Deep Sea Corals and Sponges as EFH (and related ecological musings)

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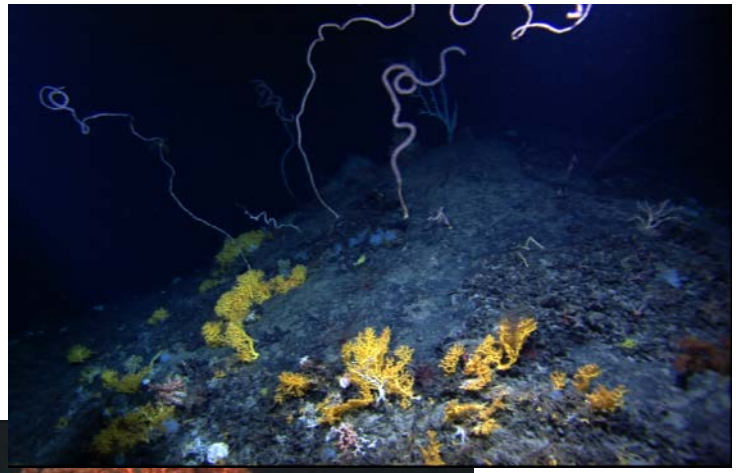
Deep Sea Corals & Sponges (DSCS)

- Magnuson EFH and deep sea corals provisions
- NMSA
- Executive memorandum promoting sustainable fisheries
- International agreements

DSCS Ecological Attributes Focus Attention

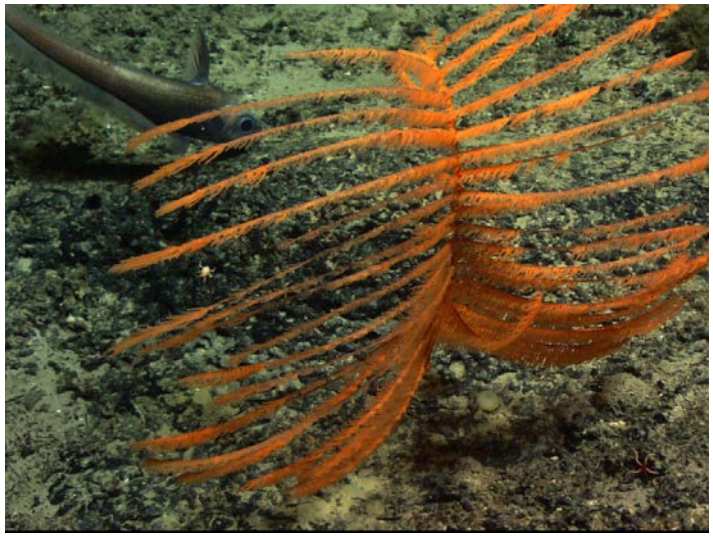
- Corals and sponges sensitive and vulnerable to disturbance
- Low recovery potential (at ecologically relevant time scales)
- Low resilience (at least at ecologically relevant time scales)

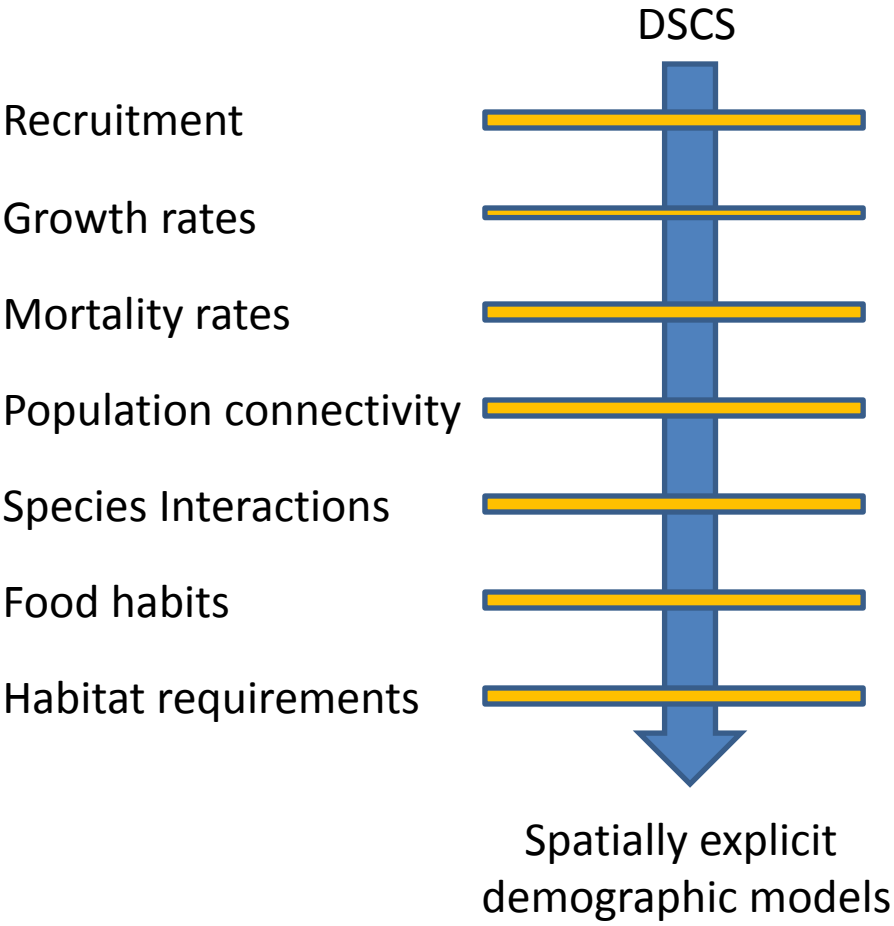


Images: Mountains-in-the-Sea & Deep Atlantic Stepping Stones Sciences Teams/IFE-URI/NOAA

