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Lessons from the development and use of numerical models in restoration planning on the Missouri and Columbia rivers

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Using ecological models in large scale adaptive management (AM) programs

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- Models are a key part of the AM process
  - Organize information and assumptions
  - Assess uncertainty
  - Evaluate management alternatives
  - Quantify learning
- Challenges in modeling diverse, complex systems
- Common lessons to apply


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Models as decision support

"Recalculating ... Recalculating ..."

Missouri River Recovery Program

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Biological Opinion in 2000, revised in 2003

Avoid jeopardy for piping plovers, least terns, and pallid sturgeon using adaptive management

Background:
Emergent Sandbar Habitat (ESH)

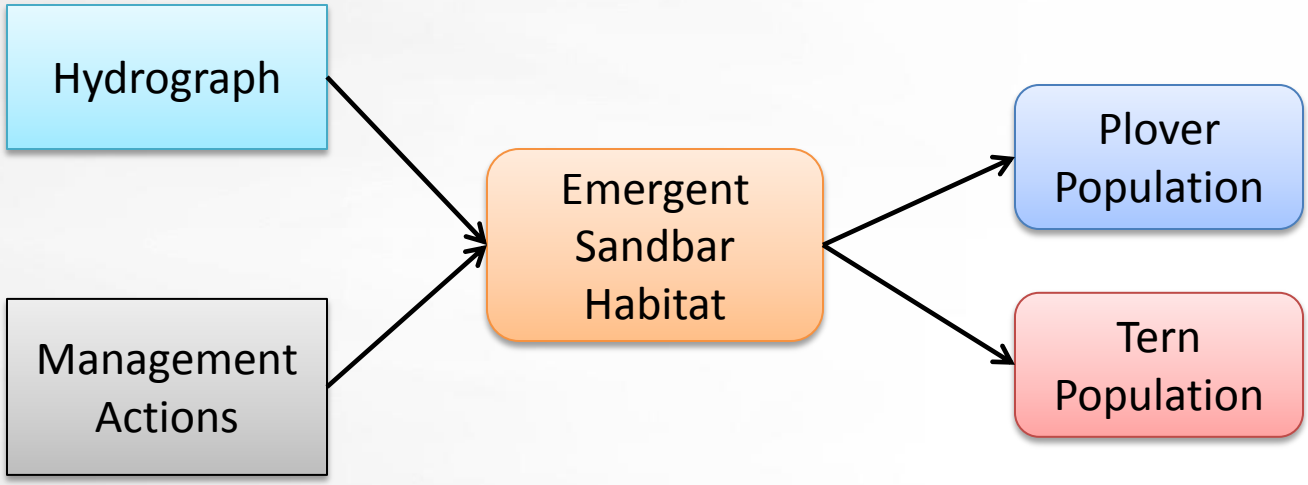
- Habitat restoration for least terns and piping plovers
- How much habitat do the birds need?
- Challenges:
  - Variable riverine environment
  - Ephemeral habitat
  - Large scale

Objectives for ESH, tern, and plover numerical model

- Habitat management actions → avian population dynamics
- Compare alternative management actions
  - Amounts of creation or maintenance
  - Direct interventions
- Understand effects of natural variability
- Track uncertainty and learning

Structure for ESH, tern, and plover model

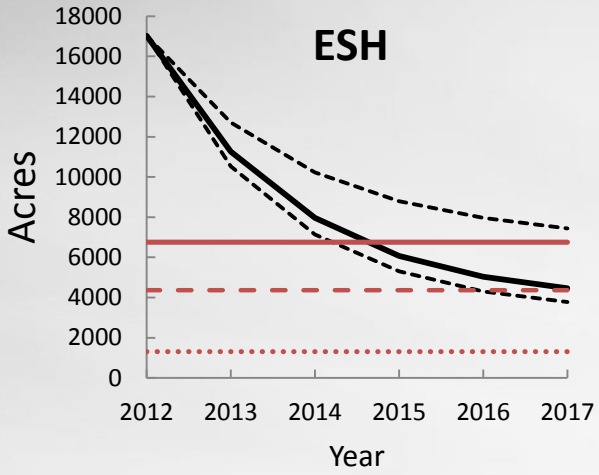
- Developed through rapid prototyping process
- Habitat model linked to population viability models
- Stage-structured populations in 4 river reaches and 3 reservoirs
- Estimation error and natural variability

