Baseline Food Web Interactions in Lake Kachess:
Seasonal Predation by Northern Pikeminnow and Burbot on Prey Important for Bull Trout

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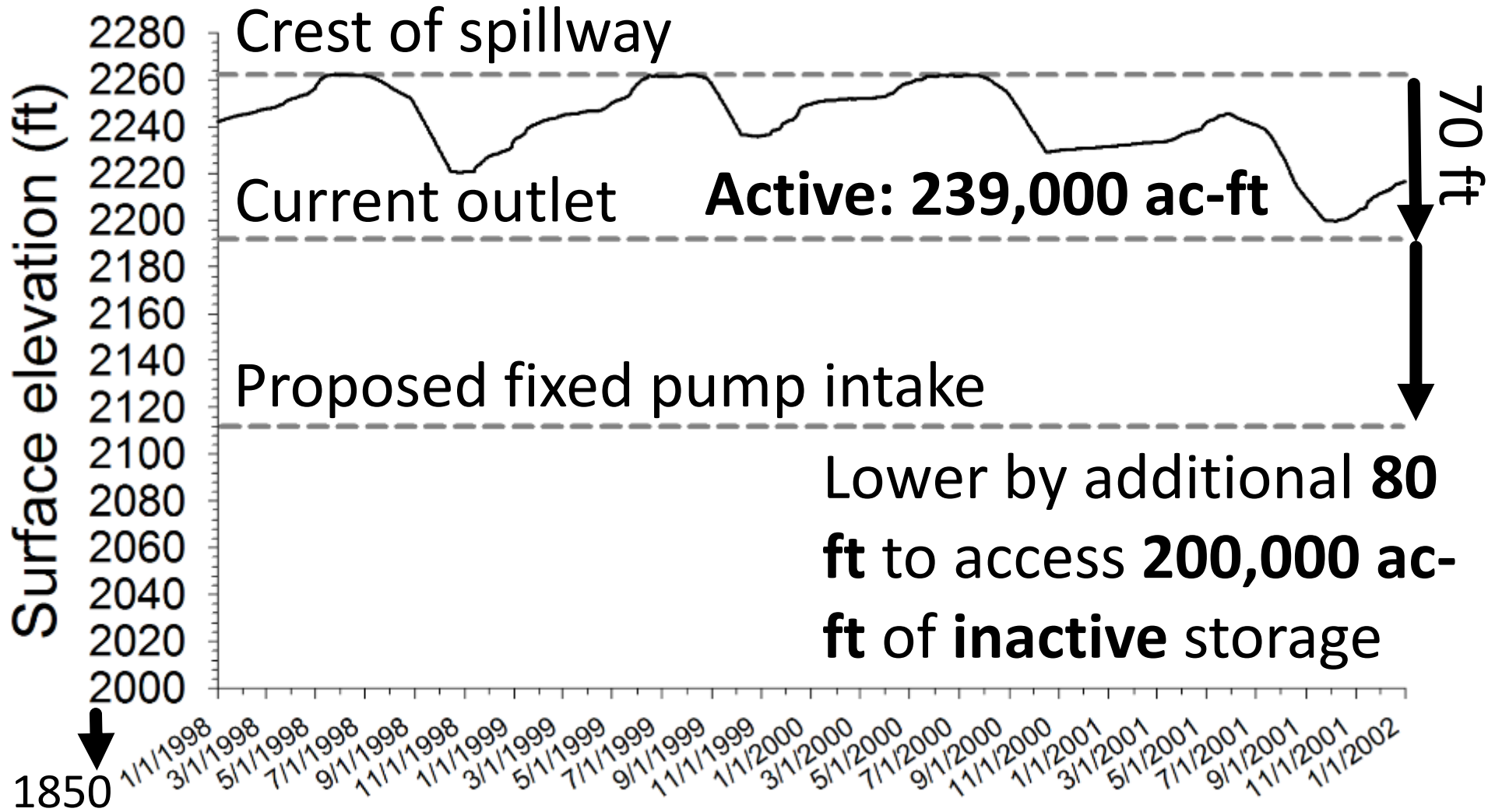
Why Quantify Food Web Interactions?

❑ Identify processes (**predation**, **competition**, **food supply**, **temperature**, **distribution**) that **LIMIT** or **PROMOTE** the growth and survival of key species (e.g., bull trout)

❑ Foundation for evaluating how different species respond to change

❖ Temperature regime
❖ Water level fluctuations
❖ Predator-prey abundance

Affected by reservoir operations

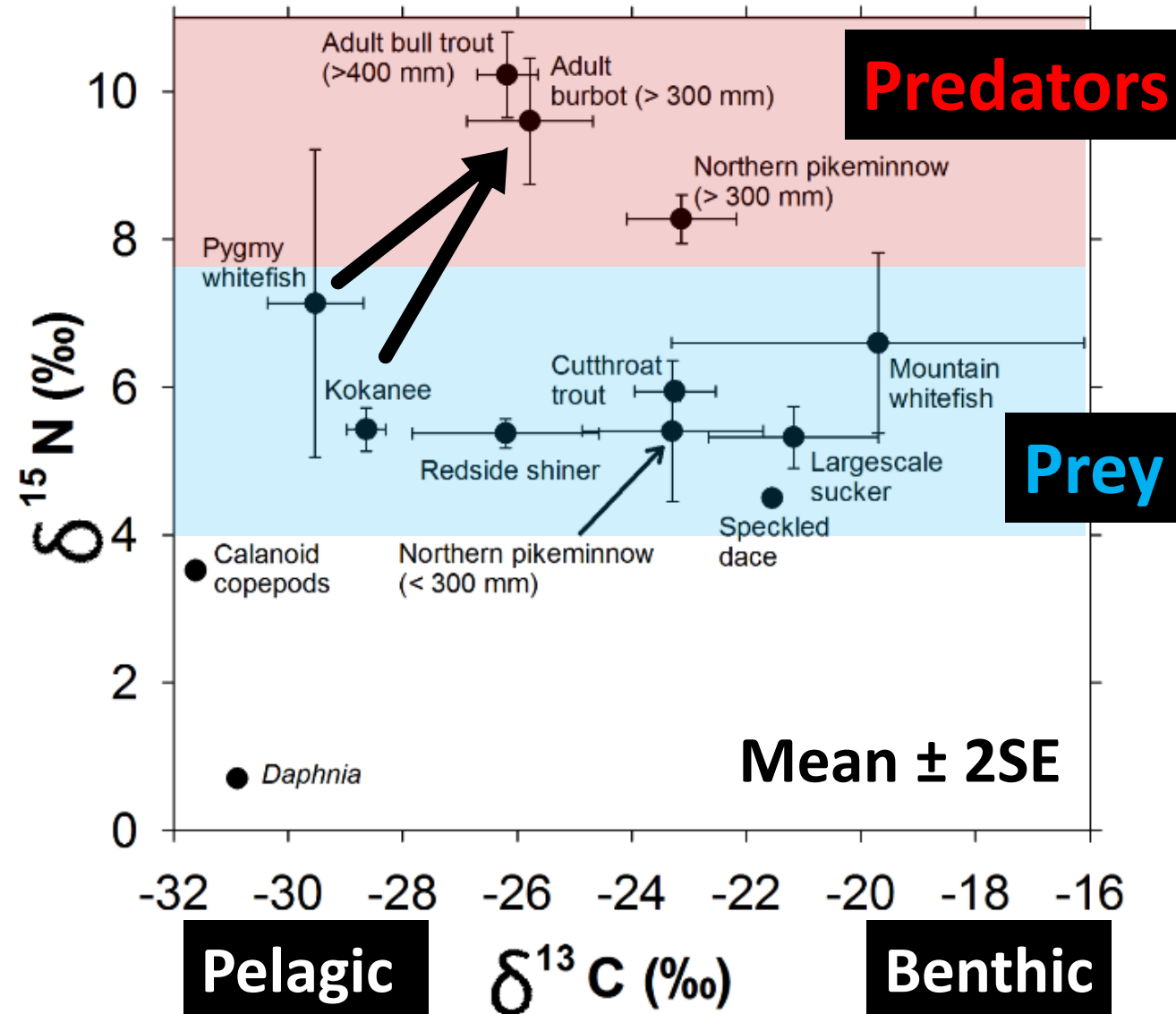# Kachess Drought Relief Pumping Plant (Fixed or Floating Barge)

