# Food web interactions among walleyes, lake whitefish, and yellow perch in Green Bay, Lake Michigan

**Lucas Koenig, Daniel Isermann, Daniel Dembkowski, Wesley Larson, Iyob Tsehaye, Scott Hansen, Steve Hogler, Tammie Paoli, and Troy Zorn**

# Green Bay Overview

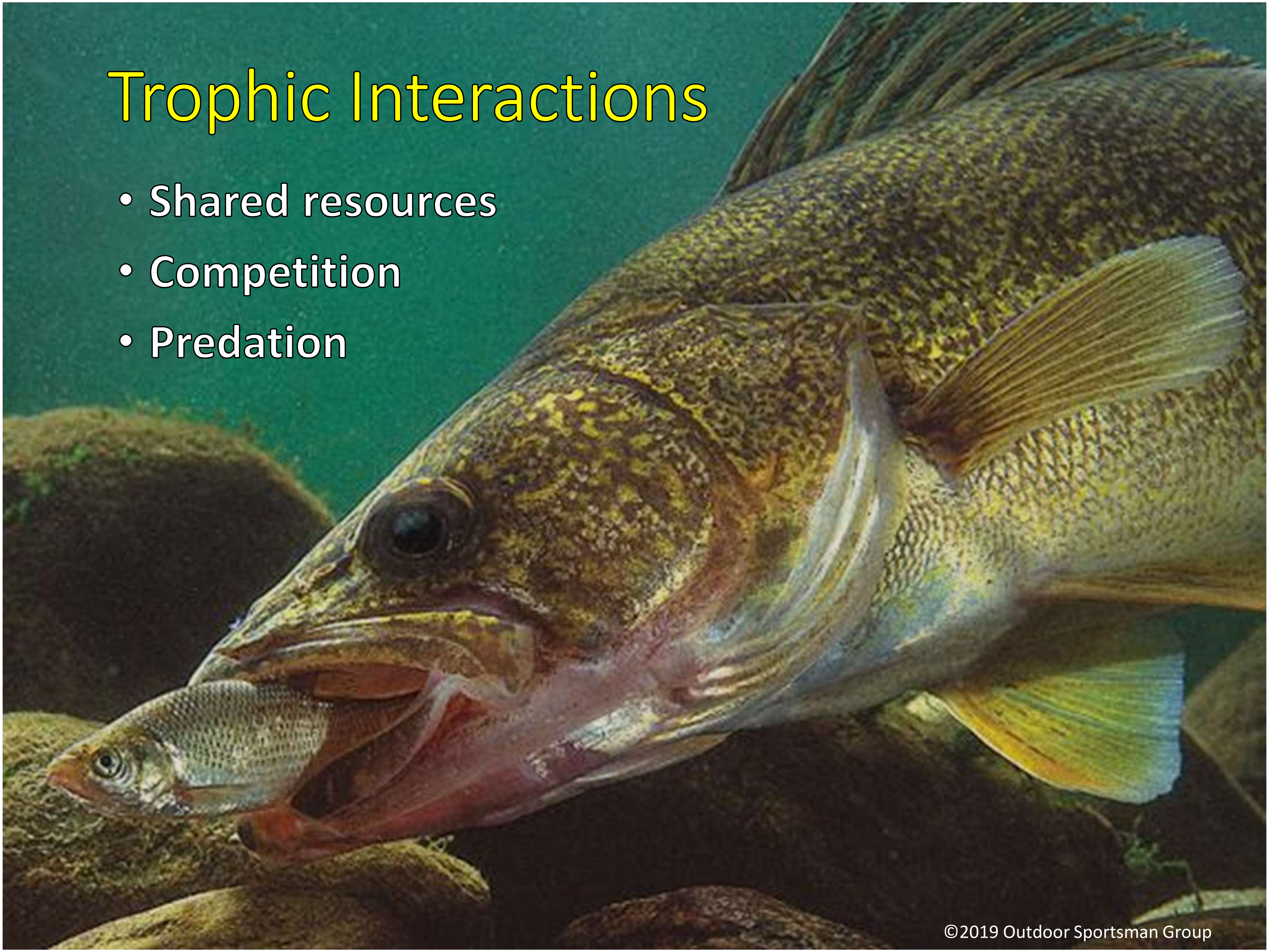
- **Largest freshwater estuary**
- **Lake Michigan's largest bay**
- **Mean depth ≈ 20 m**
- **Max depth ≈ 53 m**
- **South-to-north gradients:**
  - **Productivity**
  - **Depth**


# Current Fishery

- **Walleye (WAE) near historically high levels**
- **Lake whitefish (LWF) mixed abundance**
- **Yellow perch (YEP) near historically low levels**

