Ecological Carrying Capacity of RI Aquaculture

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COASTAL INSTITUTE

UNIVERSITY OF Rhode Island

Oyster Aquaculture

Oyster production = 97% RI aquaculture

RI Aquaculture Growth

Year	Industry	Number of Farms
2001	$300,000	18
2006	$ 1.3 million	28

Wild harvest clams

www.museum.state.il.us/.../roll2/inhs_07_300.jpg

www.capemaytimes.com/.../images/06clamming5.jpg

www.museum.state.il.us/.../roll2/inhs_07_300.jpg

Working Group
Biology Subcommittee

Limit aquaculture to 5 percent of R.I. waters, experts say

Providence Journal **Sunday, March 2, 2008**

Journal file photo / Bill Murphy

Carrying Capacity

- Physical: total area of marine farms that can be accommodated in the available physical space
- Production: the stocking density of bivalves at which harvests are maximized
- Ecological: the stocking or farm density which causes unacceptable ecological impacts
- Social: the level of farm development that causes unacceptable social impacts

Inglis *et al.* 2000

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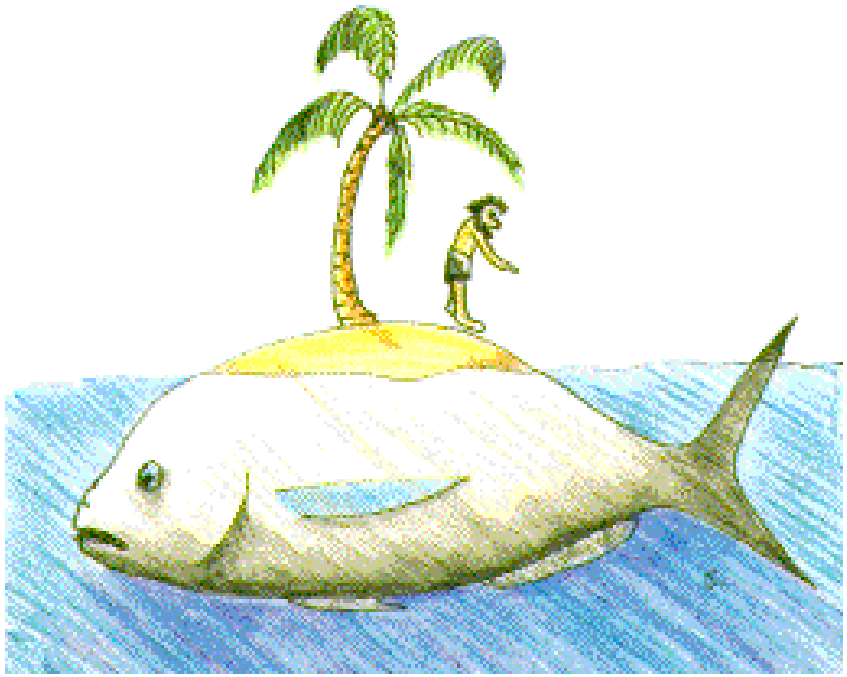

No fish is an Island

Ecopath

It signifies that all living organisms are linked together.
In the oceans, for example,
despite our great impact,
we are only one of many predators.
We must learn to behave responsibly in a realm
where we are the intruders.

