GRASS CARP SPAWNING IN LAKE ERIE TRIBUTARIES: WHEN AND WHERE?

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Photo: mdc.mo.gov

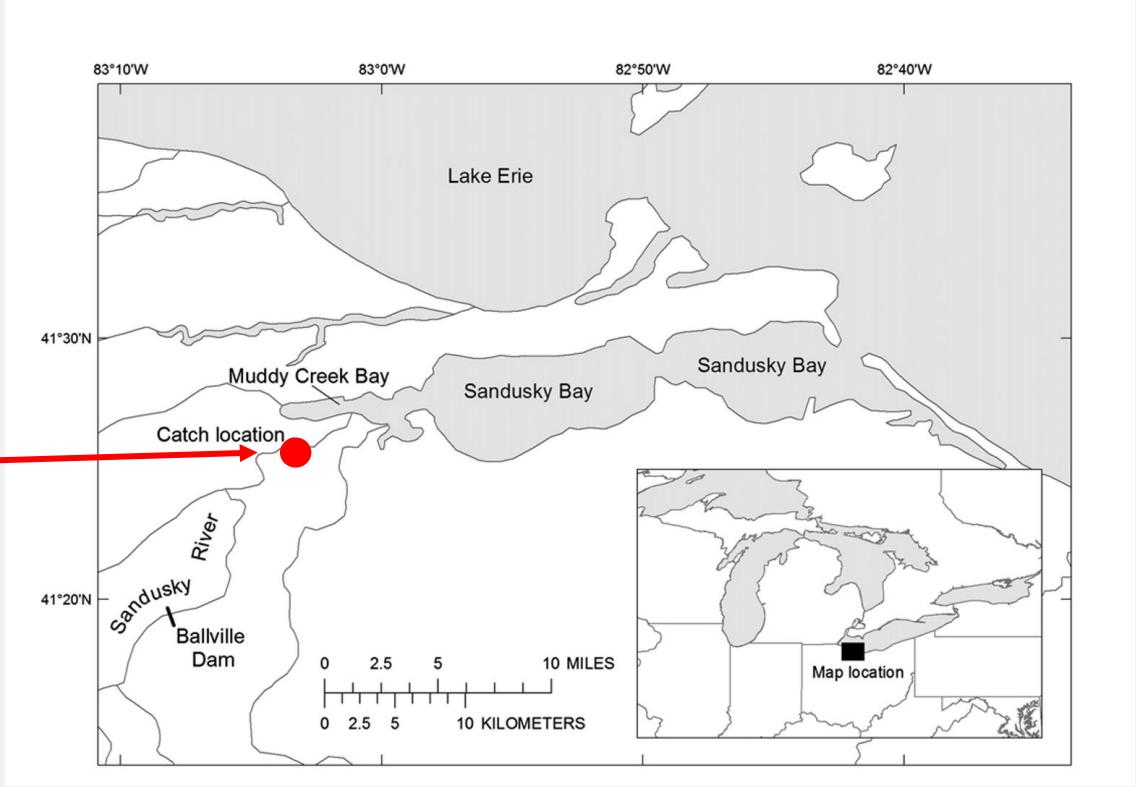
IMPACTS OF GRASS CARP

- Consume large amounts of aquatic vegetation
  - 20-100% of body weight per day
- Damage wetland ecosystems
  - Impacts on native fish species, invertebrates, waterfowl
  - May promote algal blooms
- Similar spawning requirements to other Asian Carp species

IMPACTS OF GRASS CARP

GRASS CARP IN LAKE ERIE

- Present since ~1980
- Adults captured- assumed sterile and/or incapable of successful spawning
- 8 Juveniles captured in the Sandusky river in 2012
- Spawning first documented in the Sandusky River in 2015



From Chapman et al. 2013

SPAWNING EVENTS

Sandusky River

2015 VS 2017 SAMPLING METHODS

2015

- x Side mounted Bongo net
- x Surface net only
- ✓ Left and right side of river
- x Tow time variable: 3-5 mins
- x 4 samples per site
- x 4 sites total (RKM 12-21)

2017

- x Bow mounted Bongo nets
- x Surface and 'deep' (1.7m) nets
- ✓ Left and right side of river
- x Tow time: 5 mins
- x 8 samples per site
- x 14 sites total (RKM 0.3-22.3)

2017 EQUIPMENT SET-UP
SURFACE AND DEEP NETS

(50 lbs. dog for scale)

SANDUSKY RIVER GC EGGS

2015: 8 eggs over five days

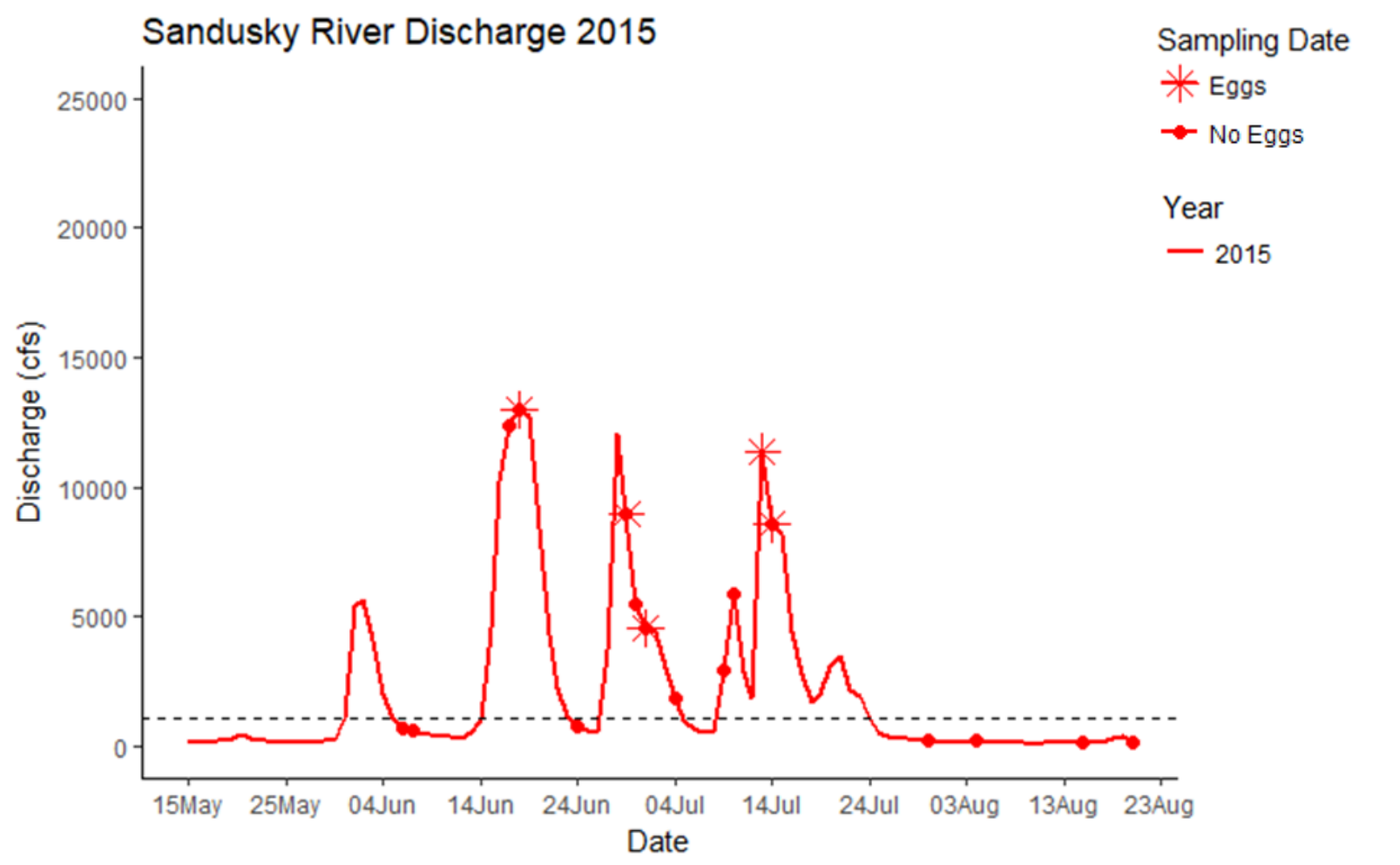
- June 18, 29
- July 1 *captured in light trap
- July 13-14

