Atlantic Salmon Recovery Science

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Part 1

Prepared for NEFSC Protected Species Science Program Review April 13-16, 2015, Woods Hole, MA

GAR Science Needs… Atlantic Salmon

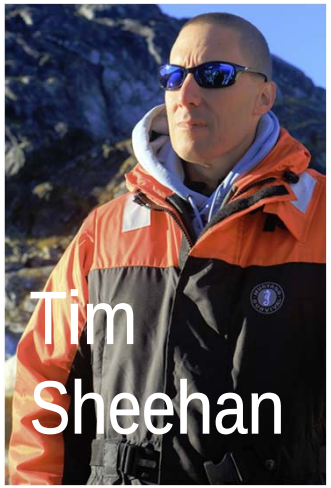
- **Population estimates by river**
- **Determine stock composition in mixed stock fisheries**
- **Evaluate impact of dams, fisheries, etc.**
- **Examine temperature and predator/prey field during migration, impacts on survival, changes with environmental change**
- **Set thresholds for dam, fisheries, etc., impacts**

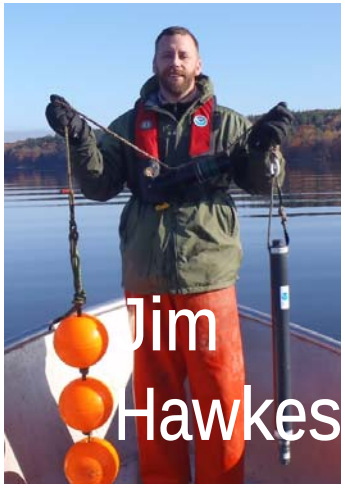
Science Needs to Support Federal Mandates

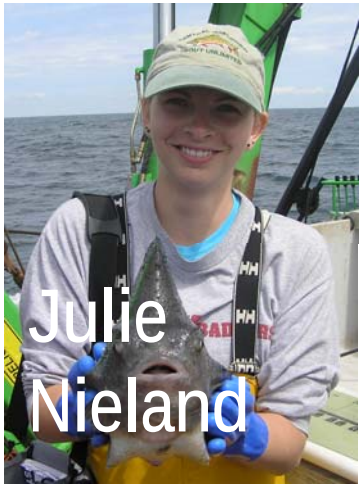
Info for Reviewers – Describe Program & Overview of:

- **Scientific Products and Advice**
  - **Quality, precision, frequency**
  - **Timeliness and impacts**
- **Major Successes of Research**
- **Data accessibility to external researchers**
- **Strengths and Challenges**
- **Recommendations to Improve**

NOAA NEFSC Salmon Team





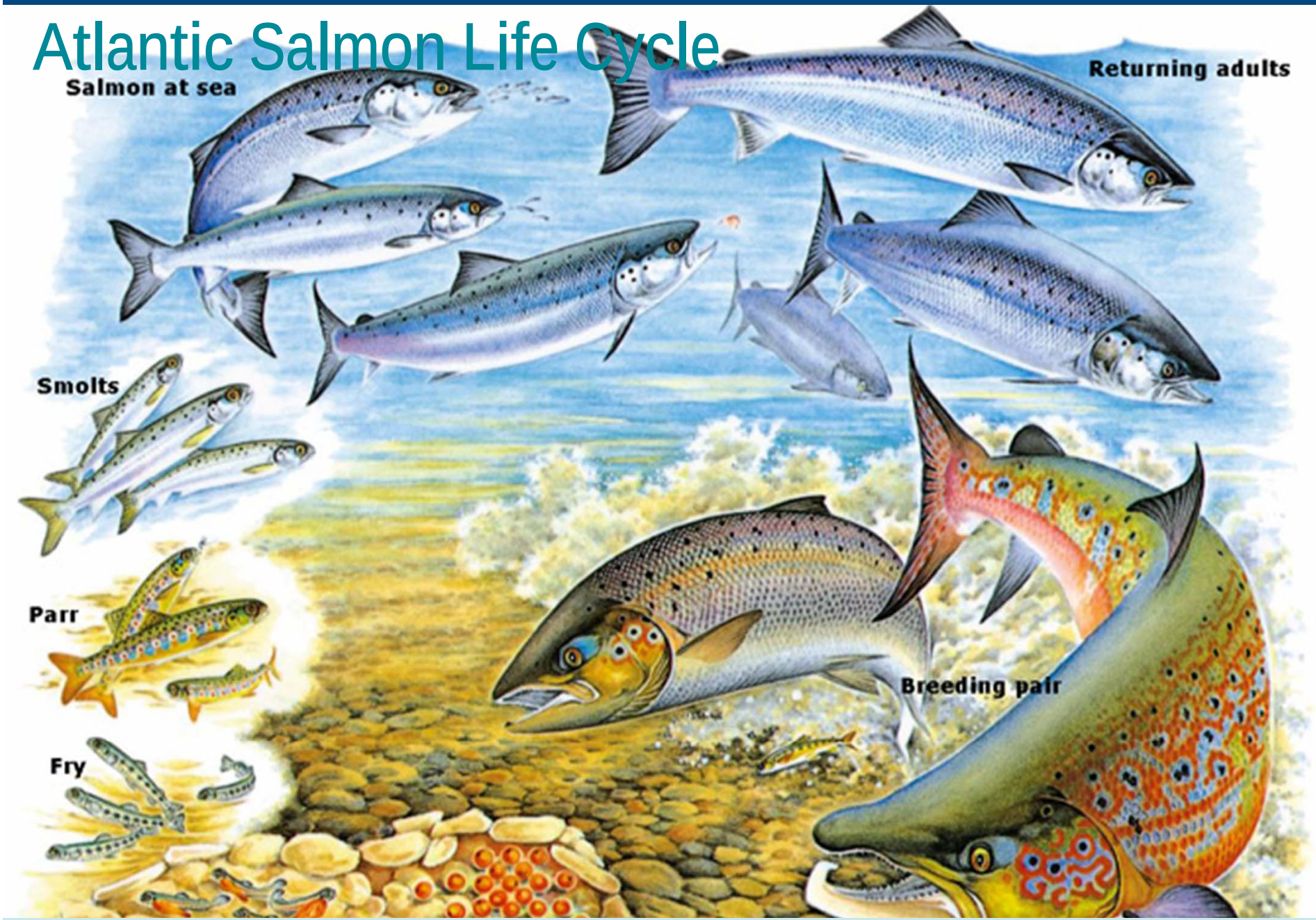


Presentation Outline

- Listed Entity and Process
- Overview of Threats
- Stock Assessment
  - ESA – Domestic
  - International
- Successes In Research
- Data Access and Information Outreach
- Strengths and Challenges

Listed Entity and Process

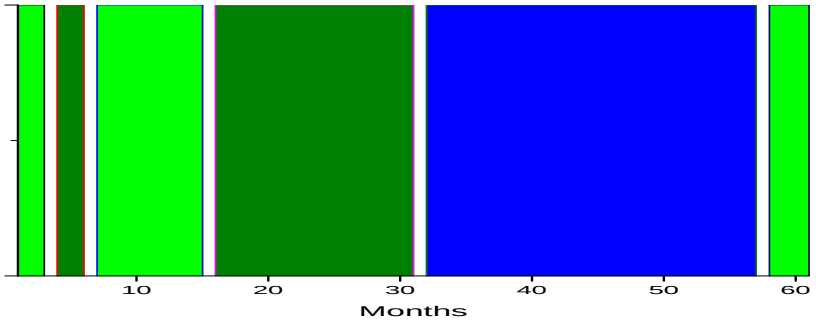
Atlantic Salmon Life Cycle



NOAA FISHERIES

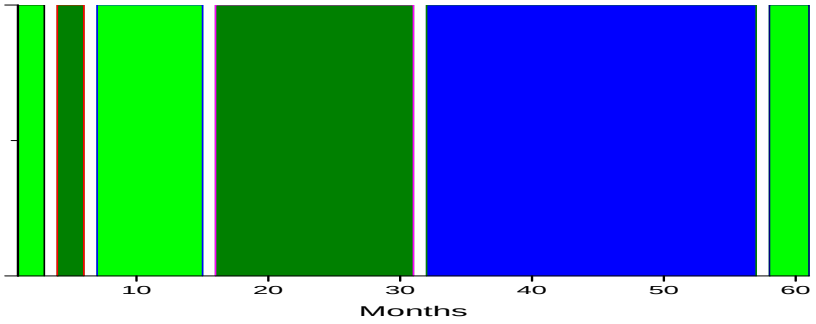
Illustration Courtesy of the Atlantic Salmon Trust and Robin Ade

Atlantic Salmon Hatchery Life Cycles



- **~ 60 Natural Life Cycle**
  - **First 30 months rivers**
  - **Next 27-30 at sea**
  - **Return 1-3 months pre spawn**

Atlantic Salmon Hatchery Life Cycles



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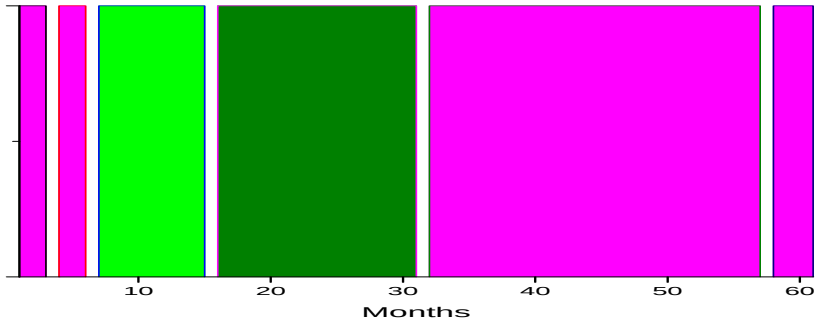
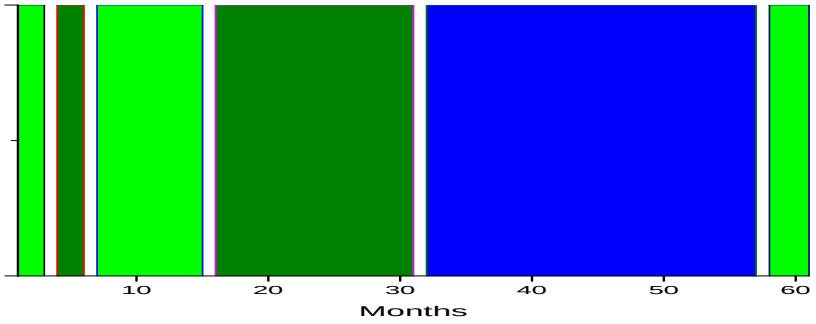


- Fry Stocked Brood Cycle
  - First 8 months hatchery
  - Next 24 months rivers
  - Next 27-30+ Hatchery

Atlantic Salmon Hatchery Life Cycles



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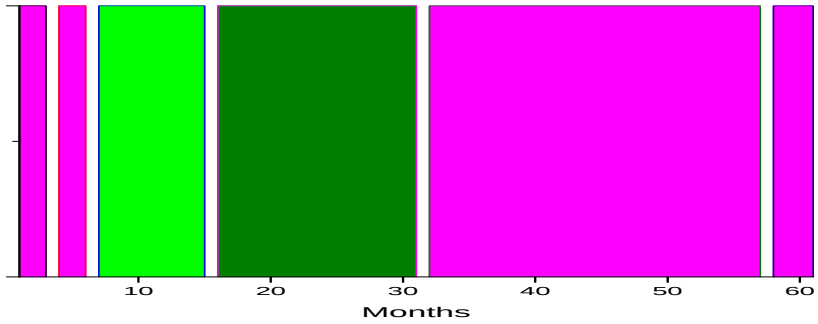