65 t km^{-2} yr^{-1}

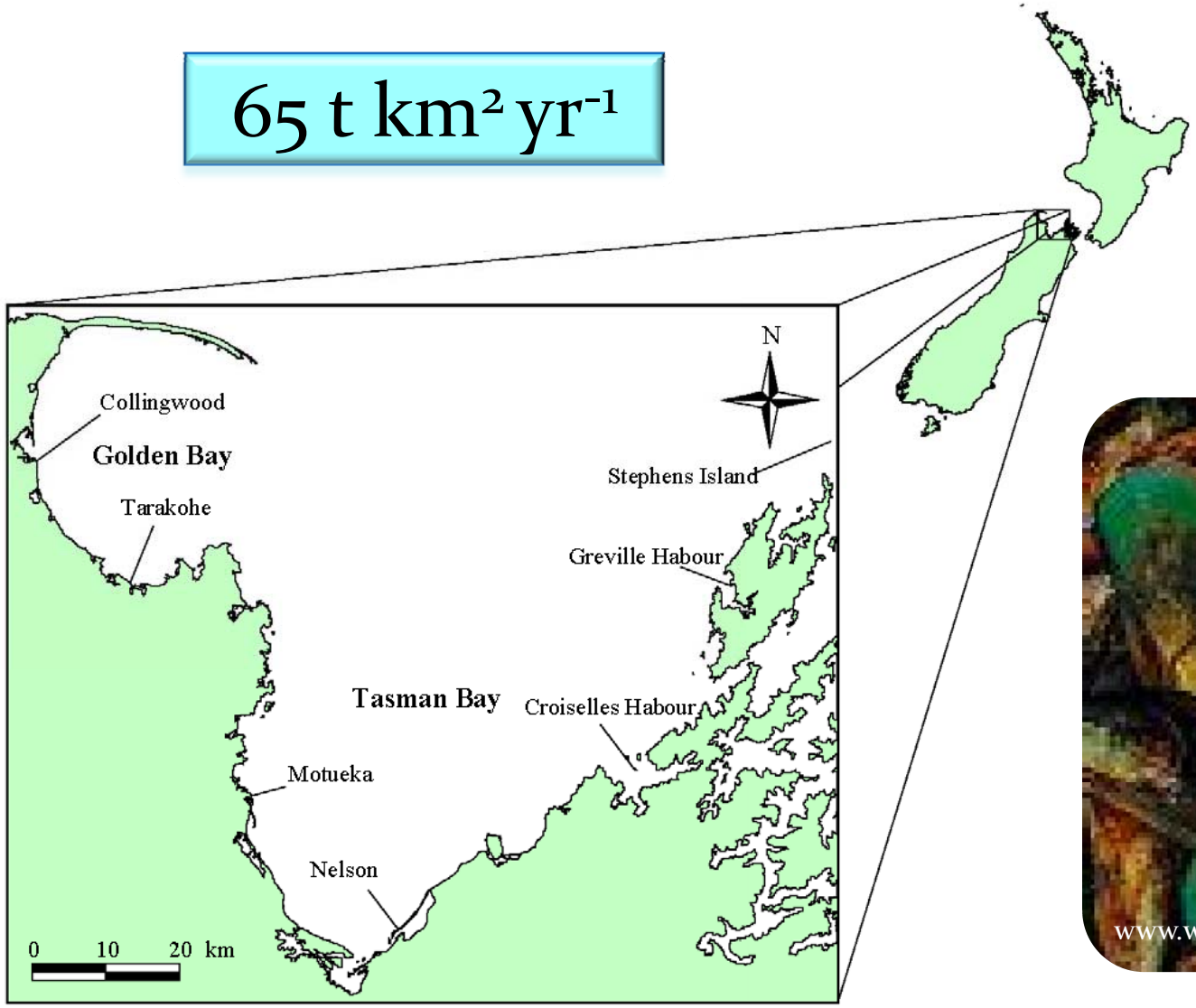

Fig. 1. Map showing Golden and Tasman Bays, northern end of the South Island of New Zealand.

Determine ecological carrying capacity using Ecopath model

What do we know &
need to know
to build the model ?

White Paper

