Linking habitat to fishery productivity

Correigh Greene
NW Fisheries Science Center
Seattle WA

NOAA Fisheries' vision of habitat science: The Habitat Assessment Improvement Plan (HAIP)

- Improve use of habitat information in stock assessments and other management tools
  - habitat-dependent abundance expansions
  - survey gear catchability
  - temporally-dynamic habitat metrics
- Refine EFH to higher levels
  - Level 1 – presence/absence
  - Level 2 – abundance
  - Level 3 – habitat-specific vital rates
  - Level 4 – production

Talk overview

- Habitat in California Current Integrated Ecosystem Assessment (CCIEA)
- National Fish Habitat Partnership's (NFHP) estuary habitat assessments
- Inshore-offshore pilot projects

Habitat in the context of the California Current IEA

Focal Ecosystem Components

Mediating Components

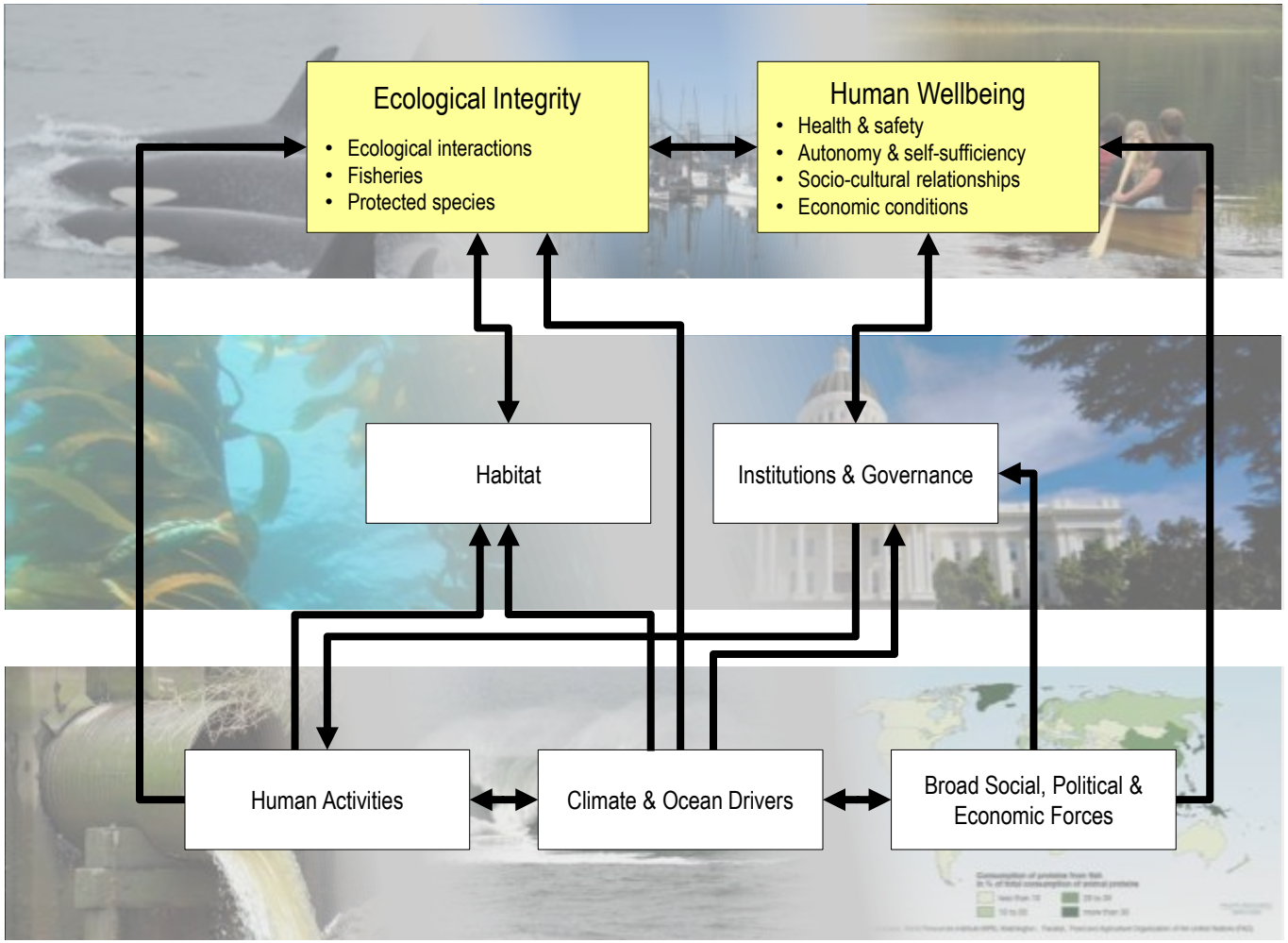
Drivers and Pressures

Habitat in the context of the California Current IEA

Focal Ecosystem Components

Mediating Components

Drivers and Pressures



Three core questions of the IEA

Is the ecosystem “healthy”?

ENGAGEMENT

INDICATORS AND REFERENCE POINTS

How vulnerable is the ecosystem to human uses and natural perturbations?

RISK ANALYSIS

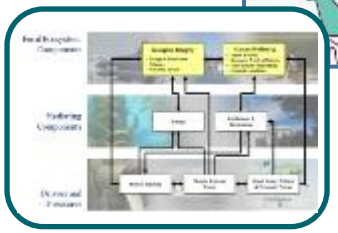
- **Assess** the vulnerability of biophysical attributes to current and future impacts
- **Assess** the cumulative effect of overlapping activities and impacts
- **Assess** the likely impacts of climate change

Now what do we do?

SCENARIO ANALYSIS

- **Identify** possible alternative futures
- **Evaluate** the likely tradeoffs associated with management alternatives

The CCIEA in action



CONCEPTUAL MODELS and SCOPING EFFORTS help frame the issues

Is the ecosystem “healthy”?

Fiel
provide
STATUS AND TRENDS

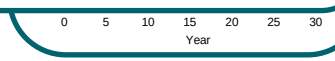
How vulnerable is the ecosystem to human uses and natural perturbations?

RISK

Exposure

Now what do we do?