2016: No eggs detected

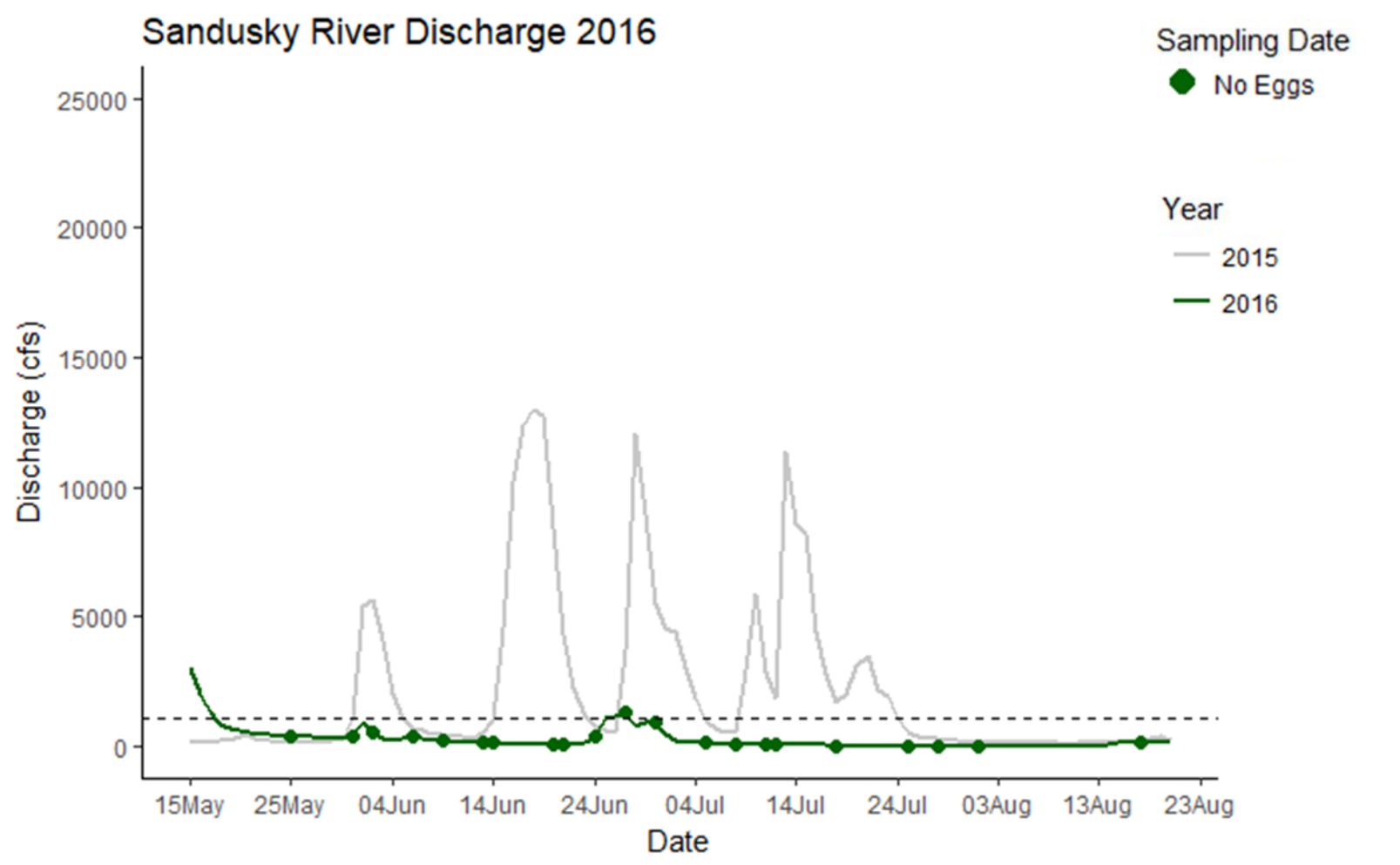
2017: ~7,800 eggs over four days

- May 30- June 1
- July 12

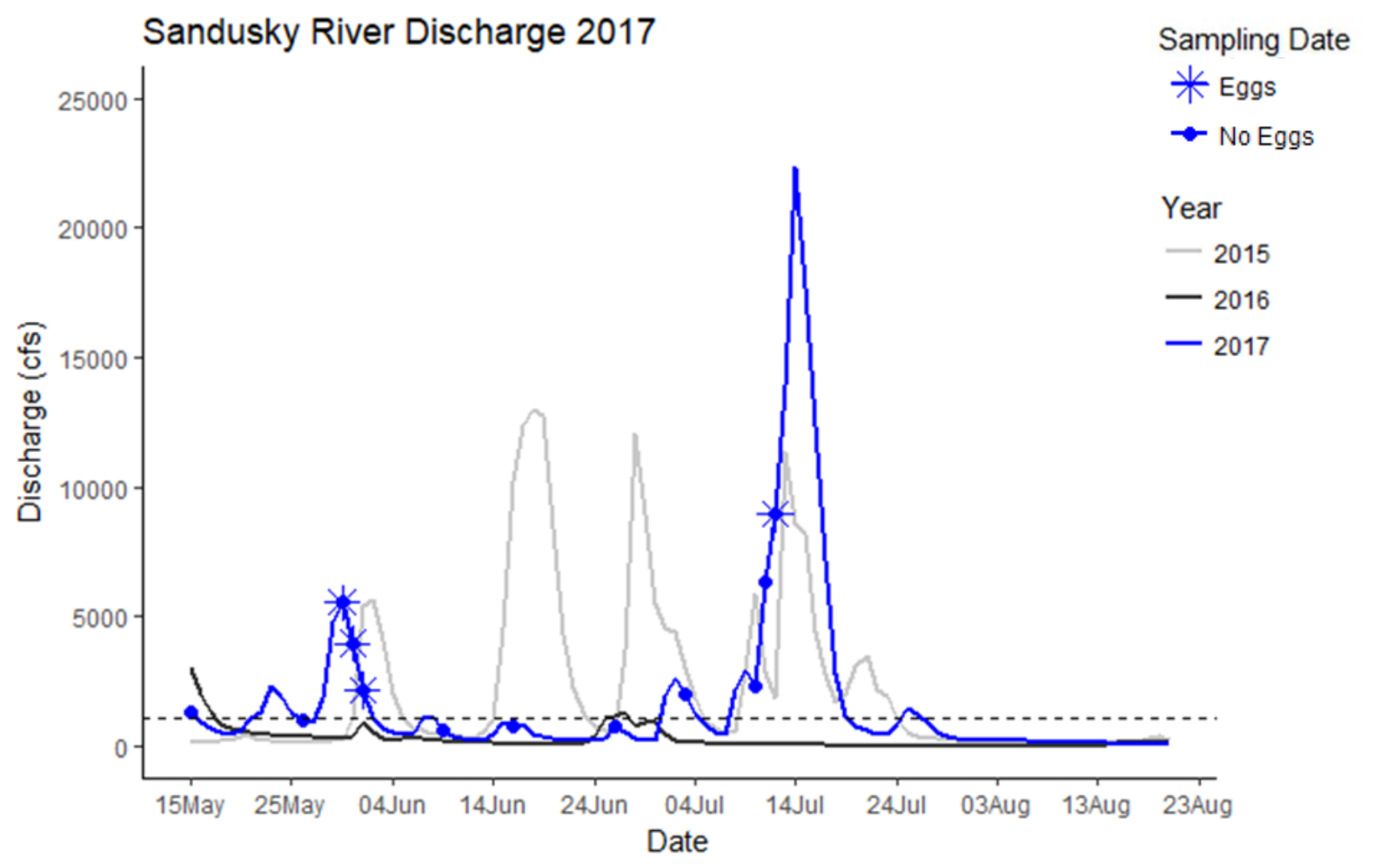
SPAWNING DURING HIGH FLOWS



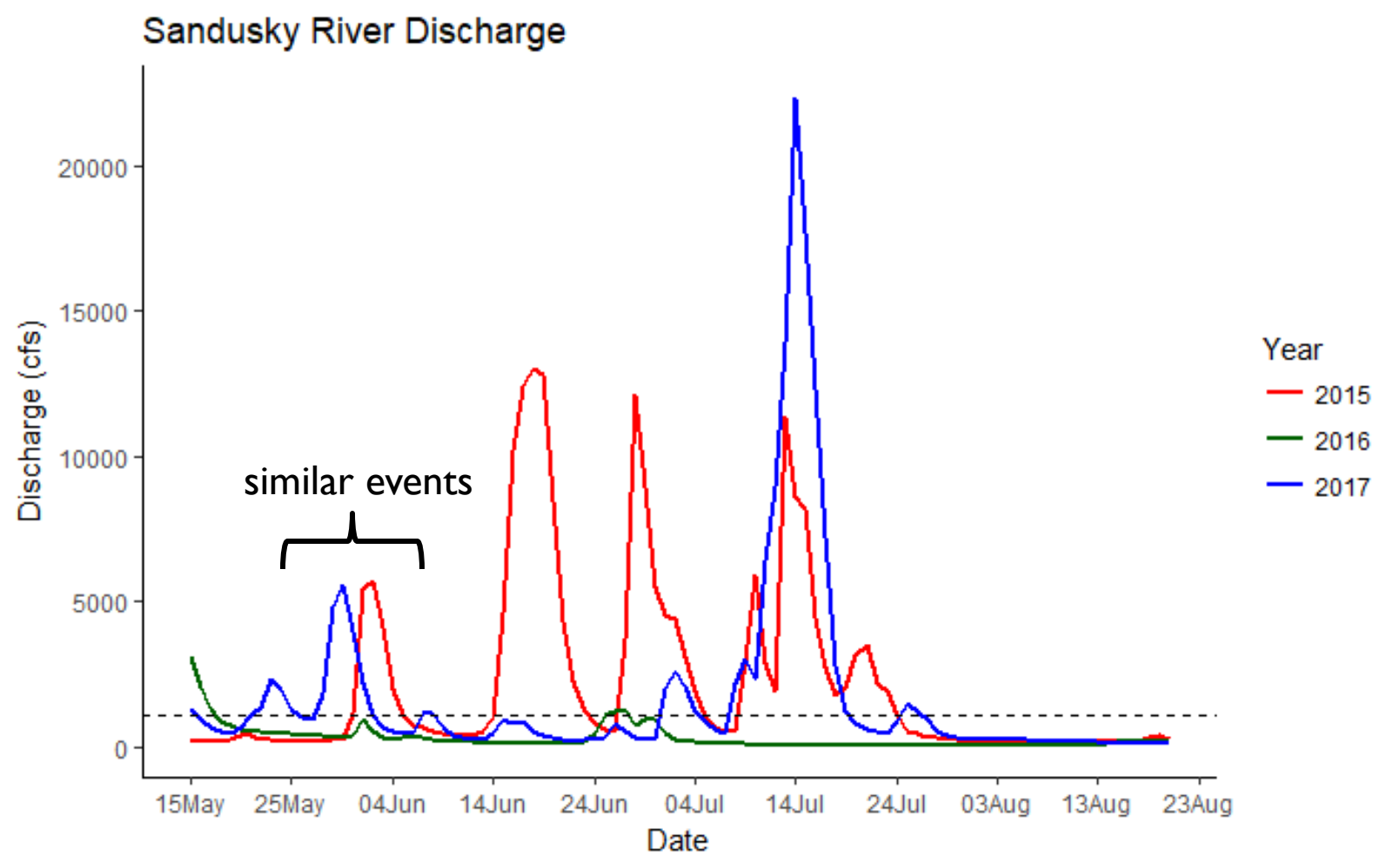
SPAWNING DURING HIGH FLOWS



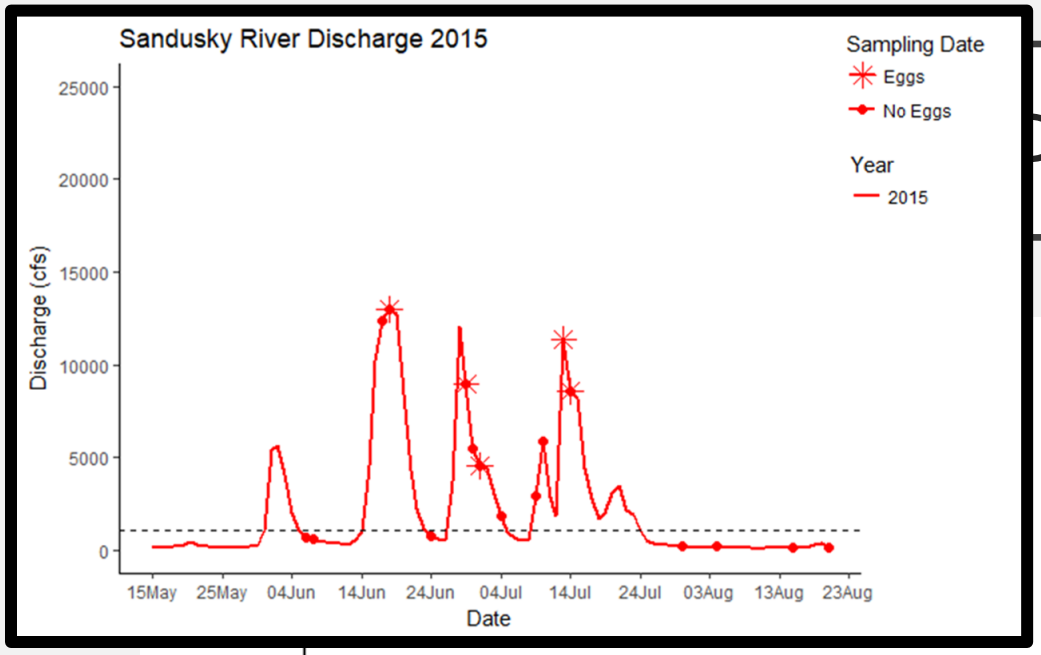
SPAWNING DURING HIGH FLOWS

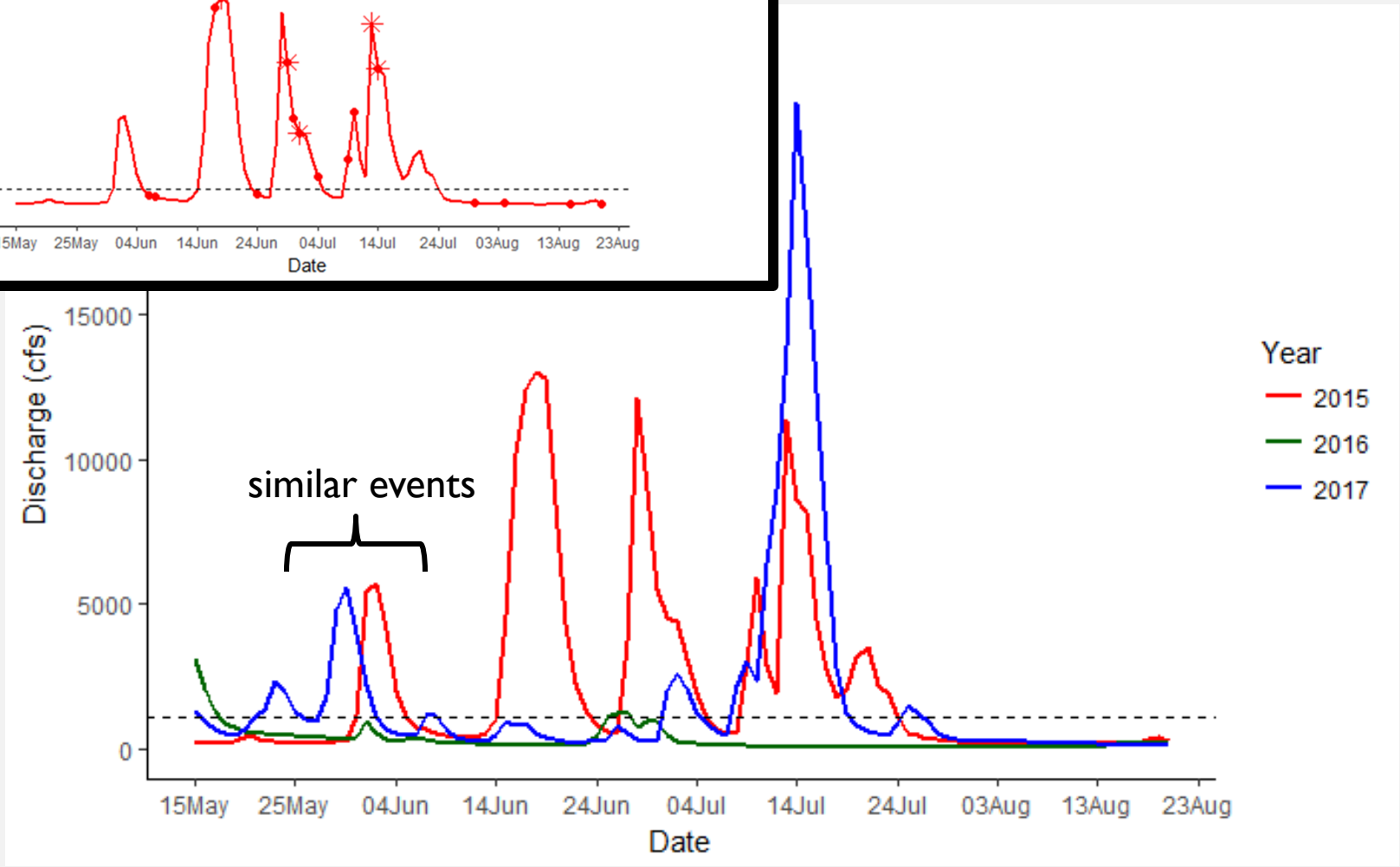


SANDUSKY RIVER DISCHARGE: 2015-2017



CHARGE: 2015-2017





EGG DENSITIES

Sandusky River

DENSITY CALCULATIONS

<u>Area of Bongo net :</u> 0.196 m^2

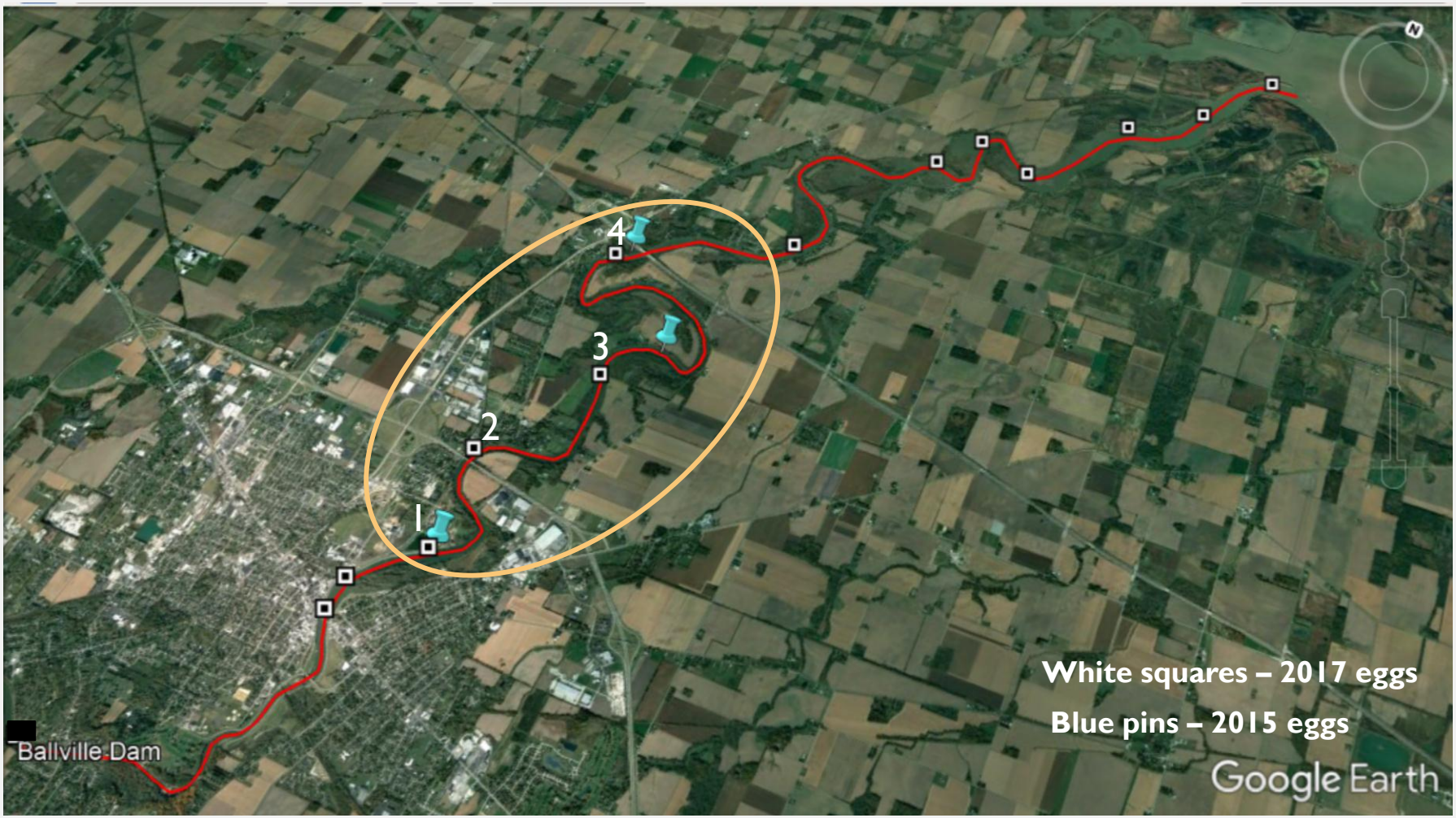
- **4 nets per depth: area sampled = 0.785 m^2**