Adapt Existing Model for Narragansett Bay

- Permission to use model
- Outline steps

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Build New Model of RI salt ponds

- Outline steps using Ecopath
- Report parameter estimates

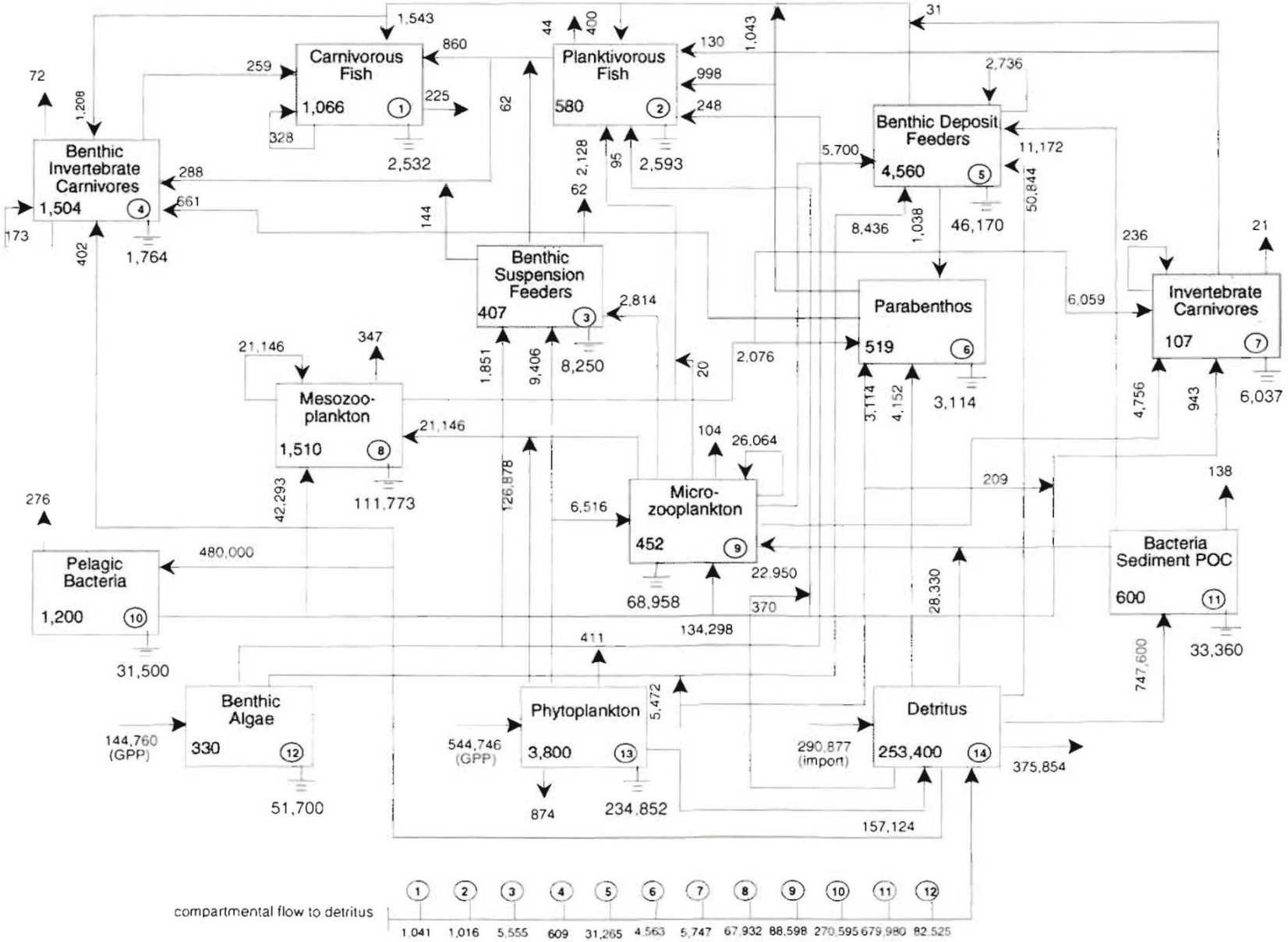
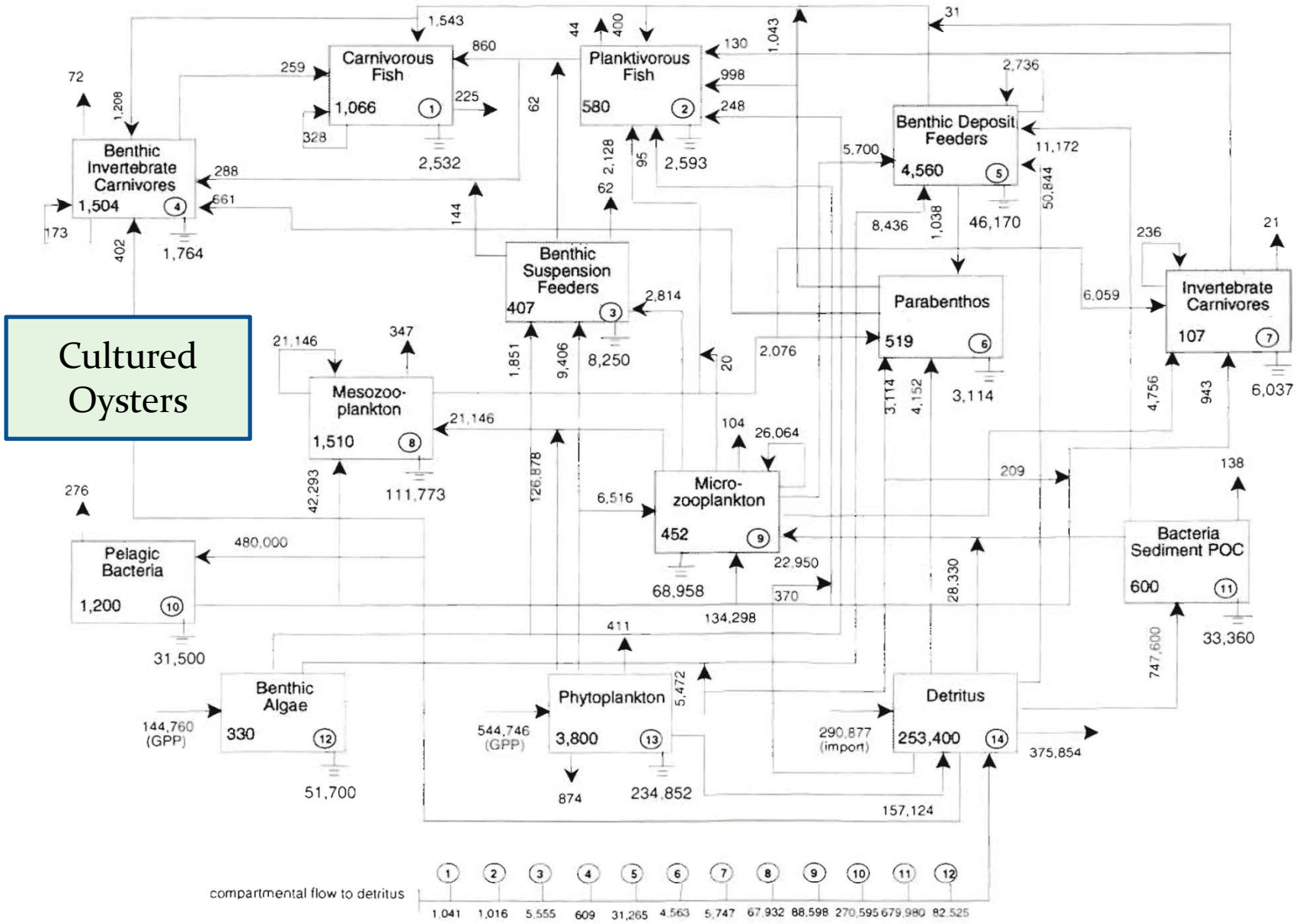