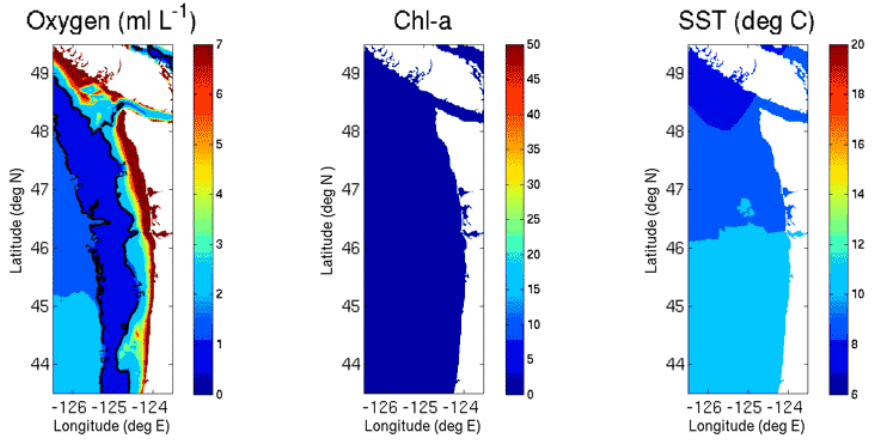
SC
ge
of
fut
tradeoffs



IEA PRODUCTS

The CCIEA in action

Example: forage fish and climate change



- **In-season climate scenarios**
- Coarse forecasts of ocean conditions (6-9 months ahead)
- Related to presence/ absence of sardines

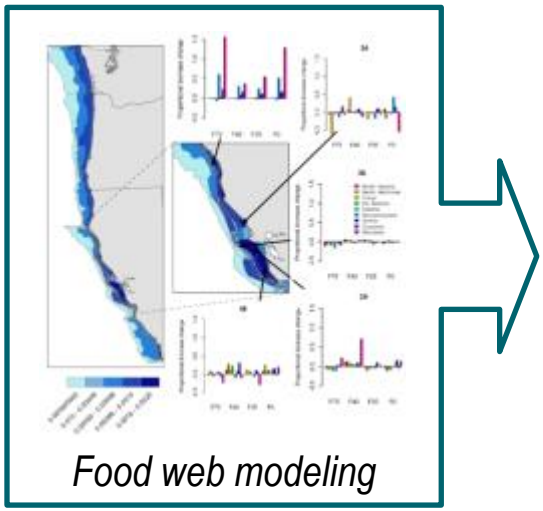
http://www.nanoos.org/products/j-scope/forecasts.php

J-SCOPE

The CCIEA in action

Example: forage fish and climate change

- **How are other groups affected by long-term decline in forage fish biomass?**



Food web modeling

Increase


Microzooplankton


Krill


Squid


Mesopelagic fish


Mackerel

Salmon

Coastal sharks

Decrease


Copepods


Crabs


Yelloweye rockfish


Cowcod


Seabirds & pinnipeds?

The CCIEA in development

Other scenarios: Habitat conservation measures

- What are the fisheries economic costs and benefits of revisions to groundfish EFH?
- How are commercial fisheries affected by coastal development activities?
- How will habitat conservation activities improve sustainable fisheries?

Three core questions of the IEA

Is the ecosystem “healthy”?

ENGAGEMENT

INDICATORS AND REFERENCE POINTS

How vulnerable is the ecosystem to human uses and natural perturbations?

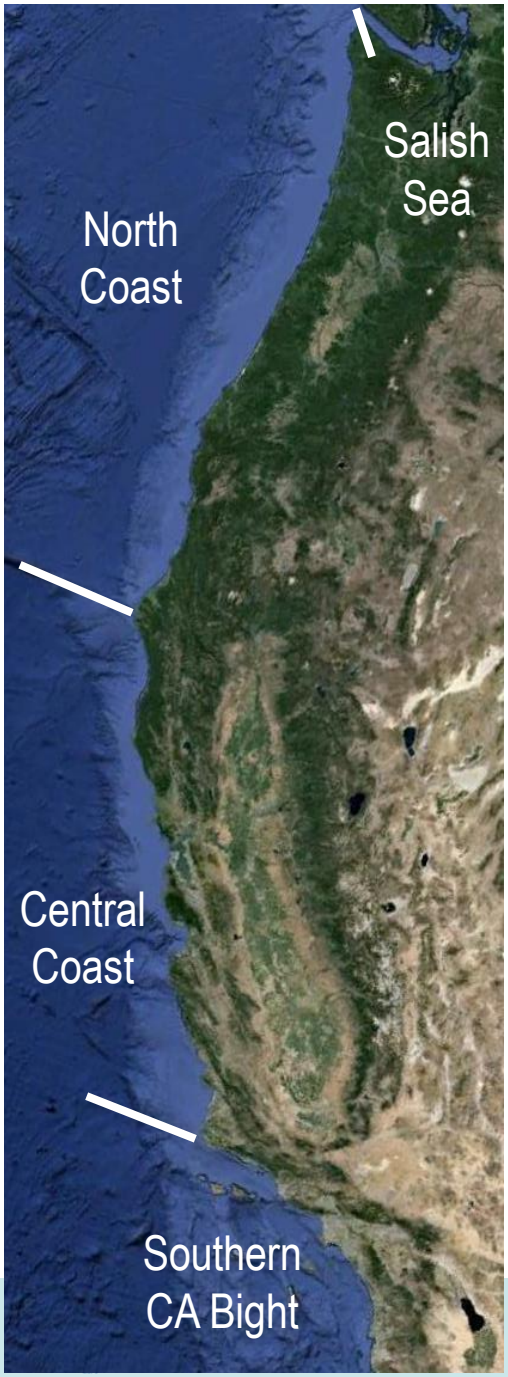
RISK ANALYSIS

- **Assess** the vulnerability of biophysical attributes to current and future impacts
- **Assess** the cumulative effect of overlapping activities and impacts
- **Assess** the likely impacts of climate change

Now what do we do?

SCENARIO ANALYSIS

- **Identify** possible alternative futures
- **Evaluate** the likely tradeoffs associated with management alternatives



Elements of spatial framework

Rivers: NHD+ to head of tide

Estuaries: NHD+, DEM, Lidar, bathymetry, head of tide to shoreline (4-10 m depth)
SAV & substrate maps desirable

Nearshore: Littoral drift cells of shoreline, 30-50 m depth contour to seafloor (photic zone),
SAV & substrate maps desirable

Seafloor: Ecoregional breaks, depth zones (shelf, upper slope, lower slope), 30-50 m to EEZ,
Substrate maps available (Groundfish synthesis)

Pelagic zone: Major ecoregional breaks, 30-50 m to EEZ

Talk overview

- Habitat in California Current Integrated Ecosystem Assessment (CCIEA)
- National Fish Habitat Partnership's (NFHP) estuary habitat assessments
- Inshore-offshore pilot projects