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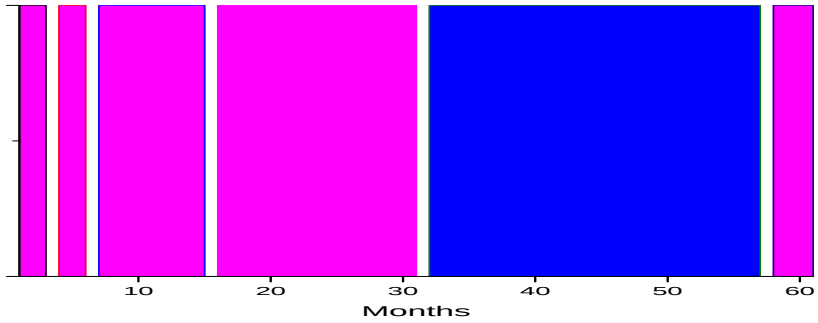
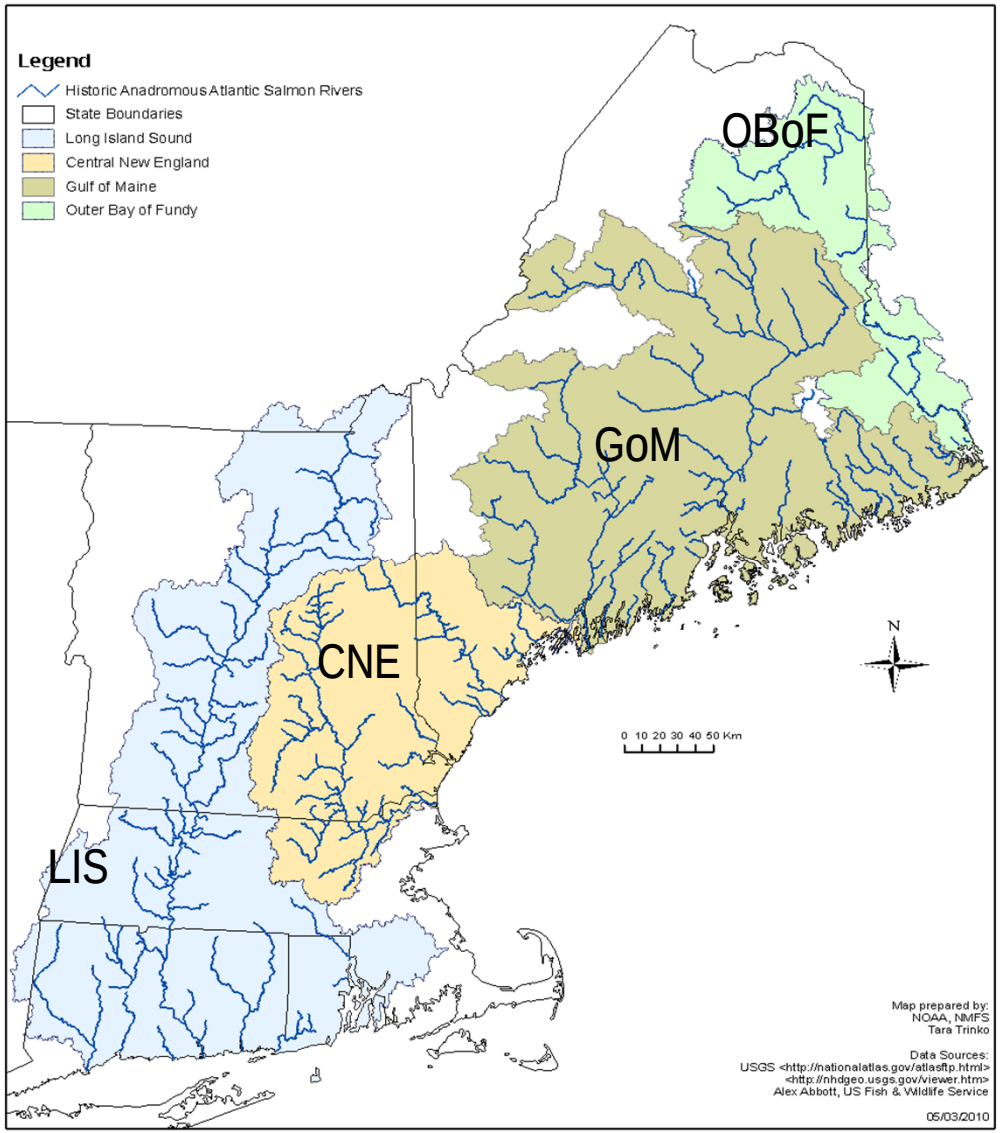


- Smolt Stocked Brood Cycle
  - First *18* months hatchery
  - Next 27-30 at sea
  - Return < 1 month in river
  - Mature and Spawn in Hatchery

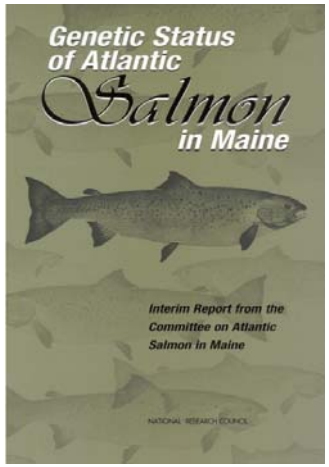
US Atlantic Salmon Stock Structure

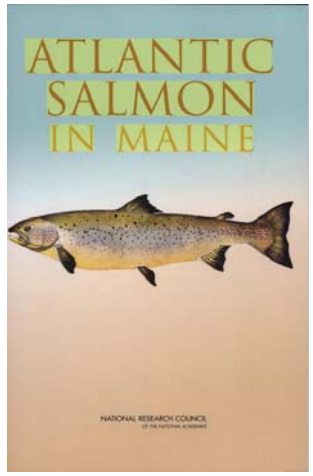


- Outer Bay of Fundy DU
  - Designatable Unit - Core in Canada
  - Endangered under SARA
- **Gulf of Maine**
  - **Last Remnant US Populations**
  - **Endangered**
- Central New England
  - Merrimack Restoration ended 2010
- Long Island Sound
  - Connecticut River
  - **Legacy Program Connecticut**

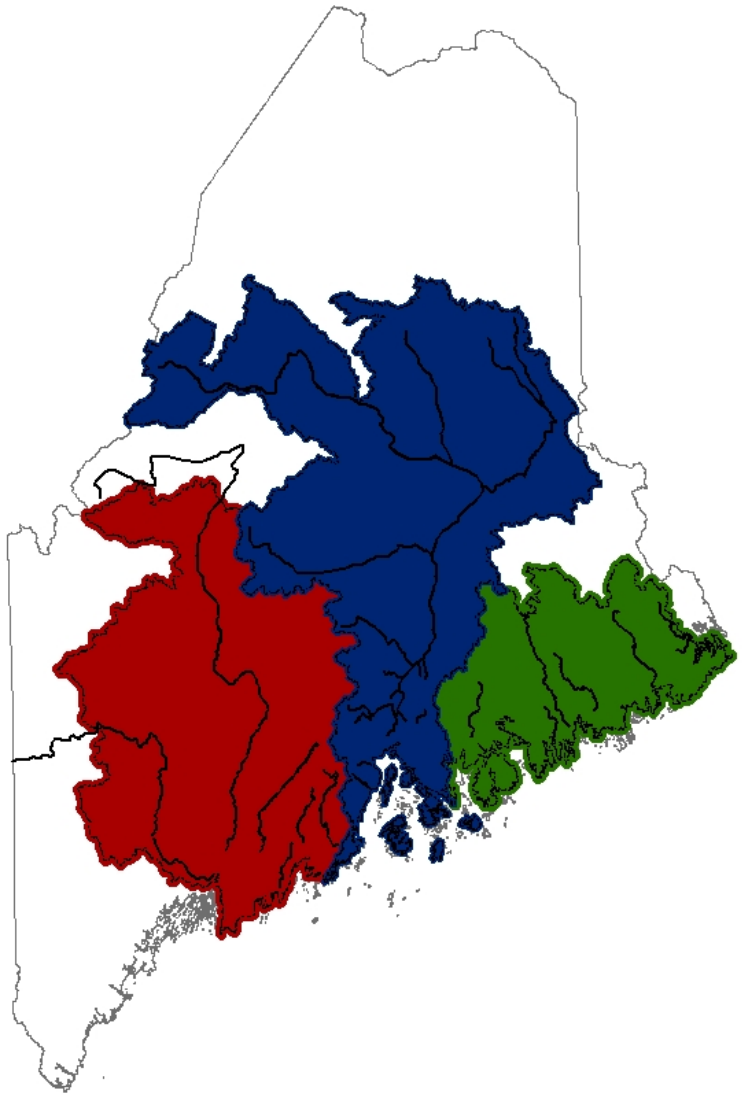
At the Beginning… Lawsuits and Challenges

- Petition Initiated the Process
- Contentious at Federal Register Notification
- *Science Challenged*
  - 2 National Academy of Science Reviews
    - Genetic Status of Atlantic Salmon in Maine
    - Atlantic Salmon in Maine
- NAS agreed with DPS determination
  - Gulf of Maine Atlantic salmon - extant
  - Populations threatened by:
    - Dams, marine survival



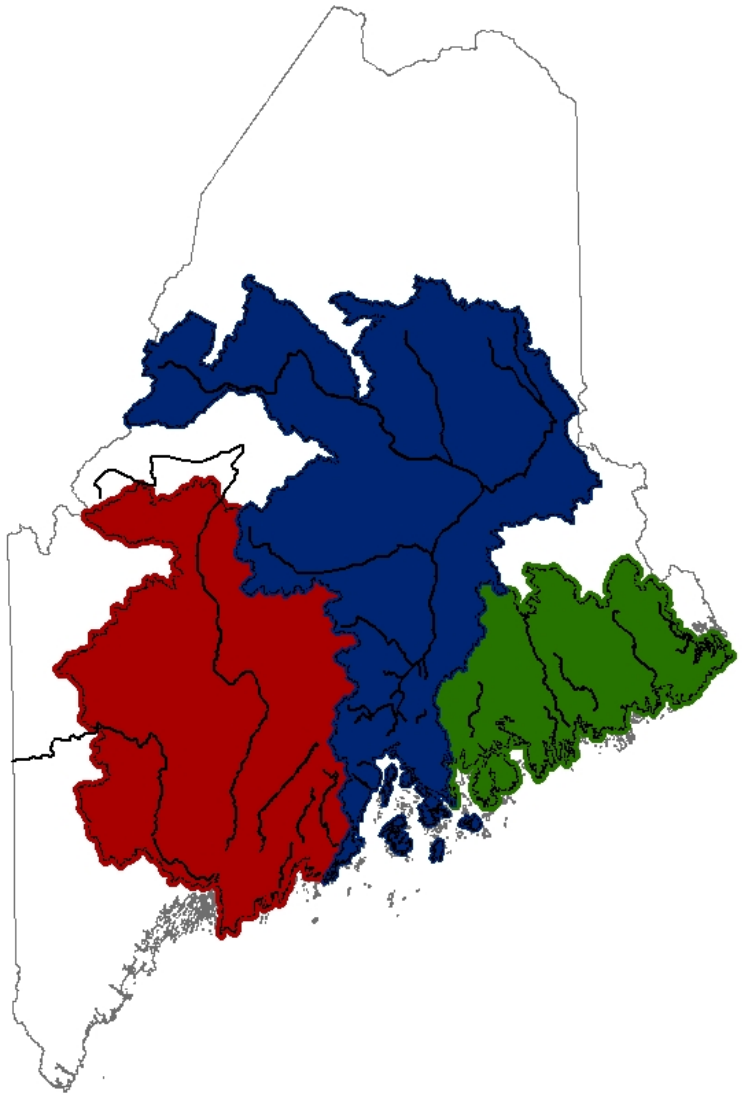


Gulf of Maine Distinct Population Segment



- Downeast Coastal
  - Dennys
  - East Machias
  - Machias
  - Narraguagus
  - Pleasant
- Penobscot Bay
  - Penobscot
  - Cove Brook
  - Ducktrap
- Merrymeeting Bay
  - Sheepscot

Gulf of Maine Distinct Population Segment



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  - Dennys
  - East Machias
  - Machias
  - Narraguagus
  - Pleasant
- Penobscot Bay
  - Penobscot
  - ~~Cove Brook~~ (2009)
  - Ducktrap
- Merrymeeting Bay
  - Sheepscot

Questions - Discussion

Overview of Threats

Threats Highlighted from Federal Listing

- Marine Survival
  - Natural mortality decrease biggest threats
    - Fishing mortality problematic but control mechanism
- Connectivity - Largest Identified Freshwater Threat
  - Dams
  - Culverts, road crossings, etc.
- Lower Tier Threats
    - Freshwater habitat
    - Aquaculture – net pens
    - Hatchery practices
- Climate Change

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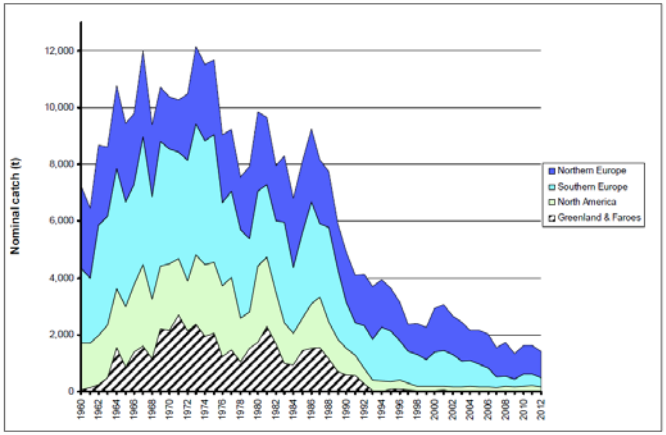
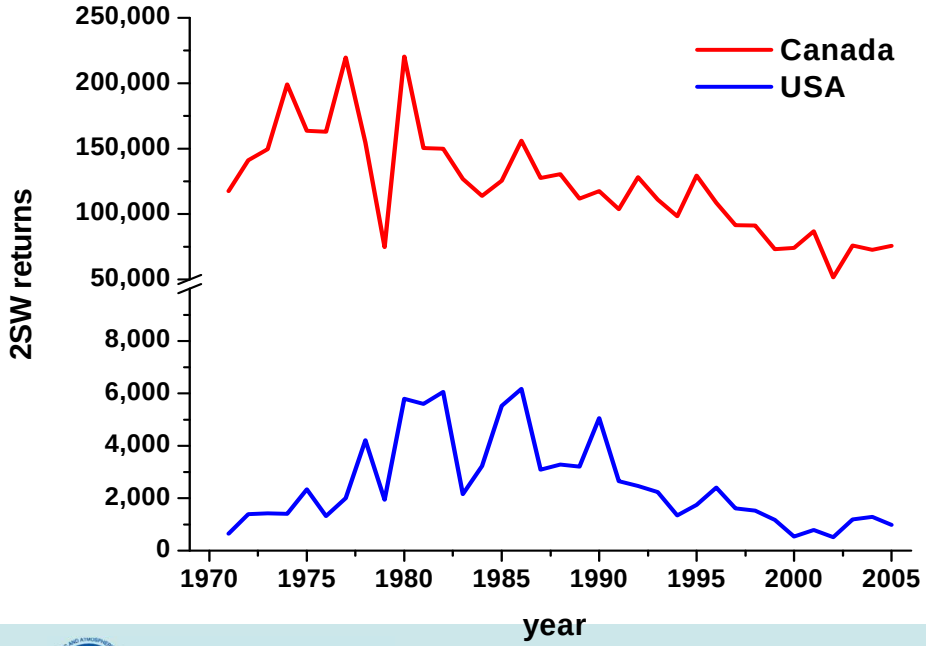
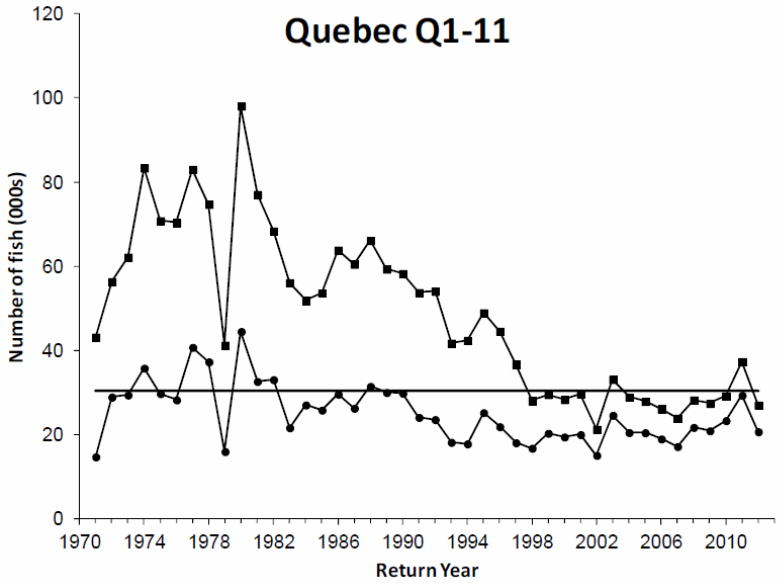
Marine Survival

