Northwest Power and Conservation Council

January 3, 2012

MEMORANDUM

TO: Fish and Wildlife Committee members

FROM: Jim Ruff – Manager, Mainstem Passage and River Operations

SUBJECT: Overview of American shad in the Columbia River and a related USGS project

Background

At the January 10, 2012, Fish and Wildlife Committee meeting, Mike Parsley and Matt Mesa from the U.S. Geological Survey's (USGS) Western Fisheries Research Center-Columbia River Research laboratory in Cook, WA will present an overview of Fish and Wildlife Program project #2007-275-00, American shad in the Columbia River, as well as a related USGS project (project #2008-719-00), Research Non-Indigenous Actions. This briefing by USGS scientists will report the findings from these studies, which contribute to a better understanding of American shad in the Columbia River, their impact on salmon restoration efforts, and provide direction for additional research.

American shad (*Alosa sapidissima*) are a highly successful introduced species in the Columbia River basin, with some adults migrating upstream as far as Rock Island Dam on the Columbia River and above Lower Granite Dam on the Snake River. Based on Corps of Engineers adult fish count records, the five-year (2006-2010) average adult shad count over Bonneville Dam is 2.22 million fish. On average, over 7900 shad passed above Lower Granite Dam on the Snake River, and about 750 shad have migrated above Priest Rapids Dam on the Columbia River during the same five year period. American shad adults, perhaps up to 20 million, enter the lower Columbia River during the April through June period for spawning. Juvenile shad out-migrate in vast numbers primarily from July through early winter, with evidence suggesting many juveniles overwinter in the estuary.

Hydroelectric development of the lower Columbia River inundated natural barriers to adult American shad migration and modifications to fish ladders at the dams in the 1970s to improve adult salmon passage also allowed American shad numbers to increase dramatically. Non-native fishes frequently impact native fish at multiple scales from population-level impacts to modifying food webs and altering ecosystem function. Non-native species typically compete with native species for food and space, facilitate the spread and virulence of diseases, and alter habitat. The abundance of American shad in the Columbia River has raised concerns about their impact on native salmonids and restoration efforts.

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Project 2007-275-00: Impact of American shad in the Columbia River
http://www.cbfish.org/Project.mvc/Display/2007-275-00

The objectives of Fish and Wildlife Program project 2007-275-00 (Impact of American shad in the Columbia River) funded by Bonneville from 2007-2010, were to: a) collect data on the diet of juvenile and adult American shad; b) develop a bioenergetics model for American shad to provide decision support; and c) to conduct empirical investigations to gain insight into several areas of study where American shad may have impact in the Columbia River. The project collected and reported detailed data on the diet of American shad, investigated the role of American shad as vectors of disease, analyzed the growth of age-0 American shad and developed a bioenergetics model for the species. In addition, project personnel collaborated extensively with other researchers to investigate important and sometimes unique aspects of American shad life history.

Project 2008-719-00: Research Non-Indigenous Actions
http://www.cbfish.org/Project.mvc/Display/2008-719-00

Ongoing Fish and Wildlife Program project 2008-719-00 (Research Non-Indigenous Actions) is investigating the food habits of non-native predators, including smallmouth bass, catfish and walleye, in the lower Columbia River during the late summer and fall to assess the role of juvenile American shad in their diets and any impacts on their health and condition. This project will provide an understanding of the general health and condition of non-native predators prior to over-wintering and the role their diet in the fall plays in determining their condition. Such information will be useful for validating previous bioenergetics analyses and for conducting new analyses.

USGS
science for a changing world

Impact of American Shad in the Columbia River

Project 2007-275-00

Michael J. Parsley

Western Fisheries Research Center
Columbia River Research Laboratory

U.S. Dept of Interior
U.S. Geological Survey

Purpose

Better understand the role of American shad in salmon restoration efforts

USGS

Today's Presentation

- History of Project 2007-275-00
- Goal and Objectives
- Results
- Future Directions

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History of Project 2007-275-00

- 2002 – USGS submitted proposal
- 2004 – Innovative Project Proposal
- 2005 – presentation to NPCC
- 2006 – Revised proposal
- 2006 – Council recommendation for funding with caveats

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2006 Proposal Review Results

Sponsor: Columbia River Research Laboratory
Budgets: FY07: $278,736 | FY08: $360,313 | FY09: $365,160

ISRP final recommendation: Fundable

Final Council recommendation (November 2006)
Funding category: Expense
Recommended budgets:
FY07: $133,334 FY08: $133,333 FY09: $133,333
Comment: Need to be complete in 3 years.

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2007-275-00 Objectives

1) Shad as potential competitors of juvenile salmon for forage
2) The role that shad play as prey for juvenile salmon and as prey supporting growth of native and introduced predators of juvenile salmon
3) The role that shad may play as vectors of disease that pose a potential threat to the restoration of salmon populations

USGS

History of Project 2007-275-00

- 2002 – USGS submitted proposal
- 2004 – Innovative Project Proposal
- 2005 – presentation to NPCC
- 2006 – Revised proposal
- 2007 – Council recommendation for funding with caveats
- 2009 – Food webs presentation to NPCC
- 2010 – Proposal to expand denied, project ended; final report delivered May 2011

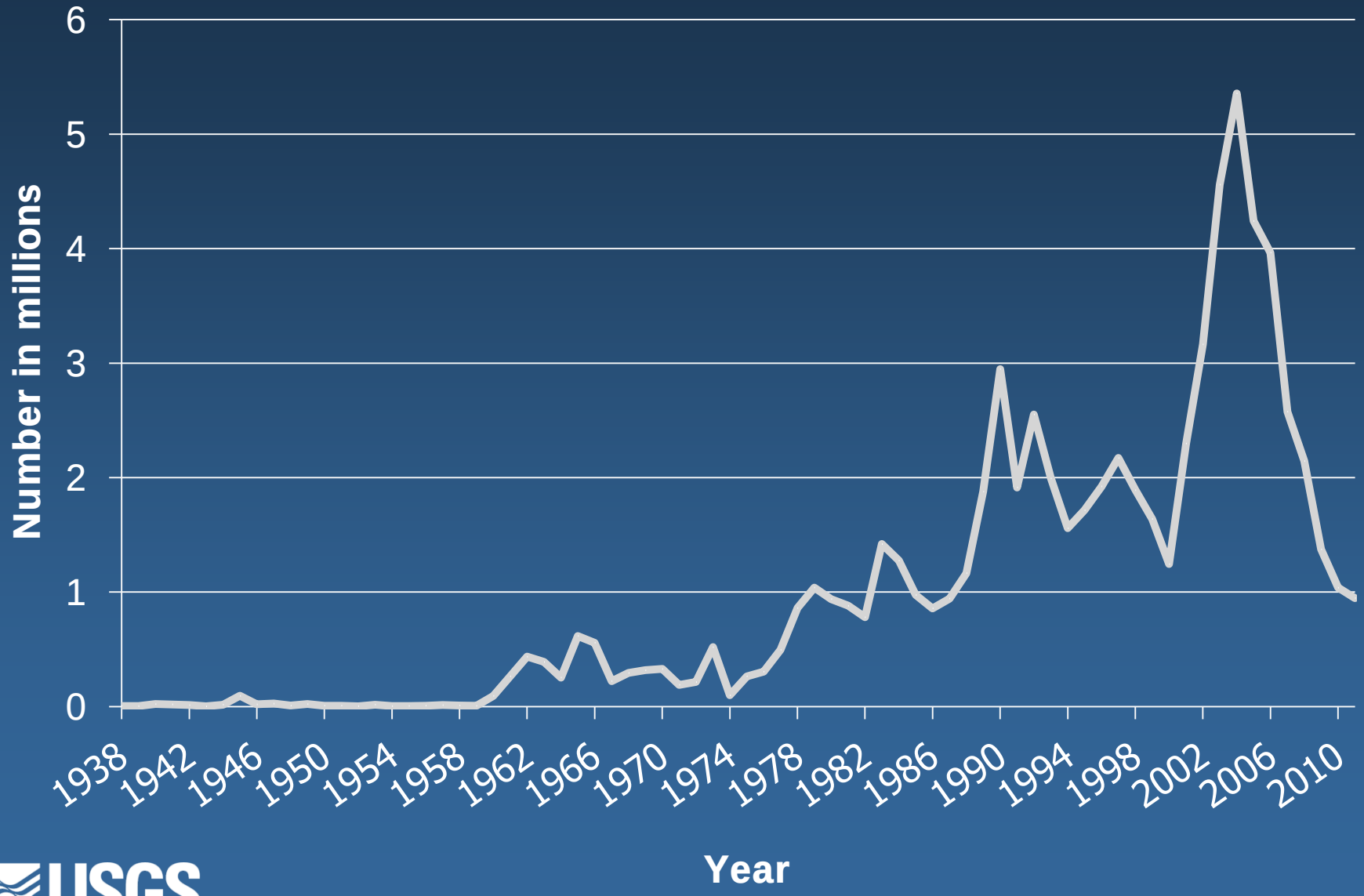
ISRP 2011 Retrospective Report

Objectives for 2007-275-00

1) **Estimate abundance of juvenile shad in reservoirs**
2) **Corroborate existing shad bioenergetics model**
3) **Characterize zooplankton in mainstem reservoirs**
4) **Characterize fitness of subyearling Chinook salmon when shad are abundant**
5) **Characterize food habits of subyearling Chinook in lower Columbia River reservoirs when shad are abundant**

