Spatial Management for Marine Ecosystems:

Predicting Outcomes, Minimizing Conflicts, Maximizing Value

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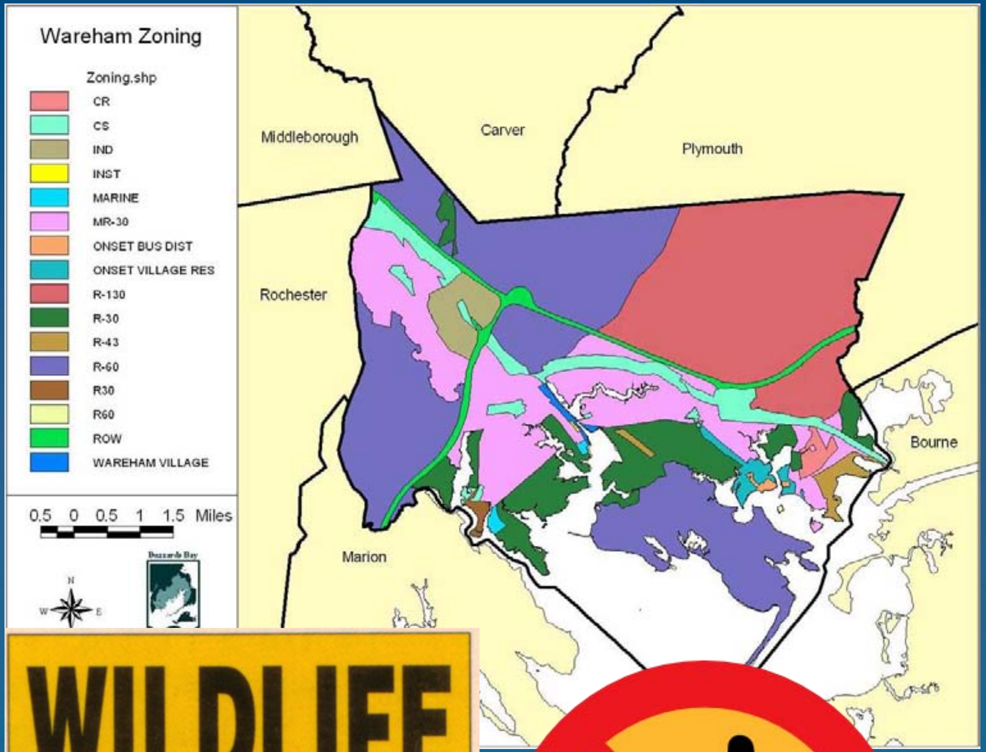
Science. Education. Community.

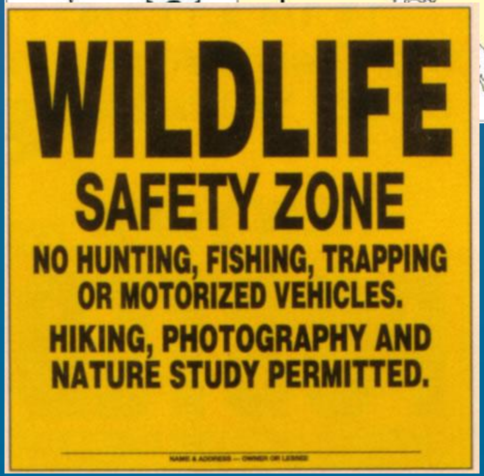
Introduction - outline

- Why use explicit spatial management – why now
- How do we predict the impacts of spatial management
- When is spatial management the best way, when isn’t it
- Evaluating exclusive use and zoning

On land explicit spatial management and exclusive use of space are the norm

- Private property or exclusive use of some type is a generally accepted way to generate value from land and terrestrial resources
- Exclusive property rights are often attenuated by zoning restrictions
- Public lands typically designate which activities are allowed/prohibited and often impose access or use fees, particularly for extractive uses