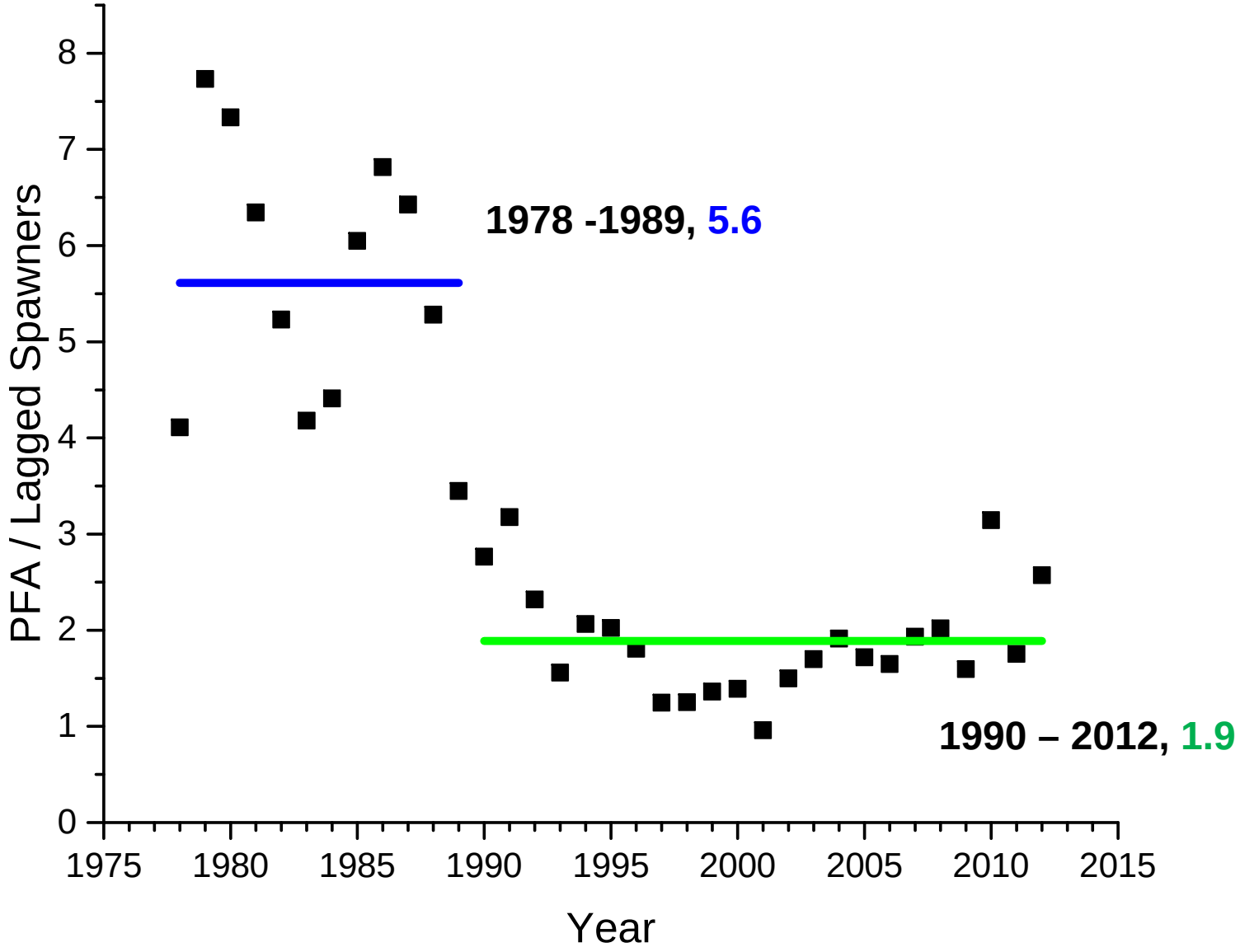
- Change in marine survival observed in many metrics
  - Declines in global nominal catch
  - Declines in regional stock complexes
  - 1989 to 1991 regime/phase shift
  - Impact highest to southern stocks



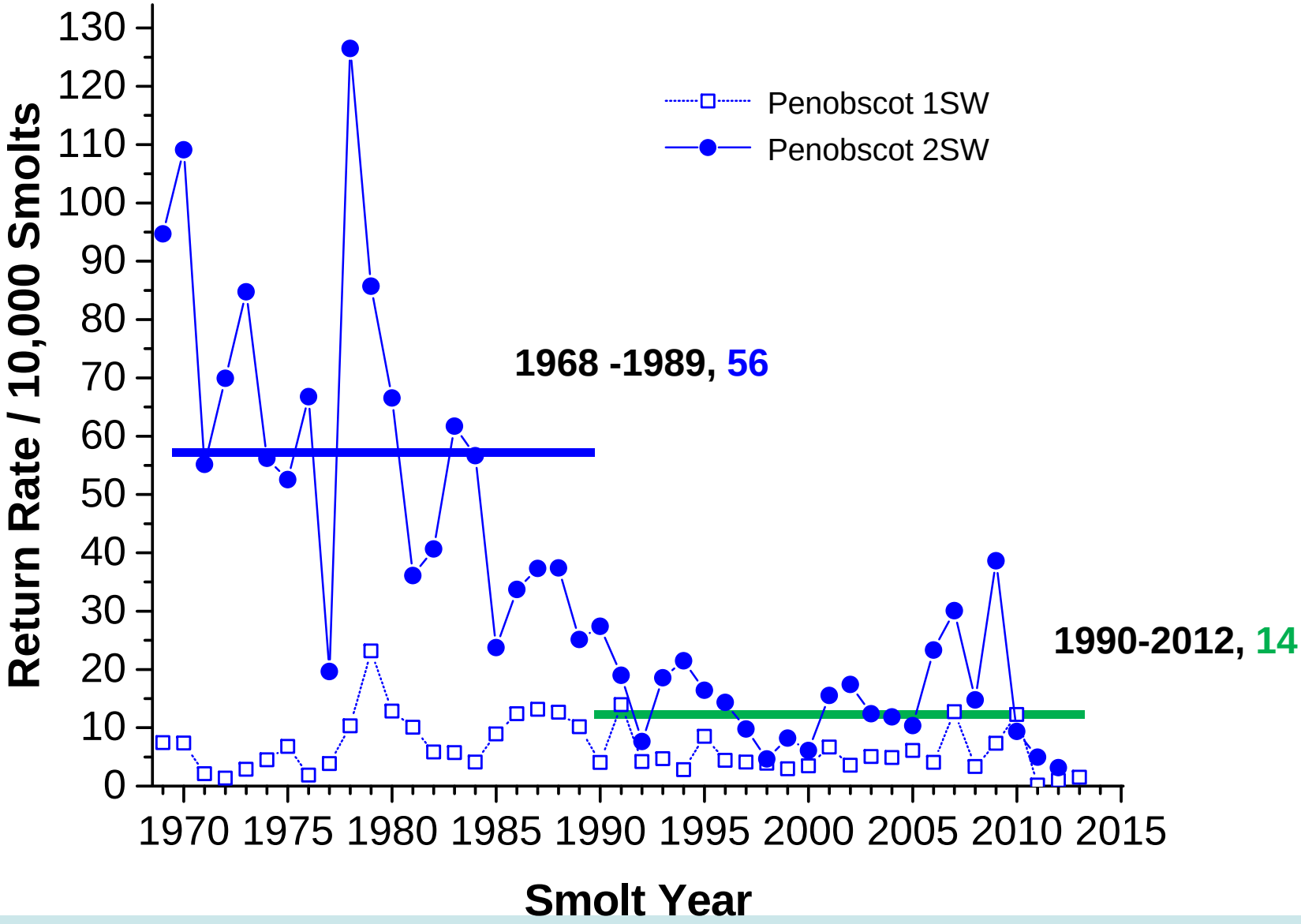




Shift in ICES Marine Productivity Index

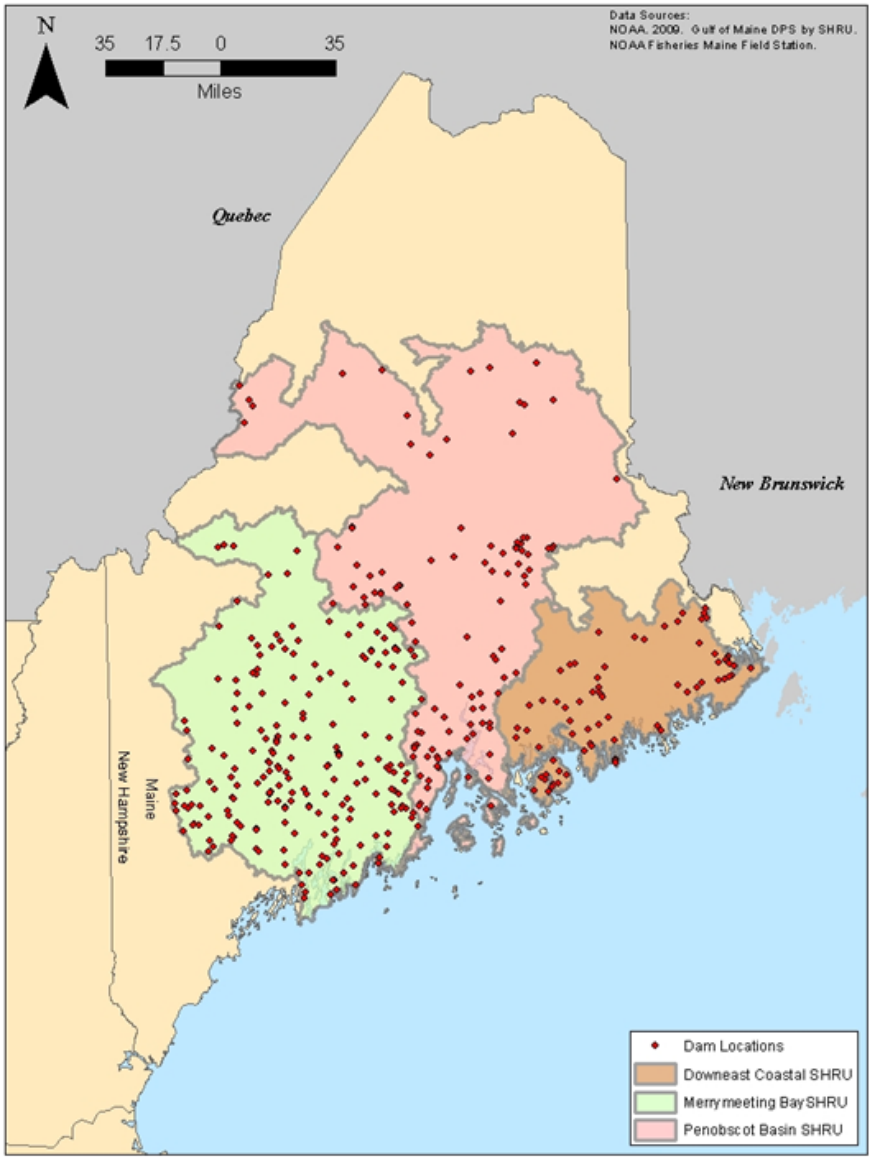


Penobscot: Smolt – Adult Return Rate (SAR)