USGS

American Shad Counted at Bonneville Dam (1938-2011)



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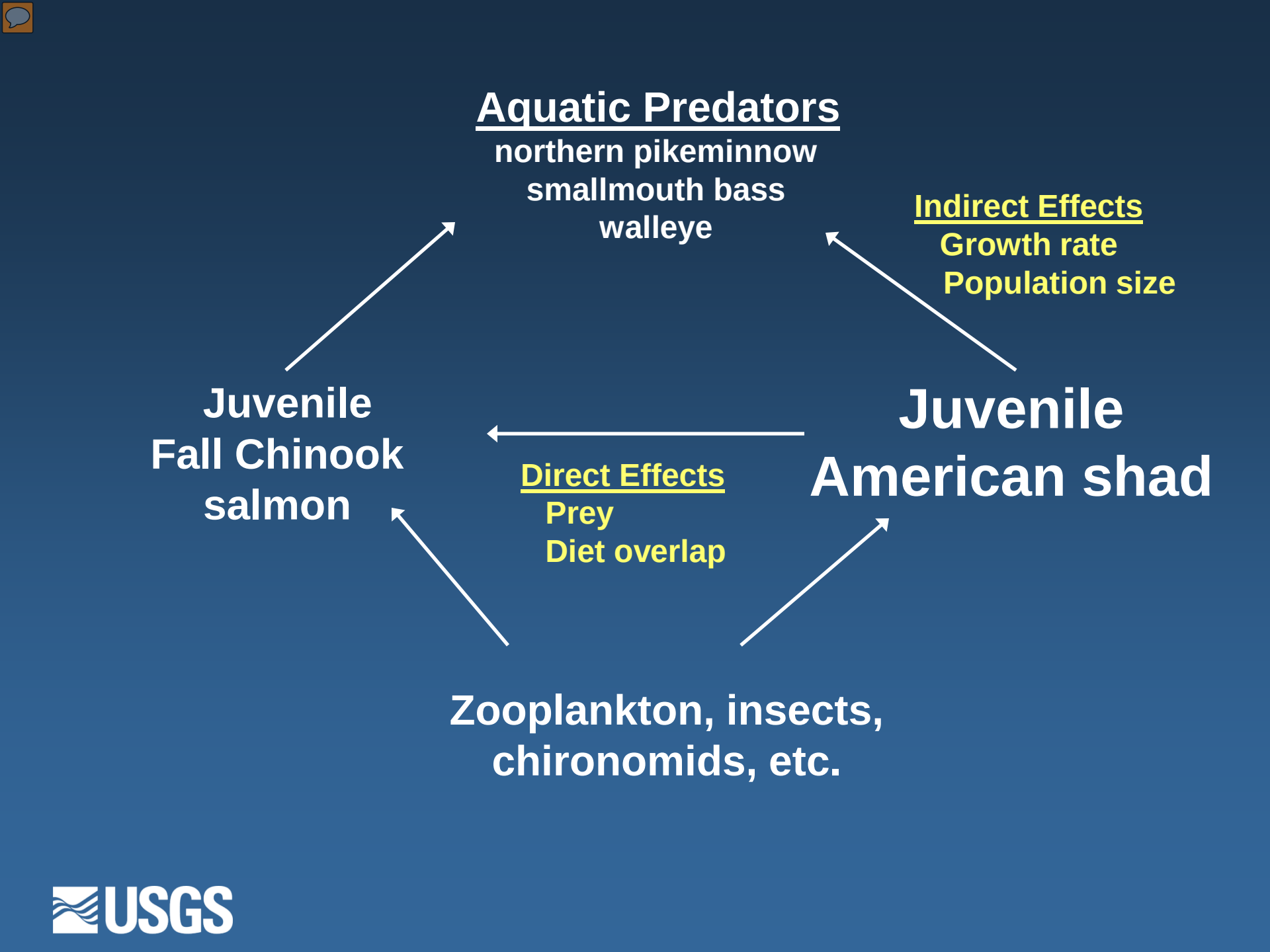

Aquatic Predators
northern pikeminnow
smallmouth bass
walleye
Indirect Effects
Growth rate
Population size
Juvenile
Fall Chinook
salmon
Juvenile
American shad
Direct Effects
Prey
Diet overlap
Zooplankton, insects,
chironomids, etc.

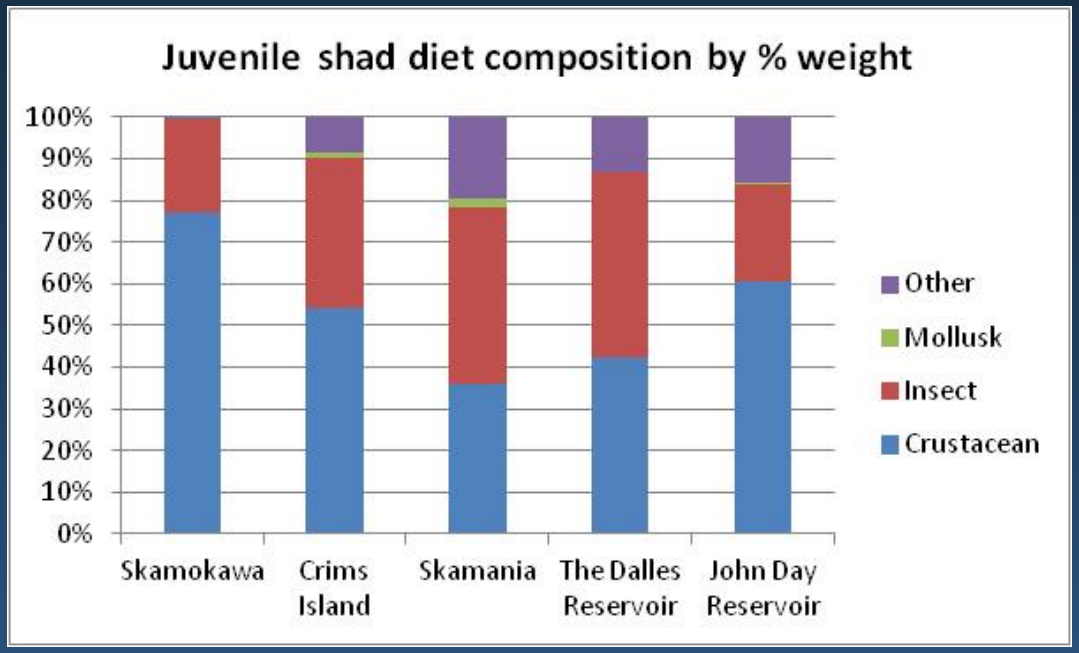
Accomplishments

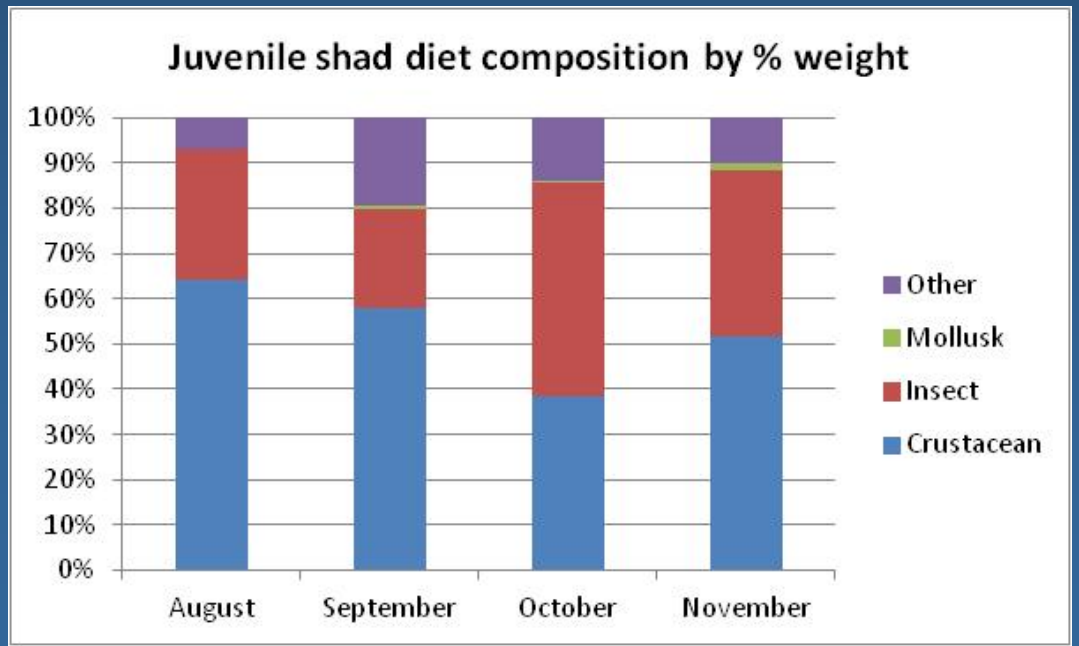
- **Broadened geographic description of juvenile American shad diet**
- **Found that some adults are feeding during freshwater migrations**
- **Growth of juvenile shad**
- **Refined shad bioenergetics model**