# Trophic Interactions

- Shared resources
- Competition
- Predation



# Potential Concerns

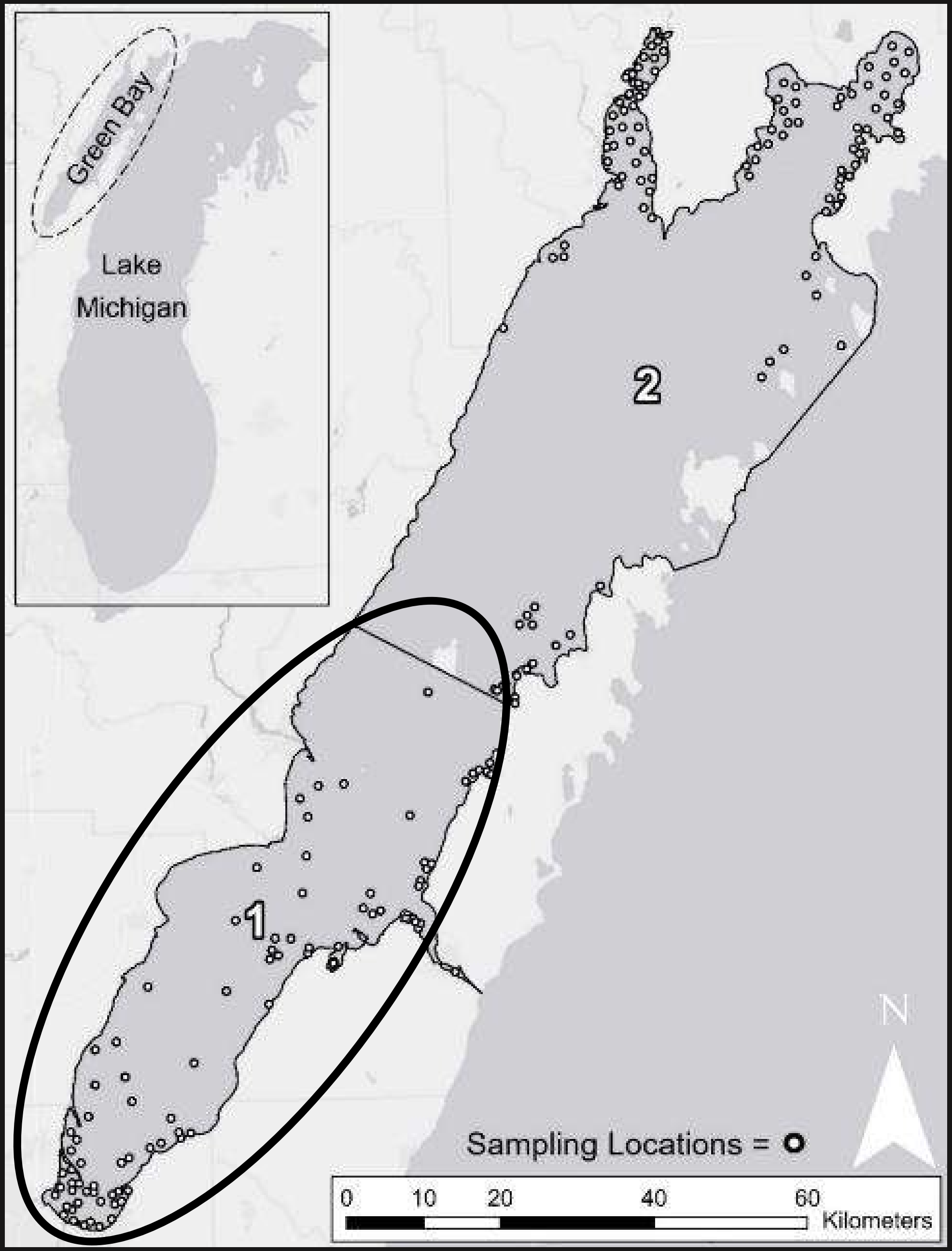
- **WAE predation may regulate LWF and YEP populations**
- **Concerns based on observations**
- **Is WAE demand enough to impact LWF and YEP recruitment?**

# Objective

**To determine if walleye predation influences the recruitment potential of lake whitefish and yellow perch in Green Bay.**

# 2018 Collections

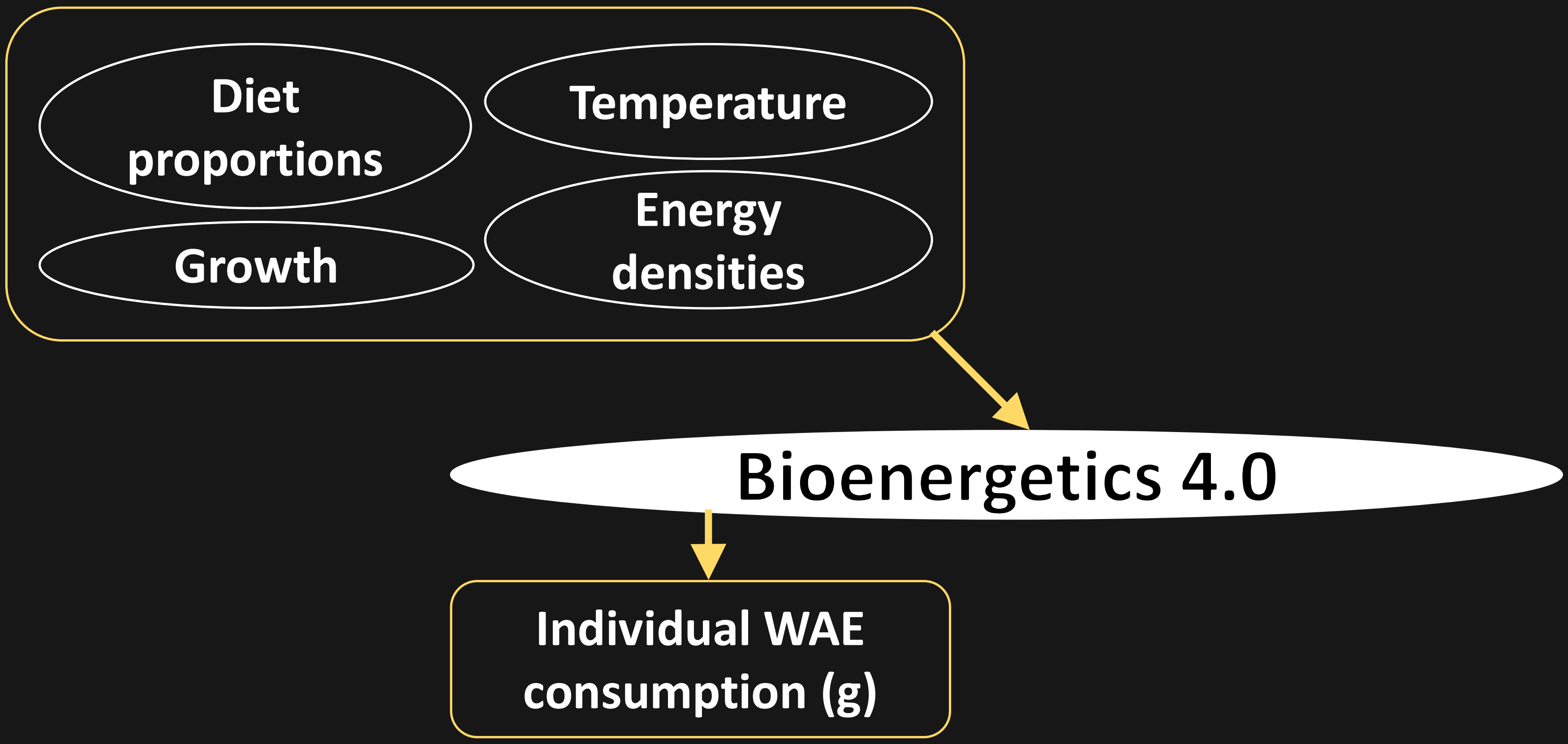
- **May 1 – October 31**
- **Primarily gill netting**
- **985 total WAE**
  - **49% empty stomachs**
- **Nonempty diets:**
  - **281 WAE diets – Zone 1**
  - **217 WAE diets – Zone 2**



