Evaluating collection, rearing, and stocking methods for Great Lakes lake sturgeon restoration programs

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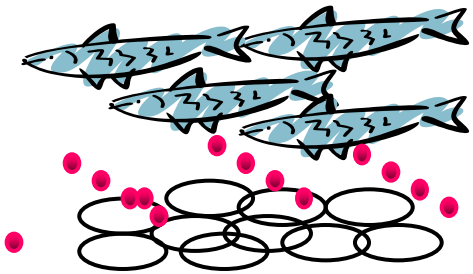
Conservation/recovery programs for under-studied species such as lake sturgeon should be based on aspects of the species' ecology

- **Important life history features of adults and juveniles**
- **How to collect progeny**
- **Where to rear progeny**
- **When to release progeny**
- **Cost/benefit relationships**



period	spawning	incubation	development in substrate	emergence and dispersal

factors

- adult phenotype
- adult ecology
- location of spawning
- timing of spawning

Characteristics of adults

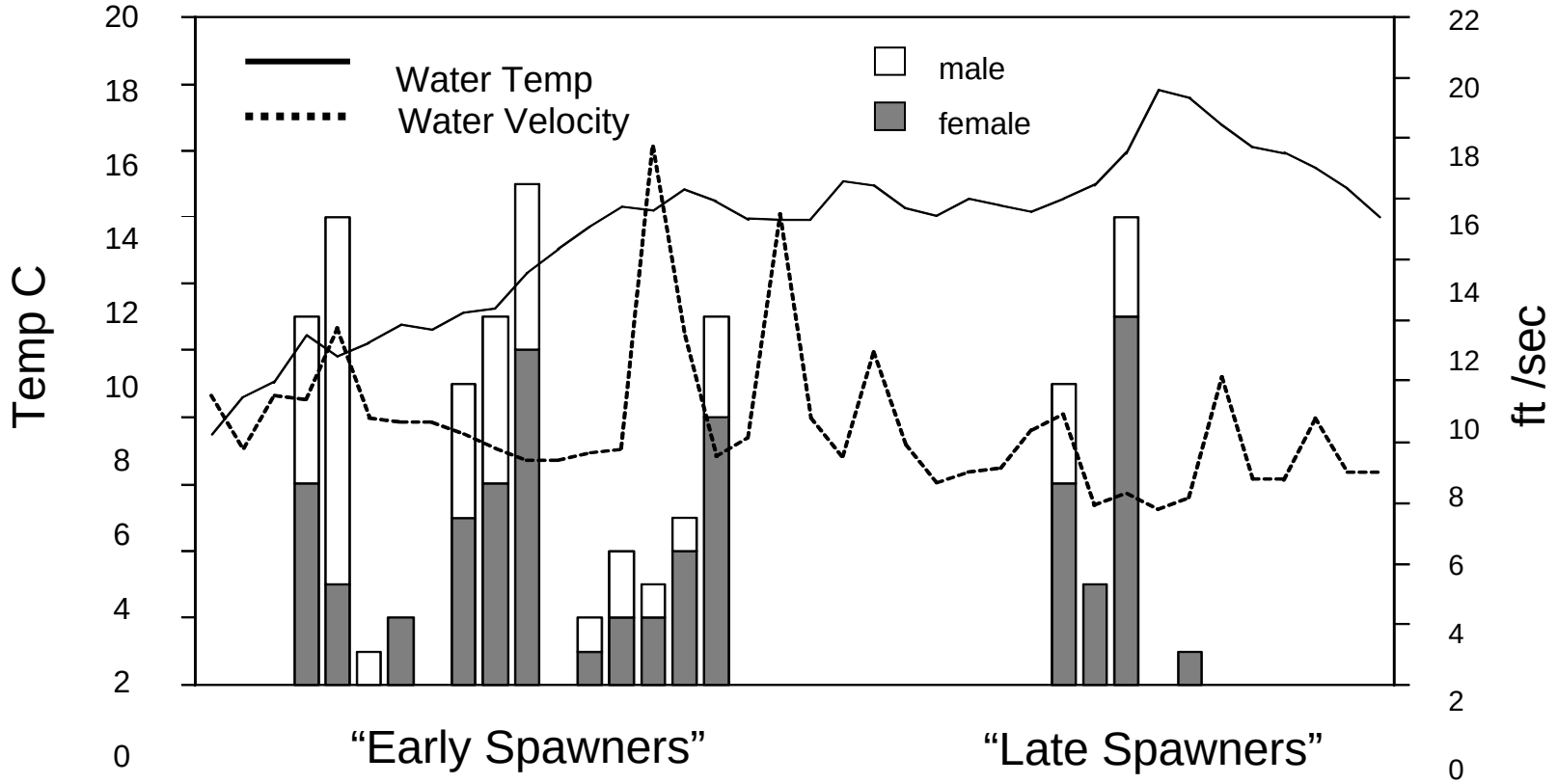
- water temp
- water flow
- food
- predators

Characteristics of environment

The chronology of events from egg deposition through larval dispersal that affect measures of programmatic success (1) <u>survival during early life stages</u> and (2) <u>levels of genetic diversity of offspring</u>

Lessons from Black Lake regarding lake sturgeon ecology

#1. Adult lake sturgeon spawn at different times



"Early Spawners"