Water velocity estimated at sampling sites from HEC-RAS model within < 30 min of time sampled

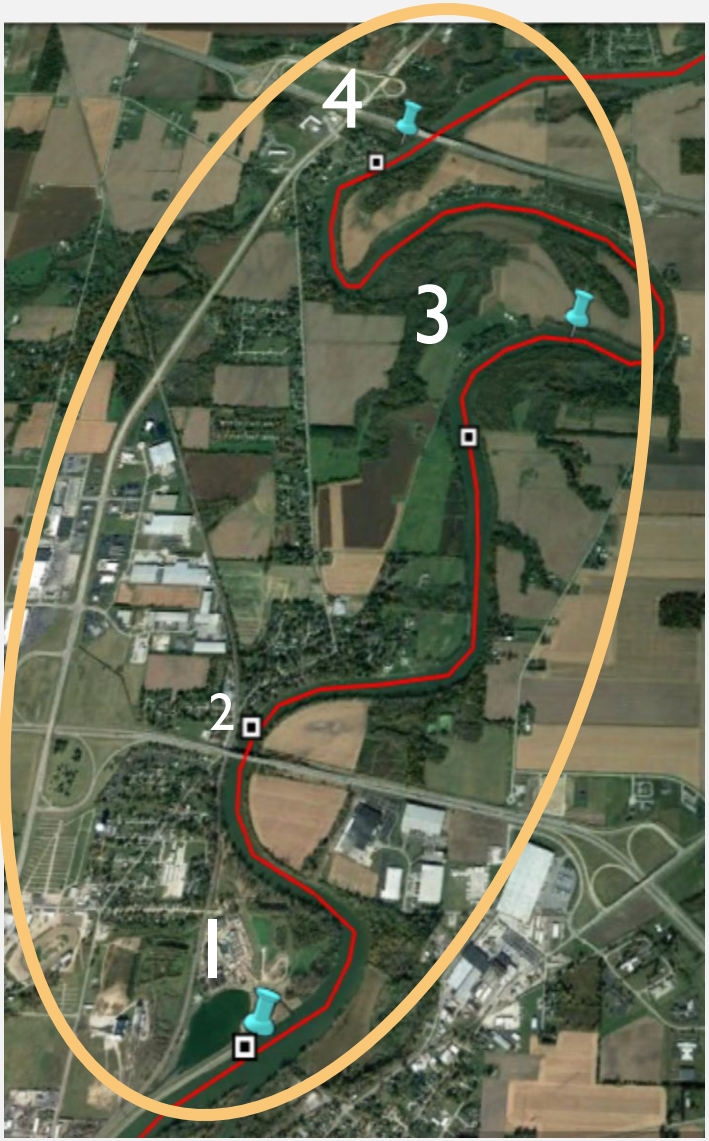
<u>Volume sampled:</u>

Net area (m^2) * Velocity (m/s) * Time sampled (s) =Volume (m^3)

2015 VS 2017 SITES



EGG DENSITIES (EGGS/M^3) *SURFACE NETS ONLY



site	2015	n	eggs/m^3
Site 1	7/13	1	0.011
Site 3	6/18	1	0.008
Site 4	6/29	1	0.007
Site 4	7/14	4	0.039

site	2017	n	eggs/m^3
Site 1	5/30	6	0.067
Site 1	5/31	36	0.546
Site 1	7/12	152	1.290
Site 3	5/30	1	0.012
Site 3	5/31	0	0
Site 3	7/12	155	1.370
Site 4	5/30	16	0.184
Site 4	5/31	3	0.049
Site 4	7/12	207	1.689