Fig. 2. Average annual energy flow (mg C m^{-2} yr^{-1}) and compartmental biomass (mg C m^{-2}) in Narragansett Bay



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Calculate Carrying Capacity

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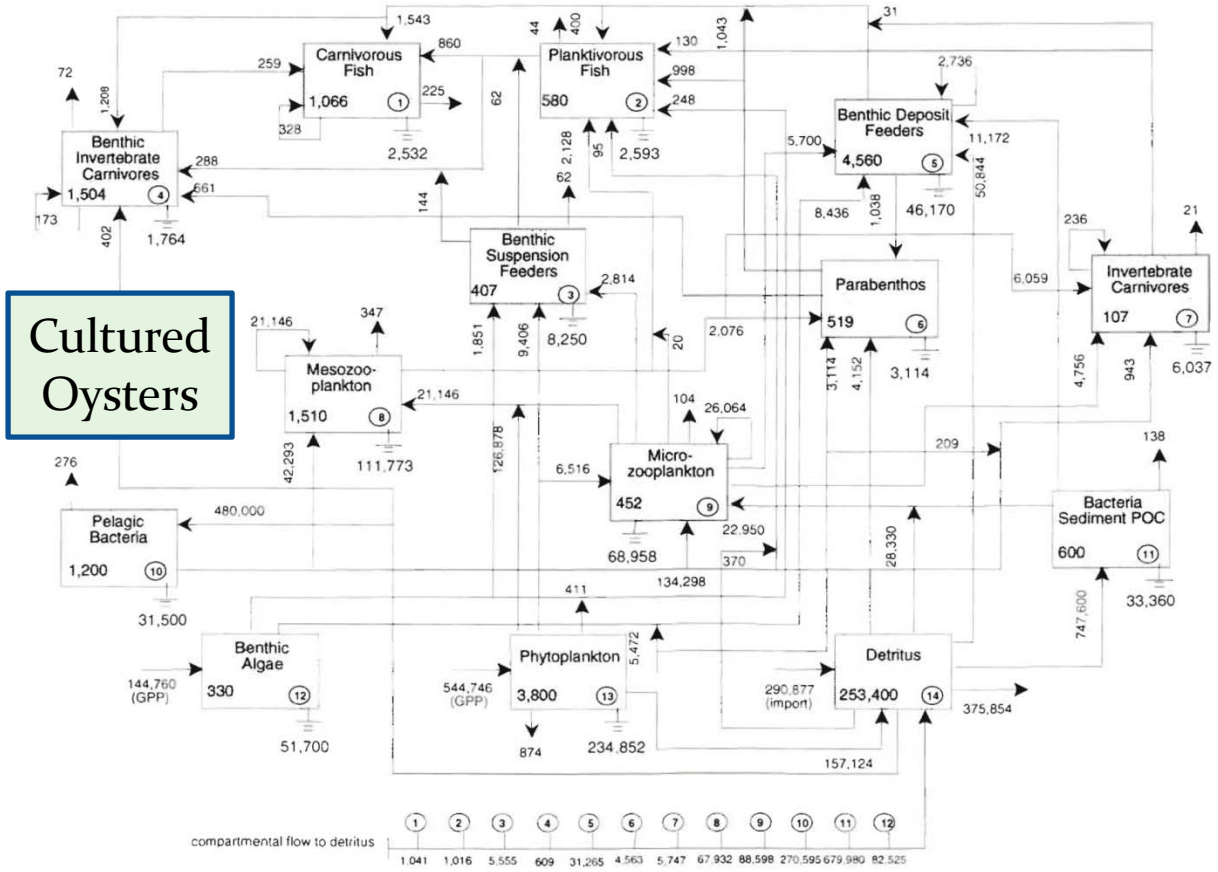

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Sea Grant
South Shore Watersheds
Saugatucket
Pawcatuck
Wequetequock
Point Judith
Winnipaug
Trustom
Cards
Potter
Green Hill
Ninigret
Little
Narragansett
Bay
Maschaug
Quononchontaug
Miles

Procedure

1. Identify Groups
2. Estimate Parameters
3. Estimate Confidence Intervals
4. Balance Equations
5. Ecosim: Solve Equations
6. Ecospace: Design Spatial Grid
7. Determine parameters at each grid point
8. Solve Ecosim equations at each grid point

Pfeiffer-Herbert 2007
Christensen & Walters 2004

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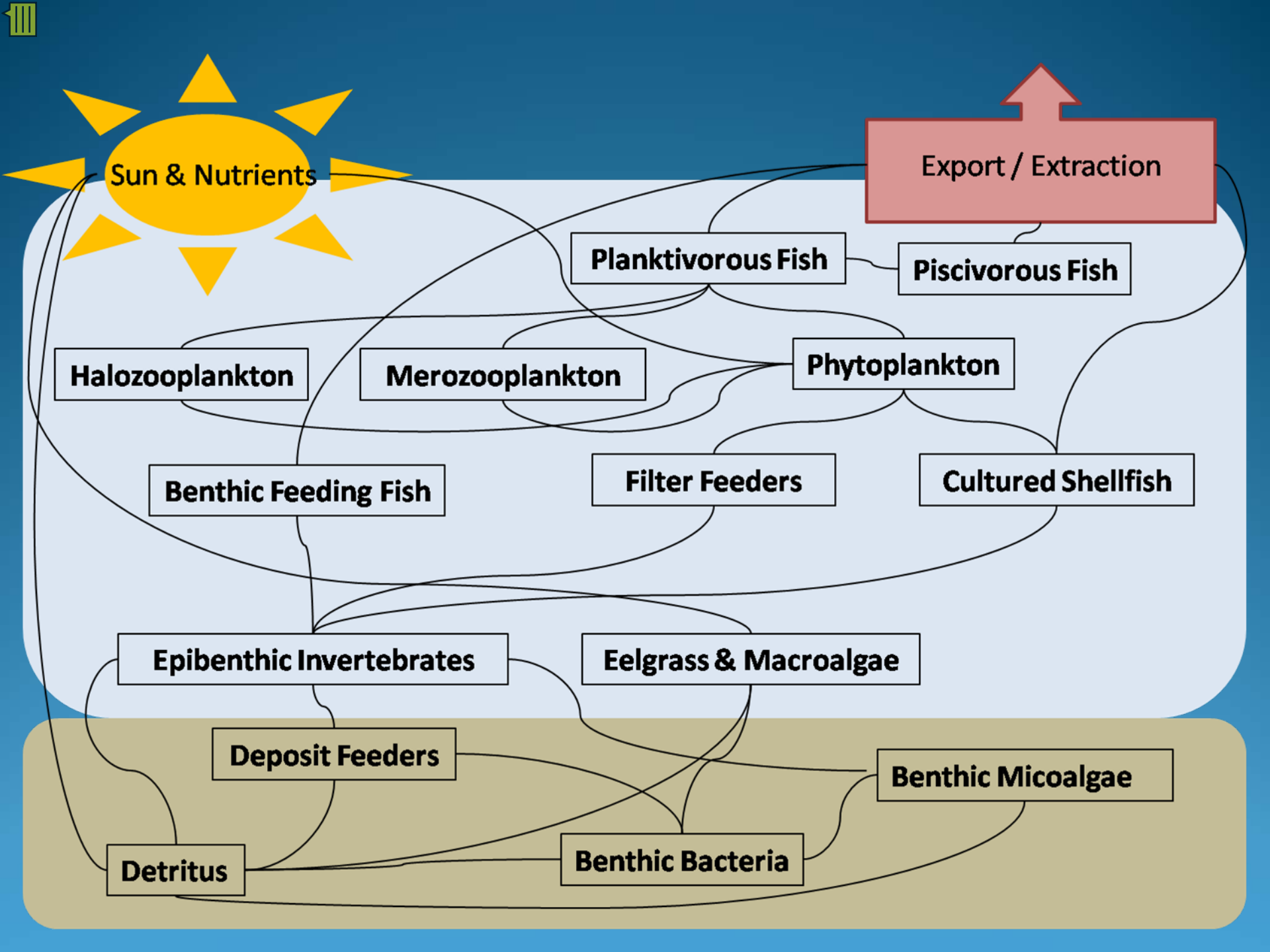
Sun & Nutrients
Export / Extraction
Planktivorous Fish
Piscivorous Fish
Halozooplankton
Merozooplankton
Phytoplankton
Benthic Feeding Fish
Filter Feeders
Cultured Shellfish
Epibenthic Invertebrates
Eelgrass & Macroalgae
Deposit Feeders
Benthic Micoalgae
Detritus
Benthic Bacteria