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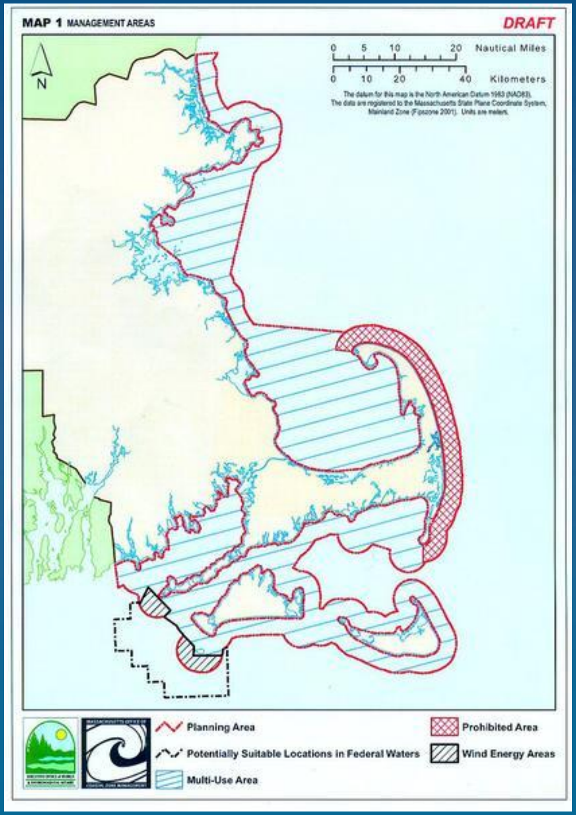
Why haven't we had explicit spatial management and exclusive use of the ocean

- **Tradition of free navigation rights**
- **Public trust doctrine**
- **Lack of knowledge about the marine ecosystem and particularly the information needed to manage spatially**
- **Mobile, wild resources and traditions of free access**
- **High enforcement costs**

Fencing the marine frontier – why now?

- Better understanding of spatial heterogeneity and dynamics of marine areas
- Increased congestion and conflicts over resources and space
- New uses of marine space that require exclusive use such as energy installations and aquaculture
- New monitoring technologies
- Recognition that gains of spatial regulation may now outweigh the costs



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Reasons More Spatial Regulation of Waters off Massachusetts

- Need for exclusive use of space for wind farms, tidal power, aquaculture, LNG terminals, etc.
- Sand mining and potentially other resource extraction (oil and gas) and concerns over impacts on the ecosystem and other users
- Gear conflicts between fixed gear and mobile gear fisheries
- Conflicts between commercial and recreational fisheries over local depletion (e.g. herring, bluefin tuna)
- Calls for better protection of habitat and marine mammals