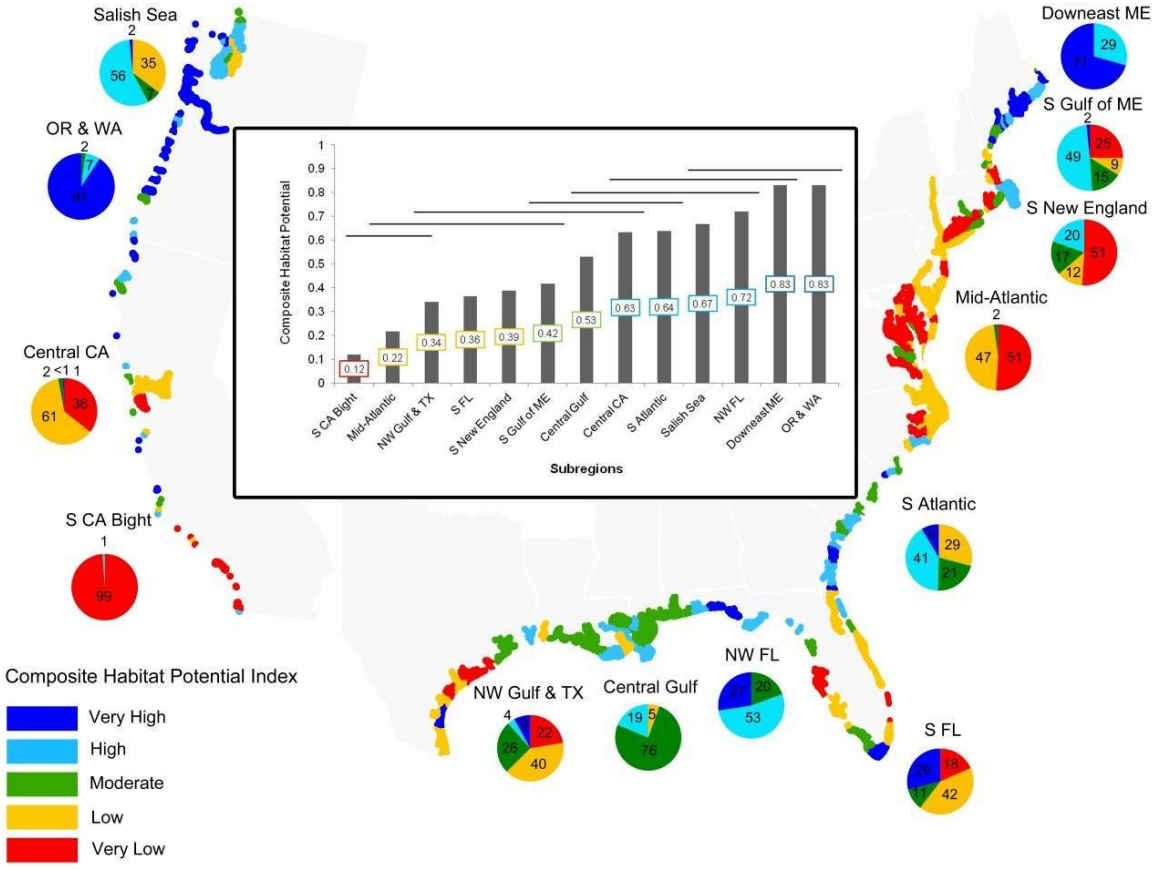
National Fish Habitat Partnership's Estuary and Coastal Assessment

National Fish Habitat Action Plan goals:

- National assessments of aquatic habitats every 5 years
- Establish habitat condition scores for all US aquatic habitats from the mountains to continental shelf

2010 National Estuary Assessment

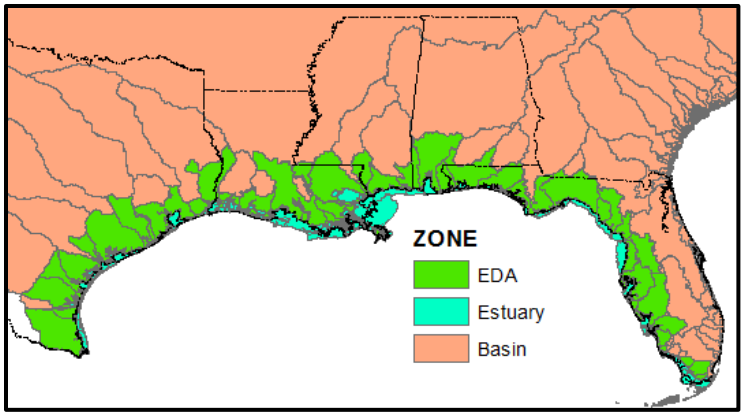
- Established a multi-scale geospatial framework for contiguous U.S.
- Assembled an index of estuary condition based on national data sets of landscape disturbance
- Did not include biological response data (i.e. fish abundance)



http://ecosystems.usgs.gov/fishhabitat/

Gulf of Mexico assessment

- 45 estuaries in the northern Gulf of Mexico
- Evaluates effects of anthropogenic activities at landscape scales on fish populations
- Approach can be readily replicated in other regions



