Marine habitats in a changing world: Looking beyond correlation

Edward Gregr[1], Rowenna Gryba, Kai Chan, and Daniel Palacios

FUTURE Session - PICES 25th Annual Meeting
San Diego CA
11 Nov 2016

1. Principal | SciTech Environmental Consulting | Vancouver, Canada
Research Fellow | Resources, Environment and Sustainability | UBC

The need

Successful, integrated resource management depends on understanding the spatial distribution of natural resources.

Understanding how resources are distributed relies on model forecasts (i.e., predictions).

Need forecasts for both tactical (short-term, management) and strategic (long-term, policy) applications.

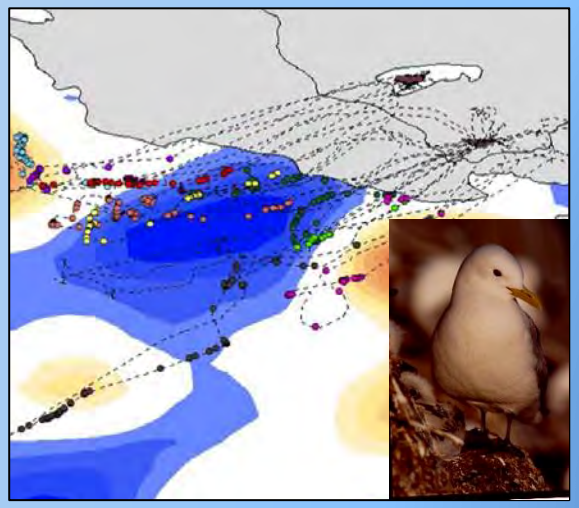
Leading edge HTL habitat models

- Tactical models for dynamic ocean management
- Process studies of habitat

Big Data:

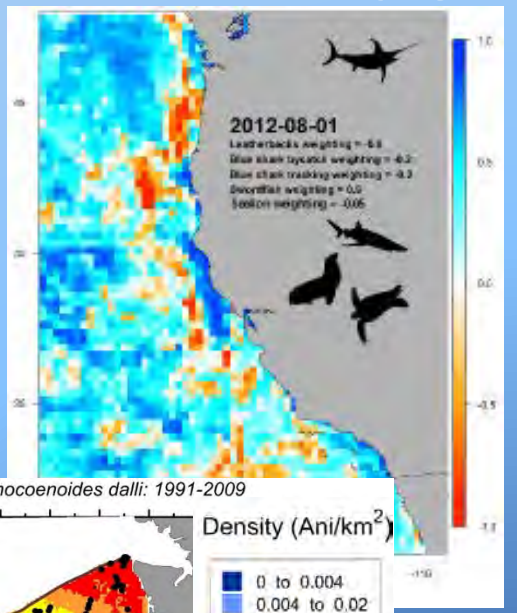
- ROMS models
- RS data (several flavors)

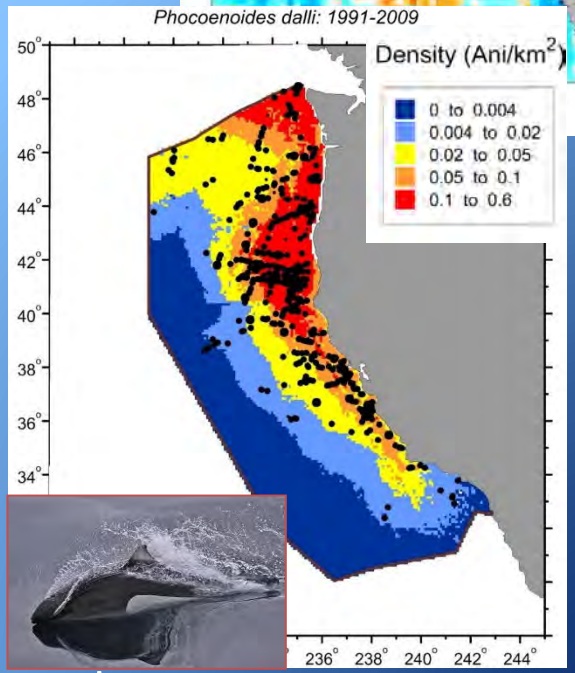
- Catch data
- Tagging data



Suryan

Hazen





Becker

Habitat models for other species, places

Observational data

- Presence only data (rare, cryptic species)
- No tagging, no surveys
- No population estimates

