development Index is prepared using information on the wind resource, water depths, technology type, and seabed
5. **Wind Farm siting Index (WiFSI)**
   WiFII and TDI are combined to provide a Wind Farm Siting Index (WiFSI)

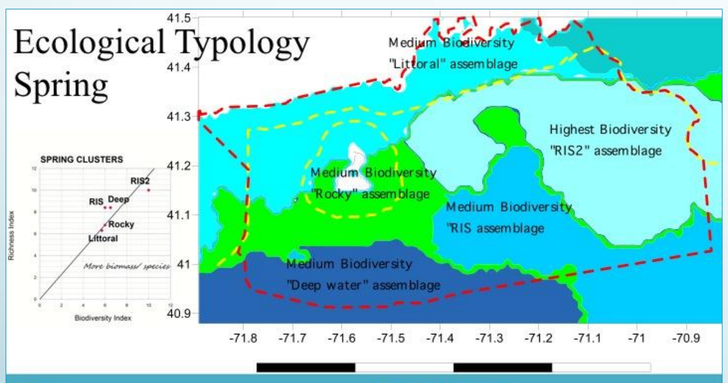




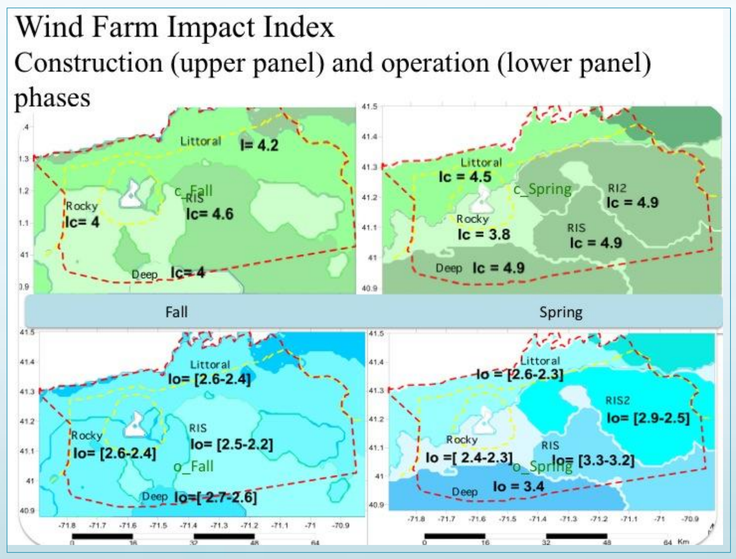


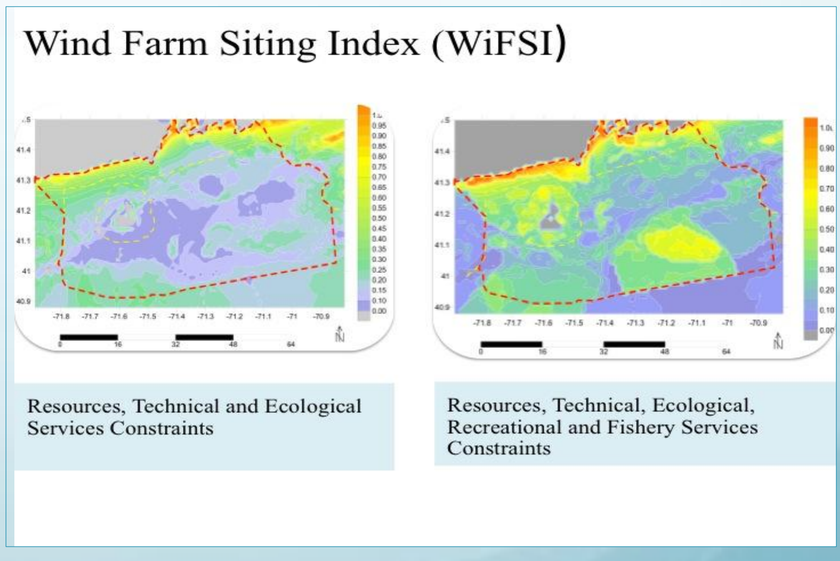


Case study: Rhode Island Ocean SAMP area



Cluster	Dominant group
Deep	Mammals
Rocky	Demersal ; mammals
RIS	Herring; Mammals
RS2	Demersal; Herring
Littoral	Demersal;Lobster





Conclusion

The typology is a robust objective methodology for offshore zoning, providing ecosystem services sub-regions, which can be described in terms of wind farm impact sensitivity[Wind Farm Impact Index:WiFII]

In combination with the Technological Development Index (TDI, Spaulding et al., 2010) the method provides a wind farm siting index (WiFSI) optimizing resources (wind power) and technological and ecological constraints.

Spaulding M.L., A. R. Grilli, C. Damon, and G. Fugate, 2010.Application of Technology Development Index and Principal Component Analysis and Cluster Methods to Ocean Renewable Energy Facility Siting. Marine Technology Society, Special Issue on Marine Technology for Offshore Wind, 44-1,8-23.

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