Presented in final report to BPA

USGS

Shad Diets





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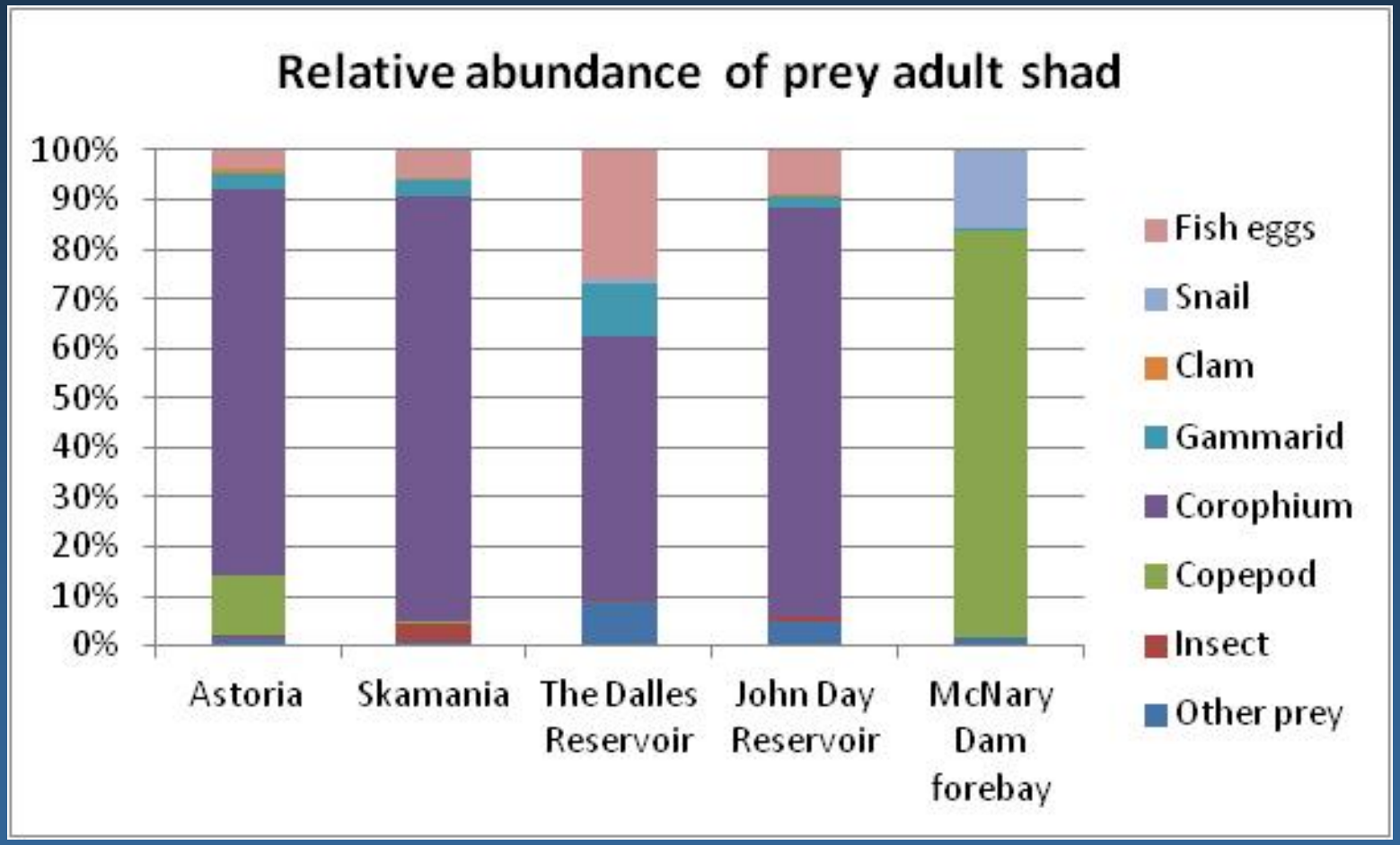
Shad Diets



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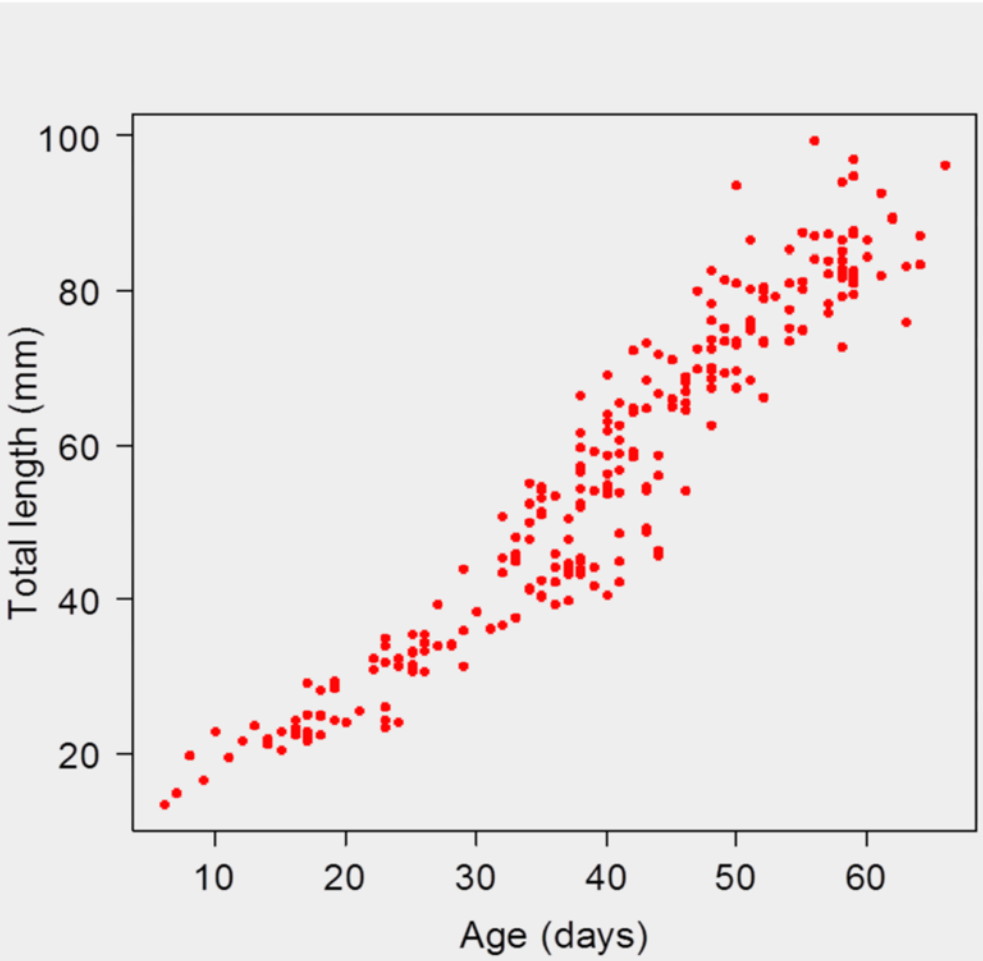
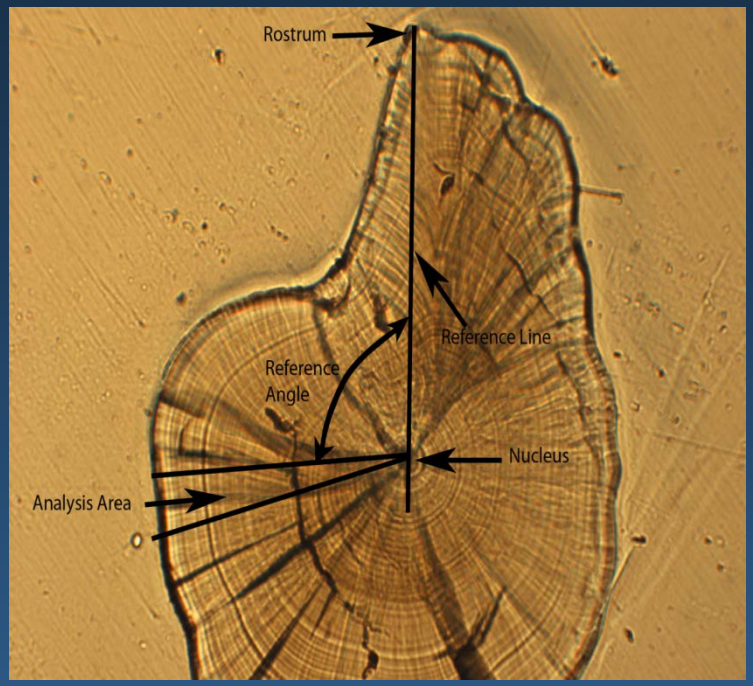
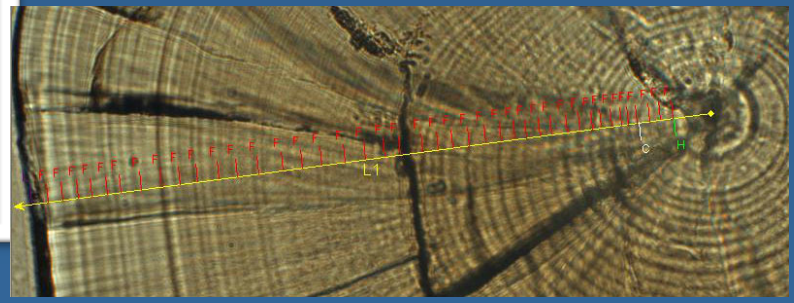
Shad Growth







