

European Seas, Marine Science, and the Future

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Approach

- WHY is research a part of the future?
 - Quick and obvious answers
- WHAT KIND of research
 - More possibilities; more perspectives
 - What is needed by Government and Society
 - What do the research community consider to be priorities?
 - WHERE DO THESE PERSPECTIVES COINCIDE?

WHY? Economic well-being

- Diverse Ocean Industries:
 - Fishing, Shipping,
 - Tourism, Energy
 - Water-borne wastes end up there
- Demographically -
 - Populations are concentrated in coastal areas
 - Populations growing fastest in coastal areas
 - Ocean related recreation & leisure growing

WHY – Social & Cultural Well-being

- In our values –
 - People want health oceans
 - Threats like spills, algal blooms are NEWS
- Culturally and psychologically
 - History of many countries tied to the sea
 - The sea is in music, art, literature
 - The sea in legends, sagas and origins of peoples

NOT treating it well

- ICES REPORT 2003 - The Environmental Status of the European Seas
 - LESS the $\frac{1}{4}$ of fish stocks have healthy sizes & are exploited at sustainable rates
 - Harmful algal blooms increasing
 - New contaminants increases (fish bans in DK)
 - Invasive species increasing
 - Climate change affecting the seas
- HUMANS HAVE LARGE ROLE IN ALL PROBLEMS (AND SOLUTIONS)

If we care about the seas, why is our record so poor?

- Incompetent or malevolent? (unlikely)
- WE ARE NOT KNOWLEDGABLE ENOUGH TO MAKE WISE CHOICES

SO

- The answer to “WHY do research?” is to support better choices:
 - Better choices leads to – healthier oceans and greater societal well- being

WHAT KIND of research can get us there?

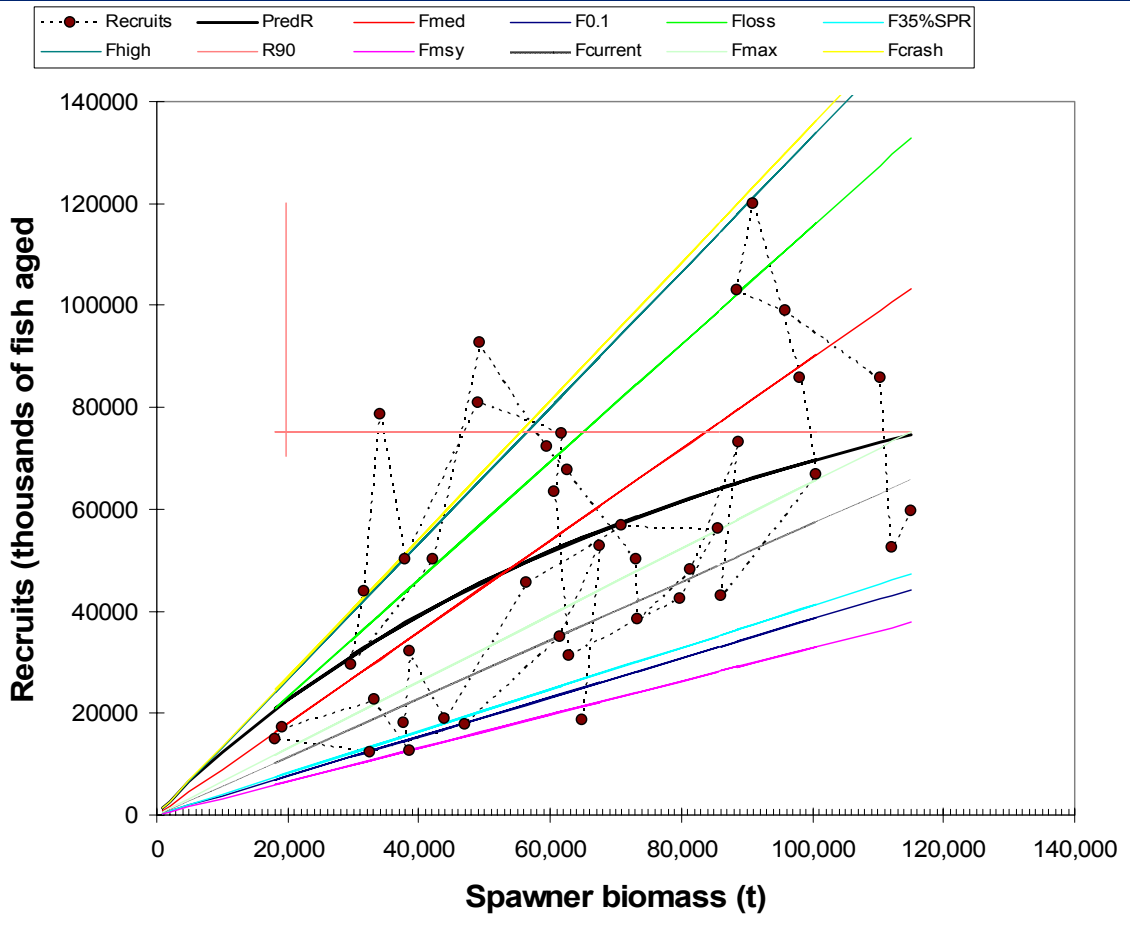
- Reduce UNCERTAINTY about consequences of choices
- FOUR types of Uncertainty interact:
 - Model Uncertainty
 - Parameter Uncertainty
 - Uncertainty about Future States of Nature
 - Implementation Uncertainty