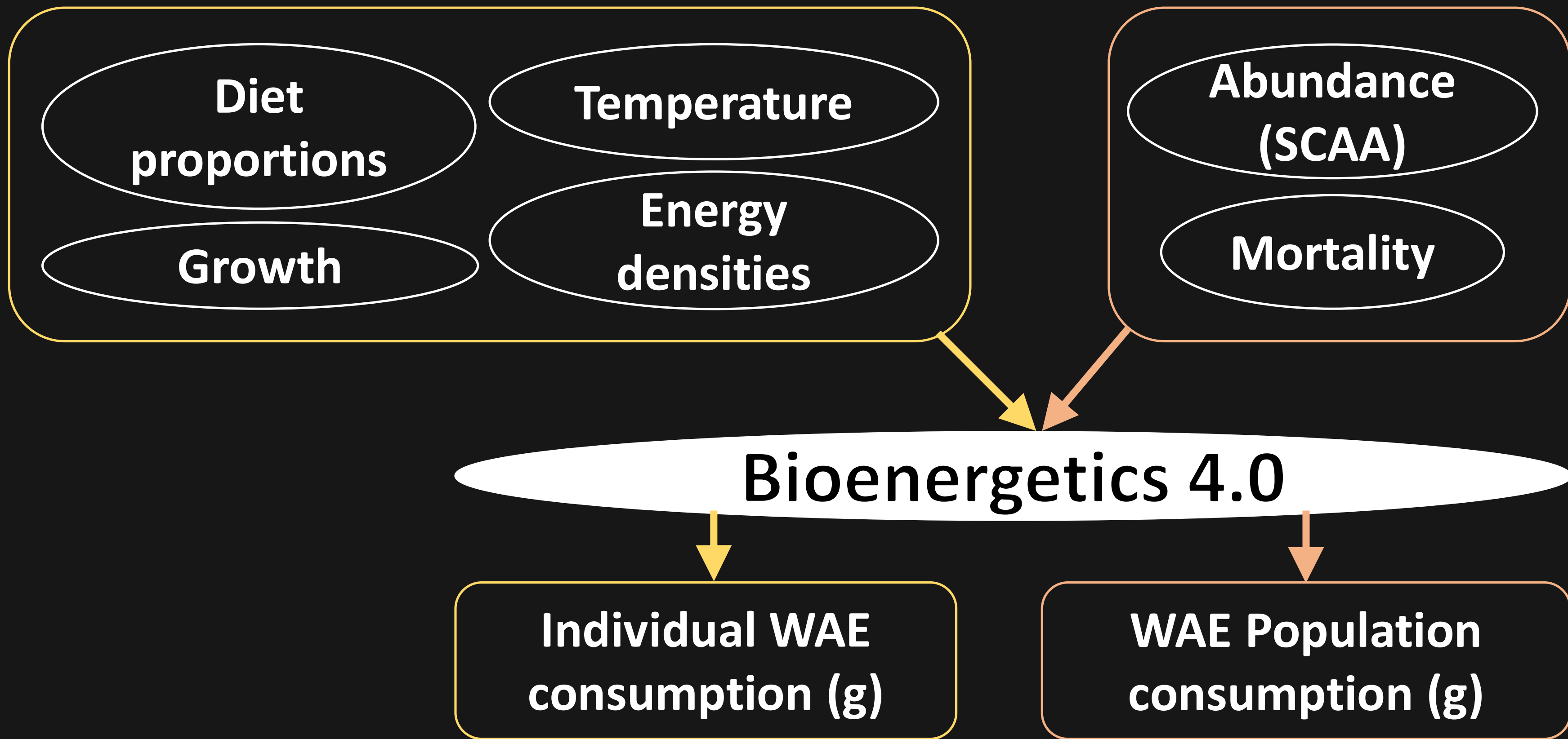

Supply

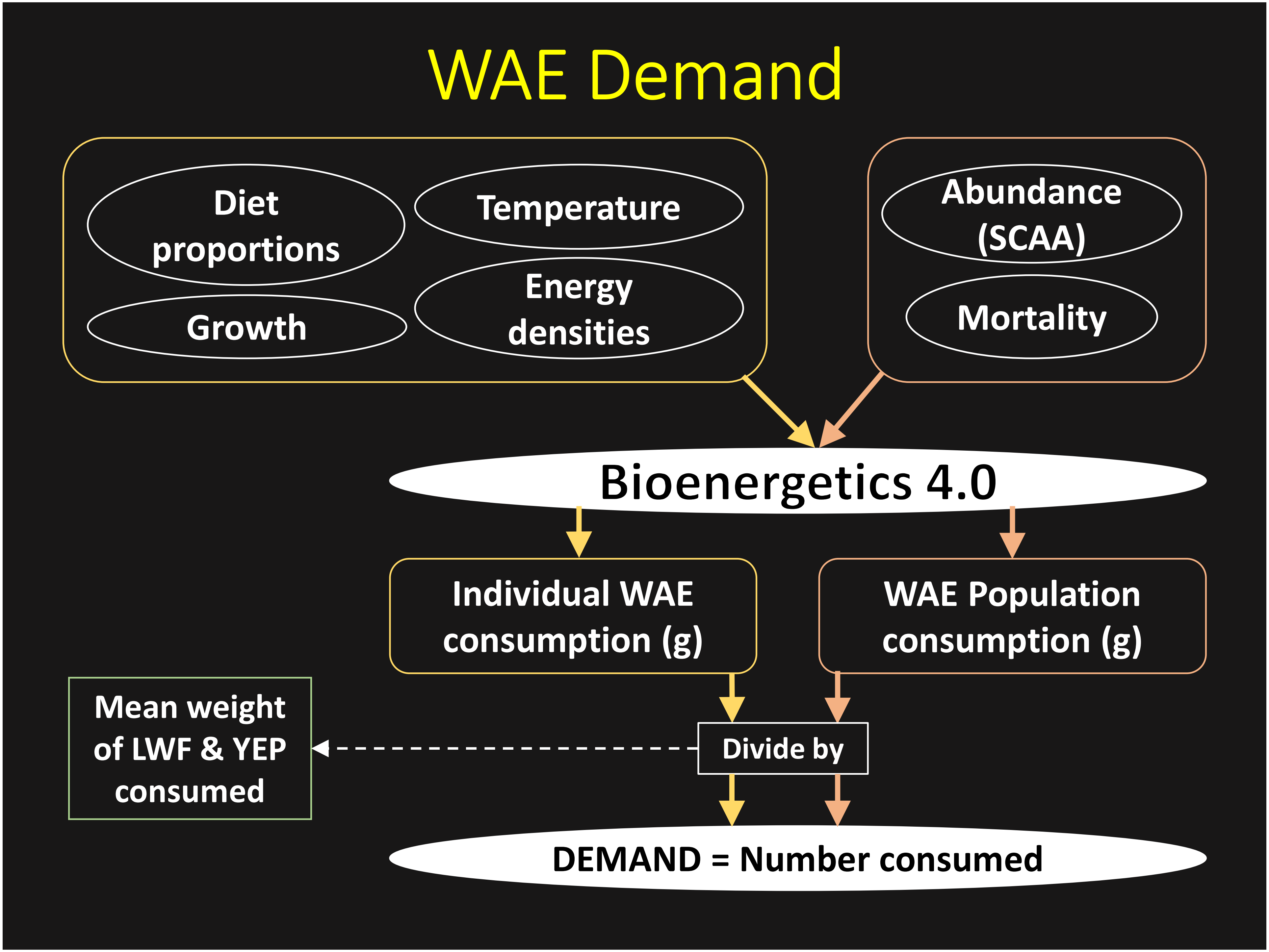

Demand

# WAE Demand


Diet proportions
Temperature
Growth
Energy densities
Bioenergetics 4.0
Individual WAE consumption (g)

# WAE Demand


Diet proportions
Temperature
Growth
Energy densities
Abundance (SCAA)
Mortality
Bioenergetics 4.0
Individual WAE consumption (g)
WAE Population consumption (g)


WAE Demand
Diet proportions
Temperature
Growth
Energy densities
Abundance (SCAA)
Mortality
Bioenergetics 4.0
Individual WAE consumption (g)
WAE Population consumption (g)
Mean weight of LWF & YEP consumed
Divide by
DEMAND = Number consumed

# LWF and YEP Supply

***Compared consumption with 2 estimates of LWF and YEP supply**

**1) SCAA abundance estimates**

**2) Population fecundity method**

# LWF and YEP Supply

***Compared consumption with 2 estimates of LWF and YEP supply**

**1) SCAA abundance estimates**

- **Model estimates available for:**
  - **Age-3 LWF**
  - **Age-1 YEP**
  - **Age-2 YEP**