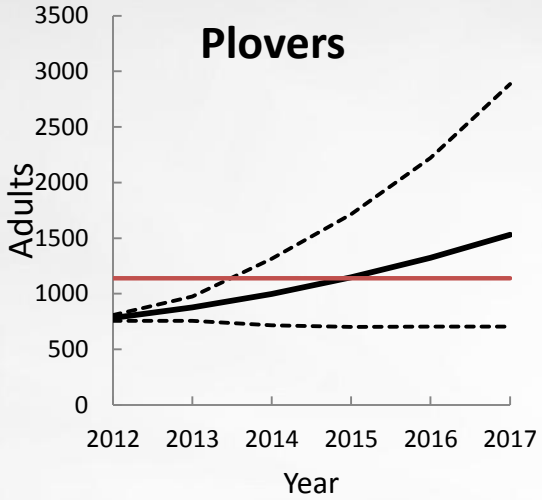


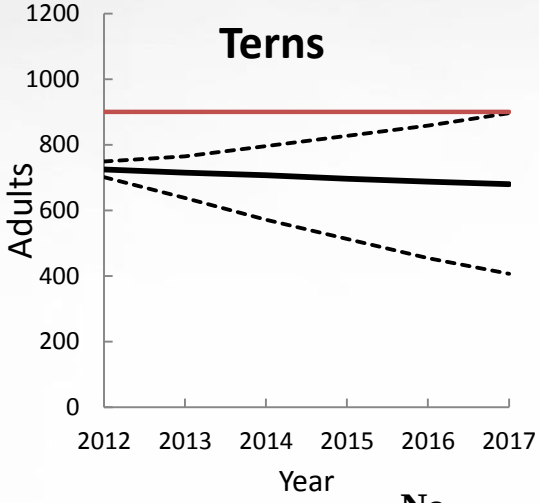
KE Buenau, TL Hiller, and AJ Tyre. 2013. River Research and Applications.