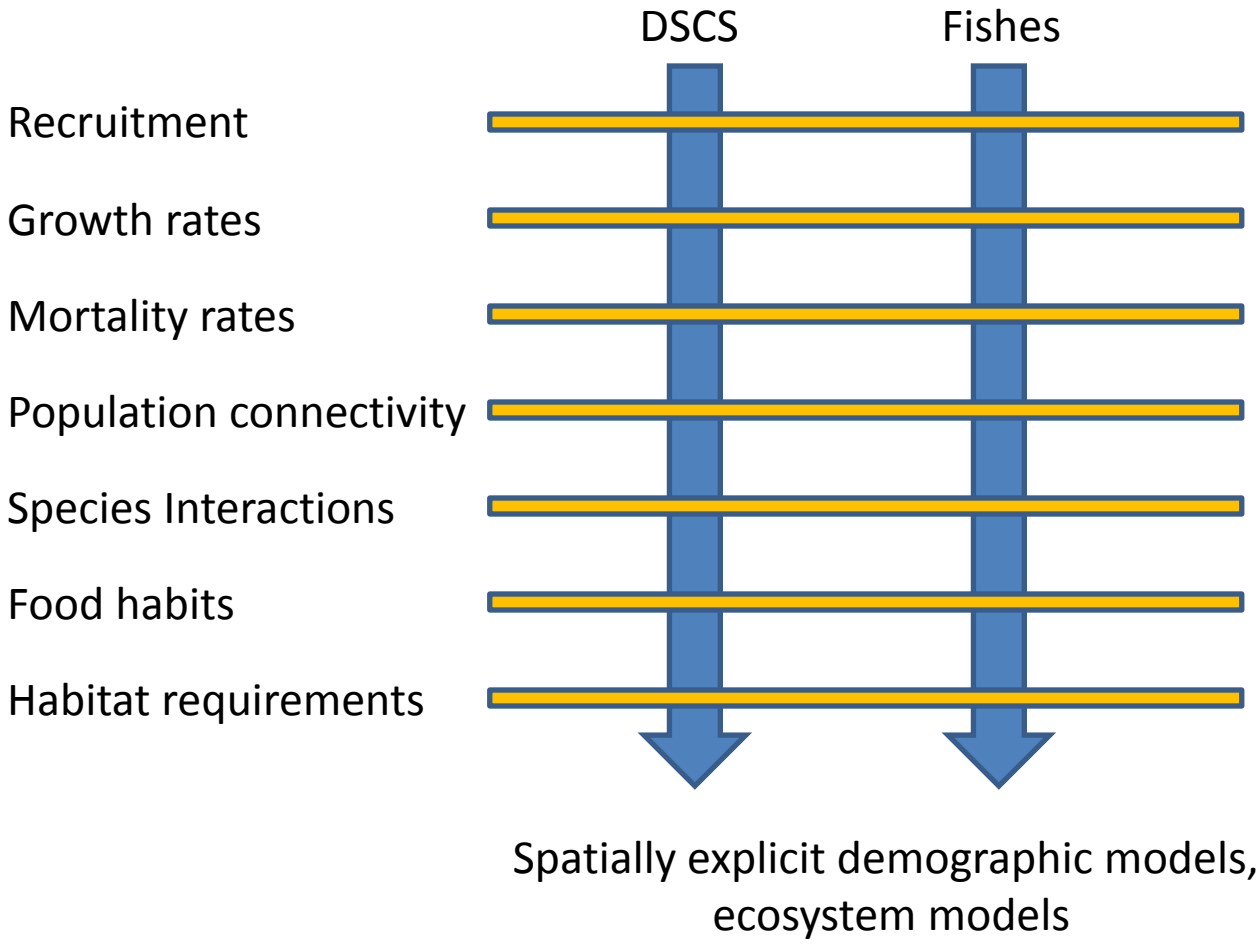
Conserving DSCS Because They Are DSCS

- Relatively straightforward scientific information needs (distribution based on direct observation, bycatch, HS modeling)