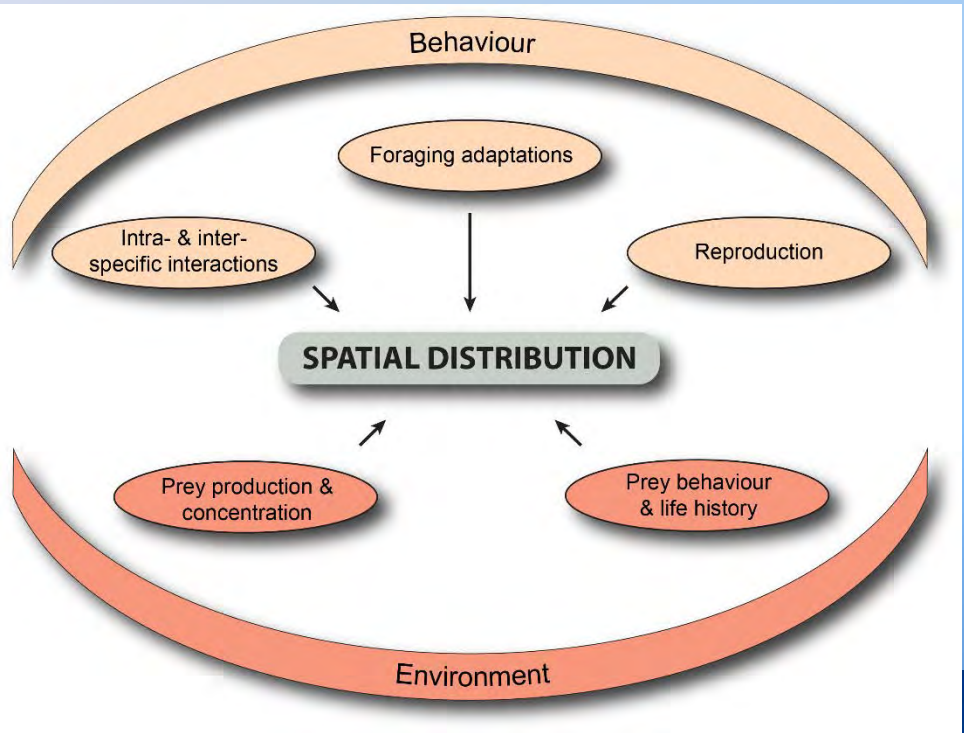
Environmental data

- No ROMS models
- RS data poorly resolved/contaminated (i.e., coastal zone)

Methodological challenges

- Biased data
- Sufficiency of model scope
- Non-stationarity
  process(es) underlying observed patterns are constant across space and time.
- Cross-validation tests widely used, but do not inform transferability (forecast skill).
- Forecast skill depends on how well models predict independent data.

Behavior begets non-stationarity

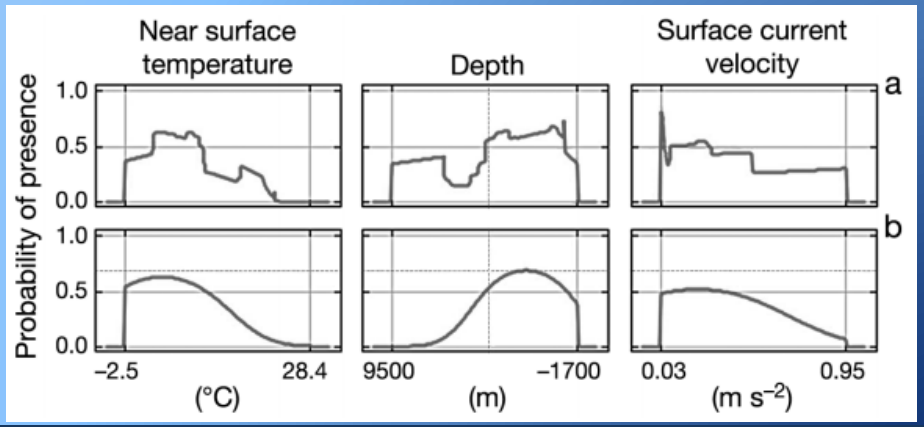


Correlative → Confirmatory → Mechanistic

Palacios, Baumgartner, Laidre, Gregr. 2013. *Beyond correlation: integrating environmentally and behaviourally mediated processes in models of marine mammal distributions*. ESR 22:191-203.