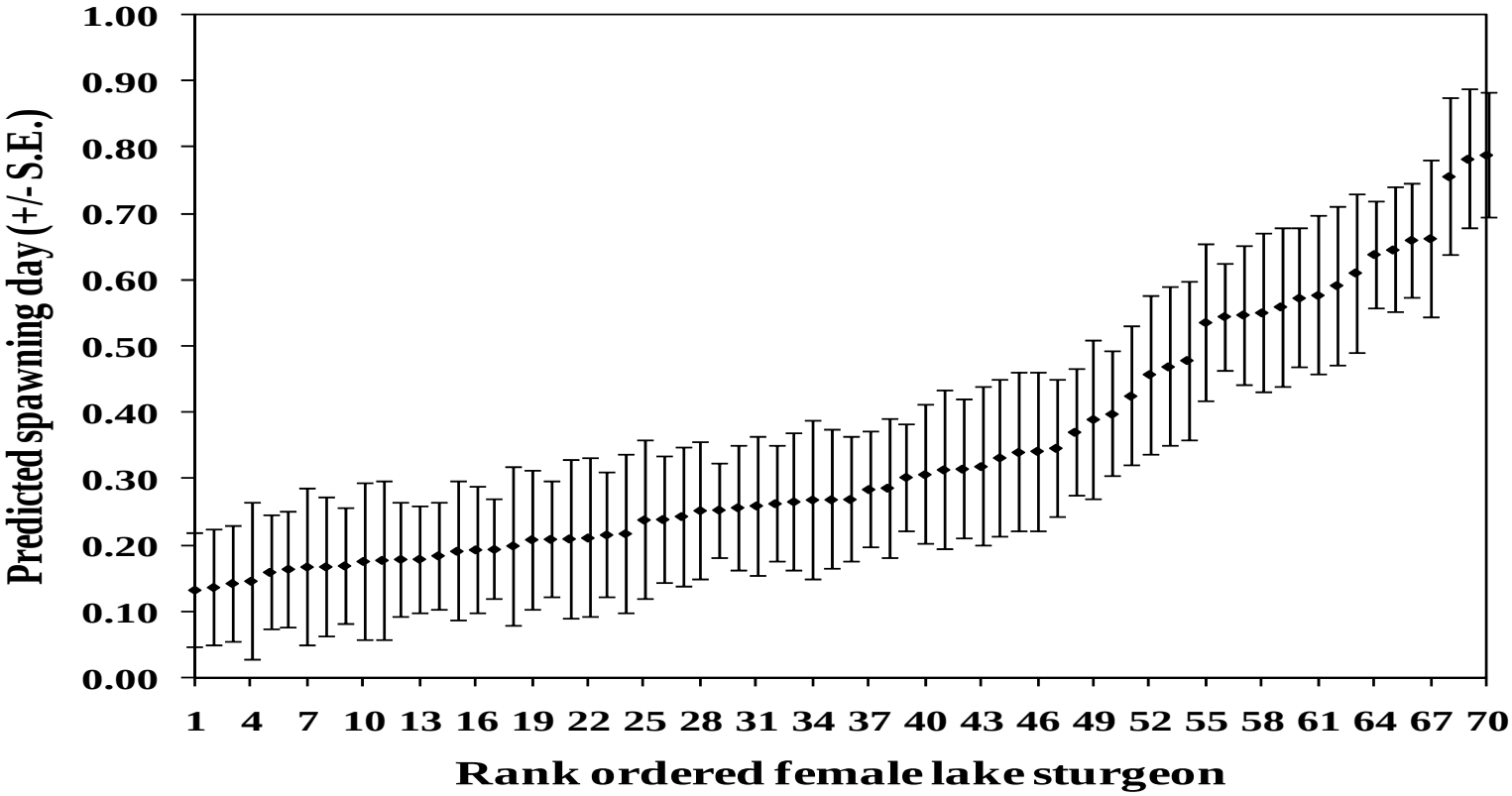
"Late Spawners"

Evidence for reproductive isolation

F_{st} ~ 0.025

Lessons from Black Lake regarding lake sturgeon ecology

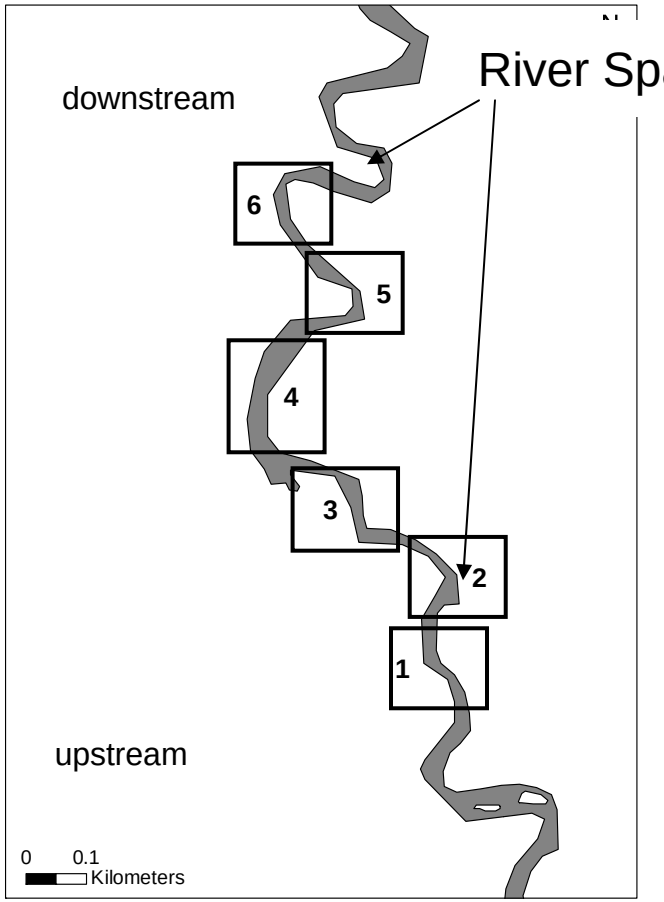
#2. Timing of spawning is highly repeatable across years

