Fish Passage Research on the Cape Fear River

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Dennis DeVries
Rusty Wright
Henry Hershey

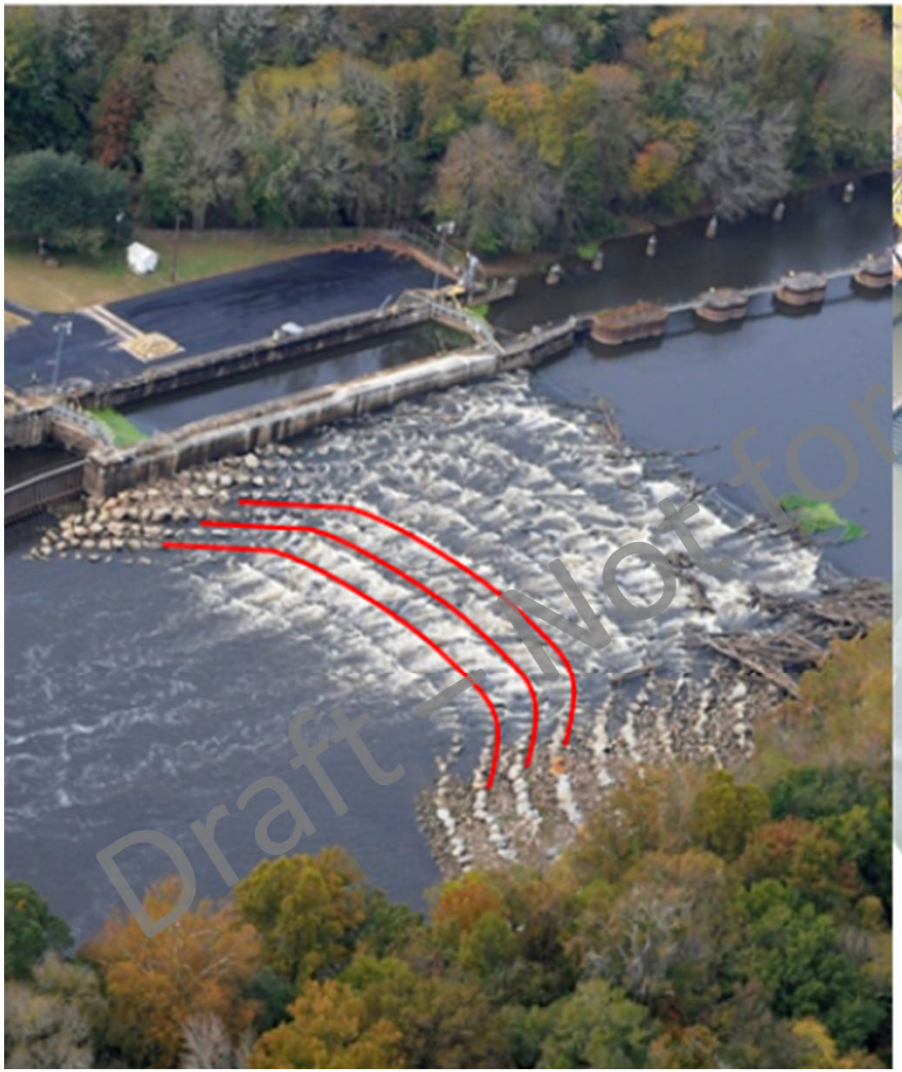
CAPE FEAR RIVER PARTNERSHIP

Dawn York
Frank Yelverton

Cape Fear River

- Several diadromous fish species
  - Striped bass
  - American shad
  - River herring (bluebacks/alewife)
  - Atlantic/shortnose sturgeon
  - American eel
- Historical spawning grounds near the fall line (Smiley Falls)
  - 200+ km upriver
- Three lock and dam structures constructed between 1915-1934
  - All downriver of historic spawning area
  - Some passage through locking
  - LD1 modified in 2012 and again in 2021

Before Modifications: 2013



After Modifications: 2021

Fish Passage on the Cape Fear River, NC

Use of both fine-scale and broad-scale acoustic telemetry to study:

- Migration timing
- Movement behavior
- Passage efficiency at the rock arch rapids at Lock & Dam 1
- Potential to enhance fish passage using environmental flows

Collaborative effort:

- Clemson University
- UNCW
- USACE
- Nature Conservancy

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ARTICLE

Evaluation of Fish Passage at a Nature-Like Rock Ramp Fishway on a Large Coastal River

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Original fishway design did not meet predetermined success criteria (80% passage efficiency)

