The Ocean is changing. The climate is changing. SO WHAT?

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Purpose of the talk

• Listen to the FUTURE discussion (yesterday)
• Listen to the Symposium Talks (Morning)
• POSE A CHALLENGE FOR THE FUTURE (in both senses of “FUTURE”)

Suppose we have now convinced the key science and policy people that the ocean DOES change and so does the climate – IT IS TIME TO MOVE FORWARD – BUT TO WHAT?
(Some of) What I heard

FUTURE
• Great Science being done, especially on ocean climate forecasting and coastal work important
• Outlooks and forecasts are the glue that binds them together
• The threads don’t have a loom on which to weave a whole fabric of explanation

Symposium
• The large scale in space, time and community patterns are there, but important dynamics underneath them are occurring at smaller scales of space, time, and species/functional groups
What was dominating my thinking?

• Remembrances of the “Beyond El Nino” Symposium in 2000
  – “Regime Shifts” outgrew their adolescence
• Discussions in IPCC Assessment Report, World Ocean Assessment & CBD COP
  – The world is ready to start making global marine policy for biodiversity. WHAT SHOULD IT BE?
• FUTURE question 1: What makes the ocean resilient, and how to forecast “it”?
• How to work a gratuitous image of a football player into the talk.
Where Do I See Challenges

• Everywhere, of course
• Better understanding of processes needs to continue
• Monitoring needs to continue
• Both need to support work at finer scales – inshore as well as offshore
• “Regime Shift explains it all” no longer enough.
  – Time to move from youth to maturity
What does resilience bring to the discussion?

• Old conceptual of a regime shift
  – Oceanographic conditions varied (without trend) around one suite of mean values
  – Around that mean a suite of species were “adapted” and “common” and another suite was “stressed” and “low abundance”
  – Oceanographic conditions changed “abruptly” to vary around a different suite of mean values
  – Suites of species “adapted” to previous conditions declined together “quickly” and those that were “stressed” increased together “quickly”
New Conceptual “Regime Shift”

• Periodic “major events” or “shocks” cause the oceanographic conditions to reconfigure.
  – Some tipping point exceeded
• After the “event” the suite of oceanographic conditions pulled by laws of physics to converge toward a mutually stable condition
  – Attractors impose order on chaos - RESILIENCE INCREASES
• Attractors pull the excursions back towards the mean, but
• Stochastic events and smaller shocks act to counter convergence
• Vulnerability to a large perturbation from anywhere depends on balance of power of attractors and size of perturbations until one of them reaches next tipping point
And For Species ....

• Species have individual “optimal environmental windows (Sensu Cury and Roy)
  – Some sets of species do have optimal range towards “colder” conditions, others towards :warmer”
  – RANGE of conditions with species adapted, not classes of species adapted to on set of conditions or the other
• Species Assembly Rules are the biotic scale attractors
• Many more forces like fishing, pollution work counter to the attractors (AND stochastic variations)
• Resilience of community again result of balance between power of assembly rules and size of stressors
• Community scale tipping points still in play. Probably at level of functional groups for assembly rules
Population / Carrying Capacity
In EITHER conceptual model

When a “regime” has been established:
- \( N \) of species or functional group is \( \sim K \)
- **Contest competition (density dependent)** dominates among groups

When the regime changes:
- for previously FAVOURED species or functional group in the short term \( N >> K \)
- For previously UNFAVoured species \( N << K \)
- **Period of Scramble competition (density INdependent)** dominates
During the transitions

• For the species in a functional groups that “win”, ability to fill the large gap between N & high K means:
  – Local conditions can affect growth rate
  – Small difference in starting N’s due to recent past events can be large advantage

• For those that lose and must try to survive period of high mortality and scarce resources
  – Same factors apply but to buffer mortality

• For both, small perturbations can have lasting effects
  – Increasing differential m for those going down
  – Increasing differential r for those going up
Implications of collective change within a functional group

• Traits-based functional groups are key
• For all functional groups, the stronger the regime or attractor, the more the transition period is a large part of the dN in dN/dt
• The more that dN occurs during periods of scramble competition, the more that contest competition winners and losers in each regime, have adaptations dissipated at each change in “regime”
Resilience in a changing world

• Tightness of co-adaptation highly constrained
• Coarse predictability is system constraint not a knowledge and sampling constraint
• Vulnerability of configuration of next period of stable regime / dominant attractors very high during transition periods
• Management matters MOST during transitions
  – Must be dealt with by greater risk aversion NOT increasingly knowledge rich predictions
So if we believe the ocean and the climate are changing

- Better ability to know when regime changes are imminent changes to knowing how system vulnerability to a shock is growing
- Not as much focus on predicting what it will like next. Too strong a stochastic component. Learn the assembly rules that apply
- Management systems that are truly precautionary
  - Increase risk aversion at early signs of regime changes or events, when uncertainty goes up too
- Human systems that retain flexibility to adapt