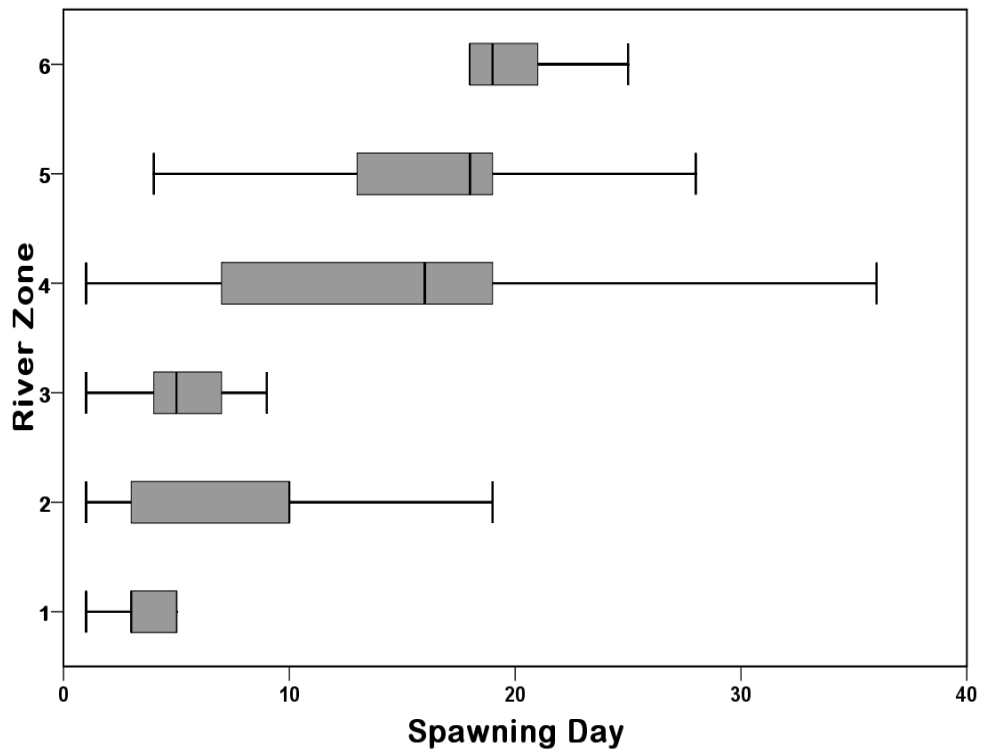


- Based on 8 years of capture-recapture data (1264 captures of 705 adults), day within spawning season is highly repeatable (females r=0.66, F=4.04, P<0.004), where r is the correlation of spawning day among years (Forsythe et al. in prep).
- Apparent heritability in spawning time (Scribner et al. in prep).

Lessons from Black Lake regarding lake sturgeon ecology

#3. Location of spawning varies within a season and is repeatable on an individual basis





Lessons from Black Lake regarding lake sturgeon ecology

#4. Embryo and larval traits are co-adapted to environmental conditions at the time of spawning

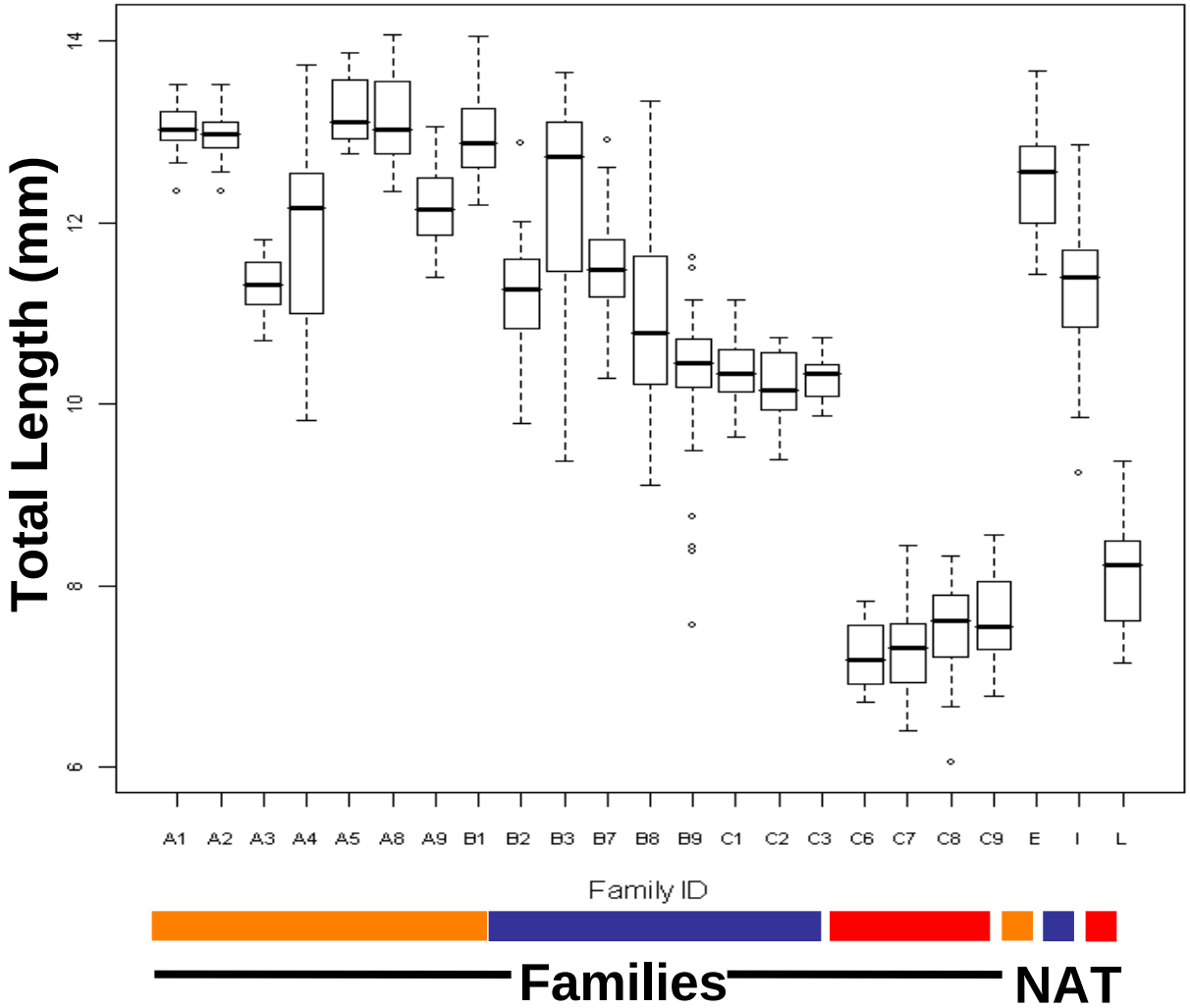
Spawning Period

Early

Intermediate

Late

Total Length at Hatch Across Half-sib Family Groups



Proposed management action #1

- **Collect gametes and/or juveniles from adults from across the spawning period**