Functional Group	Species Common Name
Detritus	
Benthic Microalgae	Diatoms, dianoflagellates, cyanobacteria
Benthic Bacteria	
Deposit Feeders	Polychaete Worms
	Benthic copepods
Eelgrass & Macroalgae	Eelgrass
	Red algae
	Green algae
Epibenthic Invertebrates	Crabs
	Grass shrimp
	Amphipods
	Juvenile lobster
	Mud snail
Benthic Feeding Fish	Tautog
	Cunner
	Black Sea Bass
	Scup
	Winter Flounder

Filter Feeders	Oysters
	Clam
	Slipper limpet
	Ascidians, Tunicates, Sea Squirts
	Clam
	Annelid worms
Cultured Oysters	Oysters
Phytoplankton	
Halozooplankton	Pelagic Copepods
Merozooplankton	Crustacean larvae (Nauplii)
	Bivalve larvae
	Fish larvae
Planktivorous Fish	Silversides
	Menhaden
	Mummichog
	Striped Kilifish
	Sheepshead Minnows
	Ctenophores
	Lions Mane Jelly
Piscivorous Fish	Bluefish
	Striped bass

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3. .
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3

Pond Data

- Peer Review Literature
  - Macro-algae
  - Eelgrass
  - Productivity
  - Physical
  - Flushing rates

www.pubs.usgs.gov
www.horta.uac.pt
www.cybercolloids.net
www.solpugid.com/cabiota/ulva_lobata.jpg

Pond Data

- DEM
  - Larval fish : Quonnie, Pt. Judith, Ninigret, Winnapaug
  - Finfish : Quonnie, Pt. Judith & Potters
  - Shellfish : RI aquaculture, Narr Bay Quohogs
- Pond Watchers
  - Productivity
- RI South Shore Sea Grant Project
  - Physical
- MapCoast
  - Habitat

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4. Balance Equations

Production =

predation

+fishery

+ other mortality

+ biomass accum.

+ net migration

4. Balance Equations

Production =
predation
+fishery
+ other mortality
+ biomass accum.
+ net migration

Consumption =
production
+ unassimilated food
+ respiration

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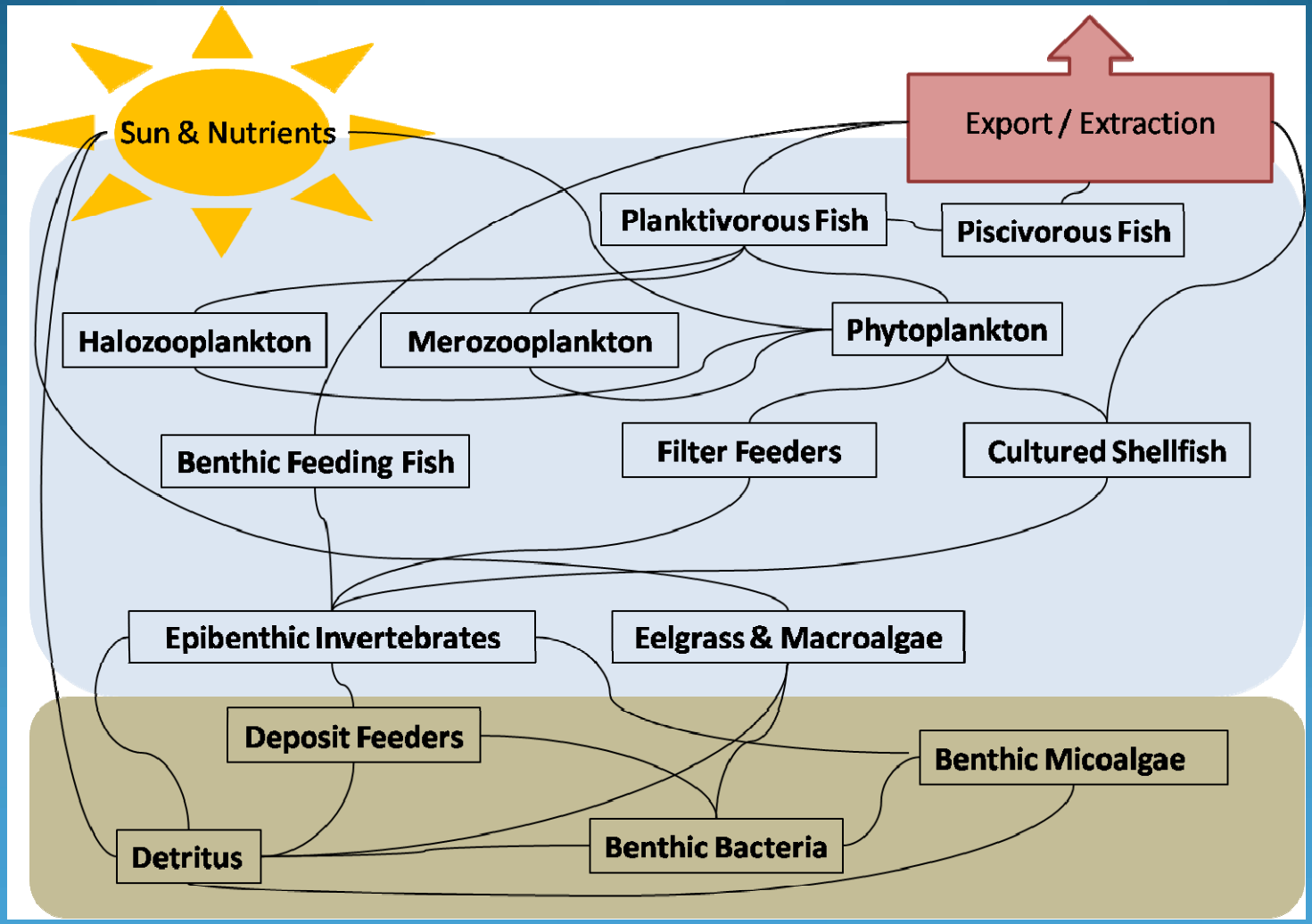

