# Effects of 2, 4-D Herbicide Treatments Used to Control Eurasian Watermilfoil on Fish and Zooplankton in Northern WI Lakes

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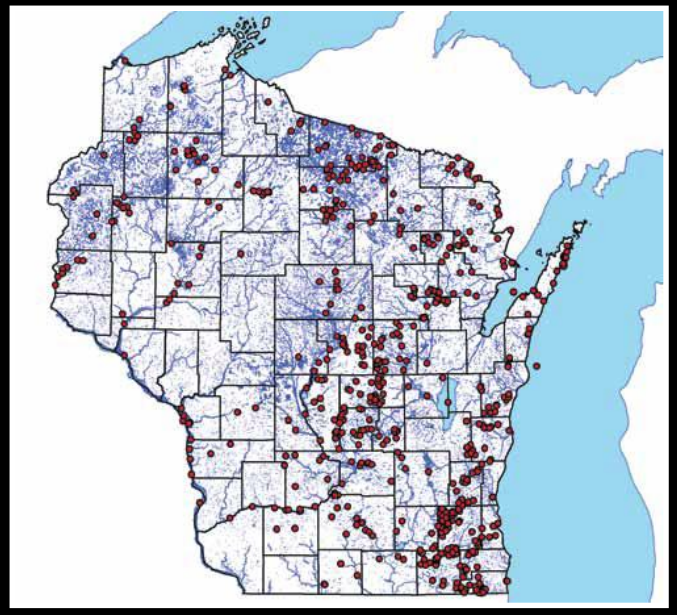
# Eurasian Watermilfoil

- Shades out native vegetation
  - Altering habitat
- Interferes with recreation
- Can spread rapidly
- One of the most widely spread aquatic invasive plants

# Eurasian Watermilfoil

- Found in 48 states
- 850 lakes and rivers in Wisconsin
- Many means of control exist



Credit: Nault et al. 2012

# 2, 4-D Herbicide

- Used since the 1950's
- Recent whole lake treatments
- Rising demand for 2, 4-D treatments

# Previous Work

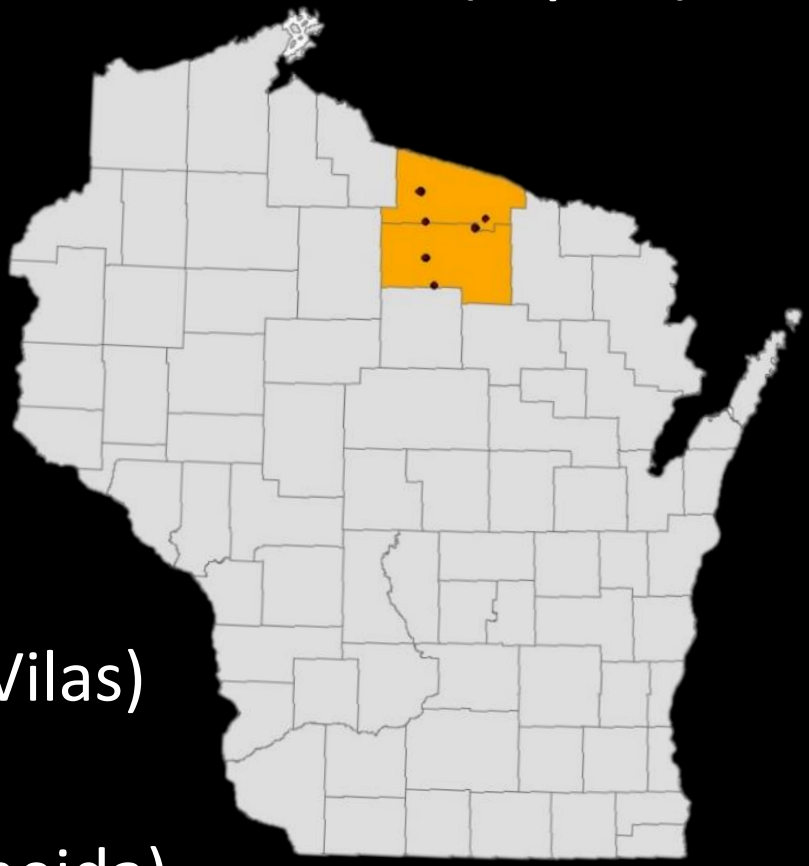
- Primarily laboratory studies
- 15% reduction in larval Fathead Minnow survival
  - At 0.05 ppm
- EPA permits spots treatments up to 4 ppm and whole lake treatments up to 2 ppm
- Little is known regarding the effect of treatments on fish and zooplankton

# Research Objectives

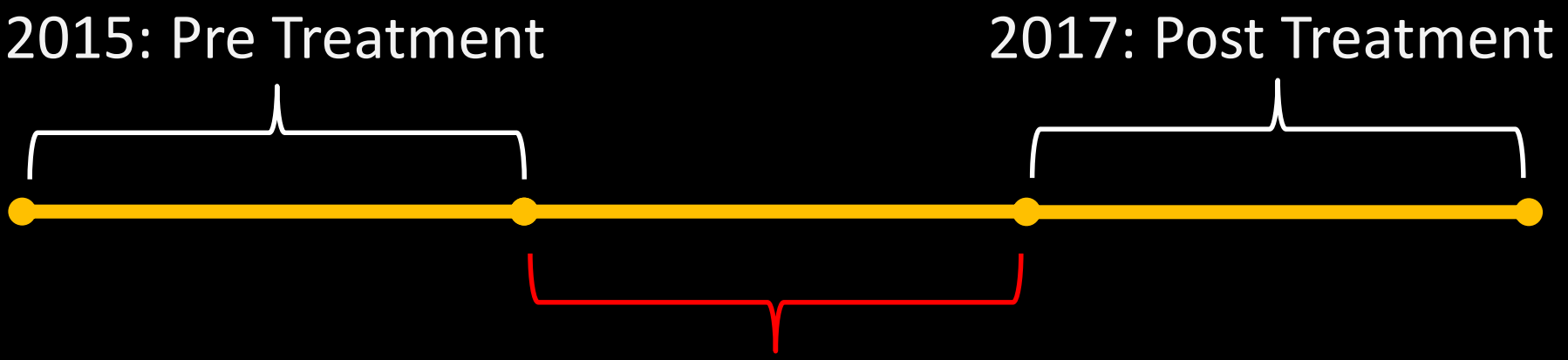
- To determine if 2, 4-D treatments affect the:
  1. Diversity, abundance, and size of zooplankton;
  2. Feeding, growth and size structure of larval fishes;
  3. Abundance, diversity, and survival of fishes at different life history stages.

# Study Location

- Whole-lake treatment with DMA® 4IVM (liquid) formulation of 2, 4-D
- Treatment lakes:
  - Manson (236 acres; Oneida)
  - Kathan (214 acres; Oneida)
  - Silver (57 acres; Vilas)
- Reference lakes:
  - Upper Gresham (362 acres; Vilas)
  - Brandy (113 acres; Vilas)
  - Little Bearskin (184 acres; Oneida)



# Study Design




Treatment Lakes:

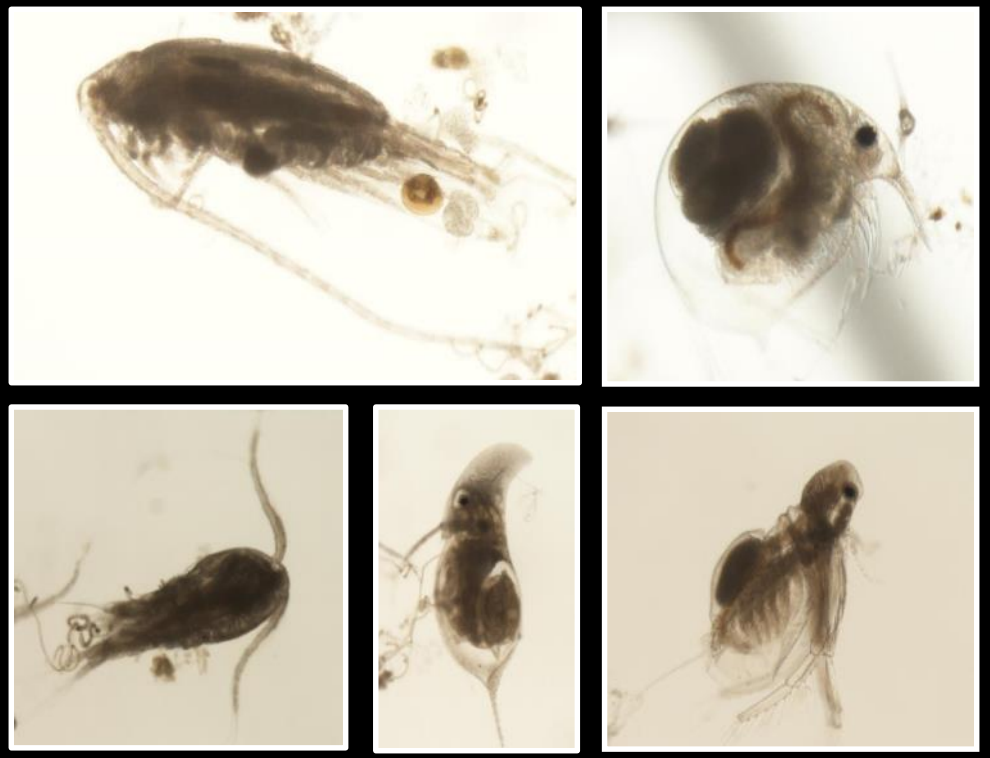
- Kathan (5/24/16)
- Manson (6/2/16)
- Silver (6/7/16)

Reference Lakes:

- Brandy
- Little Bearskin
- Upper Gresham

# Field Sampling

- May to August each year
  - 4 sites per lake; remaining fixed
- Identified and counted
- Measured
  - *Daphnia* spp., calanoid and cyclopoid copepods



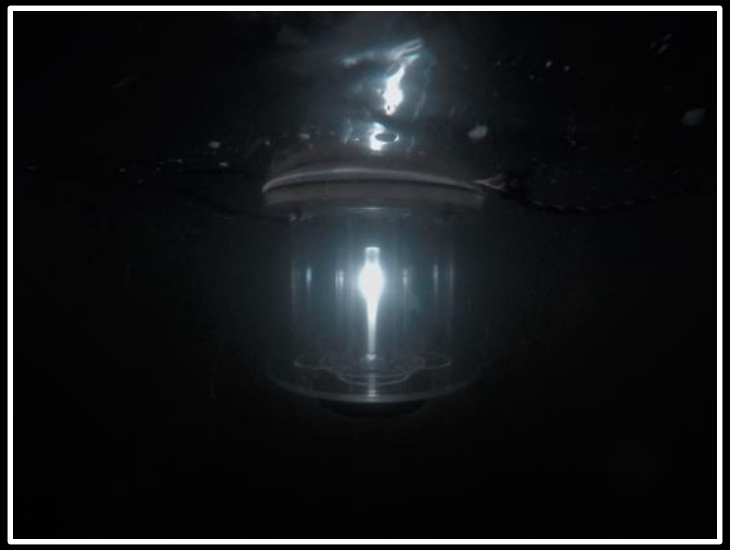
# Larval Fish

## Field Sampling

- Ichthyoplankton tows
  - 6 sites; remaining fixed

  (Silver N=4)

- Quatrefoil light traps
  - 4 sites; remaining fixed



# Larval Fish

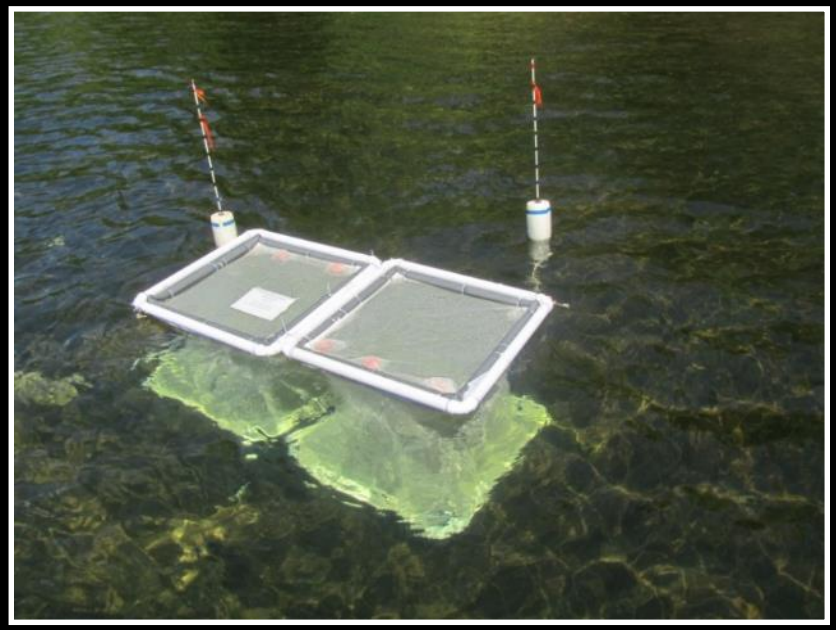
- Identified and measured
- YEP and BLG growth metric
  - Linear regression of TL across day of year
- Up to 30 larval BLC from peak abundance
  - Diets examined
  - Sagittal otoliths removed

# Shoreline Seining

- May to mid-July, every 7-10 d and once in August
  - 6 sites; remaining fixed
  - From May to early June, Yellow Perch and Bluegill were used in net pen trials

# Net Pen Trials

- 30 Yellow Perch or 30 Bluegill
  - Held in pens for 48 h
  - Look for signs of mortality
- Before, during and after treatment



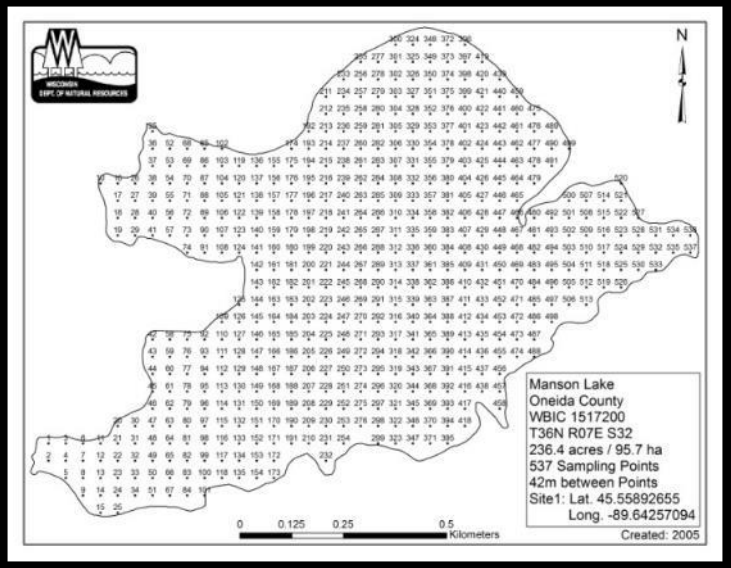
Credit: Jamie Germano

# Plant Surveys

- Follow WIDNR protocols
  - Point-intercept surveys

| Fullness Rating | Coverage | Description |
|---|---|---|
| 1 |  | Only few plants. There are not enough plants to entirely cover the length of the rake head in a single layer. |
| 2 |  | There are enough plants to cover the length of the rake head in a single layer, but not enough to fully cover the tines. |
| 3 |  | The rake is completely covered and tines are not visible. |