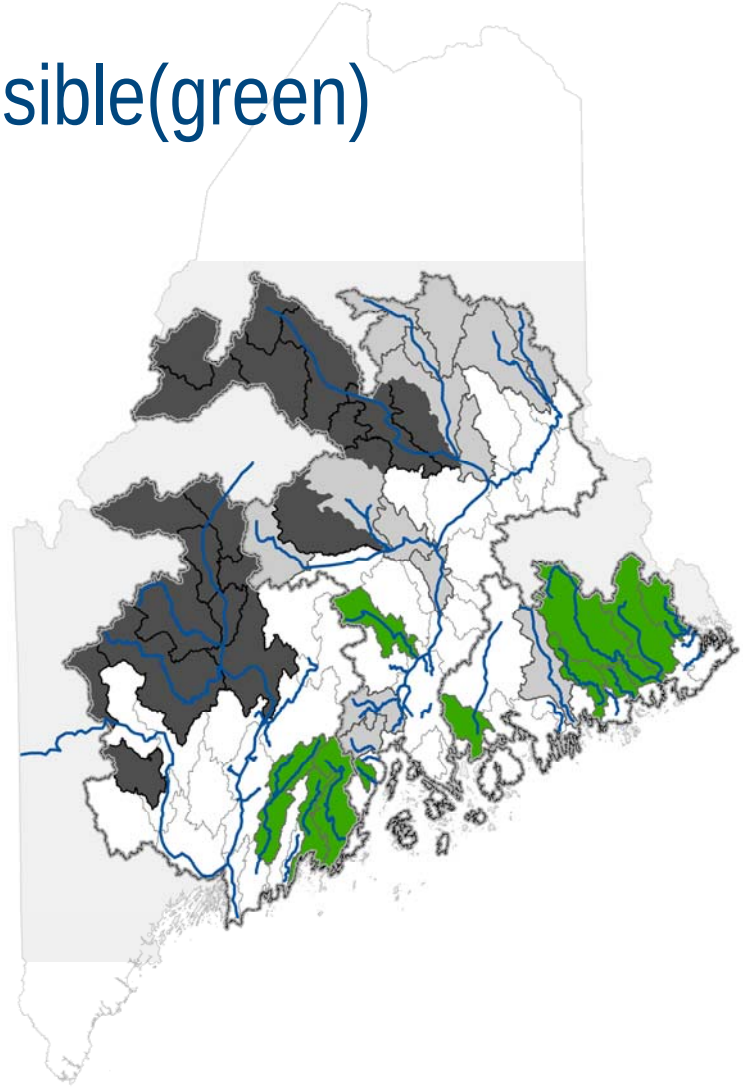
Overall Landscape of Dams in Maine

- 460 Total Dams in Watersheds
  - Total Numbers (Hydro)
  - Merrymeeting Bay
    - 245(37)
  - Penobscot Bay
    - 139 (31)
  - Downeast Coastal
    - 76 (3)



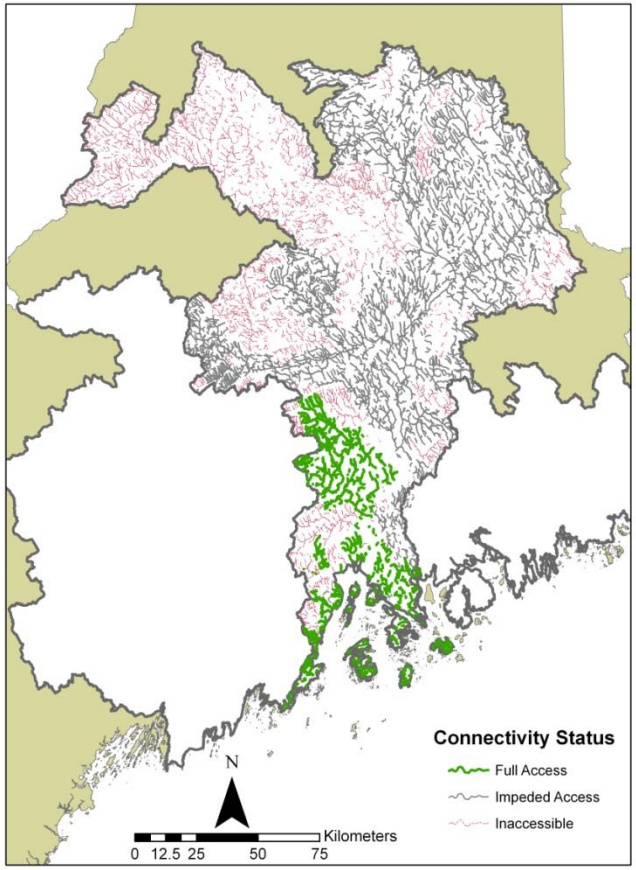
Connectivity

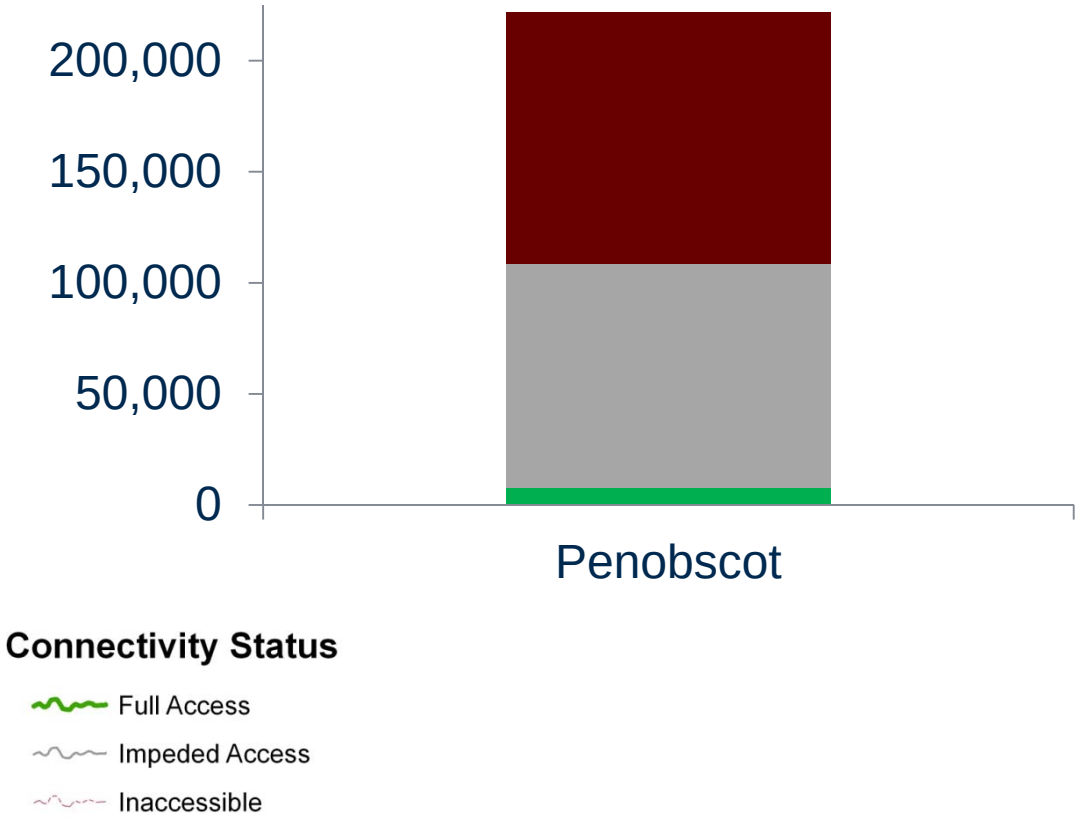
- Only 8 % of habitat fully accessible(green)
- 17% Accessible (white)
- 9% Impeded (gray)
- 66% Inaccessible (slate)



Example for Penobscot SHRU

- 7,703 high quality habitat units are fully accessible (~3% of historic)
- 31 Hydro Dams (generation/storage) in watershed restricts access



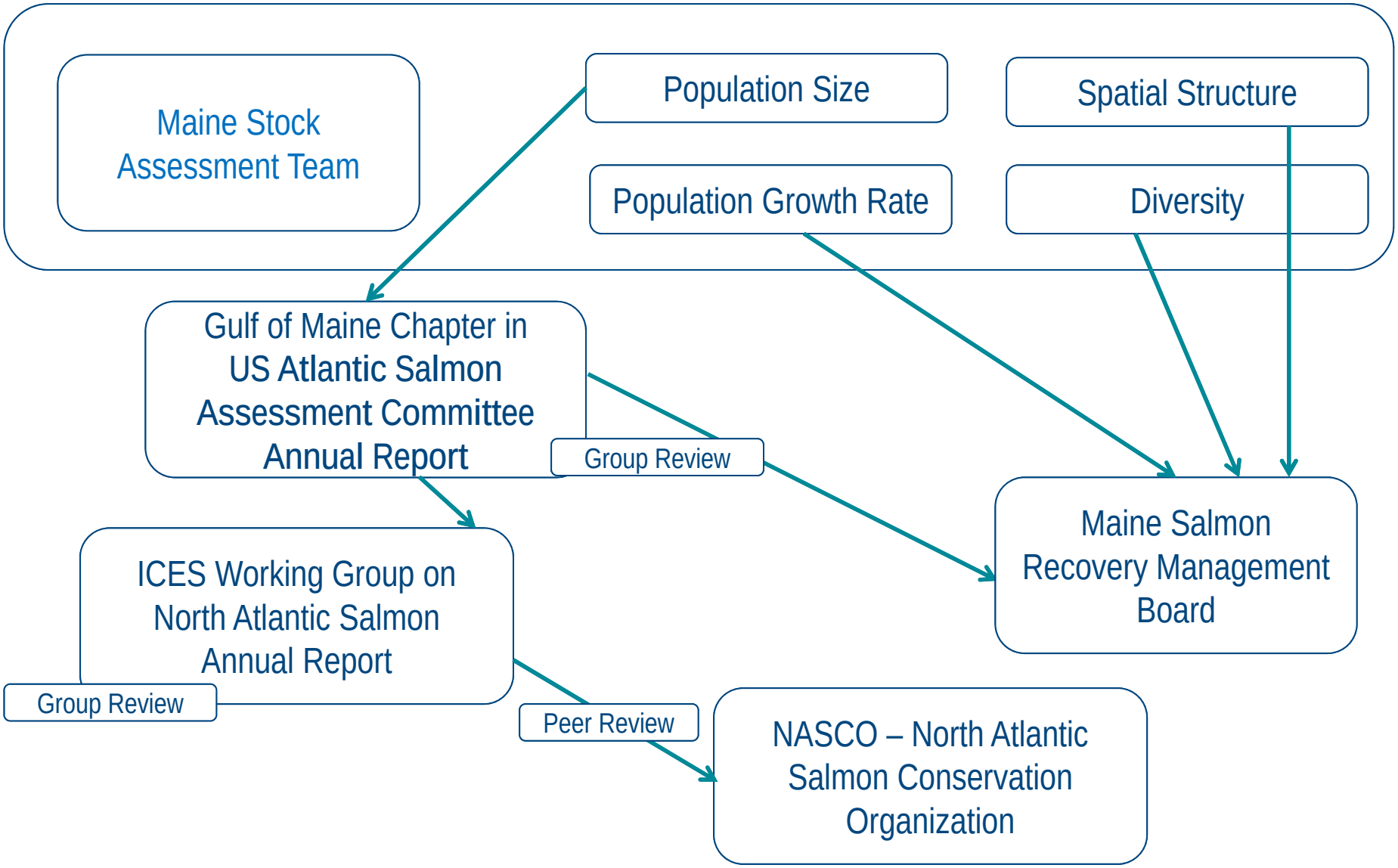


Questions - Discussion

Stock Assessment

ESA Domestic

Atlantic Salmon Stock Assessment



Stock Assessment Approach

Viable Salmonid Populations

- Population Size
- Population Growth Rate
- Spatial Structure
- Diversity

FIELD DATA
DATABASES

Co-op Agreement with Maine DMR

- "Assessments of the **Demographic Benchmarks** of the Gulf of Maine Distinct Population Segment of Atlantic Salmon of Mutual Interest"
  - NEFSC Funds (95%) Salmon Team in *Division of Sea Run Fish and Habitat*
  - Field offices
    - Jonesboro – Downeast SHRU
    - Bangor – Penobscot Bay SHRU
    - Hallowell – Merrymeeting Bay SHRU

