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

Jake Rice

Cjief Scientist – DFO

Canada

# 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 heaard

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 Assessmetn Report, World Ocean Assessment & CBD COP
  - The world is ready to start makign 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.


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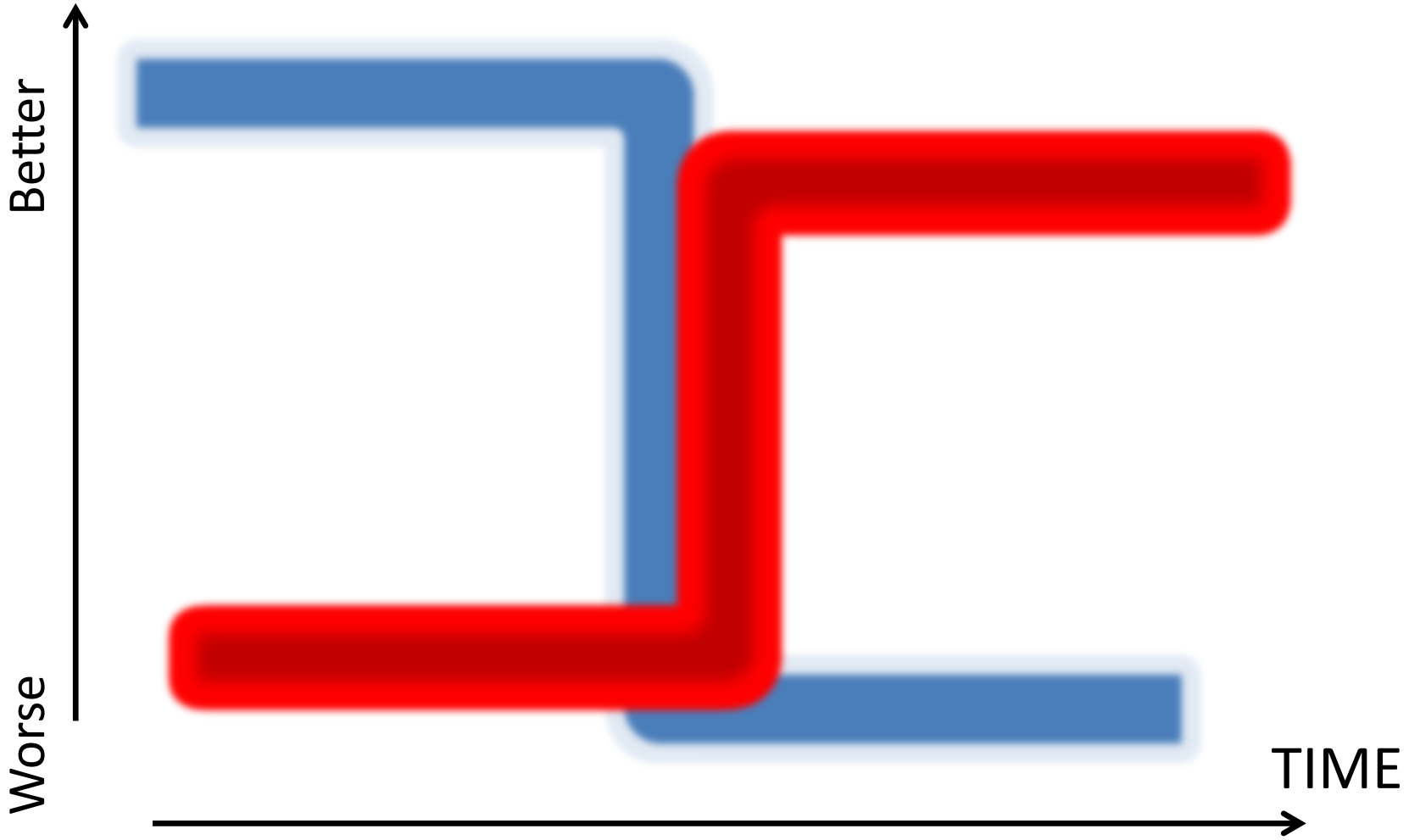
# Where Do I See Challenges

- 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”