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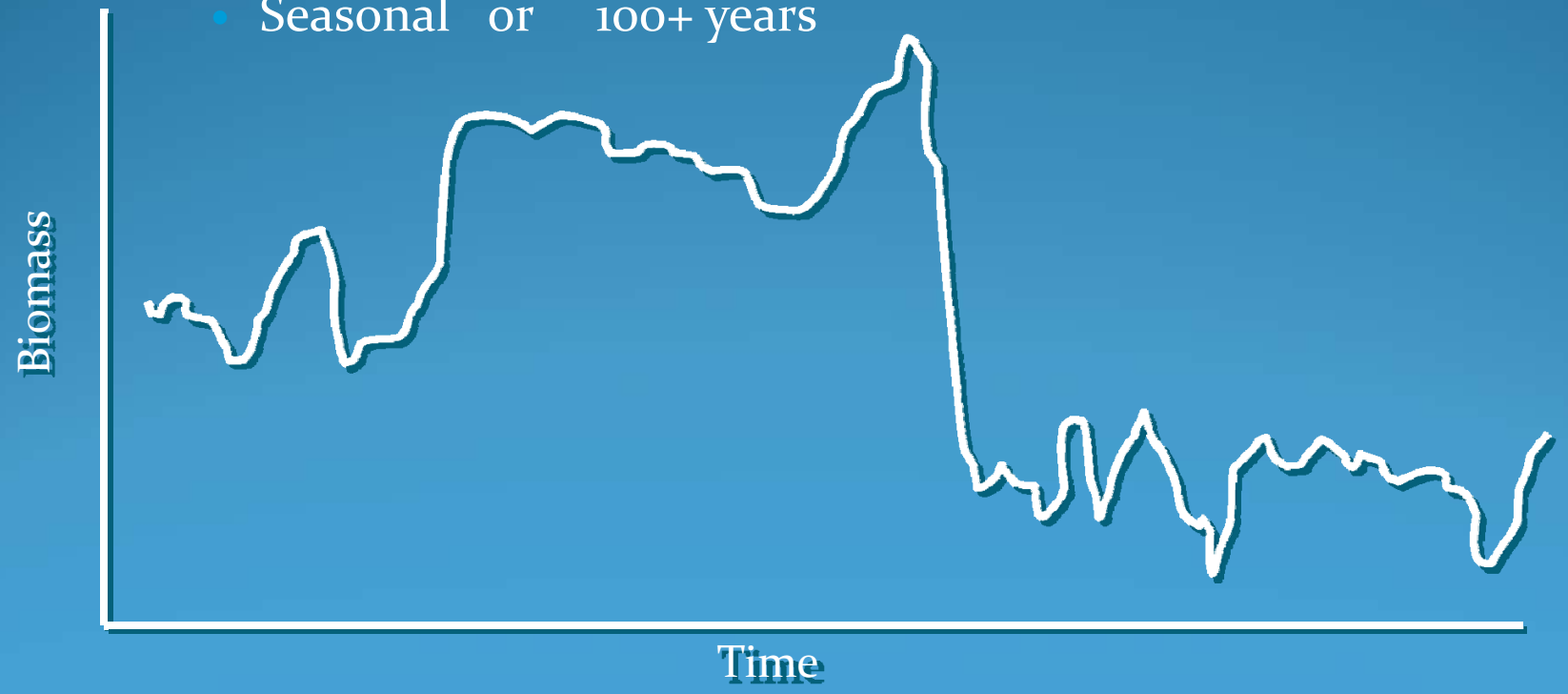
5. Ecosim

- Temporal variability in biomass
  - Repeated simulations
  - Forcing functions
    - Seasonal or 100+ years