Food Web Structure From Stable Isotopes

Feeding history and position in food web (fish fin or muscle)

❑ Top predators: large bull trout, burbot, northern pikeminnow

❑ Kokanee and other pelagic prey important for bull trout and burbot

❑ Northern pikeminnow eat mix of fish prey

Predatory Threat Dependent on Size
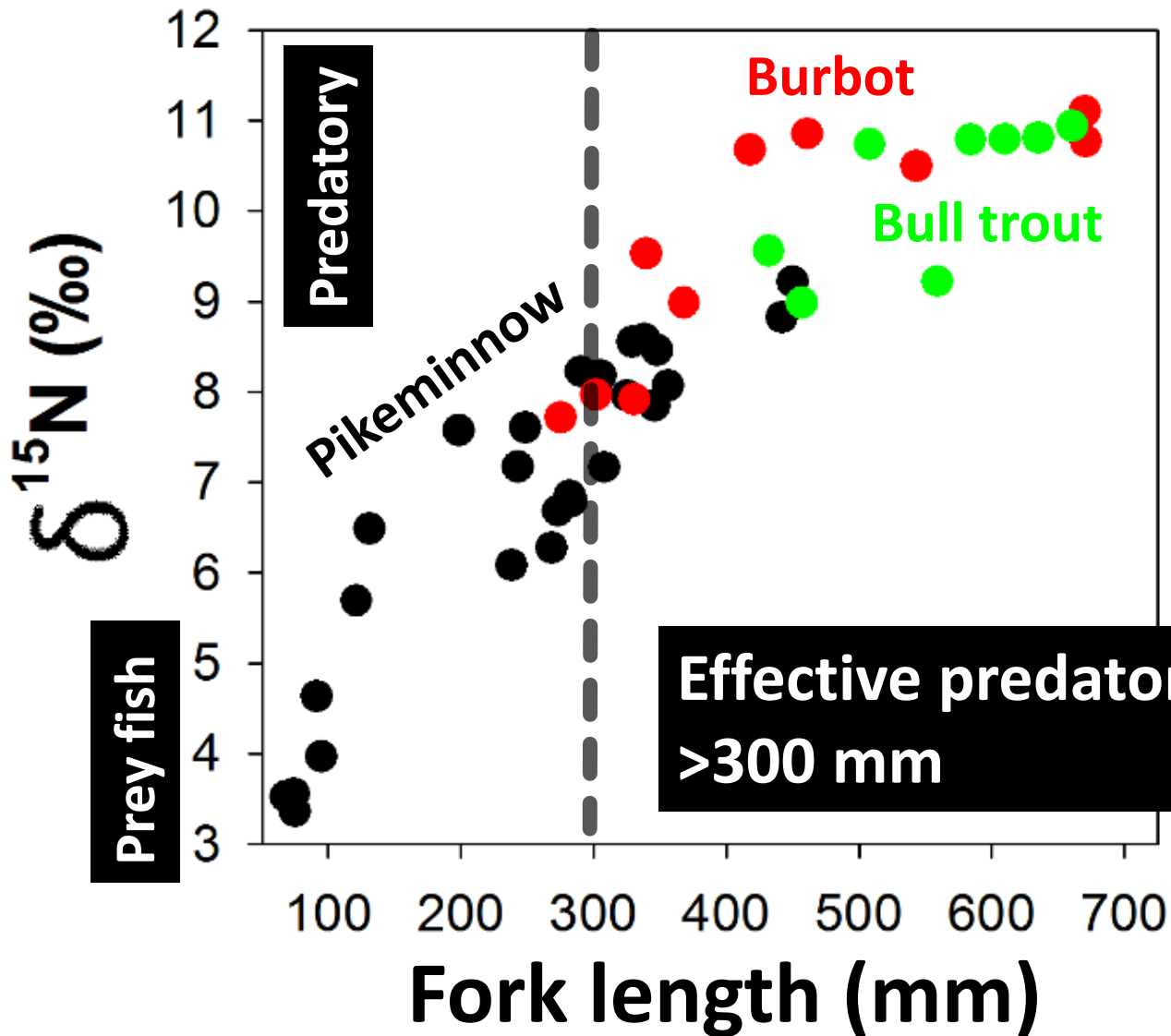
Relative number of small individuals vs. large predatory individuals?

How will pumping effect food web interactions and bull trout in Lake Kachess?

Are NPM and BURBOT imposing undue mortality on prey important for bull trout (kokanee, pygmy whitefish)?
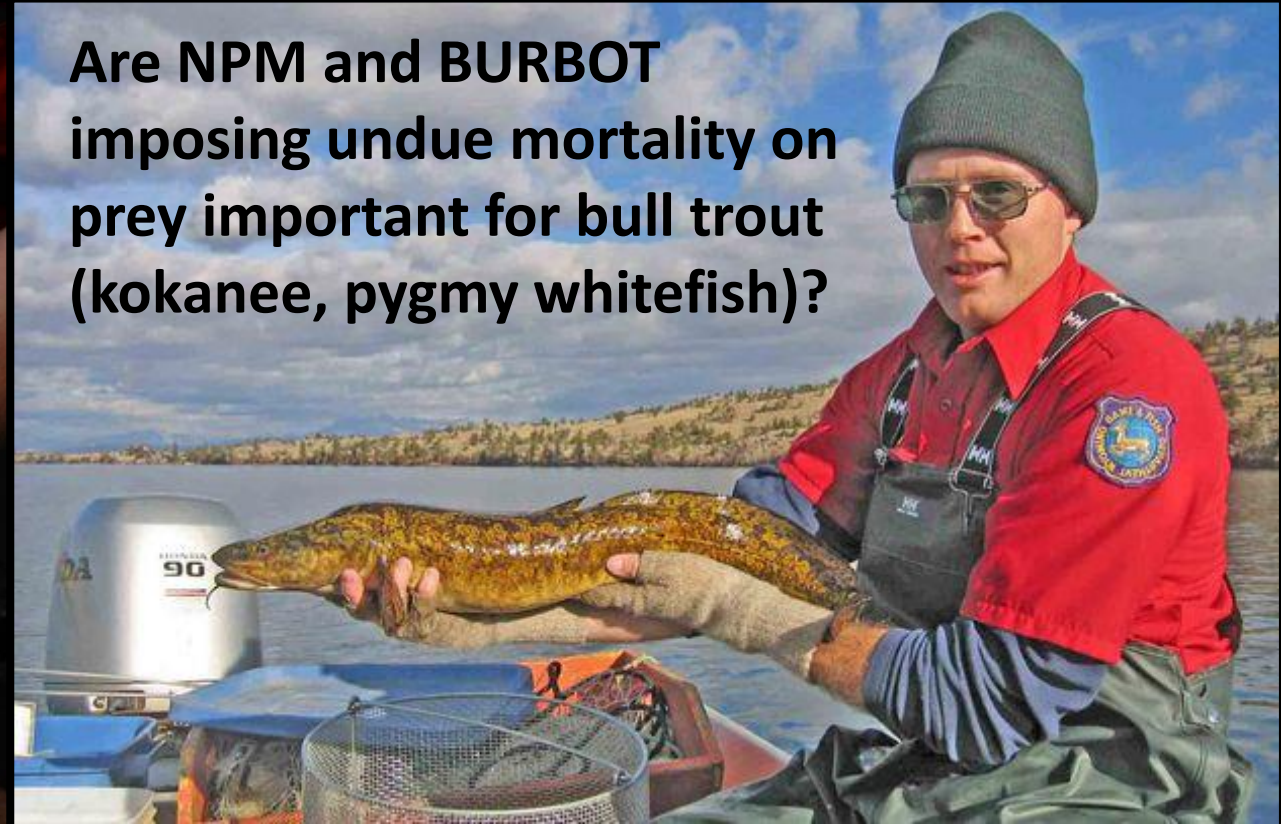
Bioenergetics Approach