Credit: Hauxwell et al. 2010



# 2, 4-D Degradation

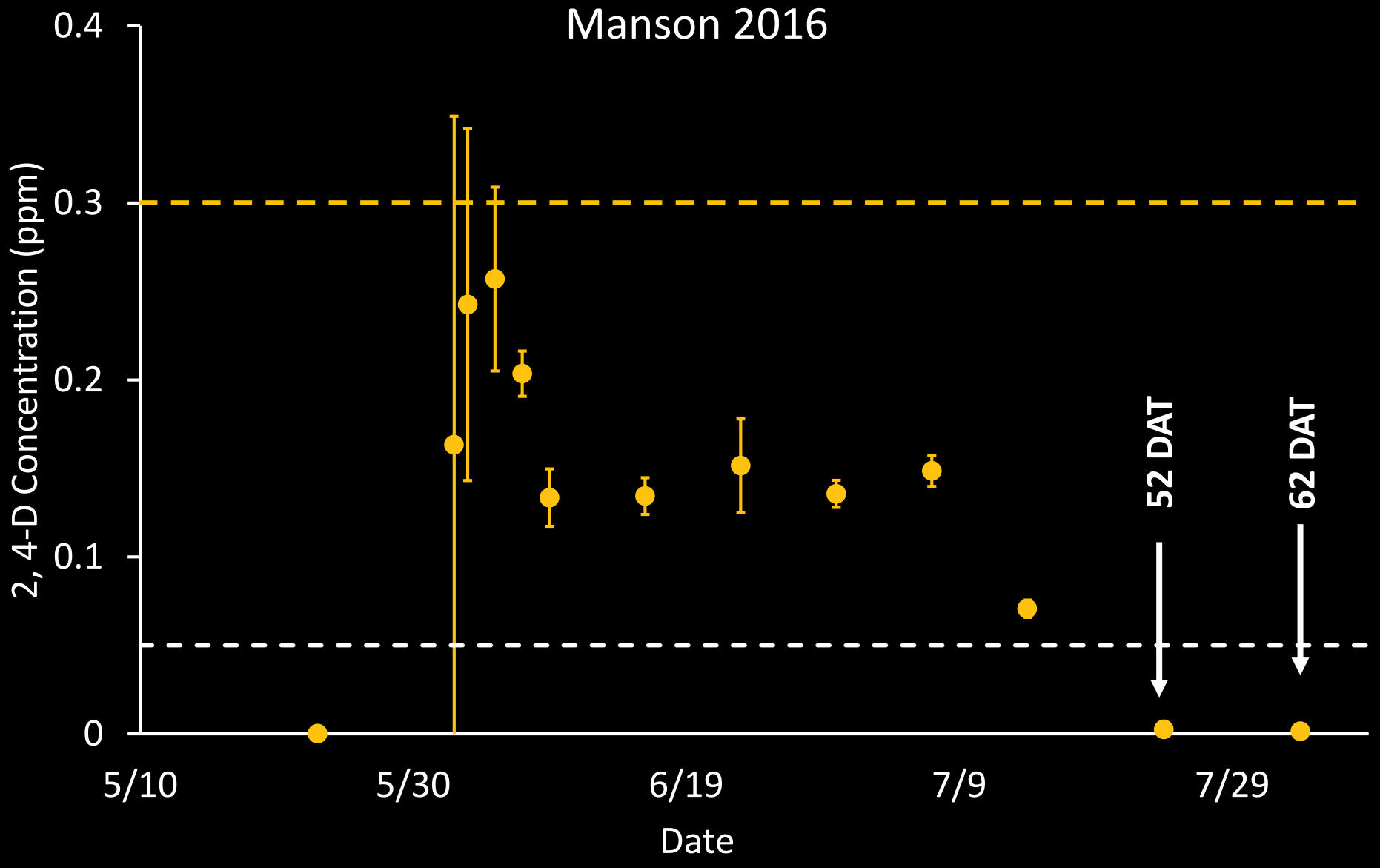
- At 4 sites per lake at 1.5 m
- HPLC
  - (0.5 ppb)
- Samples collected:
  - Week before treatment
  - Day of treatment
  - 2 d intervals up to 7-d post-treatment
  - 7 d intervals up to 42-d post-treatment
  - 10 d intervals up to 62-d post-treatment

# Results

# A Pretty Serious Effort…

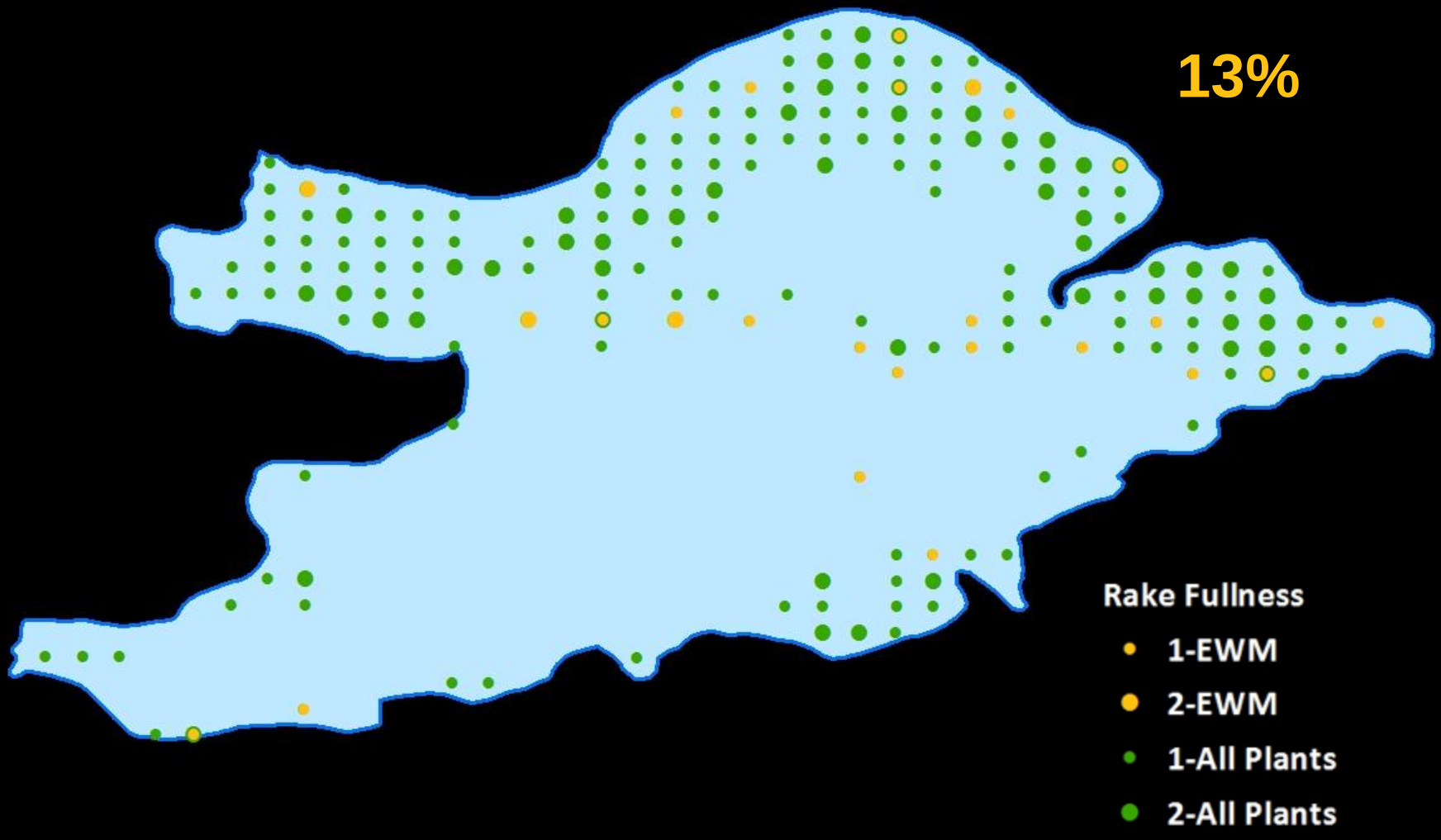
- 768 Zooplankton Samples collected
  - 729,188 zooplankton identified
  - 15,490 measured
- 525 Light traps
  - 9,882 larval fish identified
- 816 ichthyoplankton tows
  - 18,763 larval fish identified
  - 3,990 measured
- 159 Seine Hauls
  - 54 net pen trials
- 73 miles of shoreline electrofished
- 1,094 larval diets, hatch dates and daily growth rates