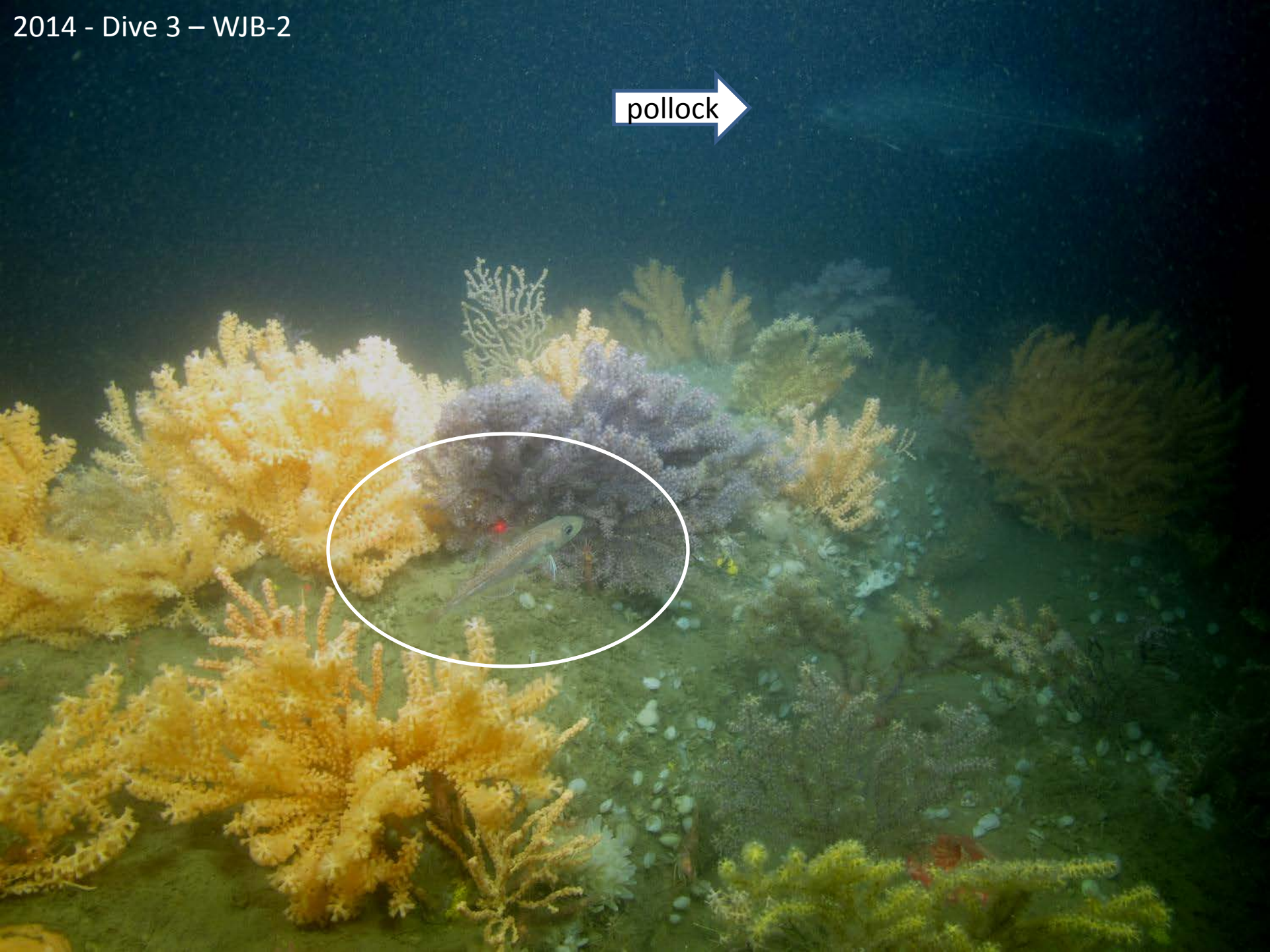


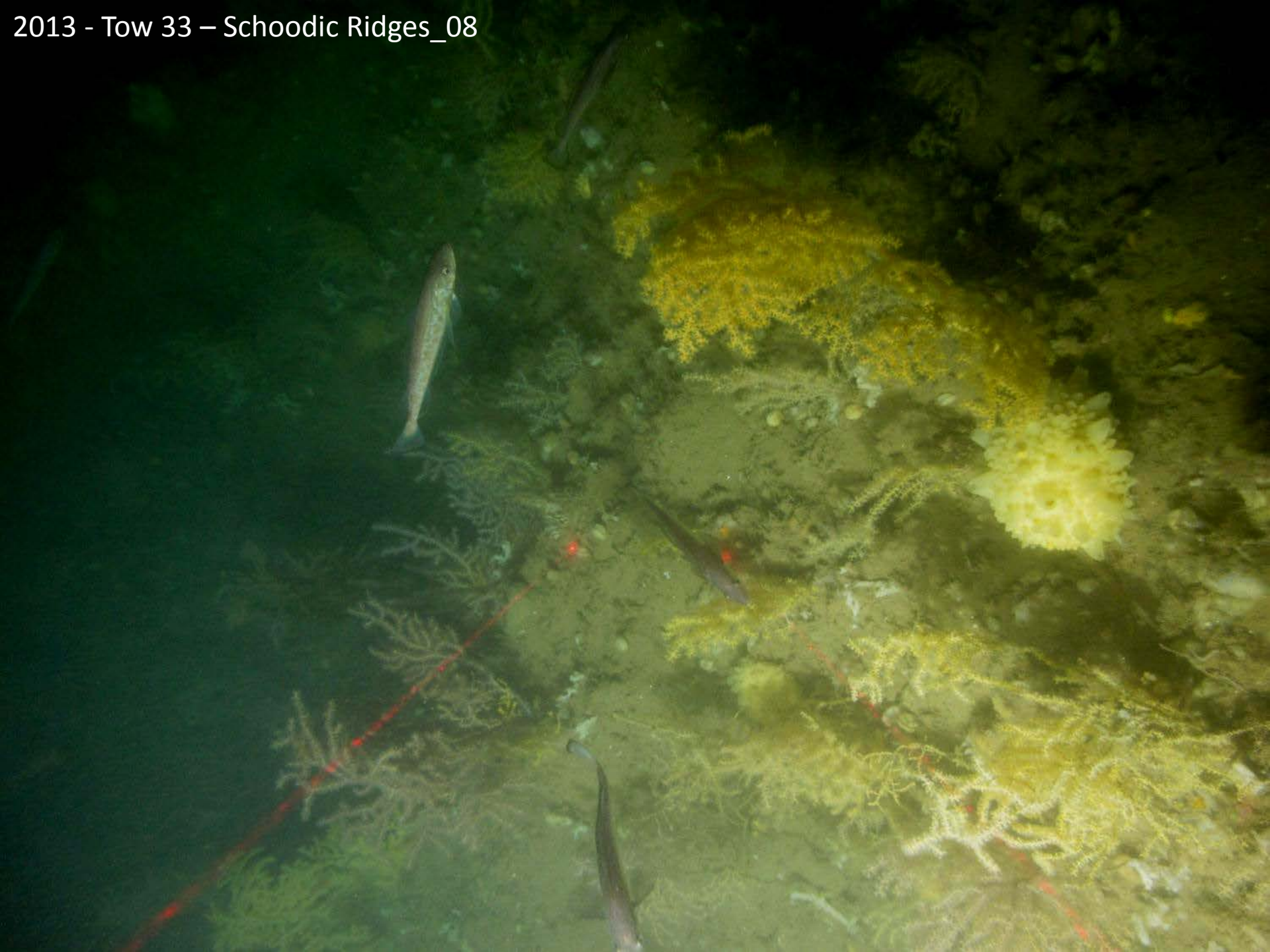
For EFH Address Ecology of DSCS & Fish



DSCS Functional Roles Key for Linking to Demographic Responses of Fish Populations

- Flow refuge
- Shelter from predators
- Foci for aggregation of prey taxa/feeding
- Foci as recruitment-nursery habitat
- Foci for spawning behavior
- Functional equivalency with other habitats


2014 - Dive 3 – WJB-2
pollock


2013 - Tow 33 – Schoodic Ridges_08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-151565243
Tow 1 - 114 Bump_01