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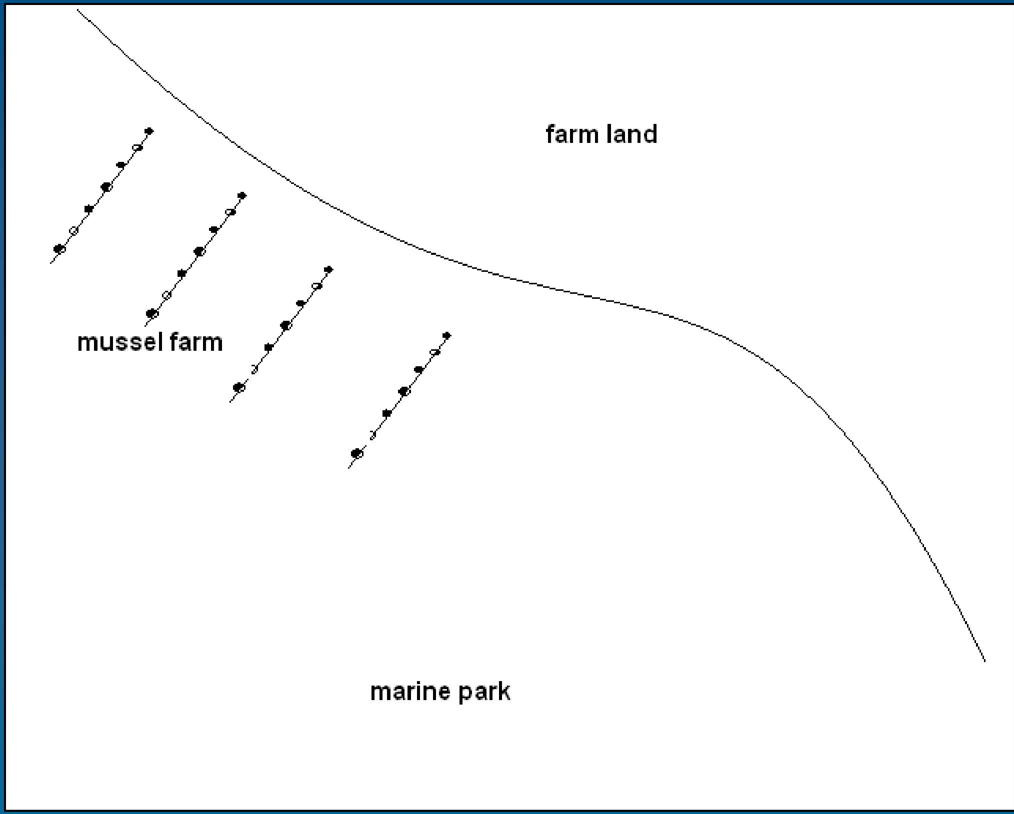
How can economics contribute to spatial management

- Evaluation of benefits from alternative size and placement of spatially explicit use policies
- Evaluation of benefits from mixed vs. exclusive use
- Prediction of human response and consequent effects
  - In short run
  - In long run (using coupled natural-human modeling)
- Design and evaluation of more effective spatial regulation and complementary policies to achieve desired outcomes more efficiently and effectively
- Design of incentive-based alternatives to spatial regulation to achieve similar objectives

Key concepts :Externalities

- Negative externality: others are harmed from something I do and I don't incur the costs (e.g. runoff from fertilizer use harms mussel farm and marine park users)
- Positive externality: others benefit from something I do and I don't capture the benefits (e.g. mussels clean the water and benefit marine park)
- Negative externalities result in too much of an activity, and positive externality, too little



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Key concepts: Substitutes and Complements

- Complements are activities that have positive synergies that decrease costs or increase value of each other: aquaculture and wind farms might be complements
- Substitutes increase costs or decrease value of the other activity: Trawling and wind farms are probably substitutes
- Prohibiting complementary activities may reduce benefits just as failing to separate substitutes
- What about recreational fishing or fixed gear commercial fishing in wind farms?
- Complementarity may depend on the level as well as the type of activity – allowing for limited mixed used may be beneficial