# 2, 4-D Concentrations



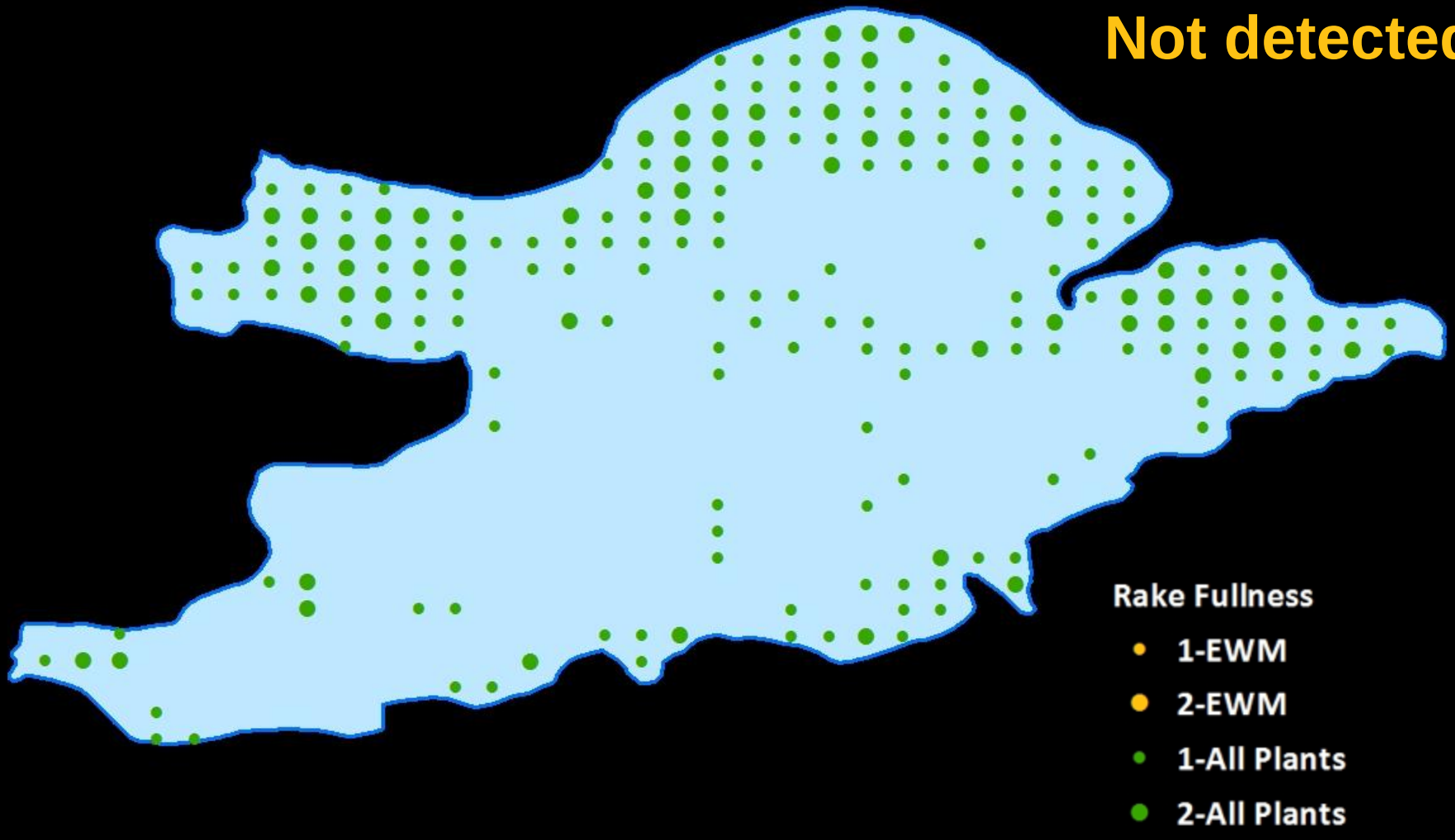
# Results

## Manson 2015



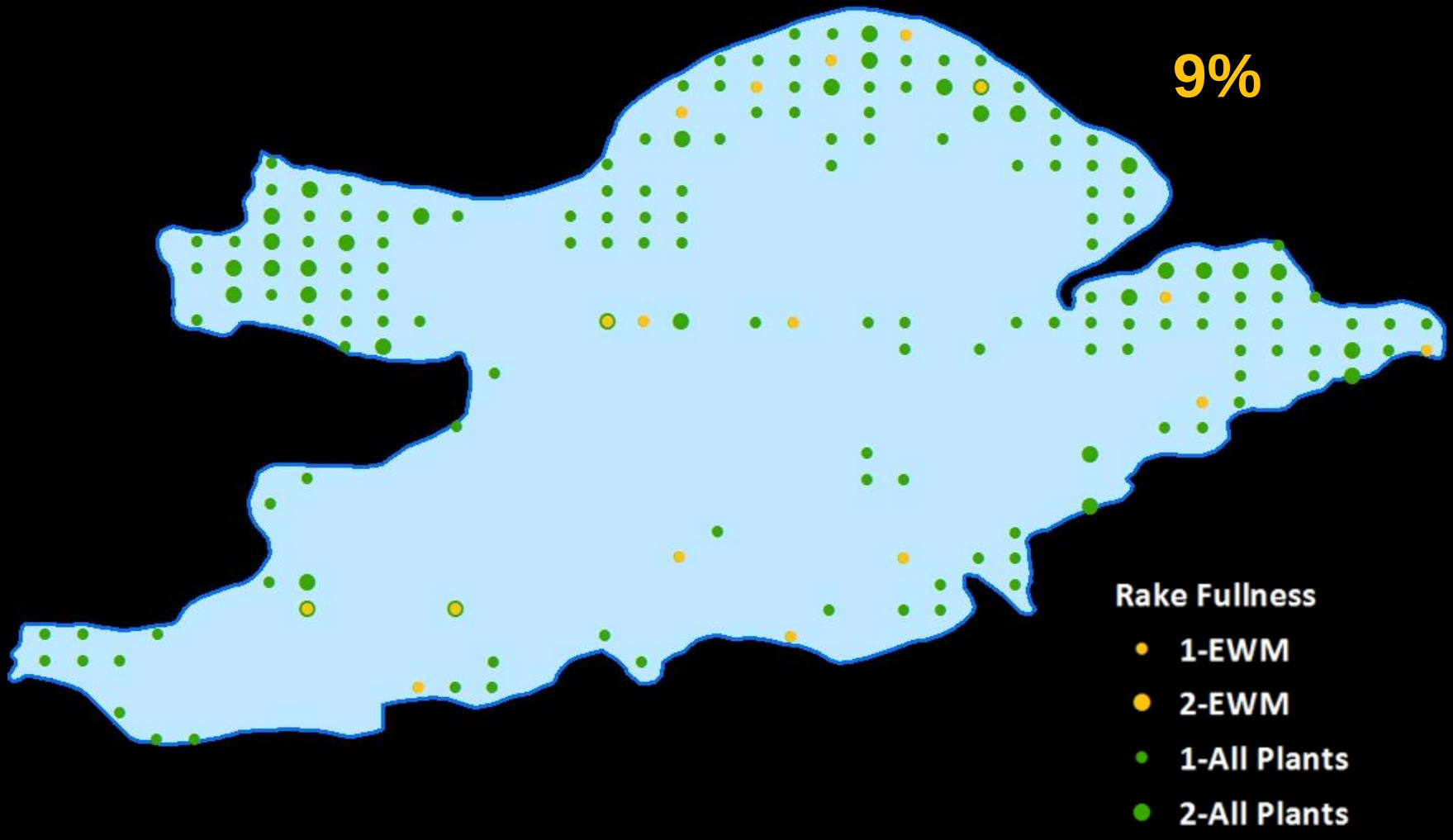
# Results

## Manson 2016



# Results

## Manson 2017

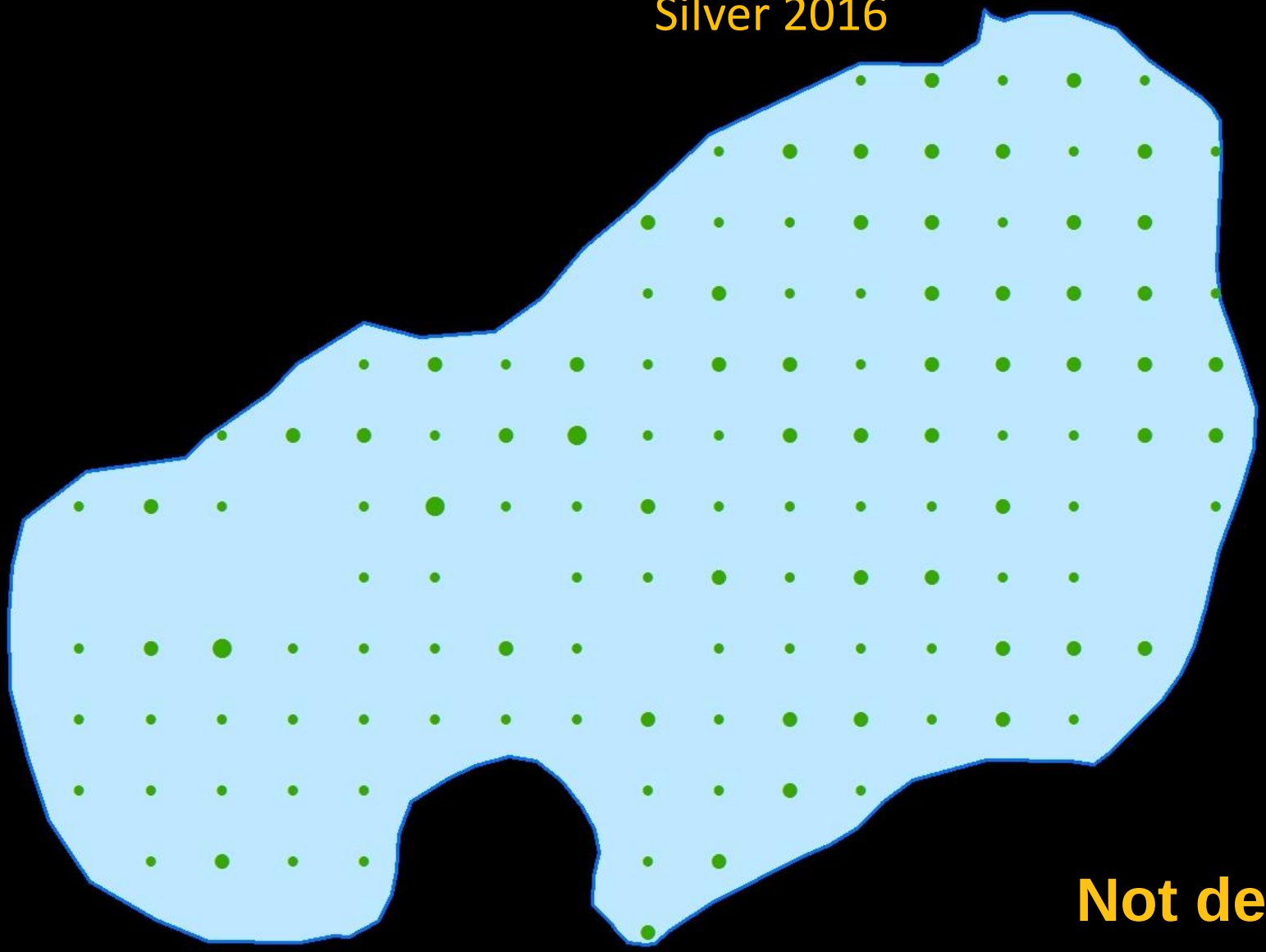


# Results

## Silver 2015

# Results

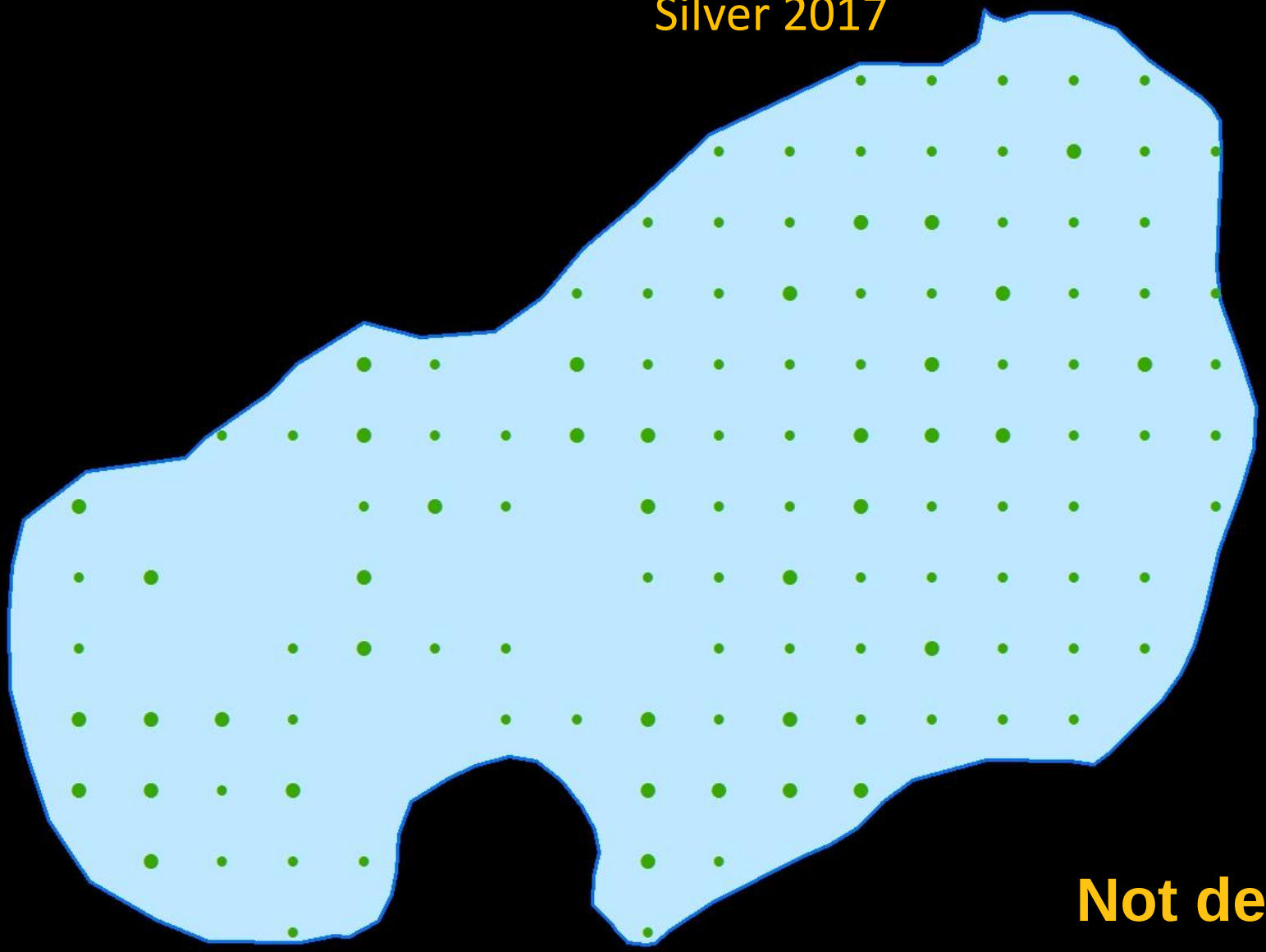