2014 - Dive 14 – OSR-C1


2014 - Dive 13– OSR-C1

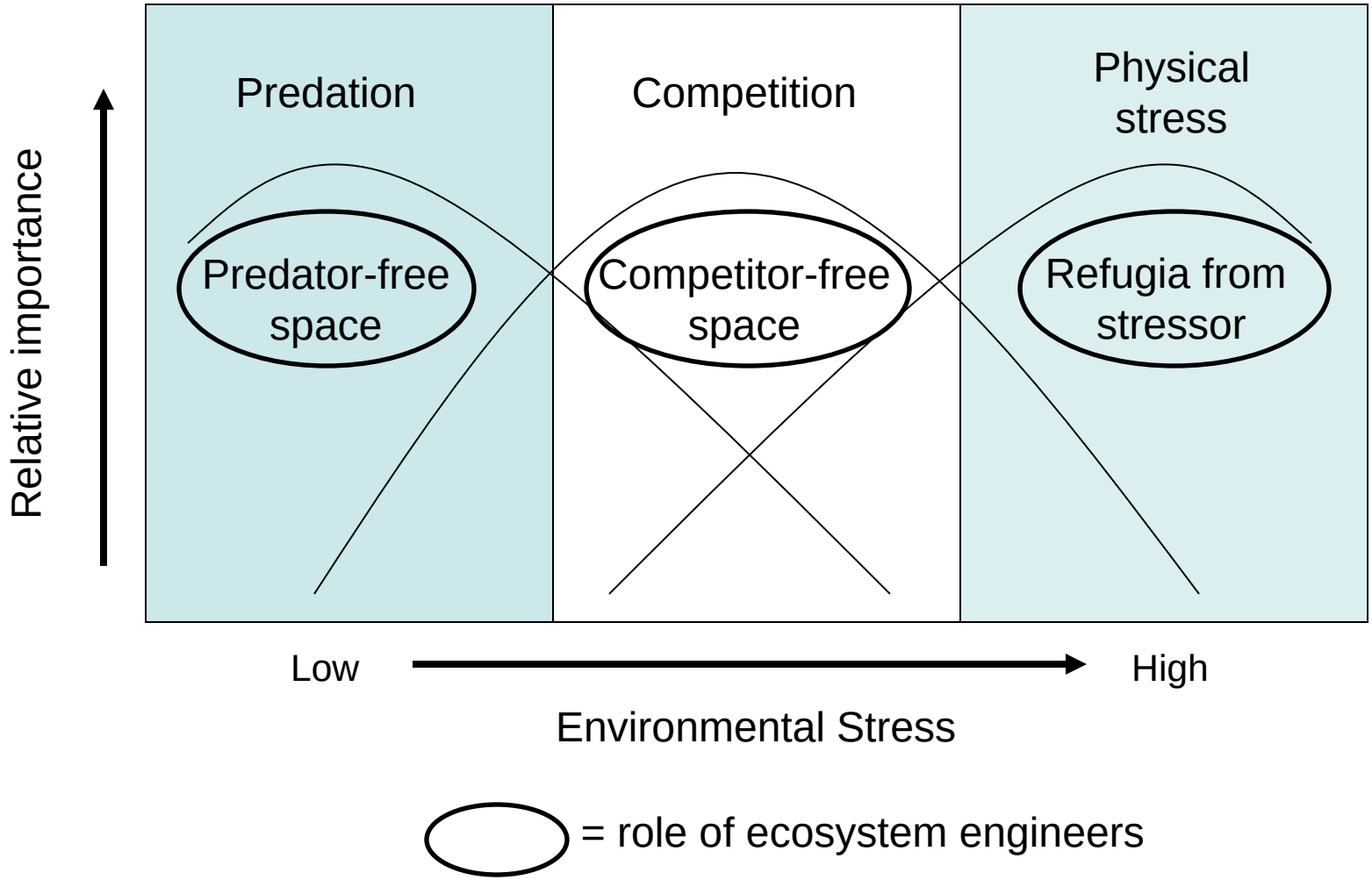

2014 - Dive 09– OSR-S1


2014 - Dive 13– OSR-C1


Tow 23 –91 Bump_01


2014 - Dive 17– CJB-1

Relative Importance of DSCS in Mediating Community Composition



Modified from Crain and Bertness. 2006. Bioscience 56:211-218.

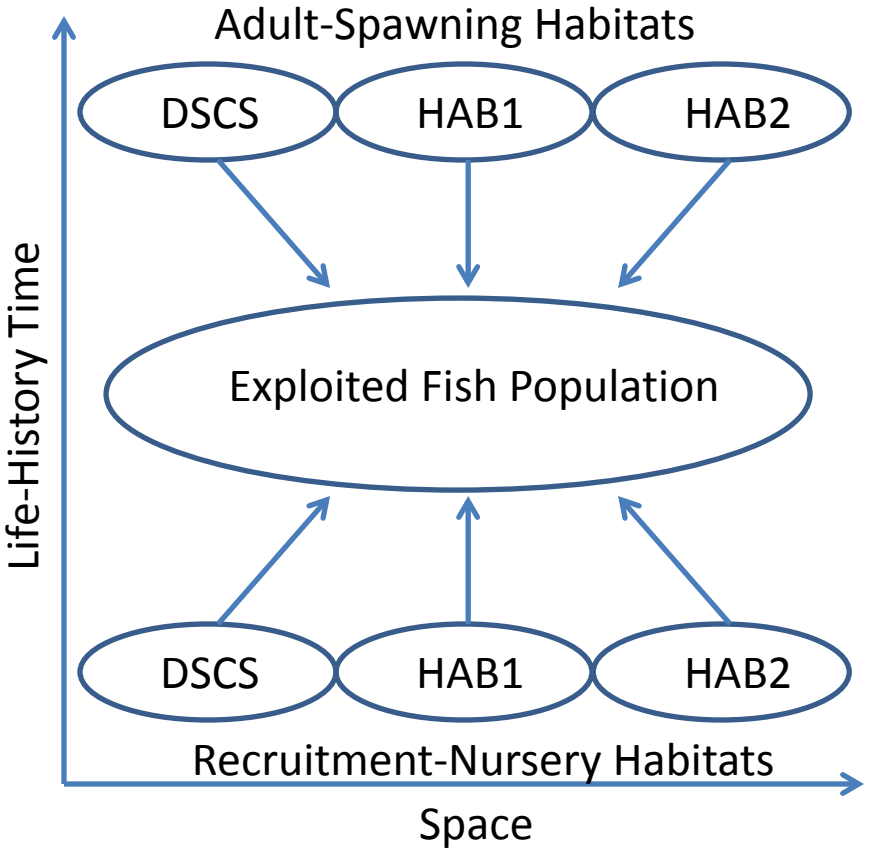
Role DSCS as Ecosystem Engineers Under Varying Levels of Environmental Stress

Environmental stress	Key engineering mechanisms	Community outcome	Importance of engineer
High	Refuge from environmental stress	Increased diversity and community resilience	Essential to maintain species richness
Intermediate	Competitor refuge	Increased diversity and community resilience	Maintain species with low competitive ability
Low	Predator refuge	Increased diversity and community resilience	Stabilize patterns of dominance and community composition

Modified from Crain and Bertness. 2006. Bioscience 56:211-218.

Observation Scale and Management Scale are Often/Sometimes Mismatched

- Coral-sponge habitats mediate recruitment and/or reproductive success?
- Coral-sponge habitats mediate physiological condition (fitness)?
- Link scale of direct observation to scale of population and management.
- Geospatial approaches using e.g. survey data may be apropo (Pereira et al. 2012 MEPS; 2014 ESR)
- Correlation is not causation … but it's something!