Major outcomes of ESH, tern, and plover model

- Projection and comparison of alternative actions



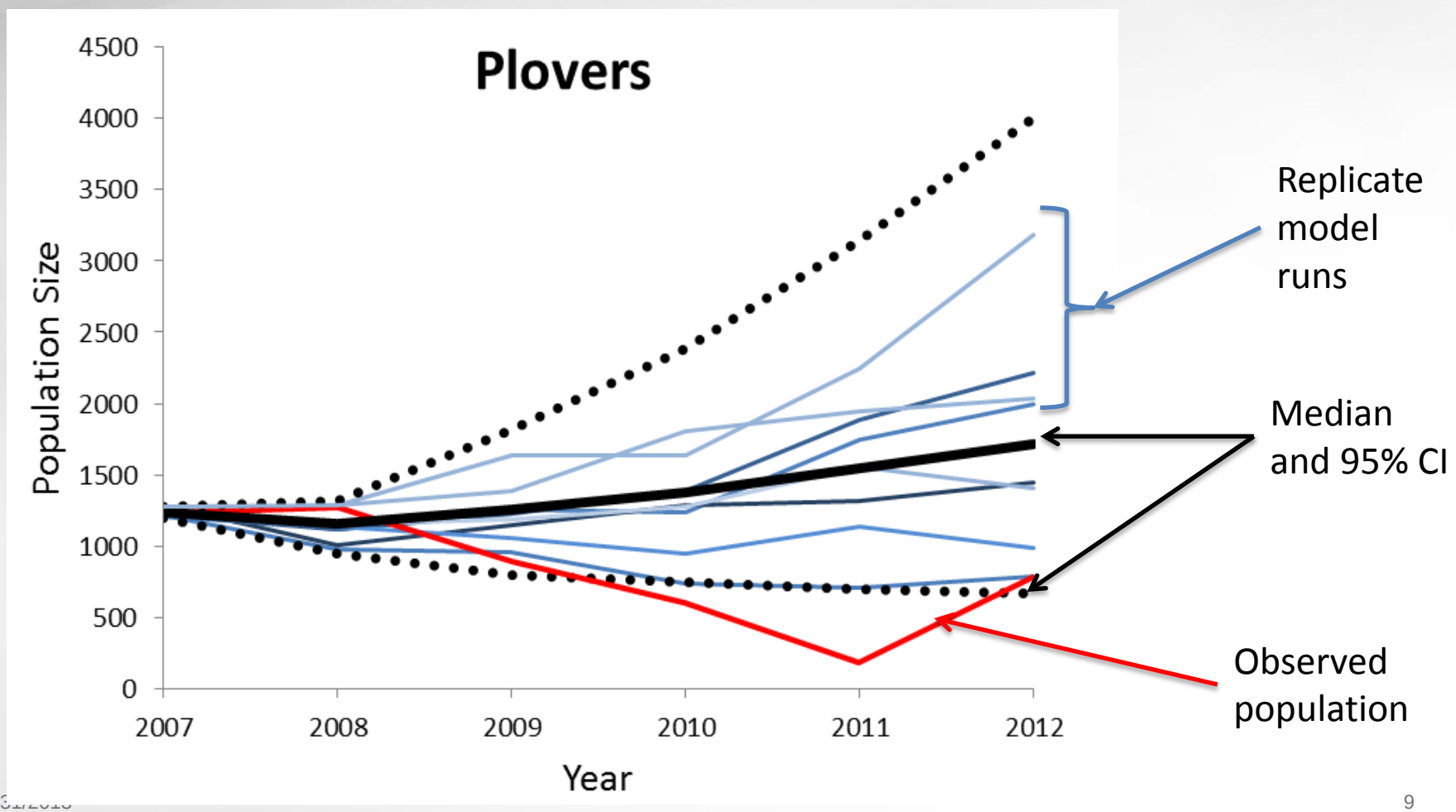




		Alt. 1	Alt. 2	Alt. 3	Alt. 3.5	Alt. 4	Alt. 5	No Build
	Target Acreage	**11,886**	**5,502**	**6,754**	**4,370**	**1,985**	**1,315**	**N/A**
Obj. 1	Tern Fledge Ratio	94.36	94.02	93.68	93.16	92.54	91.52	90.48
	Plover Fledge Ratio	94.8	92.86	93.14	90.96	83.98	77.1	76.12
Obj. 2	Tern Population	4.8	4.98	4.8	5.26	5.4	5.04	4.42
	Plover Population	76.68	74.64	75.46	74.38	71.44	69.54	69.02

Major outcomes of ESH, tern, and plover model

- Model validation: are predictions reasonable?



Major outcomes of ESH, tern, and plover model

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- Predicting impacts of extreme events