Spatial Units

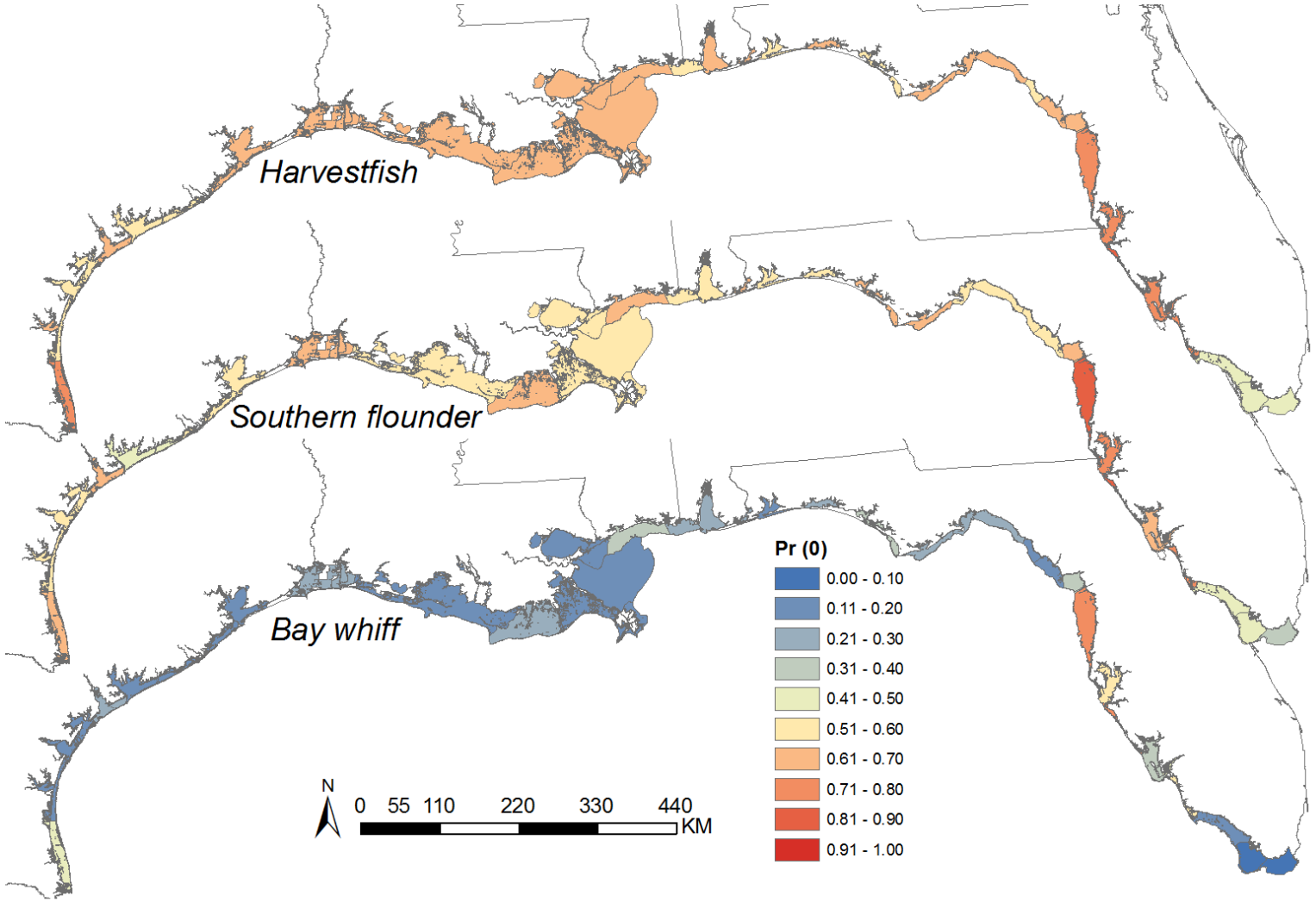
Estuary = shoreline to 4m depth contour

Shoreline = 500m buffer around estuary polygon

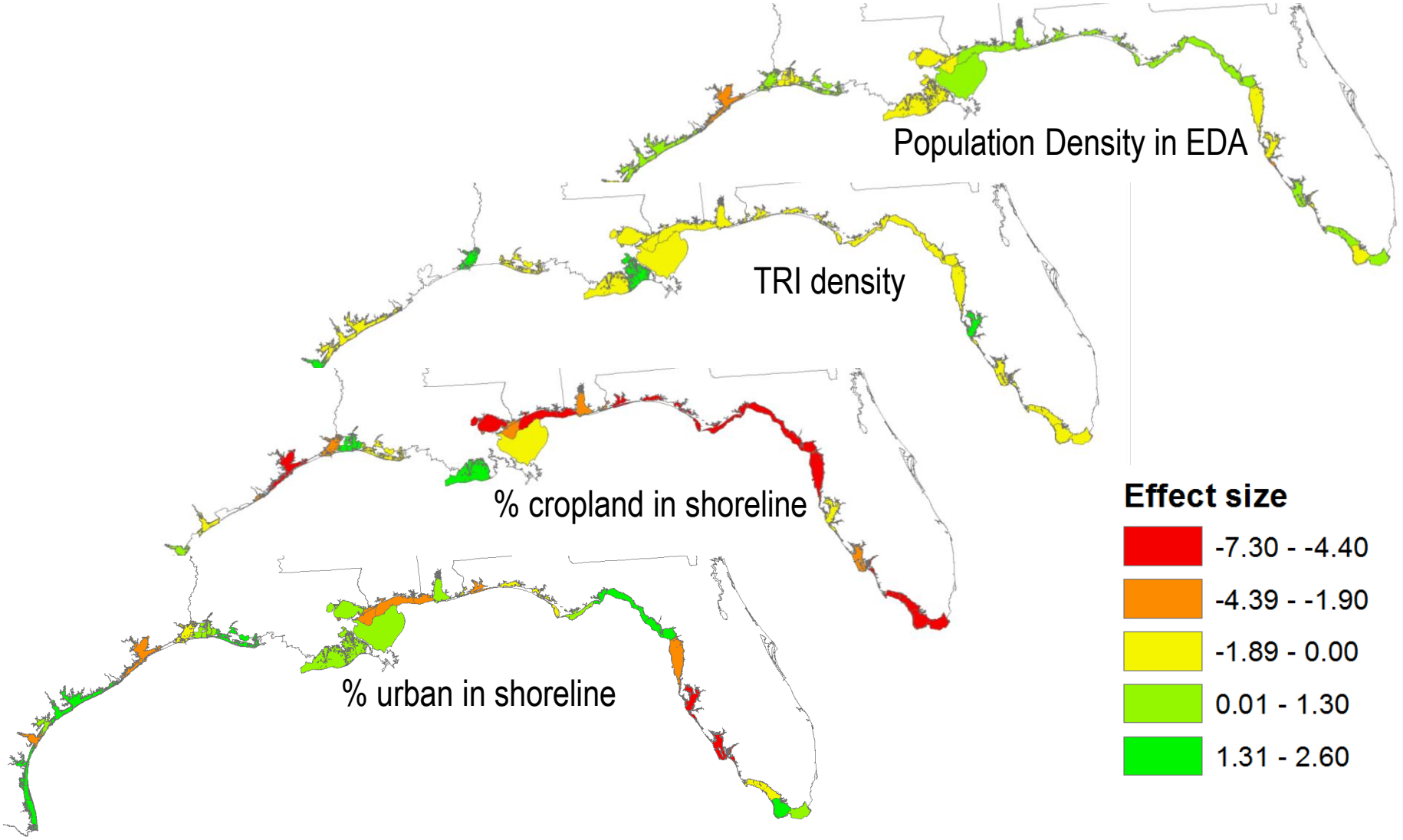
EDA = estuarine drainage area based on proximate HUC-8 unit

Basin = to the top of the watershed divide

Modeling species occurrence



Modeling effects of potential threats



PMEP nursery assessment

Goal: Assess nursery roles of Pacific coast estuary habitats and their threats.