**2) Population fecundity method**

# LWF and YEP Supply

***Compared consumption with 2 estimates of LWF and YEP supply**

## 1) SCAA abundance estimates

- **Model estimates available for:**
  - Age-3 LWF
  - Age-1 YEP
  - Age-2 YEP

## 2) Population fecundity method

Mature female SCAA abundance

↓

Number of eggs

↓ Survival = 1%

Age-0 supply

↓ Survival = 1%

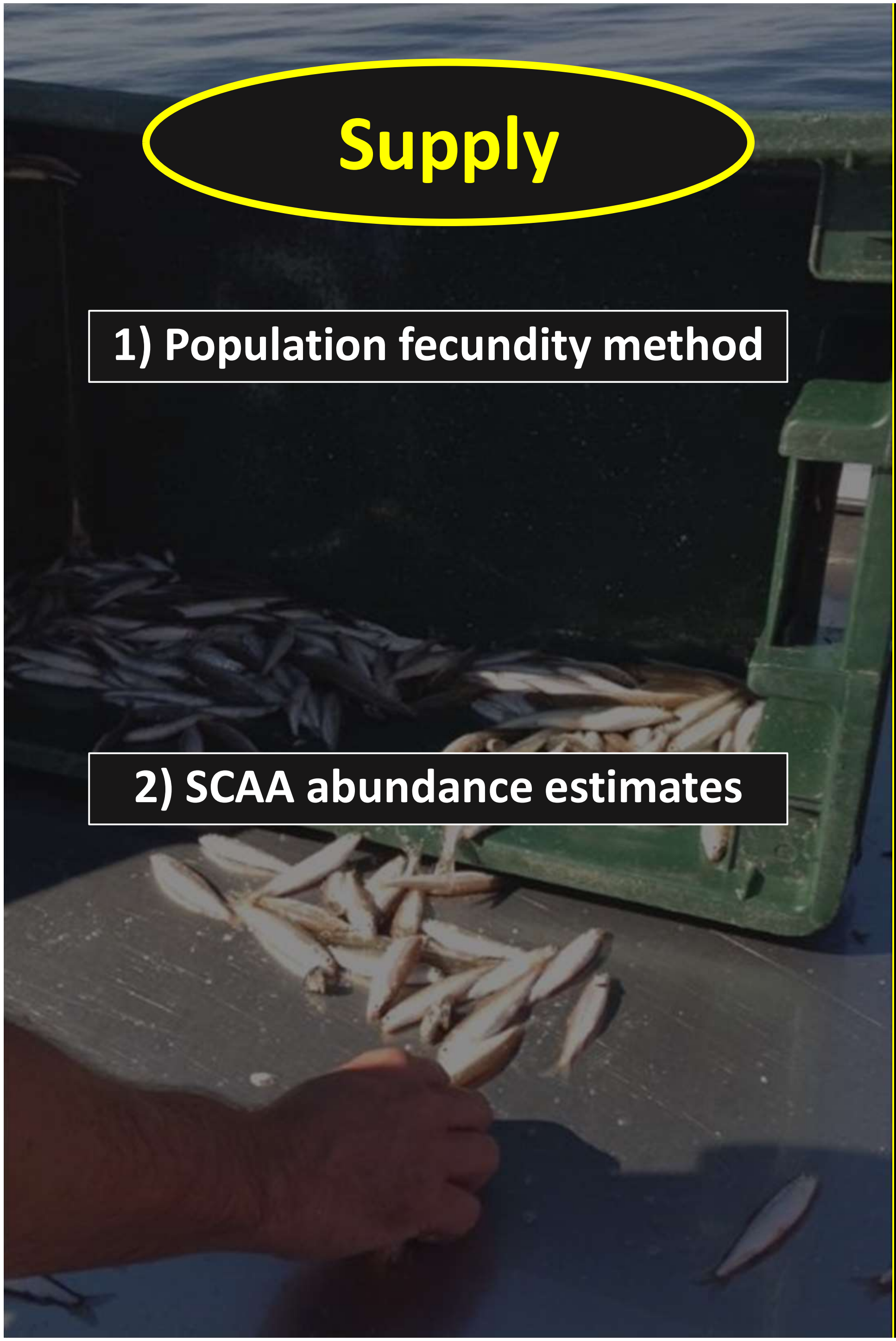
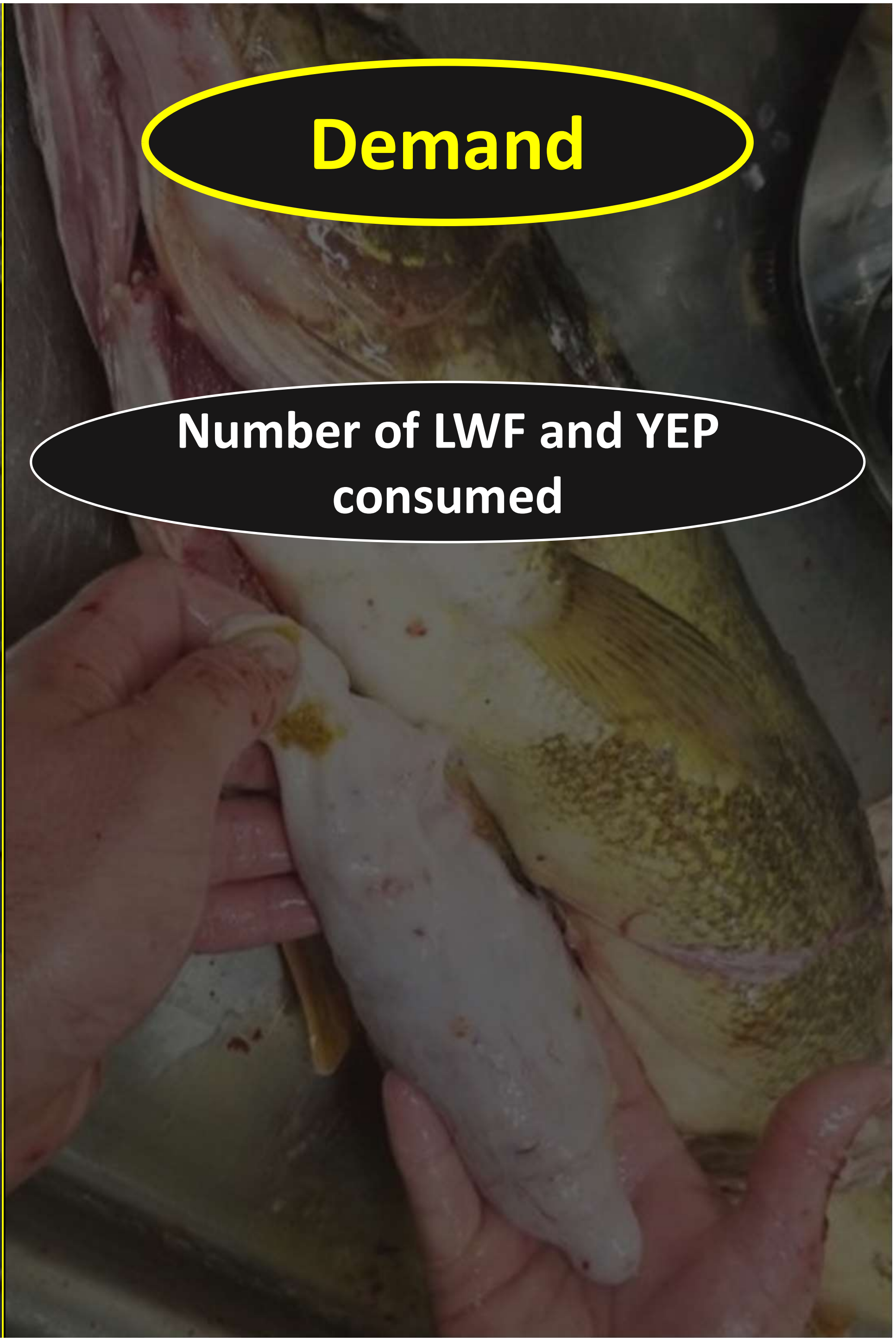
Age-1 supply