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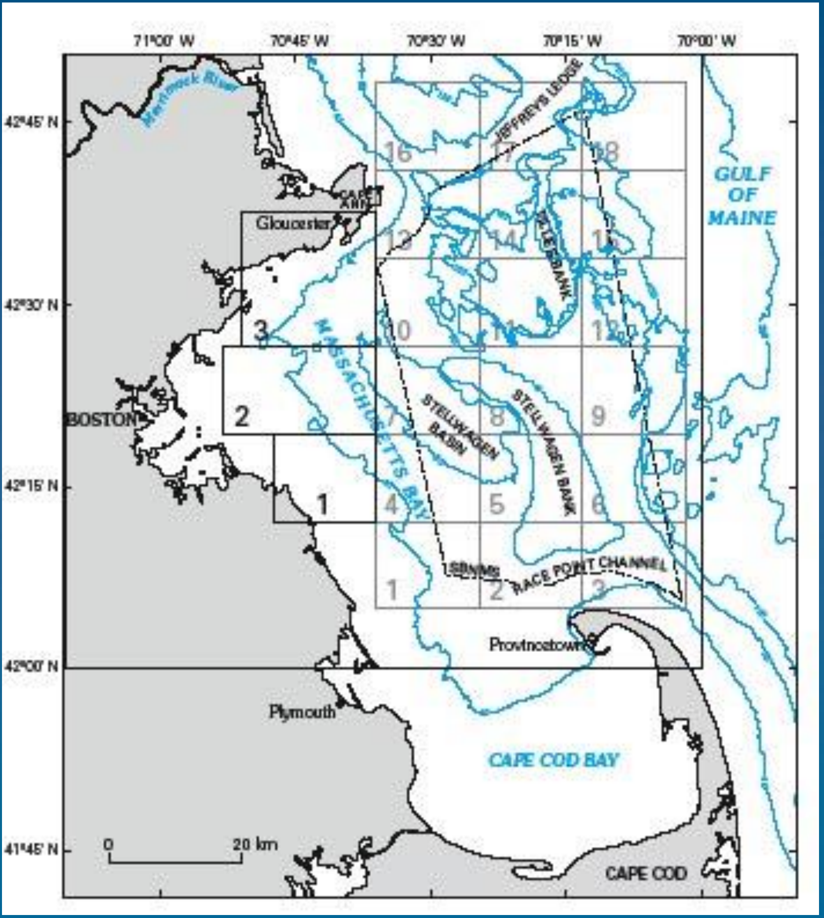
Evaluating Spatial Regulation: Example - MPAs

- Estimate present value of current uses continuing
- Estimate present value after some or all human activities excluded – include changes in value outside as well as inside the MPA
- Identify location, size and restrictions that achieve objectives but minimize losses to excluded users (CEA) *or* maximize net benefits including winners and losers (CBA)
- Evaluate alternatives: Is an MPA the best approach to achieve the desired outcome or are there alternatives?

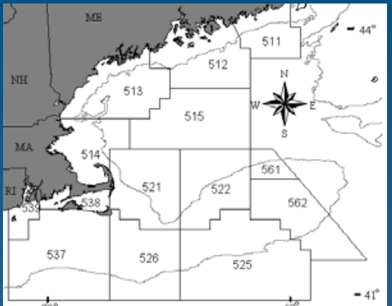


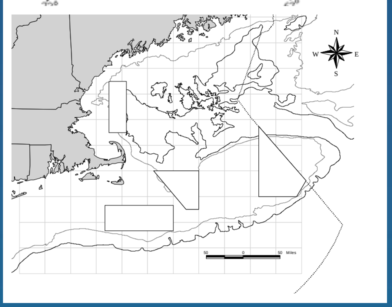
Modeling Spatial Behavior Can Be Critical to Understanding Impacts of MPAs

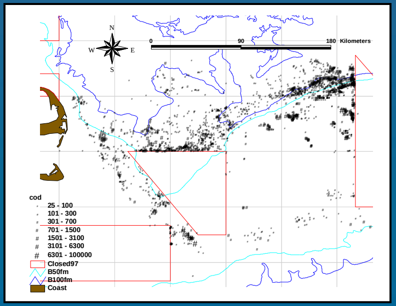
- Increased use by non-excluded users inside the regulated area and increased us by excluded users outside the regulated area will both impact the benefits and costs of the regulated area
- Random utility models (RUM) use data on actual choice behavior to infer how the attributes of choices generates value to the chooser
- By using the RUM model as a predictive model coupled with assumptions about how those attributes will change we can guess how uses inside and outside the regulated area may change
- In the absence of sufficient data on actual choices and choice attributes a similar model could be estimated based on hypothetical choices elicited with a survey
- Understanding long-run impacts may require coupling the behavioral model with an ecological model that predicts changes inside and outside the MPA