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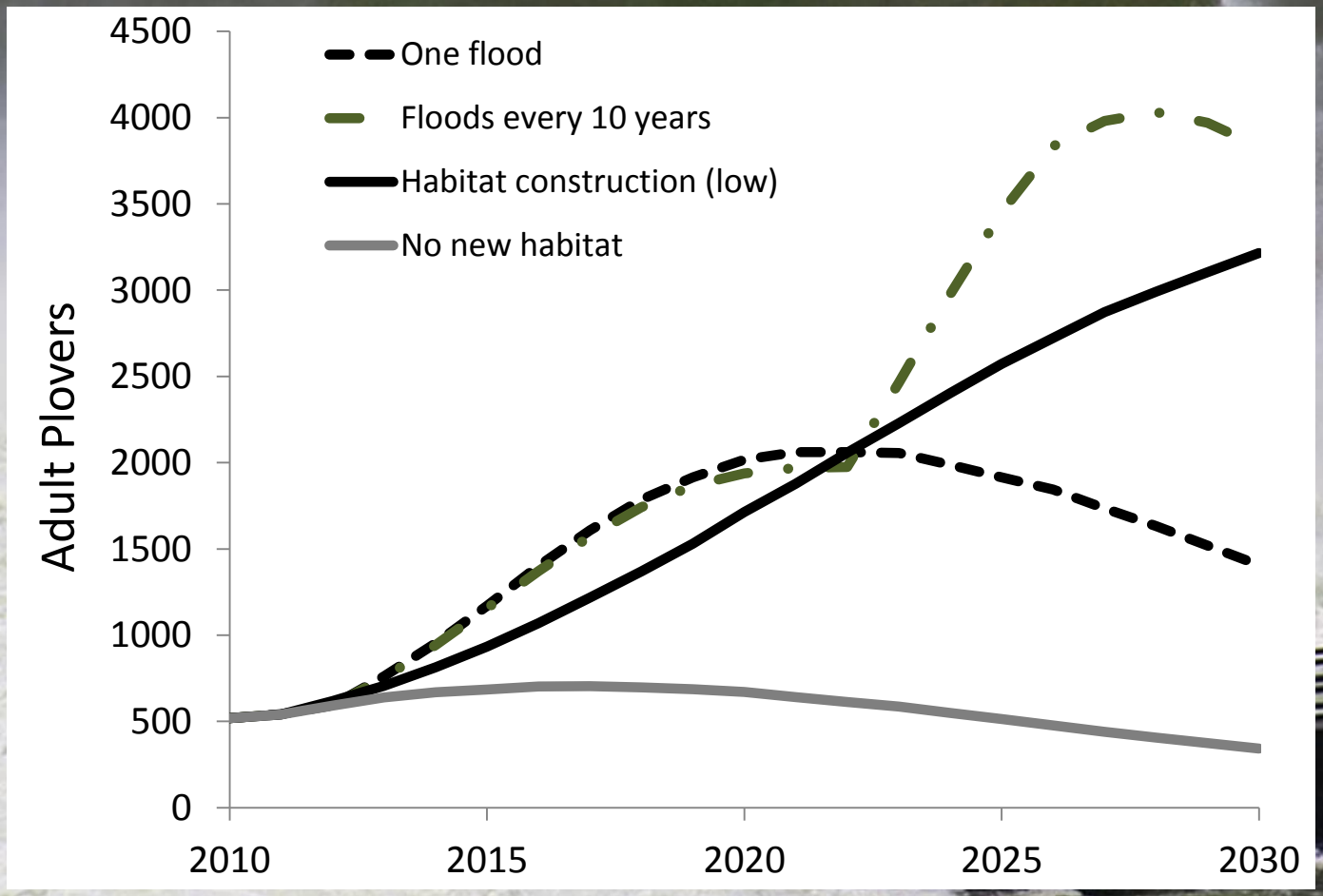
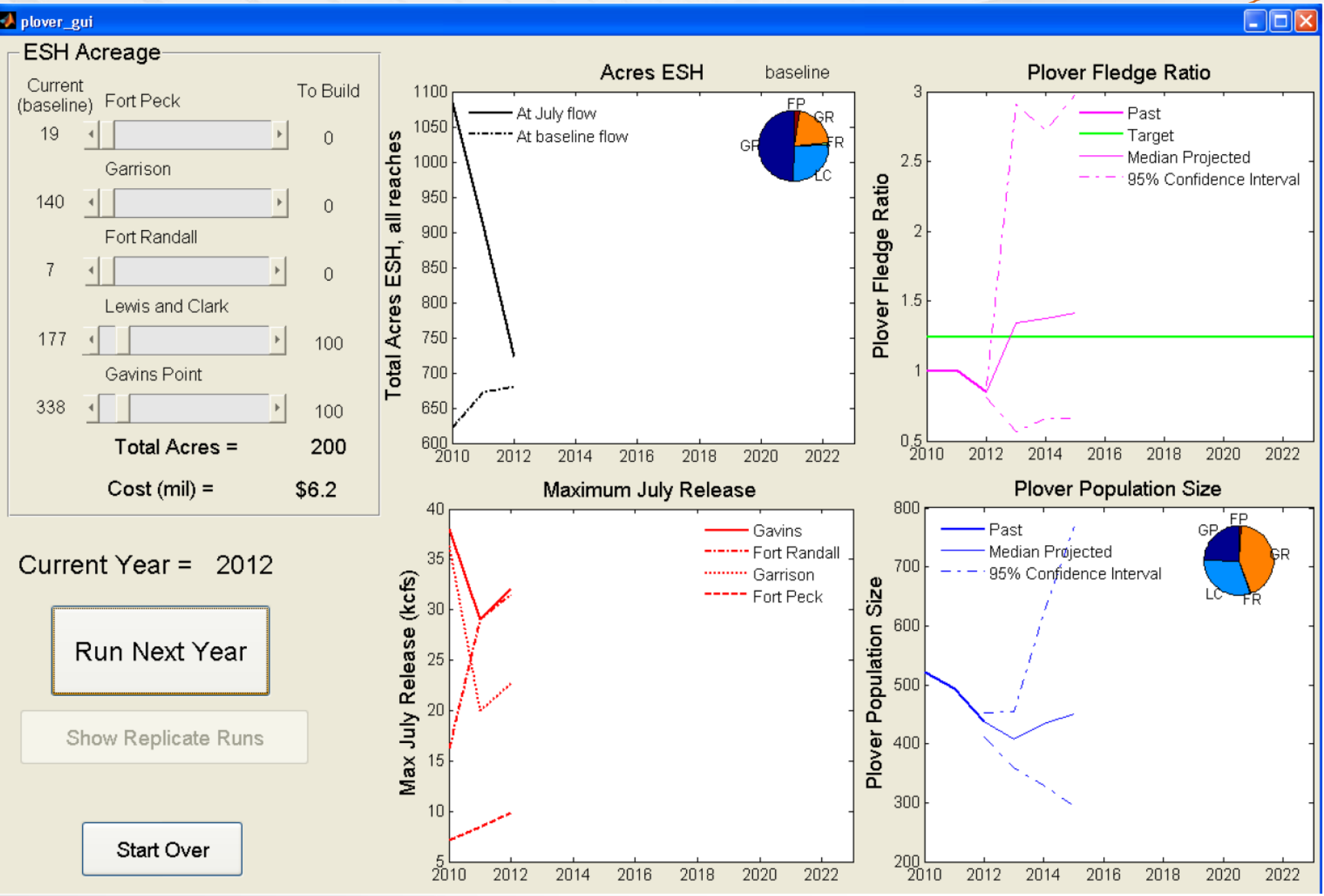