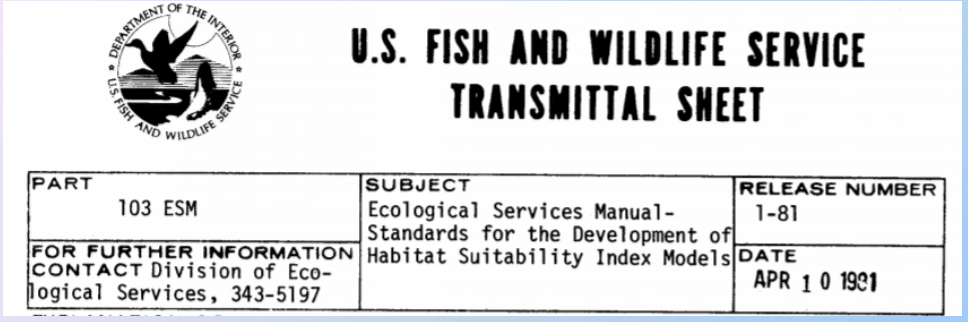
From correlation to process

- Correlative models may not always lead to process.
- Sophisticated pattern matching approaches can generate ecologically meaningless relationships.
- Model forecasts need to be rooted in ecology.
- Directed studies required to understand process in different behavioral (physiographic) contexts.



Gregr 2011: Insights into N Pacific Right Whale habitat from historic whaling records. ESR.

Process models

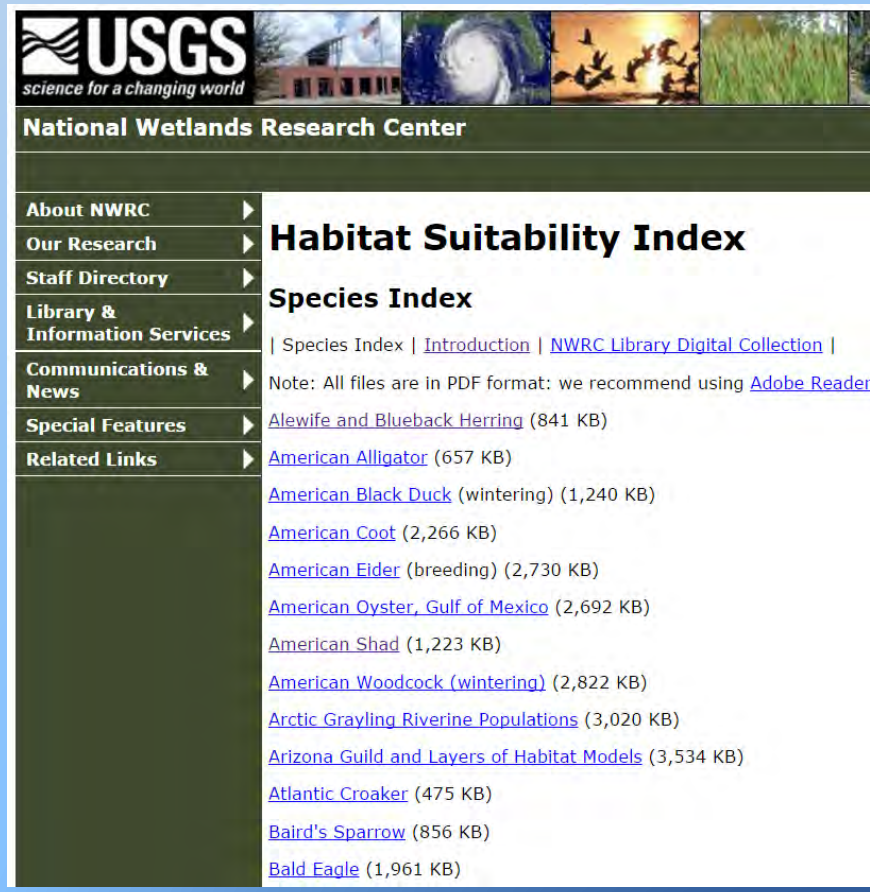


U.S. FISH AND WILDLIFE SERVICE
TRANSMITTAL SHEET

PART	SUBJECT	RELEASE NUMBER
103 ESM	Ecological Services Manual- Standards for the Development of Habitat Suitability Index Models	1-81
FOR FURTHER INFORMATION CONTACT Division of Ecological Services, 343-5197		DATE APR 10 1981

Habitat Suitability Index (HSI) articulated 35 years ago.