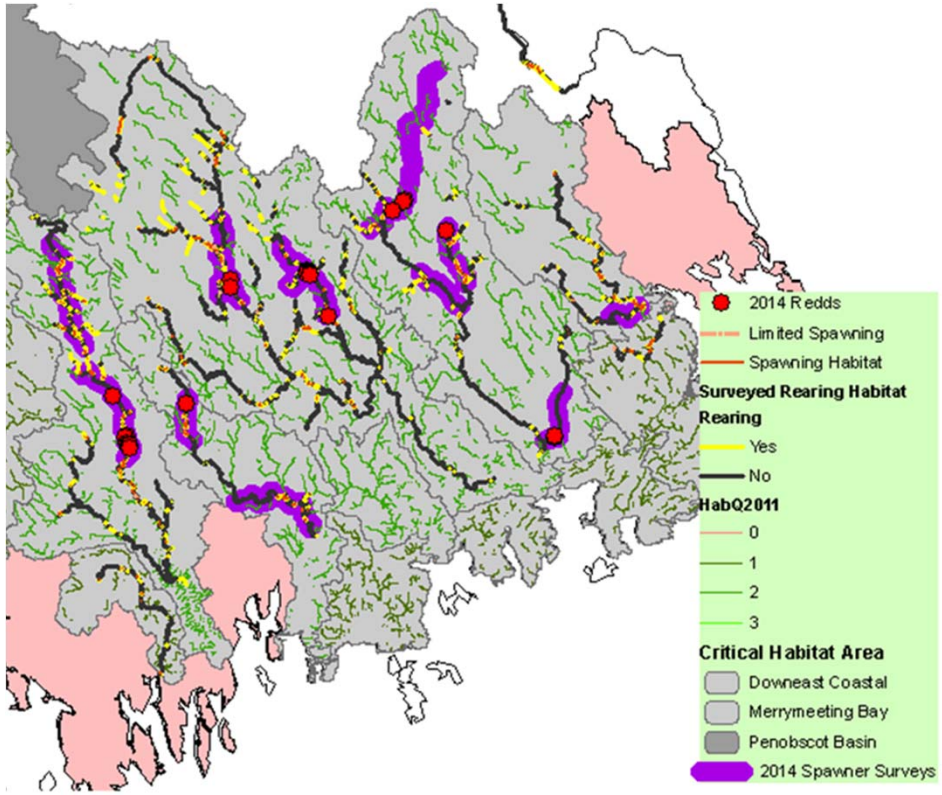
Co-op Agreement with Maine DMR

- Adult Atlantic Salmon Assessments
  - Trap Counts
    - Actually handle > 90% of all returning adults
    - A management opportunity – cull aquaculture escapes
  - Redd Counts

Redd Counts

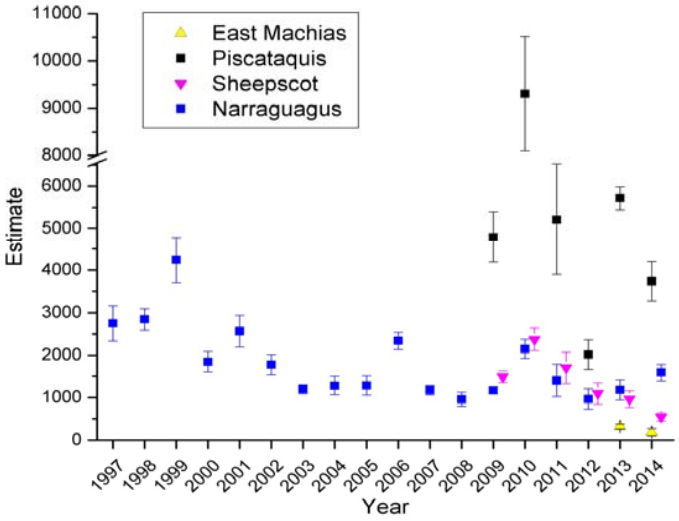
- Coverage
  - > 75% coverage in priority areas
  - Developing extrapolation difficult but ongoing

Drainage	Drainage Total	StreamName	Redds	Proportion of Habitat Surveyed
Dennys	0	Cathance Stream	0	66.67
		Dennys River	0	0
East Machias	16	Beaverdam Stream	0	84.77
		Chase Mill Stream	11	100
		Creamer Brook	0	0
		East Machias River	3	98.66
		Harmon Stream	0	0
		Northern Stream	2	100
		Seavey Stream	0	0
Machias	11	Crooked River	0	59.87
		Machias River	2	50.37
		Mopang Stream	0	14.1
		Old Stream	9	76.58
Narraguagus	20	Narraguagus River	20	81.71
Pleasant	1	Eastern Little River	0	0
		Pleasant River	1	85.25



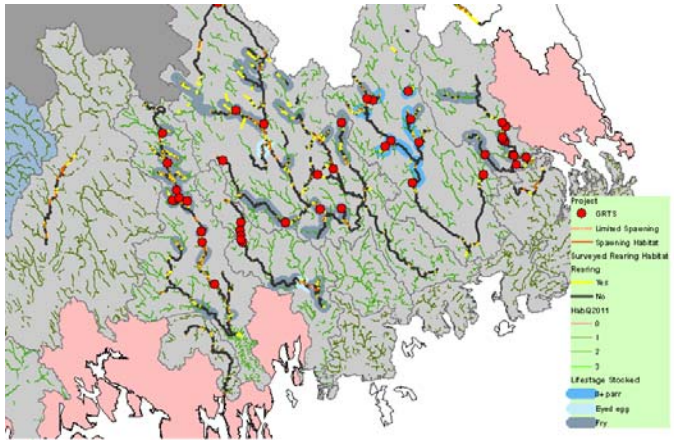
Co-op Agreement with Maine DMR

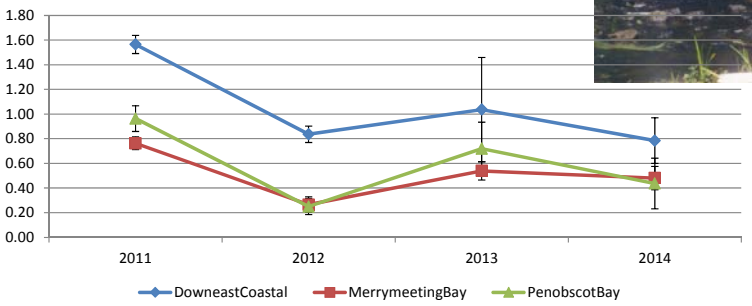
- Smolt Rotary Screw Trap Assessments
  - NOAA initiated in 1996
  - Stratified Mark-Recapture Estimates
    - handle ~ 20% of estimated population



Co-op Agreement with Maine DMR

- Juvenile Electrofishing
  - Historic Index Sites

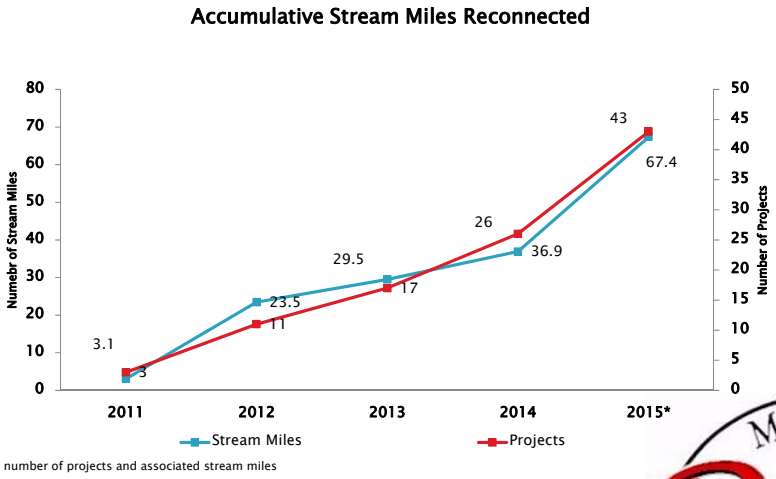




  - Generalized Random Tessellated Stratified (GRTS) design
    - randomly selected
    - stratification by stream width

Co-op Agreement with Maine DMR

- Habitat Databases
  - Consulting and leading NGOs with restoration
  - Updating Habitat inventories – quantity and quality



ed number of projects and associated stream miles

Questions - Discussion

Stock Assessment Approach

Viable Salmonid Populations

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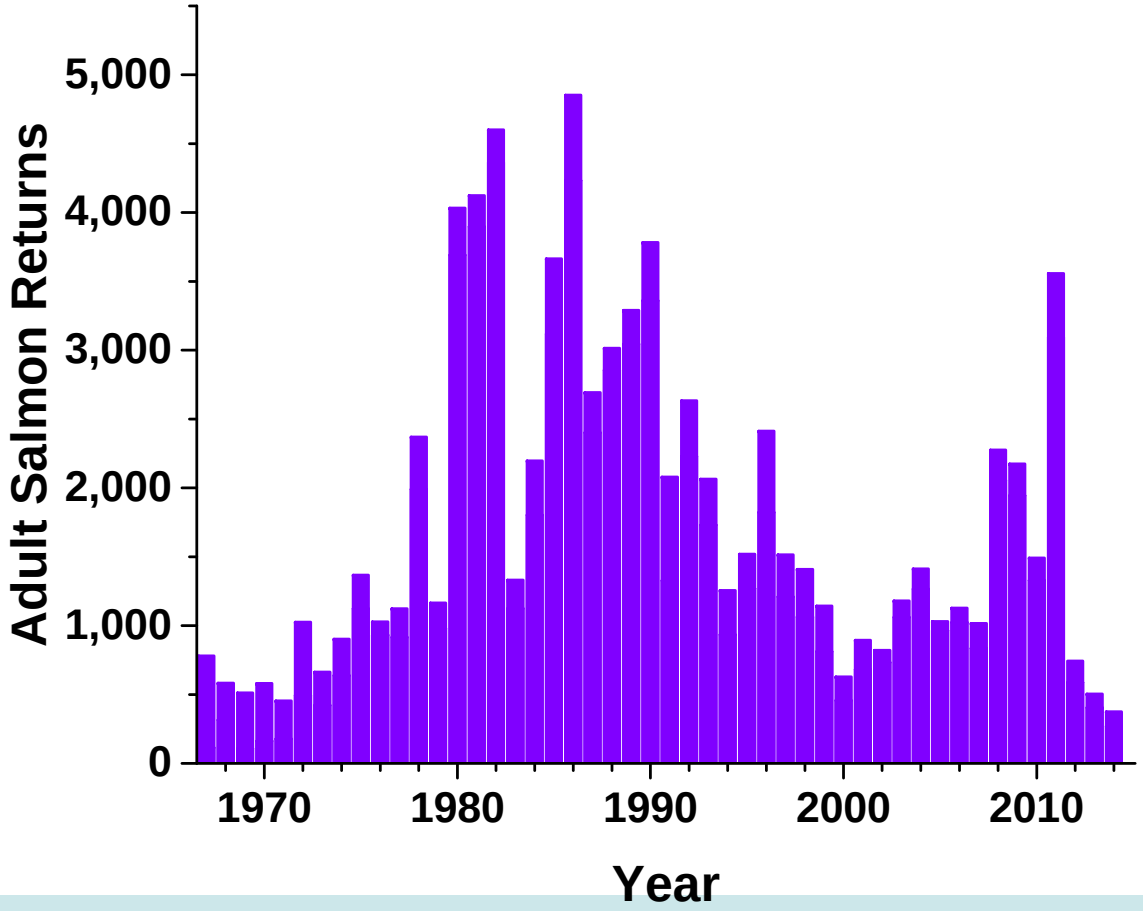
Viable Salmonid Populations

- **Population Size**
  - Adult Counts – trap + redd model
  - Smolt Estimate – Index
    - DC – Narraguagus since 1997
    - MB – Sheepscot since 2009
  - Juvenile – Index
    - Sweka – long term time series
    - GRTS - since 2011

Population Size - census dominated by trap catch

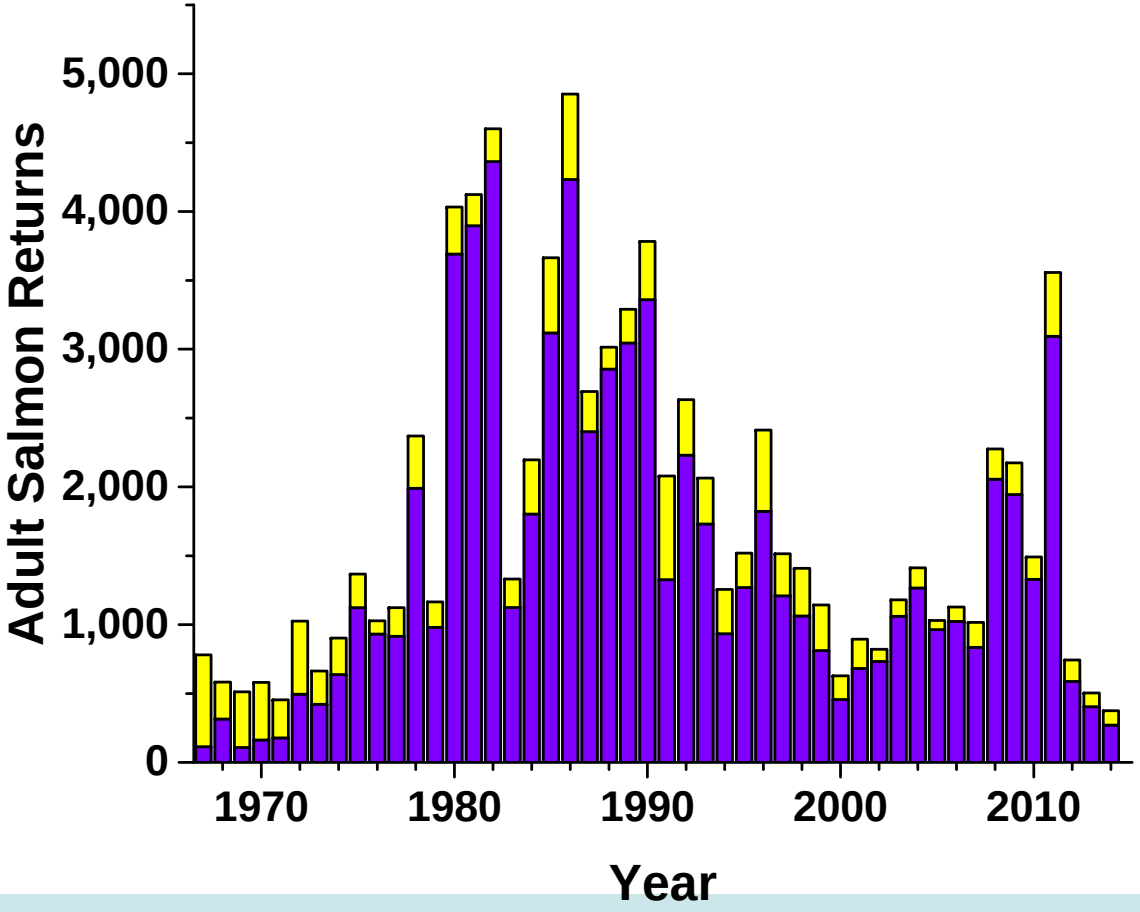
- Overall abundance trends:
  - <1990 some rod catch (and kill)
  - > 1990 redd counts