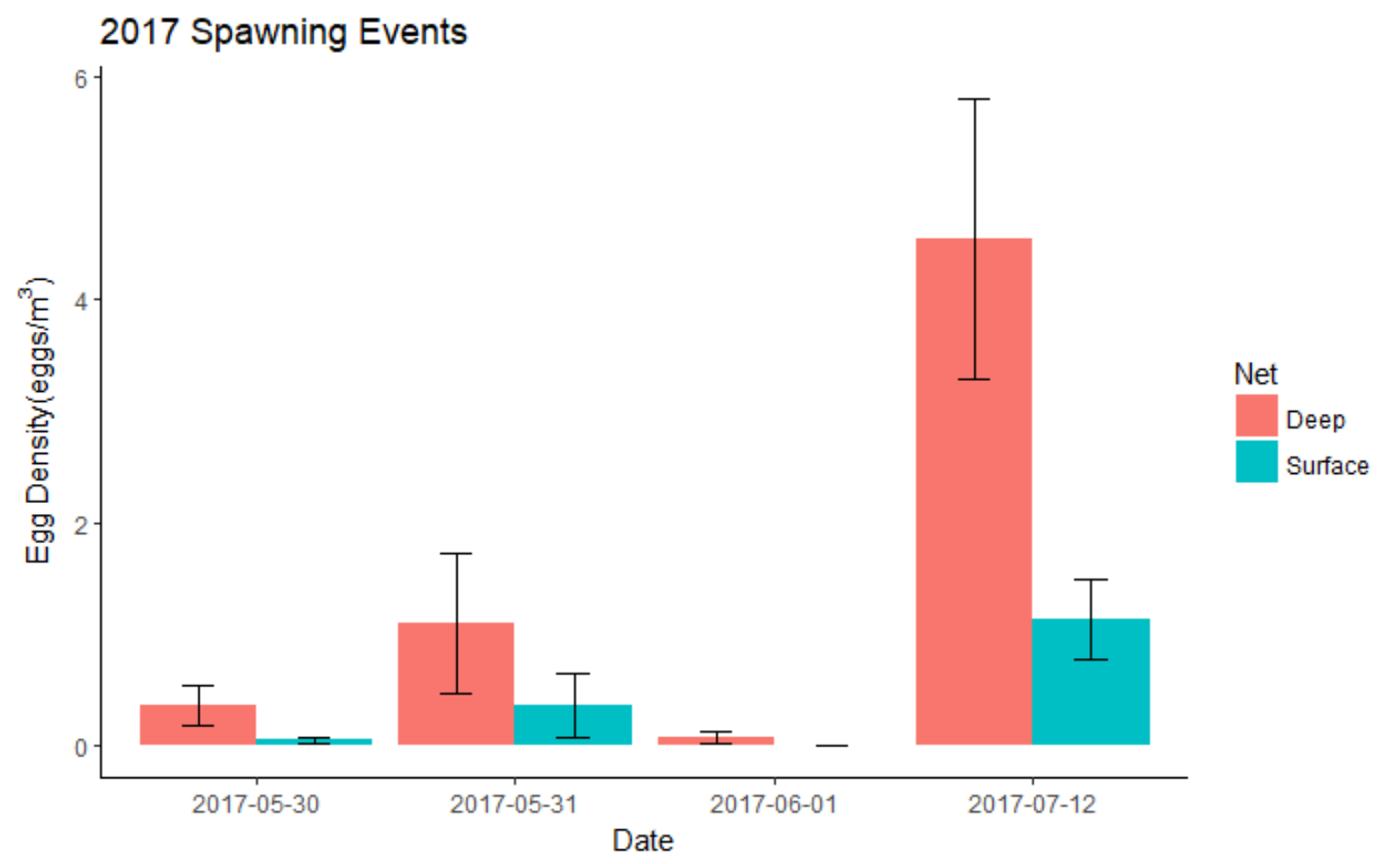
Max density

→ 0.039

=43X higher density

→ 1.689

SURFACE V DEEP NETS

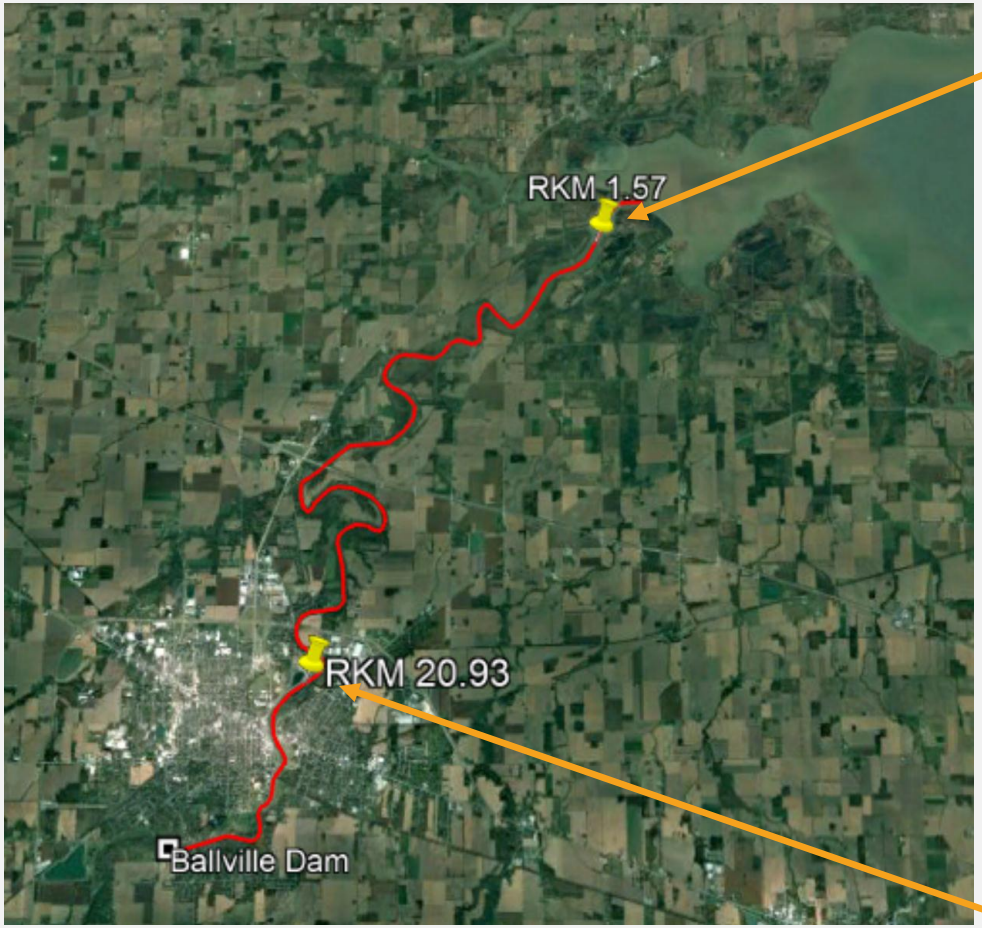


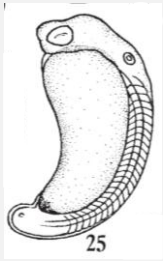
Means +/- standard error

EGG DEVELOPMENT

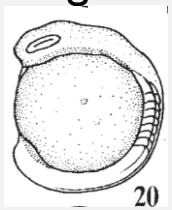
Sandusky River

DEVELOPMENTAL STAGES

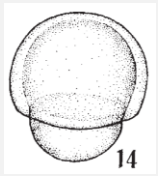




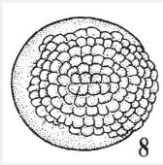
Stage 25



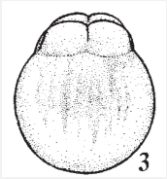
Stage 20



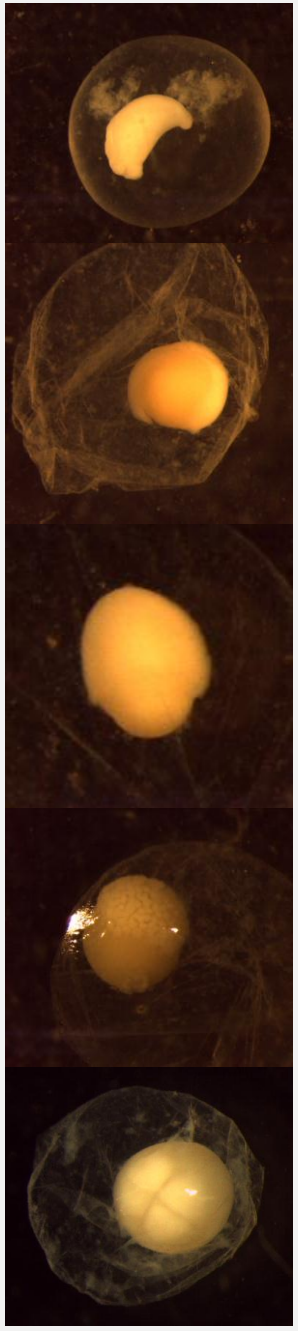
Stage 14



Stage 8

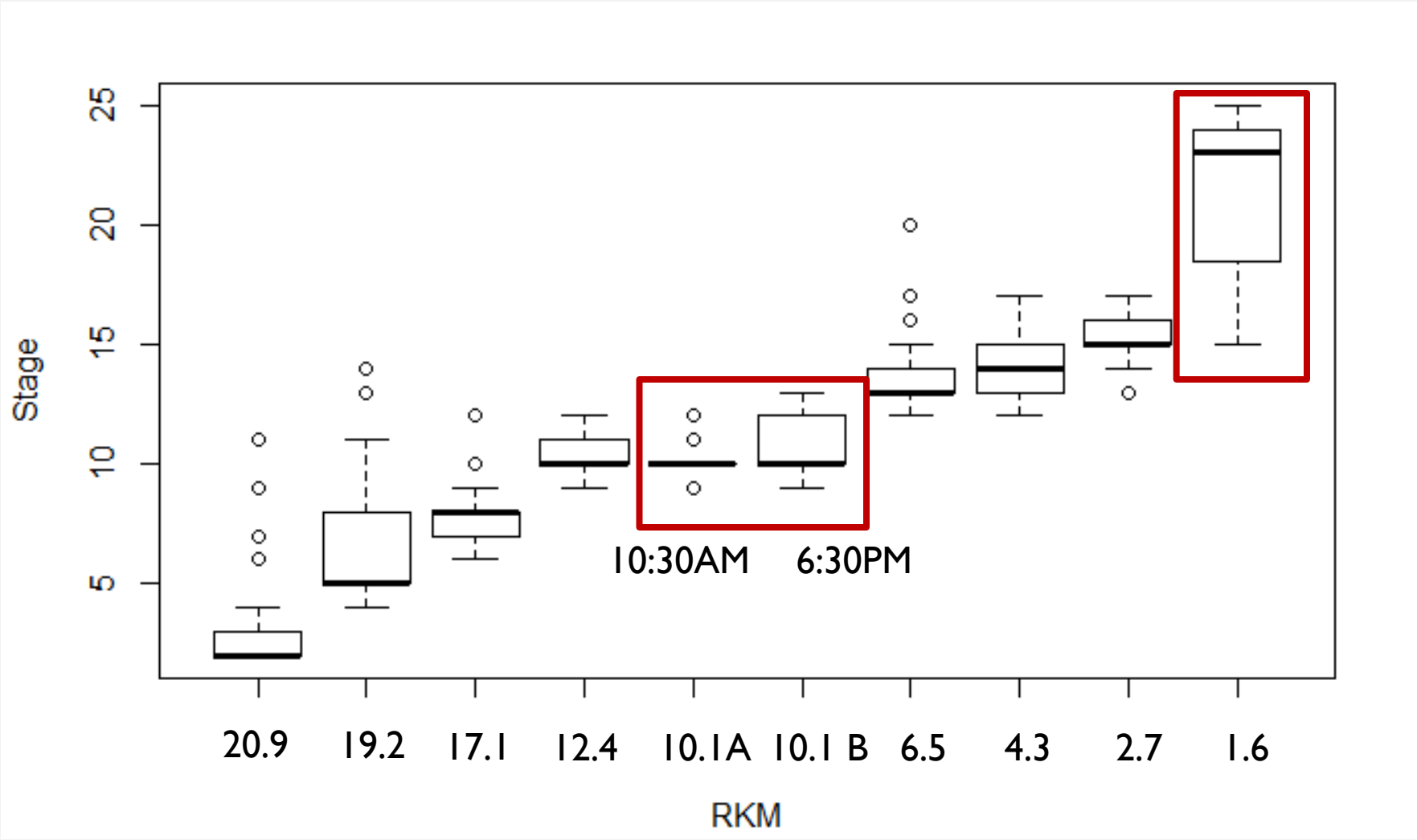


Stage 3



Yi, B., Liang, Z., Yu, Z., Lin, R., and He, M., 2006, A study of the early development of grass carp, black carp, silver carp, and bighead carp in the Yangtze River, China, chap. 2 *of* Chapman, D.C., ed., Early development of four cyprinids native to the Yangtze River, China: U.S. Geological Survey, Data Series 239, p. 15–51.

GC EGG DEVELOPMENT 7.12.17



flow

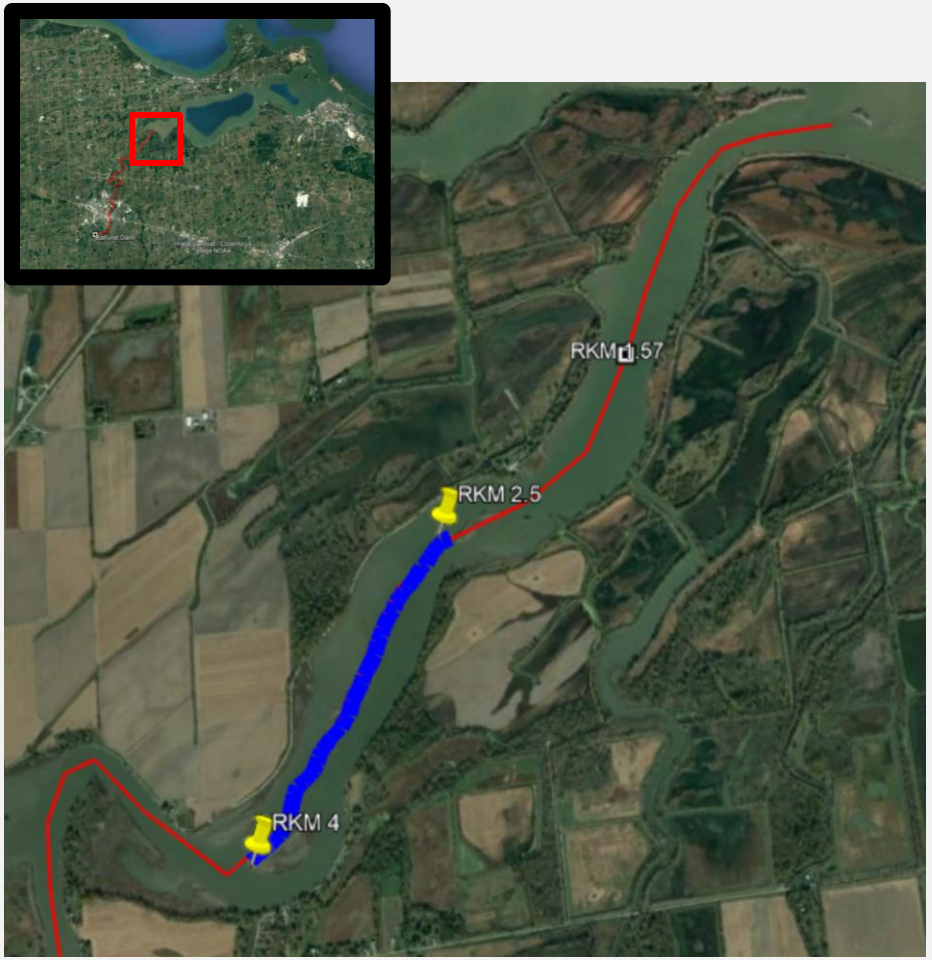
EGG DEVELOPMENT & FLOW

Estimated hatch location from 2015 eggs (FluEgg):

- RKM 2.5-4

Under 7/12/2017 flow conditions:

- Stage 25 at RKM 1.57 (stage 30 is hatch)