Silver 2016



**Not detected**

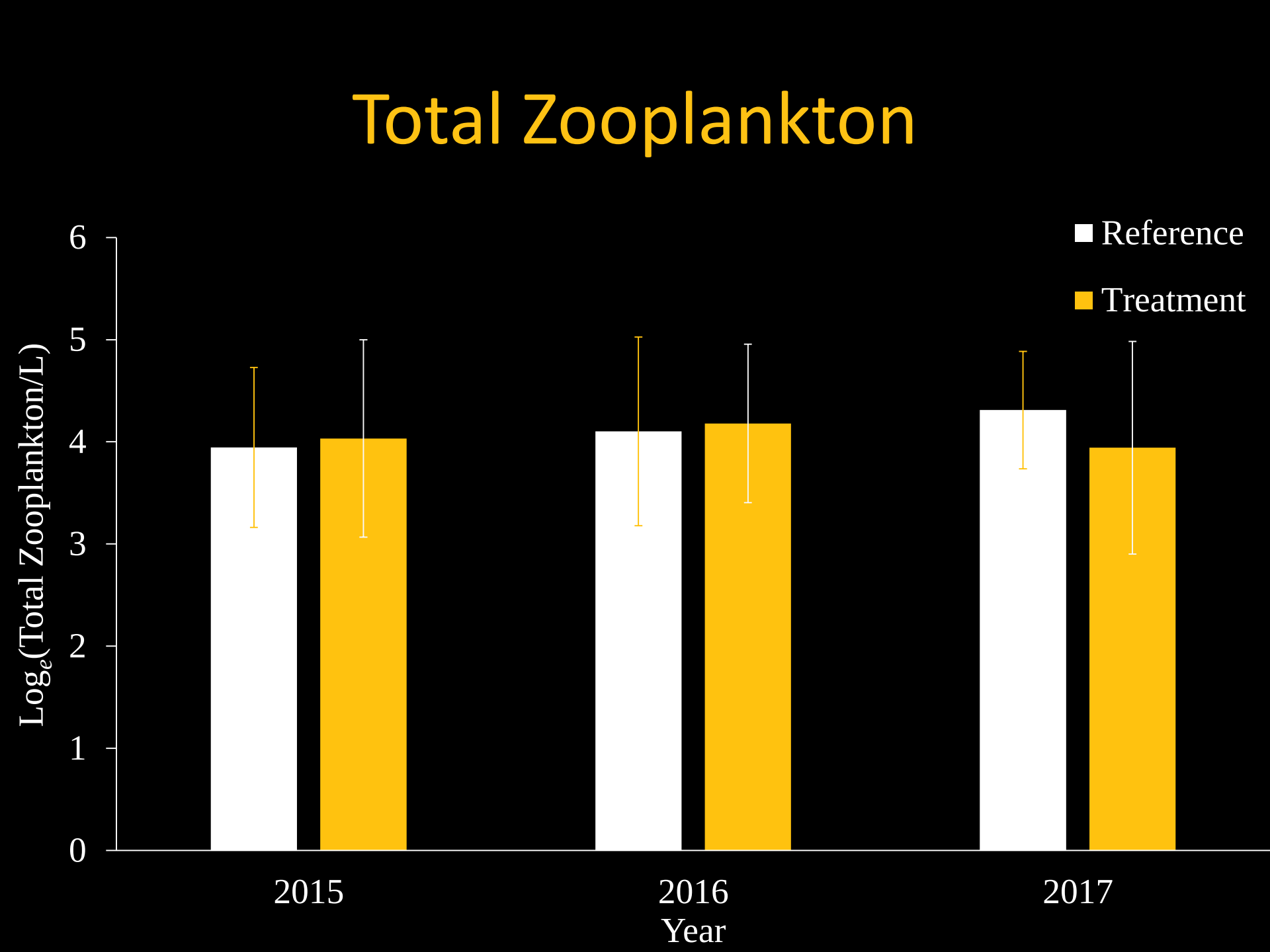
# Results

Silver 2017



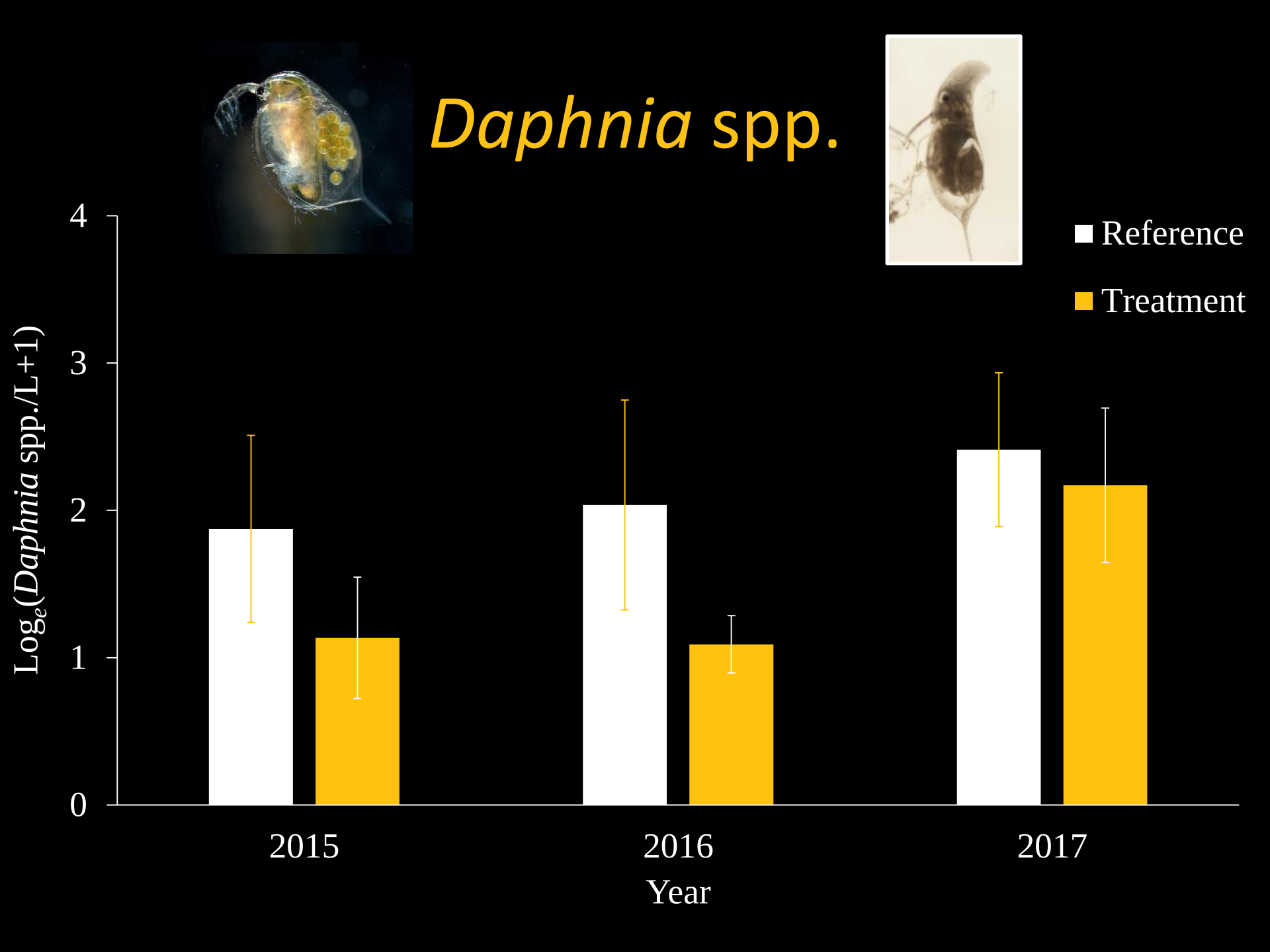
**Not detected**

# Total Zooplankton

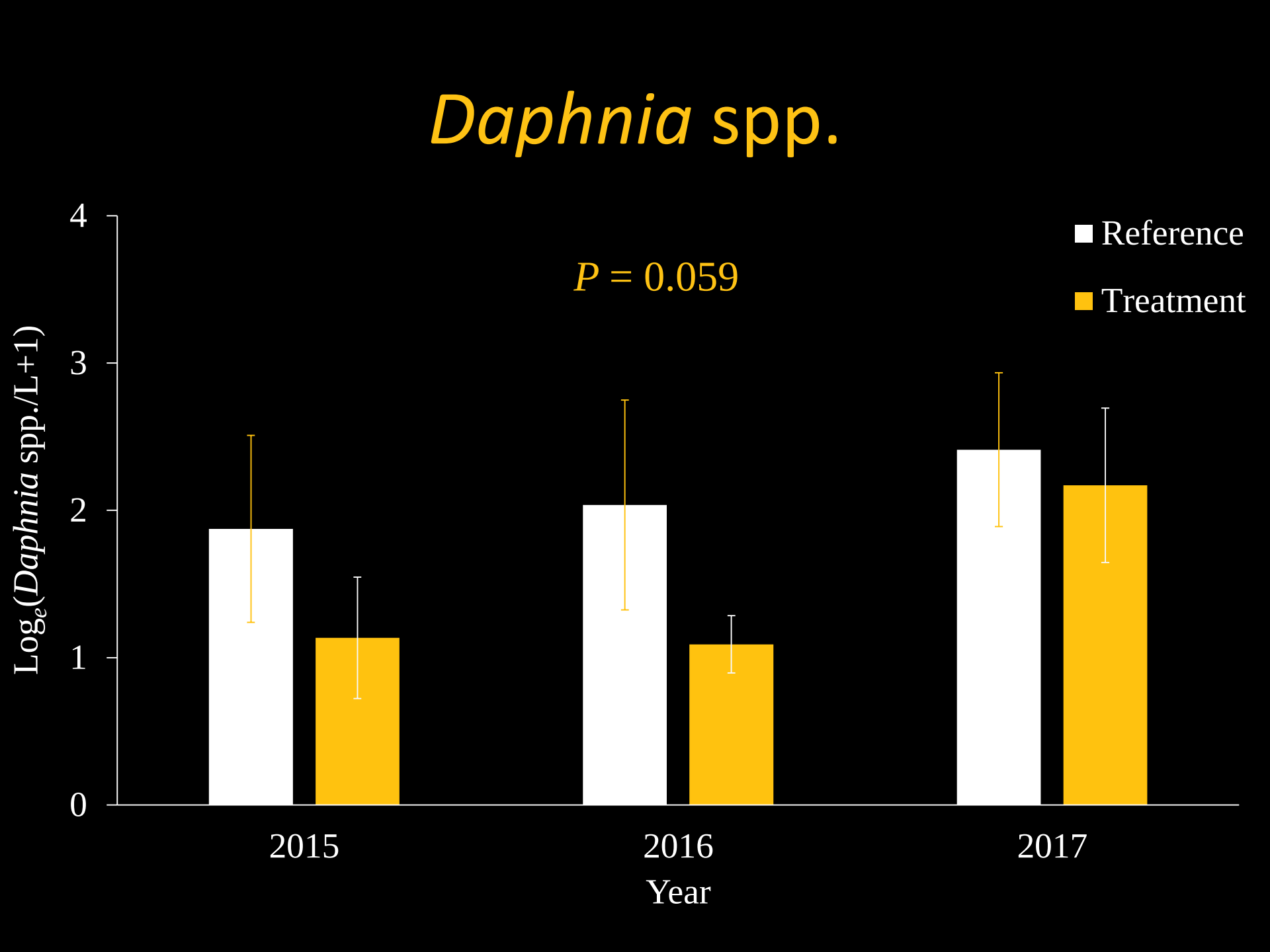


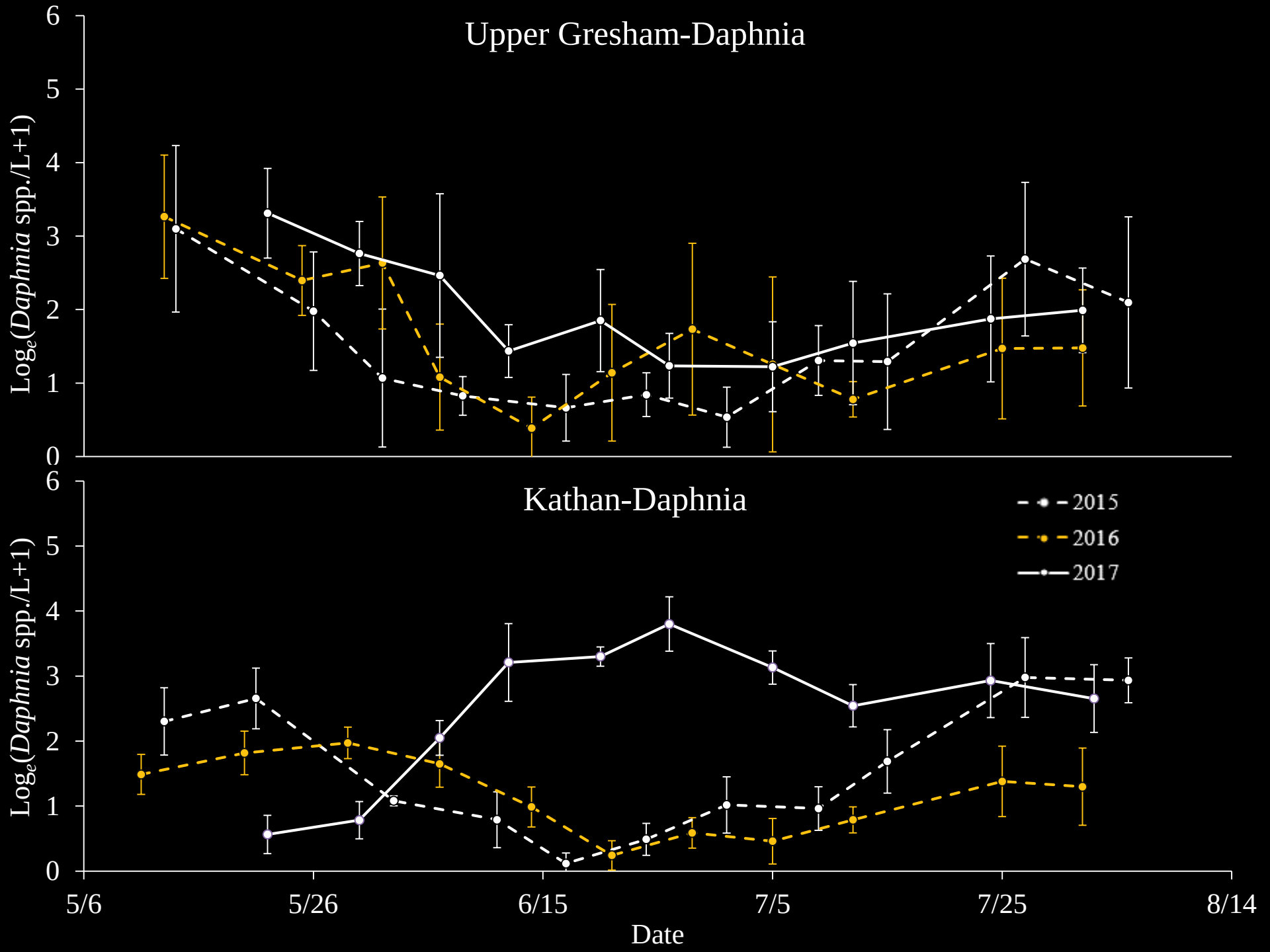
# *Daphnia* spp.