- American Shad 53-65%
- Striped Bass 19-25%

Cape Fear River Watch led efforts to modify the fishway to improve fish passage

- Modifications completed in summer/fall 2021

<u>Current Study:</u>

Replicate the previous study to evaluate the effectiveness of the modifications

Evaluate e-flow effects on fish passage at LD1, LD2, LD3

General study Timeline

Pre-modification

Spring 2021
Initial Tagging
Fine/broad-scale arrays
E-flow events

n=50
n=50

Modification

Fall 2021
Modifications to Fishway

Post-modification

Spring 2022
Additional tags
Fine/broad-scale arrays
E-flow events

n=50
n=50

Spring 2023
Repeat Raabe study
Broad-scale + receiver gates
E-flow events

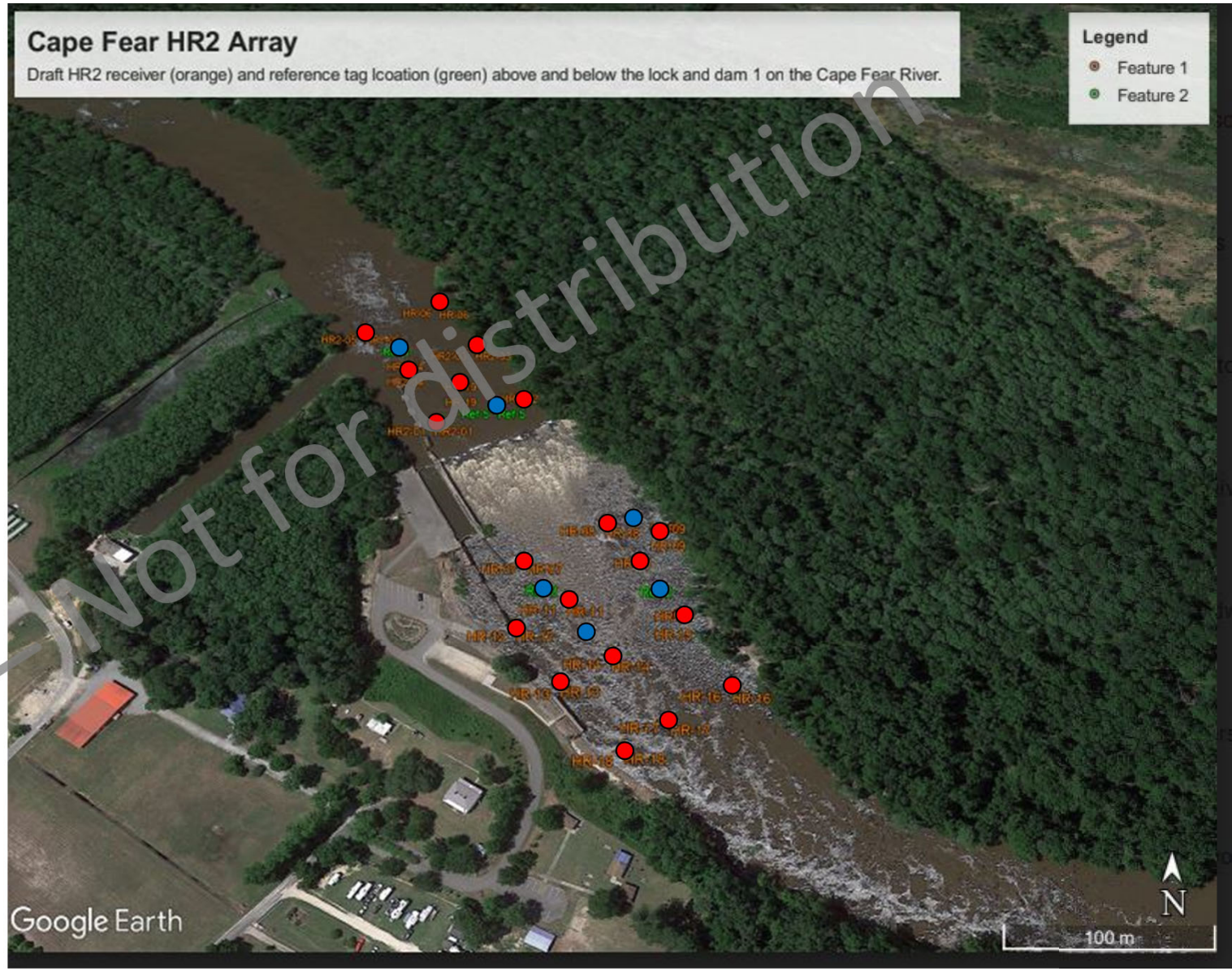
n=100
n=100
n=20

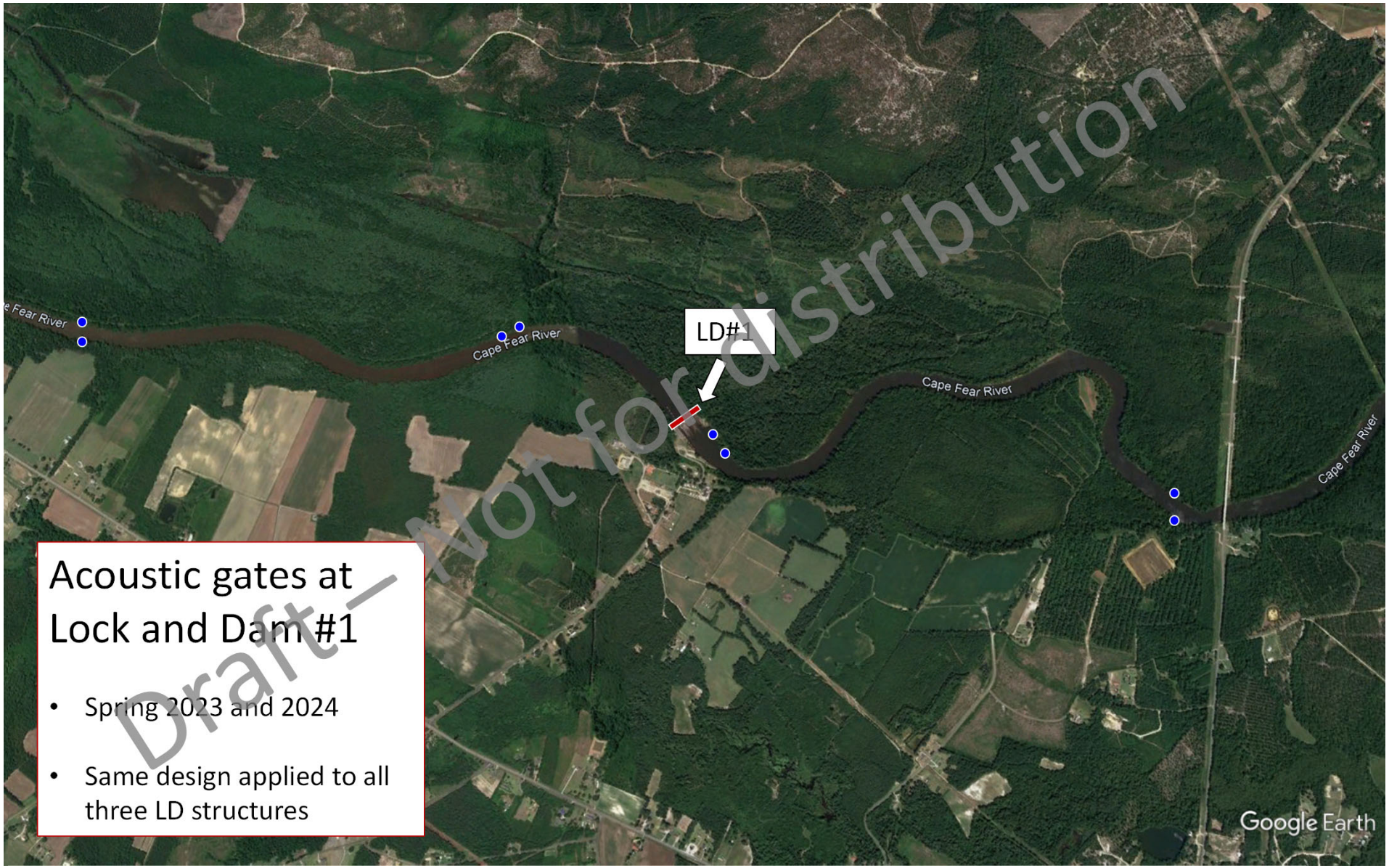
Spring 2024
Repeat Raabe study
Broad-scale + receiver gates
E-flow events

n=100
n=100
n=20

Fine-scale acoustic receiver array at Lock and Dam #1

- In place for spring 2021 and spring 2022
- Fine-scale movement behavior below/above the fishway