"Models should be viewed as hypotheses … rather than proven cause and effect relationships. Value is as a basis for improved decision-making & increased understanding … because they specify hypotheses that can be tested and improved."



USGS science for a changing world

National Wetlands Research Center

- About NWRC
- Our Research
- Staff Directory
- Library & Information Services
- Communications & News
- Special Features
- Related Links

Habitat Suitability Index

Species Index

| Species Index | Introduction | NWRC Library Digital Collection |

Note: All files are in PDF format: we recommend using Adobe Reader

Alewife and Blueback Herring (841 KB)
American Alligator (657 KB)
American Black Duck (wintering) (1,240 KB)
American Coot (2,266 KB)
American Eider (breeding) (2,730 KB)
American Oyster, Gulf of Mexico (2,692 KB)
American Shad (1,223 KB)
American Woodcock (wintering) (2,822 KB)
Arctic Grayling Riverine Populations (3,020 KB)
Arizona Guild and Layers of Habitat Models (3,534 KB)
Atlantic Croaker (475 KB)
Baird's Sparrow (856 KB)
Bald Eagle (1,961 KB)

How do correlational studies improve on these simpler, process-based models?

Kelp habitat in Pacific Canada

- Review ecology of kelp habitat
- Use survey data to build a set of increasingly complex correlative models
- Test the transferability of the models in time using independent data

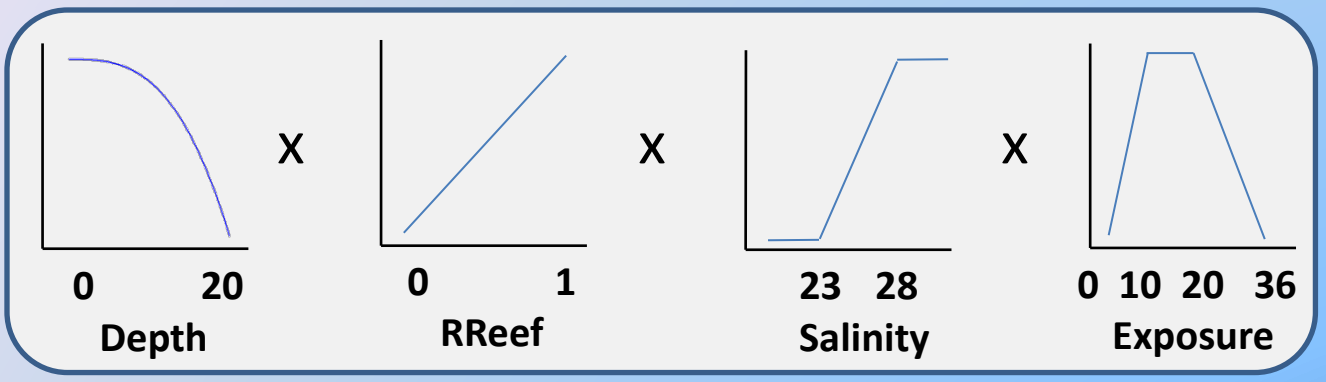
Model data

- 181 stations sampled in 2010-2013 for percent cover of 2 canopy species.