❑ Sample fish within **seasonal**, **depth**, and **size-structured** framework
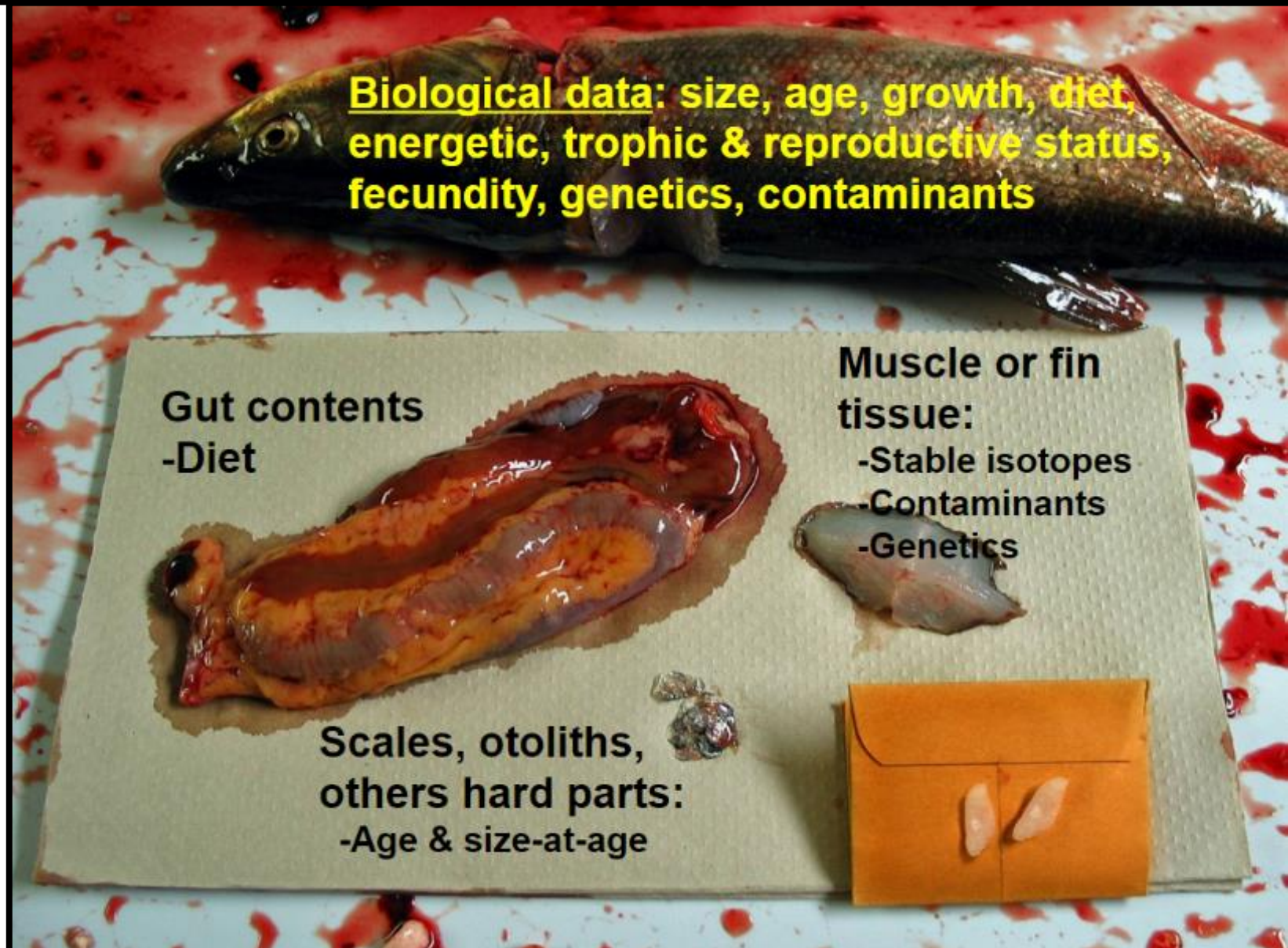

Hydroacoustics

Gill netting

Midwater trawling

Electrofishing

Matt Polacek, LLRT

Bioenergetics Approach

❑ Collect fish samples within a **seasonal**, **depth**, and **size-structured** framework

❑ Fish sampling informs:
  ❖ Abundance, distribution, size-structure
  ❖ Age, growth, survival
  ❖ Diet composition
  ❖ Thermal experience
  ❖ Food web structure

Biological data: size, age, growth, diet, energetic, trophic & reproductive status, fecundity, genetics, contaminants

Gut contents
-Diet

Muscle or fin tissue:
-Stable isotopes
-Contaminants
-Genetics

Scales, otoliths, others hard parts:
-Age & size-at-age
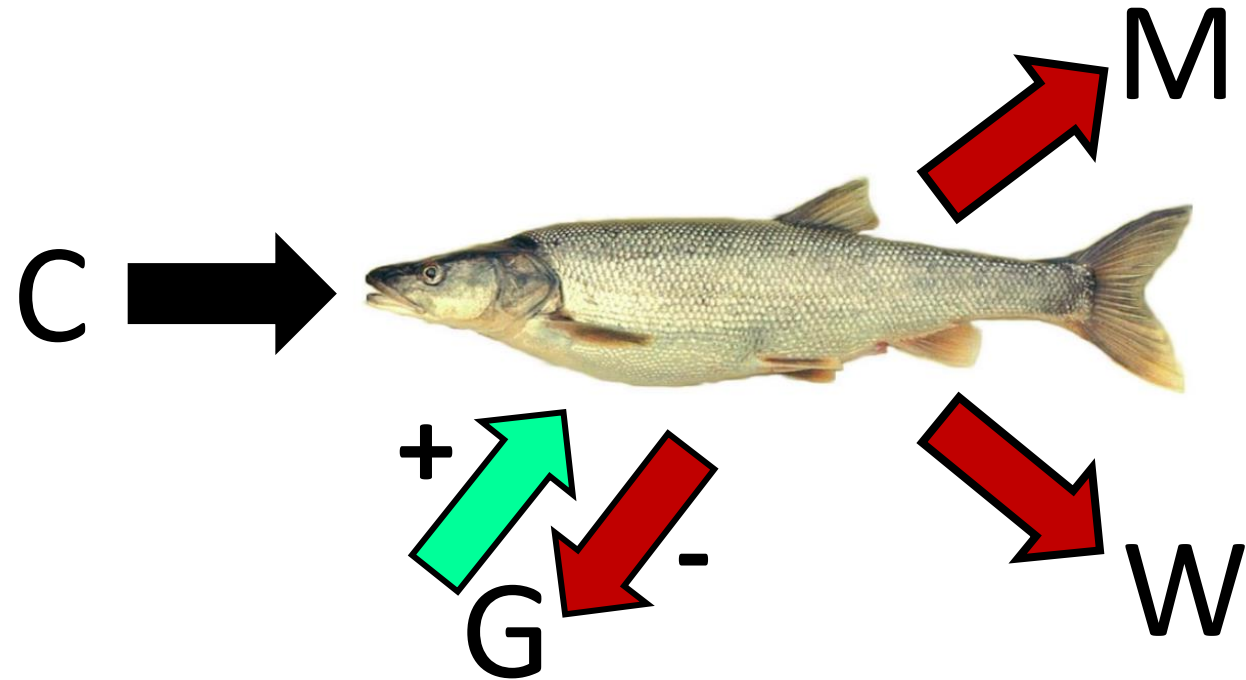
Bioenergetics Approach

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- Inputs for a bioenergetics model of consumption

Consumption = **M**etabolism + **W**aste + **G**rowth (in weight)

C

M

W

+ G -

Dependent on temperature and body size

Bioenergetics Approach

- Collect fish samples within a **seasonal**, **depth**, and **size-structured** framework