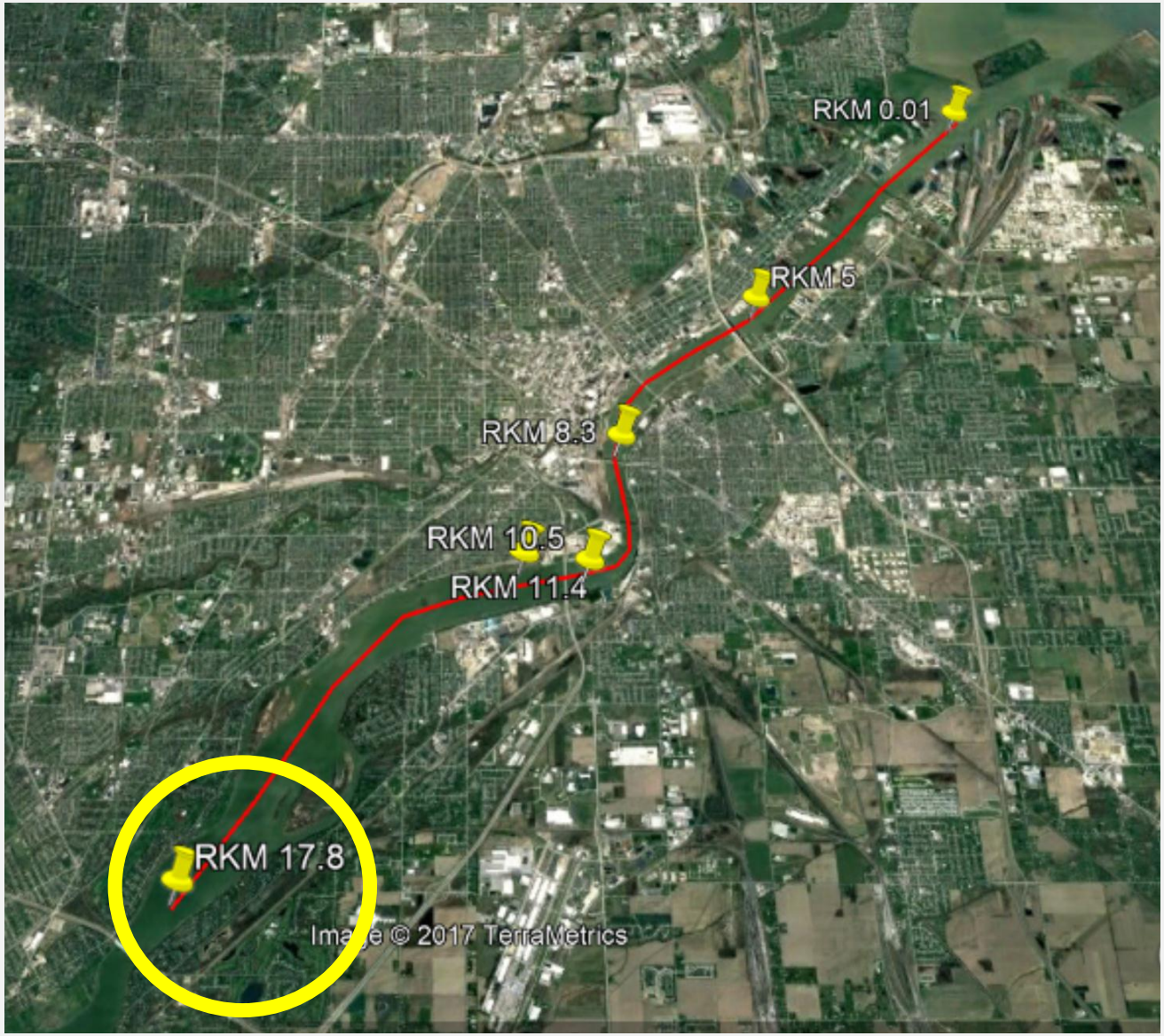
SPAWNING EVENTS

Maumee River

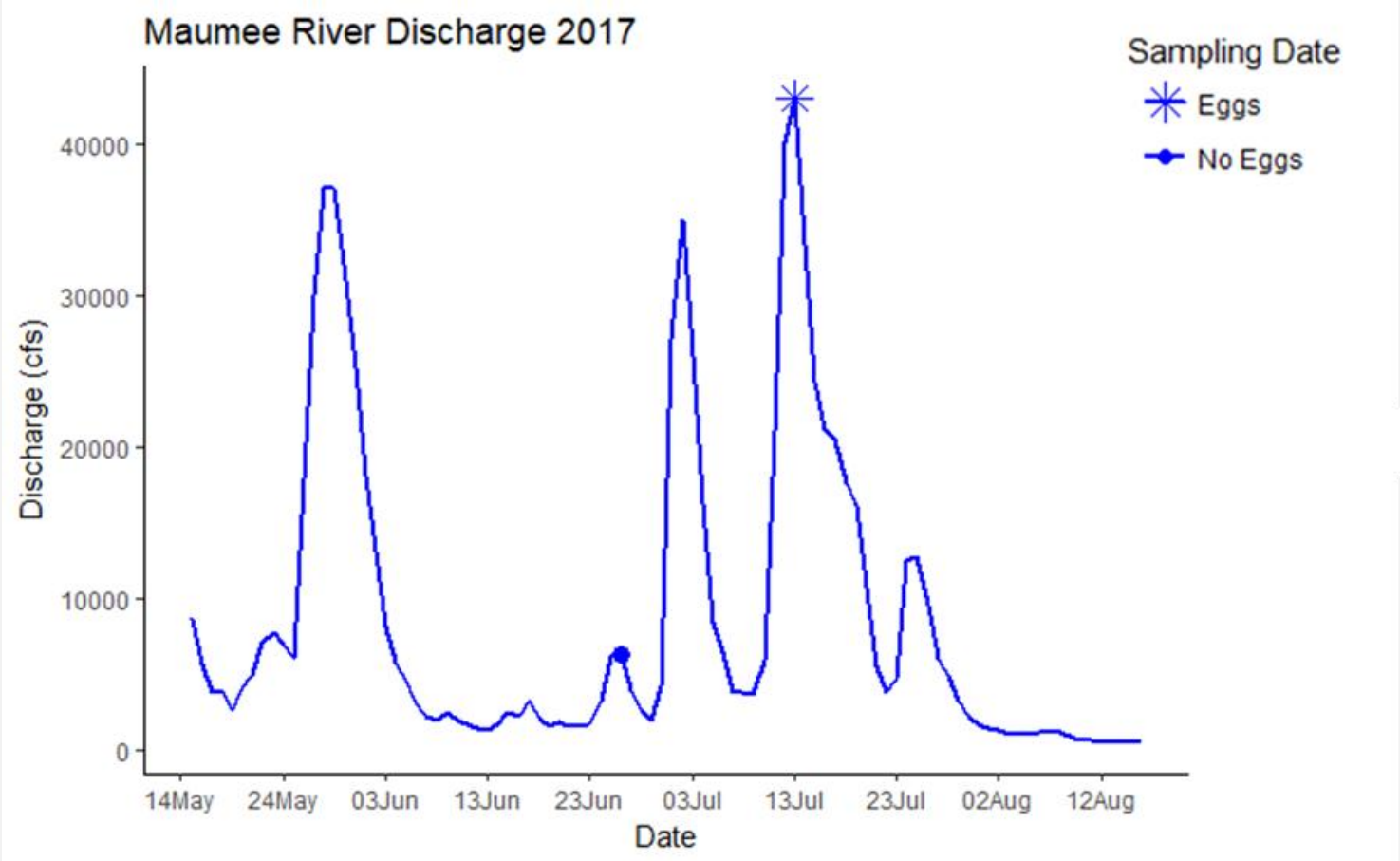
2017 SAMPLING METHODS

- Single bongo net
  - Stern mounted
  - Mid water column
  - 10 minute tows across river channel

MAUMEE RIVER SITES



SPAWNING DURING HIGH FLOWS?



MAUMEE RIVER GC EGGS

5 eggs collected on 7/13

- 3 sent for genetics and verified
- 2 retained
  - Stage 25

- Also collected a common carp egg

- Likely hatched in river (RKM 17.8)

FUTURE WORK

Sandusky River:

- Run FluEgg on 2017 eggs
- Sampling post Ballville Dam removal

Maumee River:

- More sampling
- Need HEC-RAS data for FluEgg

Prospective sampling of other rivers?

- Portage, Huron, Vermillion, Cuyahoga, Grand, Rocky

CONCLUSIONS

- Spawning in 2 Lake Erie tribs confirmed
- Spawning during high flows
  - potentially more events than previously documented
- Probability of recruitment linked to flow conditions
  - not all eggs hatch in river

THANK YOU & QUESTIONS?

Thank you ODNR & USGS!

Nicole R. King

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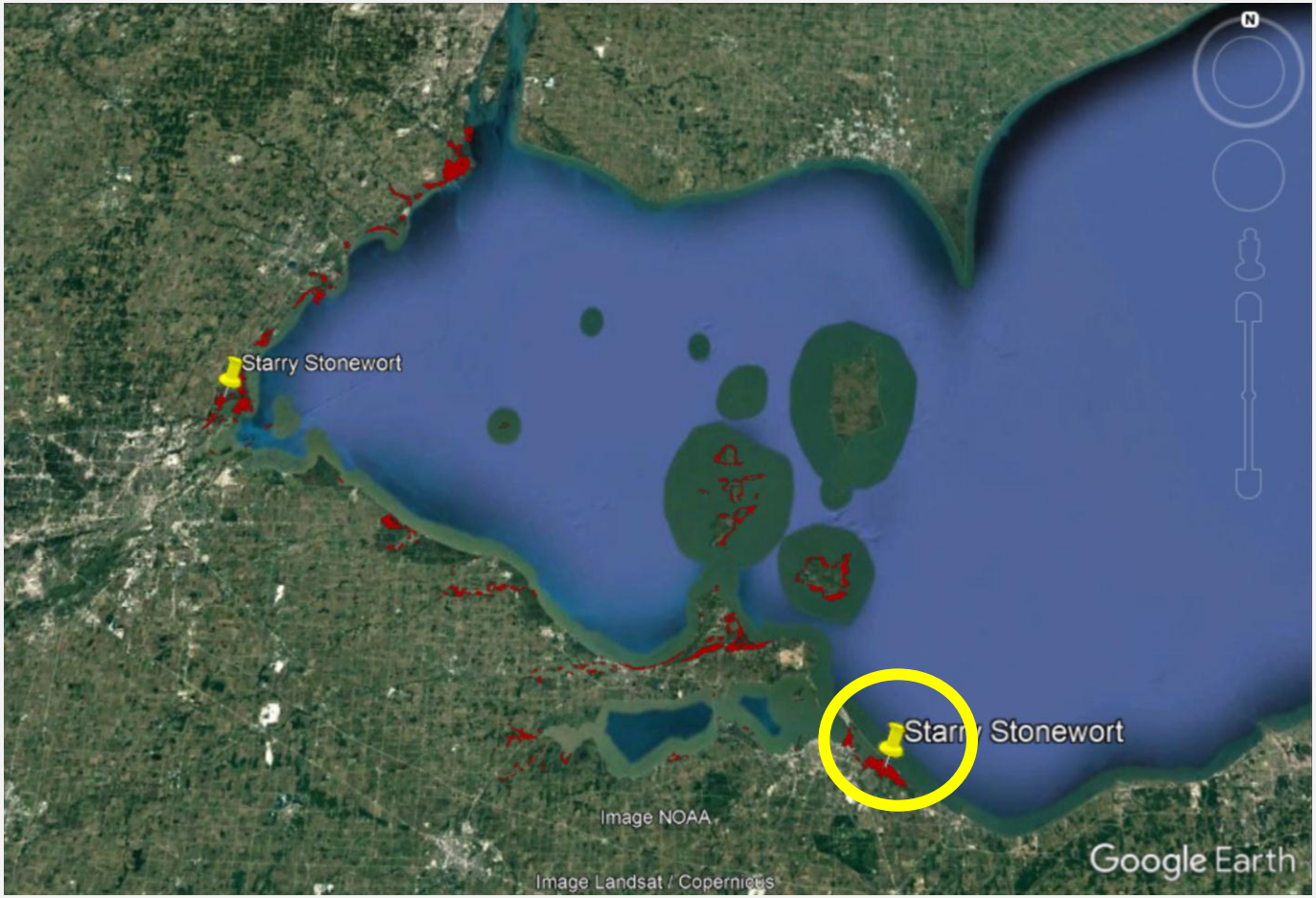
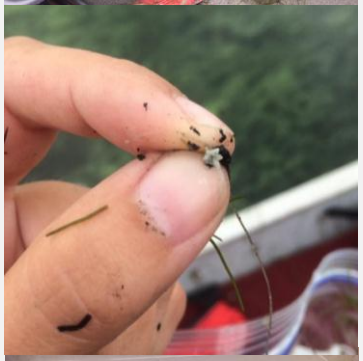
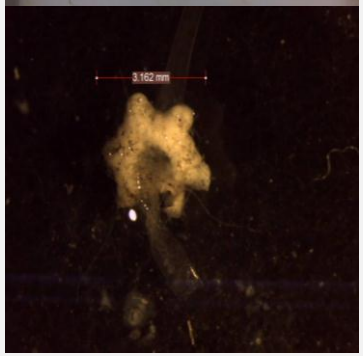
NEW OCCURRENCE OF STARRY STONEWORT

NEW OCCURRENCES OF STARRY STONEWORT

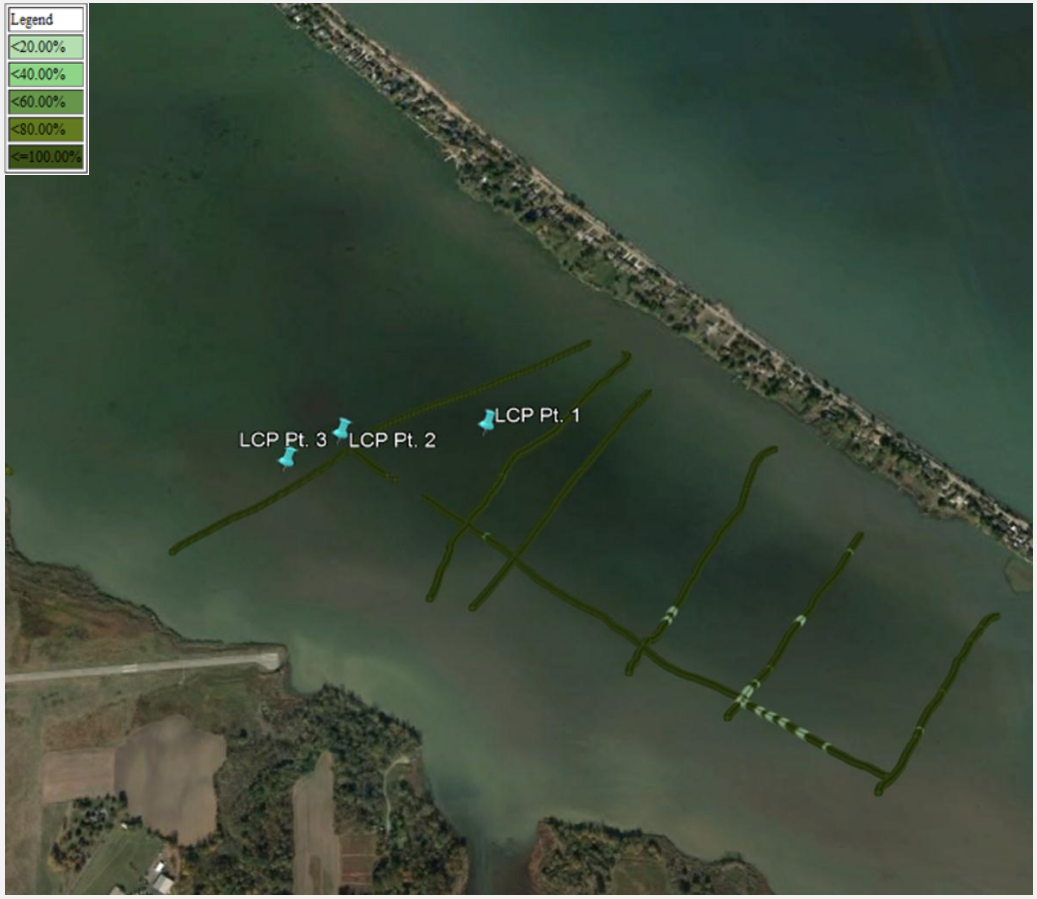


LOWER CEDAR POINT





LOWER CEDAR POINT



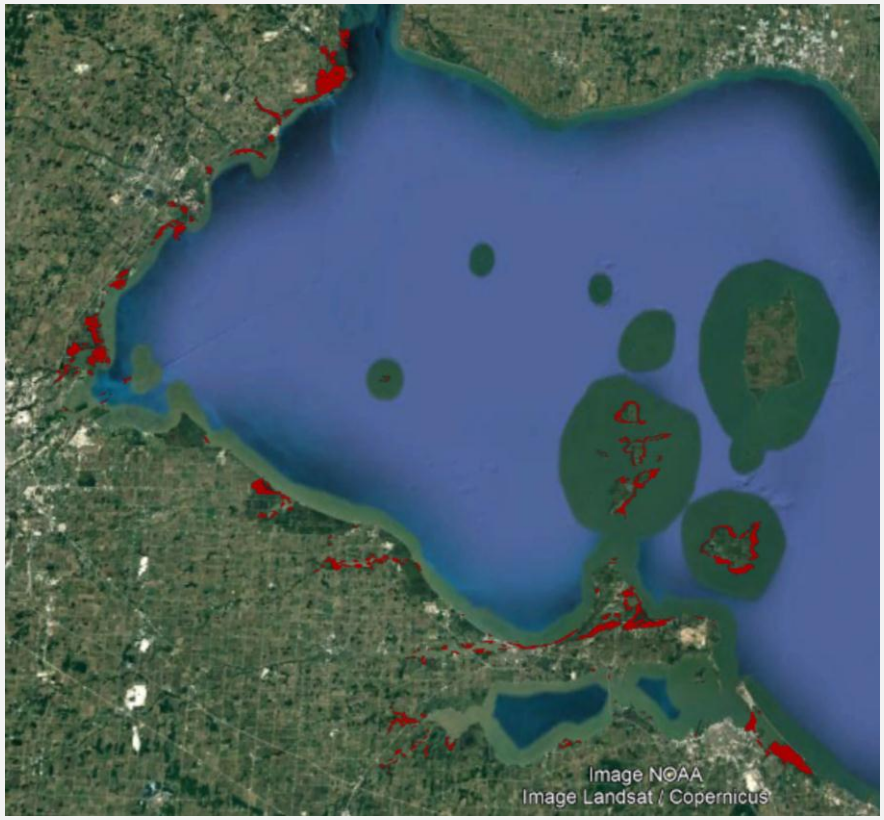
- SSW made up 1.5-45.5% of total mass
- 20% overall
- Mostly EWM