Habitat Selection Theory and Empirical Data May Provide a Link

- Use survey data and standard(?) metrics (length, weight, reproductive state, gut contents)
- Depending on survey design, may require additional stations to address DSCS distributions

Model	Geographical range	Local density	Local fitness	Spatiotemporal variation in fitness
CDM	Increases with N	Constant over N	Constant over N	Spatial variance at high N
PDM	Constant over N	Constant proportion of N	Constant over N	Spatial variance at high N
BM	Increases with N	Increases with N[a]	Decreases with N	No change in spatial variance with N

[a]The increase may be more pronounced if fish follow a Beverton-Holt stock–recruitment relationship

From: Pereira et al. 2012 MEPS

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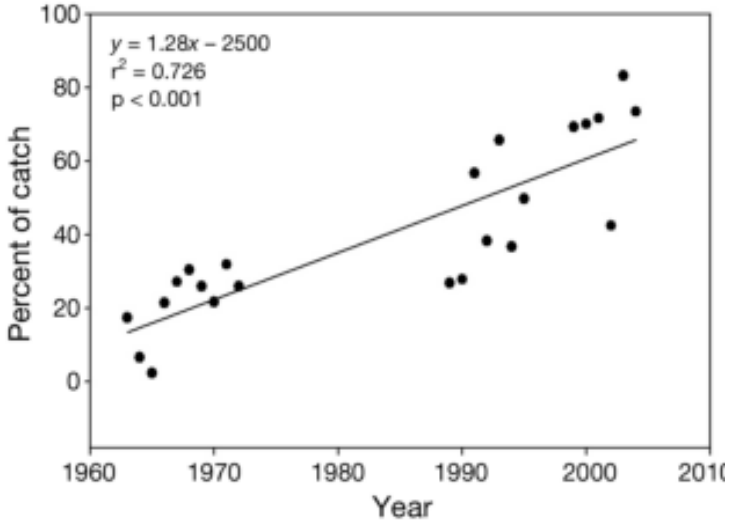


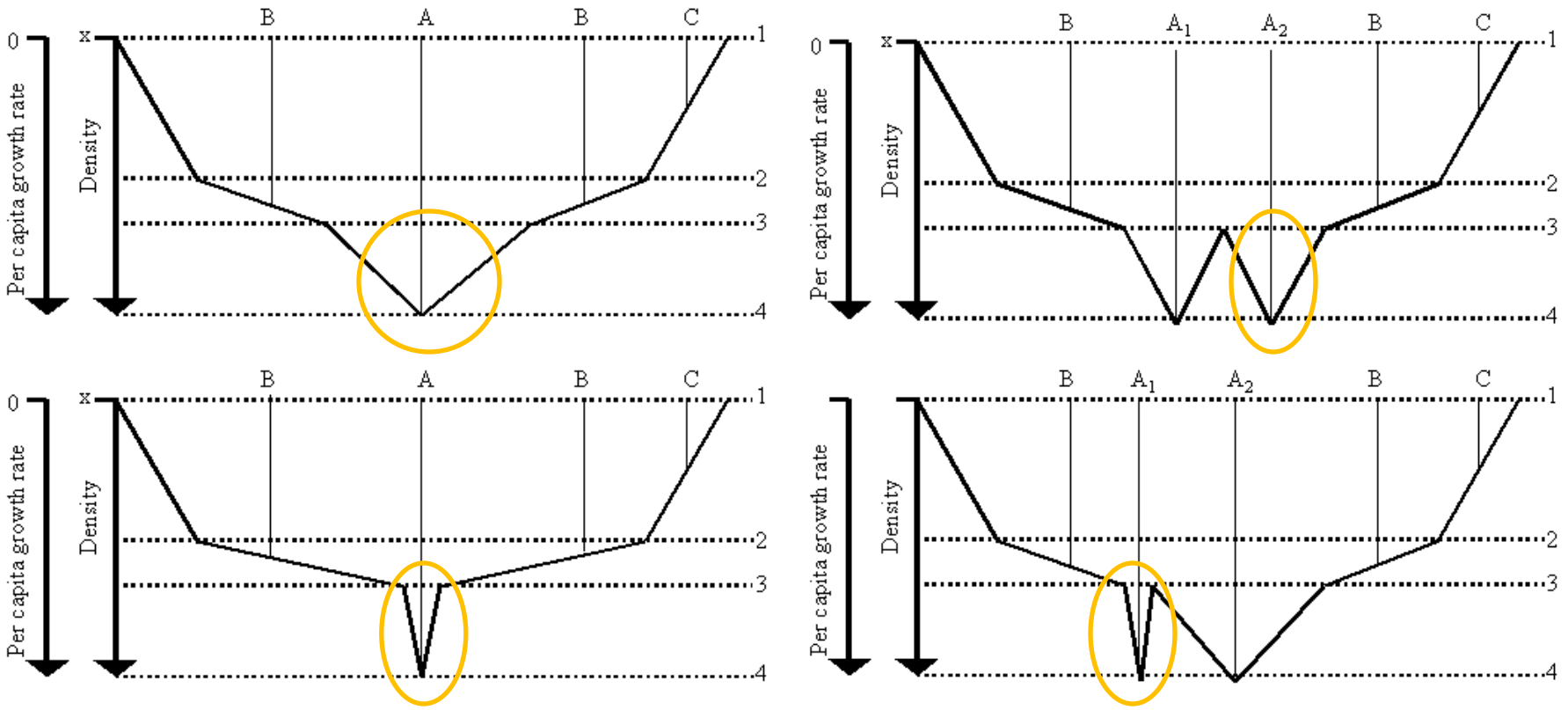
Fig. 4. *Limanda ferruginea*. Proportional abundance of yellowtail flounder in preferred habitat (Stratum 1160, see Fig. 1). Abundance is expressed as a percentage of the total survey catch on Georges Bank. Equation for least-squares regression, correlation coefficient, and p-value are indicated

Table 3. *Limanda ferruginea*. Test of spatial and temporal variability in condition. Results of mixed-model ANOVA, testing each sex separately. Abundance: abundance period. When the degrees of freedom (df) for an effect differed between males and females they were both listed (as males, females). MS: Type III mean squares. *F* and p-values given for the null hypothesis that there is no effect. Significant p values (≤0.05) in **bold**

	df	Males			Females		
		MS	*F*	p	MS	*F*	p
Abundance (a)	1	0.0043	1.13	0.29	0.044	6.3	**0.01**
Stratum (s)	9	0.068	2.0	**0.05**	0.0038	0.6	0.79
Season (e)	1	0.032	8.41	**0.005**	0.002	0.26	0.61
a × s	8	0.032	1.06	0.4	0.02	0.36	0.94
a × e	1	0.0003	0.08	0.8	0.004	0.55	0.46
s × e	9	0.049	1.43	0.19	0.02	0.35	0.94
a × s × e	5	0.0226	1.2	0.32	0.0013	0.21	1.0
Year(a × s × e)	76, 84	0.287	2.69	**<0.0001**	0.6	3.5	**<0.0001**
Error	950, 921	0.0014			0.002		