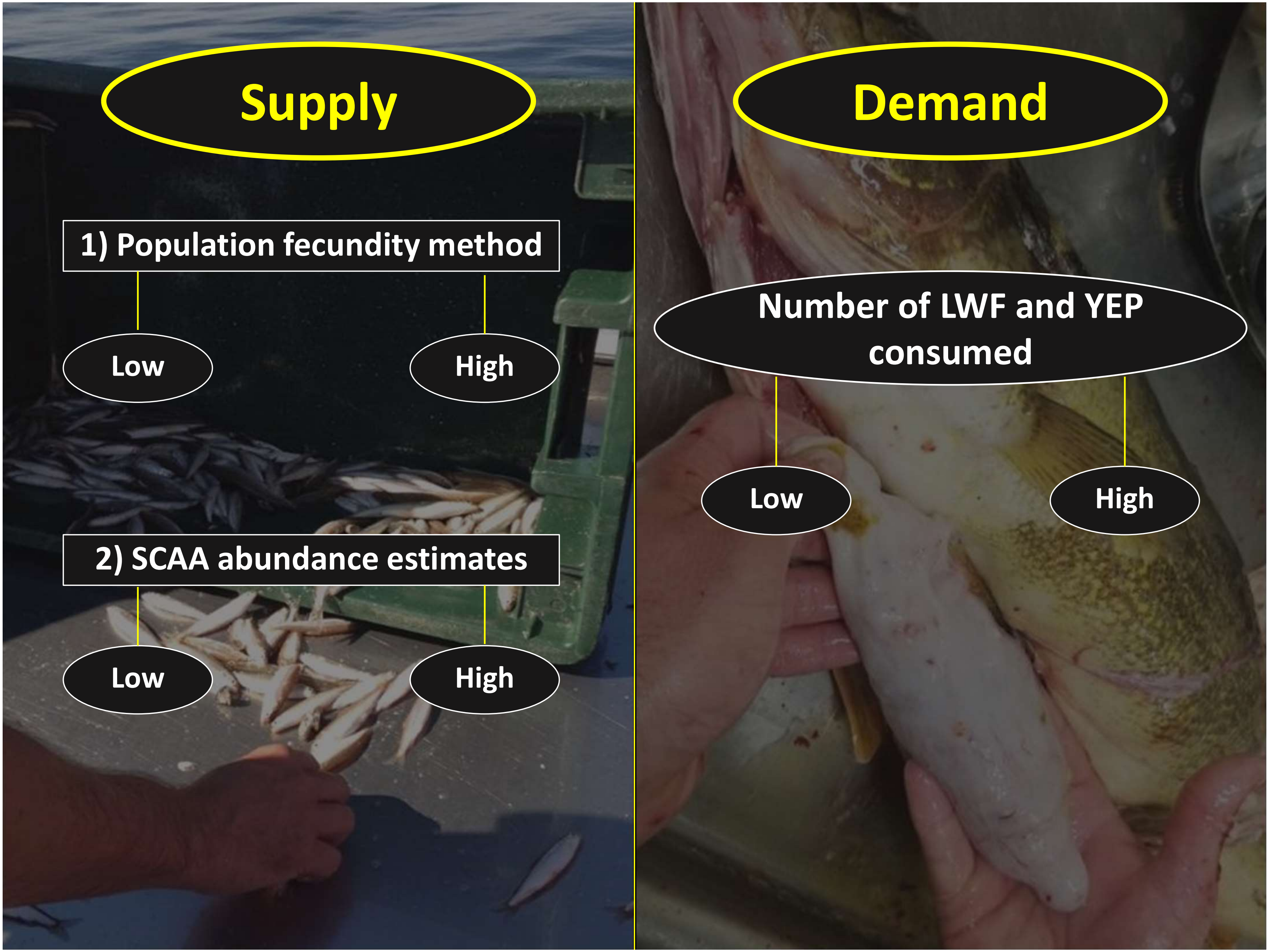
↓ Survival = 60%

Age-2 supply

↓ Survival = 60%

Age-3 supply


Supply
1) Population fecundity method
2) SCAA abundance estimates

Demand
Number of LWF and YEP consumed

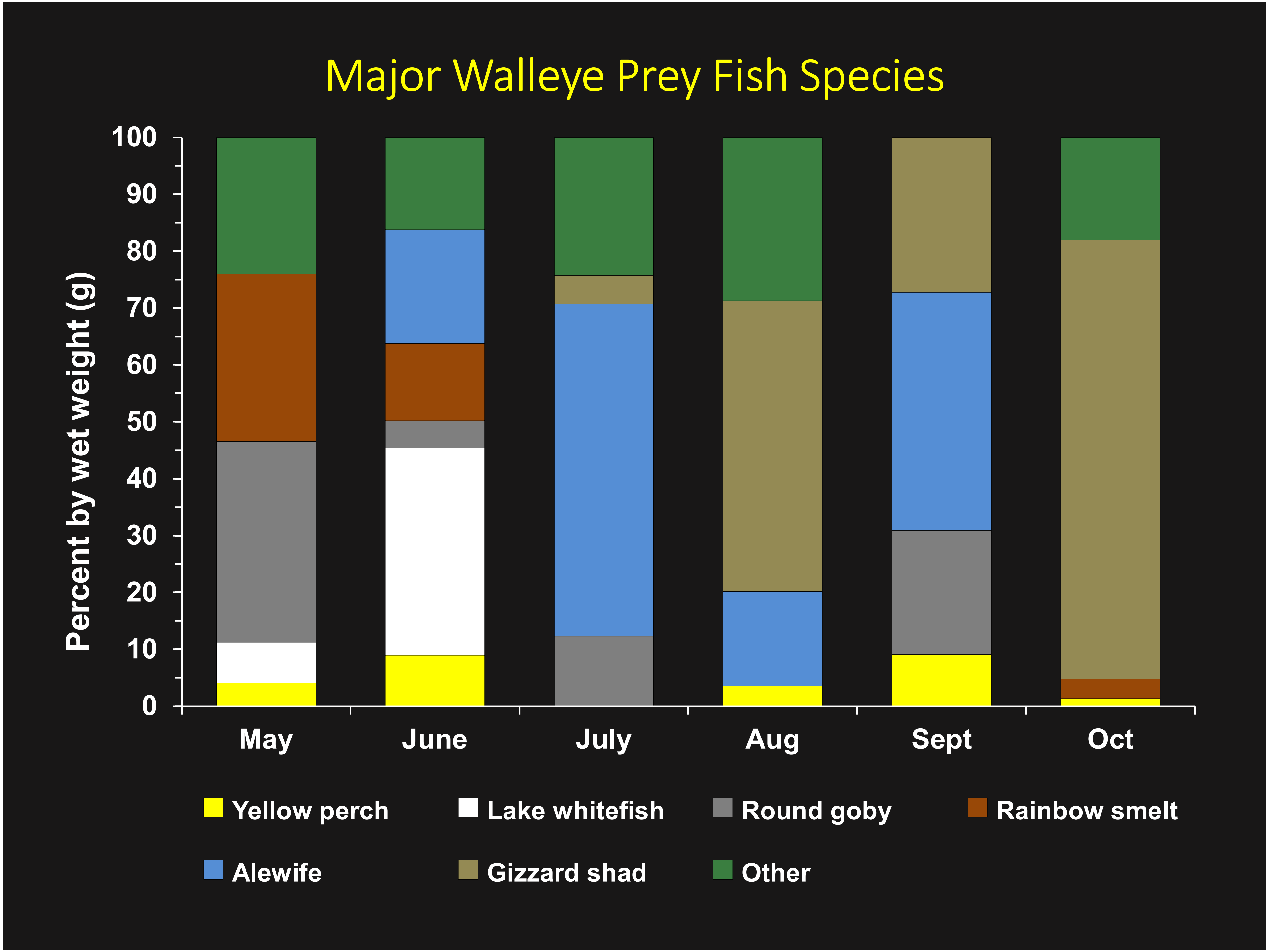

Supply
1) Population fecundity method
Low
High
2) SCAA abundance estimates
Low
High
Demand
Number of LWF and YEP consumed
Low
High

# Recruitment Potential Lost to WAE

- **Best case scenario → High supply;  Low WAE demand**
- **Worst case scenario → Low supply;  High WAE demand**
- **WAE demand divided by available supply**
- **≥ 20% will be considered important**

# Results


LINEAR METRIC UNITS AND SYMBOLS
1000 millimeters (mm) = 1 meter(m)
millimeters, include the final zero.



Major Walleye Prey Fish Species
Percent by wet weight (g)
0
10
20
30
40
50
60
70
80
90
100
May
June
July
Aug
Sept
Oct
Yellow perch
Lake whitefish
Round goby
Rainbow smelt
Alewife
Gizzard shad
Other

# Individual WAE Consumption by Number

| WAE Age(s) | LWF Age-0 | LWF Age-1 | LWF Age-2 | LWF Age-3 | Total |
|---|---|---|---|---|---|
| 1, 2 | 37 | - | - | - | 37 |
| 3 | 74 | - | - | - | 74 |
| 4, 5, 6 | - | - | - | - | 0 |
| 7+ | - | 6 | 1 | < 1 | 7 |

# Age-3 LWF Consumed by WAE

***LWF supply = Age-3 SCAA abundance estimates**

**•Best case scenario → High LWF supply;  Low WAE demand**

**•Worst case scenario → Low LWF supply;  High WAE demand**

| Scenario | Age-3 LWF Supply (SCAA) | WAE Demand | Percent Consumed |