- Depth, bottom type, exposure, temperature, salinity, aspect, tidal currents

Models

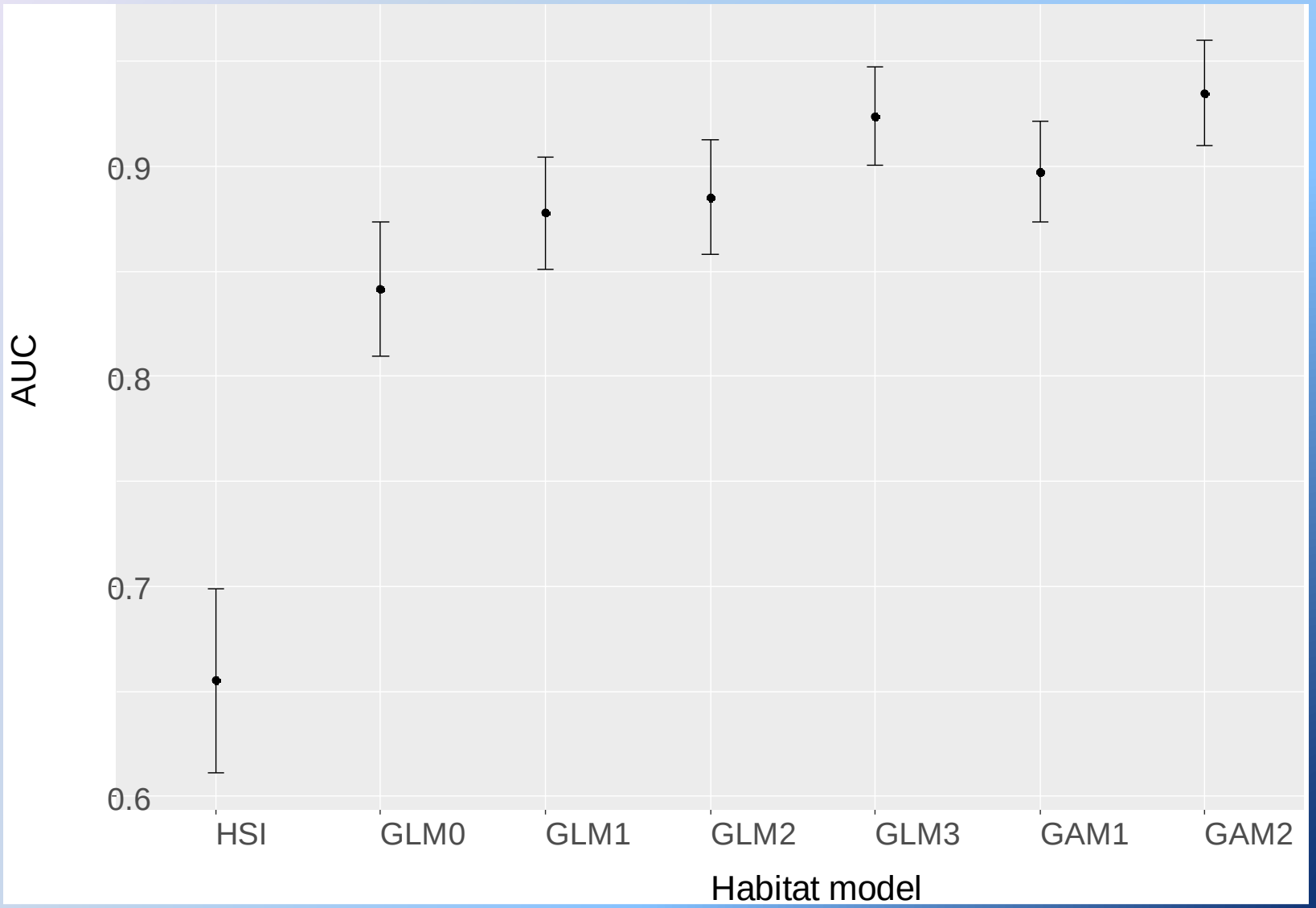
HSI



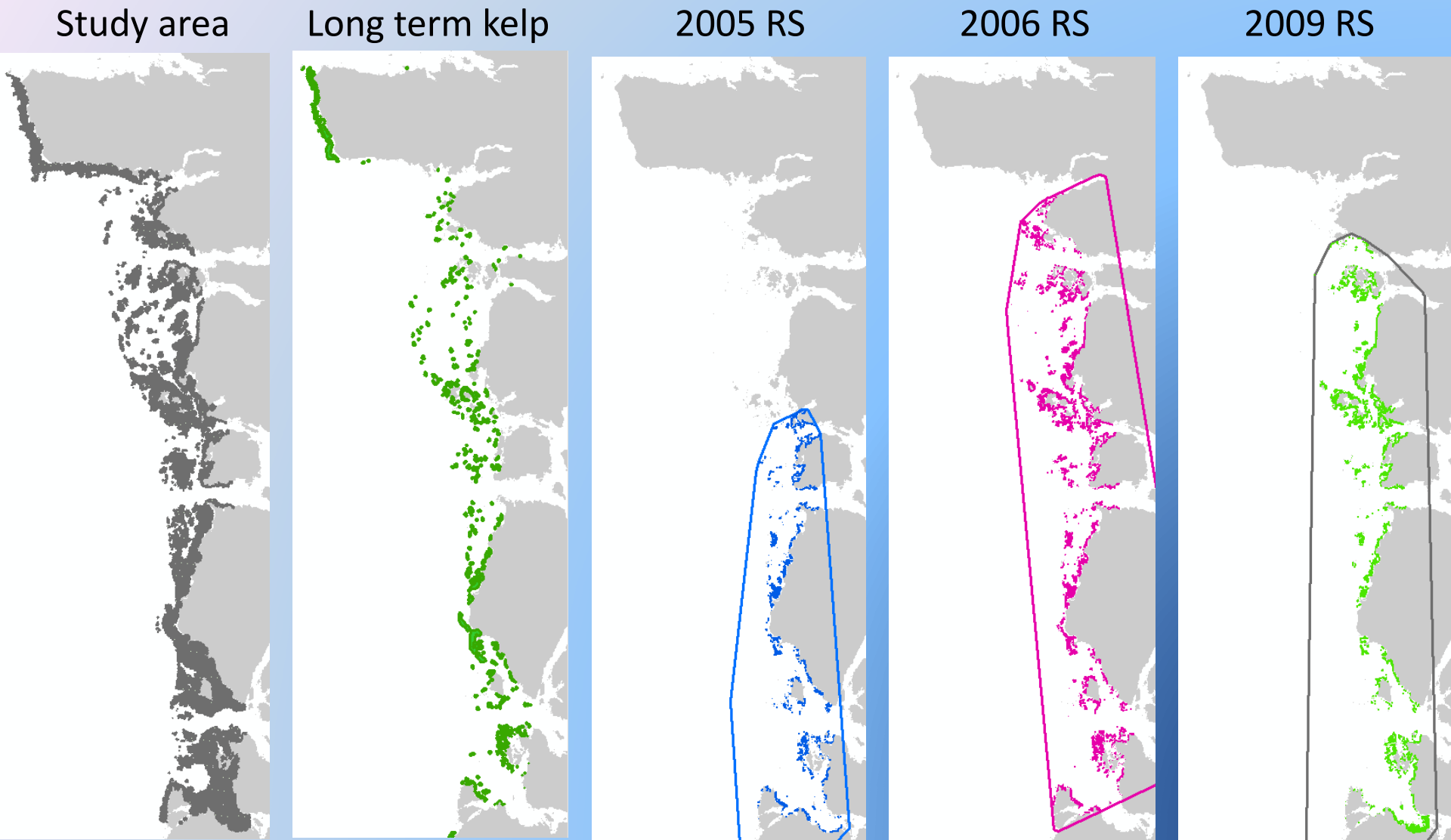
	Model Scope	AIC	ΔD
	GLMs		
GLM0	Same as HSI		
GLM1	GLM0 with potential for higher order terms		
GLM2	Addition of other significant predictors		
GLM3	Exploration of potential interactions		
	GAMs		
GAM1	Replication of GLM3 in a GAM context		
GAM2	Extension of GAM1 to a maximum level of smoothing		