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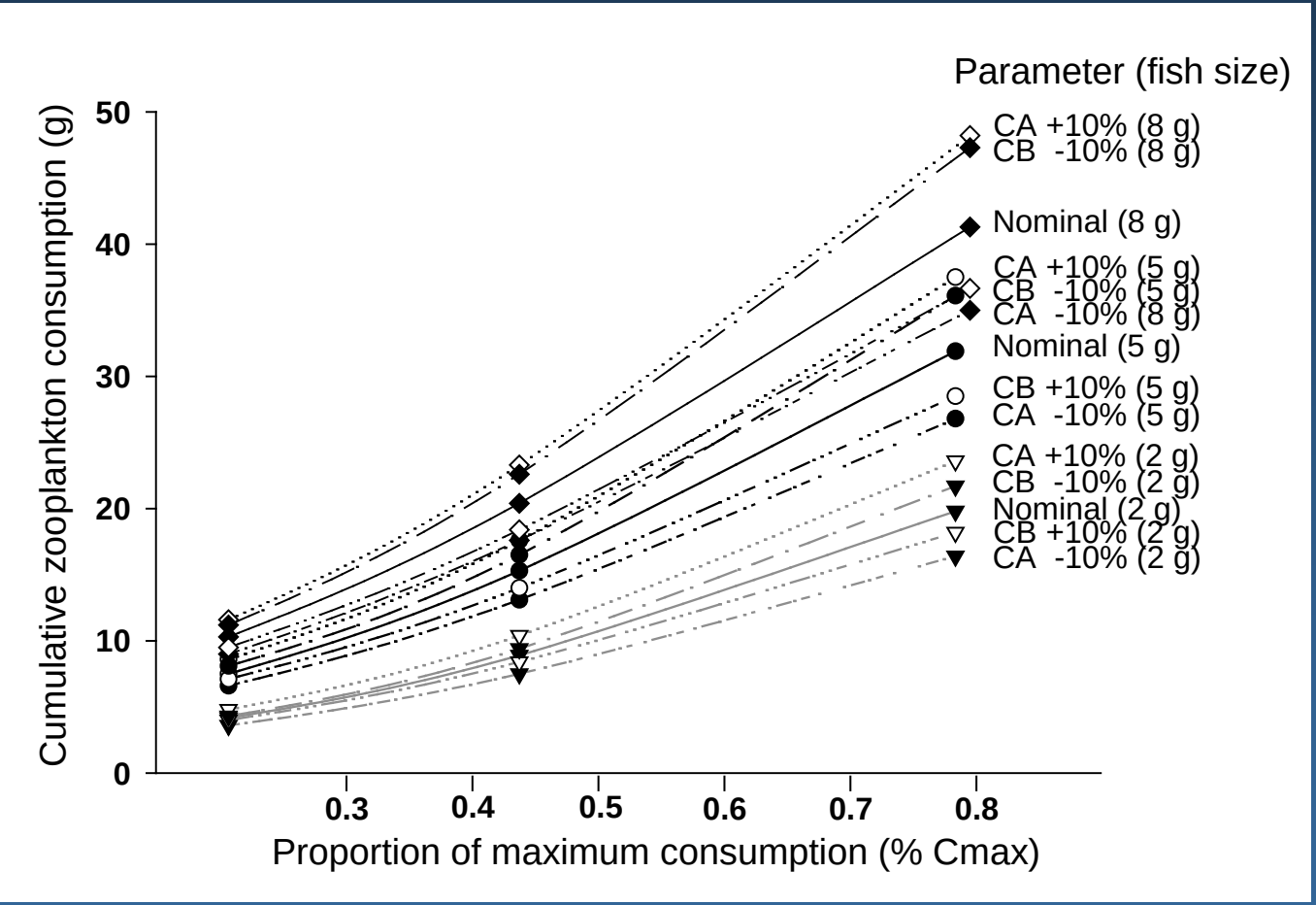
Bioenergetics Models

Zooplankton consumption by juvenile shad



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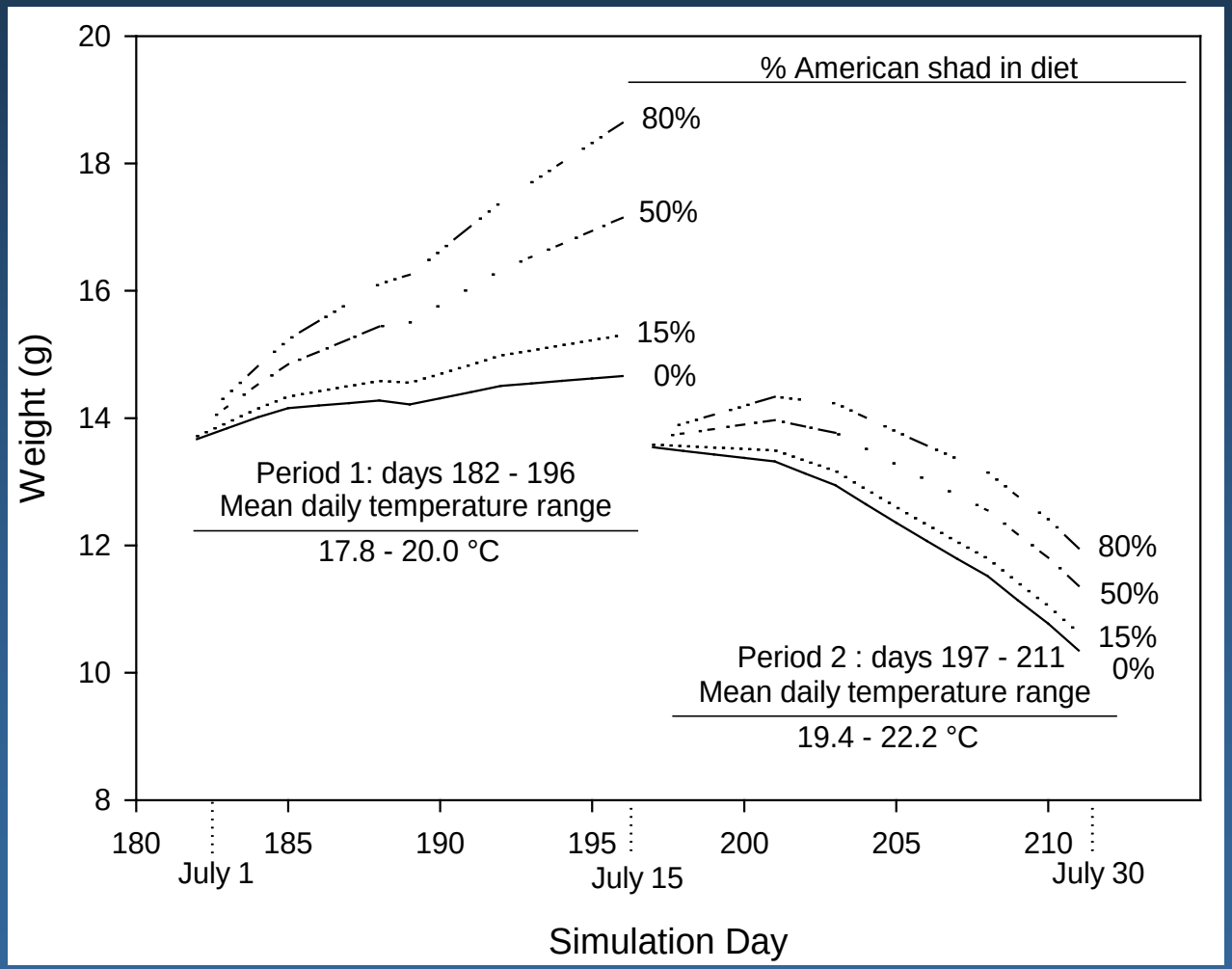
Bioenergetics Models