Surrogate measures of programmatic success: stages in supplementation practices where genetic variation and survival can be affected

Process/Stage	Causal Factors
Wild Population	
↓	- numbers bred - timing of take - age/size of individuals - gamete collection/mixing
Captive Offspring	
↓	- degree of domestication - size and age at release - location of release in relation to location of origin - probability of mixing with natives
Release of Offspring	

Evaluation of larval/gamete collection methods and rearing conditions of comparatively under-studied species

Treatment 1: gamete/larval collection method

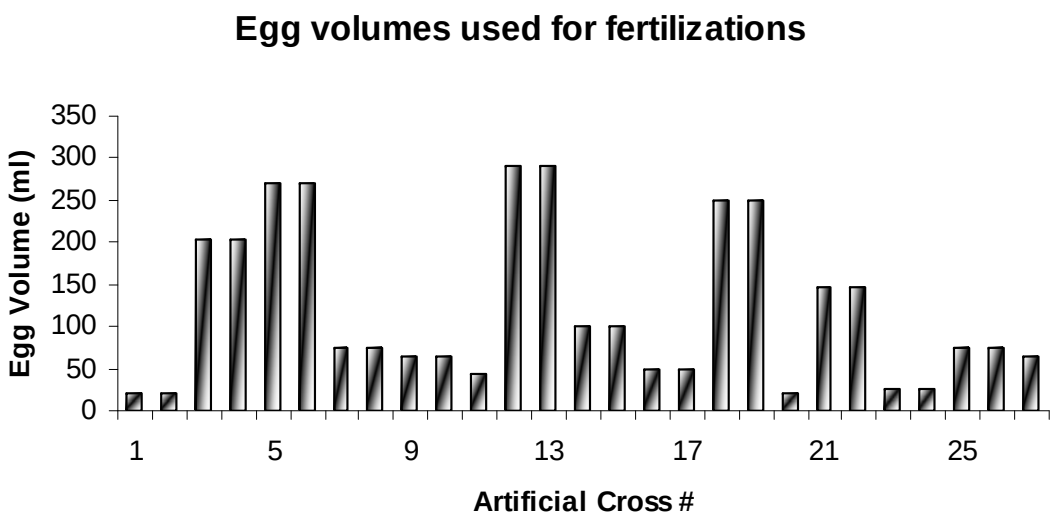
- Direct Egg Take

Known:
Genetic Diversity
Growth
Survival

<u>Less Intrusive</u>:

- Naturally Produced Eggs
- Larvae Dispersing Downstream of Spawning Sites

Unknown but can be estimated:
Genetic Diversity
Growth
Survival


Egg volumes used for fertilizations
Egg Volume (ml)
350
300
250
200
150
100
50
0
1
5
9
13
17
21
25
Artificial Cross #

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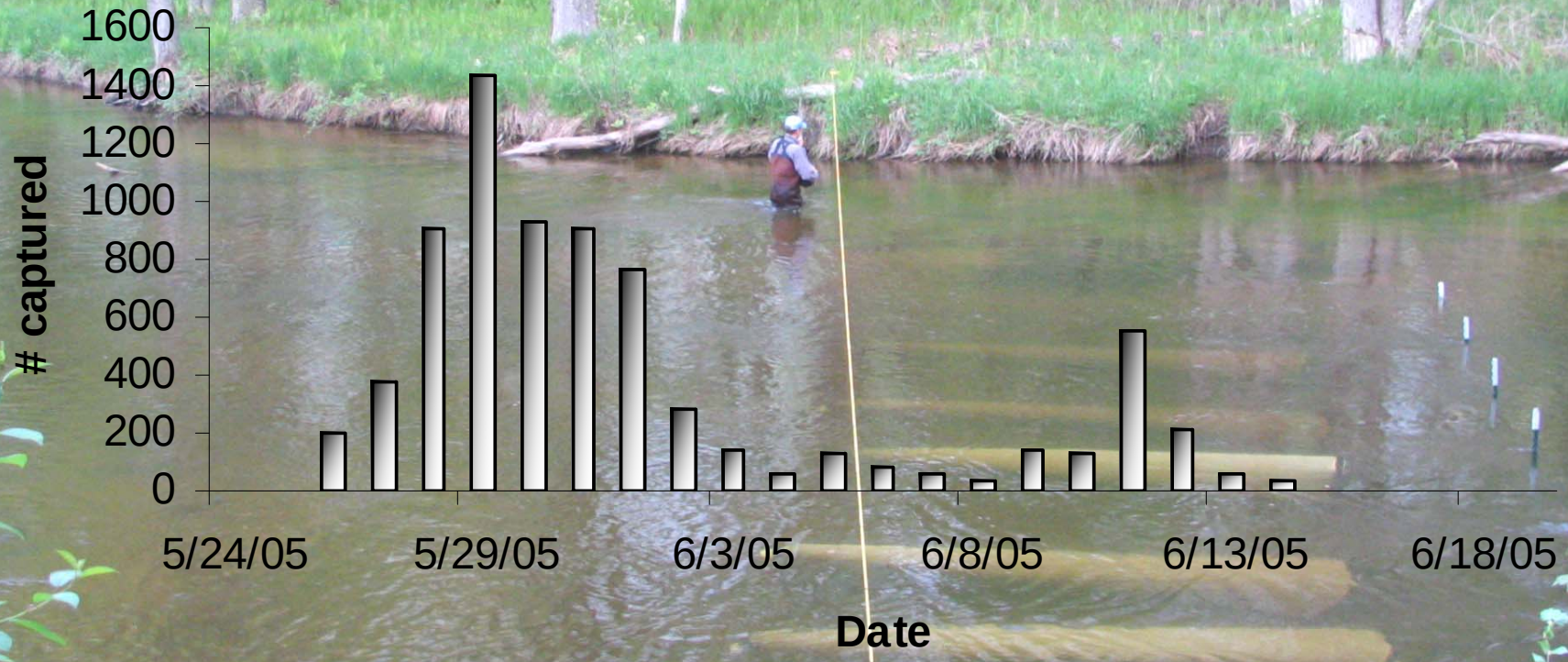
Naturally Produced Eggs