Challenges of ESH, tern, and plover model

- Quantifying habitat and species-habitat relationships from large-scale monitoring data
  - What is habitat?
  - Detection of nesting birds
  - Migration and dispersal
- Making models useful—salience and accessibility


plover_gui
ESH Acreage
Current (baseline)
To Build
Fort Peck
19
0
Garrison
140
0
Fort Randall
7
0
Lewis and Clark
177
100
Gavins Point
338
100
Total Acres = 200
Cost (mil) = $6.2
Current Year = 2012
Run Next Year
Show Replicate Runs
Start Over
Acres ESH
baseline
At July flow
At baseline flow
Total Acres ESH, all reaches
FP
GR
FR
LC
GP
Plover Fledge Ratio
Past
Target
Median Projected
95% Confidence Interval
Maximum July Release
Gavins
Fort Randall
Garrison
Fort Peck
Max July Release (kcfs)
Plover Population Size
Past
Median Projected
95% Confidence Interval

Columbia River Estuary

Biological Opinions in 2000, 2004, and 2008

Recommended to restore 10,000 acres of shallow water habitat for juvenile salmonids

Background: Columbia Estuary

- Hydrological reconnection for juvenile salmonids
- What types of habitat restoration are best? Is restoration working?
- Challenges:
  - Highly variable environment
  - Life history diversity
  - Habitat takes time to develop
  - Use is ephemeral