Explore with research needed for a sustainable fishery quota

- *Comparatively* simple problem
- Not EASY problem
 - Tough choices among ecological, economic, social, cultural trade-offs
- These trade-offs part of EVERY choice on uses of oceans and their resources.
- Setting fishery quotas is more defined problem than most others on COSTS, BENEFITS, and IMPACTS.
 - NOT small, but other industries have even more interactions.

Model Uncertainty

- How to represent relationships among properties mathematically
 - (from an average to a complex family of equations)
- Example – Recruitment Dynamics
 - Shape of function; flat-topped or dome
 - add temperature, predators etc?
- PROCESS BASED RESEARCH –
 - The core of what scientists ASK to do.



**TO REDUCE MODEL
UNCERTAINTY THERE
MUST BE SUBSTANTIAL
PROCESS-ORIENTED
RESEARCH IN THE
FUTURE MARINE
RESEARCH AREA**

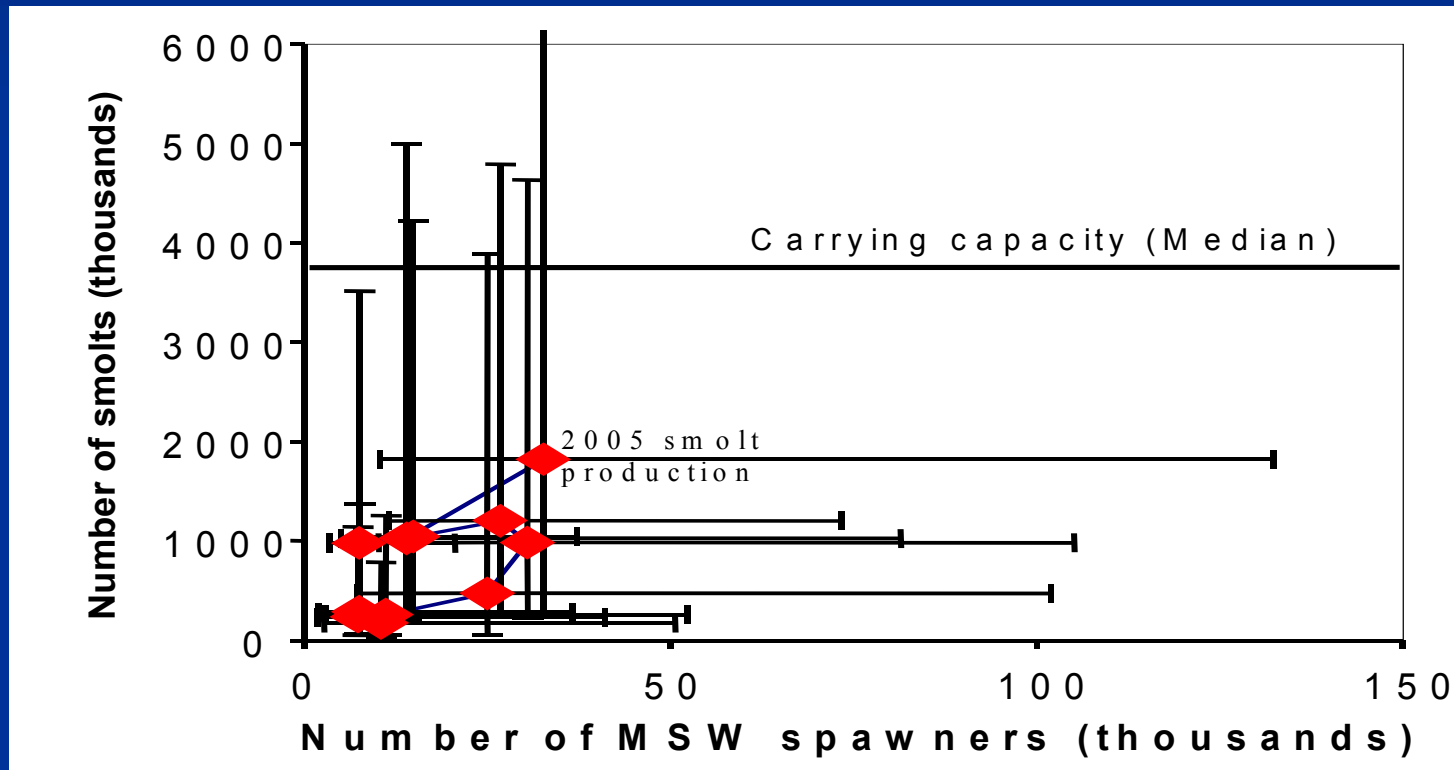
PARAMETER UNCERTAINTY

- The “Unknowns” in the equations
 - $\text{Recruits} = 1 / (\underline{\alpha + \beta} / \text{spawners})$
- Model Parameters to be estimated can be:
 - Very simple – average catch per year
 - VERY complex – diet preferences, energy requirements, abundance of all prey
- Estimates based on observations from laboratory, surveys, or catch recording