|---|---|---|---|
| Best Case | 18,853,100 | 6,598 | 0.03% |
| Worst Case | 6,280,480 | 90,991 | 1.5% |

# LWF Consumed by WAE

*LWF supply = Population fecundity method

•Best case scenario → High LWF supply;  Low WAE demand

| LWF Age | LWF Supply | WAE Demand | Percent Consumed |
|---|---|---|---|
| 0 (post-larval) | 2,299,089,986 | 4,906,011 | 0.2% |
| 1 | 22,990,900 | 303,360 | 1.3% |
| 2 | 13,794,540 | 33,306 | 0.2% |
| 3 | 8,276,724 | 6,598 | 0.08% |

# LWF Consumed by WAE

*LWF supply = Population fecundity method

•Worst case scenario → Low LWF supply;  High WAE demand

| LWF Age | LWF Supply | WAE Demand | Percent Consumed |
|---|---|---|---|
| 0 (post-larval) | 915,931,230 | 133,446,875 | 14.6% |
| 1 | 9,159,312 | 2,451,698 | 26.8% |
| 2 | 5,495,587 | 332,634 | 6.1% |
| 3 | 3,297,352 | 90,991 | 2.8% |

# Individual WAE Consumption by Number

| WAE Age(s) | YEP Age-0 | YEP Age-1 | YEP Age-2 | Total |
|---|---|---|---|---|
| 1, 2 | 77 | 2 | - | 79 |
| 3 | 7 | 7 | - | 14 |
| 4, 5, 6 | - | < 1 | - | < 1 |
| 7+ | 3 | 3 | 9 | 15 |

# Age-1 YEP Consumed by WAE

***YEP supply = Age-1 SCAA abundance estimates**

- **Best case scenario → High YEP supply;  Low WAE demand**
- **Worst case scenario → Low YEP supply;  High WAE demand**

| Scenario | Age-1 YEP Supply (SCAA) | WAE Demand | Percent Consumed |
|---|---|---|---|
| Best Case | 1,100,880 | 546,380 | 49.6% |
| Worst Case | 246,293 | 9,452,007 | ALL |