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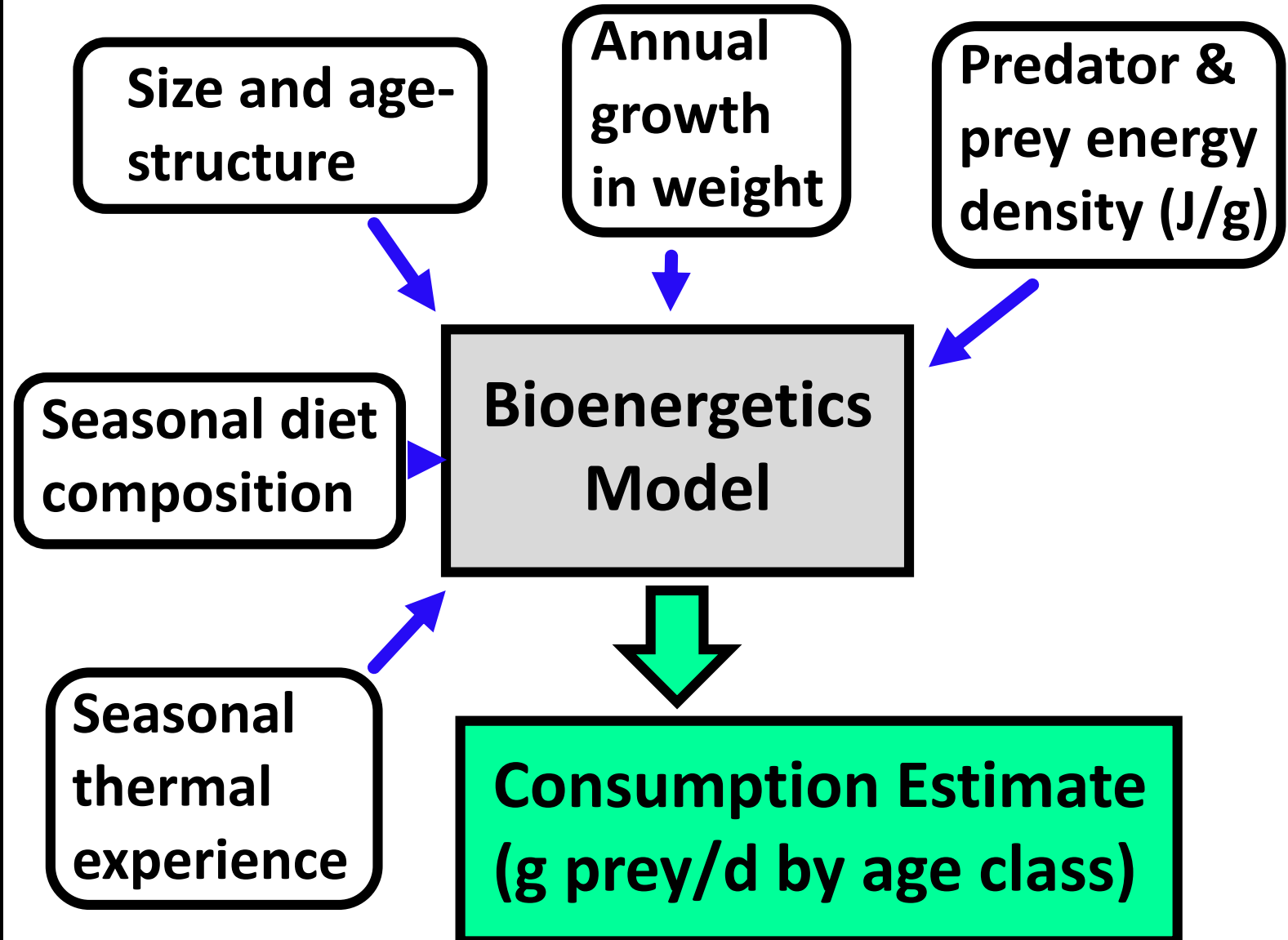Size and age-structure

Annual growth in weight

Predator & prey energy density (J/g)

Seasonal diet composition

Seasonal thermal experience

Bioenergetics Model

Consumption Estimate (g prey/d by age class)

Seasonal Diet Composition: **NPM**

- ❑ Diet varied by size and season (fish: 22-75% of diet)
- ❑ Predation on kokanee by large NPM: spring & summer (8-19%)
- ❑ No pygmy whitefish detected

SPRING   **SUMMER**   **LATE SUMMER (FALL)**

Legend:
- Plant material
- Zooplankton
- Other inverts
- Sculpin
- Redside shiner
- Kokanee
- Other salmonids
- Other fish