Assessment steps	
1: Refine existing geospatial framework	In progress
2: Determine list of focal species	√
4: Assemble and evaluate available habitat and fish data	In progress
5: Assemble data on potential threats	In progress
6: Model biological responses to habitat characteristics and potential threats	

Talk overview

- Habitat in California Current Integrated Ecosystem Assessment (CCIEA)
- National Fish Habitat Partnership's (NFHP) estuary habitat assessments
- Inshore-offshore pilot projects

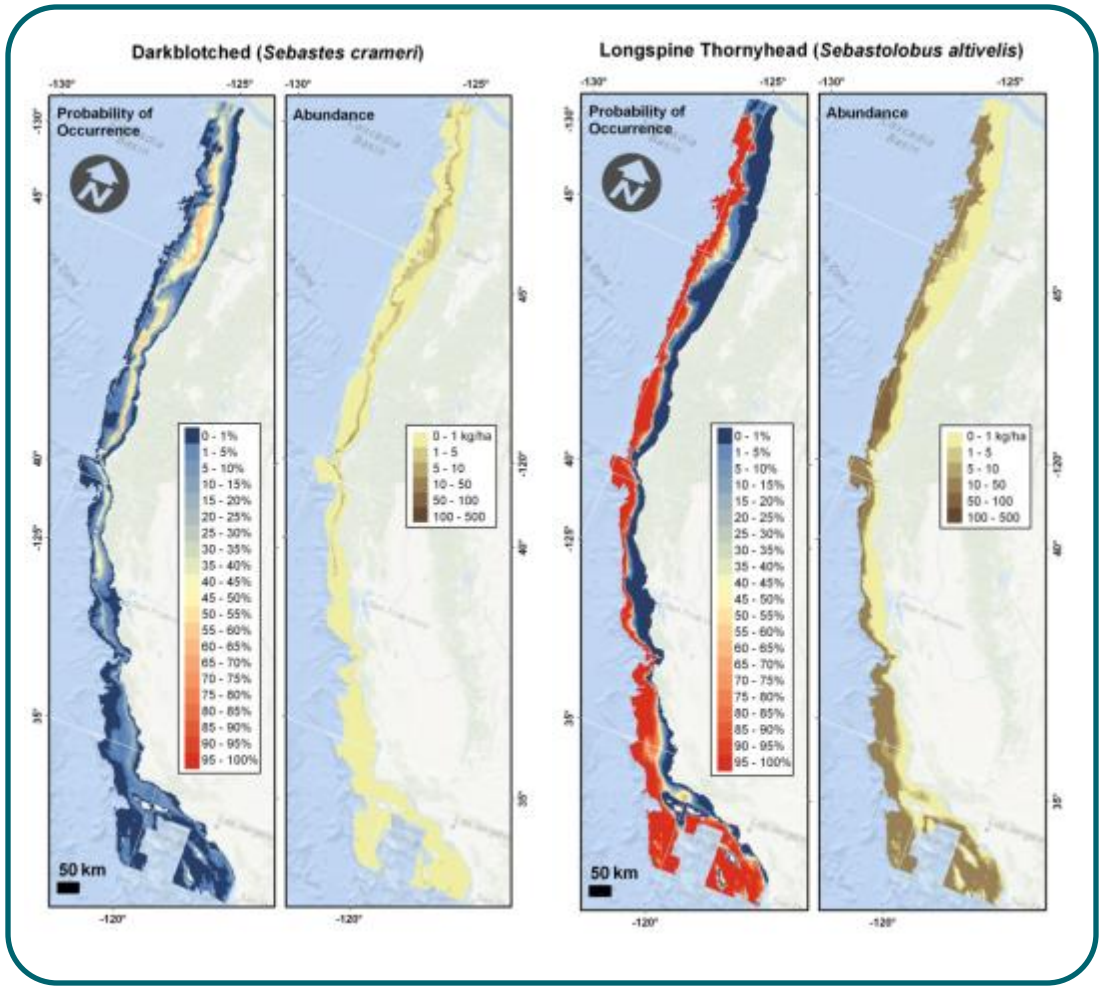
Connectivity of fisheries to coastal systems: two pilot projects

Statistical and ecosystem simulation approaches

Pacific coast: statistical approach using fisheries-independent data

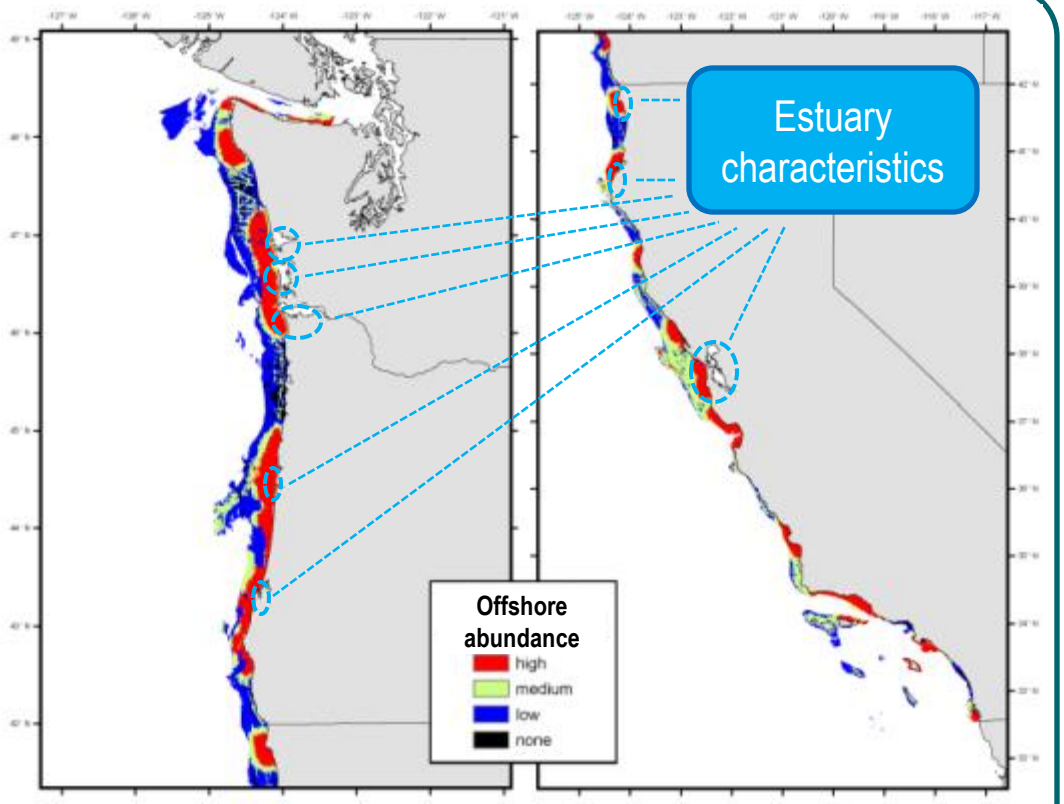
Mid-Atlantic Region: recruitment simulations using Atlantis model