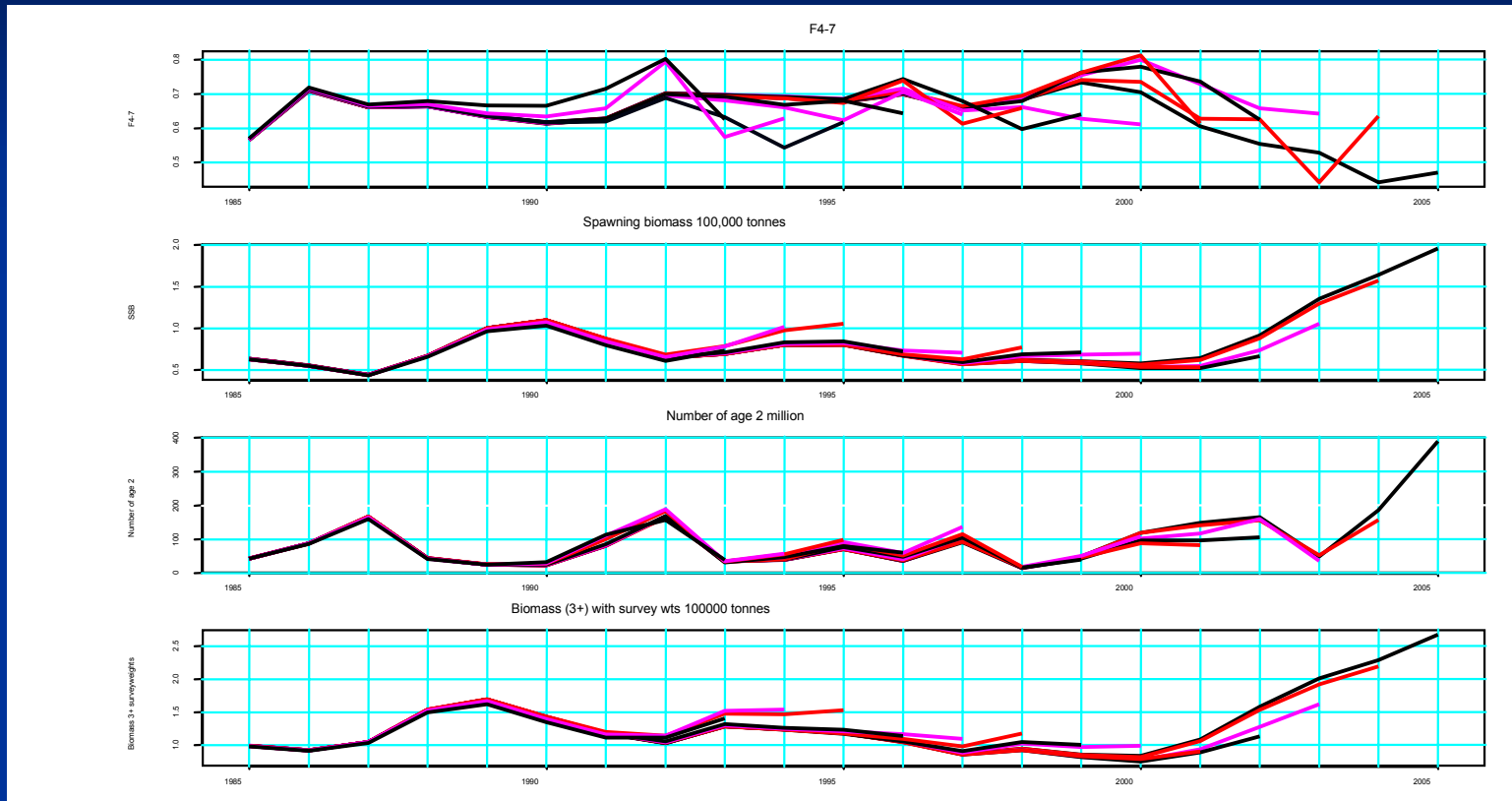
Sources of uncertainty in parameter estimates

- Variation - wide confidence intervals
 - Too few observations
 - Inherently noisy biological processes
- Bias – misleading or wrong estimates
 - Accidental:
 - poor sampling design or tools
 - Incomplete coverage of the area
 - Intentional
 - Inaccurate reporting