From: Pereira et al. 2012 MEPS

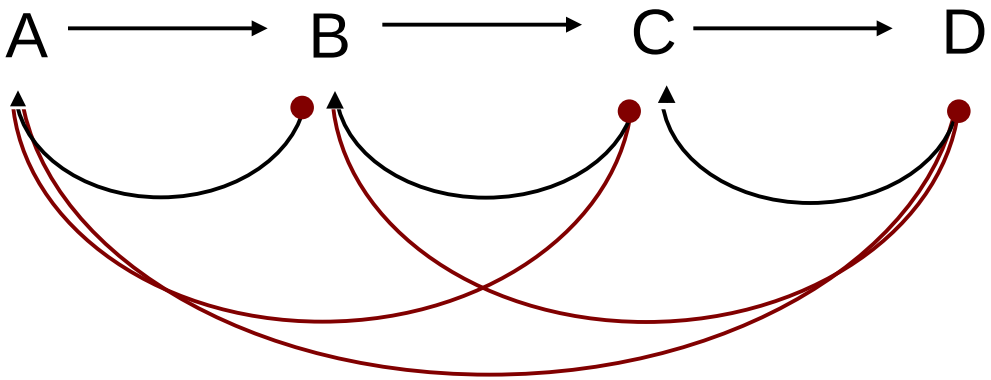
Habitat Selection Theory and Empirical Data May Provide a Link



- Expand assessment of habitat use patterns to non-DSCS elements
- Assess distribution and fitness metrics
- Links to rest of EFH

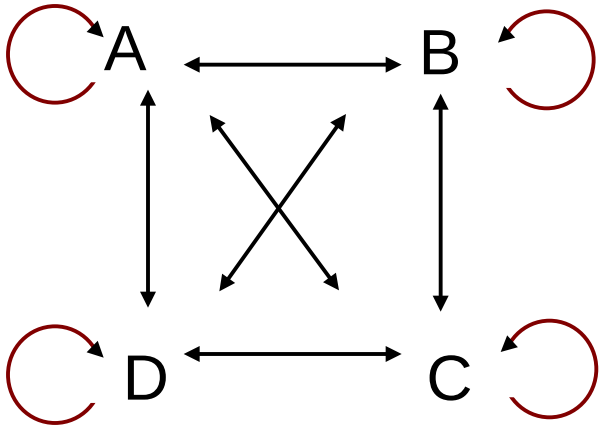
Auster 2005; Modified from MacCall 1990

Impacts and Resilience



Successional model which has predictable shifts in community type

A lottery based model which has stochastic, non-linear responses to disturbance

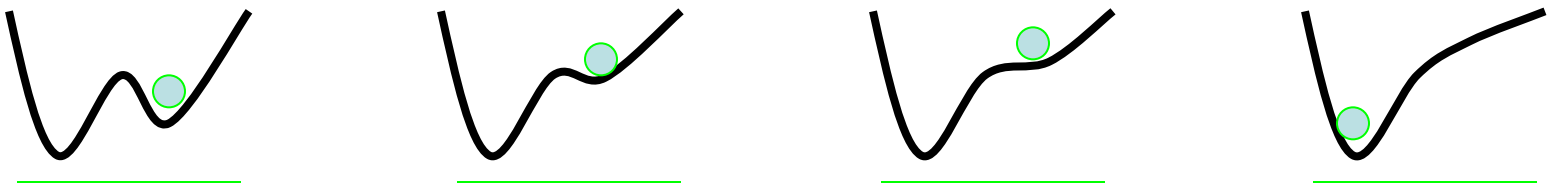


From Auster & Langton 1999

Resilience and multiple states

Ecosystem services of value ⇢ **Loss of ecosystem services**

Desirable state — Undesirable state



Community state → Community state

- Cerianthid forest
- Horse mussel community
- Sponge forest
- Deepwater coral

→ Local acute and chronic disturbances →

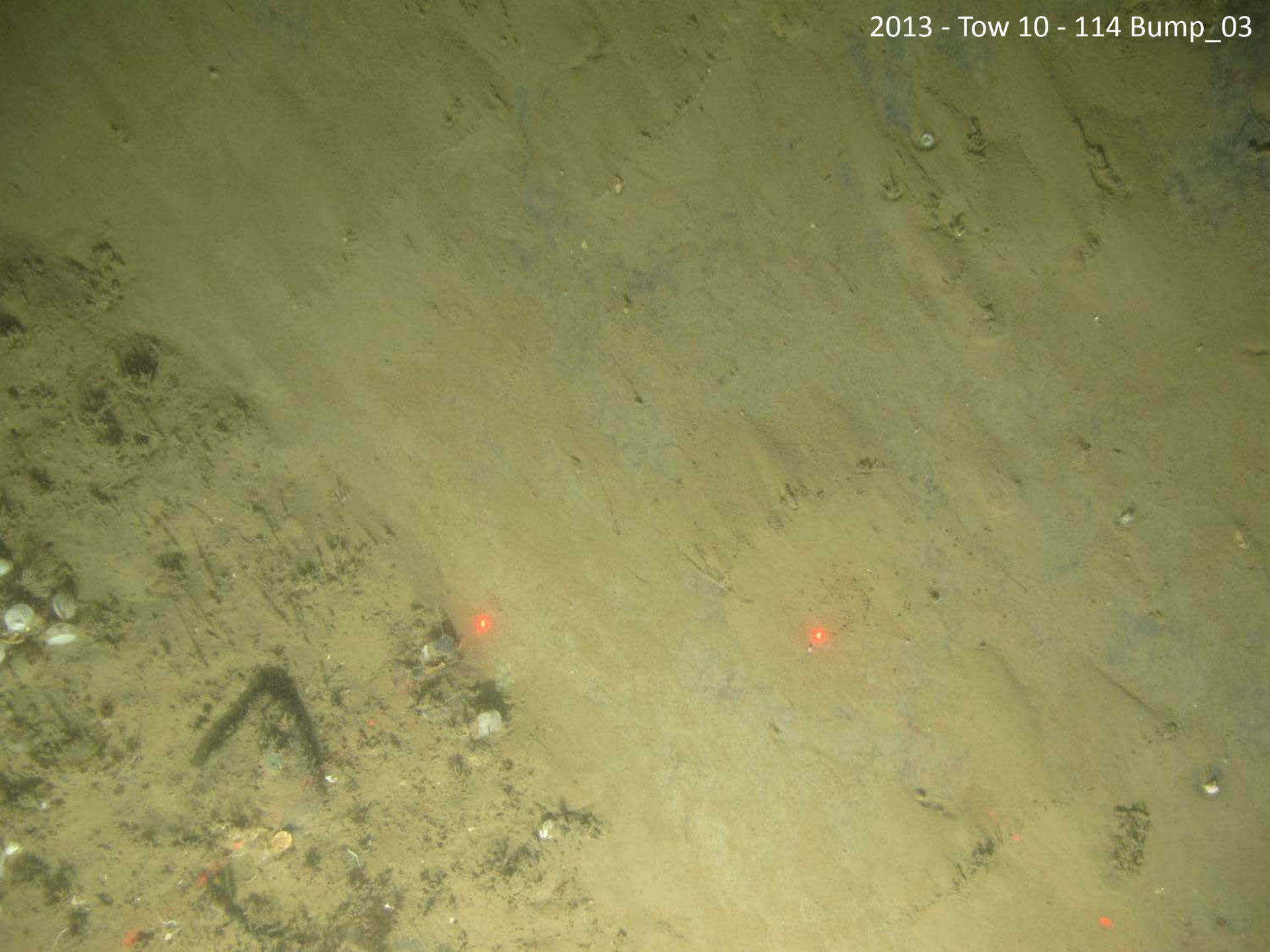
- Mud draped gravel/mud
- Rock/encrusting epifauna
- Rock/encrusting epifauna
- Rock/encrusting epifauna