- Transects below Spawning Sites
  - Kick nets

- Incubated by location

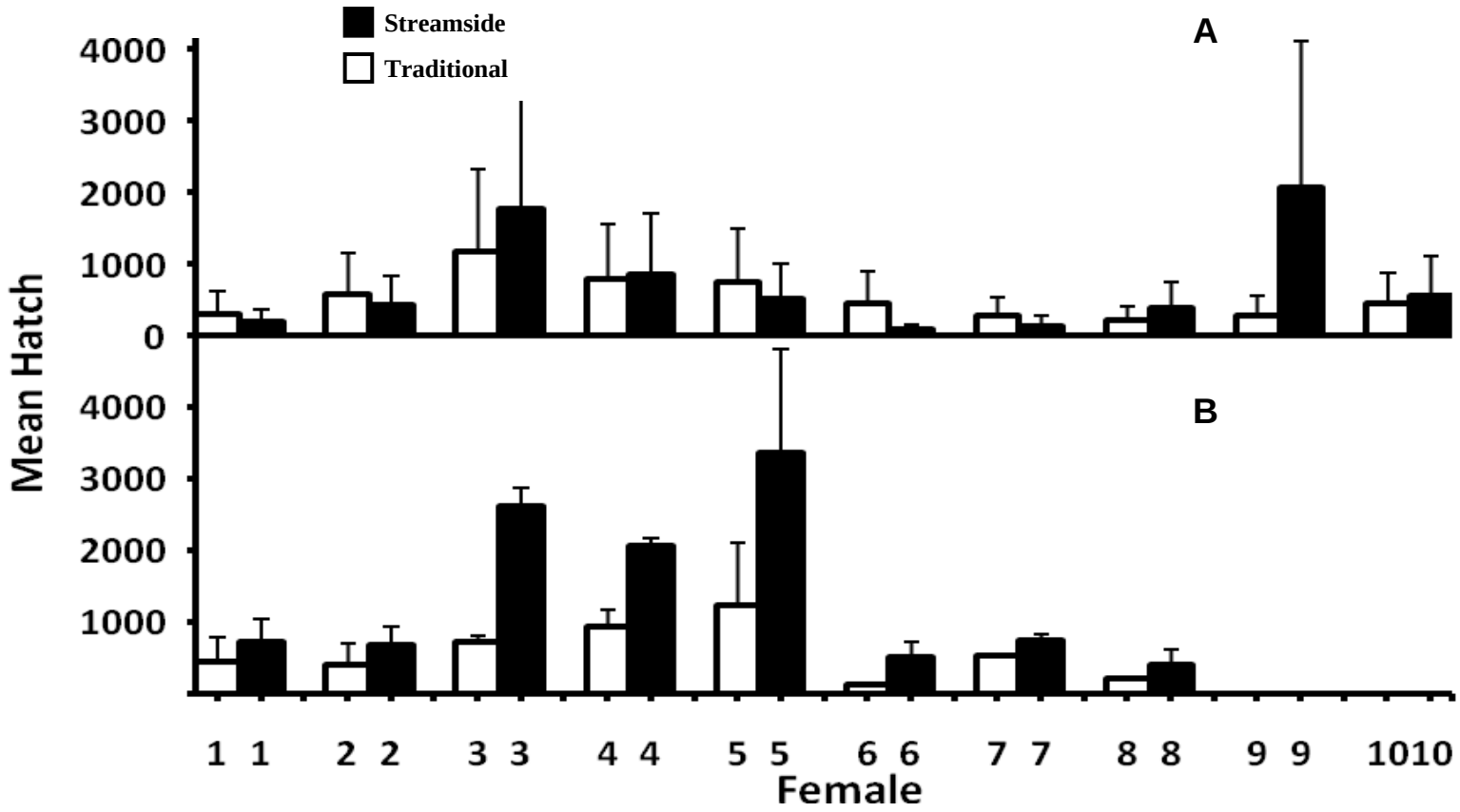
Larval Drift



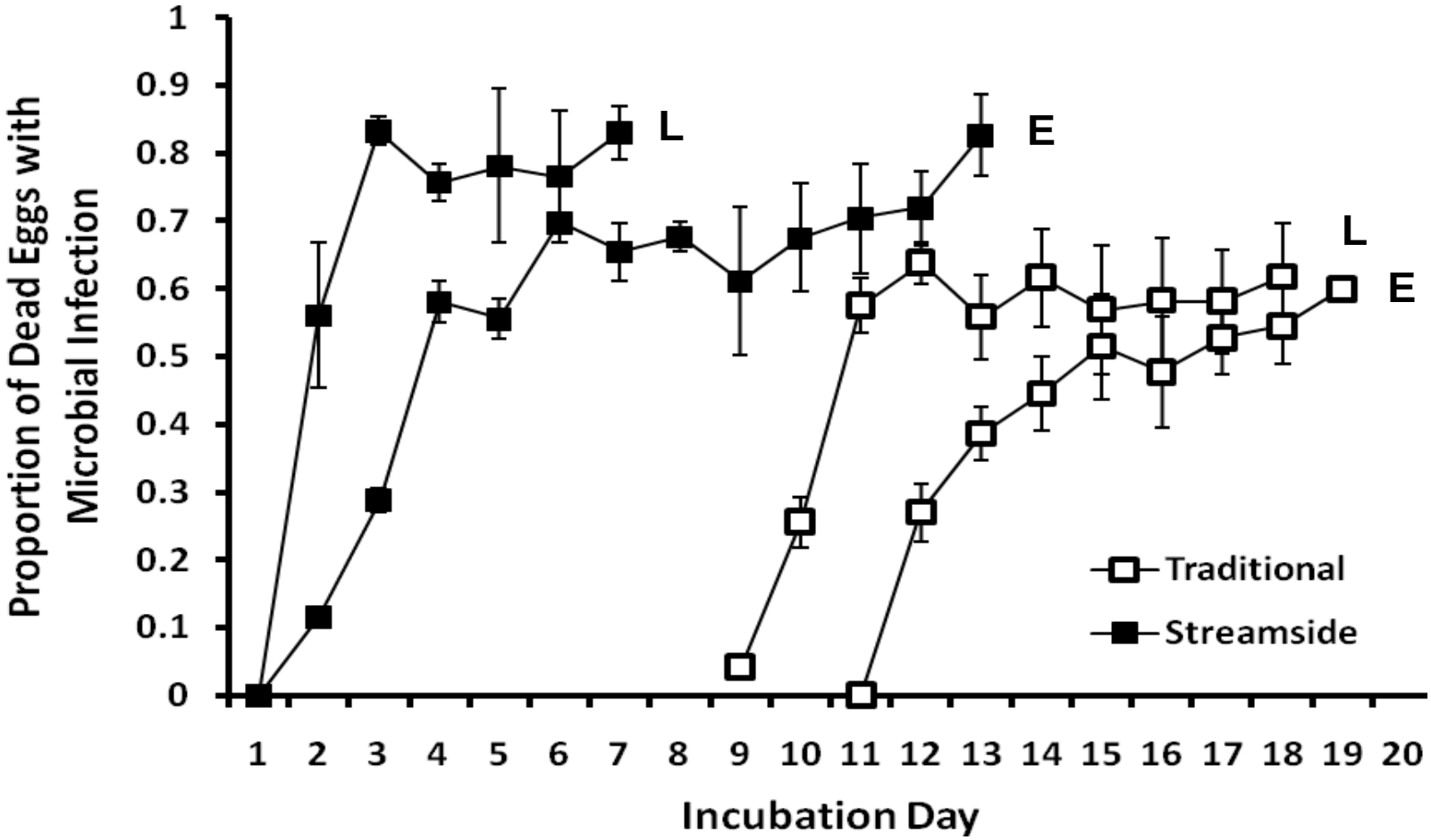
Treatment 2: Rearing Conditions

1: Wolf lake hatchery facility, Mattawan, MI.