VEGETATION SURVEYS

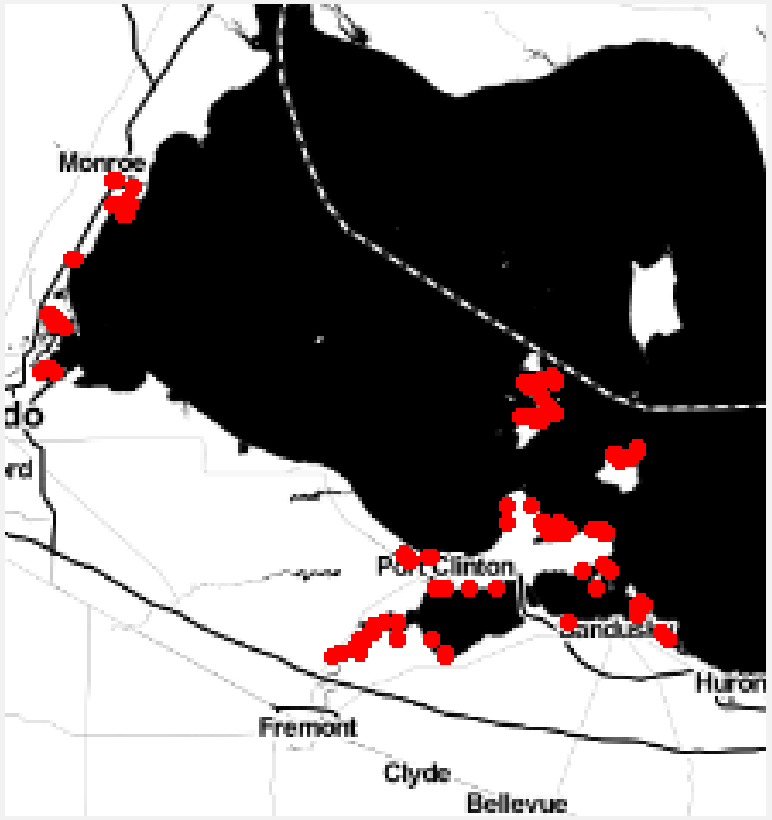
WESTERN BASIN LAKE ERIE

VEGETATION SURVEY LOCATIONS

OBIA polygons indicating presence of SAV



Sampling points: Sonar & Rake



GC FEEDING PREFERENCES: AREA RANKS

Plant preference based on documented feeding trials

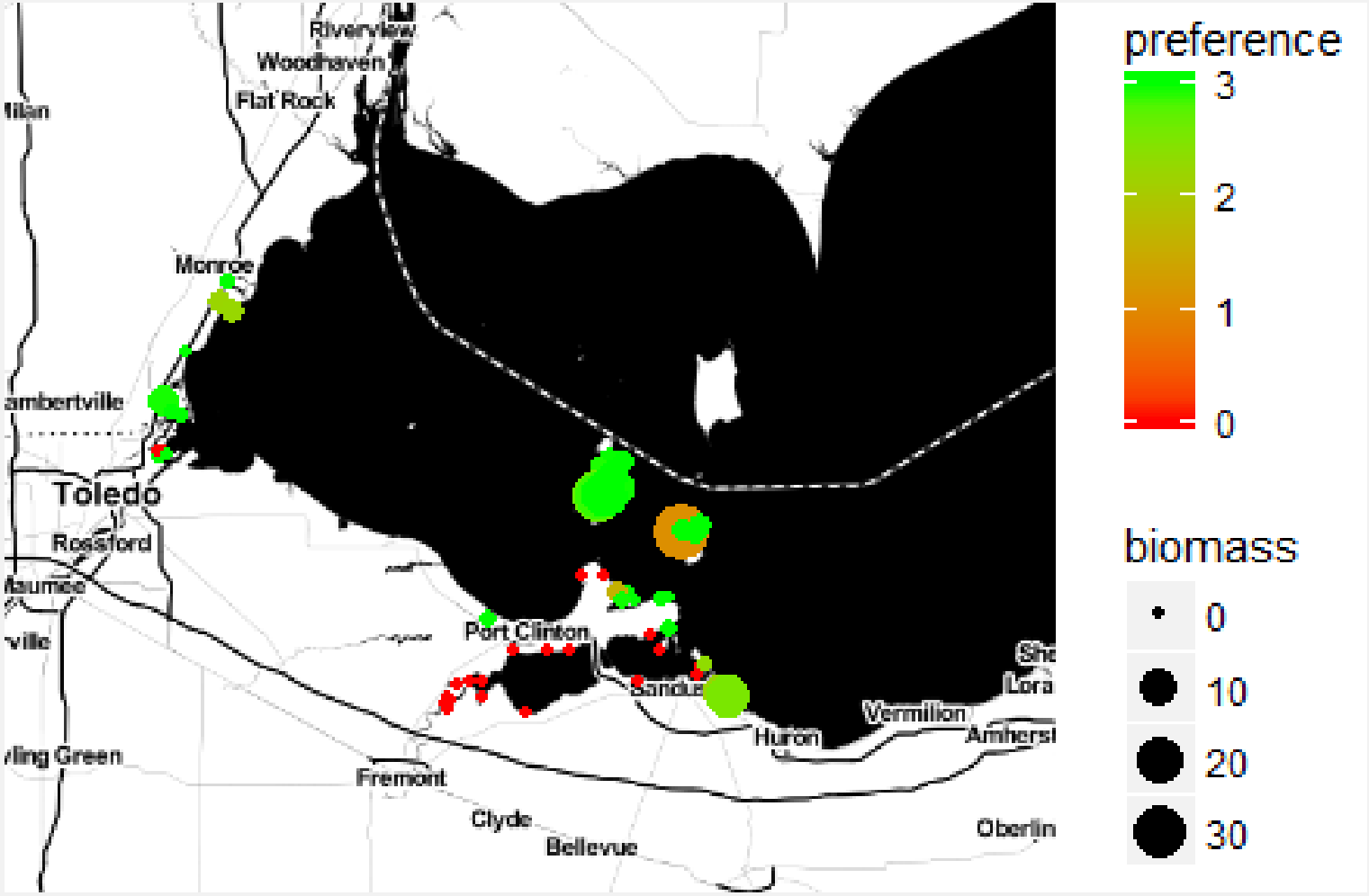
- 1=Low preference
- 2=Moderate preference
- 3=High preference

Area ranks take into account:

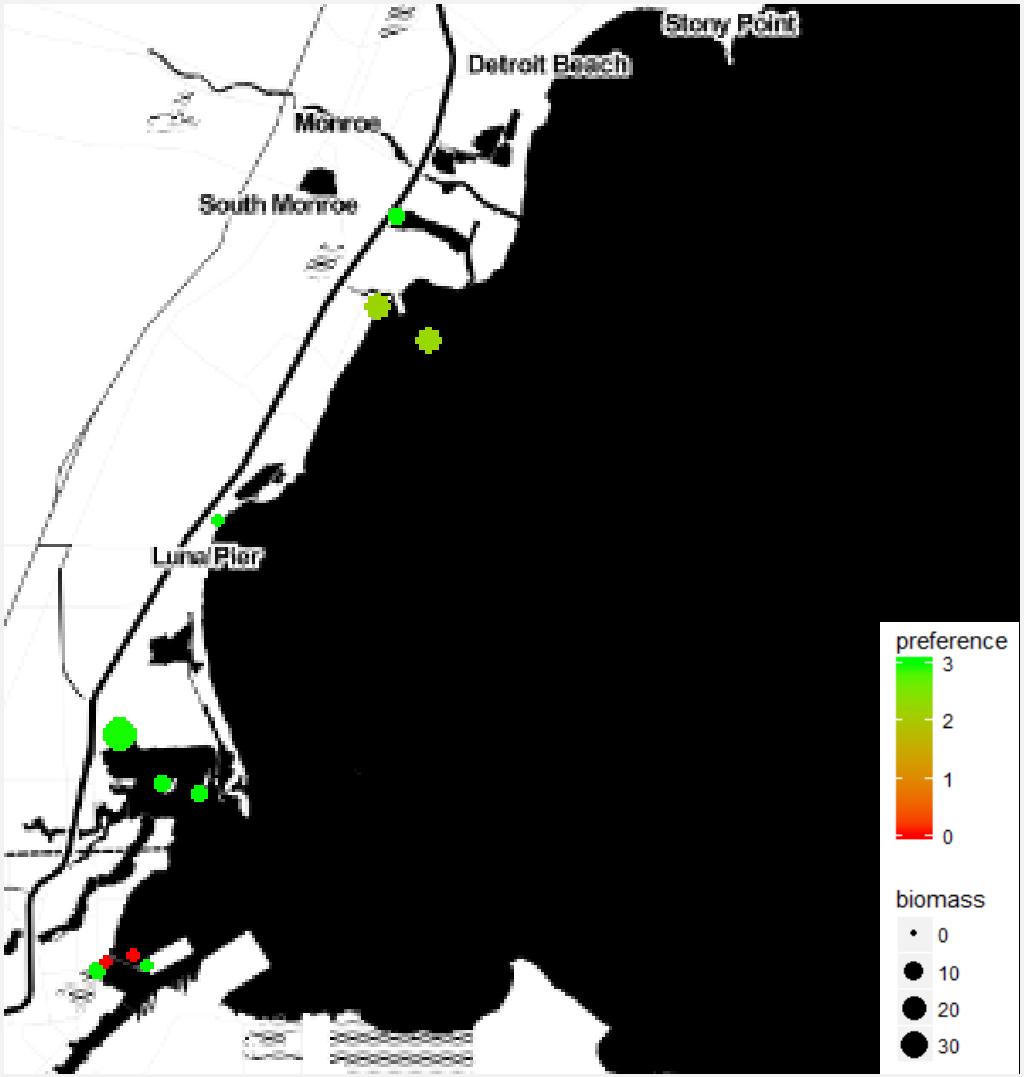
- Relative abundance of species
- Feeding preference
- Area biomass

SAV Species	Preference
Cladophora spp.	High[11]
Ceratophyllum demersum (Coontail)	Low[1,2,11]
Elodea canadensis (Waterweed)	High[3,4,5]
Heterantha dubia (Water Stargrass)	High?
Myriophyllum spicatum (Eurasian Water Milfoil)	Low[1,2,3 ,10,11] **Med**/High[6,7,8,9]
Myriophyllum spp. (Milfoil)	Med
Najas gracillima (Slender Waternymph)	High
Najas guadalupensis (Southern Waternymph)	High[2,10]
Sedge spp.	1-?
Potamogeton pectinatus (Sago Pondweed)	3-Mid[1,2] **High**[3,4,11]
Potamogeton pusillus (Small Pondweed)	High[11]
Potamogeton richardsonii (Clasping Leaved Pondweed)	High ?
Vallisneria americana (Eelgrass)	High
Zannichellia palustris (Horned Pondweed)	High?
Nitellopsis obtusa (Starry Stonewort)	High[5]

GRASS CARP PREFERRED FOOD



WEST SHORE


Stony Point
Detroit Beach
Monroe
South Monroe
Luna Pier
preference
3
2
1
0
biomass
0
10
20
30

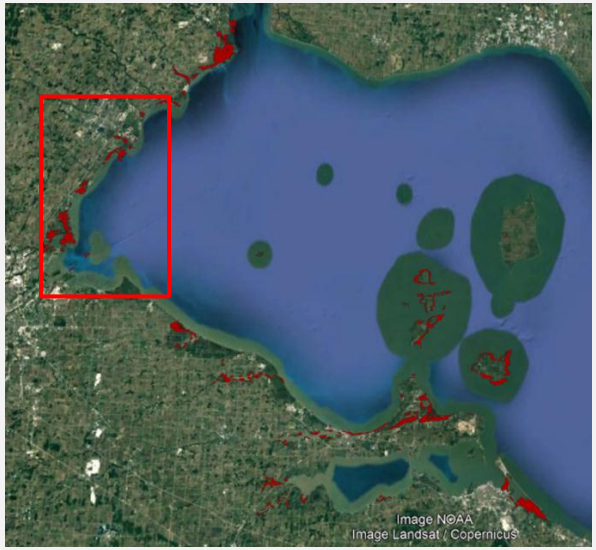
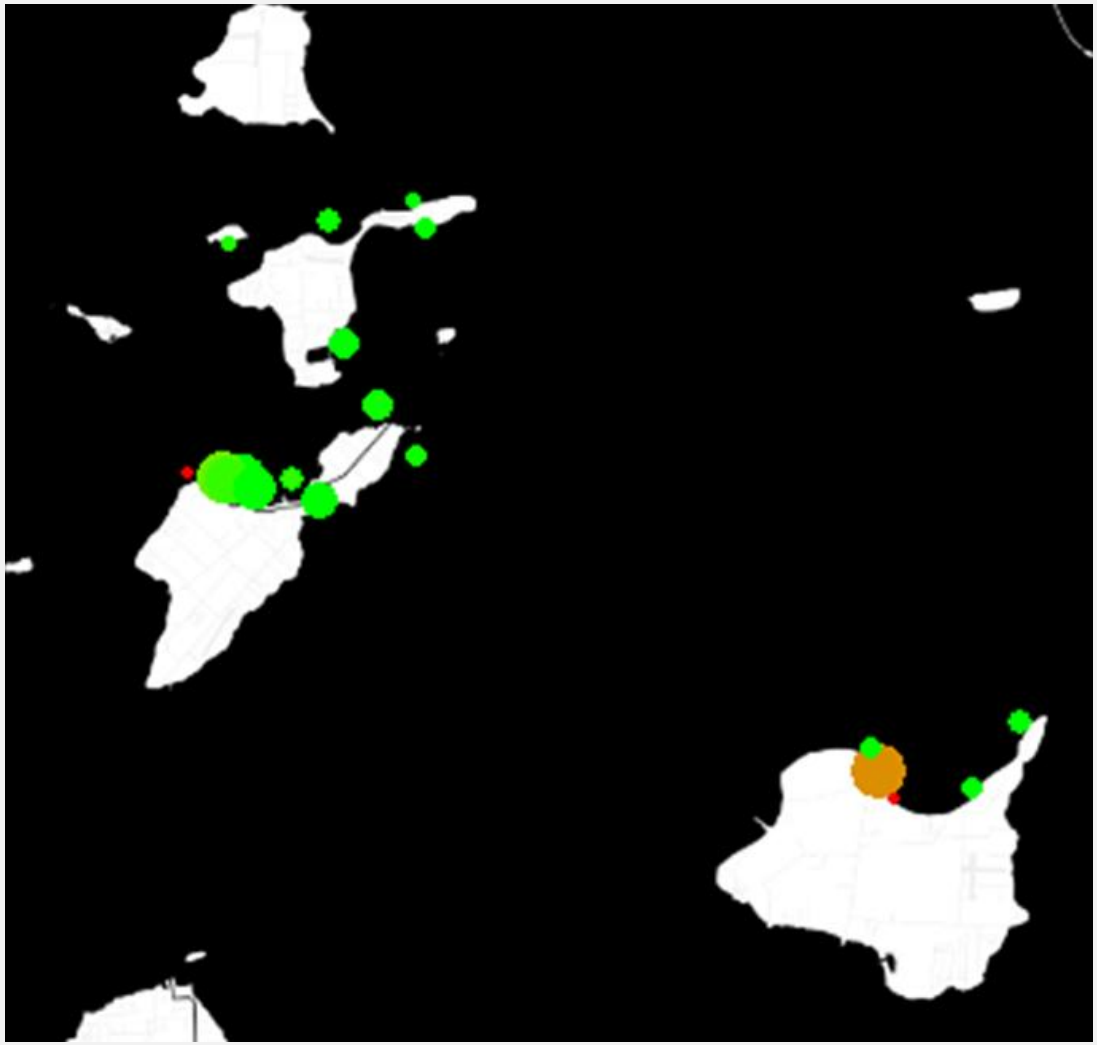