Example: Modeling Commercial Fishing Location Choice

- Model choice of several discrete fishing location
  - Need to define choice spatially (e.g., statistical areas, grid, other depending on data) and temporally (e.g. trip, day, tow)
- Data: logbook data, observer data, dealer data
- Assume choices observed reflect highest utility alternative for individual observed
- Explanatory variables – attributes of choice alternatives that drive choices
  - Expected revenue or profit by location at time of choice
  - Steam time to location from port or previous location
  - Previous experience fishing in that location by that individual
- Model predicts probability of individual choosing location
- Summing probabilities over fishermen making choices can yield predictions of total effort for each location
- Qualitative results may be useful as well – how responsive are people to incentives? – how fast will we see change?







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Using spatial choice models to estimate changes in benefits resulting from area closures

- If the RUM model includes attributes in monetary terms, we may be able to use it to estimate the change in value (welfare) to those affected by the regulated areas (both directly and indirectly)
- For example we might have revenue per day as a modeled attribute and we can estimate how much more profitable an area outside the closure would have to be for the individual to choose it voluntarily over the area being closed (i.e. “compensating variation”)
- Even for commercial users profit or revenue may be only part of choice decisions --not including other factors that drive decisions may bias valuation estimates derived from a RUM model

Some Key Issues with Predictive Behavioral Models

- Scale and quality of data on choice behavior will limit scale of and quality of predictive model – but data is getting better
- Spatial use decisions are often dependent on past choices which can complicate predictive modeling but may be critical to predicting outcomes
- Predicting impacts of closures easier than for openings
- Predicting long-run behavior is much more difficult and may require models that predict how attributes change
- Spending the time to talk to users to understand what drives decisions and what information they utilize can help the analyst build a better predictive model

Example: Excluding purse seining for bluefin in Cape Cod Bay

- Not about allocating fish explicitly since total quota was not taken in recent years
- Dividing quota does not solve the problem
- Closure would increase cost to purse seiners and may result in lost revenue for fish not caught
- Closure would increase revenue and consumer surplus for general category and recreational fishers
- Size and timing of closure could be adjusted to maximize net benefits
- Buying easements on commercial fishing permits is a potential alternative approach

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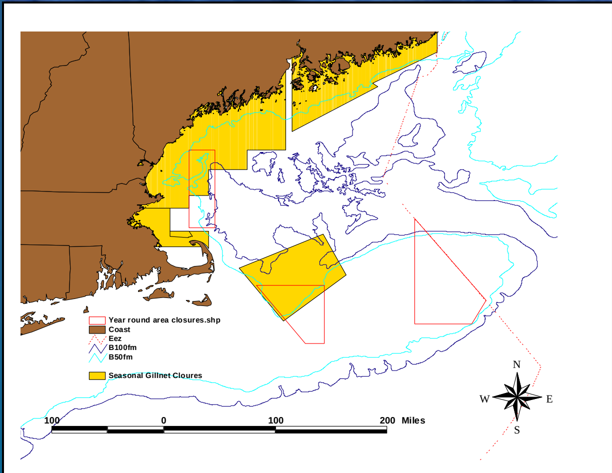
Evaluating a Purse Seine Closure or Ban

- CBA would require comparison of lost producer surplus (profit) for purse seiners to gains in producer and consumer surplus for other users given alternative exclusion policies
- Cost: Producer surplus could be estimated by comparing costs of catching tuna inside and outside closure and applying difference to the amount typically caught inside the closure (RUM model could also be used but probably not feasible or worthwhile)
- RUM based on observed choices or a survey could be used to estimate increased consumer surplus for non-excluded recreational users but requires assumptions about how conditions will change once purse seiners are gone
- Comparison of months when ban in place to months without ban might provide insight

Alternatives to Spatial Management

- In <u>some cases</u> it may be more effective to focus on regulating outcomes rather than trying to regulate behavior directly with gear/area closures
- Seasonal area closures for fixed gear have been used to reduce entanglement mortality of harbor porpoise in New England
- Are closures at the appropriate spatial and temporal scale? Are harbor porpoise distributions consistent in time and space?
- Would fishermen with individual or group catch limits be better able to adjust behavior in real time and alter fishing techniques to reduce bycatch?
- Can we monitor porpoise mortality at the level of individual fishermen or groups of fishermen?
- Is this approach legal or politically acceptable?