Objectives for Salmon Estuarine Habitat Index (SEHI)

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- Evaluate effects of hydrological reconnection actions on juvenile salmon growth
- Compare alternative management actions at a site
  - Dike breaches
  - Culverts
  - Tidegates
- Go beyond a habitat suitability index model

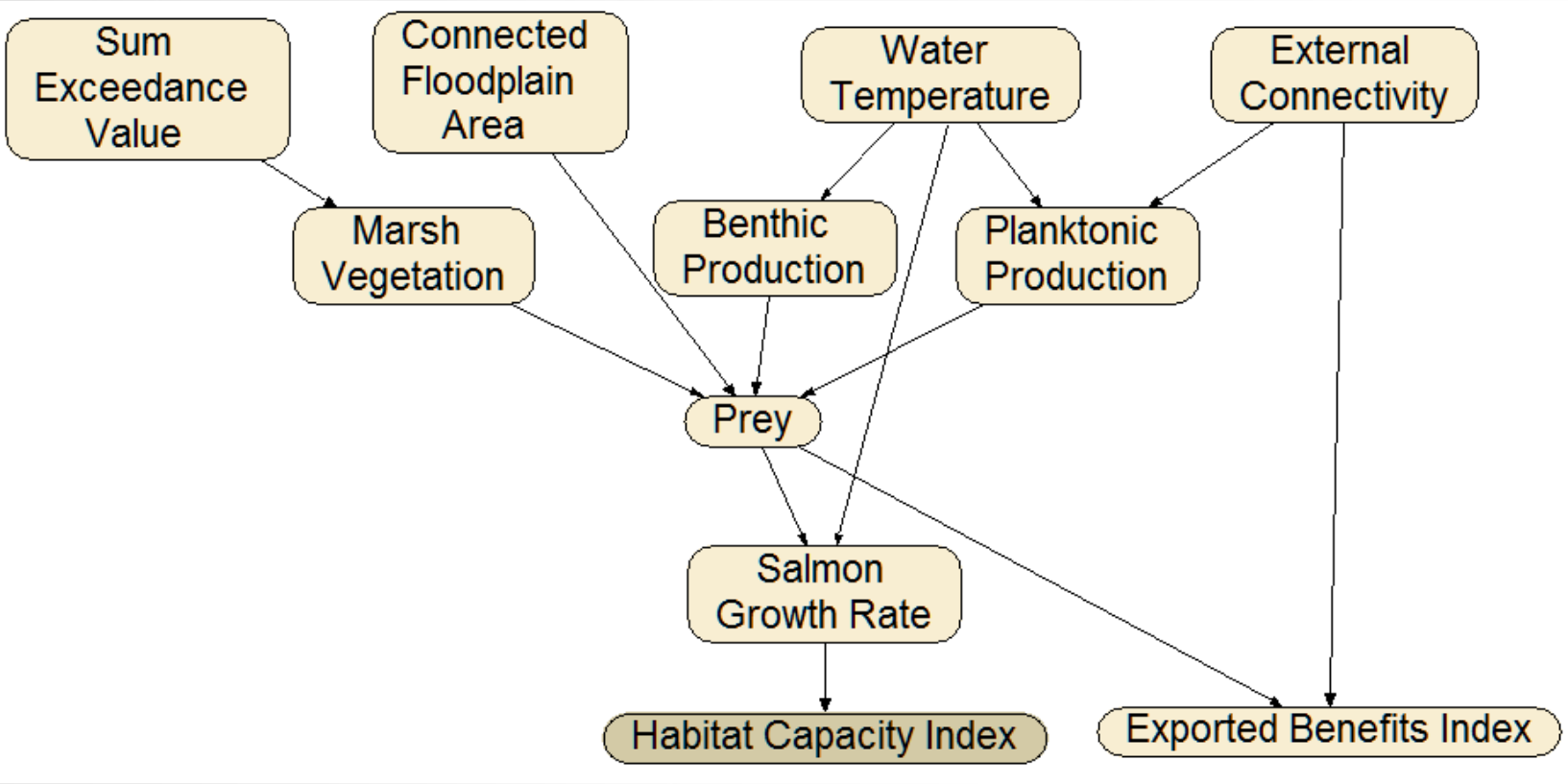
Structure for SEHI

- Developed through rapid prototyping process
- Link physical characteristics to biotic to salmon physiology
- Bayesian Belief Network