2: Stream side rearing on the Upper Black River.

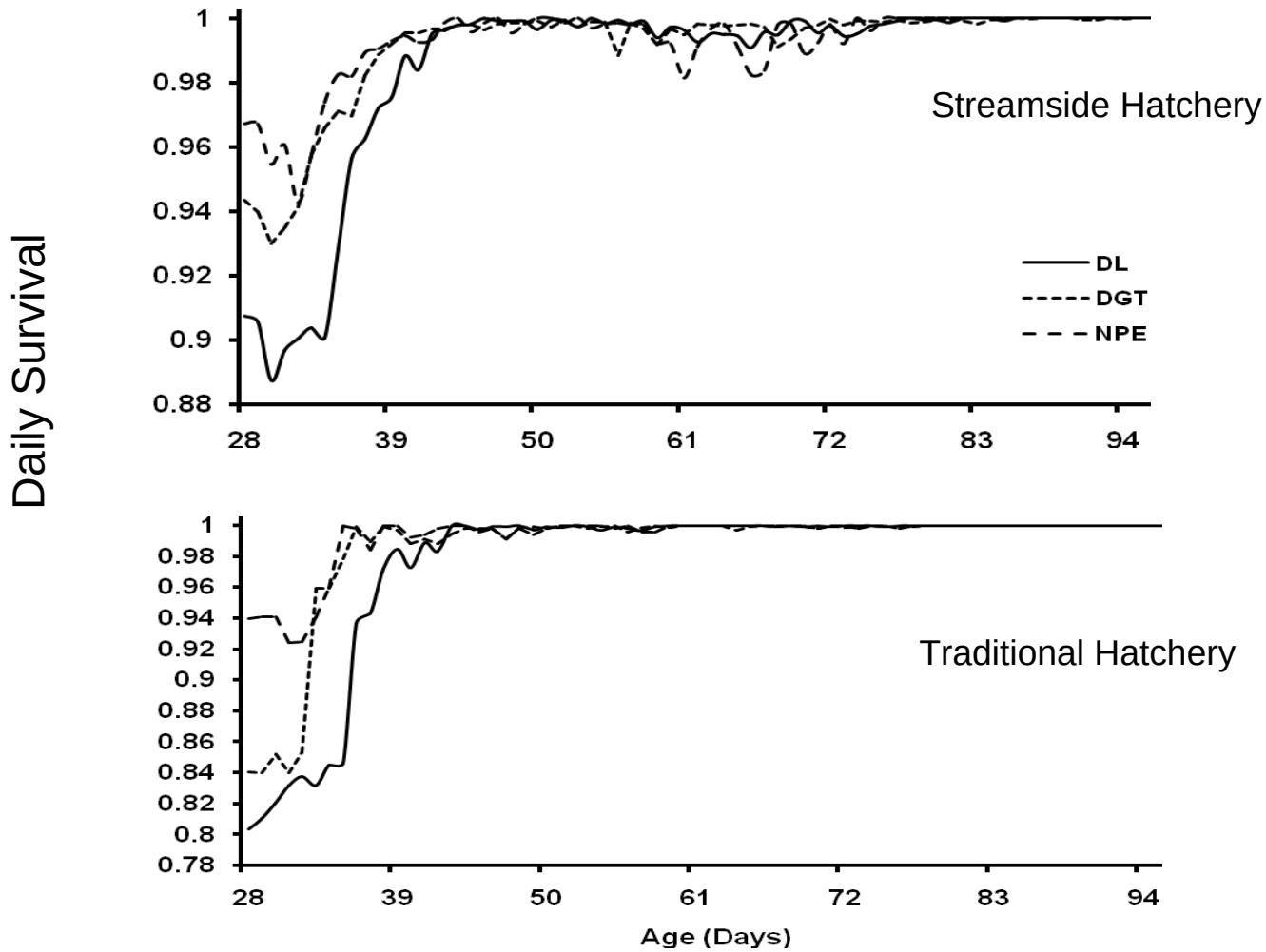


Number of larvae hatched (mean ± 1SD) from females in two different hatchery environments in A) 2005, and B) 2006.