Larval shad consumption by juvenile Chinook salmon



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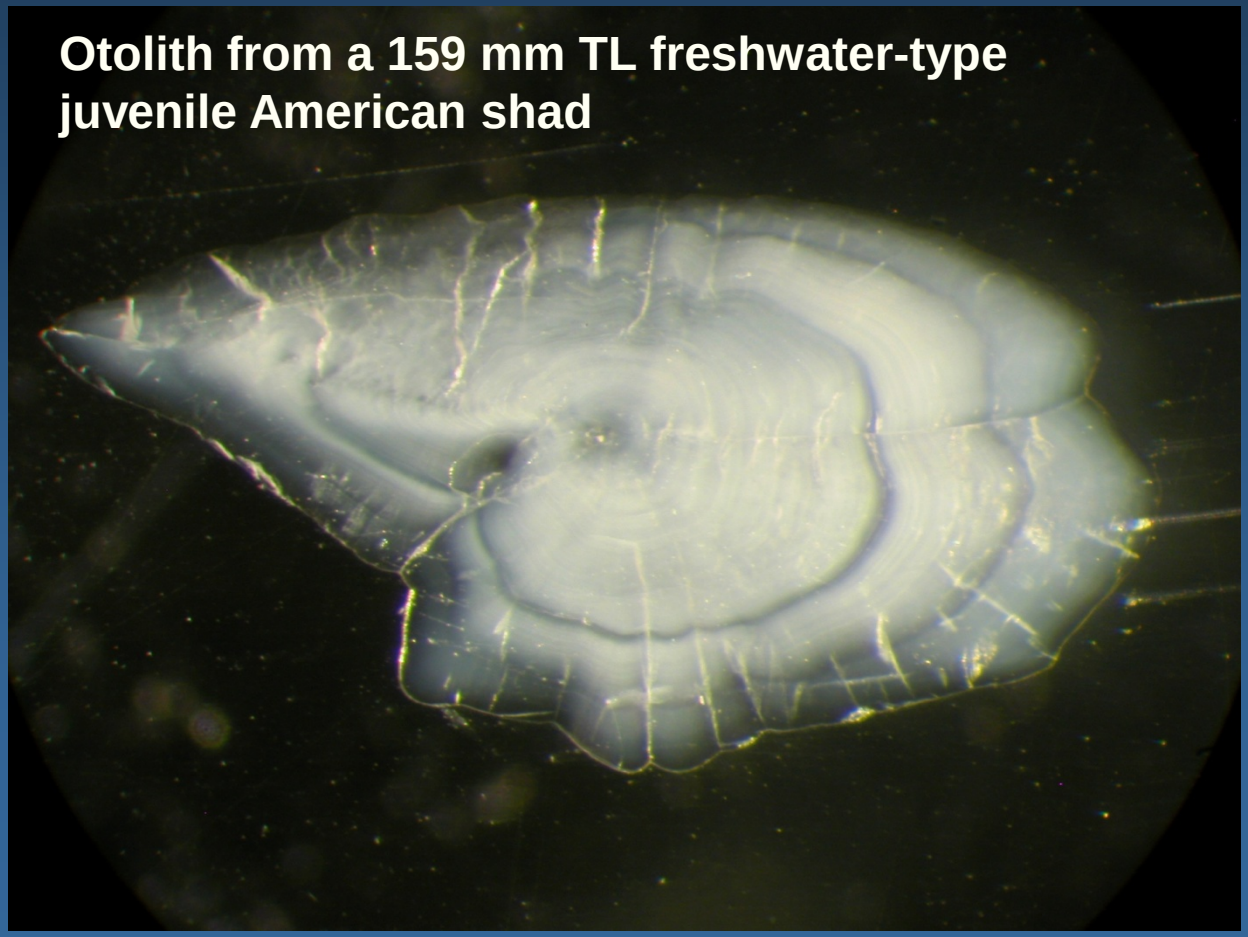
Interesting Findings

- Freshwater-type juvenile shad exist



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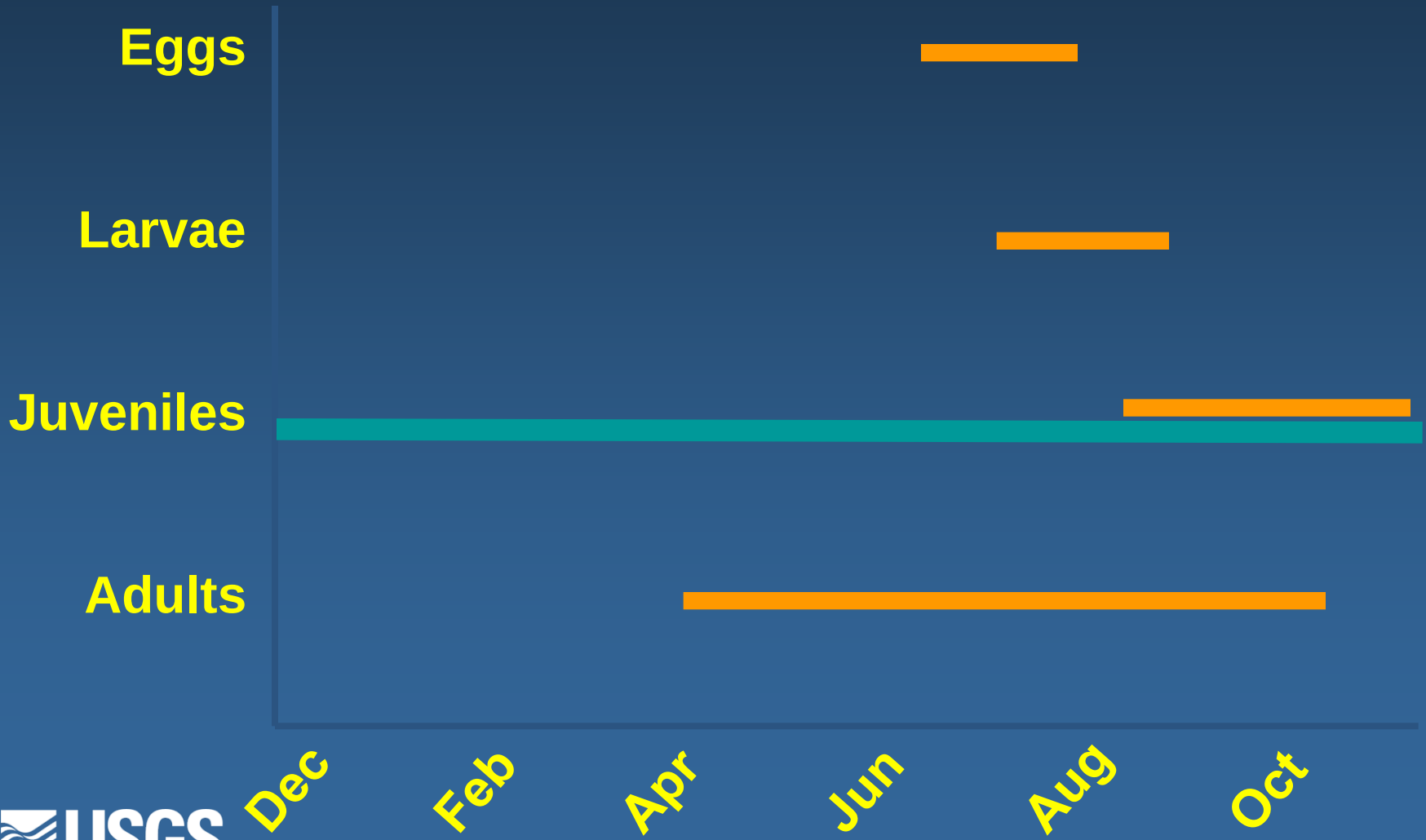
Why should we care?

- Juvenile shad are available as forage throughout the year
- Juvenile shad are consuming food in freshwater throughout the year

USGS

Timing of American Shad in Freshwater



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Interesting Findings

- Freshwater-type juvenile shad exist
- Thiaminase activity is higher than that in Great Lakes forage fish

Why should we care?