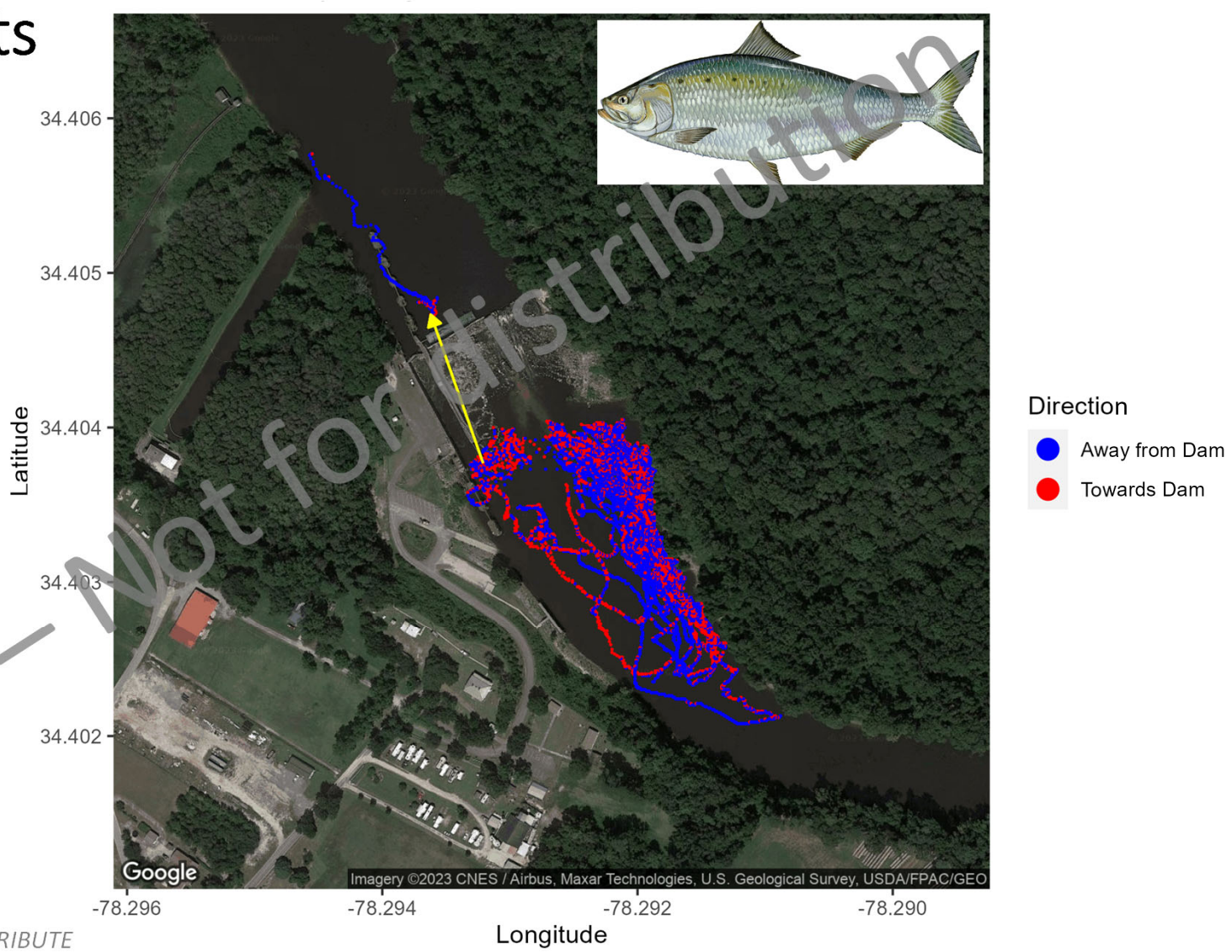
Acoustic gates at Lock and Dam #1

- Spring 2023 and 2024
- Same design applied to all three LD structures

Fine-Scale Results

American Shad

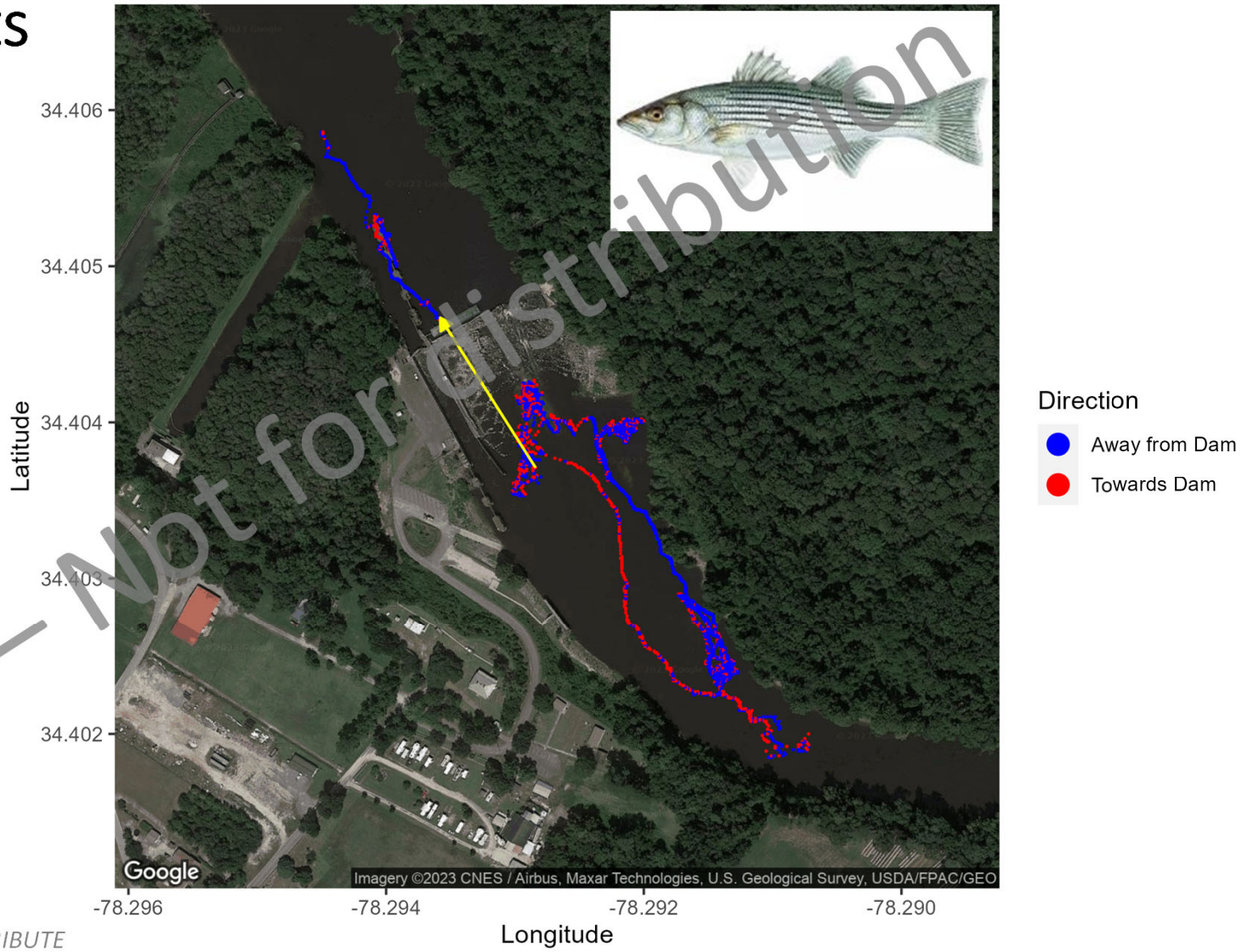
- Tagged below LD1
  - March 20, 2021
- Total length = 473 mm (18.5”)
- Passed LD1
  - April 12, 2021
  - Discharge = 6,200 cfs