Image NOAA
Image Landsat / Copernicus

ISLANDS



SANDUSKY BAY & CATAWBA

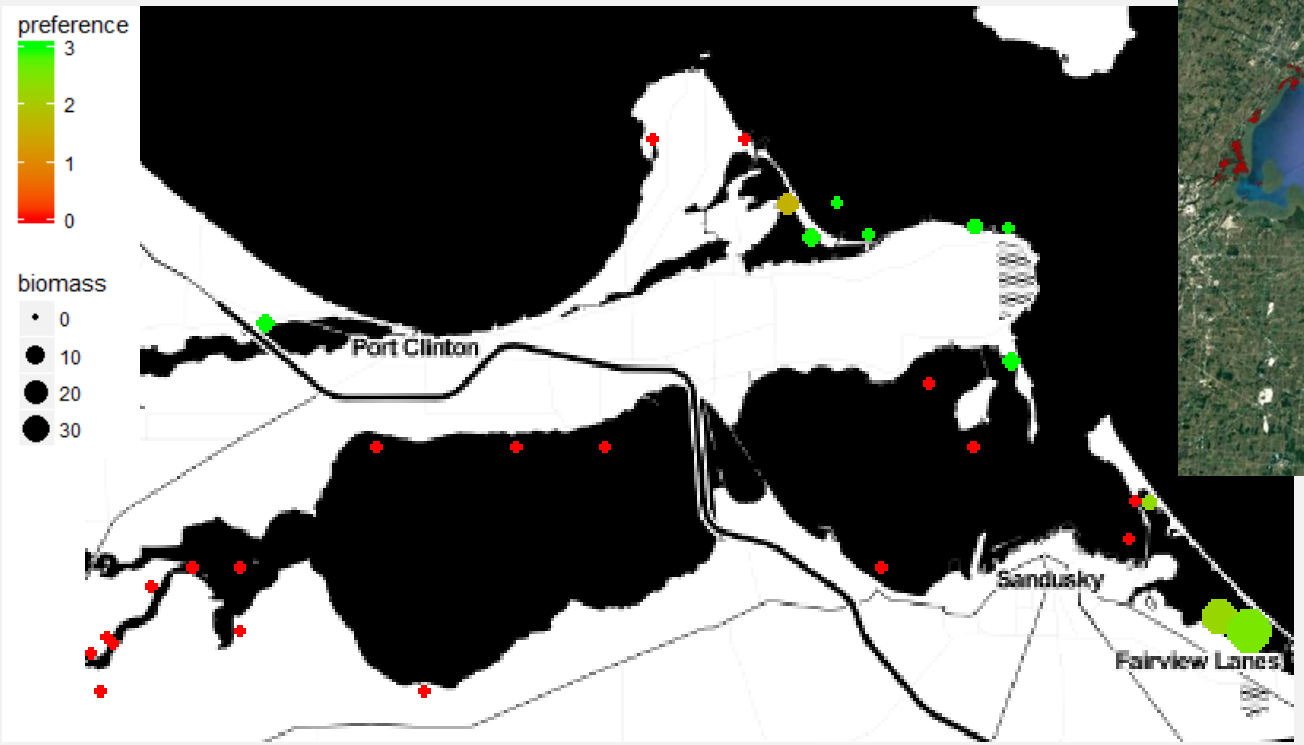


Table 1
Site locations of bongo net and light trap sampling where grass carp eggs were captured with corresponding distance from Ballville Dam and Muddy Creek Bay, number of eggs collected and their developmental stages according to Yi et al. (2006), corresponding mean daily discharge, and river water temperature measurements for the day of egg collection.

Site	Location	Method	Distance (km) from Ballville Dam	Distance (km) from Muddy Creek Bay	Dates collected	N eggs	Developmental stage(s)	Mean daily discharge (m^3/s)	Water temperature (°C)
B1	N 41.3566, W 83.1045	Bongo Net	5	20	7/13/2015	1	2	323	19.8
B3	N 41.3864, W 83.0908	Bongo Net	10	15	6/18/2015	1	8	368	22.8
B4	N 41.3972, W 83.1026	Bongo Net	14	11	6/29/2015	1	10	254	19.5
					7/14/2015	4	9, 10, 10, 12	244	21.1
LT2	N 41.4267, W 83.0503	Light Trap	21	4	7/1/2015	1	13	129	20.3

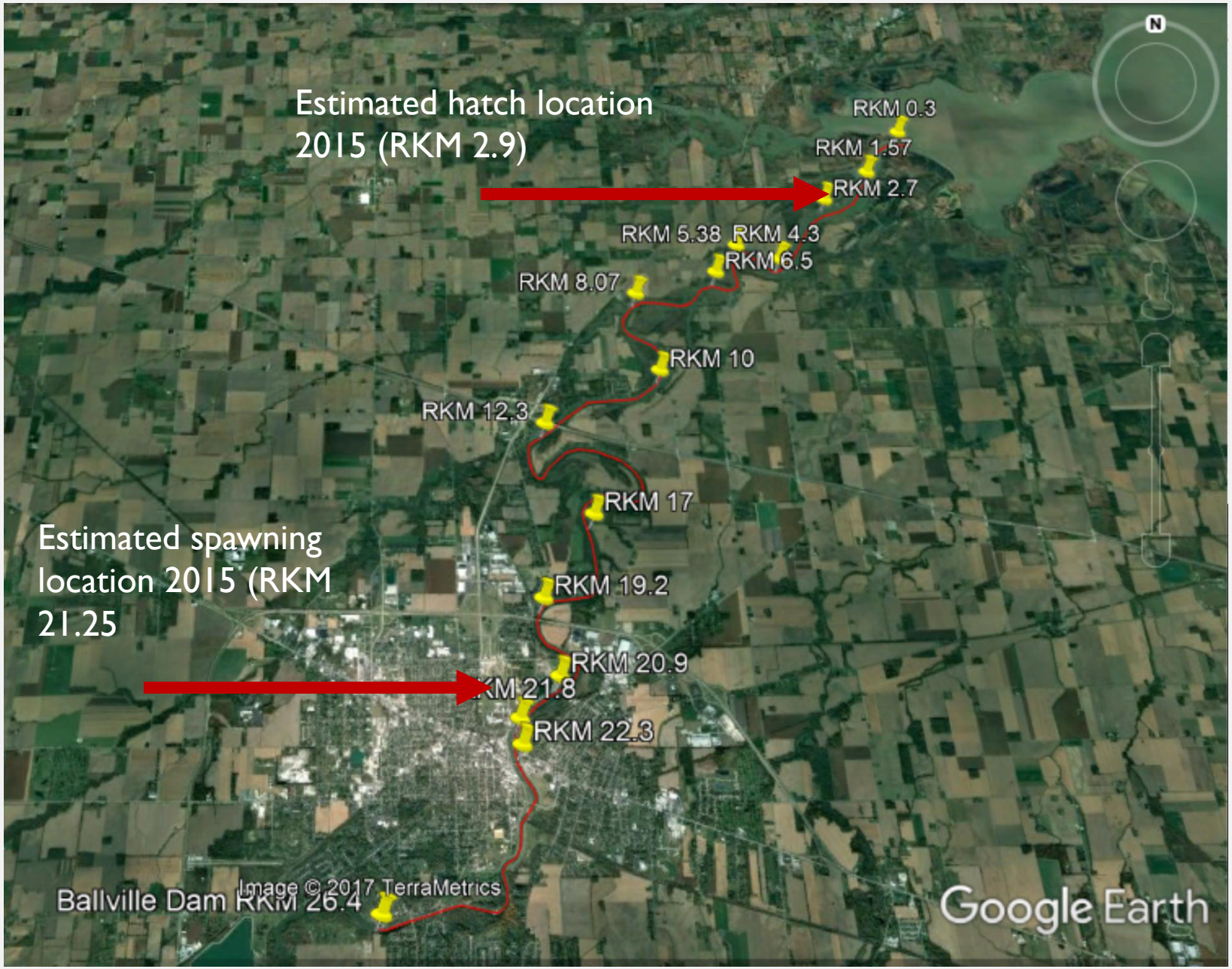
Results

There were two high-flow events that occurred in 2014 when mean daily discharge exceeded 31 m^3/s: June 6–12 and June 19–30 (Fig. 2). The peak flow of the first event in 2014 was ~98 m^3/s while the peak flow of the second event was ~166 m^3/s. During the summer of 2015, there were three high-flow events when mean daily discharge exceeded 31 m^3/s: June 15–23, June 27–July 4, and July 9–23 (Fig. 2). The first event of 2015 (June 15–23) peaked at ~370 m^3/s. The second event (June 27–July 4) had a peak flow of ~340 m^3/s. The third event was the longest and persisted for 15 days (July 9–23), with the peak flow of ~320 m^3/s. All three events achieved peak flow within five days of exceeding 31 m^3/s. The thermal threshold for maturation of 633 ADD15 was reached on June 22, 2014 and June 17, 2015.

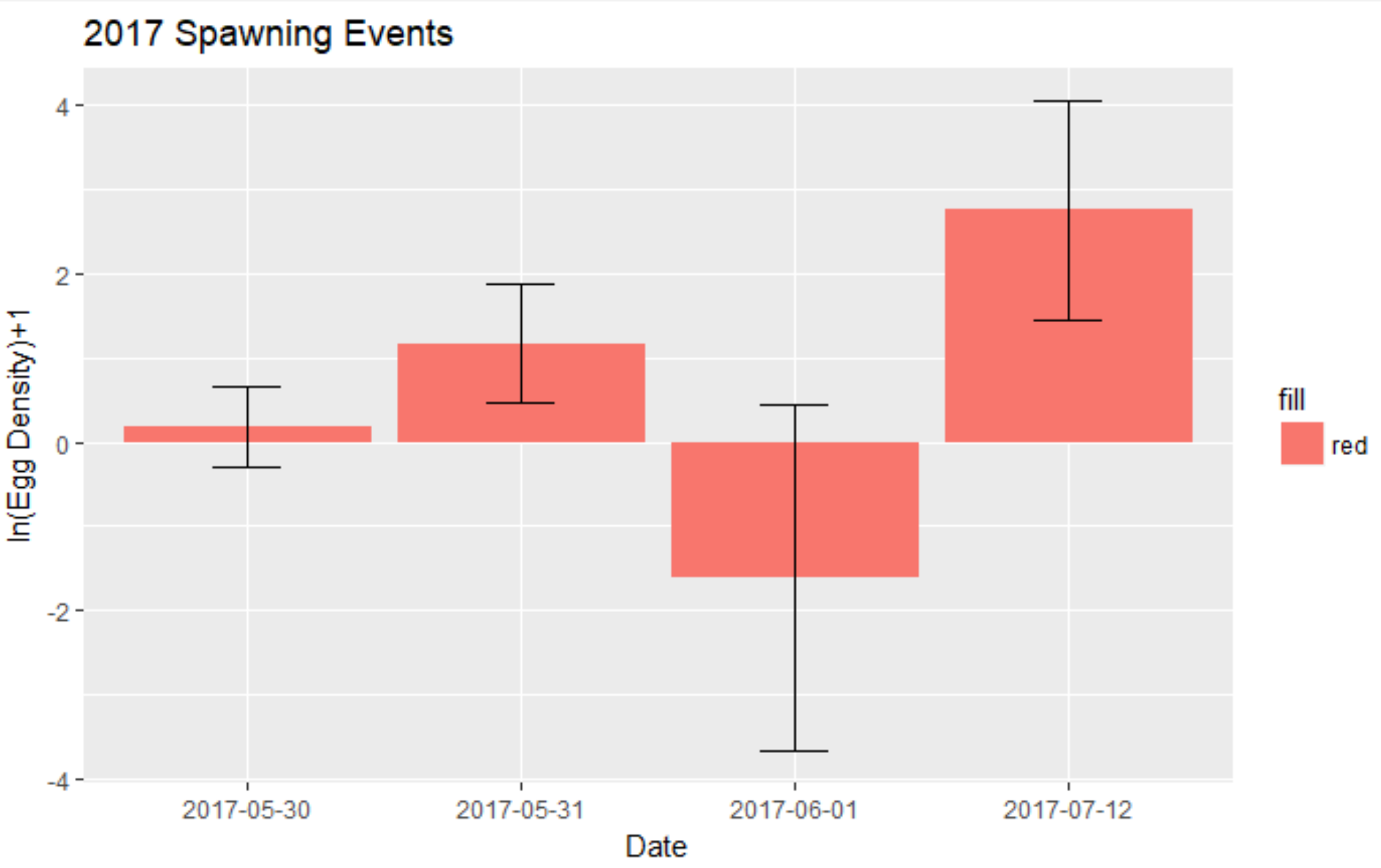
Success of egg capture varied between years. In 2014 there were no eggs collected that were morphologically consistent with grass carp. In 2015 we identified and staged eight potential grass carp eggs on five