Affects reproductive success in Great Lakes salmon

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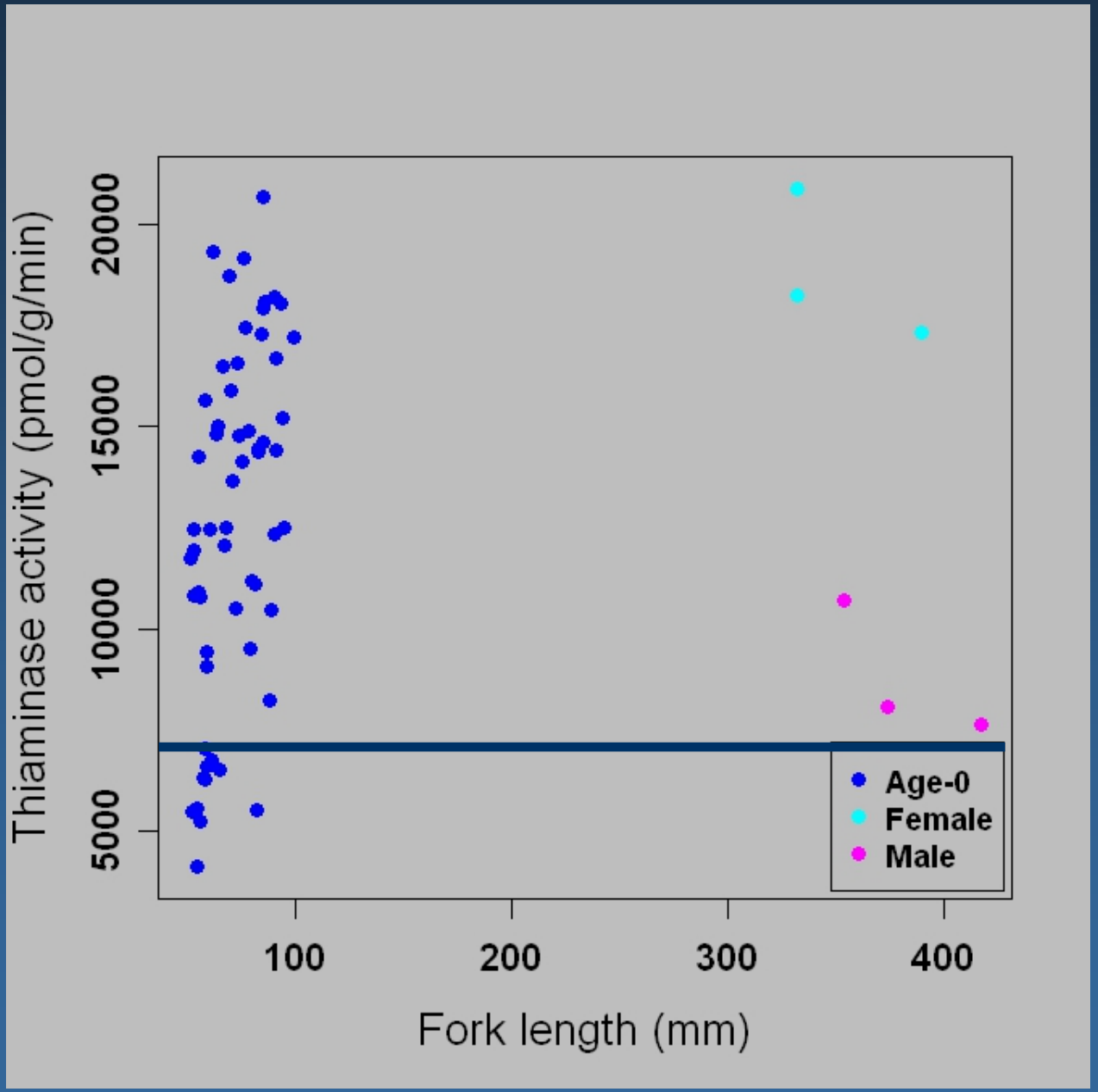
Thiaminase Activity in Shad



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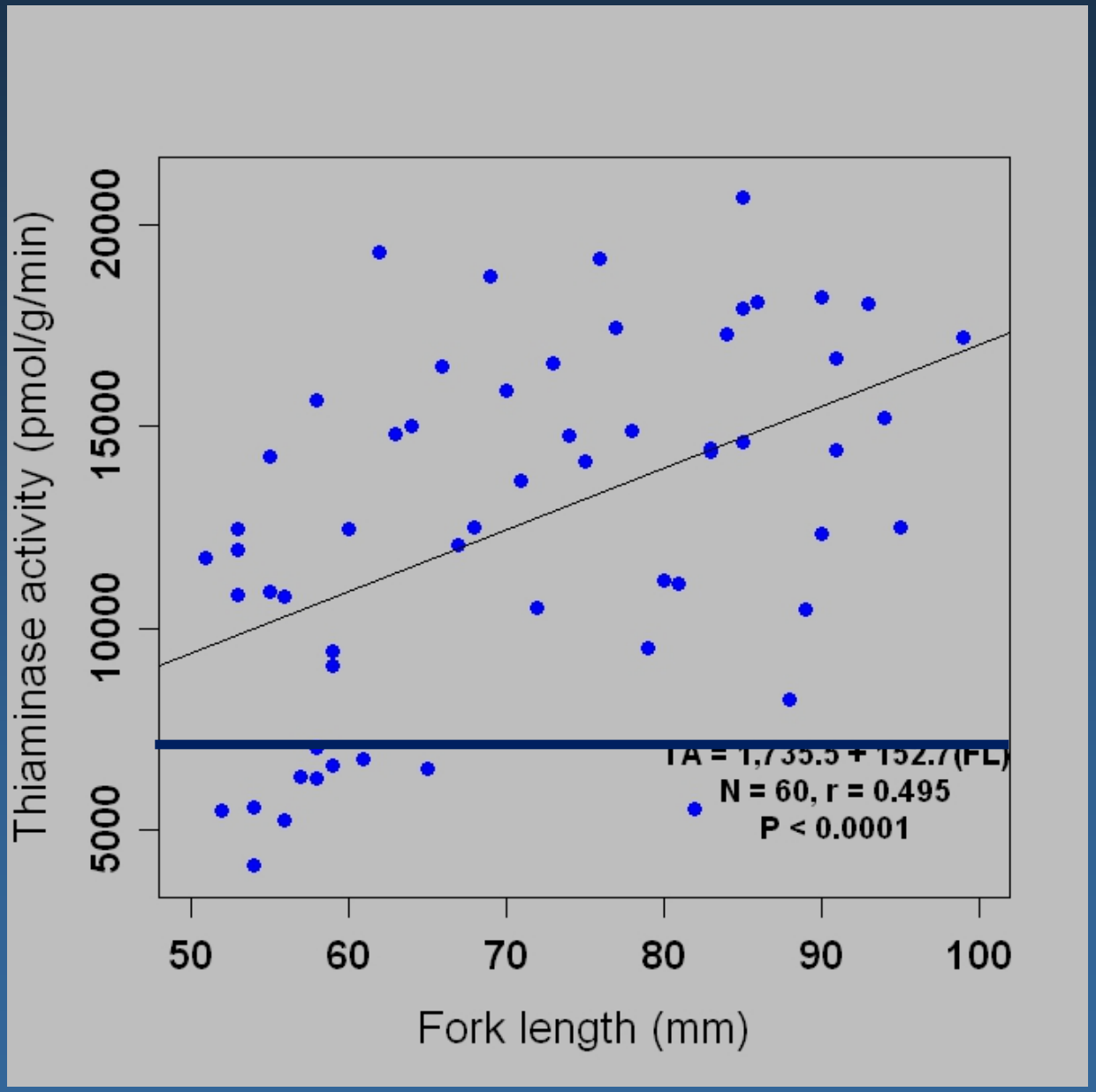
Thiaminase Activity in Shad



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Interesting Findings

- Freshwater-type juvenile shad exist
- Thiaminase activity is higher than that in Great Lakes forage fish
- Prevalence of *Ichthyophonus* infection was high

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Ichthyophonus is in many fishes