Daily mortality attributed to microbial-induced embryonic development arrest (mean ± 1SE) for 2 different groups of eggs from early-reproducing (E) and late-reproducing (L) females reared in natal stream water at a streamside research facility and in ground water at a traditional hatchery.

Estimates of daily survival of juvenile lake sturgeon produced using different collection methods and reared in different hatcheries

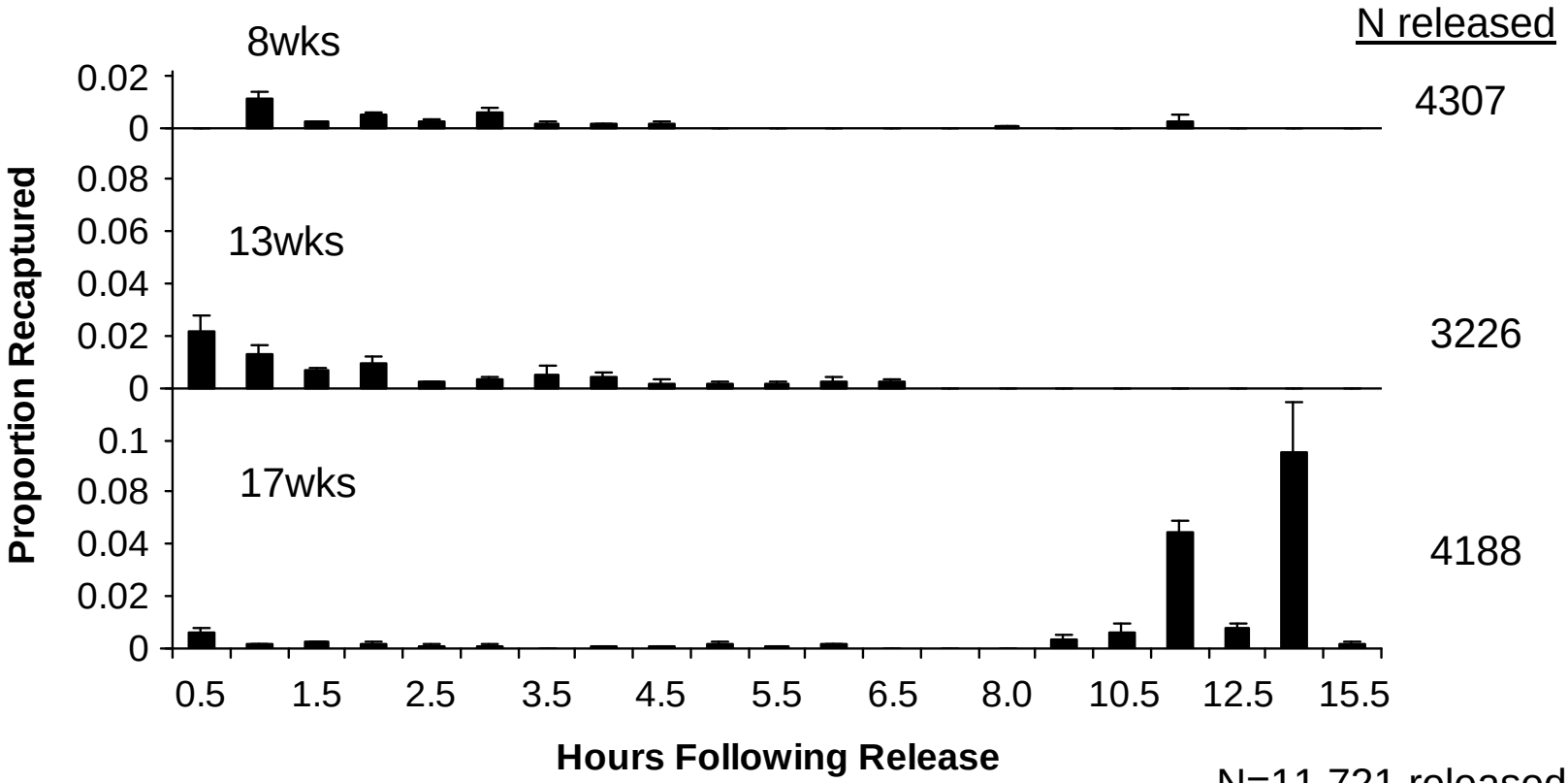


Comparison of measures of genetic diversity among offspring collection and rearing methods

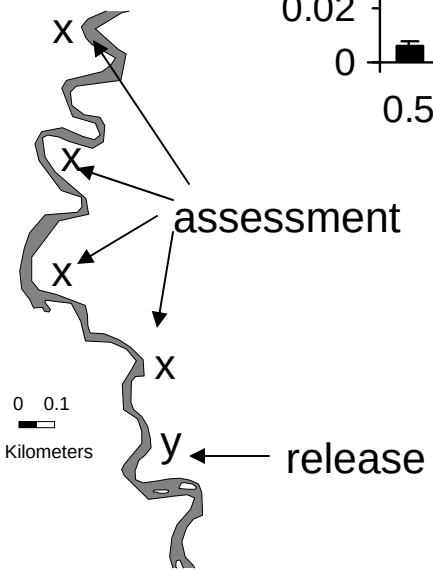
Treatments					
Collection Method	Hatchery Envir.	N	N_{male}:N_{female}	relatedness θ	N_{ev}
Direct Gamete	Streamside	94,856	22:12	0.020	38
	Traditional	79,985	16:8	0.026	29
Natural Eggs[1]	Streamside	772	23:20	0.004	40
	Traditional	366	18:16	0.014	14
Dispersed[1] Larvae	Streamside	3500	42:30	0.004	70
	Traditional	2000	49:35	0.004	88

[1]Determined using genetic determination of parentage.