Mapping of Pacific groundfish habitat



- Groundfish EFH
- Habitat-based predictions of distribution and abundance

Adaptation for inshore-offshore work



Hypothetical abundance of an estuarine or nearshore nursery species

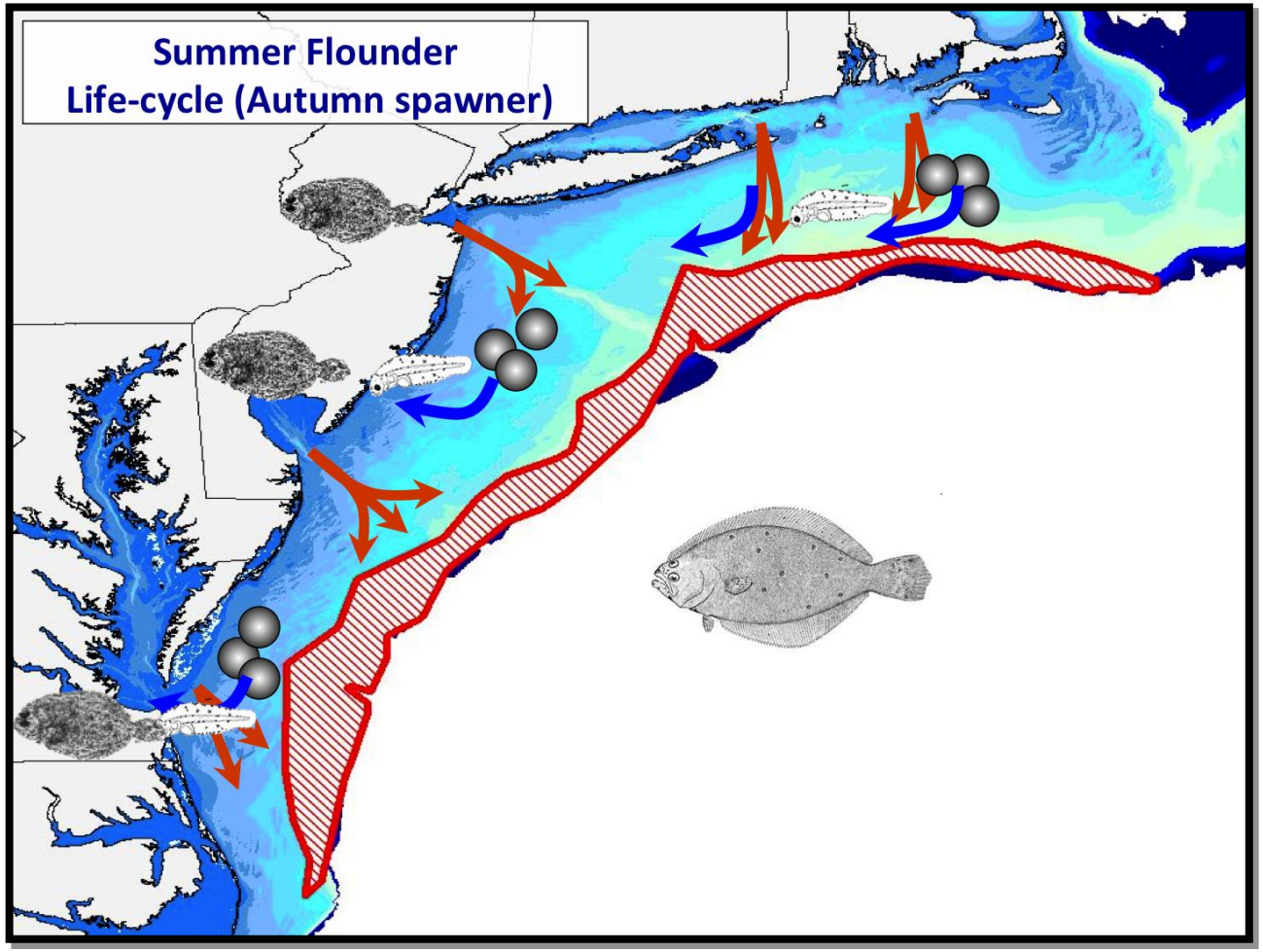
Estuary characteristics

- Amount of habitat
- Temperature
- Dissolved oxygen
- Urbanization

Fish characteristics

- Abundance
- Distance from estuary
- Recruitment size

Mid-Atlantic Project: Summer Flounder Habitat

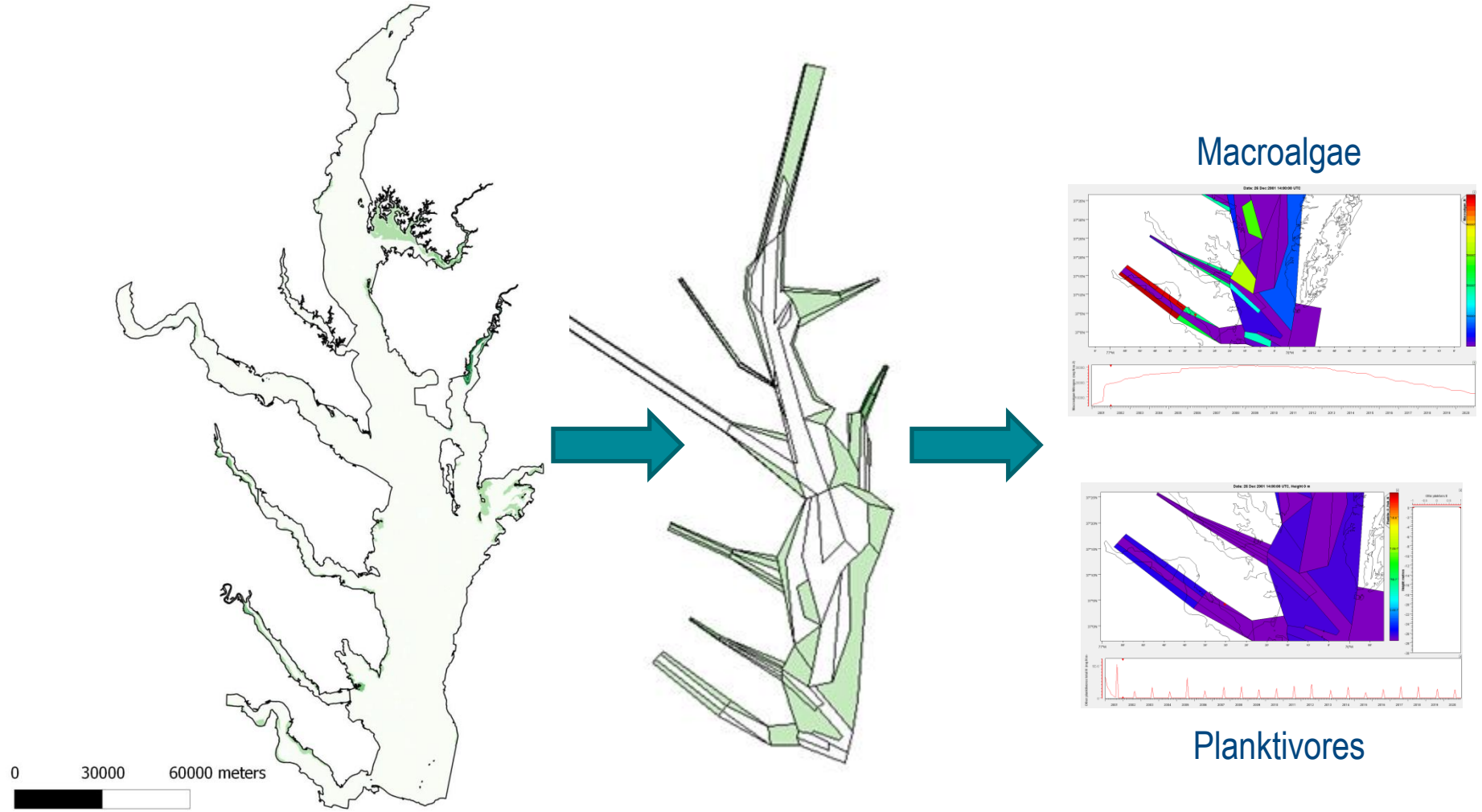


Integrated Database – Connecting Fish Surveys to Habitat Data

EFH Interface File Layout v1.0 (Seine)

FldName	Desc	Format	Example
Record Identifier	Seine Interface Record Version - fixed	VARCHAR2 (20 BYTE)	EFH-S-1.0
FILE-SOURCE	Orgnaization sending file	VARCHAR2 (30 BYTE)	MA-DMF
FILE-FILEIDENTIFIER	Unique (within File-Source) file id.	VARCHAR2 (30 BYTE)	20110701A
CRUISE_ID	Code uniquely identifying cruise. The first four digits indicate the year and the last two digit uniquely identify the cruise within the year.	VARCHAR2 (6 BYTE)	201105
STATION	Unique sequential order in which stations have been completed. Hangups and short tows each receive a non-repeated consecutive number.	VARCHAR2 (4 BYTE)	1
ITIS	code of each species caught	VARCHAR2(12 BYTE)	
SCINAME	Scientific name of specimen.	VARCHAR2 (45 BYTE)	
COMNAME	Accepted common name of a fish or invertebrate species.	VARCHAR2 (45 BYTE)	
LENGTH	Length (1 cm bins unless otherwise specified)	Number(4)	
DECDEG_BEGLAT	Tow Beginning Decimal Data Lat	NUMBER(10,6)	43.923733
DECDEG_BEGLON	Tow Beginning Decimal Data Long	NUMBER(10,6)	-68.77875
BEGIN_GMT_TOWDATE	Tow Begin Date - GMT	Date	2004-01-31
GMT TIME	Tow start time - GMT	VARCHAR2(8 BYTE)	12:05:10
PURPOSE_CODE	Code referencing purpose of cruise conducted. See SVCRUISE_PURPOSE table.	VARCHAR2(2 BYTE)	10
PURPOSE	Description of purpose_code to identify type of cruise conducted (e.g. Bottom Trawl, Scallop, Clam, etc.)	VARCHAR2(100 BYTE)	NMFS NEFSC BOTTOM TRAWL SURVEY