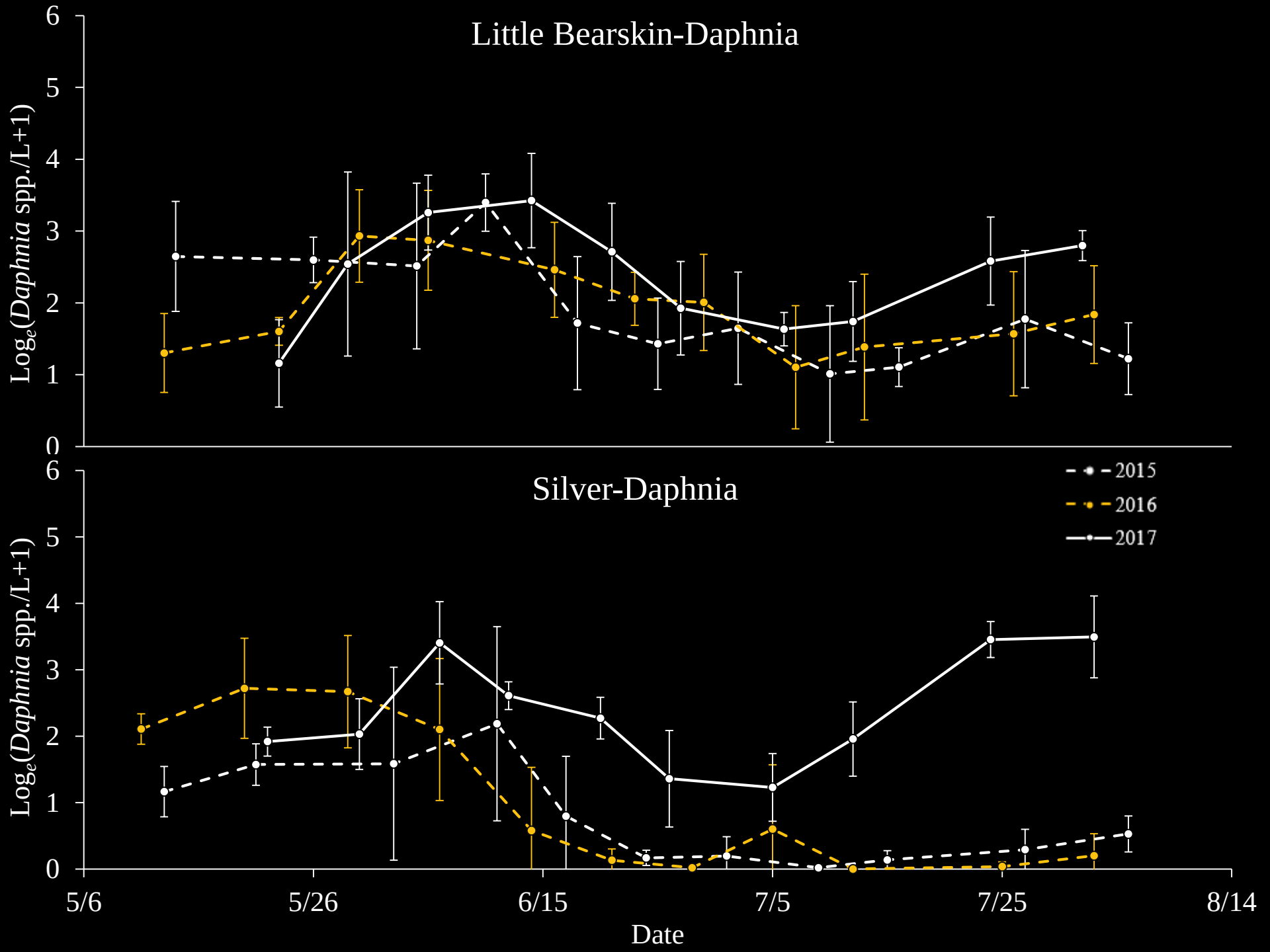


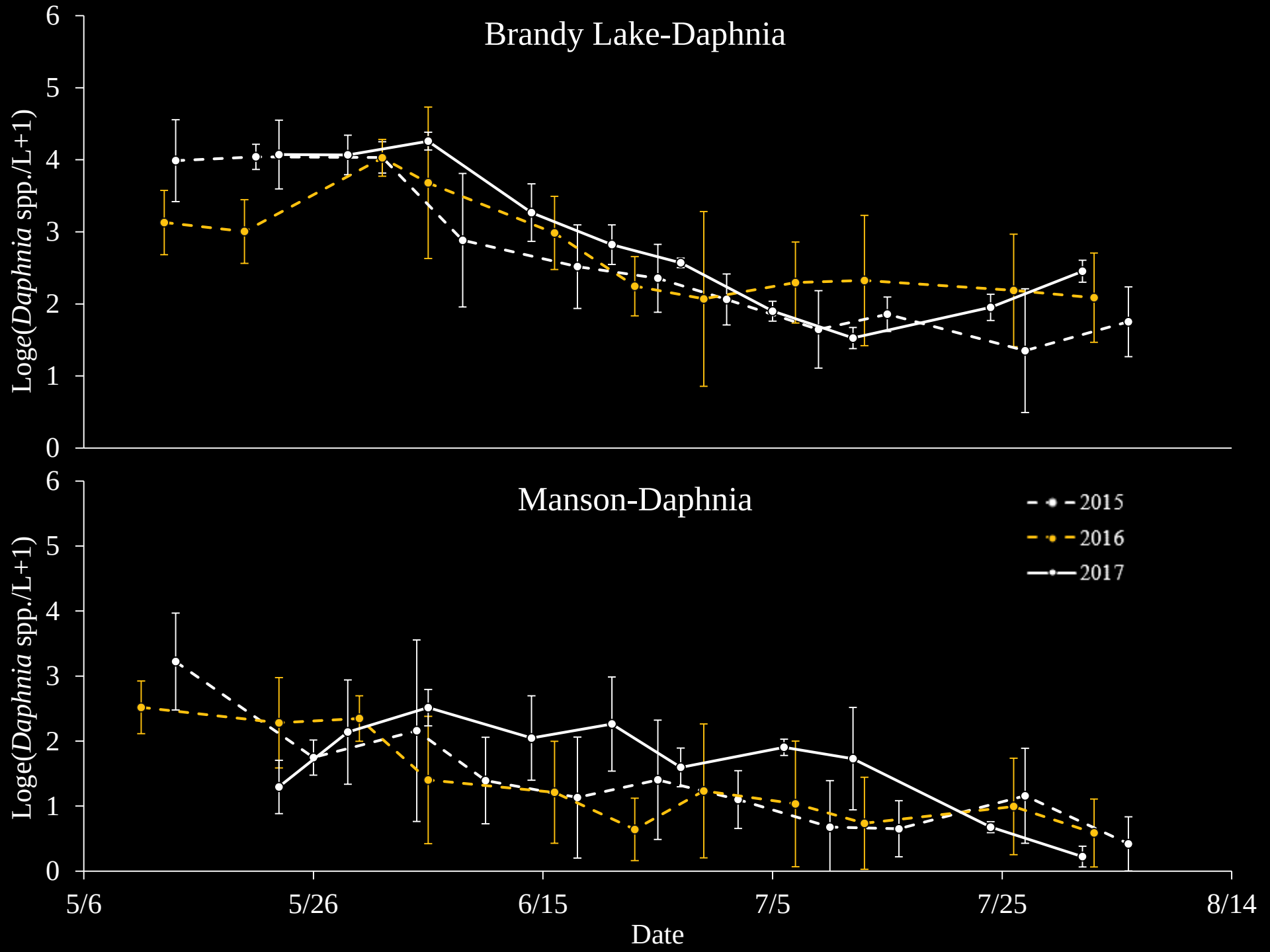

Reference
Treatment
4
3
2
1
0
Log$_e$(*Daphnia* spp./L+1)
2015
2016
2017
Year

# *Daphnia* spp.

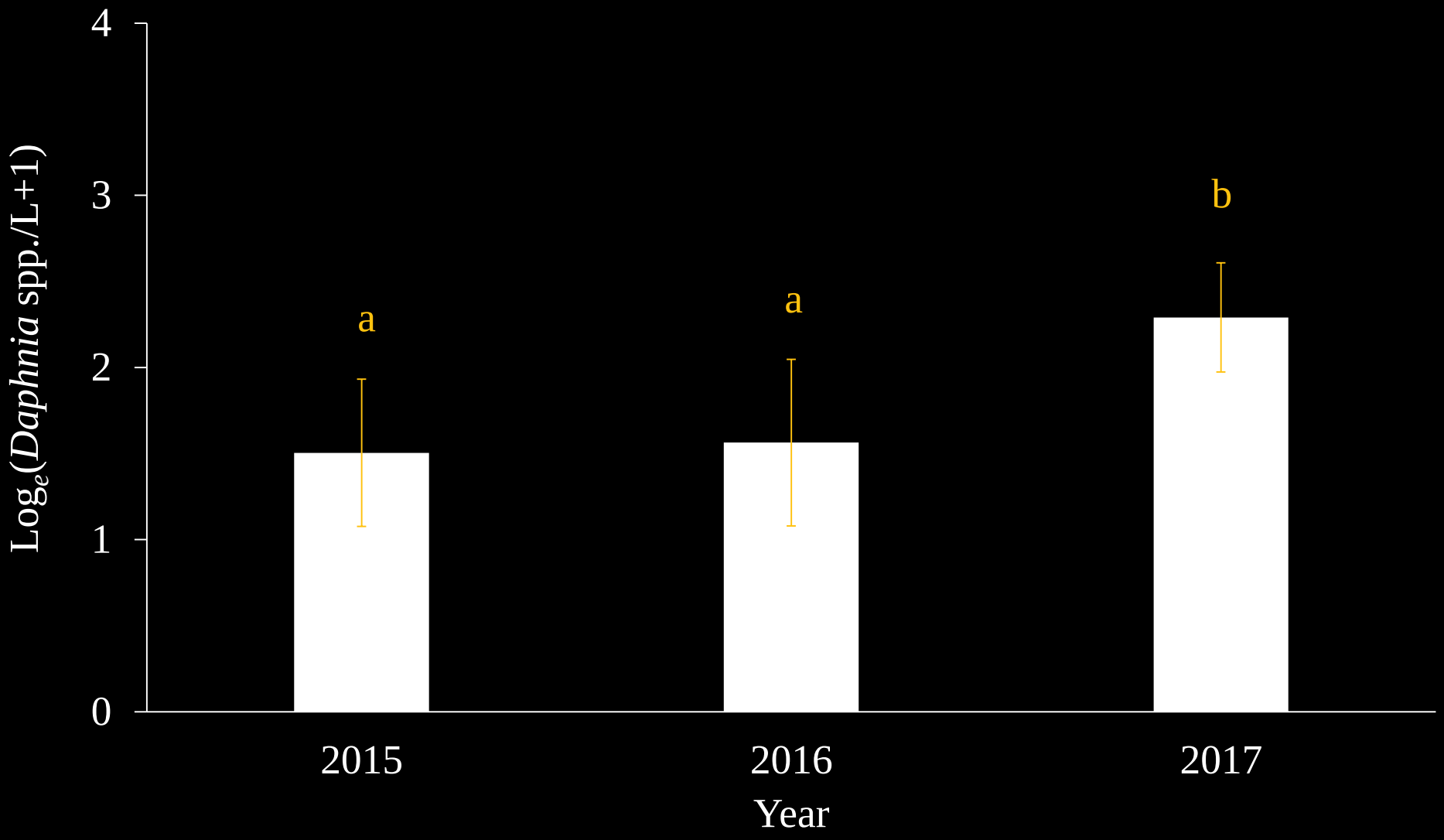

Reference
Treatment
P = 0.059
Log_e(Daphnia spp./L+1)
4
3
2
1
0
2015
2016
2017
Year


Upper Gresham-Daphnia
Kathan-Daphnia
Log$_e$(*Daphnia* spp./L+1)
0
1
2
3
4
5
6
5/6
5/26
6/15
7/5
7/25
8/14
Date
2015
2016
2017

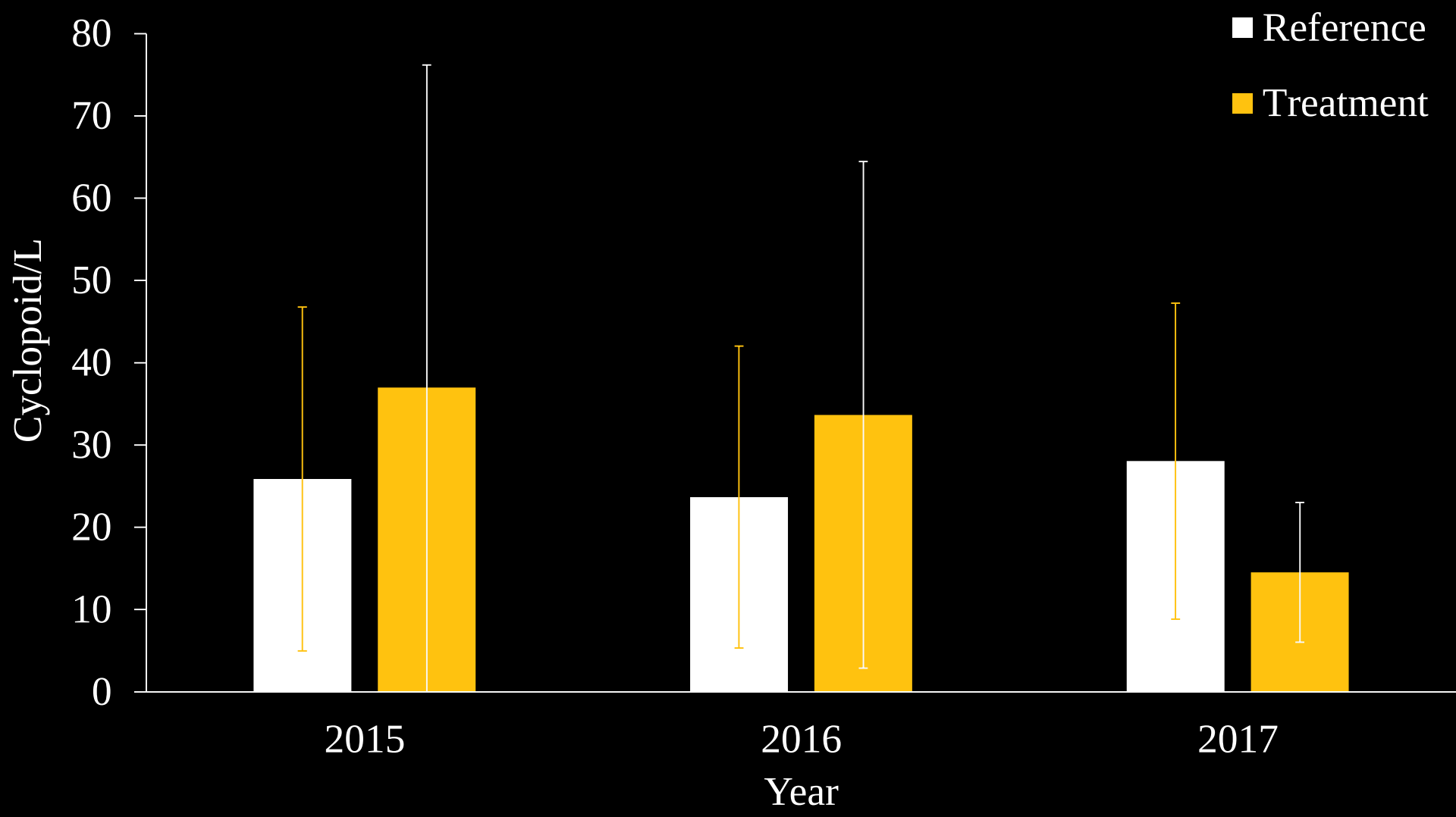

Little Bearskin-Daphnia
Silver-Daphnia
Log$_e$(*Daphnia* spp./L+1)
0
1
2
3
4
5
6
5/6
5/26
6/15
7/5
7/25
8/14
Date
2015
2016
2017

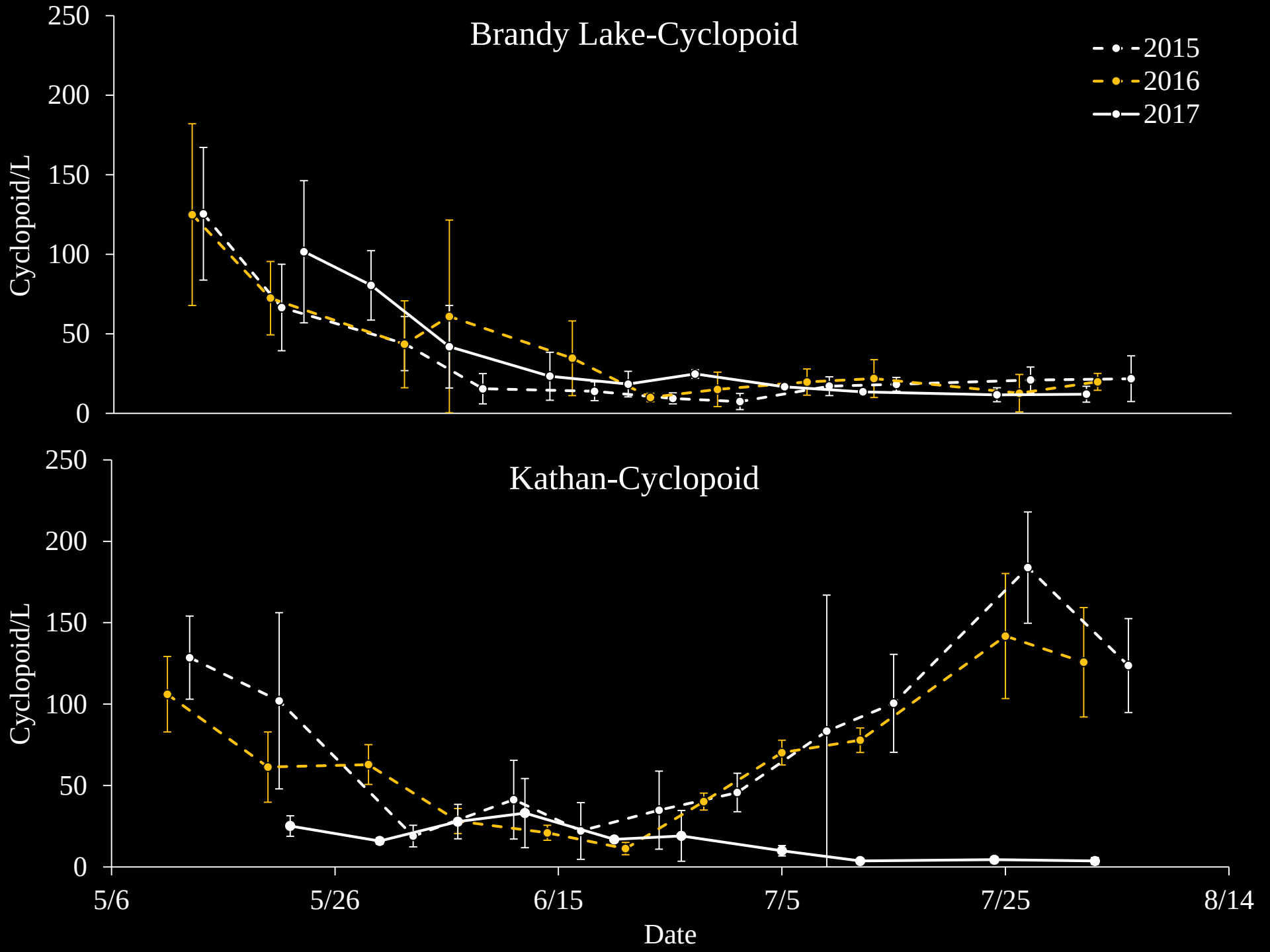

Brandy Lake-Daphnia
Manson-Daphnia
Loge(Daphnia spp./L+1)
0
1
2
3
4
5
6
5/6
5/26
6/15
7/5
7/25
8/14
Date
2015
2016
2017