Model cross-validation

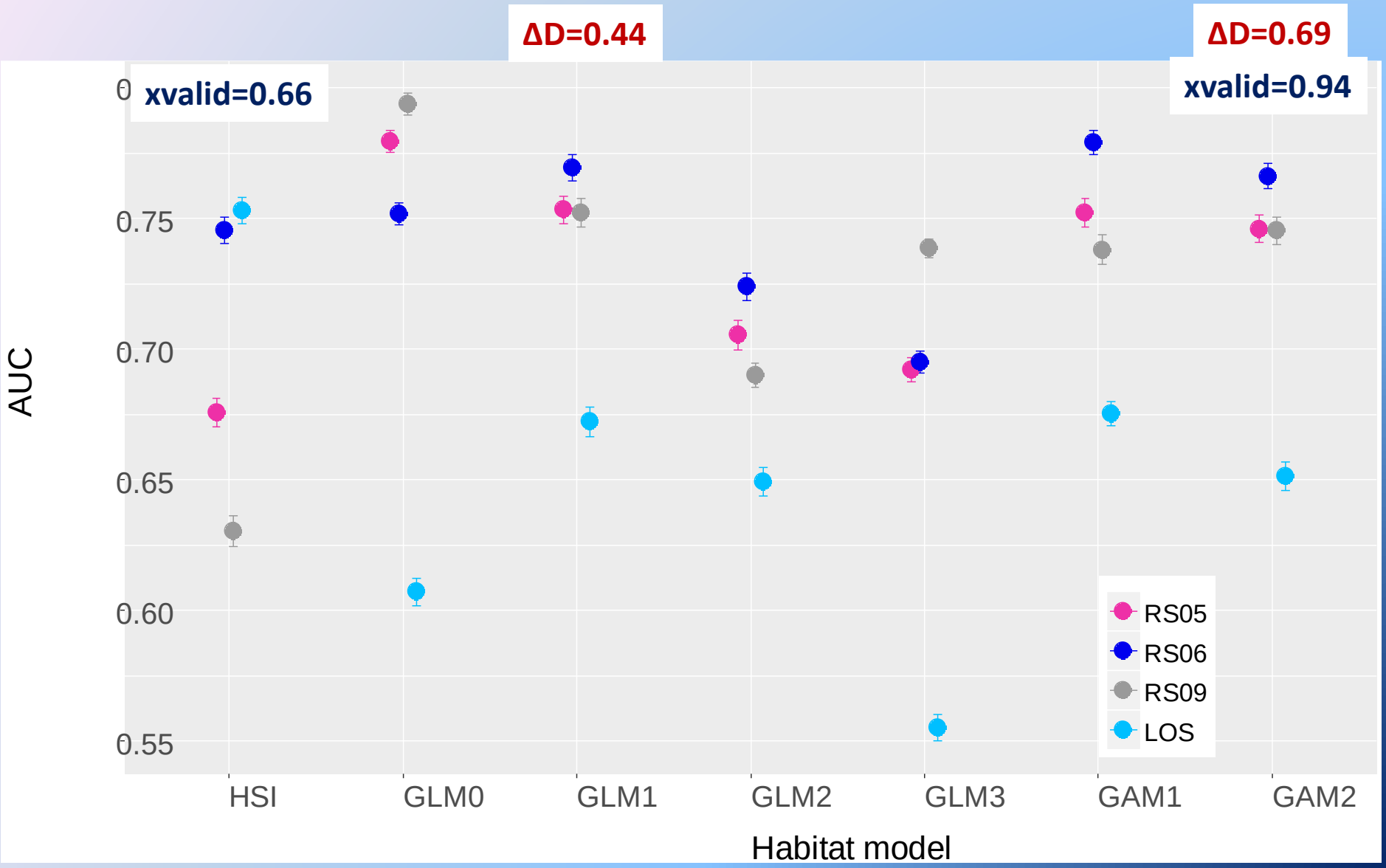
(Uses survey data on which the regression models were built)



Independent data



Independent data validation



Take home messages

- Independent data evaluation is a more accurate test of forecast skill than cross-validation
- Simpler models likely better for strategic (potential habitat) forecasts than more complex ones
- Simpler models provide more guidance on process, and improve model credibility

What about FUTURE?

- Movement towards process-based, context dependent models encouraging.
- Credibility will be enhanced by more independent data validation.
- Models must also be relevant, legitimate.

Cash et al. 2003: Knowledge systems for sustainable development. PNAS 100(14).

- Legitimacy will be enhanced by indicators people care about, at scales that matter.

Connecting Human And Natural Systems Lab

chanslab.ires.ubc.ca

ejgregr@gmail.com

@EcoRational