Population Size - dominated by Penobscot

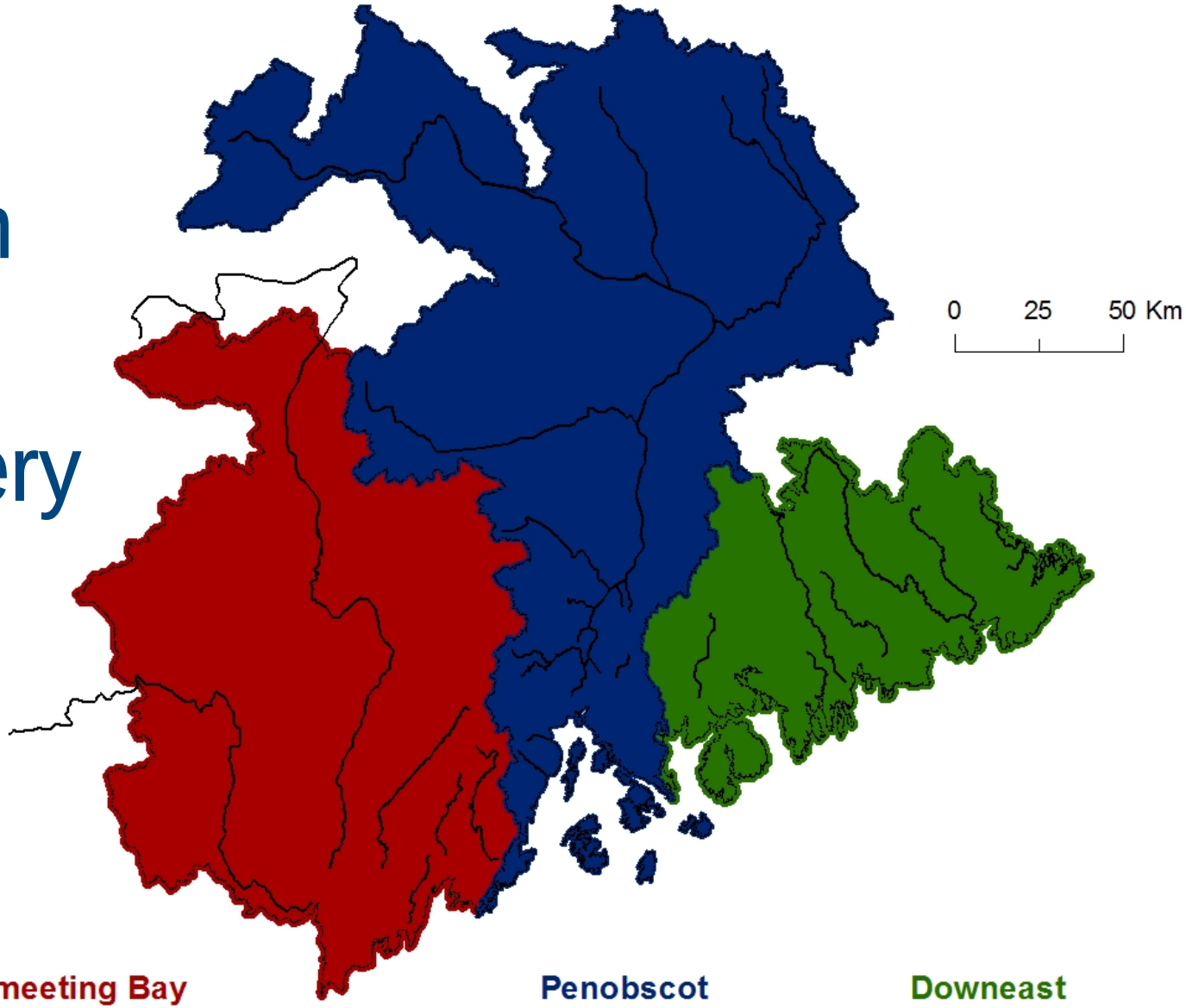
- Hatchery-smolt (purple) returns dominate Penobscot time series
- Naturally-reared (yellow) returns dominate smaller rivers

2014 Returns = 375:
270 hatchery origin
105 naturally reared



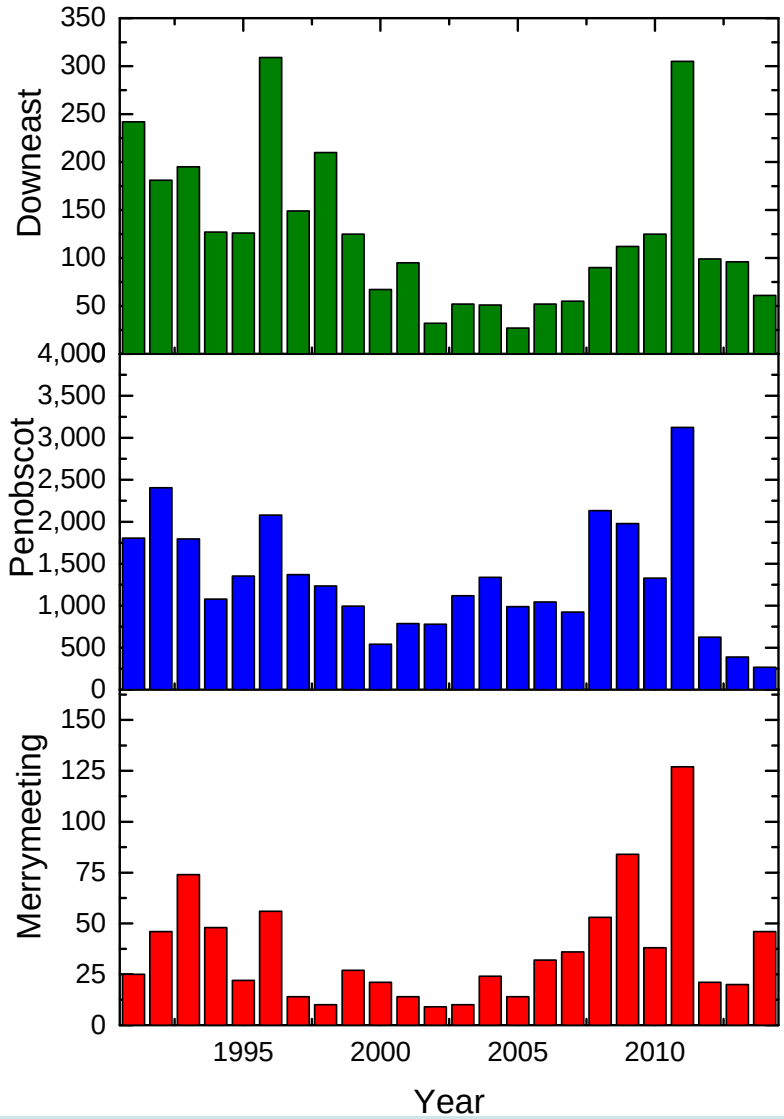
Population Size across 3 SHRU's

Salmon Habitat Recovery Units



Population Size by SHRU since 1991

- Similar Effort over time period
- Median Estimated Returns
  - Downeast Coastal = 105
  - Penobscot Bay = 1,176
  - Merrymeeting Bay = 26

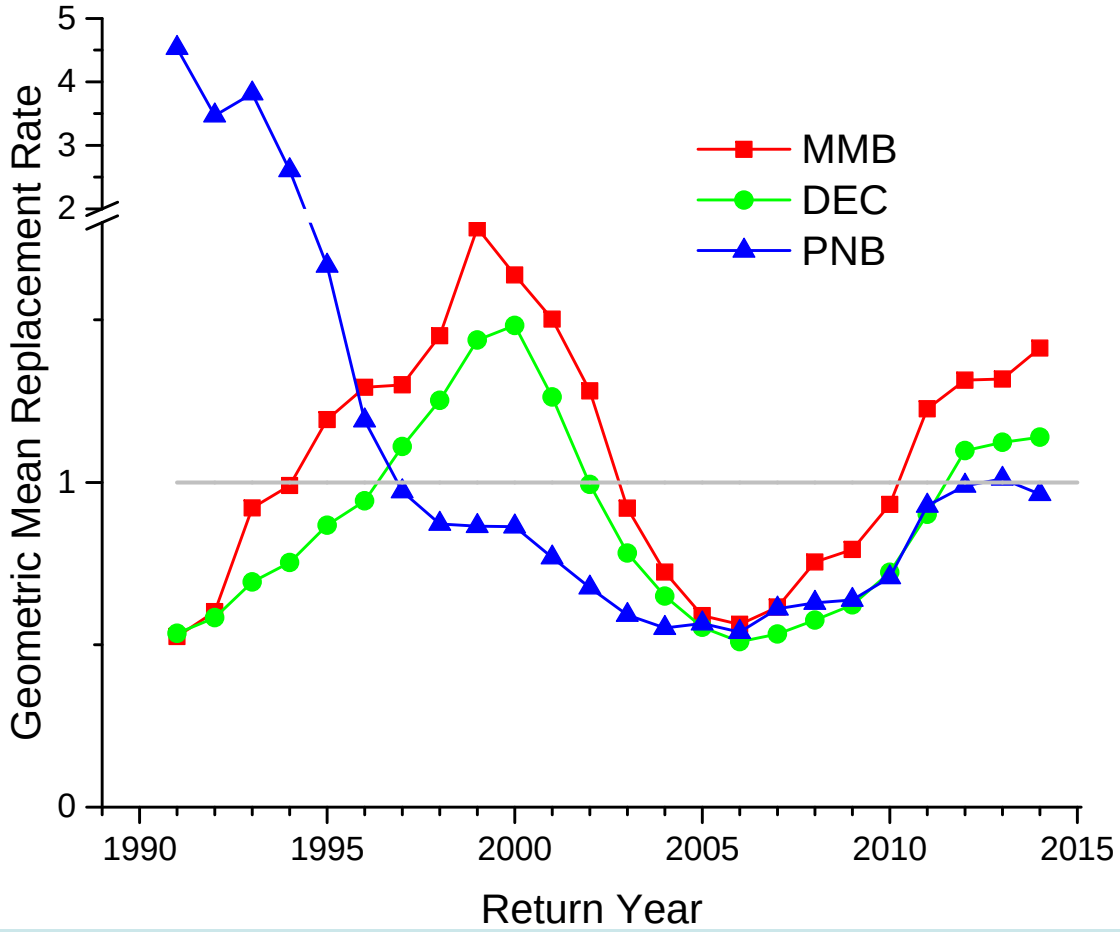


Viable Salmonid Populations

- **Population Growth Rate**
  - Replacement Rate
  - Geometric Mean (10 year, 2 generations)

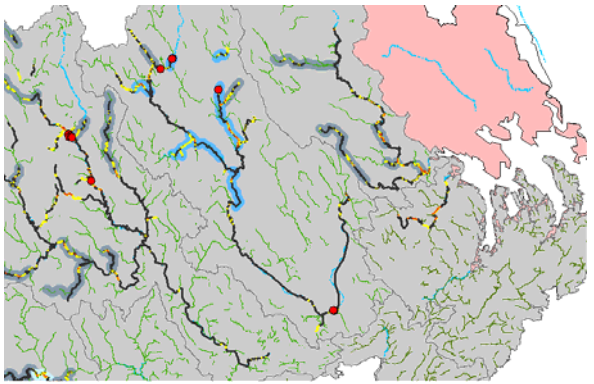
Population Growth Rate - Replacement Rate

- Useful Index for progress but wild/hatchery confounded
  - Variable Stocking #
  - “Naturally-Reared” fish
    - Wild Spawning
    - Fry Stocking