# *Daphnia* spp.

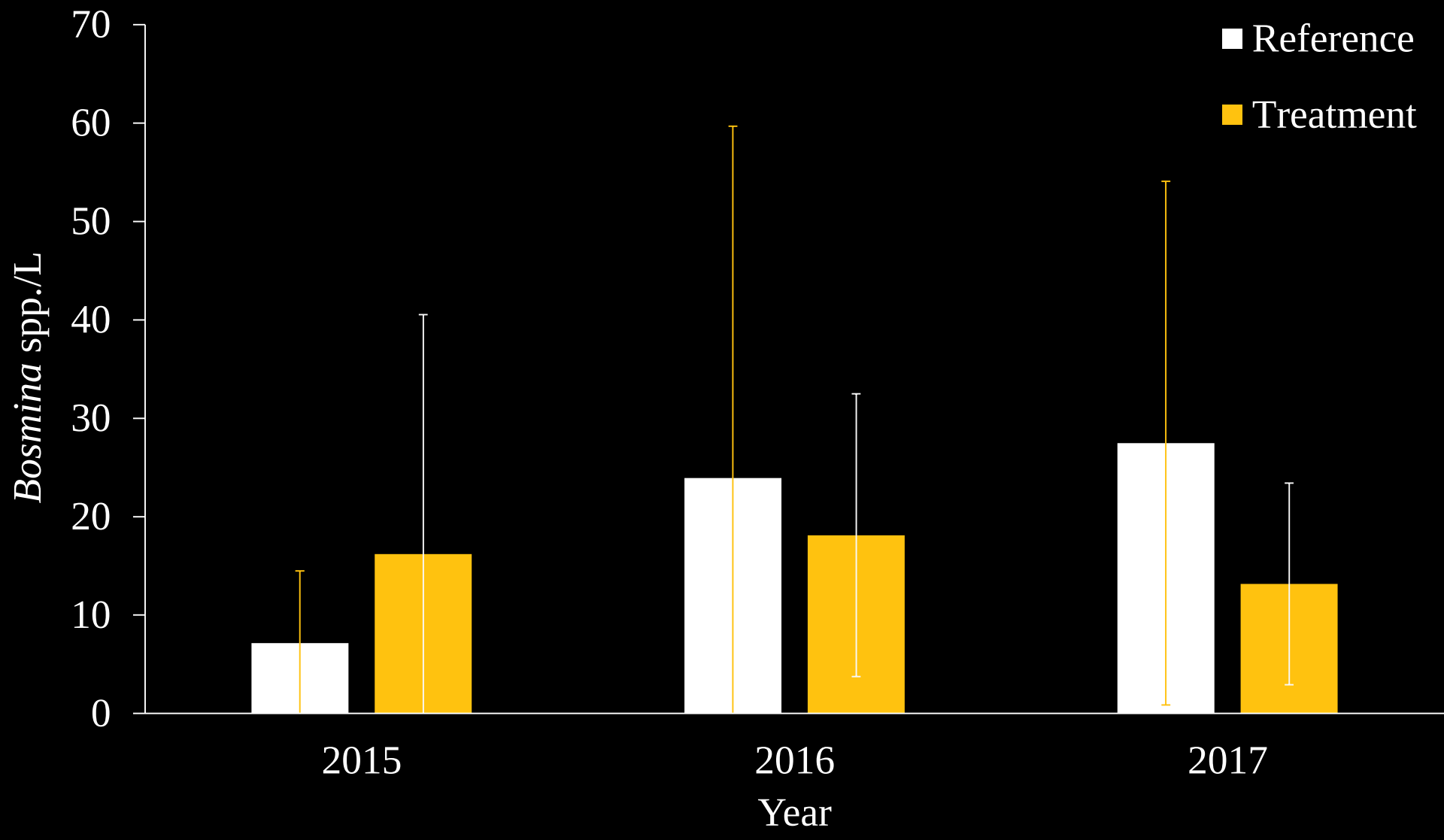


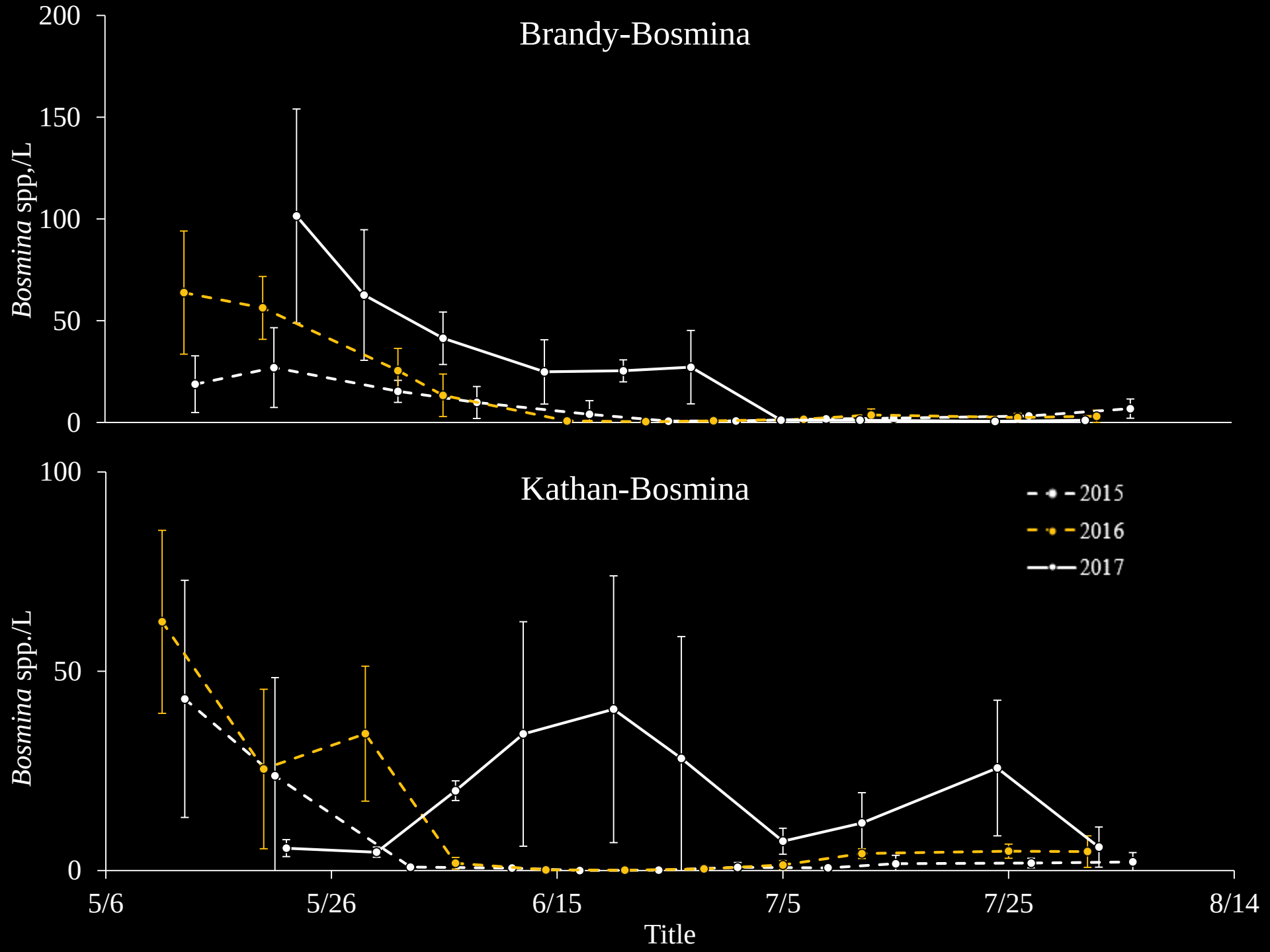
# Cyclopoid Copepods



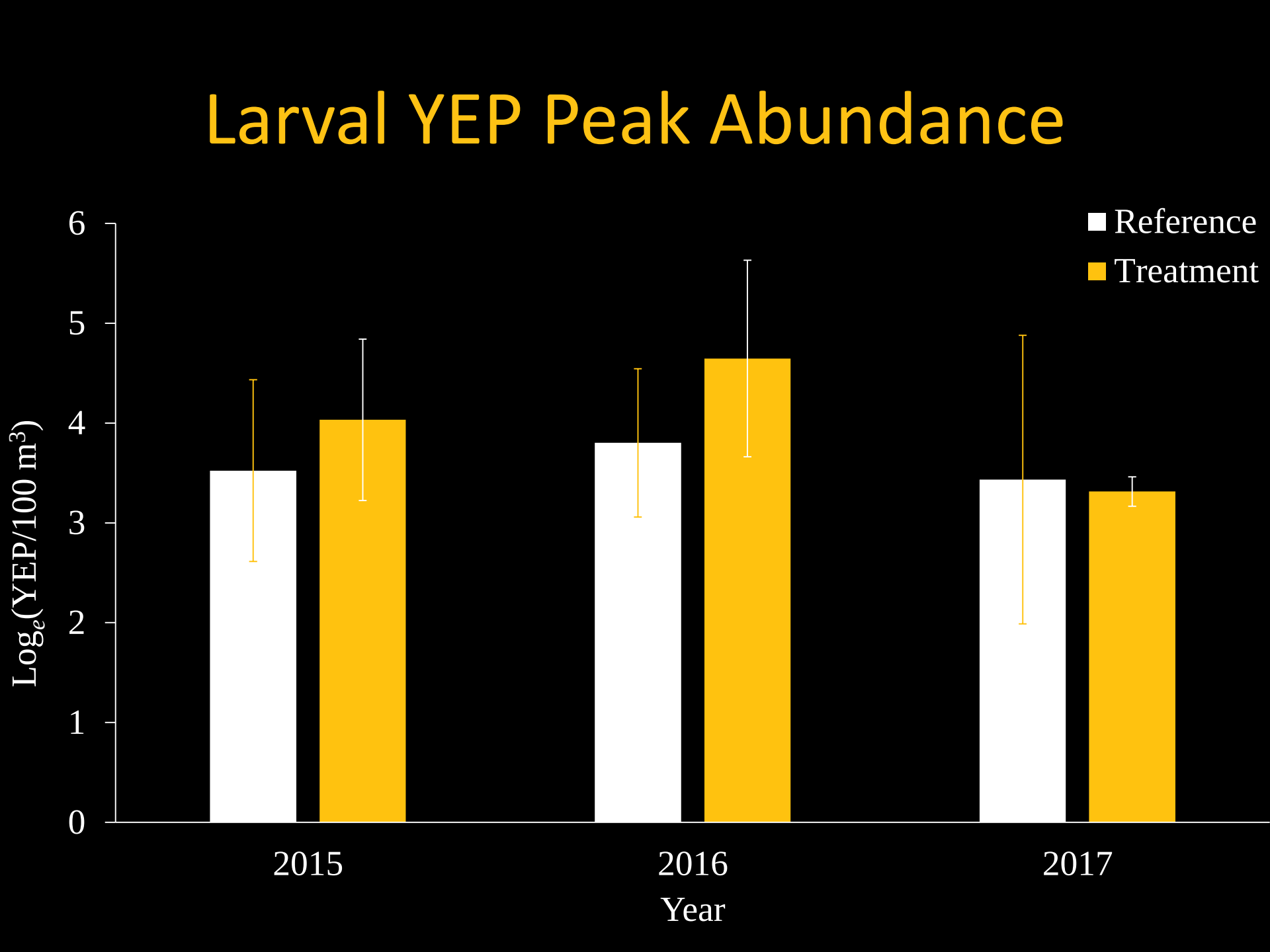

Brandy Lake-Cyclopoid
2015
2016
2017
Cyclopoid/L
250
200
150
100
50
0
Kathan-Cyclopoid
Cyclopoid/L
250
200
150
100
50
0
5/6
5/26
6/15
7/5
7/25
8/14
Date

# *Bosmina* spp.

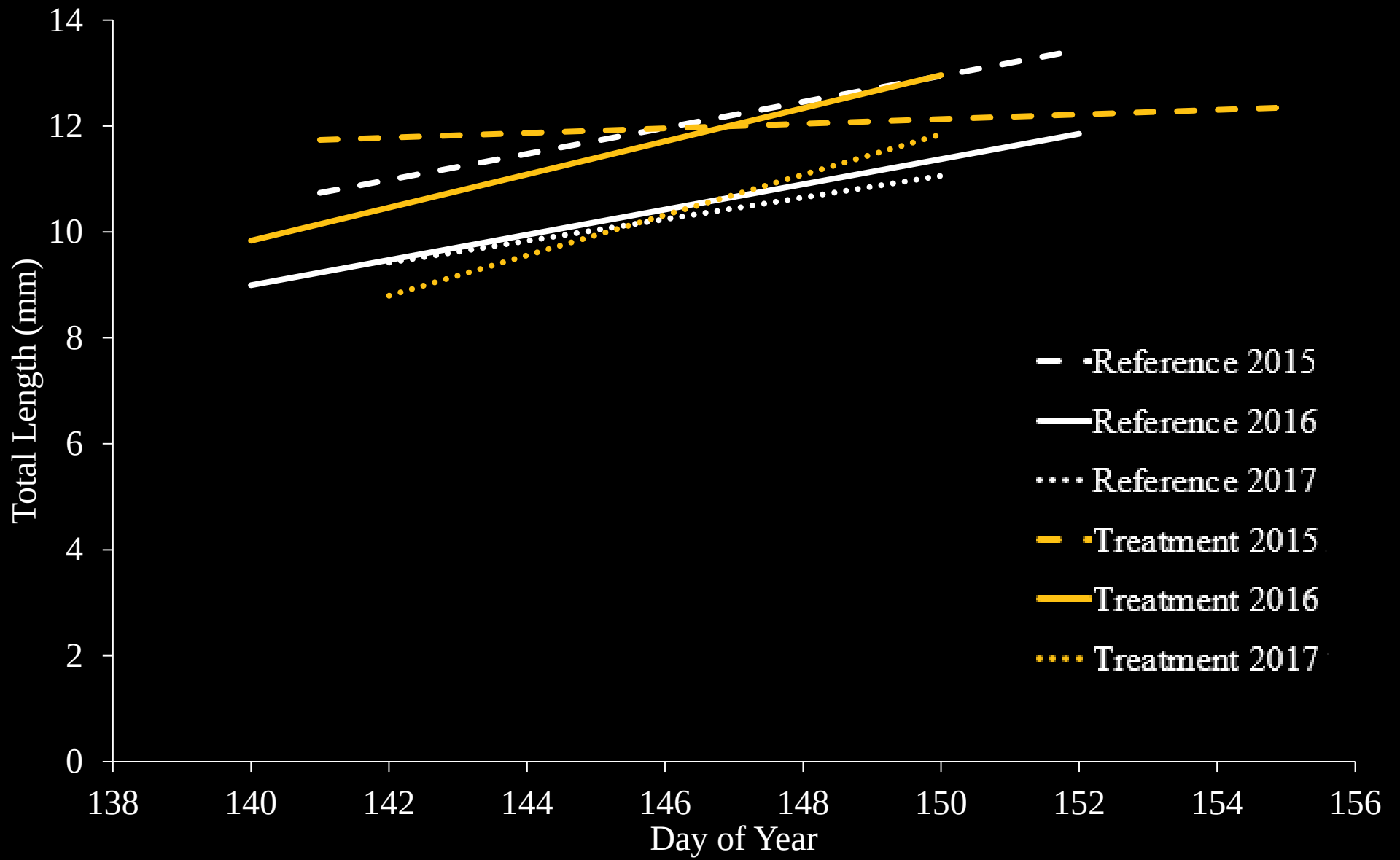

70
60
50
40
30
20
10
0
Bosmina spp./L
Reference
Treatment
2015
2016
2017
Year


Brandy-Bosmina
Bosmina spp,/L
200
150
100
50
0
Kathan-Bosmina
Bosmina spp./L
100
50
0
2015
2016
2017
5/6
5/26
6/15
7/5
7/25
8/14
Title