Auster, unpub; Modified from Elmqvist et al. 2003


2014 - Dive 17– CJB-1


2014 - Dive 17– CJB-1


2013 - Tow 10 - 114 Bump_03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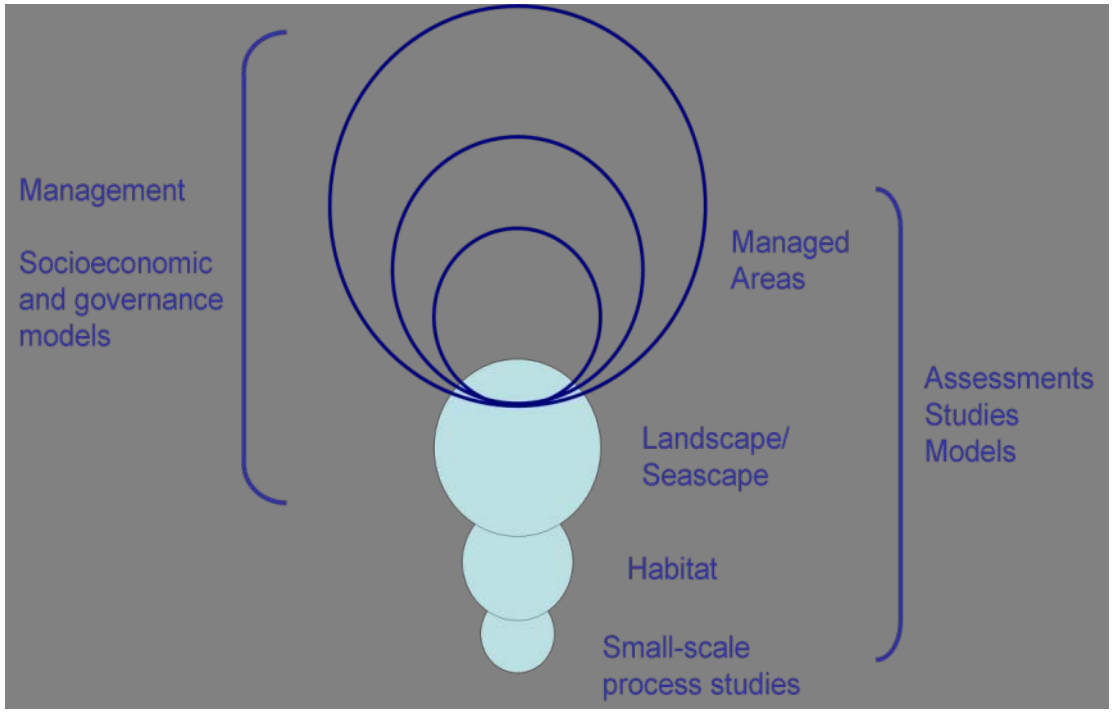
Tow 16 - 114 Bump_03