NPM; Suckers; Dace

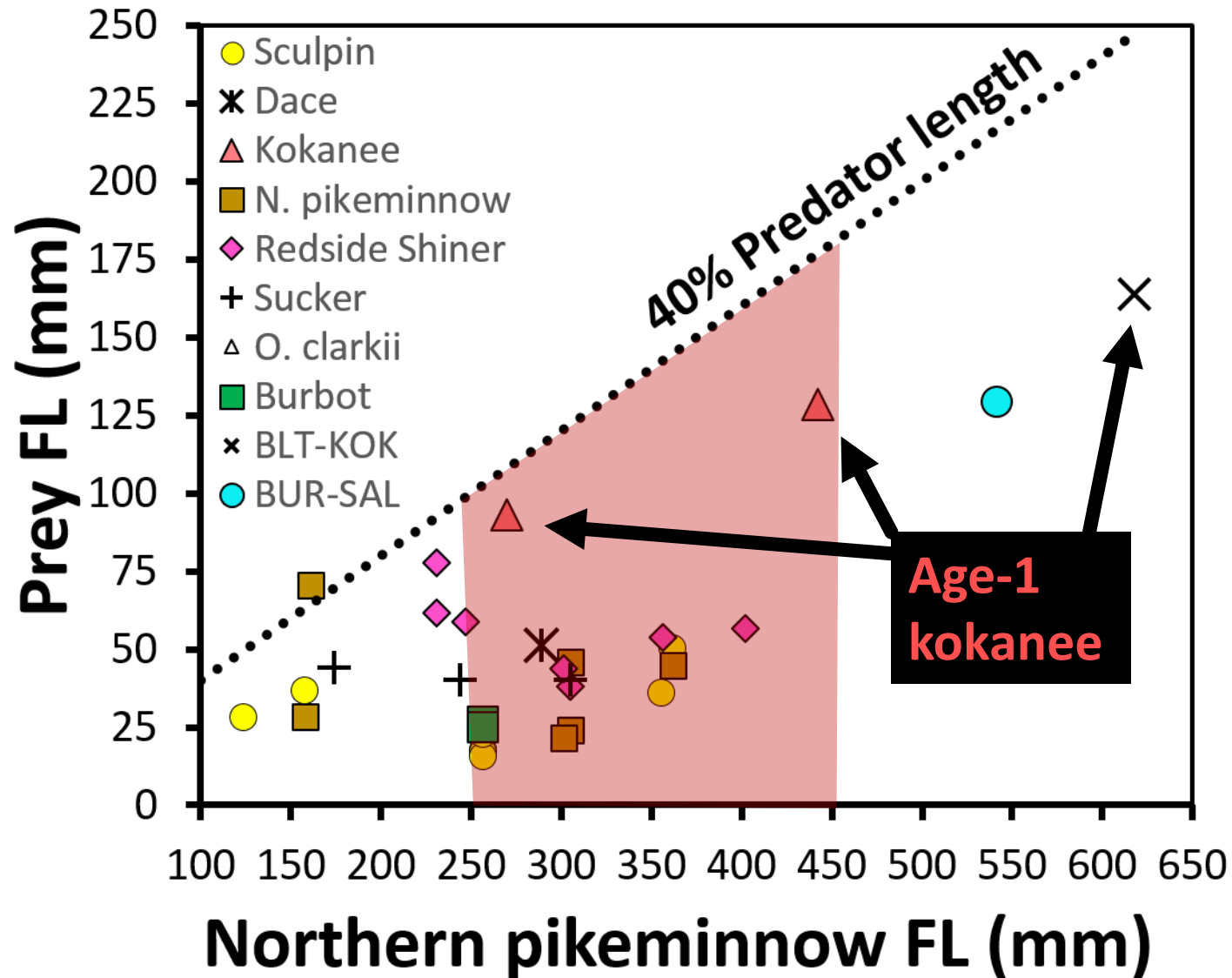Cutthroat; M. Whitefish

Seasonal Diet Composition: BURB

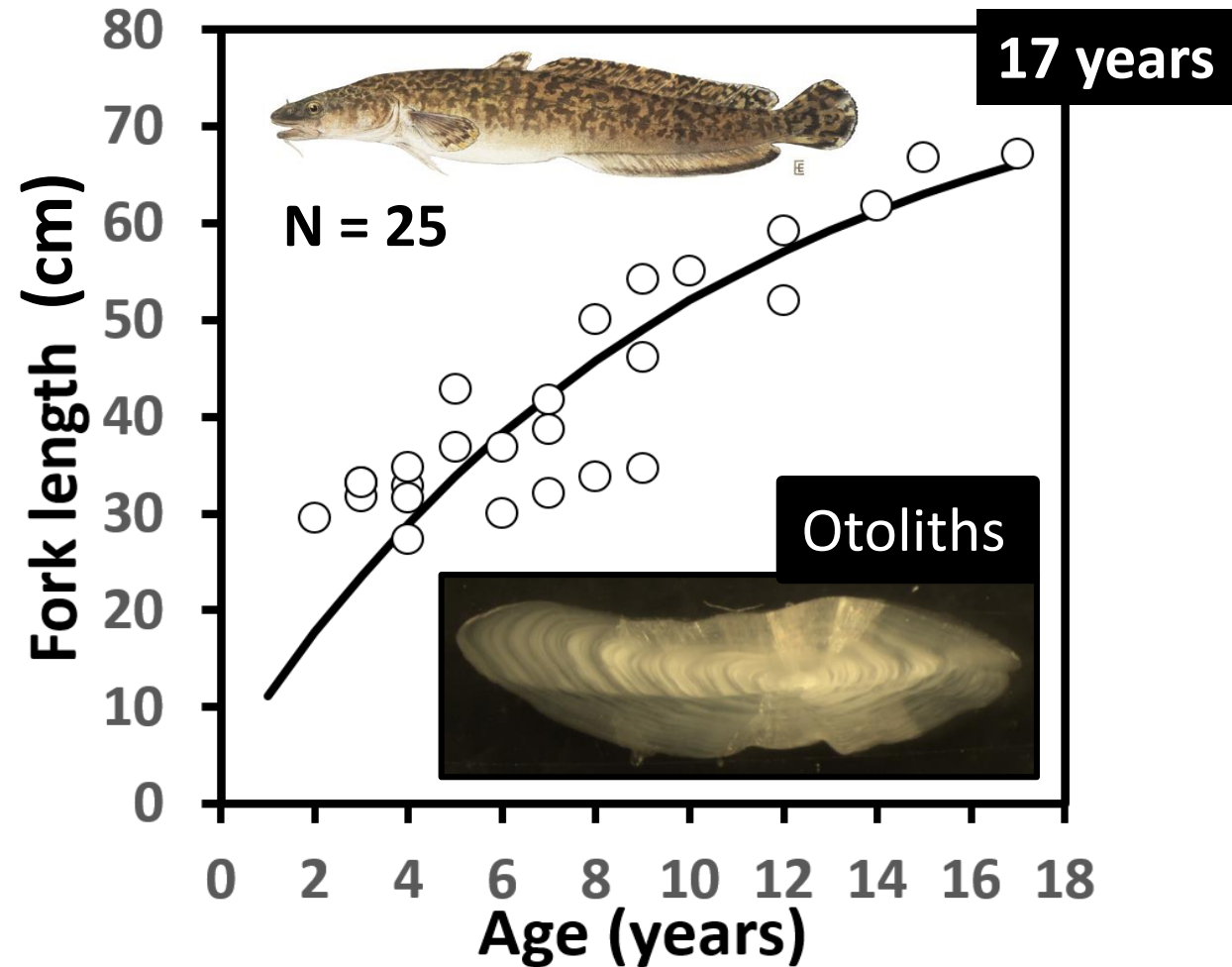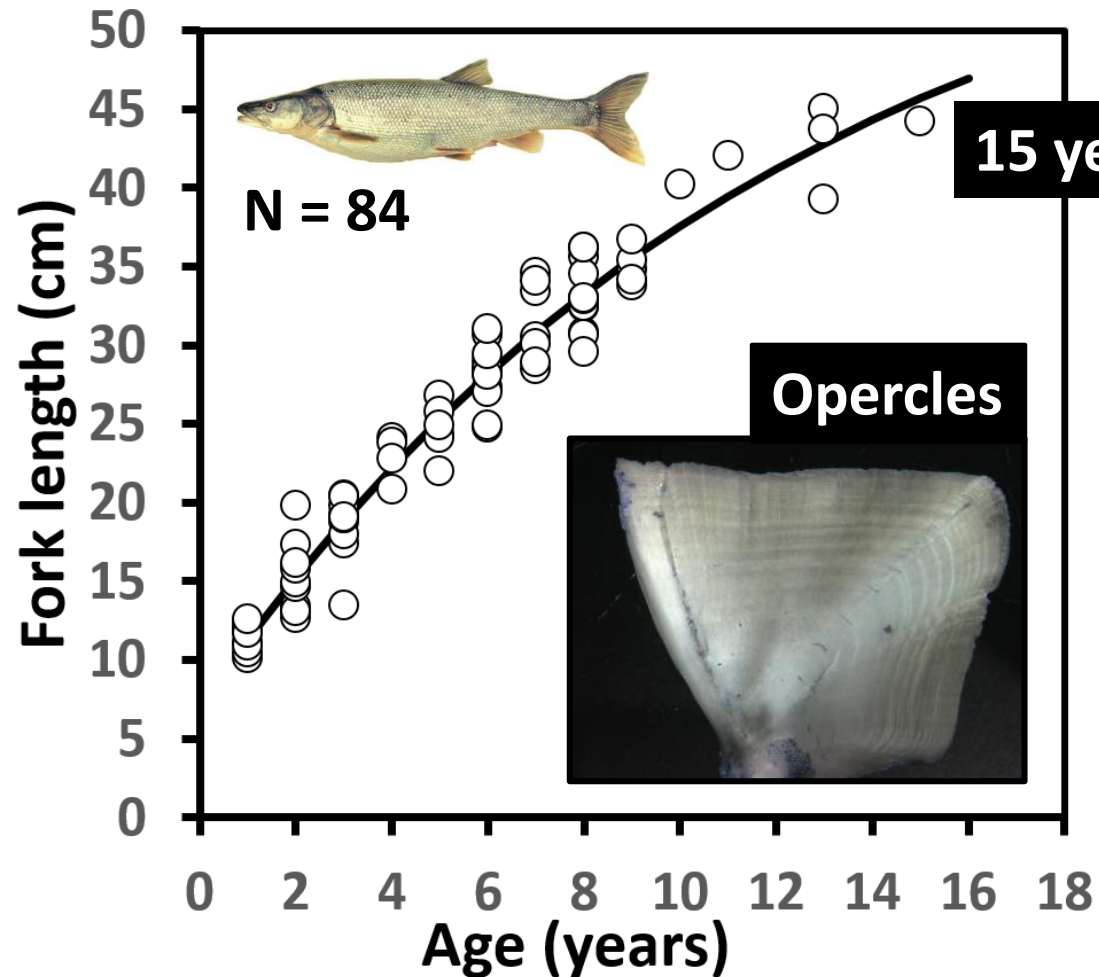❑ Diet composed largely of fish, including salmonids (fish: 42-78%)
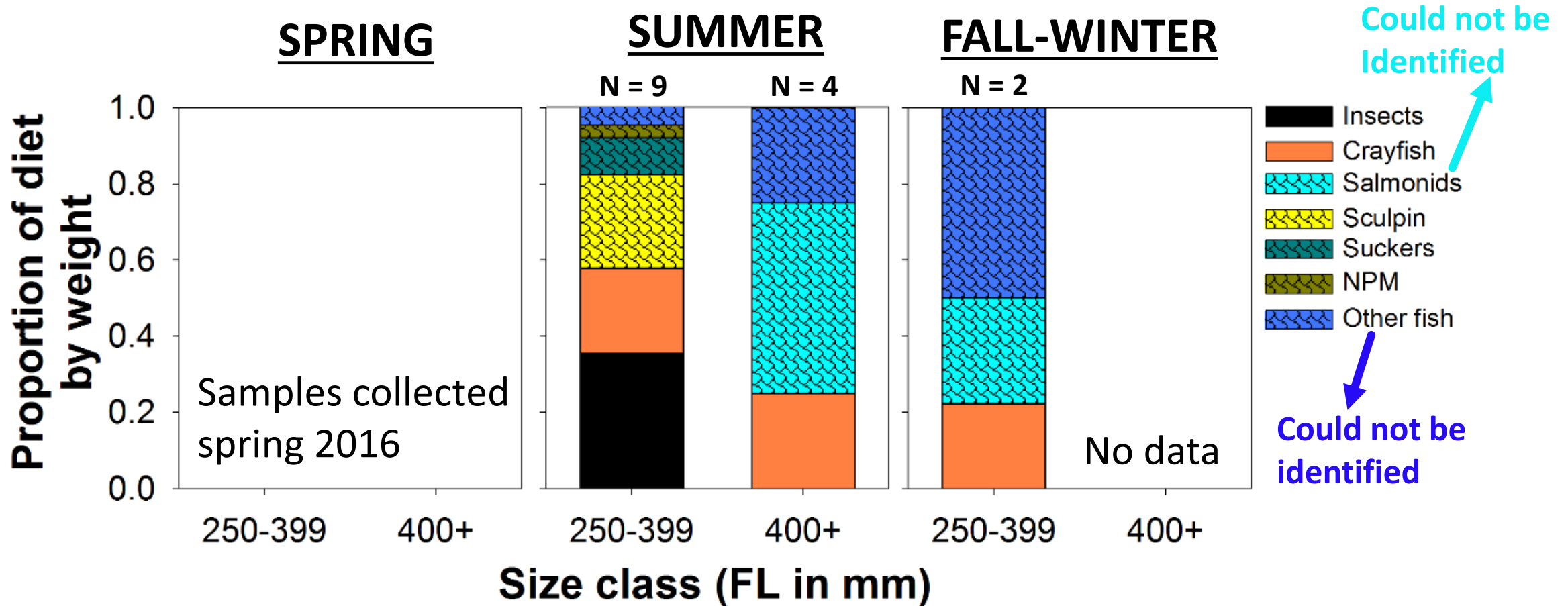
Predator-Prey Size Relationship