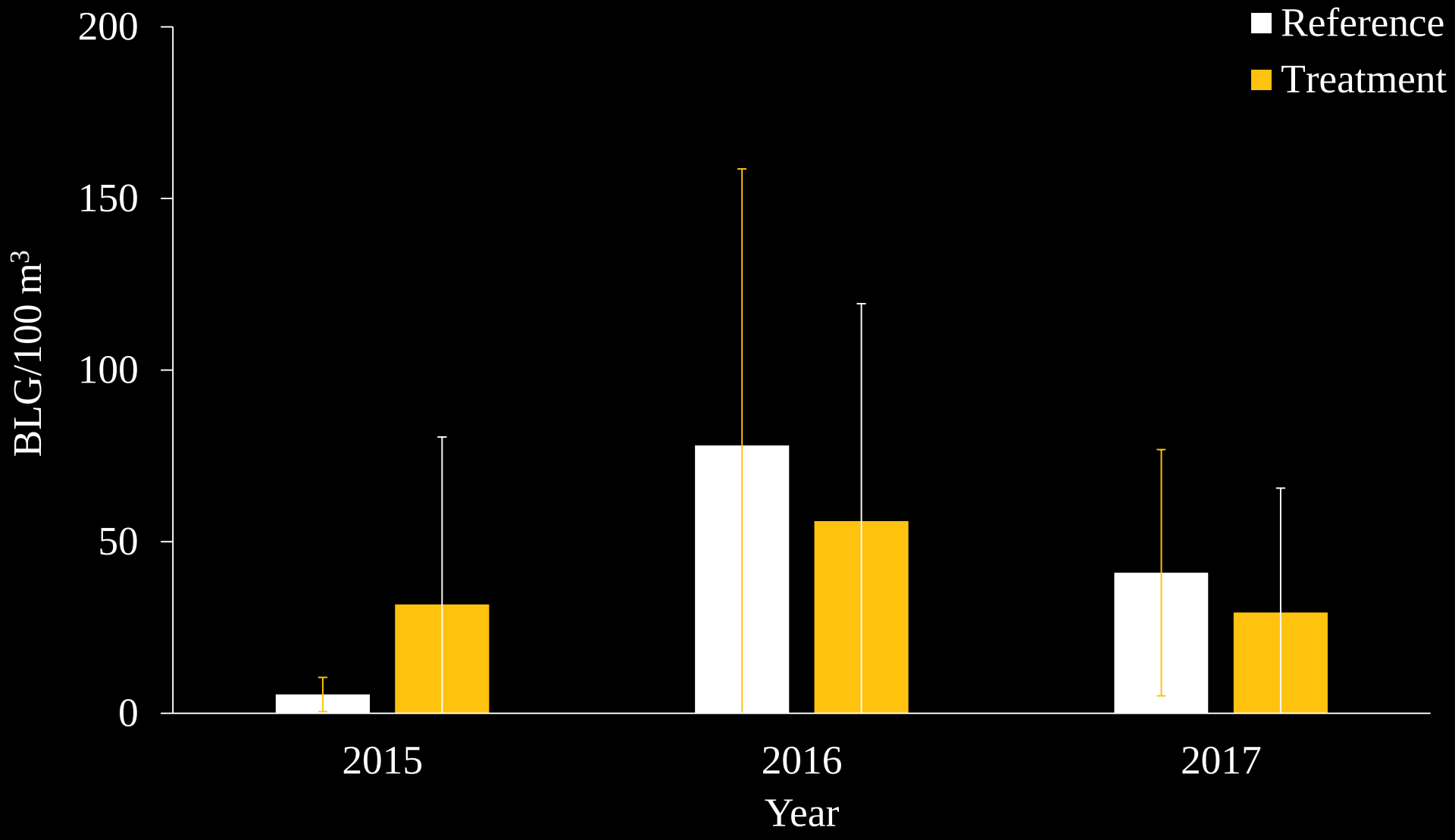
# Larval YEP Peak Abundance



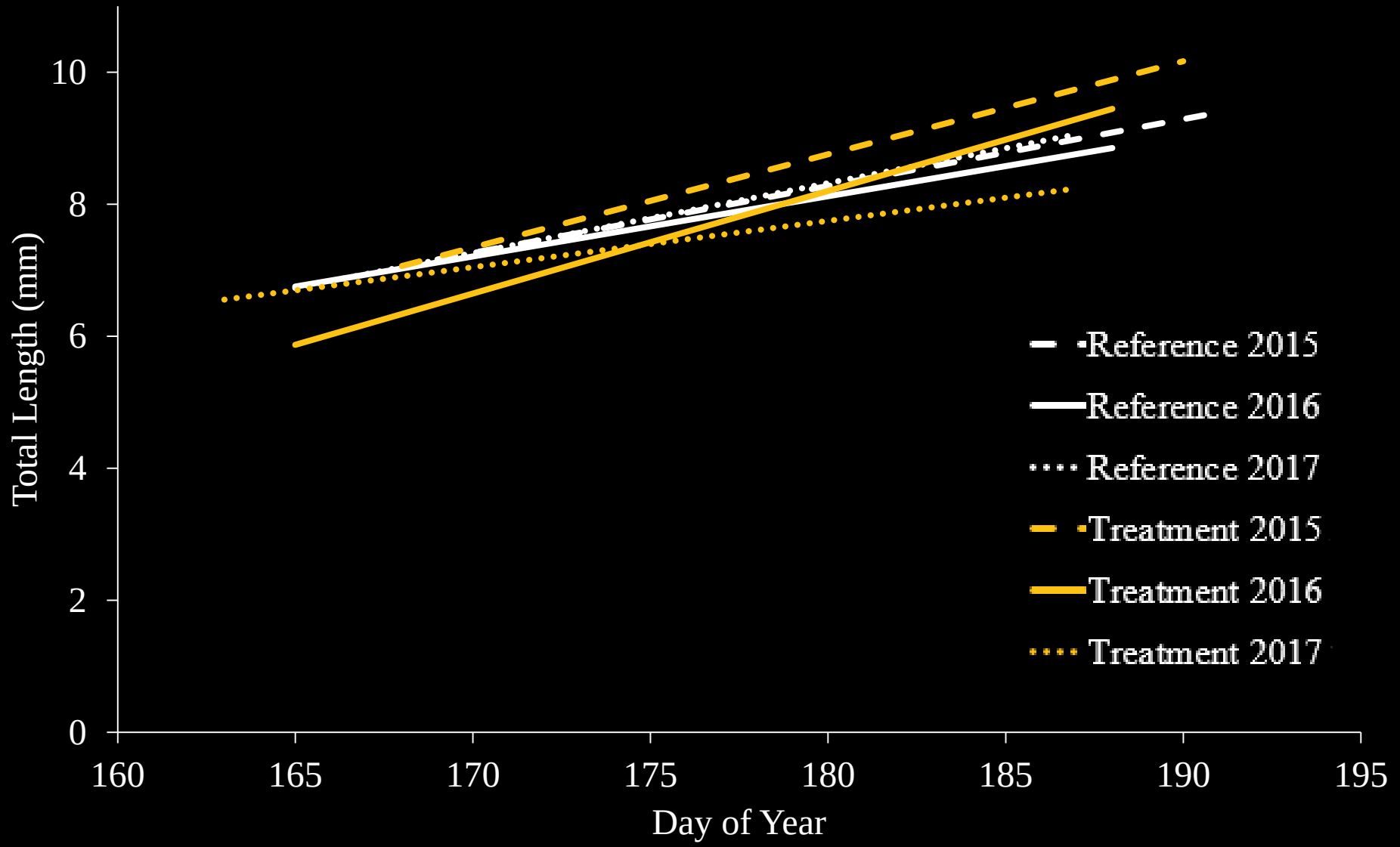
# Larval YEP Daily Growth



# Larval BLG Peak Abundance

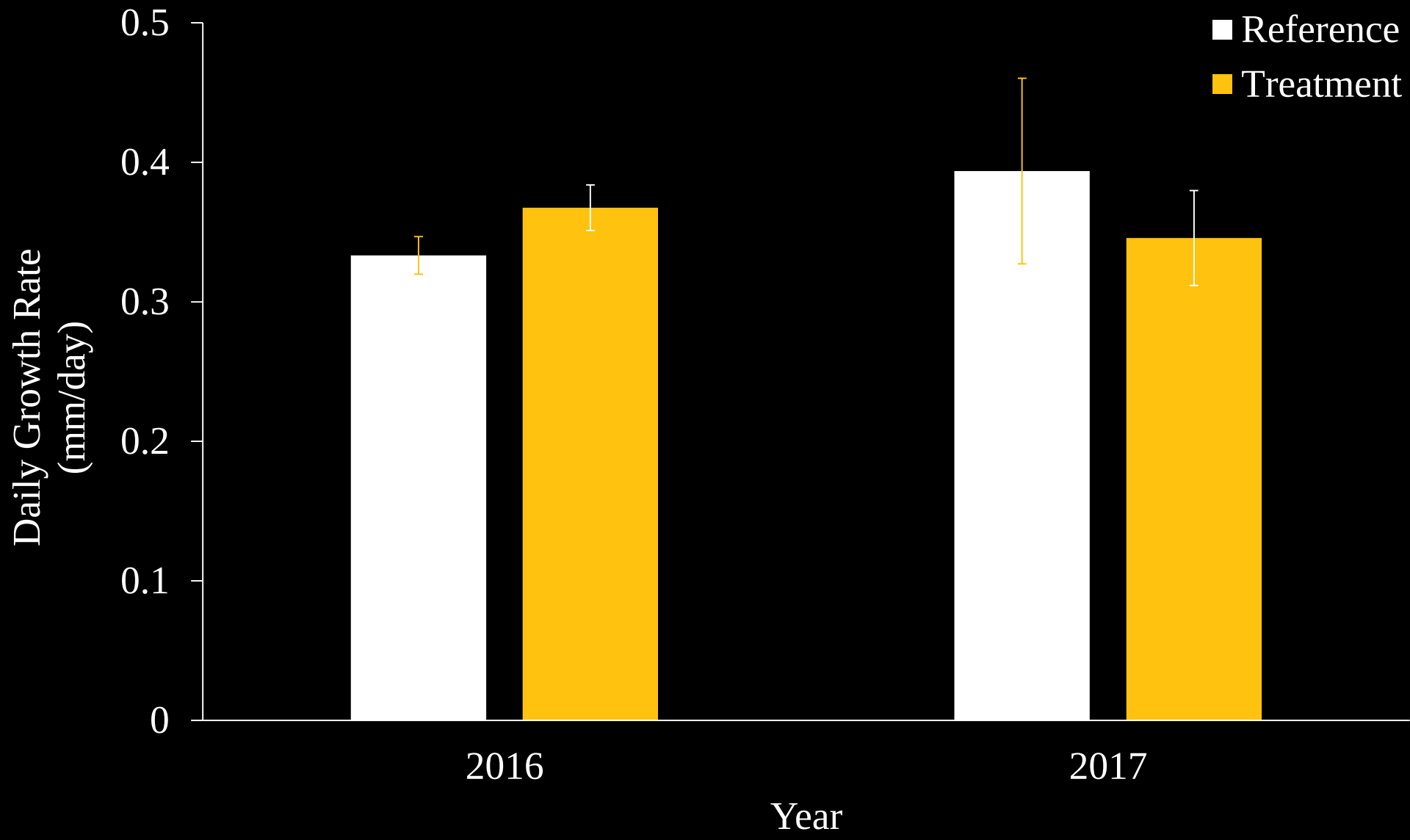


# Larval BLG Daily Growth

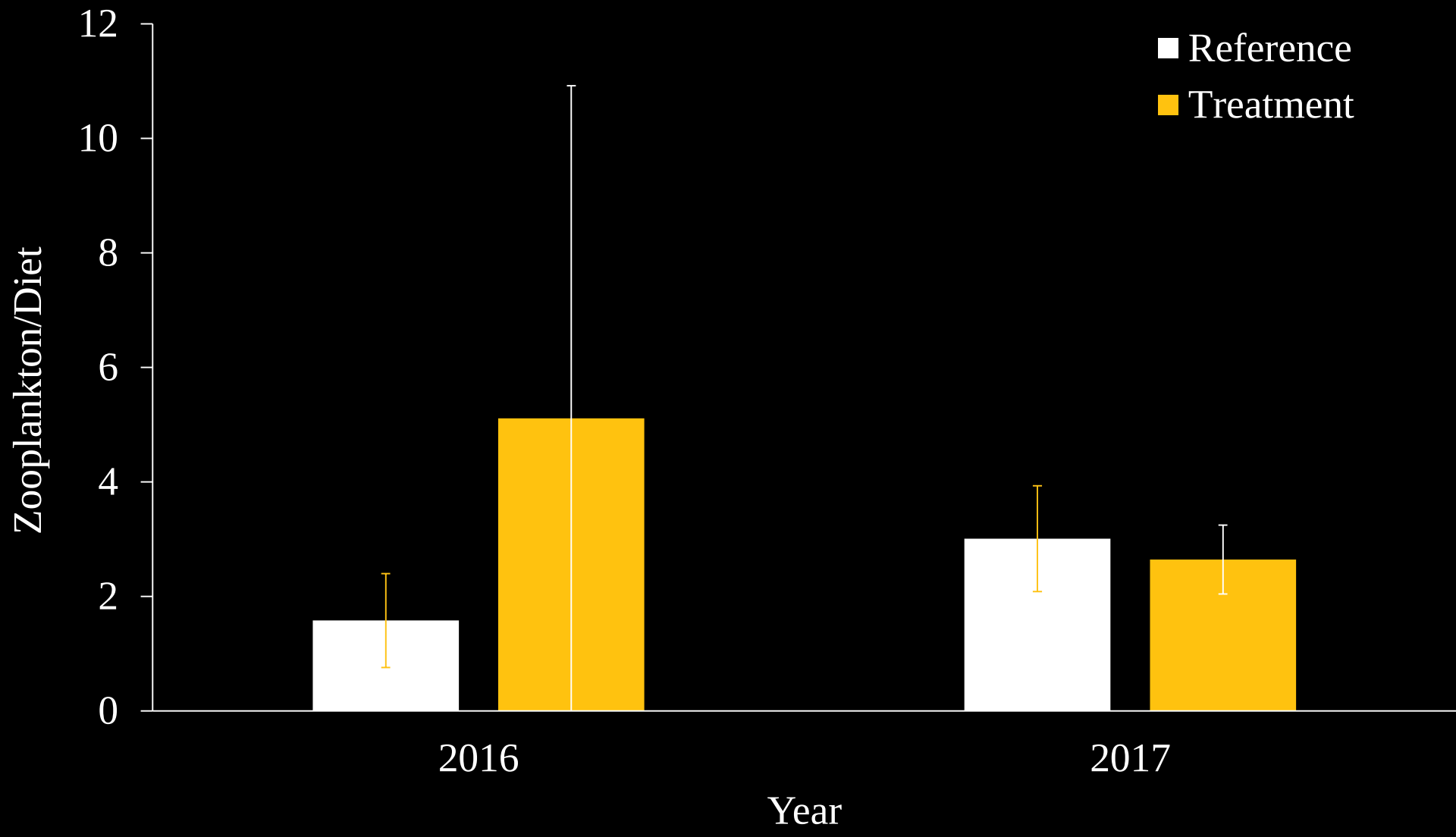


# Larval BLC Peak Abundance

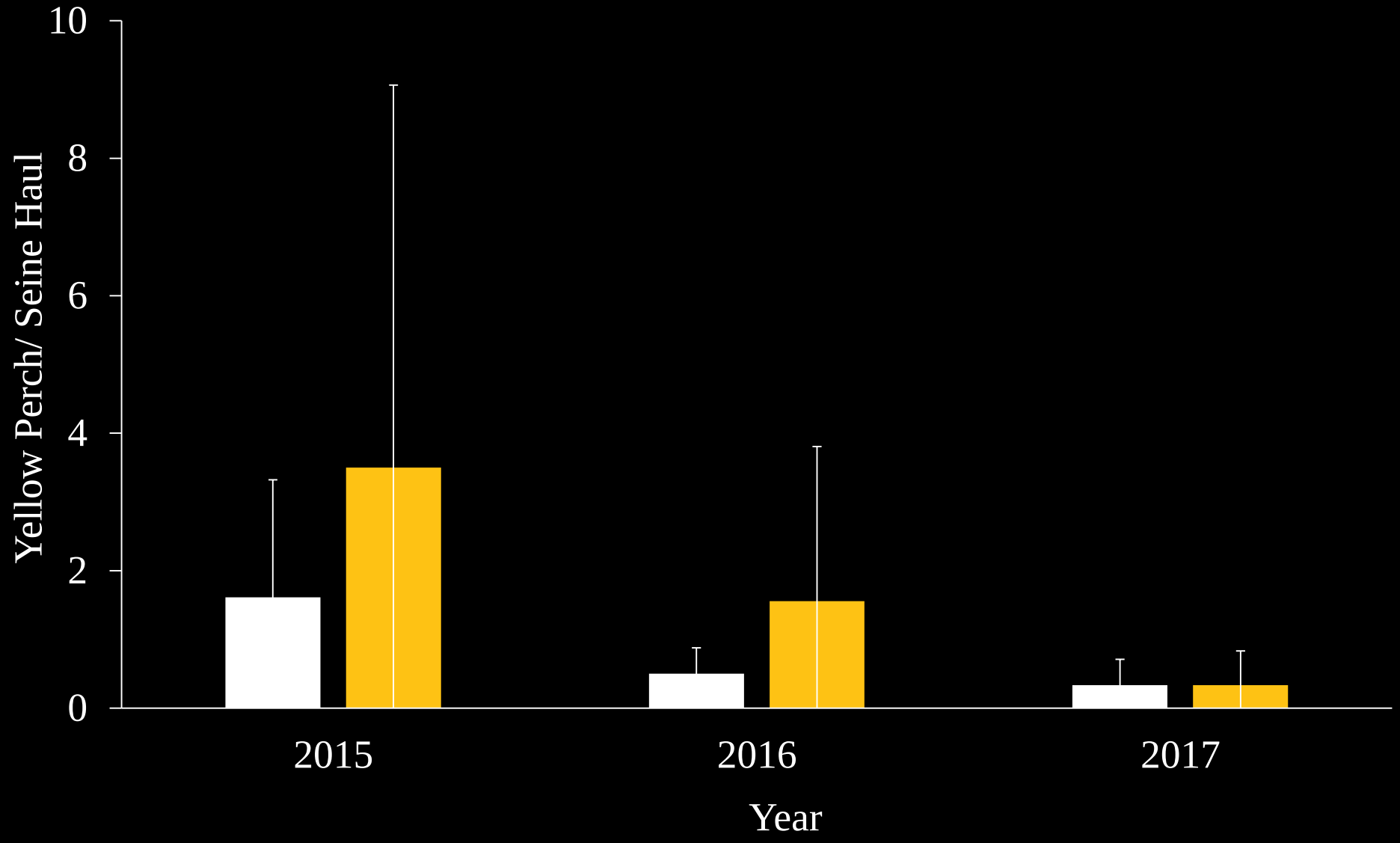
# Larval BLC Daily Growth



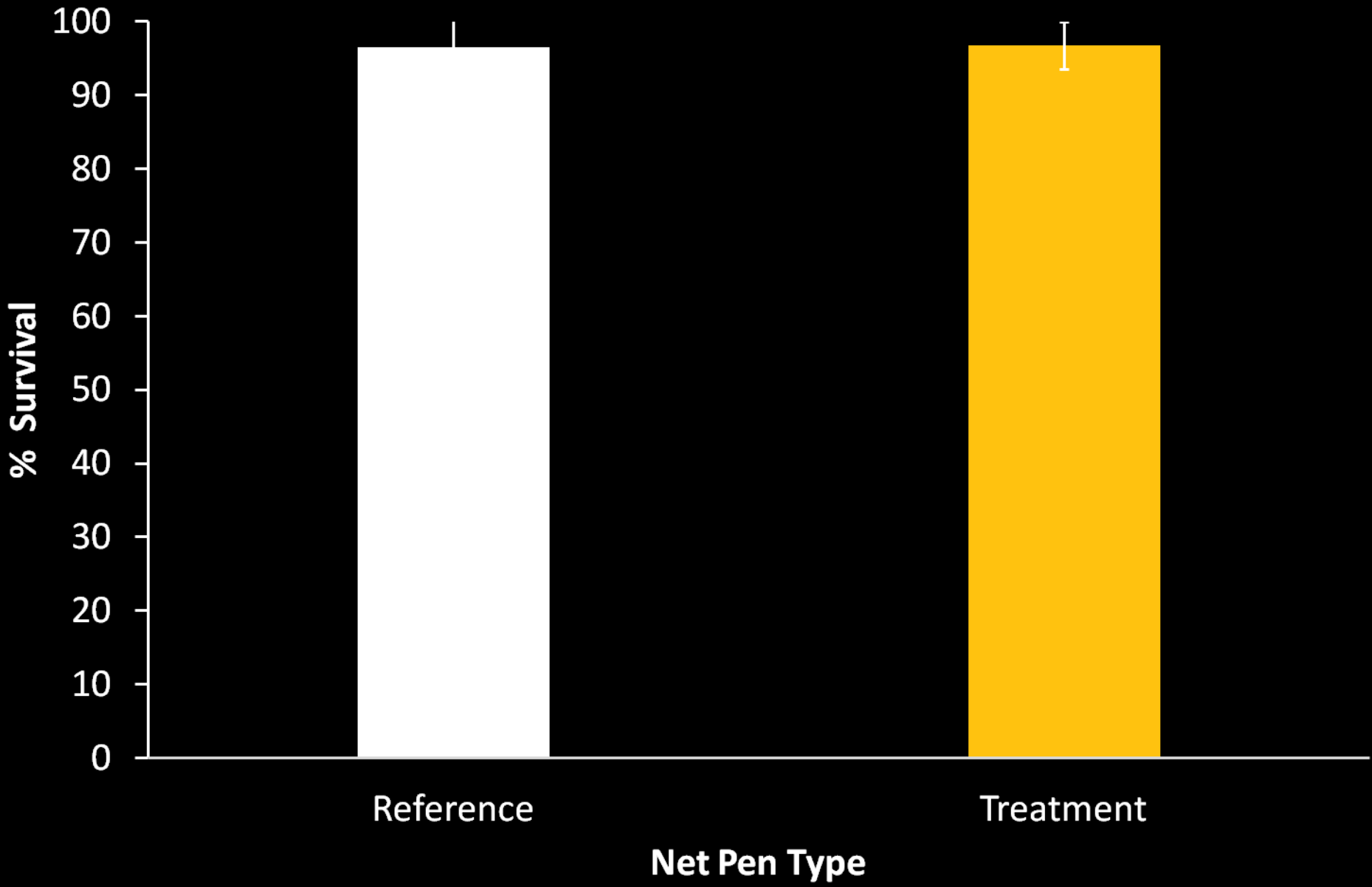
# Larval BLC Foraging Success



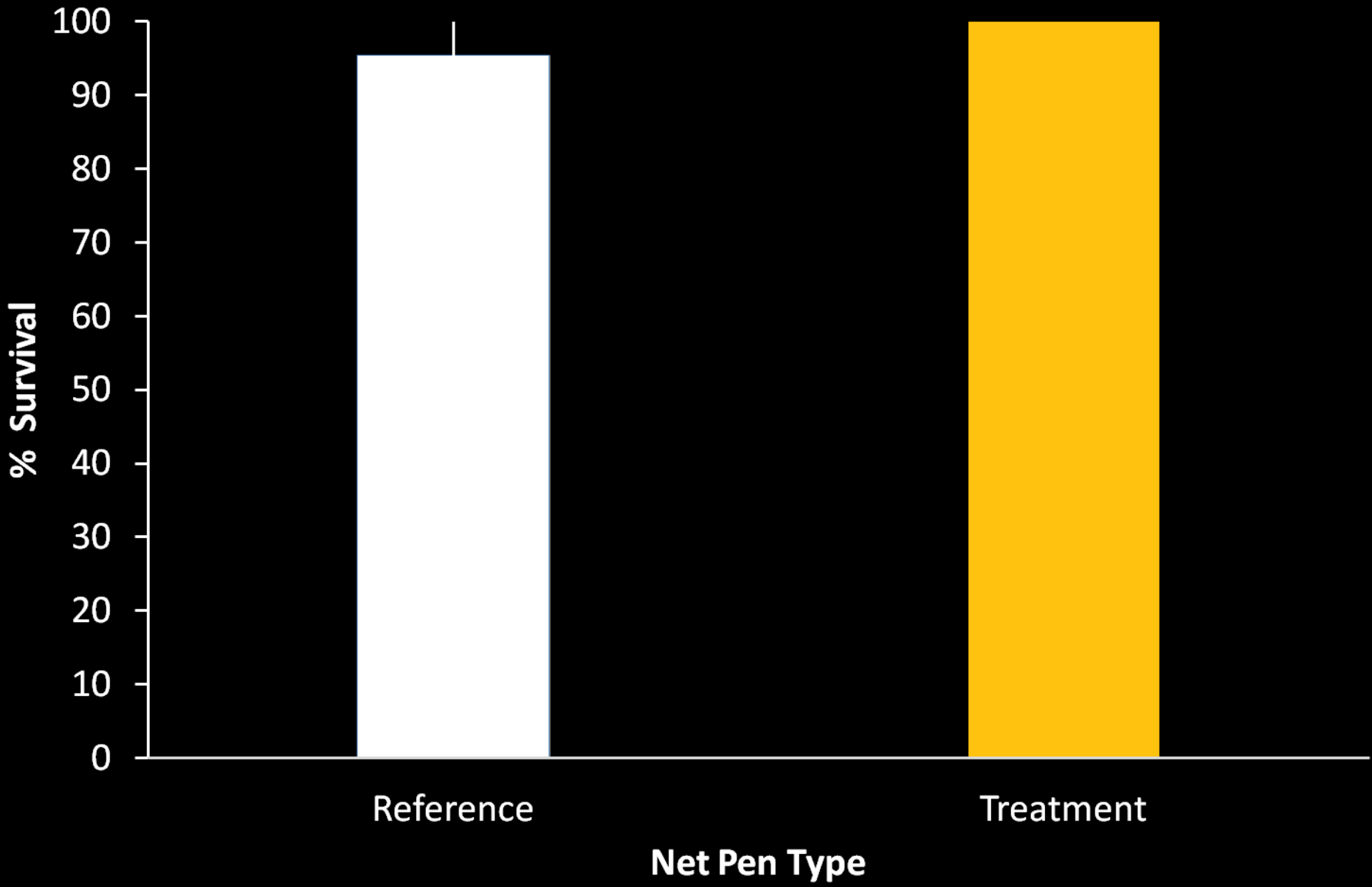
# Age-1 YEP Seine CPE



# BLG Net Pen Trials



# YEP Net Pen Trials



# Discussion

- No meaningful treatment level effects.
- Does not mean no effects, just means we did not detect any.
- Lots of natural variability.
- Mortality of larval fish is always extraordinarily high (> 99%).

- In the year after treatment, zooplankton trends were not consistent among individual lakes.
  - Not statistically different.
  - Effects in some lakes, but not others?

- Larval YEP peak abundance lower?
  - Loss of spawning habitat, forage, refuge, endocrine disruptor or environmental factor?
  - No change in growth.

# Future Work

- Laboratory studies
  - Zooplankton
  - Yellow Perch
- Aquatic plant interactions
- Effects of repeated treatments

# Acknowledgments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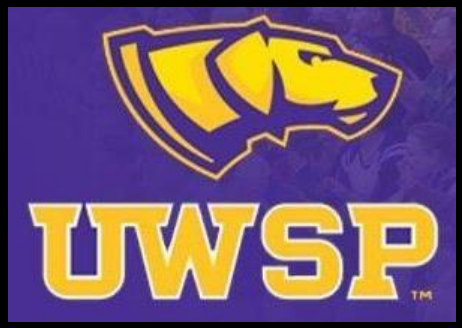


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