Links to EBFM



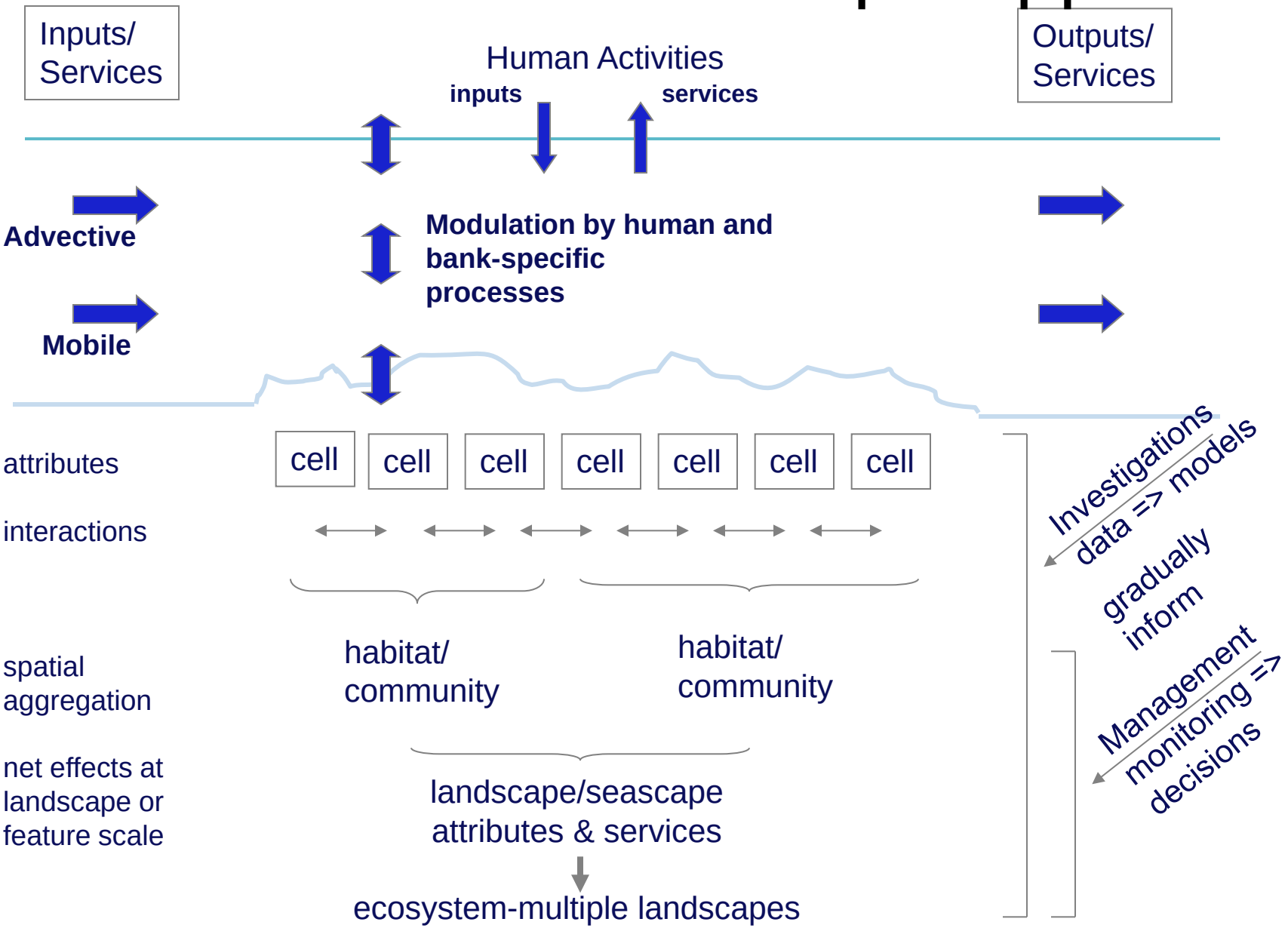
Operational Objectives

Linking DSCS to rest of EFH:

- formalizes a consensus of "what matters" and what to manage for
- high level & integrative -- dampens out the "noise"
- helps to maintain management focus and be inclusive
- provides a framework for stimulating "use-inspired" research at multiple scales

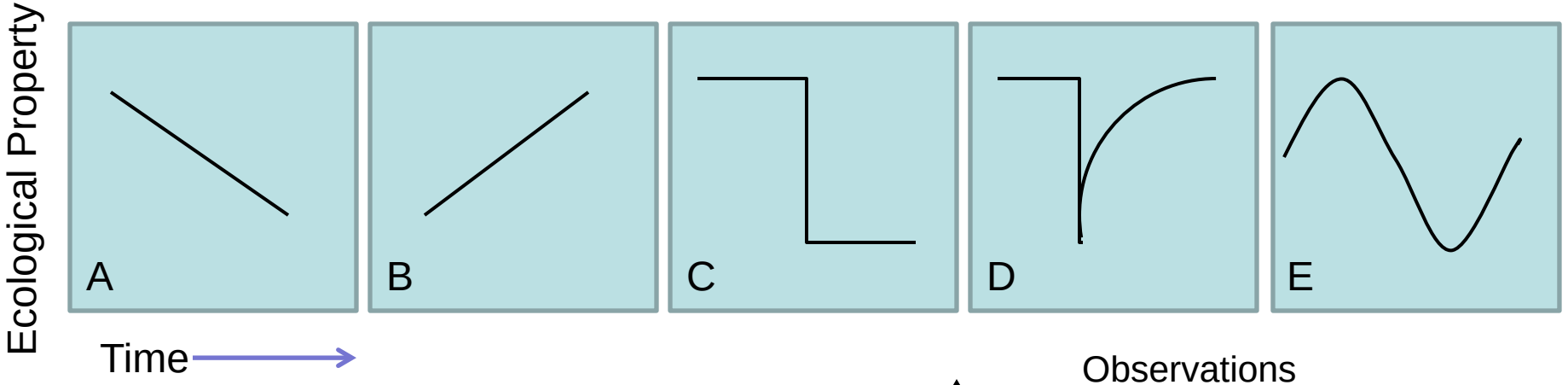
Adapted from Incze and Auster 2008, AAAS Annual Mtg.

Links to EBFM – Landscape Approach

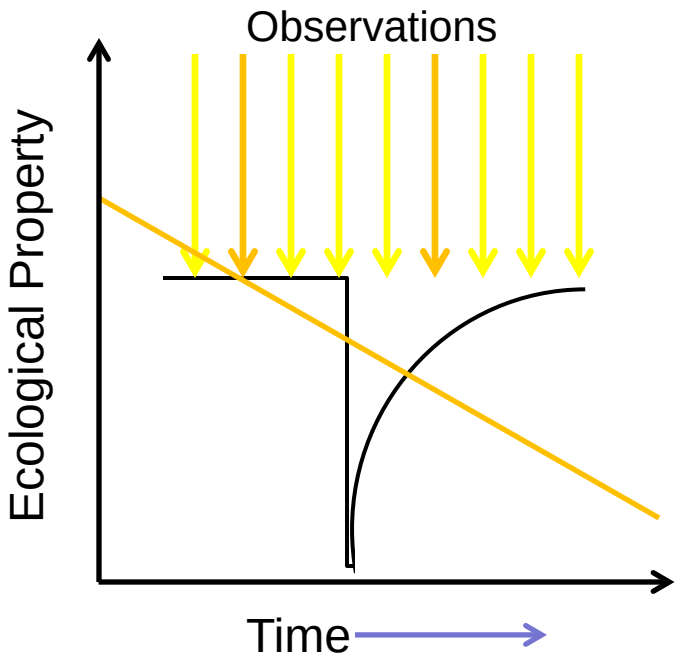


From Incze and Auster 2008, AAAS Annual Mtg.

Time series needed: Inference of Process from Spatial Pattern



A. Decreased survivorship or growth (predation, competition, stress)
B. Increased survivorship or growth (recruitment, food supply)
C. Change in state
D. Resilience
E. Cyclical dynamics (NAO)



Blatant adoption from Kennedy et al. 2014 Front Ecol Environ

Where might we go from here?

- Focus on population processes and species interactions for link to EBFM
  - Surveys (time series across space)
  - Observatories (time series across time)
  - Experimental approaches (field & lab)