Unhelpfully large confidence intervals



Retrospective pattern for a haddock stock



Consequences

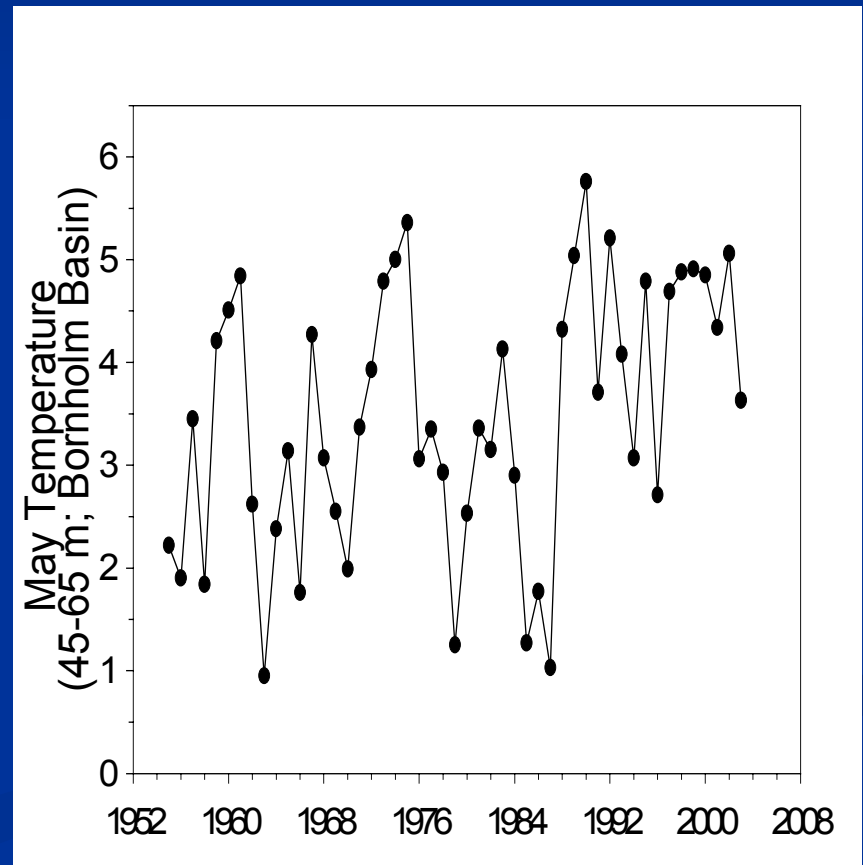
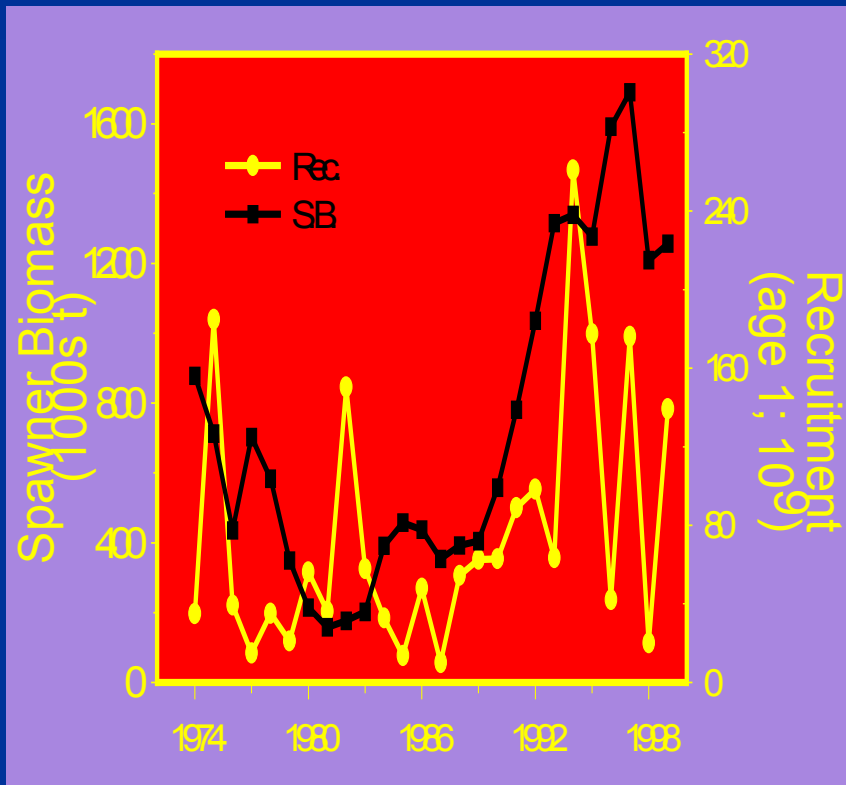
- Systematic bias can be corrected
 - Retrospective error shows up
 - Price paid by resource and users
- Good MONITORING is the key to reducing variance and eliminating bias
- Monitoring is particularly unglamorous – just happens to be essential.