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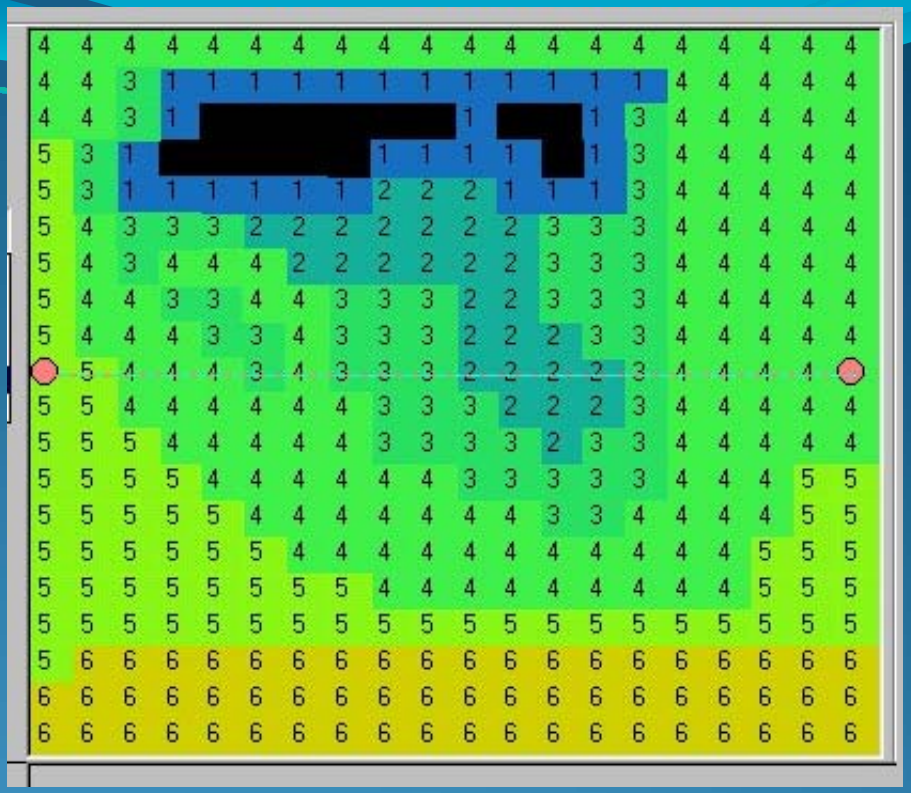

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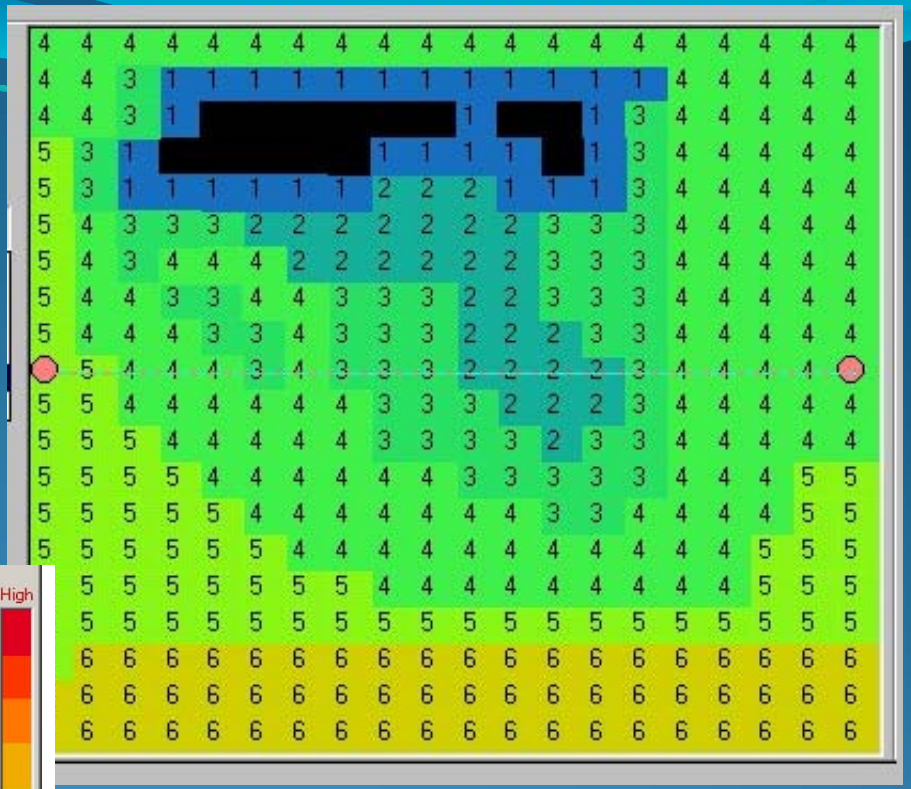