CATCHSEX	A one digit alphanumeric code used to identify species that are sexed at the catch level. This code is used to represent the entire catch of a particular species and not an idividual fish or invertebrate. The available catchsex codes are as follows: 0=Unsexed 1 = Male 2 = Female Lobster codes (svspp=301): 0 = Forgot to look 1 = Male 2 = Female 3 = Female with egg 4 = Female V-notch 5 = Female V-notch with eggs Northern Shrimp codes (306): 1=Male 2=Female Stage I for Northern Shrimp 3=Female Stage II for Northern Shrimp 4=Transitional for Northern Shrimp 5=Ovigerous for Northern Shrimp 6=Non-spawning Female for Northern Shrimp 7=Female for Northern Shrimp not staged (stage I or II not determined)	VARCHAR2(1 BYTE)	1
EXPCATCHNUM	Expanded number of individuals of a species caught at a given station. For Seine and Trawlwill be per 1 cm length bin, for Ichthyoplankton will be total number of Eggs / Larvae.	NUMBER(8)	32
CATCH_COMMENT	Comments on a species level.	VARCHAR2(500 BYTE)	
CATCHNUM_BASIS	C=Count, S=Sub Samples, E=Estimate	VARCHAR2(1 BYTE	
GEAR_CODE	Type of gear code	NUMBER(2)	

Ecosystem Modeling Approach to Test Summer Flounder Sensitivity to Habitat Change

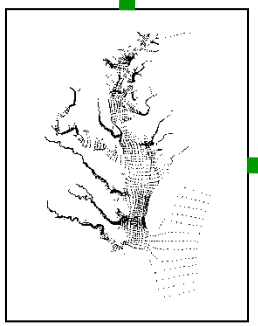


Effects of Eutrophication on Chesapeake Fisheries

Species Habitat Preferences

	Temperature				Salinity				Dissolved oxygen	
	required		optimal		required		optimal		required	optimal
Species	min	max	min	max	min	max	min	max	min	min
Blue crab [a]	5.2	36.5	15	30	3	56	10	30	0	2.8
Atl. menhaden [b]	5	33	14	30	0	35	5	10	1.1	3
N. quahog clam [c]	4	36.5	9	31	10	35	21	30	0.5	2.4
Striped bass [d]	0	31	14	25	0	35	0	35	2	3
Eastern oyster [e]	-2	41	20	32	5	44	10	30	0	1
Atl. croaker [f]	1	36	13	28	0	36	5	20	0.5	1
Summer flounder [g]	4	28	9	27	10	60	28	60	1	2
Spot [h]	4	31	17	25	0	60	0	60	2	4
Black sea bass [i]	6	28	13	21	1	36	14	36	2	4
White perch [i]	3	34	12	33	0	22	0	16	0.8	2.9
Blue catfish [k]	0	40	26	29	0	8	0.5	3	2	5
Bluefish [l]	8	35	14	30	5	36	25	35	5.1	8
Tautog [m]	6	32	6	32	5	40	5	40	2	3
American shad [n]	8	26	14	21	0	60	0	60	2	5