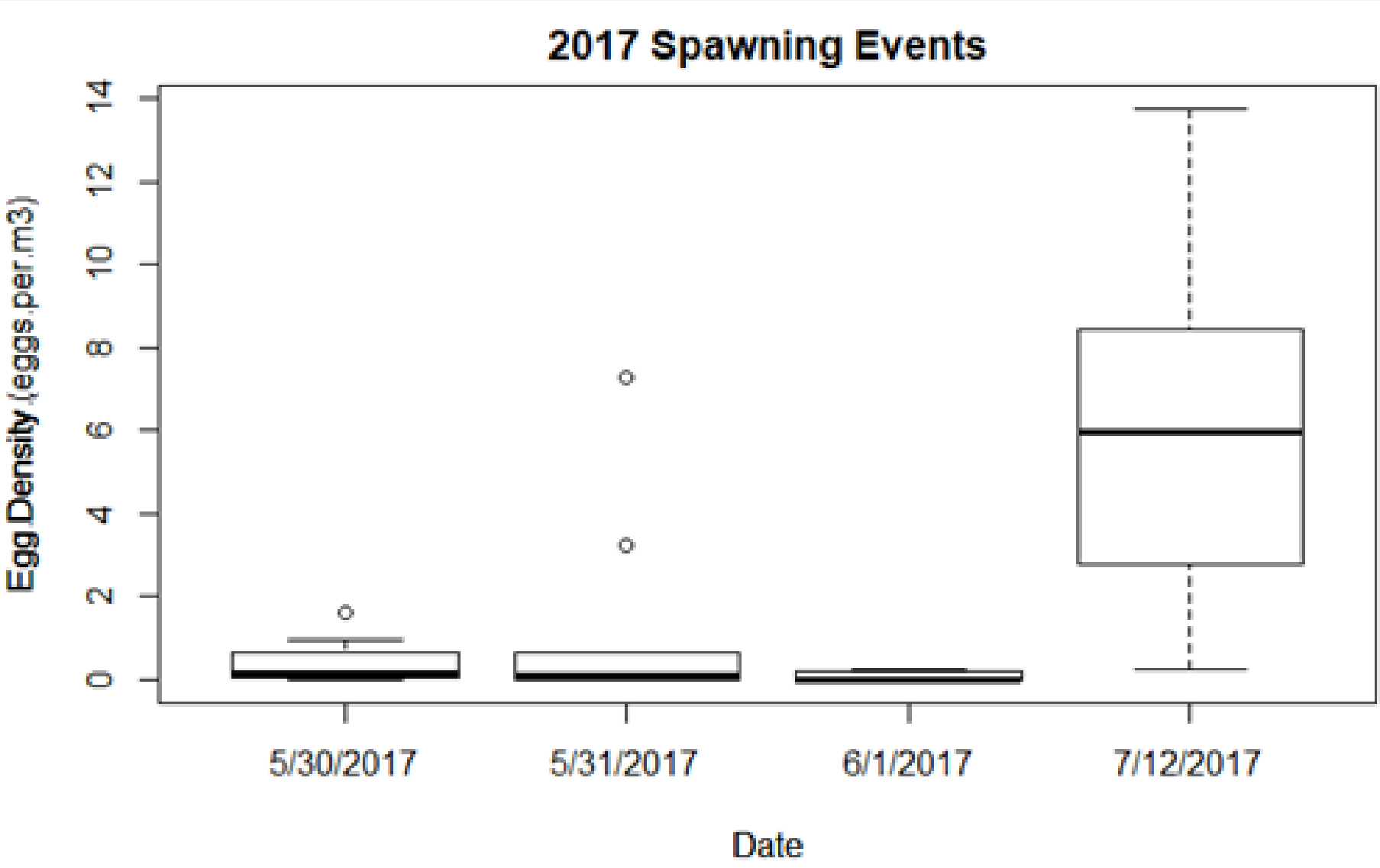
All eggs were collected during high-flow events, either on the day of peak flow or 1–2 days following peak flow. This finding supports an earlier suggestion (Chapman et al., 2013) that high-flow conditions favor grass carp spawning. This pattern is consistent with Lin (1935), who reported that high magnitude increases in flow were required to trigger grass carp spawning in Chinese rivers. Although high flows were associated with spawning evidence collected in 2015, others have demonstrated that non-native populations of Asian carps have successfully spawned despite only low-magnitude changes in flow (Aliyev, 1976; Coulter et al., 2013). In the Kara-Kum Canal in Turkmenistan, several species of Asian carp, including grass carp, spawn without discernable flow changes (Aliyev, 1976). Additionally, in the Wabash River, bighead carp and silver carp, which have very similar spawning requirements as grass carp, have spawned regardless of flow increases (Coulter et al., 2013, Deters et al., 2013). Although our sampling was more intense during high-flow events, we did sample during low flows. Collectively, the weight of the evidence suggests high magnitude increases in flow are

Sandusky River rkm 20.93 stage 3, rkm 1.57 stage 25 (~1rkm upstream stage 17 highest)

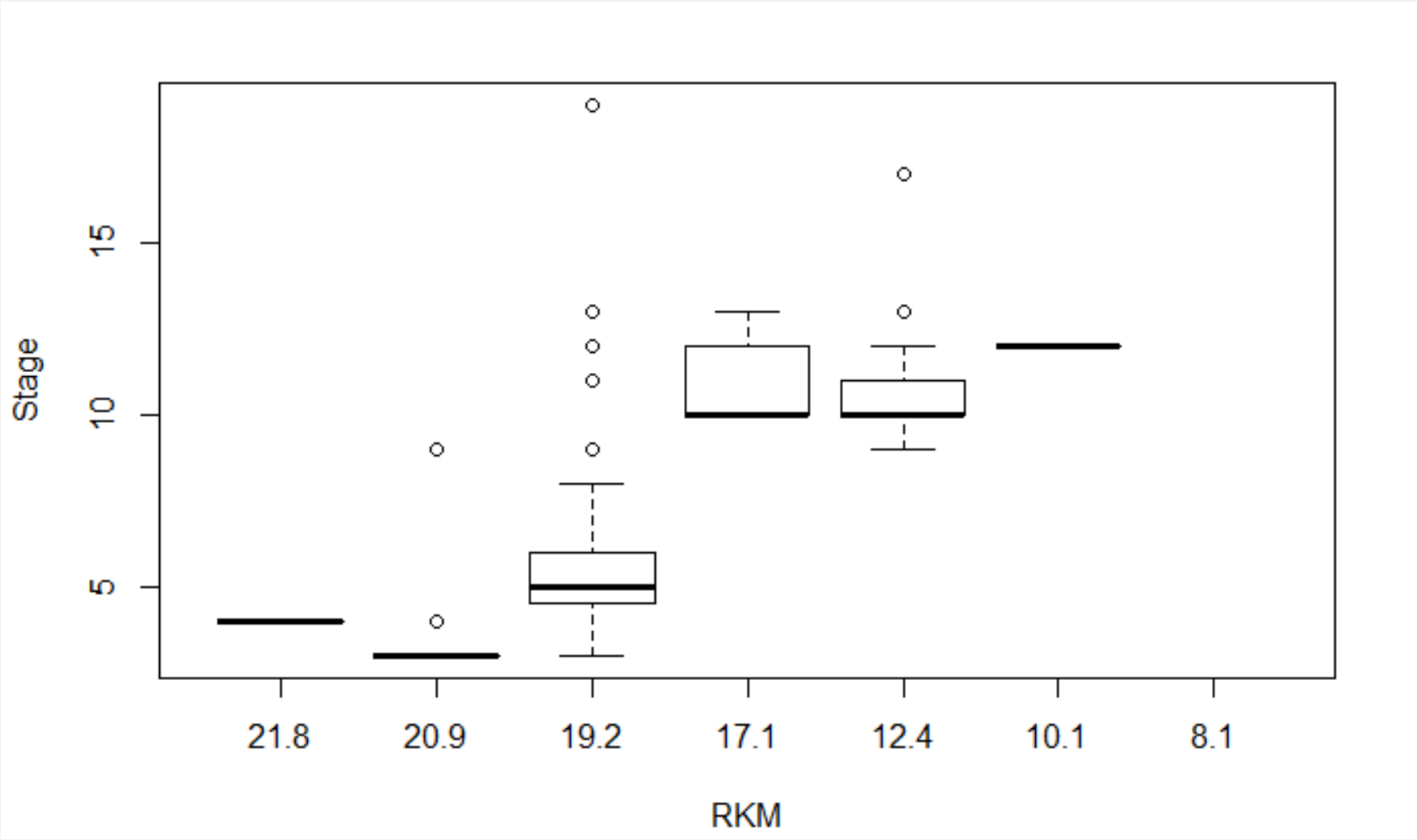


Site Name	RKM
Ballville Dam	RKM 26.4
Groceries Bridge	RKM 22.25
Upstream Bradys	RKM 21.84
s1	RKM 20.93
s2	RKM 19.22
s3	RKM 17.11
s4	RM 12.35
s5	RKM 10.05
RIverfront Marina	RKM 8.07
Memory	RKM 6.46
LT	RKM 5.38
Swarts chan	RKM 4.3
Fisher	RKM 2.7
Jon	RKM 1.57
Mouth	RKM 0.3


2017 Spawning Events
4
2
0
-2
-4
ln(Egg Density)+1
2017-05-30
2017-05-31
2017-06-01
2017-07-12
Date
fill
red


2017 Spawning Events
Egg Density (eggs.per.m3)
0
2
4
6
8
10
12
14
5/30/2017
5/31/2017
6/1/2017
7/12/2017
Date

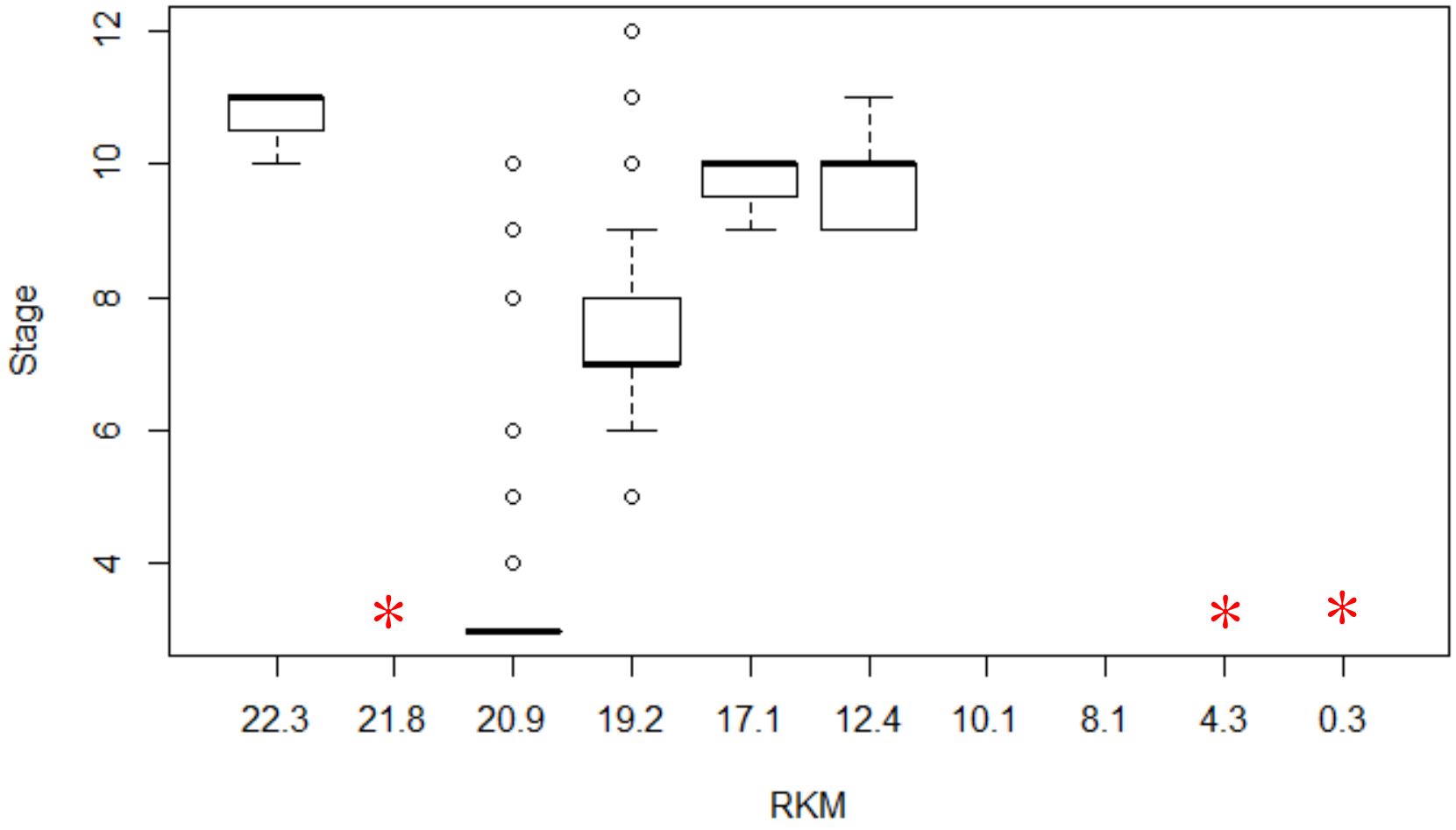
GC EGG DEVELOPMENT 5.30.17



flow

GC EGG DEVELOPMENT 5.31.17

* Eggs present, none stageable



flow