Better
Worse
TIME

# New Conceptual “Regime Shift”

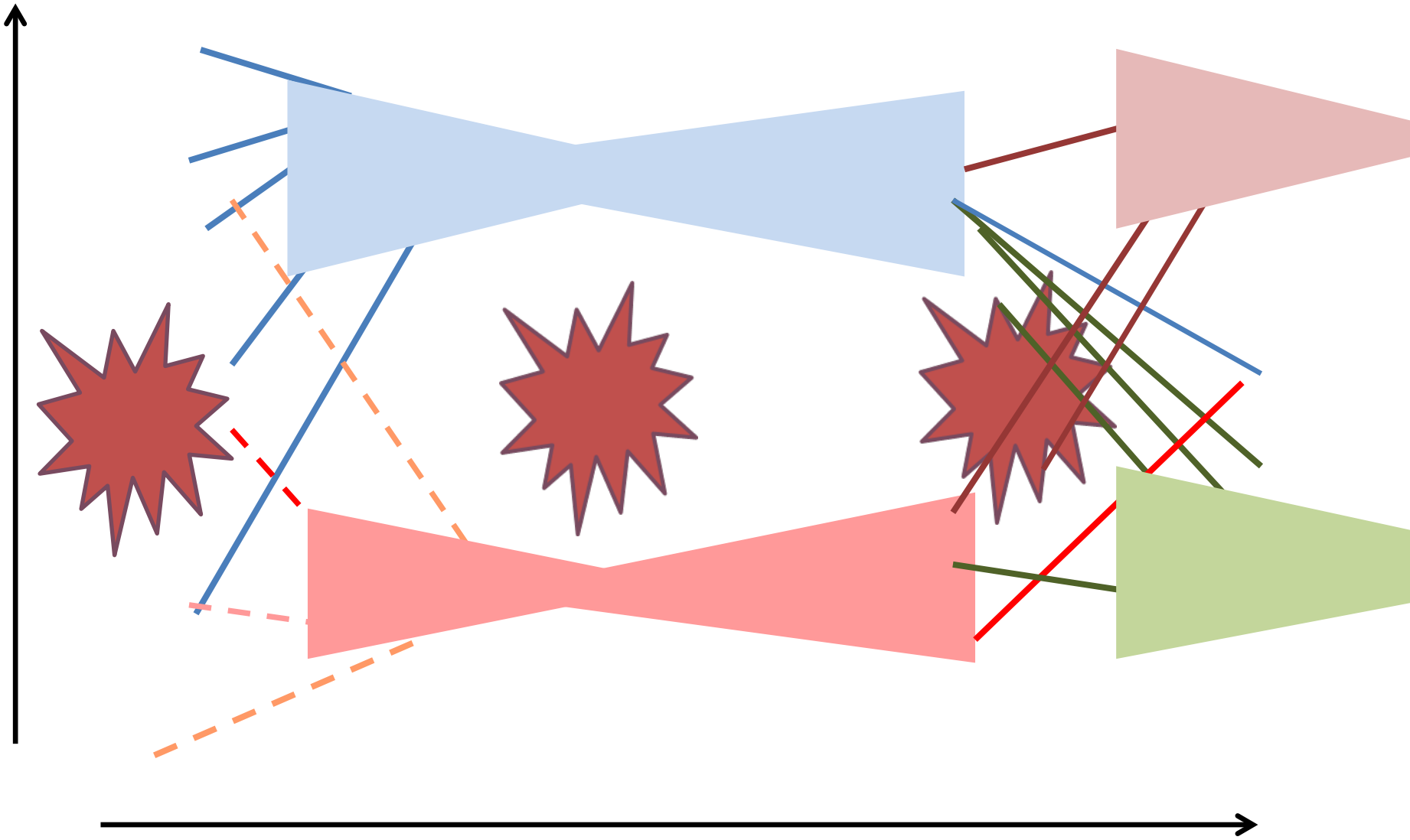
- Periodic “major events” or “shocks” cause the oceanographic conditions to reconfigure.
  - Some tipping point exceeded
- After the “event” the suite of oceanographic conditions pulled by laws of physics to converge toward a mutually stable condition
  - Attractors impose order on chaos - RESILIENCE 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 ~ K
- **Contest competition (density dependent)** dominates among groups

When the regime changes:

- for previously FAVOURED species or functional group in the short term N is >> 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 perdicting what it will like next. Too strong a stochastic component. Learn the assembly rules that appy
- 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