**TO REDUCE PARAMETER
UNCERTAINTY THERE MUST
BE SUBSTANTIAL
MONITORING OF
ECOSYSTEM COMPONENTS
AND HUMAN IMPACTS IN
THE FUTURE MARINE
RESEARCH AREA**

Uncertainty about future states of nature

- Historically dismissed or ignored
 - Assume future is identical to average past
- Long-term data sets show this assumption is FALSE for ecosystem AND human activities
 - “Regime shifts”, “PDO”, “NAO”
 - Efficiency creep in fishing vessels 2-6% per yr

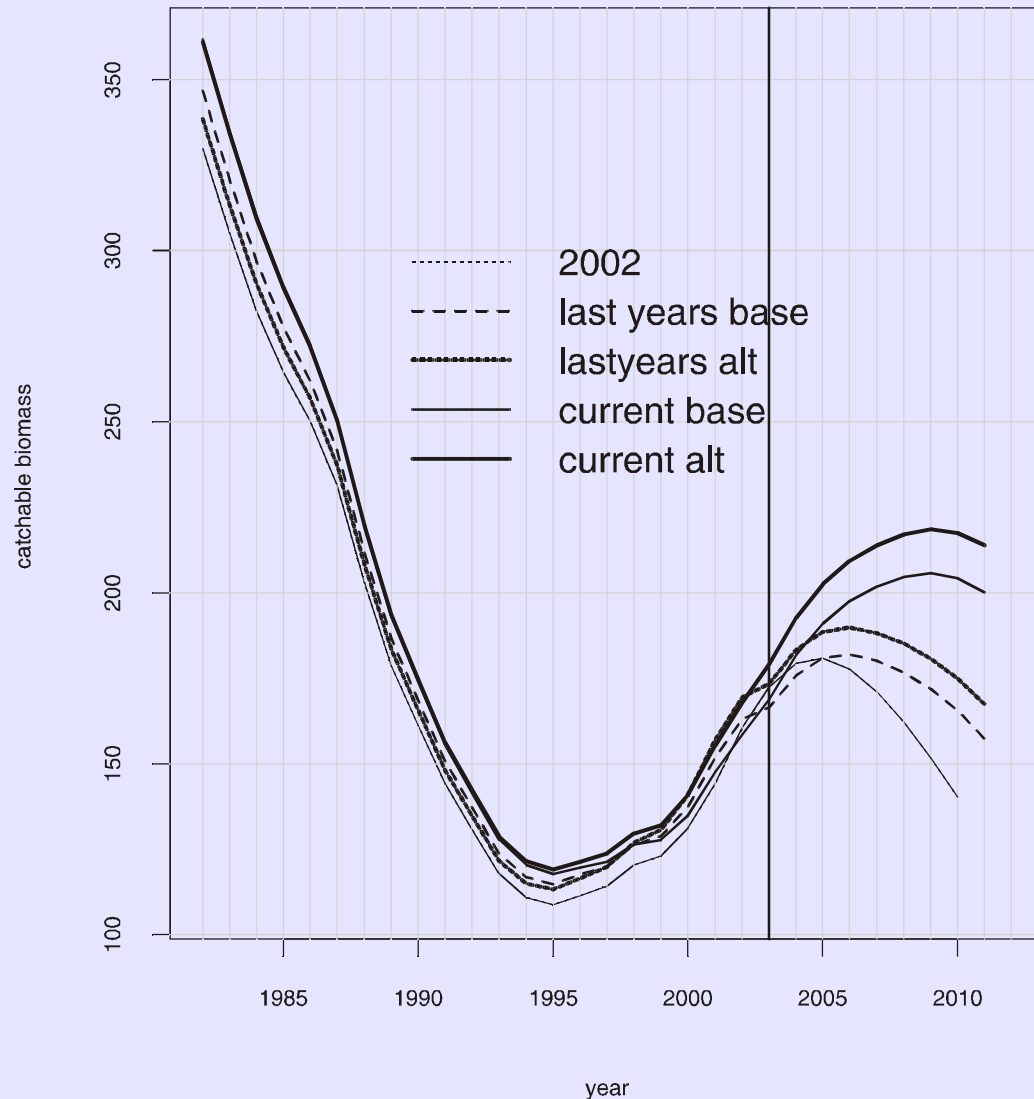
Multiyear time patterns in Baltic sprat stock & water temperature