- ❑ Which size or age-classes of prey are most vulnerable to different size or age-classes of predator?

- ❑ Numerical predation rates

- ❑ Age-2 and older kokanee not vulnerable to NPM

- ❑ Assuming majority of predation on kokanee by NPM focused on age-1

Age & Growth: **NPM** and **BURBOT**

❑ Annual growth in length estimated from model that describes length as a *f*(age)

Left graph: Fork length (cm) vs Age (years). N = 84. Opercles. 15 years.

Right graph: Fork length (cm) vs Age (years). N = 25. Otoliths. 17 years.

Survival and Age-Structure: **NPM**

- ❑ **Total abundance unknown**: estimate predation on key prey by age-structured population unit of 1,000 NPM **≥150 mm or ≥age-3**

- ❑ Useful metric for gauging extent of predation mortality and quantifying baseline food web interactions

- ❑ Need estimate of annual survival to develop age-frequency distribution

Shifts in diet, consumption, thermal experience, growth with predator size or age
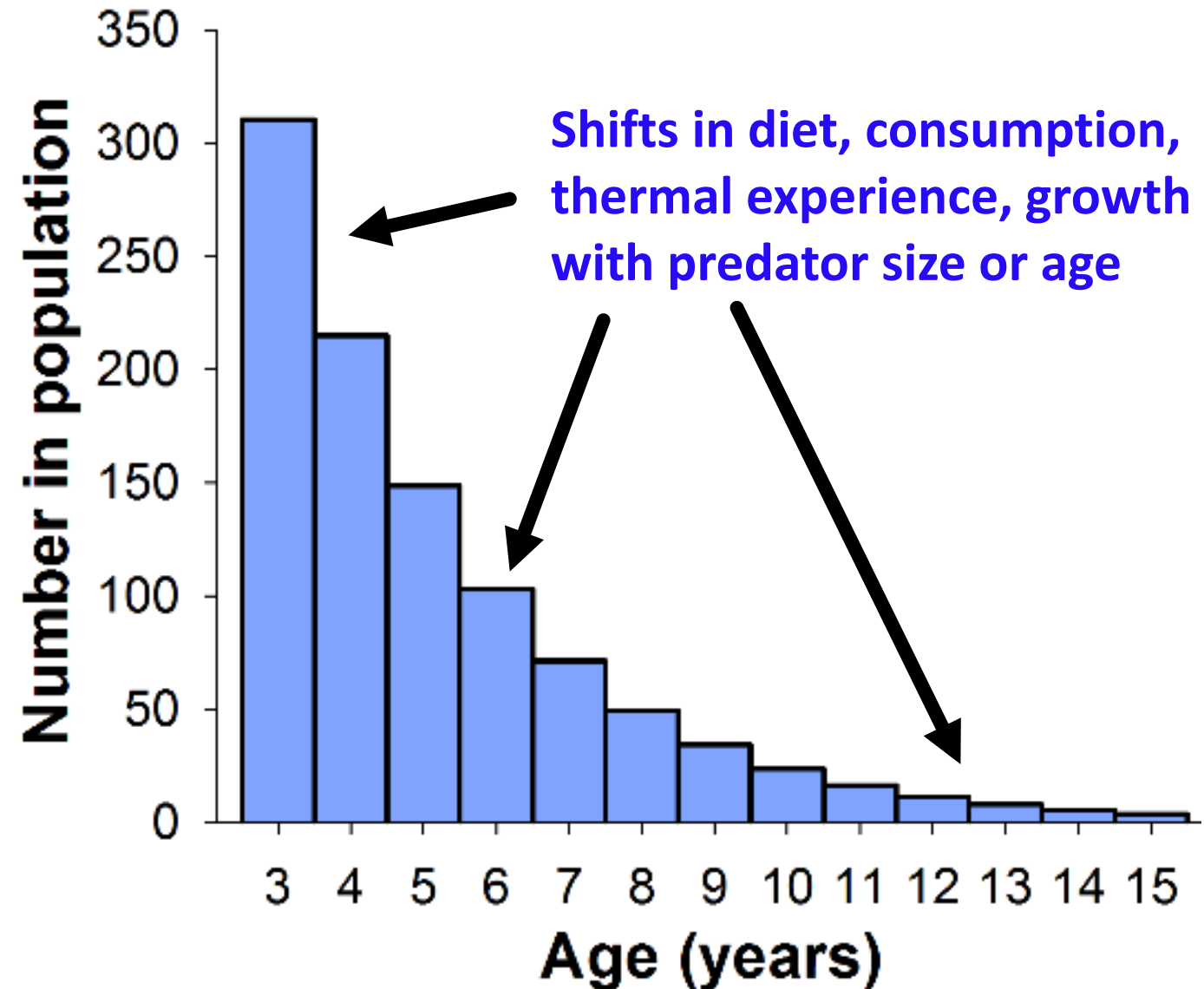
Annual Consumption by **NPM**
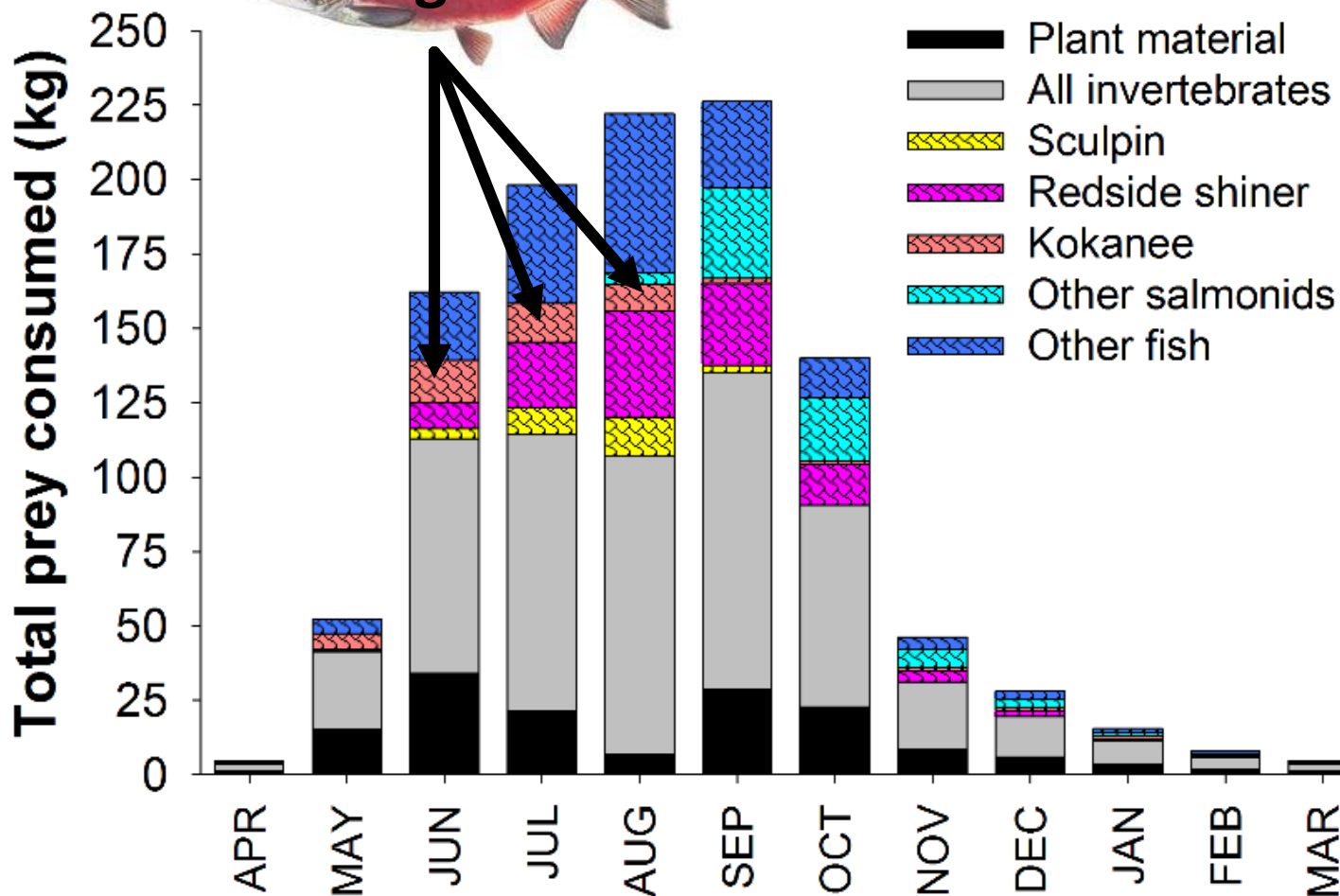
❑ Unit population of 1,000 NPM ≥ age-3