Fine-Scale Results

Striped Bass

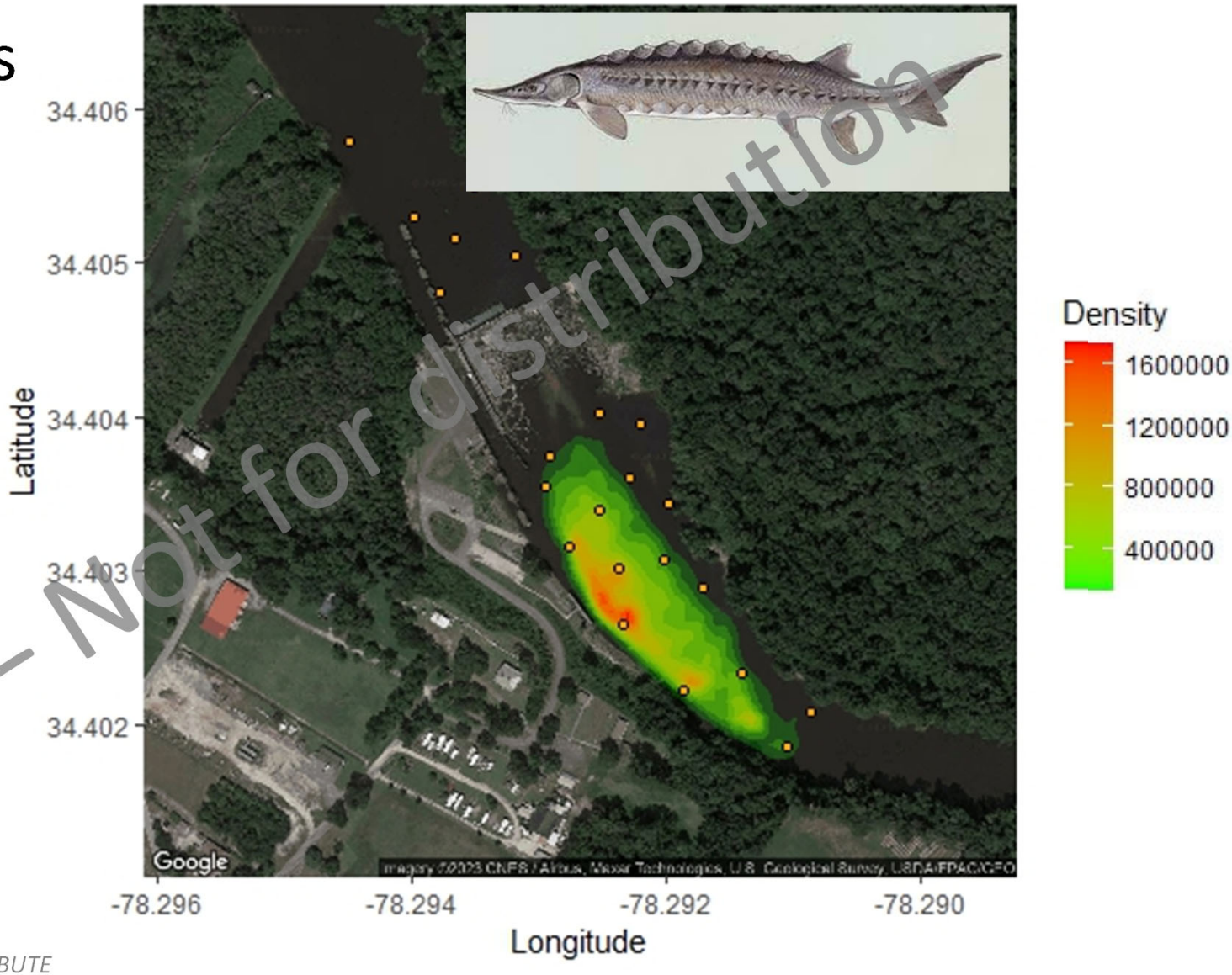
- Tagged below LD1
  - March 13, 2022
- Total length = 505 mm (20”)
- Passed LD1
  - May 21, 2022
  - Discharge = 1,360 cfs



Fine-Scale Results

Atlantic Sturgeon Kernel Density Plot Spring 2022

- No tagged ATS passed LD1
- Extensive movement below LD1 during April 2022
  - Spawning?
- Nine (9) tagged ATS spent time in lower array
- ATS present from April - May



Broad-Scale Passage Results
American Shad

		LD1		
Total Tagged (Location)	**Year**	**Available**	**Passed**	**Raw Eff (%)**
50 (LD1)	2013	30	16	53%
50 (LD1)	2014	23	15	65%
25 (LD1)	2015	10	6	60%
41 (LD1)	2021	15	7	47%
60 (LD1), 32 (LD2)	2022	49	27	55%
50(LD1), 25 (LD2), 24 (LD3)	2023	39	28	72%

Raabe et al. 2019
Original fishway

Current study
Original fishway

Current study
Modified fishway

Mean American Shad passage efficiency across years:

Original Fishway = **56.2%**

Modified Fishway = **63.5%**

Broad-Scale Passage Results
American Shad

		LD1			LD2				LD3			
Total Tagged (Location)	**Year**	**Available**	**Passed**	**Raw Eff (%)**	**Available**	**Passed**	**Raw Eff (%)**		**Available**	**Passed**	**Raw Eff (%)**	
50 (LD1)	2013	30	16	53%	14	5	36%		5	5	100%	
50 (LD1)	2014	23	15	65%	14	8	57%	**53%**	6	5	83%	**92%**
25 (LD1)	2015	10	6	60%	6	4	67%		NA	NA	NA	
41 (LD1)	2021	15	7	47%	3	1	33%		1	0	0%	
60 (LD1), 32 (LD2)	2022	49	27	55%	40	13	33%	**43%**	13	2	15%	**22%**
50(LD1), 25 (LD2), 24 (LD3)	2023	39	28	72%	46	29	63%		45	23	51%	

Raabe et al. 2019
Locking 2-3x daily

Current study
Limited (2021) or
No locking (2022-2023)

Broad-Scale Fish Passage
Striped Bass

		LD1		
Total Tagged (location)	**Year**	**Available**	**Passed**	**Raw Eff (%)**
118 (LD1)	2013	42	8	19%
35 (LD1)	2014	79	17	22%
50 (LD1)	2015	53	13	25%
37 (LD1)	2021	9	2	22%
40 (LD1)	2022	50	18	36%
75 (LD1), 25 (LD2)	2023	72	24	33%

Raabe et al. 2019
Original fishway

Current study
Original fishway

Current study
Modified fishway

Mean Striped Bass Passage across years:

Original Fishway = **22.0%**

Modified Fishway = **34.2%**

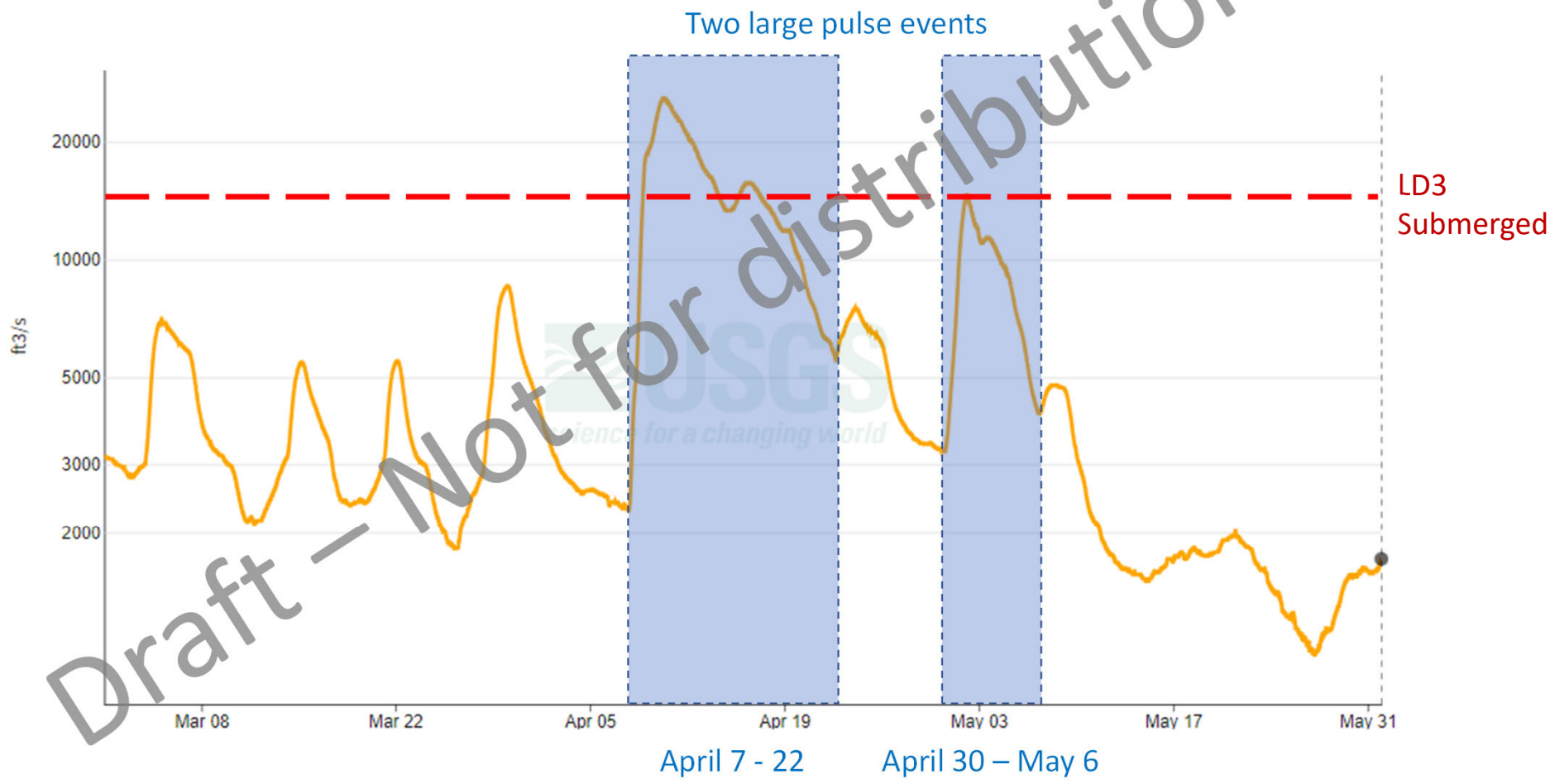
Broad-Scale Fish Passage
Striped Bass

		LD1			LD2				LD3			
Total Tagged (location)	**Year**	**Available**	**Passed**	**Raw Eff (%)**	**Available**	**Passed**	**Raw Eff (%)**		**Available**	**Passed**	**Raw Eff (%)**	
118 (LD1)	2013	42	8	19%	9	7	78%		7	7	100%	
35 (LD1)	2014	79	17	22%	18	16	89%	**82%**	15	8	53%	**77%**
50 (LD1)	2015	53	13	25%	9	7	78%		NA	NA	NA	
37 (LD1)	2021	9	2	22%	2	1	50%		1	0	0%	
								48%				**15%**
40 (LD1)	2022	50	18	36%	17	8	47%		8	0	0%	
75 (LD1), 25 (LD2)	2023	72	24	33%	38	18	47%		18	8	44%	

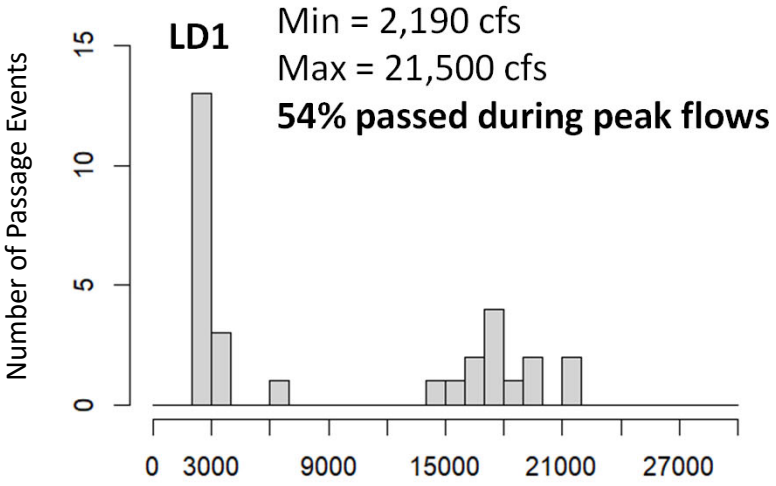
Raabe et al. 2019
Locking 2-3x daily

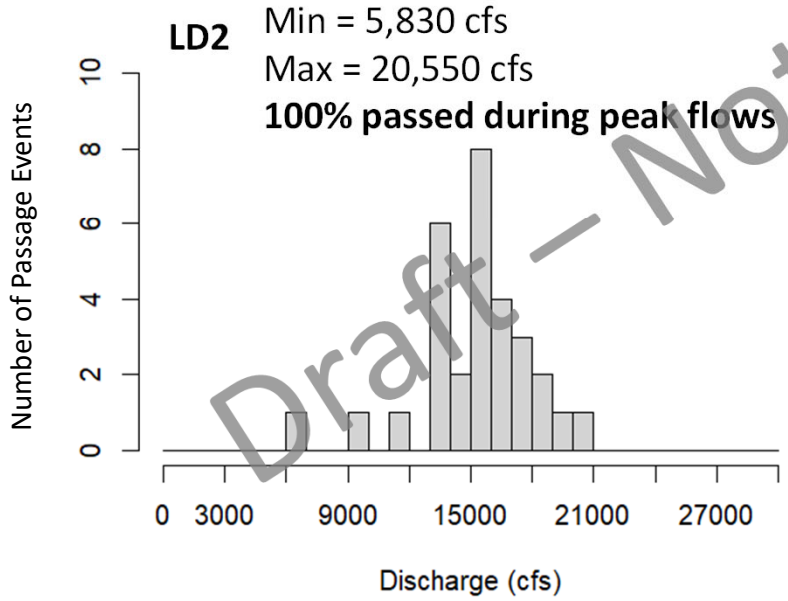
Current study
Limited (2021) or
No locking (2022-2023)