Science Advice is accommodating this uncertainty

- Forward Projection Models explore different scenarios about possible futures
- HOW WILL EACH POLICY CHOICE PERFORM UNDER DIFFERENT ASSUMPTIONS ABOUT THE FUTURE?
 - What are the high risk combinations?
 - “ ” “ROBUST” alternatives? (Avoid BAD surprises)
- Problem – TANGLE of projections, esp when model and parameter uncertainty are added

Different future trajectories with slightly different assumptions



Reducing Forecasting Uncertainty

- Understand more about how things interact on large space and time scales.
- Structure IS being found:
 - Multi-decadal ocean climate patterns (“regimes”)
 - Size-based models of species interactions
- This is “BIG PROJECT” science
 - High cost, high risk, large scale, long term
 - HIGH IMPACT WHEN IT SCORES

**TO REDUCE
UNCERTAINTY ABOUT
FUTURE STATES OF
NATURE THERE MUST
BE “BIG SCIENCE”
PROJECTS IN THE
FUTURE MARINE
RESEARCH AREA**

Implementation Uncertainty

- Success of choices made depends on how PEOPLE react to regulation / decisions
 - Will reduced quota increase discards?
↓
 - Will fewer days at sea increase efficiency?
 - People NOT rigidly programmed, but also not behaving haphazardly
- This is the domain of SOCIAL SCIENCES
 - Bridged sometimes in Bio-economics
 - RARELY in anthropology & sociology

Little history to work with

- Cost of NOT building bridges is clear:
 - Policies that don't include human responses will not achieve objectives
 - Actual uses of marine ecosystem may be unsustainable
 - Public DISsatisfaction (ALL "users") will grow
 - Science experts, policy developers, and general public will increase DIStrust of the other sectors

**TO REDUCE
IMPLEMENTATION
UNCERTAINTY THERE MUST
BE MORE LINKAGES
BETWEEN NATURAL AND
SOCIAL SCIENCES IN THE
FUTURE OF THE MARINE
RESEARCH AREA**

CONSOLIDATION

- Started with setting single species fishing quota, NOT an Ecosystem Approach
- ONLY reasonable approach ENDS UP with an Ecosystem Approach
- Marine Strategy does not CREATE new research needs
 - Gives structure to needs that already exist
 - Calls attention to TWO-SIDED relationship between Human Activities and Marine Ecosystems

Fishing Quotas is an **EXAMPLE**

- Not the most important activity in the sea
- Easy for all to understand
- **VERY SIMILAR ARGUMENTS COULD BE DEVELOPED FOR ANY ACTIVITY**
- Similar arguments could be developed for ethical/cultural relationships with the sea
- Not trying to set priorities within the four types of uncertainty.
 - **ALL** are important and case specific

CONCLUSION

- WE NEED RESEARCH TO ALLOW SOCIETY TO MAKE BETTER CHOICES
 - PROCESS-BASED RESEARCH
 - MONITORING,
 - “BIG SCIENCE”,
 - SOCIAL SCIENCE LINKS
- THERE ARE NO BIG DISCREPANCIES BETWEEN THE RESEARCH WE NEED AND THE RESEARCH SCIENTISTS WANT TO DO.
- NEED LINKS BETWEEN SCIENCE PRIORITIES AND POLICY NEEDS