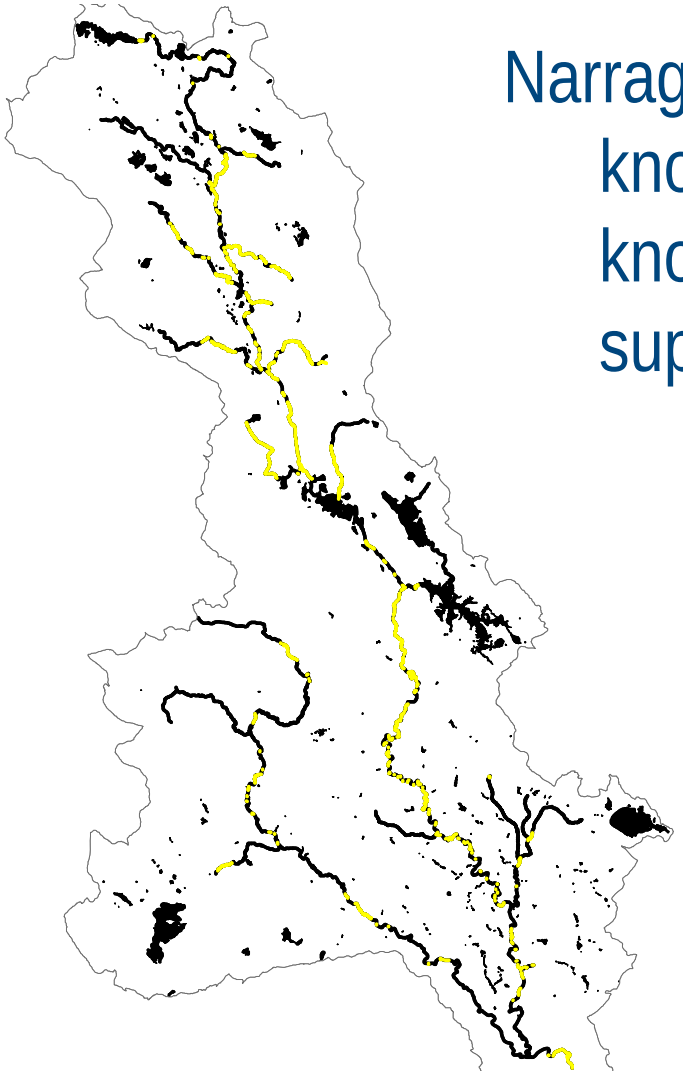


Viable Salmonid Populations

- **Spatial Structure**
- Wild Structure - monitored
  - Redds (red dots)
  - Conservation buffers
- Available Support Tools:
  - 7 Hatchery Supported Stocks
  - Multiple hatchery products
    - Fry Stocked (grey)
    - Parr Stocked (blue)
    - Smolt Stocked (Penobscot + 1-2 others)



Managing Spatial Structure at Watershed Level



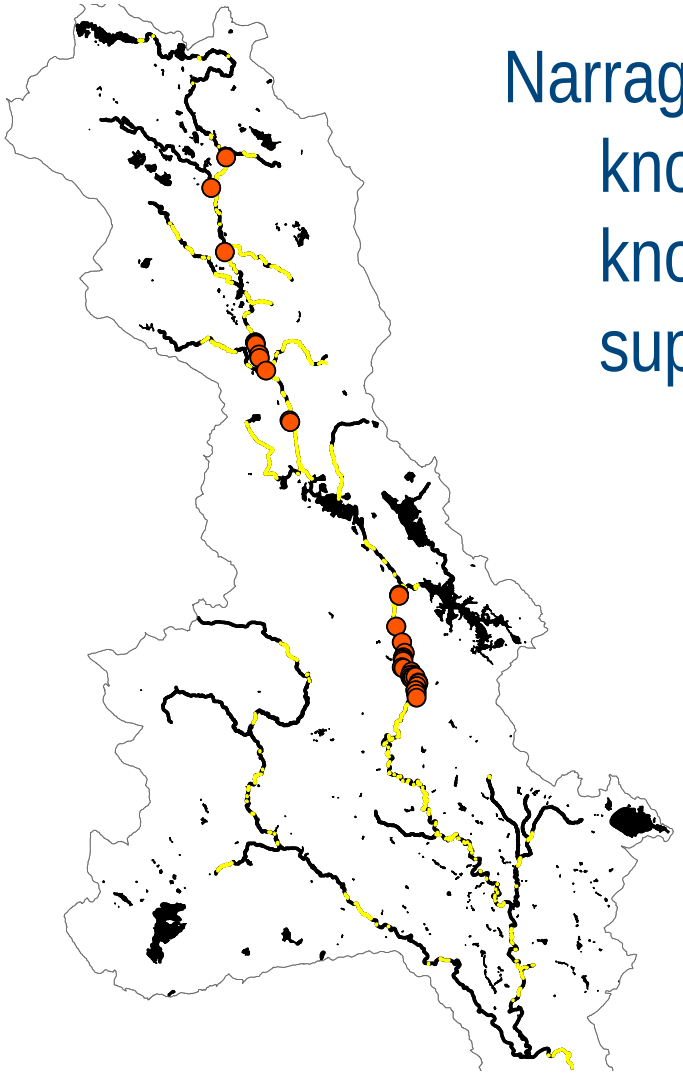
Narraguagus River

know habitat locations

know redd locations

supplement population

Managing Spatial Structure at Watershed Level



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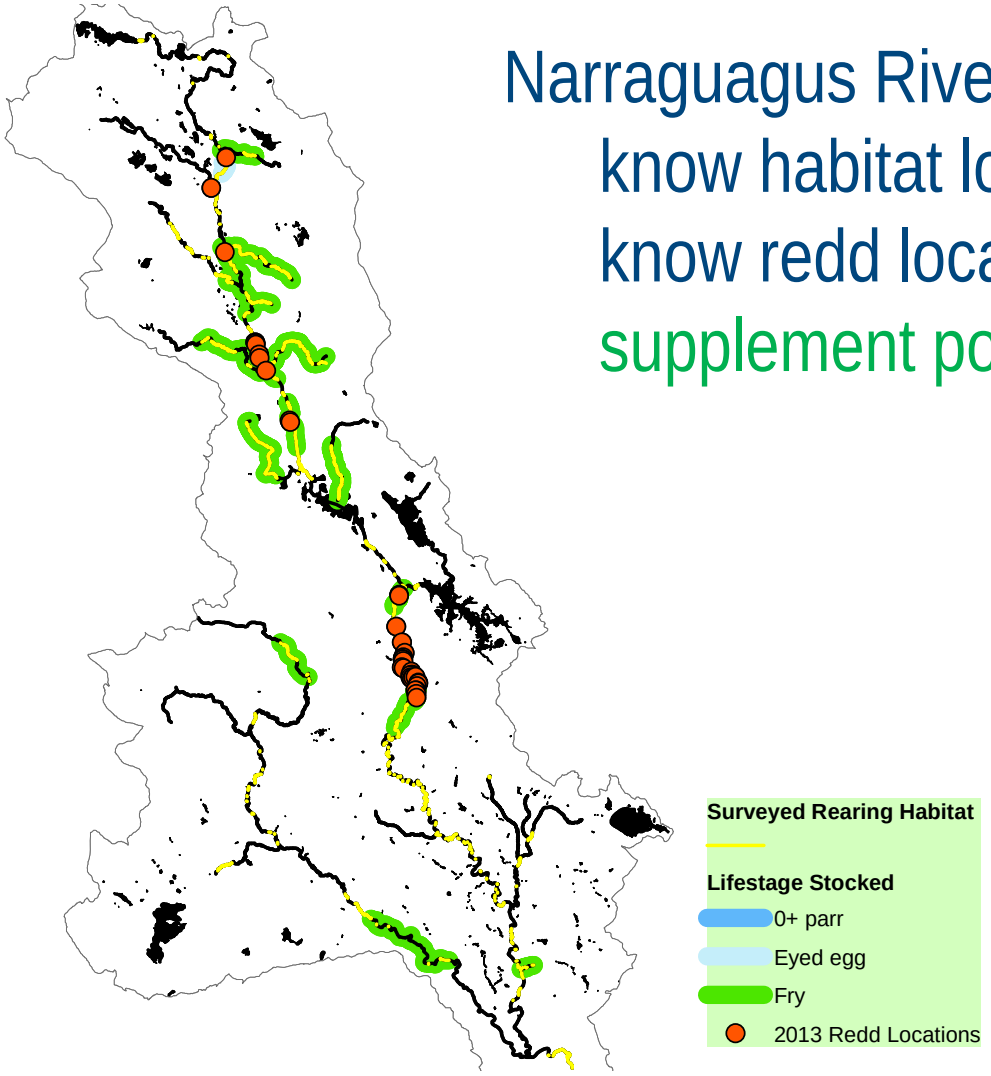

Narraguagus River

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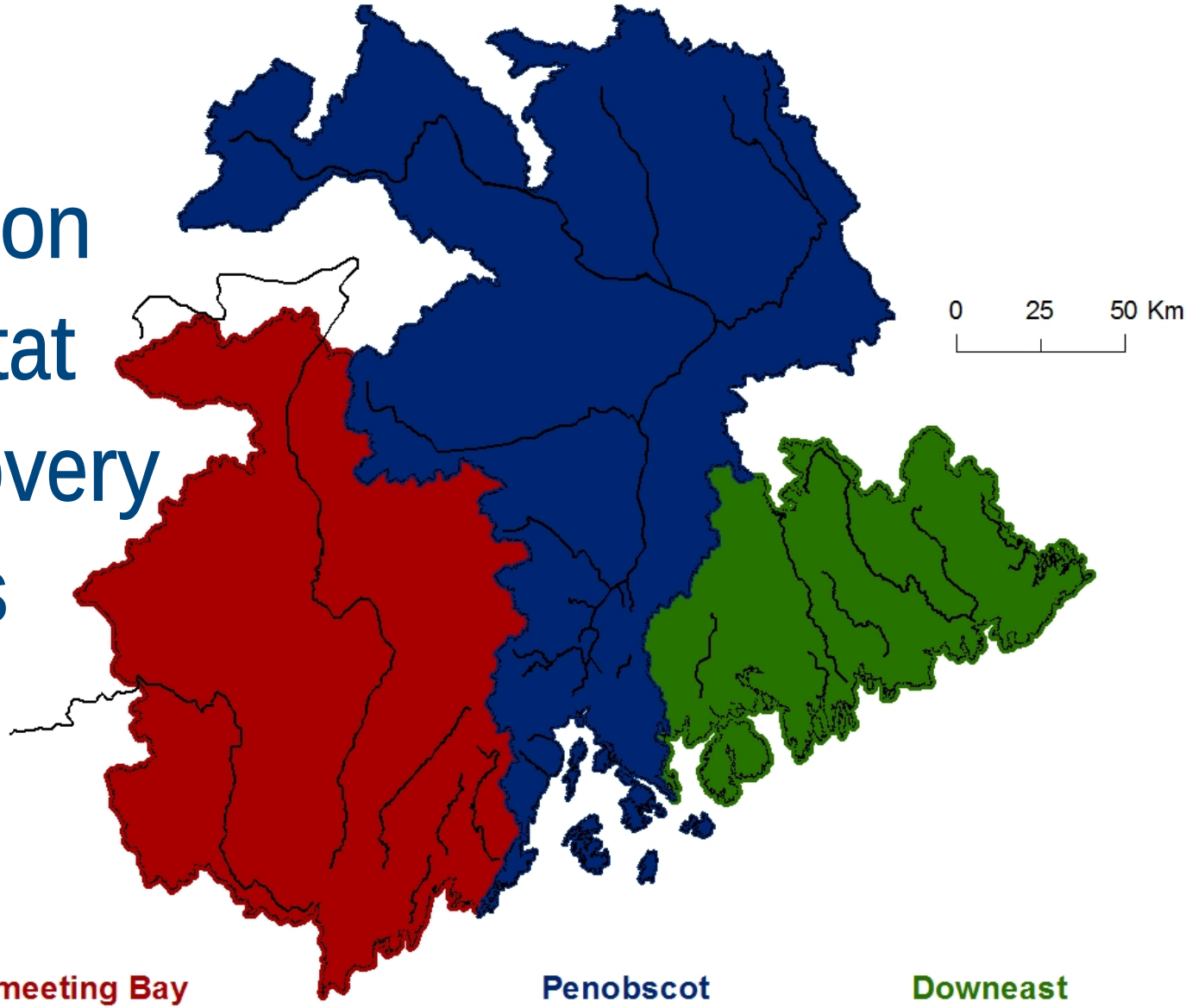
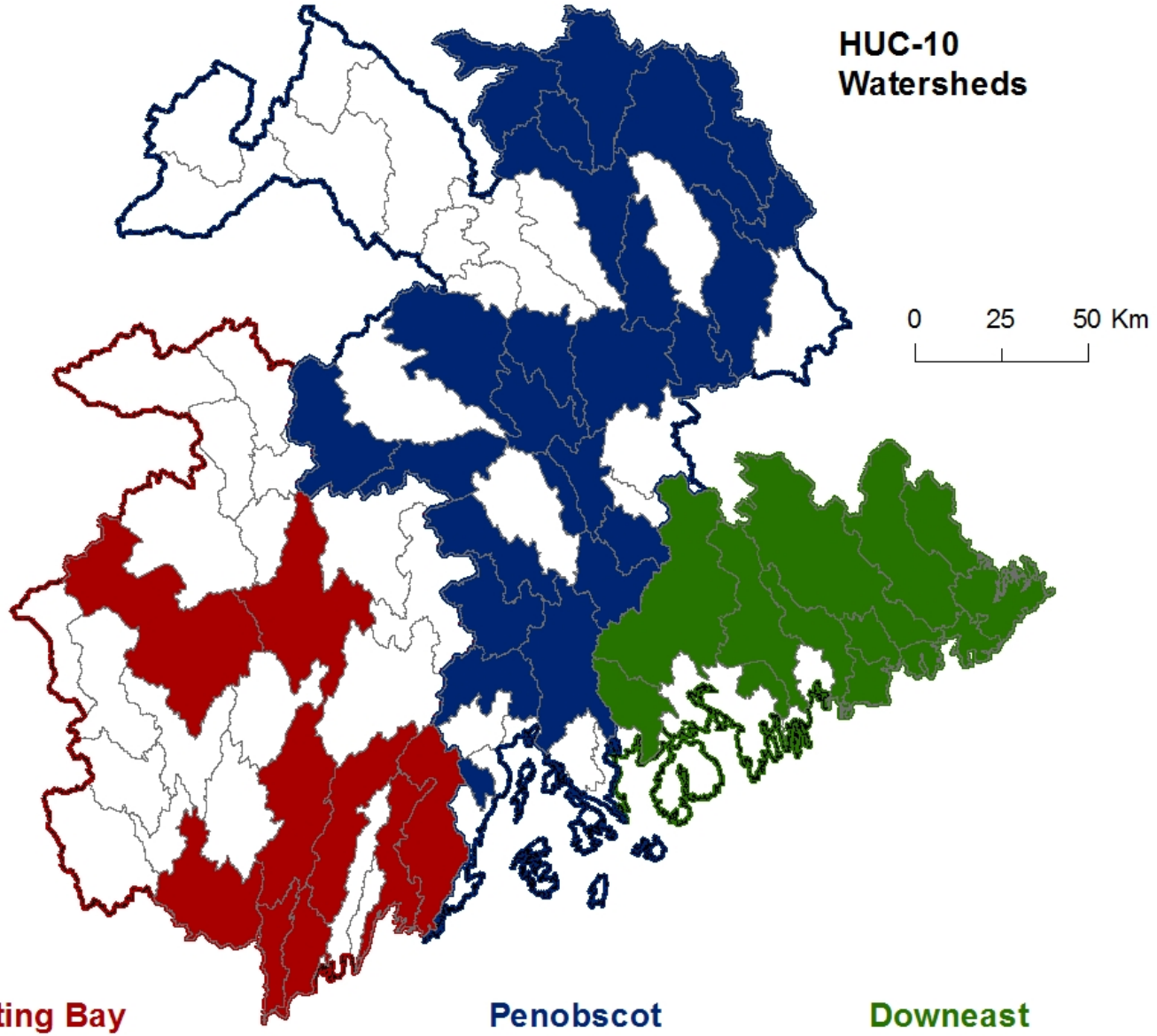
Managing Spatial Structure at DPS Level

