EXPLORING RIO GRANDE SILVERY MINNOW MOVEMENT DYNAMICS IN THE MIDDLE RIO GRANDE

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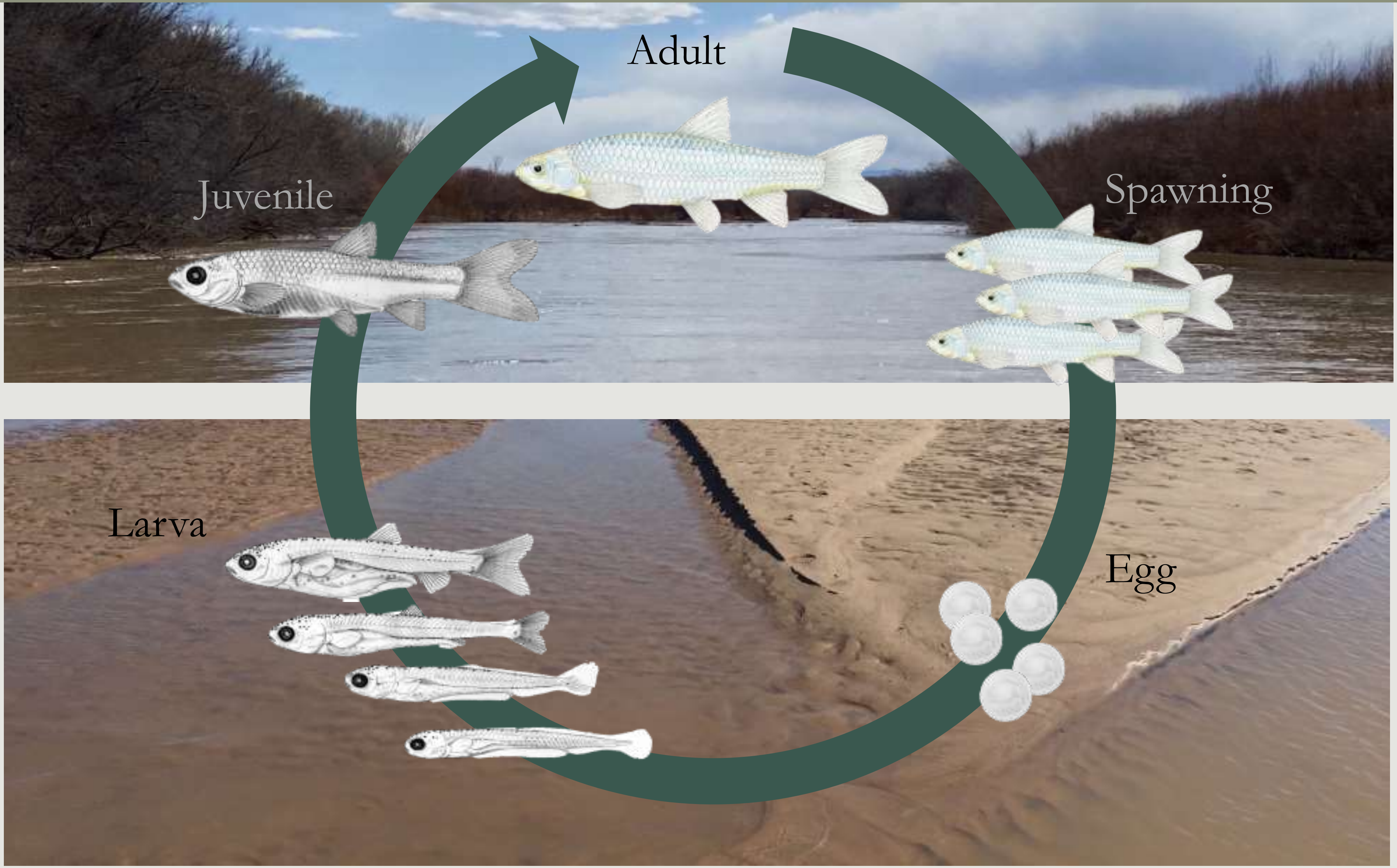
Middle Rio Grande Endangered Species Collaborative Program
Science Symposium
14 February 2024

MOVEMENT PATTERNS AND SPACE USE



WHY DO FISH MOVEMENT PATTERNS MATTER?