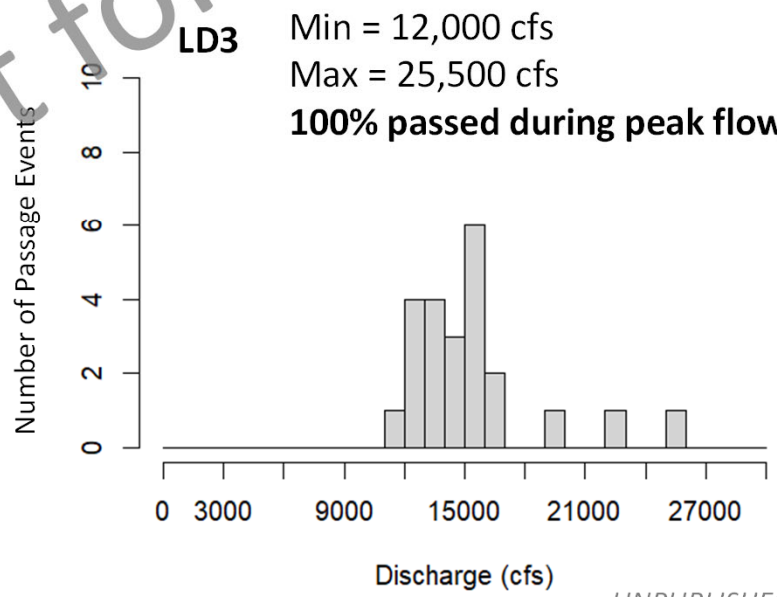
Flow Effects on Fish Passage, 2023



Flow Effects on Fish Passage, 2023
American Shad



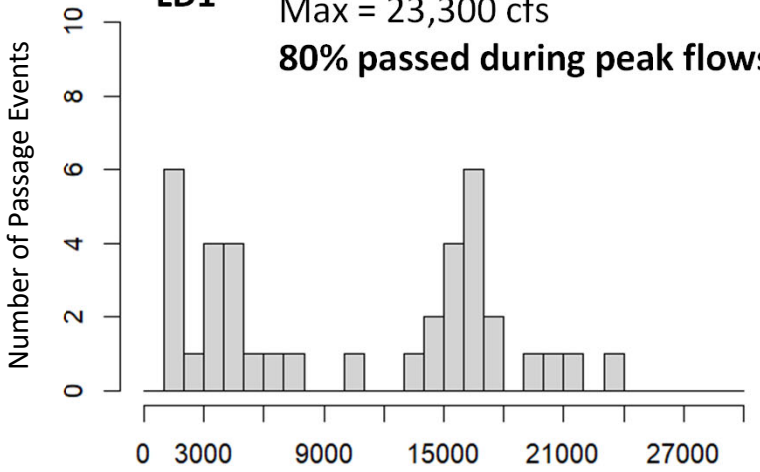




Flow Effects on Fish Passage, 2023
Striped Bass

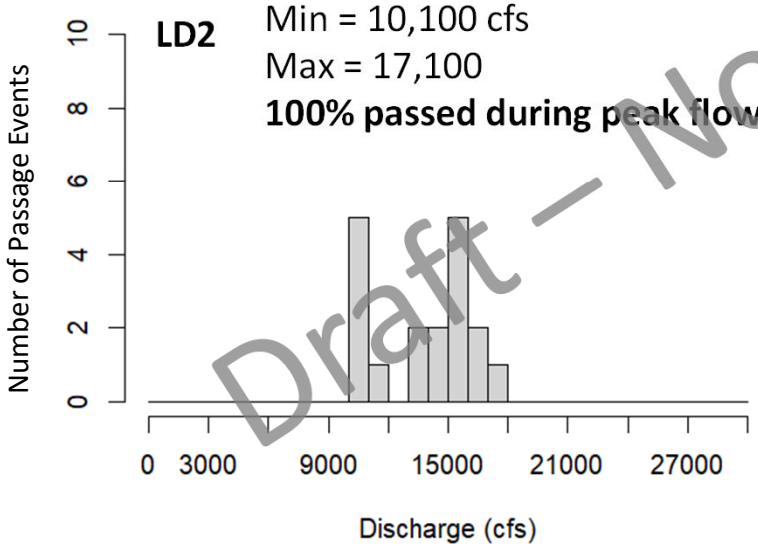
LD1

Min = 1,520 cfs
Max = 23,300 cfs
80% passed during peak flows



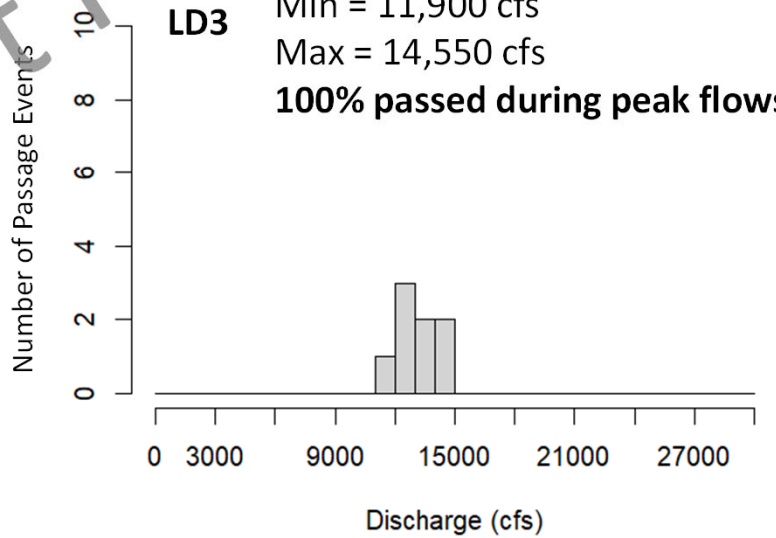
LD2

Min = 10,100 cfs
Max = 17,100
100% passed during peak flows



LD3

Min = 11,900 cfs
Max = 14,550 cfs
100% passed during peak flows



Take Home Messages

Preliminary results: modest improvements in American Shad and Striped Bass passage efficiency at LD1 following modification of the fishway

- LD1 fishway still well below 80% target
- American Shad 64% passage efficiency during 2022-2023
- Striped Bass 34% passage efficiency during 2022-2023

E-flow pulse events supported 100% of passage events at LD2, LD3 during 2022-2023

- Repaired locks at LD2, LD3 allow potential for conservation lockage to resume in 2024

Fine-scale movement study providing value insight into fish movement/behaviors

- Pre- and post-modification to LD1 fishway
- Flow effects on fish movement & passage

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