Salmon Habitat Recovery Units



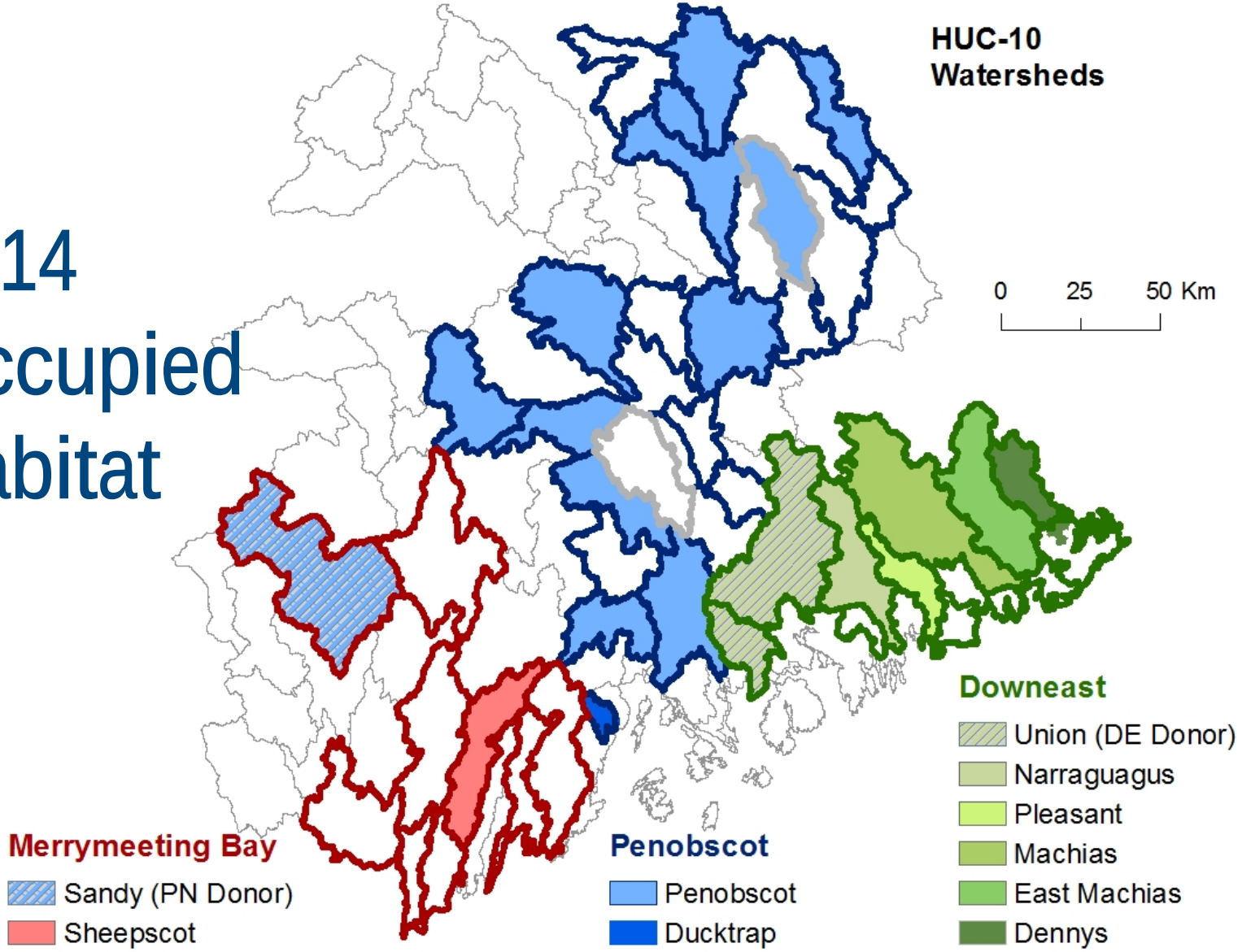
Managing Spatial Structure at DPS Level

Critical Habitat



Managing Spatial Structure at DPS Level

2014 Occupied Habitat



Viable Salmonid Populations

- **Diversity**
  - Varying traits

Transactions of the American Fisheries Society
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http://www.tandfonline.com/loi/utaf20

Marine Growth and Morphometrics for Three Populations of Atlantic Salmon from Eastern Maine, USA

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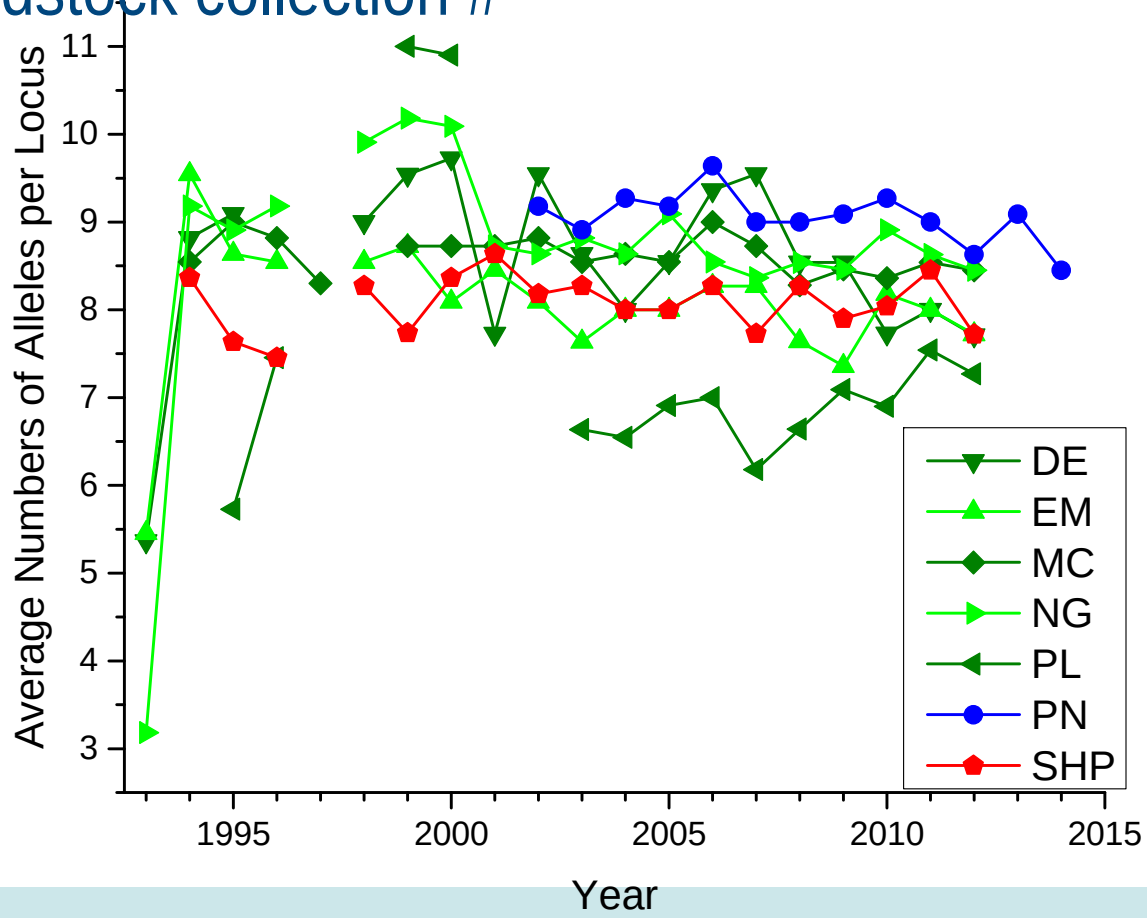
- Molecular genetic characteristics
  - DNA or protein sequence variation

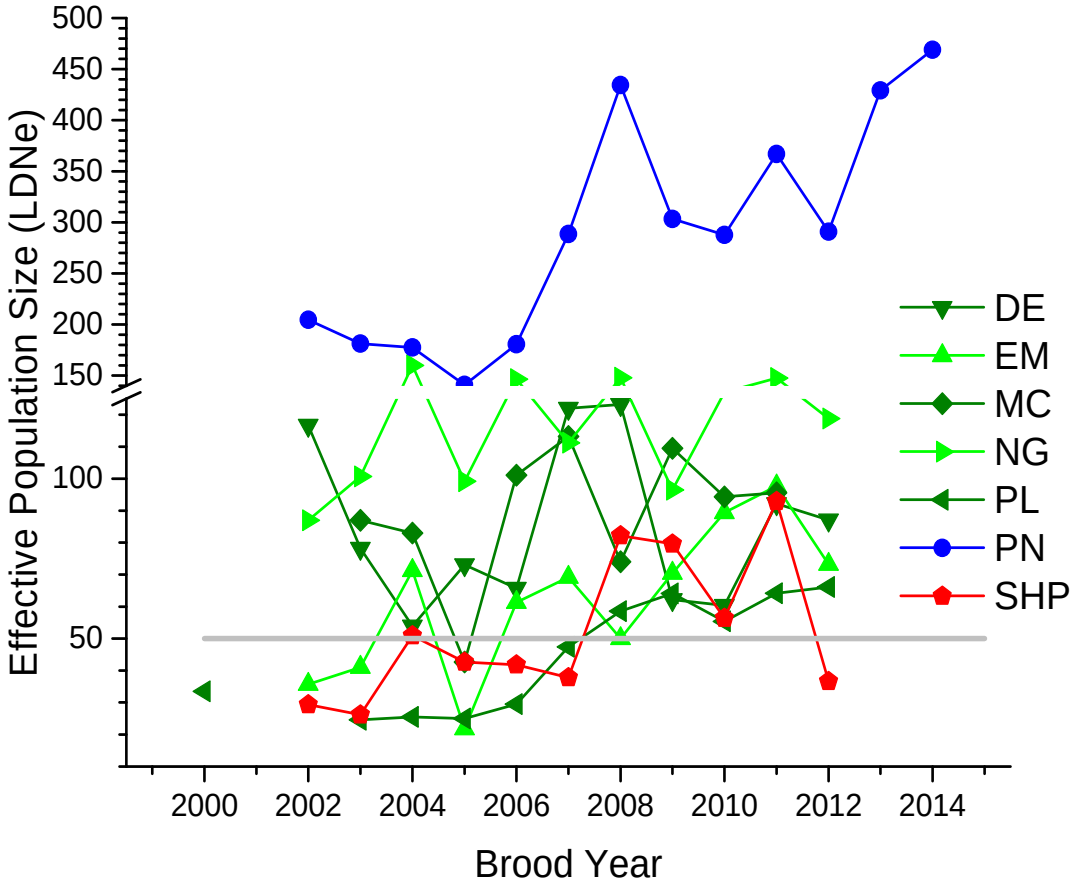
Allelic Diversity

- allelic diversity varies between population
- trends in allelic diversity relatively stable
- actively increasing broodstock collection #
- 11 loci shown
- Increased to18
  - Parentage work



Effective Population Sizes

- Effective population size LDNe (Waples and Do 2008)
- PN – greater numbers
  - Changed to 1:1
- Pedigree lines
  - Successful for PL
  - Incorporating for:
    - Dennys



US Atlantic Salmon Assessment Committee

- Meets Annually
- Review Data and Analysis
- At Meeting Analysis
- Update Access Dbases
- Report & Data to ICES and US Section NASCO

ANNUAL REPORT OF THE U.S. ATLANTIC SALMON ASSESSMENT COMMITTEE

REPORT NO. 25 - 2012 ACTIVITIES

Old Lyme, Connecticut
February 25-28, 2013

PREPARED FOR

U.S. SECTION TO NASCO

Questions - Discussion