The proportion of juvenile lake sturgeon captured at consecutive hours following release into the Upper Black River at 8, 13, and 17 weeks of age

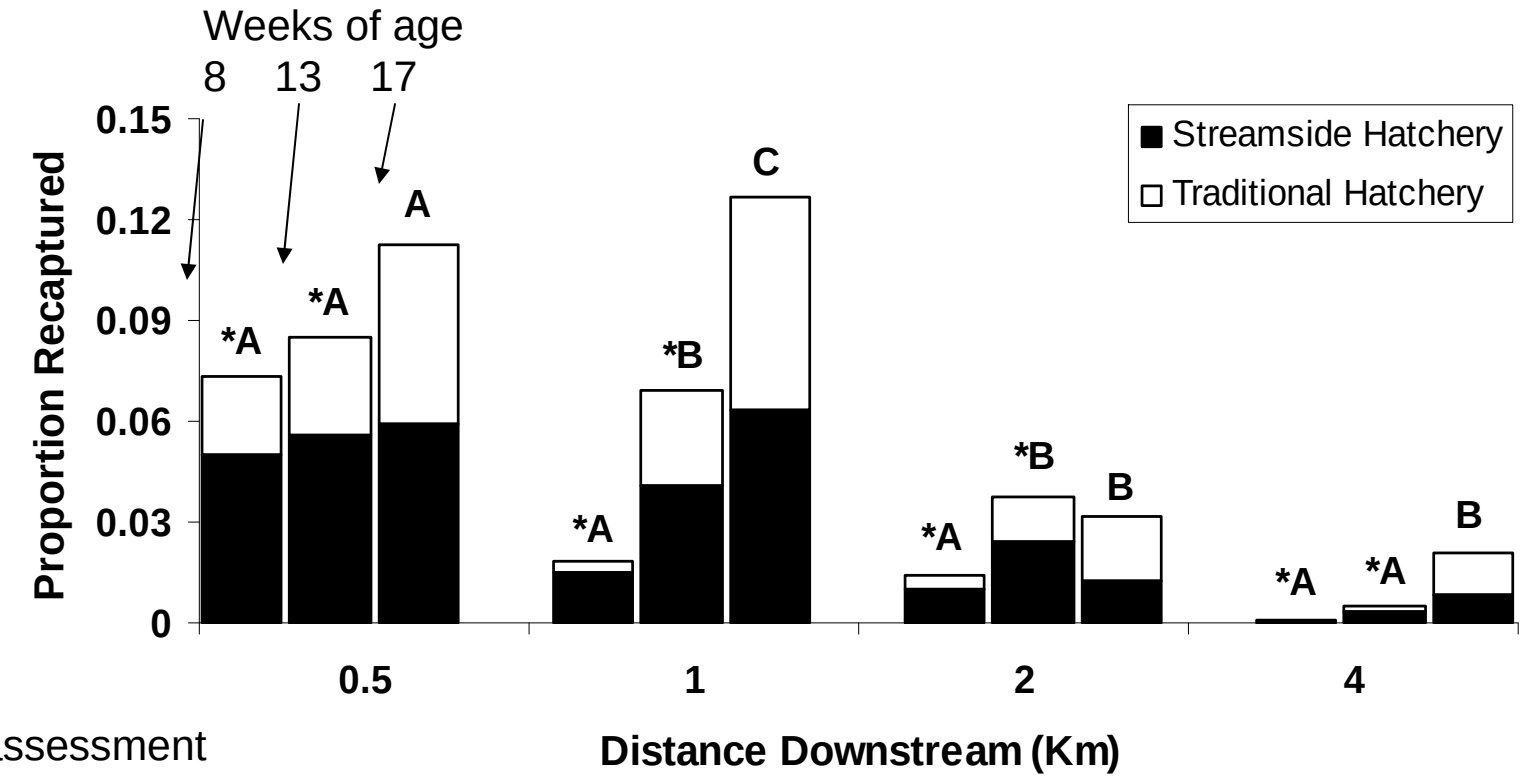


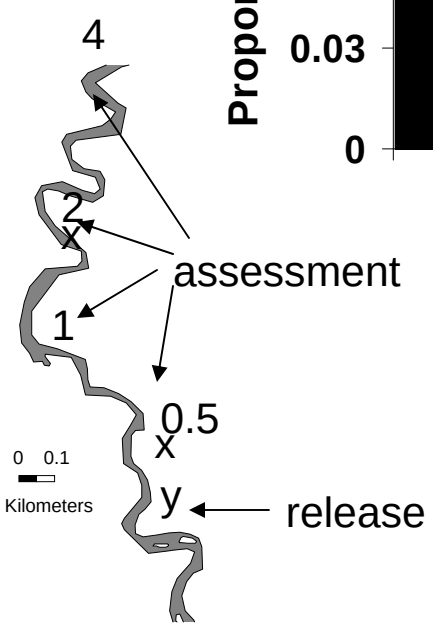
N=11,721 released



drift nets used
for assessment

Estimates of juvenile lake sturgeon survival during simulated release





Significant Effects

- age at release
- rearing environment (for ages 8 and 13 weeks)

Proposed management action #2 (juvenile survival)

- rear progeny in stream-side facilities if release is to occur at younger/smaller ages
- release progeny at larger size and/or older ages
- release progeny at night

Proposed management action #3 (genetic diversity of released juveniles)

- juveniles sampled from the larval drift represent a larger and likely more representative sample from spawning adults than do either alternative methods evaluated
- lower inter-family variance in juvenile survival was realized in stream-side compared to traditional rearing environments

Acknowledgements

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