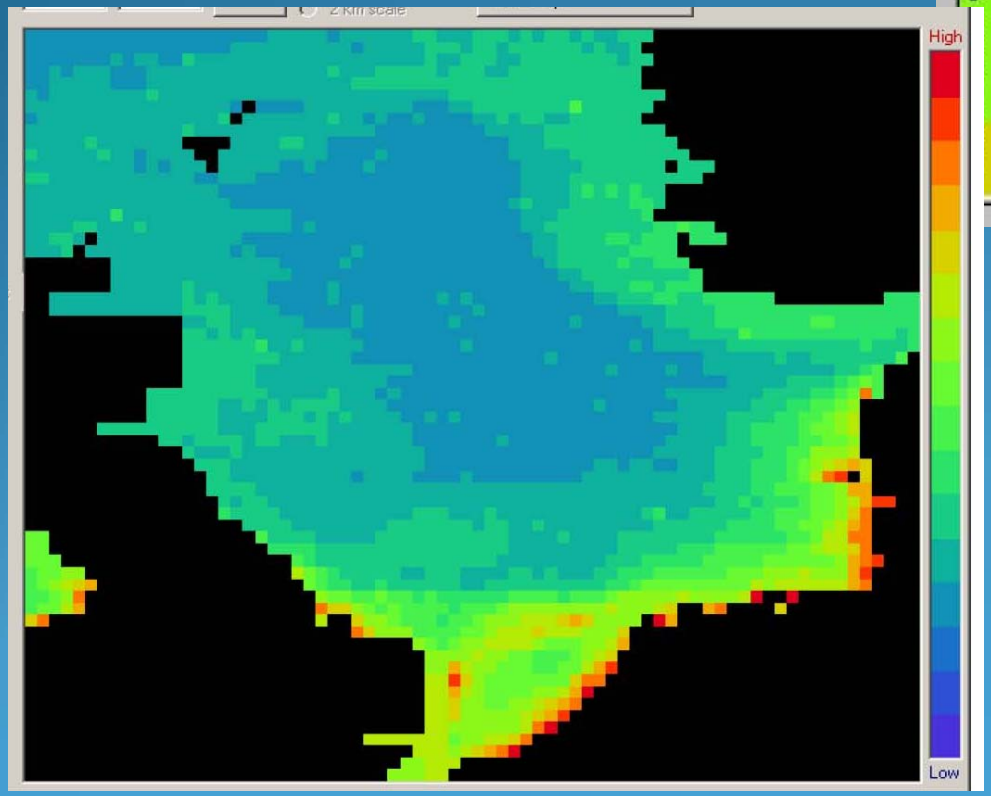

3D-gaming engine driven by EwE

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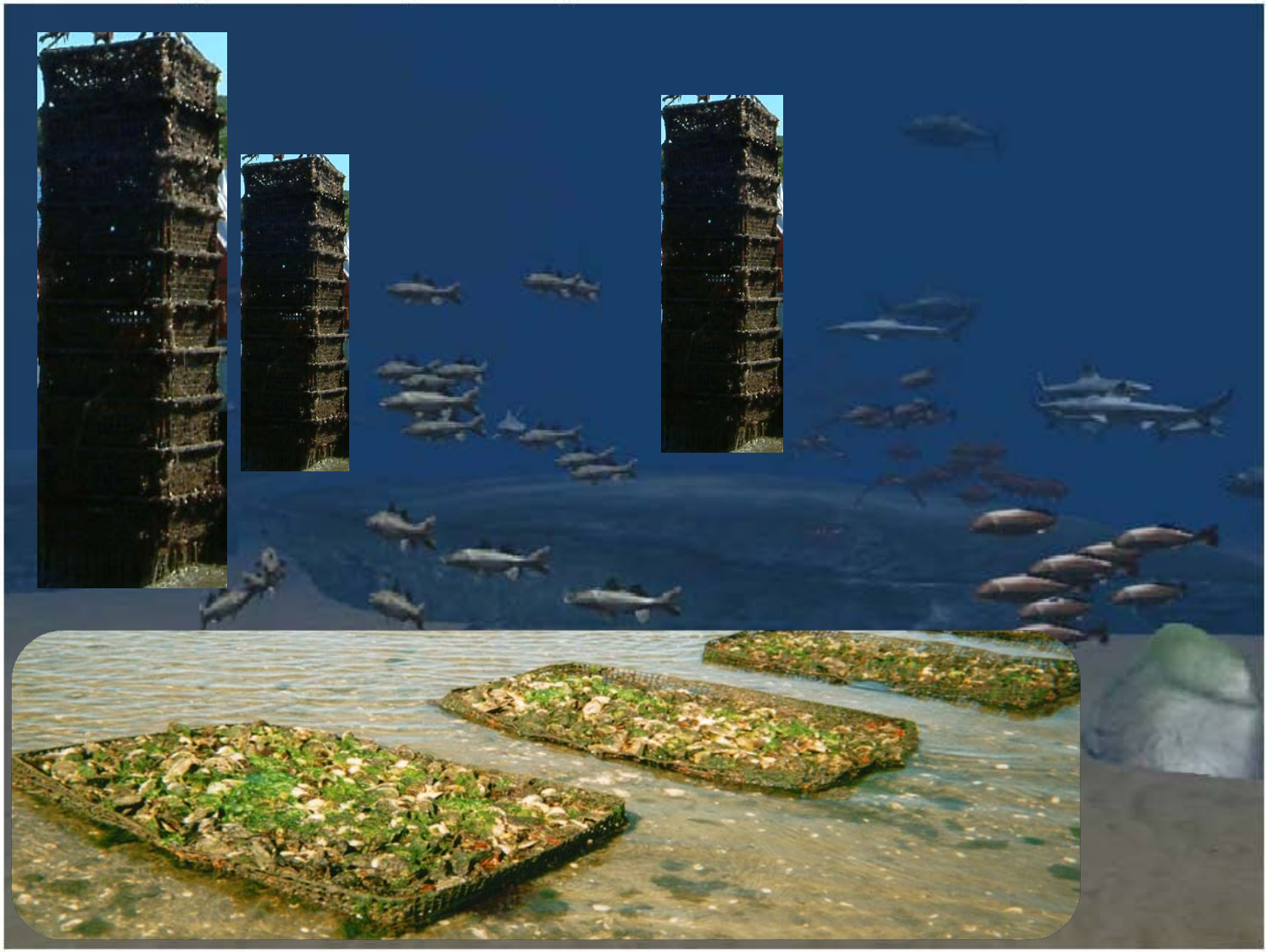


Recommendations

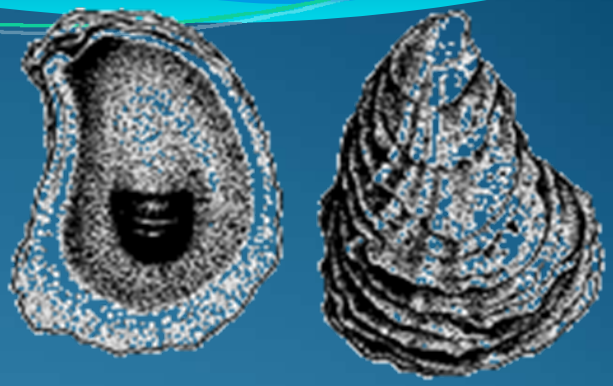
Narragansett Bay

1. Add ‘cultured oysters’ group

Salt Ponds

1. Rescale Narr Bay model
2. Build new model
   - Limited data in ponds
   - Infer parameters from other locations

Acknowledgements



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