Temp, Salinity, DO



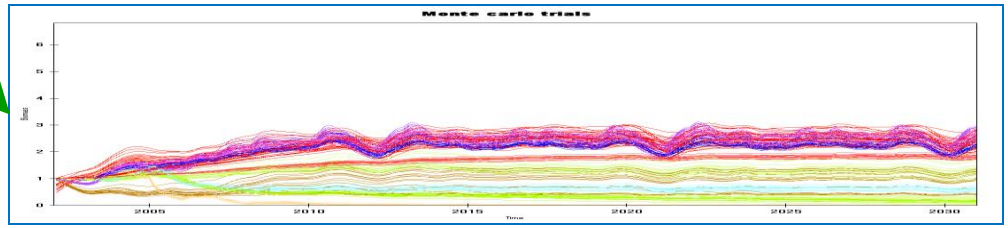
Chesapeake Eutrophication Model

N Loads

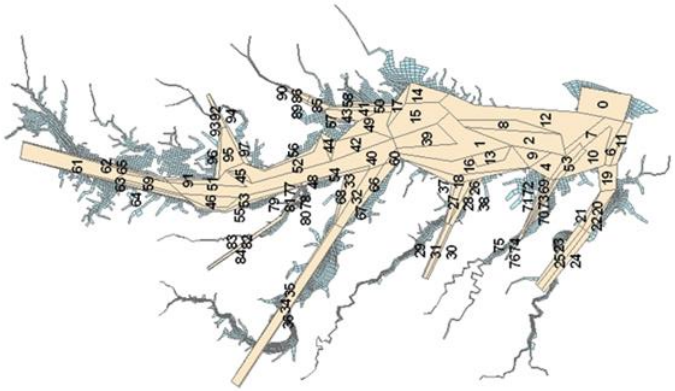
First Order Ecosystem Model

$$\frac{dN_{it}}{dt} = N_{it}\left[a_i + \sum_{j(=i)=1}^{I}\left(\theta_i b_{ij} - b_{ji}\right)N_{jt} - \left|b_{ii}N_{it} - F_i\right|\right]$$

Chesapeake Bay Fisheries Ecosystem Model



Chesapeake Atlantis Model



Utility of both approaches

Statistical approach

- Correlational
- Grounded in reality, fewer assumptions

Ecosystem simulation approach

- Many assumptions in model
- Causal modeled scenarios
- sensitivity analyses are easy to do

Talk overview

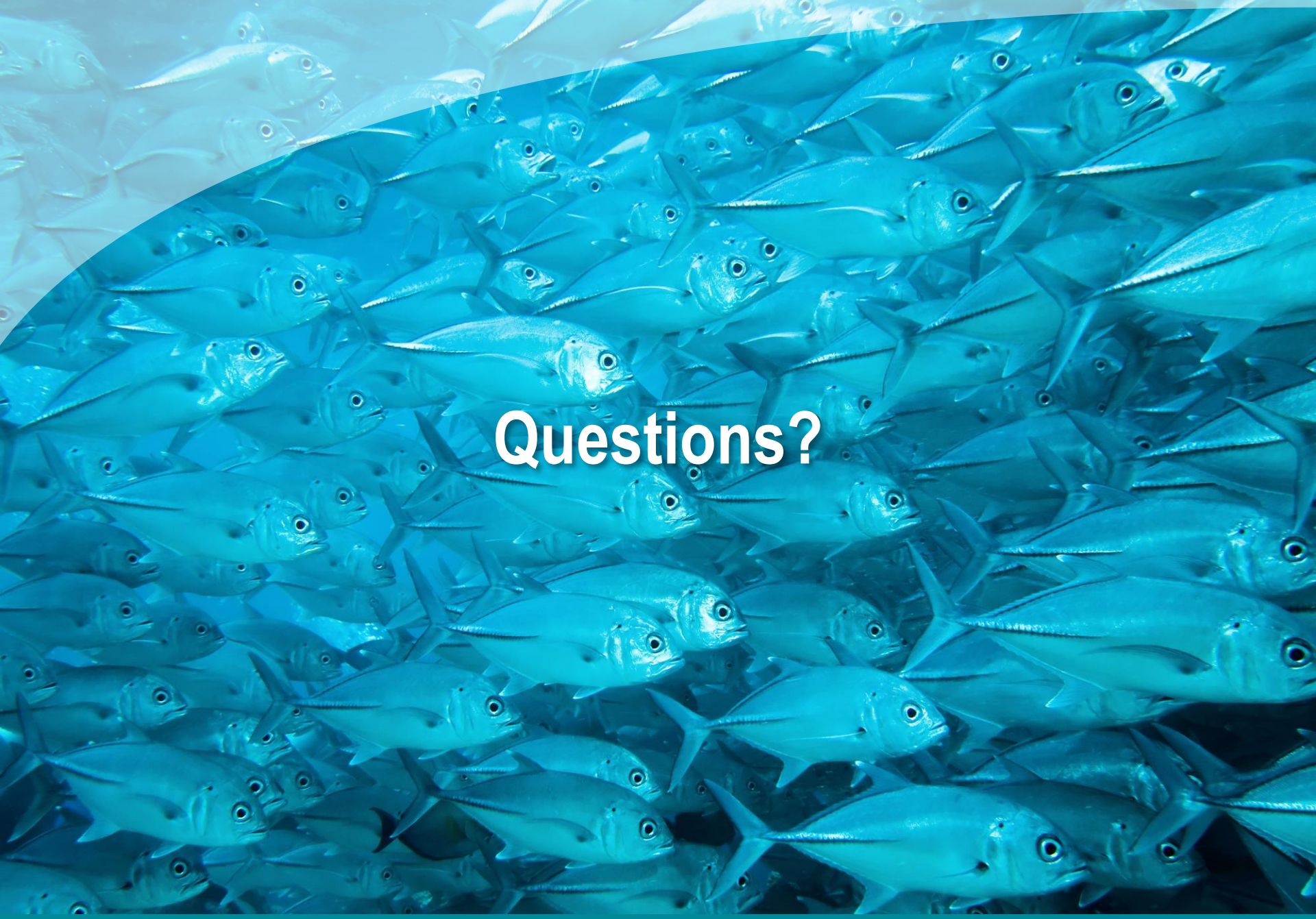
- Habitat in California Current Integrated Ecosystem Assessment (CCIEA)
- National Fish Habitat Partnership's (NFHP) estuary habitat assessments
- Inshore-offshore pilot projects

Talk overview

- Habitat in California Current Integrated Ecosystem Assessment (CCIEA)
  - ➢ *Improved utility of IEAs for fisheries management*
- National Fish Habitat Partnership's (NFHP) estuary habitat assessments
  - ➢ *Improved ability to prioritize habitat restoration benefiting fisheries*
- Inshore-offshore pilot projects
  - ➢ *Development of tools to assess coastal habitat conservation on abundance and productivity of offshore stocks*

Final points

- Models useful for management need data
  - Improved fisheries-independent surveys
  - Bigger, better habitat assessments
- Partnerships are vital
  - Across divisions within NMFS
  - Across NOAA
  - Between NMFS and other regional and national partners


Questions?