Physical

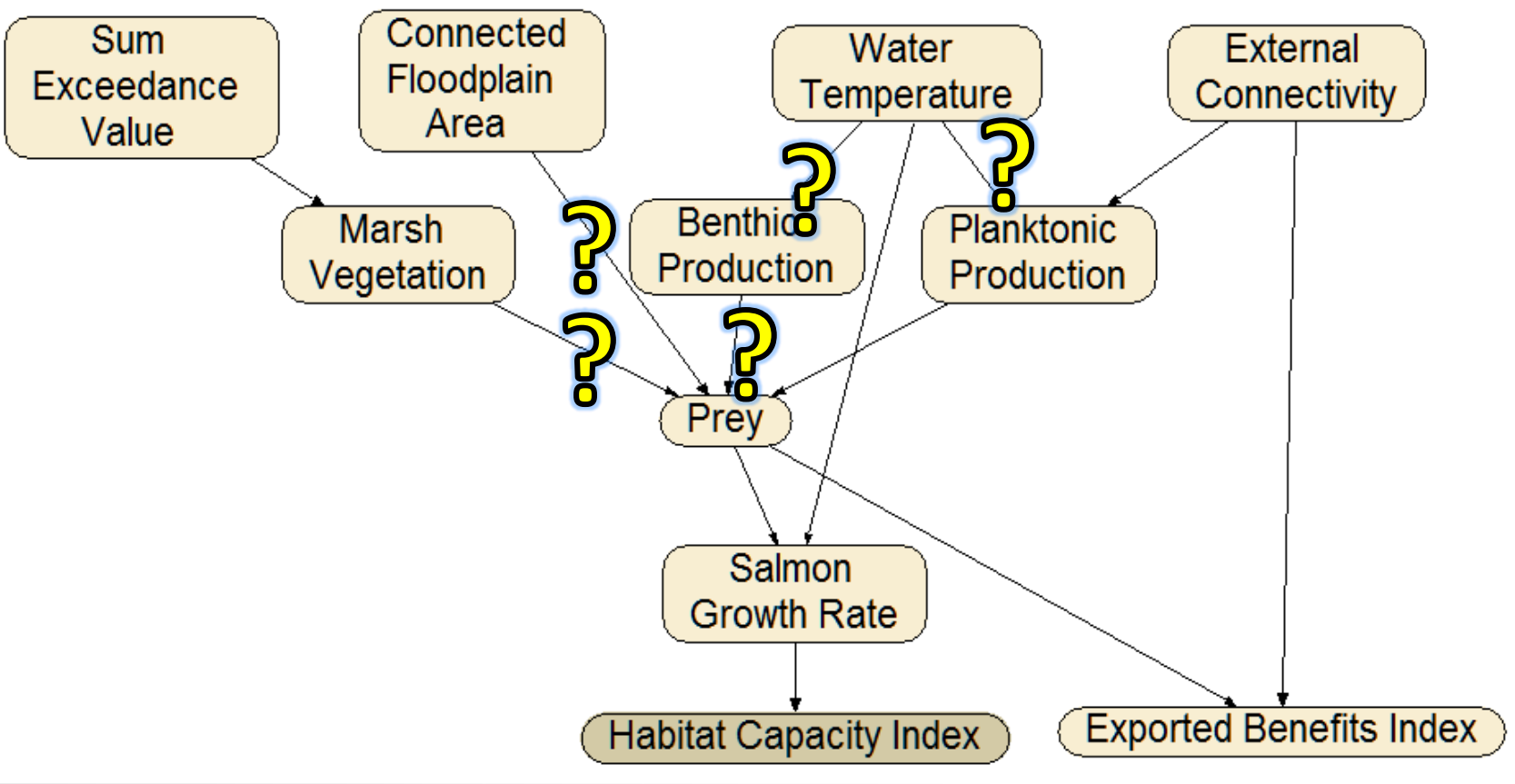
Biotic

Salmon



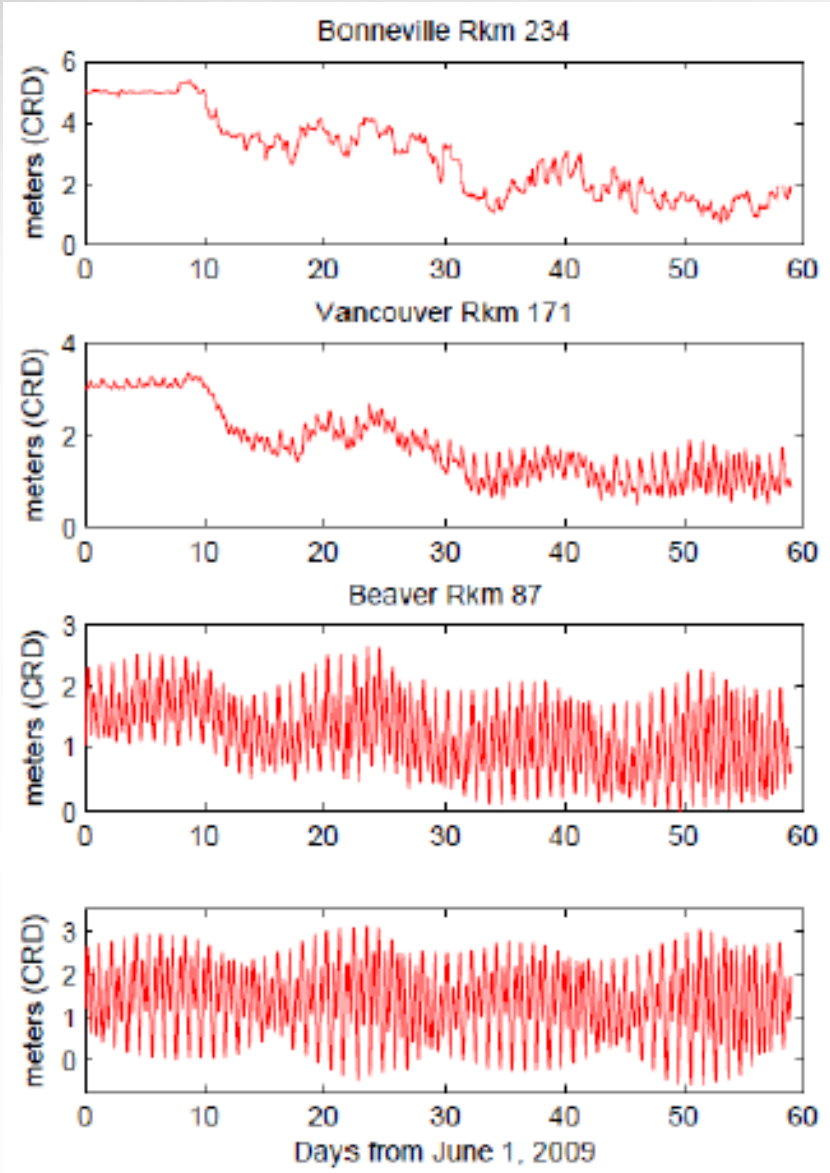
Major outcomes of SEHI

- Working to develop critical model relationships
- Identified data gaps



Challenges for SEHI

- Reliance on limited observational studies
- Difficulty in measuring effects of habitat on juvenile salmon
- Complexity in space and time



Lessons learned from modeling for AM on large rivers

- Primary application of models: assess state of knowledge, understand uncertainty, and estimate the value of information

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  - User interfaces or interactive work sessions

Acknowledgments

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