❑ Total consumption of kokanee: **48 kg**

❑ **~6,200 age-1 kokanee**

❑ **~3.0% of age-1 kokanee at large August 2014 (206,000)**

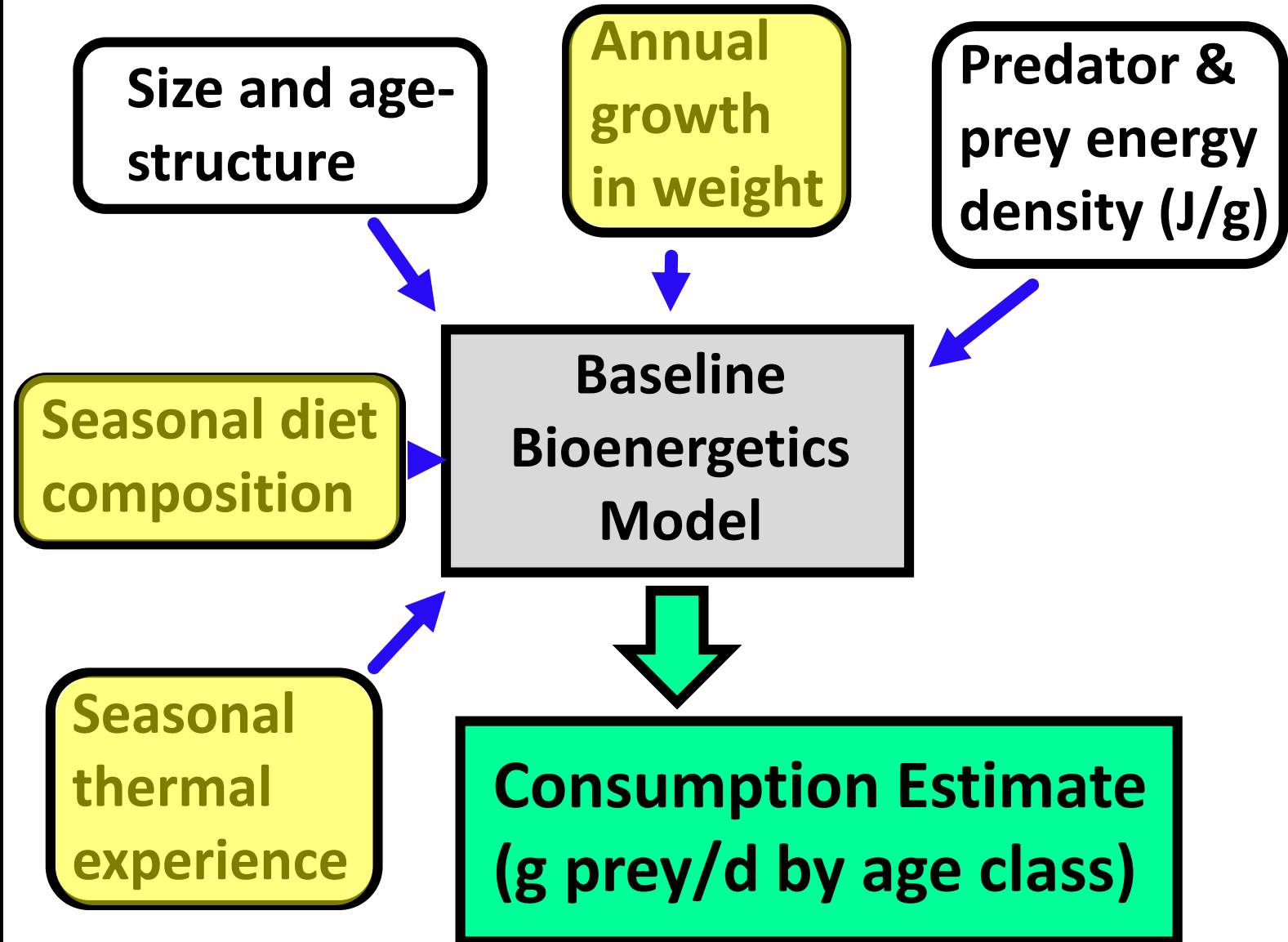❑ **Age-structured unit of 100 bull trout: 22,000; 10.7%**

Summary

- ❑ Modest predation on kokanee by NPM

- ❑ Numerically, sufficient kokanee to support age-structured unit of 100 bull trout and population expansion