12-45% Yukon Chinook

15% Kuskokwim Chinook

23% Chinook

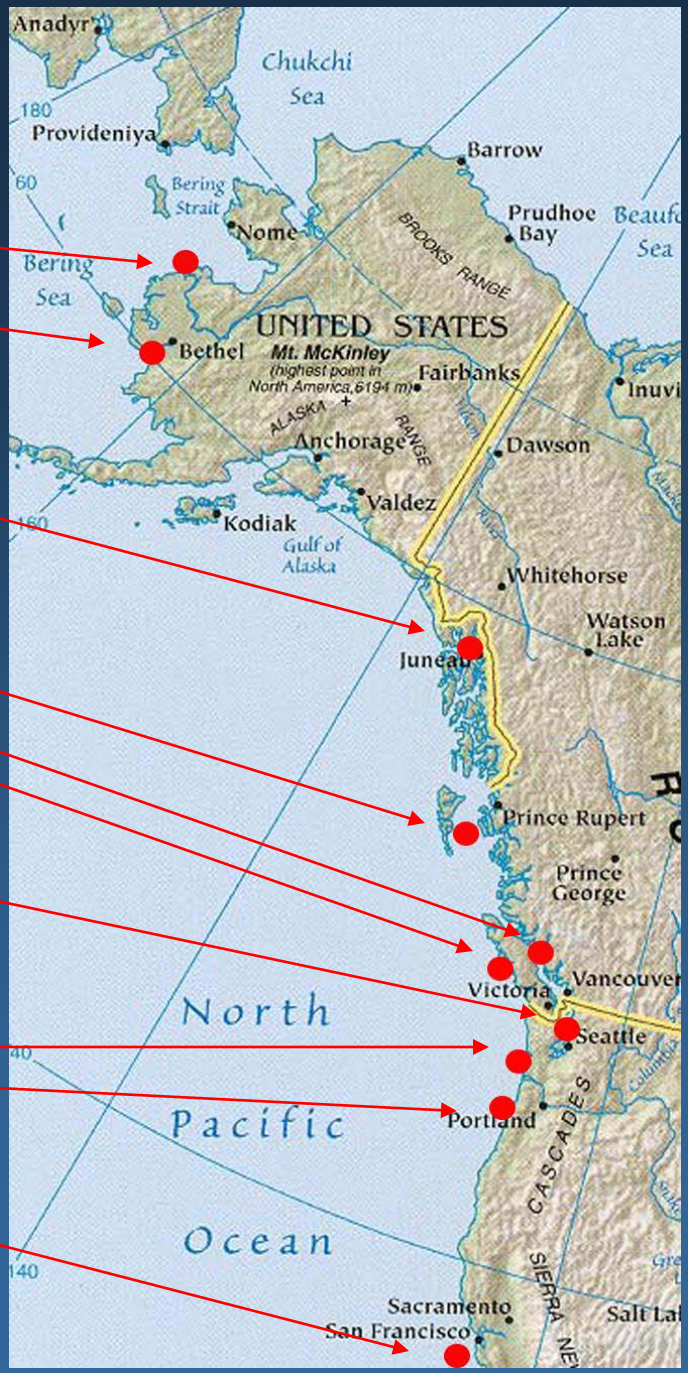
5-78% Rockfishes

13% Rockfishes

and other species

72% American Shad (2007; this study)

0-64% Yellowtail Rockfish



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Biol Invasions
DOI 10.1007/s10530-010-9760-5

ORIGINAL PAPER

Amplification and transport of an endemic fish disease by an introduced species

Paul K. Hershberger · Bjorn K. van der Leeuw · Jacob L. Gregg · Courtney A. Grady · Kenneth M. Lujan · Susan K. Gutenberger · Maureen K. Purcell · James C. Woodson · James R. Winton · Michael J. Parsley

Received: 20 November 2009 / Accepted: 1 April 2010

Abstract The introduction of American shad from the Atlantic to the Pacific coast of North America in the late 1800's and the subsequent population expansion in the 1980's resulted in the amplification of *Ichthyophonus* sp., a Mesomycetozoean parasite of wild marine fishes. Sequence analysis of the ribosomal DNA gene complex (small subunit and internal transcribed spacer regions) and *Ichthyophonus* epidemiological characteristics indicate a low probability that *Ichthyophonus* was co-introduced with American shad from the Atlantic; rather, *Ichthyophonus* was likely endemic to marine areas of the Pacific region and amplified by the expanding population of a highly susceptible host species. The migratory life history of shad resulted in the transport of amplified *Ichthyophonus* from its endemic region in the NE Pacific to the Columbia River watershed. An *Ichthyophonus* epizootic occurred among American shad in the Columbia River during 2007, when infection prevalence was 72%, and 57% of the infections were scored as moderate or heavy intensities. The epizootic occurred near the record peak of shad biomass in the Columbia River, and corresponded to an influx of 1,595 mt of infected shad tissues into the Columbia River. A high potential for parasite spillback and the establishment of a freshwater *Ichthyophonus* life cycle in the Columbia River results from currently elevated infection pressures, broad host range, plasticity in *Ichthyophonus* life history stages, and precedents for establishment of the parasite in other freshwater systems. The results raise questions regarding the risk for sympatric salmonids and the role of *Ichthyophonus* as a population-limiting factor affecting American shad in the Columbia River.