# Age-2 YEP Consumed by WAE

*YEP supply = Age-2 SCAA abundance estimates

- Best case scenario → High YEP supply; Low WAE demand
- Worst case scenario → Low YEP supply; High WAE demand

| Scenario | Age-2 YEP Supply (SCAA) | WAE Demand | Percent Consumed |
|---|---|---|---|
| Best Case | 718,604 | 372,940 | 51.9% |
| Worst Case | 392,650 | 3,319,662 | ALL |

# YEP Consumed by WAE

*YEP supply = Population fecundity method

•Best case scenario → High YEP supply;  Low WAE demand

| YEP Age | YEP Supply | WAE Demand | Percent Consumed |
|---|---|---|---|
| 0 | 318,955,020 | 5,736,185 | 1.8% |
| 1 | 3,189,550 | 546,380 | 17.1% |
| 2 | 1,913,730 | 372,940 | 19.5% |

# YEP Consumed by WAE

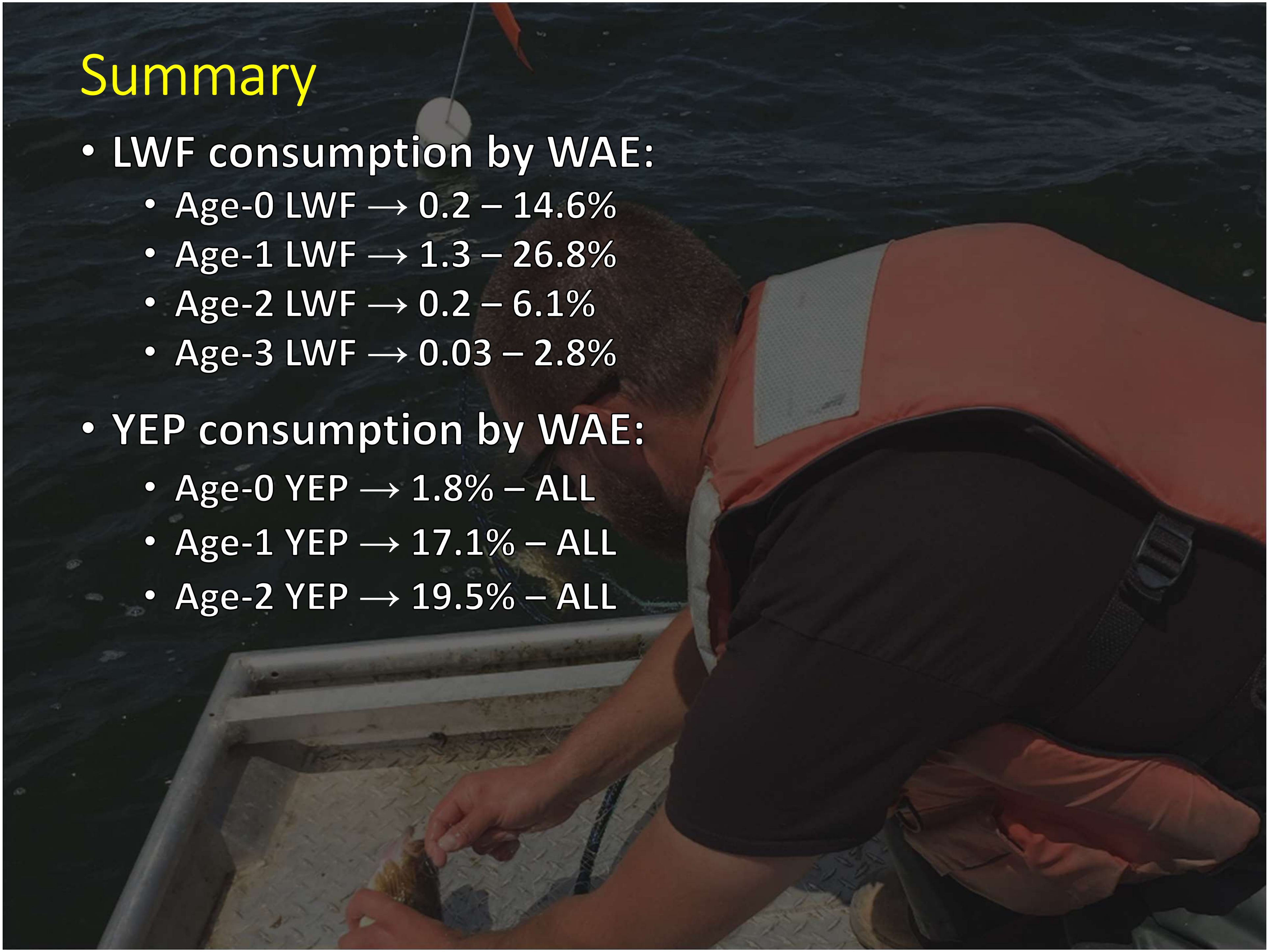
***YEP supply = Population fecundity method**

**•Worst case scenario → Low YEP supply; High WAE demand**

| YEP Age | YEP Supply | WAE Demand | Percent Consumed |
|---|---|---|---|
| 0 | 140,401,907 | 301,371,740 | ALL |
| 1 | 1,404,019 | 9,452,007 | ALL |
| 2 | 842,441 | 3,319,662 | ALL |

# Summary

- LWF consumption by WAE:
  - Age-0 LWF → 0.2 – 14.6%
  - Age-1 LWF → 1.3 – 26.8%
  - Age-2 LWF → 0.2 – 6.1%
  - Age-3 LWF → 0.03 – 2.8%
- YEP consumption by WAE:
  - Age-0 YEP → 1.8% – ALL
  - Age-1 YEP → 17.1% – ALL
  - Age-2 YEP → 19.5% – ALL



# Conclusions

Could walleye predation influence the recruitment potential of lake whitefish?

Maybe, but unlikely

Could walleye predation influence the recruitment potential of yellow perch?

Likely yes

These results can help guide management actions because changes in one species will likely affect fisheries for all three species.

Management actions promoting walleye may provide economic benefit by attracting anglers but could limit angling and commercial opportunities for yellow perch.

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