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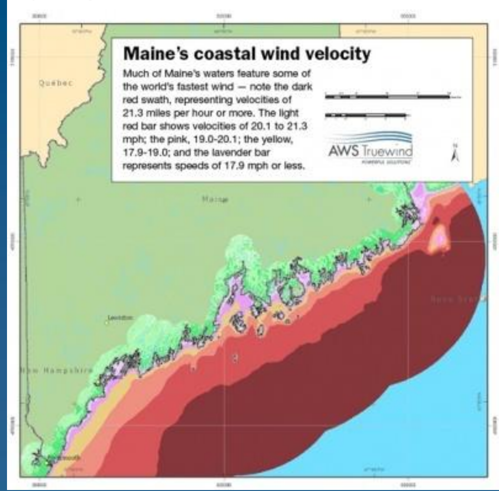
Spatial Regulation vs. Incentive-based policies

- Before regulating spatial choices directly consider:
  - Is exclusive use or absolute exclusion of some users necessary?
  - Do scale and dynamics of activities and interactions match up with ability and information necessary to regulate in space and time?
  - Do users have key information that regulators don't have?
  - Will users innovate if given the right incentives?
  - Is it possible to monitor outcomes at individual or small group level?
  - Can users resolve conflicts on their own – perhaps given some additional authority?
- When is regulating spatial choice likely to be the best choice?
  - When no level of use is acceptable
  - When there are threshold effects and irreversible or catastrophic outcomes associated with an activity
  - When monitoring and enforcement of outcomes is too costly and monitoring and enforcement of inputs is less costly

Exclusive Use

- The net benefits depend on: proximity to land or population centers or electrical grid; water depth; presence or absence of wind, waves, or currents, etc.
- The external costs of the installations (on other stakeholders) may also vary substantially by location
- Optimal location of a facility requires balancing site characteristics that are favorable for the installation with negative impacts on existing users and ecosystem services
- Determining the relative costs and benefits of siting facilities in alternative locations will often require nonmarket valuation methods to determine costs, such as exclusion of recreational activities or loss of amenity values associated with unsightly installations
- Failure to consider non-market values will often bias outcomes in favor of development
- Ways for winners to compensate losers may help avoid rent seeking and deadlock but won't necessarily ensure optimal outcomes unless all stakeholders are represented

Map/Courtesy AWS TrueWind



Zoning for ocean use

- Designating areas for various uses such as windfarms, tidal energy installations, and aquaculture could help reduce use conflicts and thereby increase value to society
- It *might* also reduce permitting costs which may otherwise be prohibitive
- But can state and federal managers and stakeholders identify the right areas ahead of time at a fine enough scale?
- Coarse scale designations may not be much use and could be counterproductive while fine scale designation is likely to miss the right spots
- Zoning is more likely to provide benefits if it is paired with an effective and efficient permitting process

Conclusions

- Spatial regulation can increase benefits society derives from marine ecosystem services but can also decrease them
- Spatial policies can be hard to reverse, particularly if they involve large investments in a specific place – thus we need to consider long run costs and benefits and treat uncertainty seriously
- Comparison of costs and benefits can provide important input to decisions that have traditionally been driven by science and politics – but will generally not, and probably should not, be the sole consideration
- Economic models can help predict outcomes and avoid unintended consequences as well as assess benefits and costs
- Spatial regulation tends to create winners and losers – Equity considerations may be important and economic analysis may be able quantify these and counter false claims and red herrings