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Shad as vectors of disease

Ichthyophonus

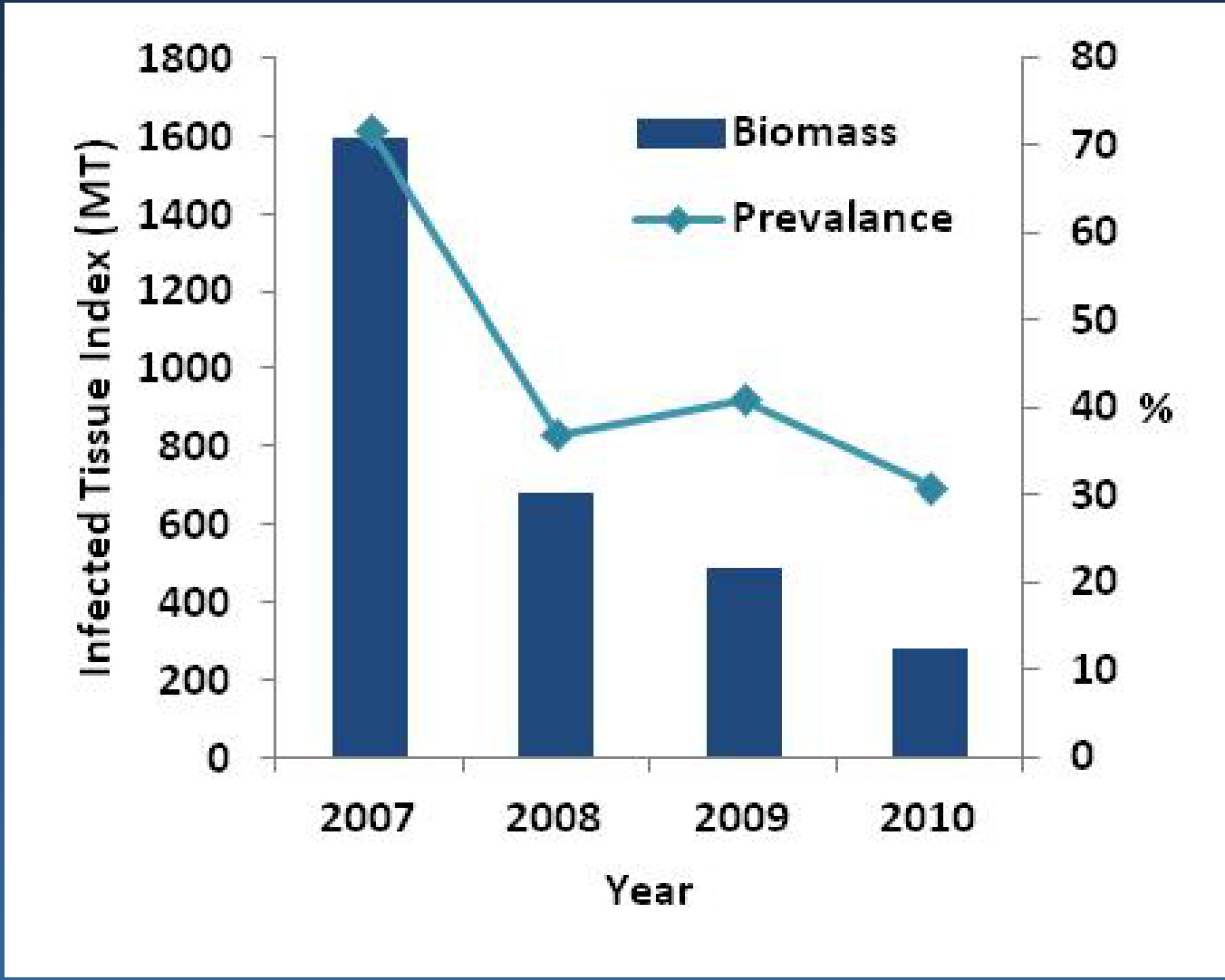
USGS

Shad as vectors of disease

Ichthyophonus

USGS

Ichthyophonus in Shad



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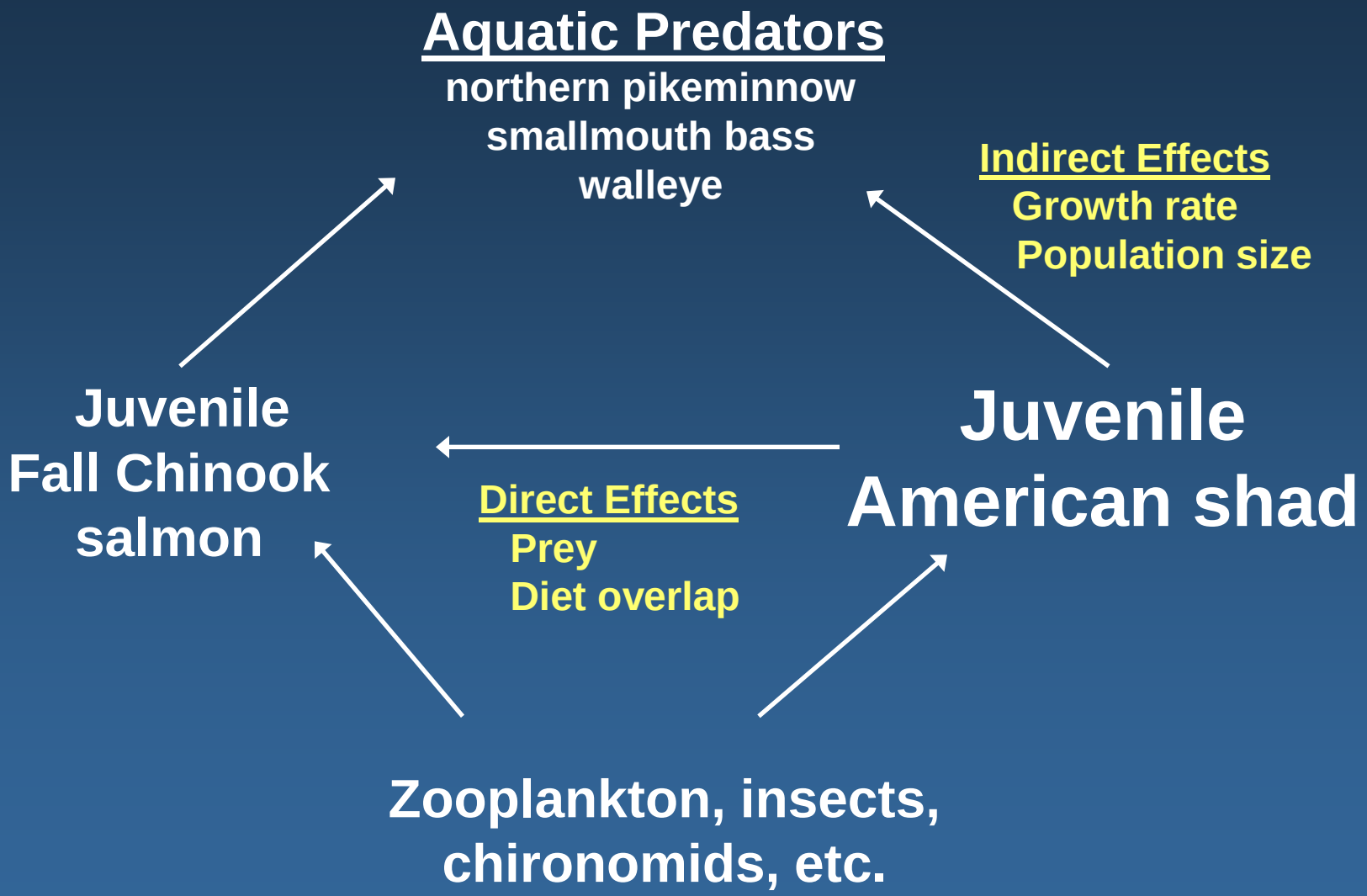
What next?



USGS

Understanding the influence of predation by introduced fishes on juvenile salmonids in the Columbia River Basin: closing some knowledge gaps

Matthew Mesa and Brien Rose
U. S. Geological Survey
Columbia River Research Laboratory
&
Thomas Rien and Christine Mallette
Oregon Department of Fish and Wildlife
Ocean Salmon and Columbia River Programs

USGS

Goal & objectives

Provide a greater understanding of the predatory impact of non-native piscivores on juvenile salmonids in the CRB

Objective 1: Document the food habits of smallmouth bass, walleye, and channel catfish in three reservoirs of the lower Columbia River during the late summer and fall.

Objective 2: Evaluate the physiological condition of smallmouth bass, walleye, and channel catfish during the late summer and fall in three reservoirs of the lower Columbia River.

All with a focus on American shad

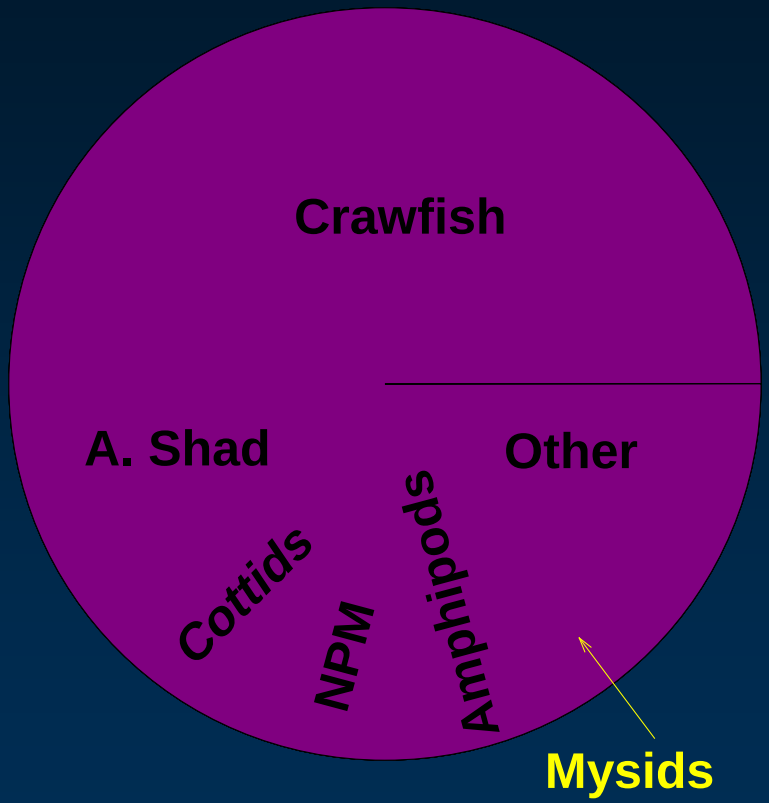
USGS

2010 collections (9/27–11/9)

USGS

SMB diet

- % biomass
  - Crawfish (50%)
  - American shad (12%)
  - Cottids (8%)
- Most common prey fish
  - American shad
  - NPM
  - Cottids



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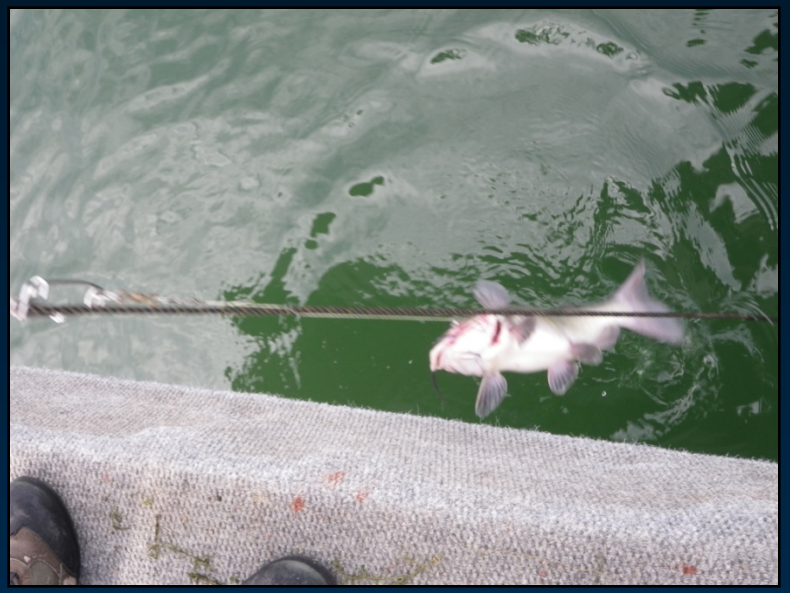
Walleye diet

- % biomass
  - Peamouth (44%)
  - American shad (42%)
  - *NPM* (14%)
- Most common prey fish
  - American shad
  - Peamouth
  - *NPM*

USGS

Channel catfish diet

- % biomass
  - Crawfish (37%)
  - Trichopterans (13%)
  - Vegetation (12%)
  - Amphipods (7%)
  - Mysid shrimp (4%)



- No shad

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2011 (Aug to mid-Nov)

- First full year (high water)
- Proximate analysis on 120 fish
- Collected diet info
  - 1,500 smallmouth bass
  - 150 walleye
  - 250 channel catfish
- Results forthcoming

USGS

The future

- Continued diet & physiology studies
- Telemetry for movements & distribution (?)

USGS

ISAB Food Web Report Recommends:

- Be Proactive on Non-native Species
- Quantify Food Webs and Ecological Networks
- Model Physical Controls on Structure and Processes
- Survey Base of the Food Web

USGS

ISAB Food Web Report Knowledge Gaps

Be Proactive on Non-native Species

- Develop fundamental understanding of the implications of novel food webs and the characteristics that will continue to support important ecological functions.

USGS

ISAB Food Web Report Knowledge Gaps

Quantifying Food Webs and Ecological Networks

- Gather requisite food web data
- Develop systemwide food web model
- Develop modeling and network tools coupling land-water systems

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ISAB Food Web Report Knowledge Gaps

Physical Controls on Structure and Processes

- Use models to produce a dynamic physical map of the “state of the system” to predict response to perturbations

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ISAB Food Web Report Knowledge Gaps

Base of the Food Web

- Mount major systematic surveys of the lower layers of aquatic and riparian food webs
- Identify pathways
- Determine role of temperature & flow

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What next?

- **Improve estimates of total zooplankton consumption by shad**
  - **Abundance of juvenile shad in reservoirs**
  - **Characterize zooplankton in reservoirs**
  - **Further refine shad bioenergetics model**

USGS