- ❑ Sufficient numbers ≠ sufficient access

- ❑ Refinements to baseline food web interactions still needed
  - ❖ Seasonal diet for NPM and Burbot (**FALL**)
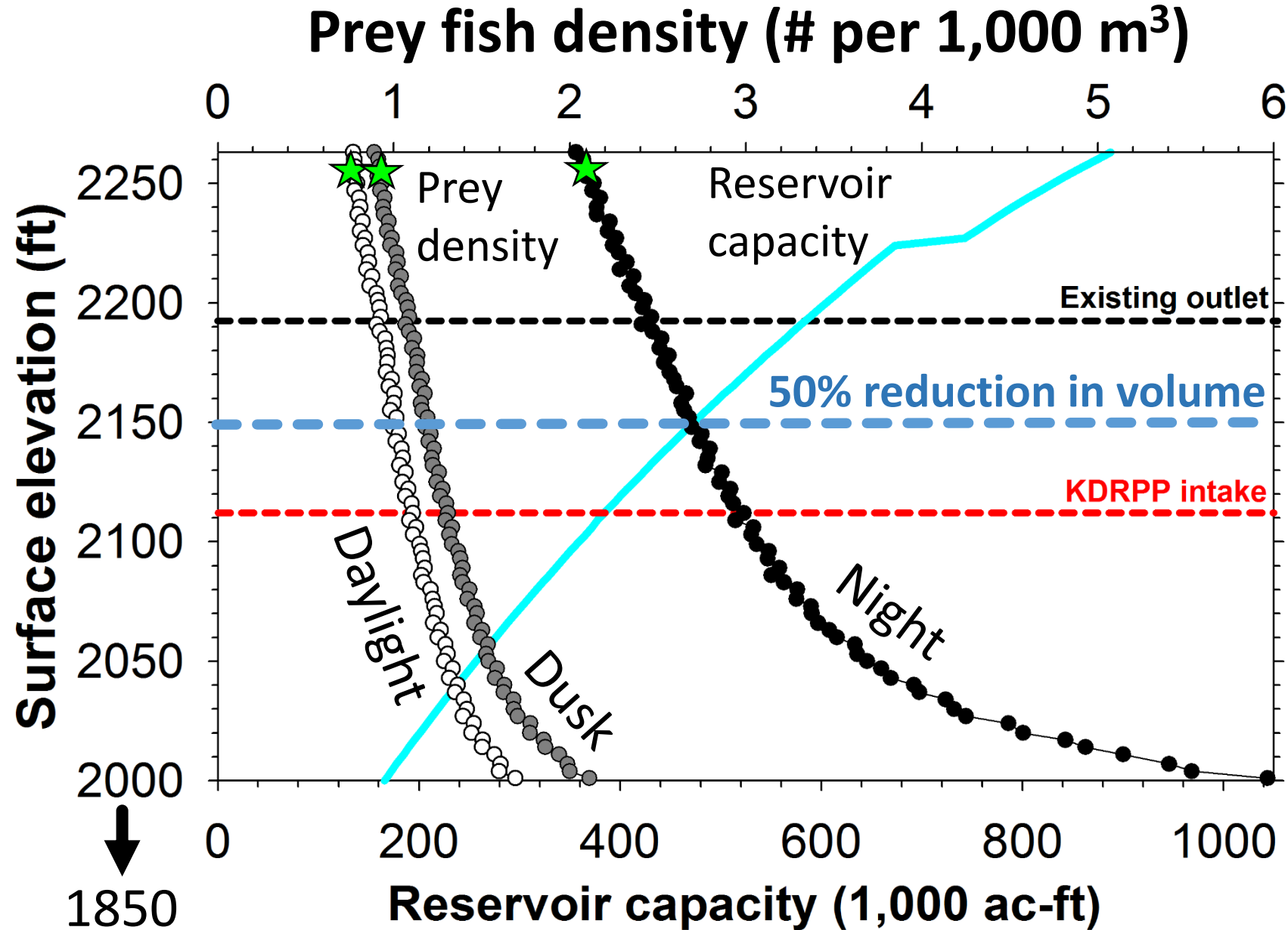 - ❖ Distribution
  - ❖ Age & growth

Next Steps

☐ Modeling effects of alternative pumping strategies on thermal structure (Scott Wells, Portland State)

Questions?

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  Size and age-      Annual        Predator &
  structure          growth        prey energy
                     in weight      density (J/g)
                         |
         \               |              /
          \              v             /
           \                          /
  Seasonal diet  →    Baseline   ←
  composition         Bioenergetics
                      Model
                         |
  Seasonal          →    v
  thermal
  experience        Consumption Estimate
                    (g prey/d by age class)
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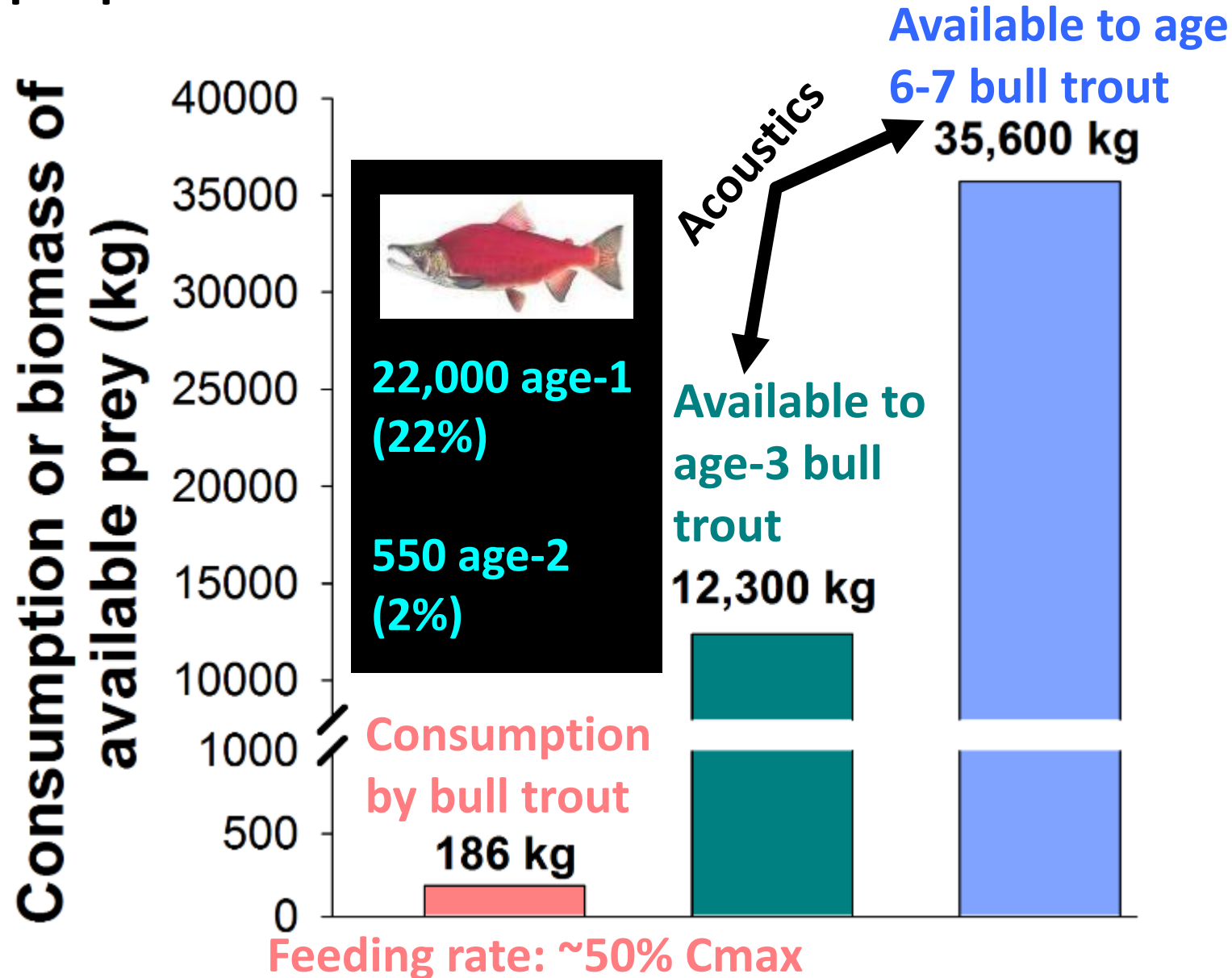
Simulated effect of drawdown on prey density

Little change w/n region of operation

Buffered by steep bathymetry & depth

Not really changing the game

Access to spawning tribs, thermal structure, downstream impacts

Annual consumption of fish by size-structured population unit of **100** bull trout

Available to age 6-7 bull trout
35,600 kg

Acoustics

22,000 age-1 (22%)

550 age-2 (2%)

Available to age-3 bull trout
12,300 kg

Consumption by bull trout
186 kg

Consumption or biomass of available prey (kg)

Feeding rate: ~50% Cmax

Assumptions:

Annual growth: averages for 400-700 mm bull trout from Bumping & Rimrock

Annual survival and size-age structure: Lake Billy Chinook

Ages 3-7 dominate reservoir population

Diet 100% fish (kokanee)