- Advance conservation and management efforts
- Provide insight into larger ecological processes

RIO GRANDE SILVERY MINNOW (RGSM)

Hybognathus amarus

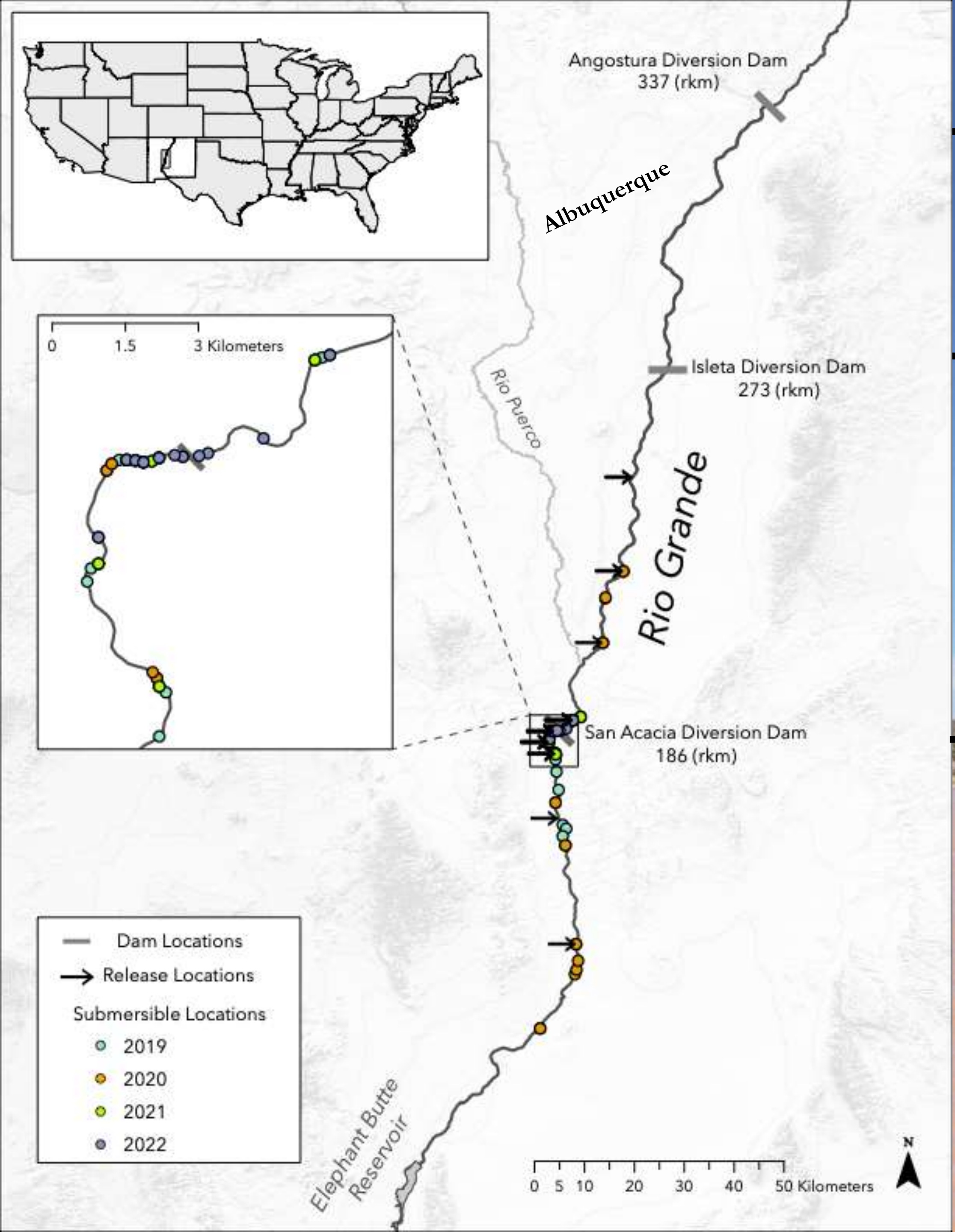
Average Body Length: 50 mm SL

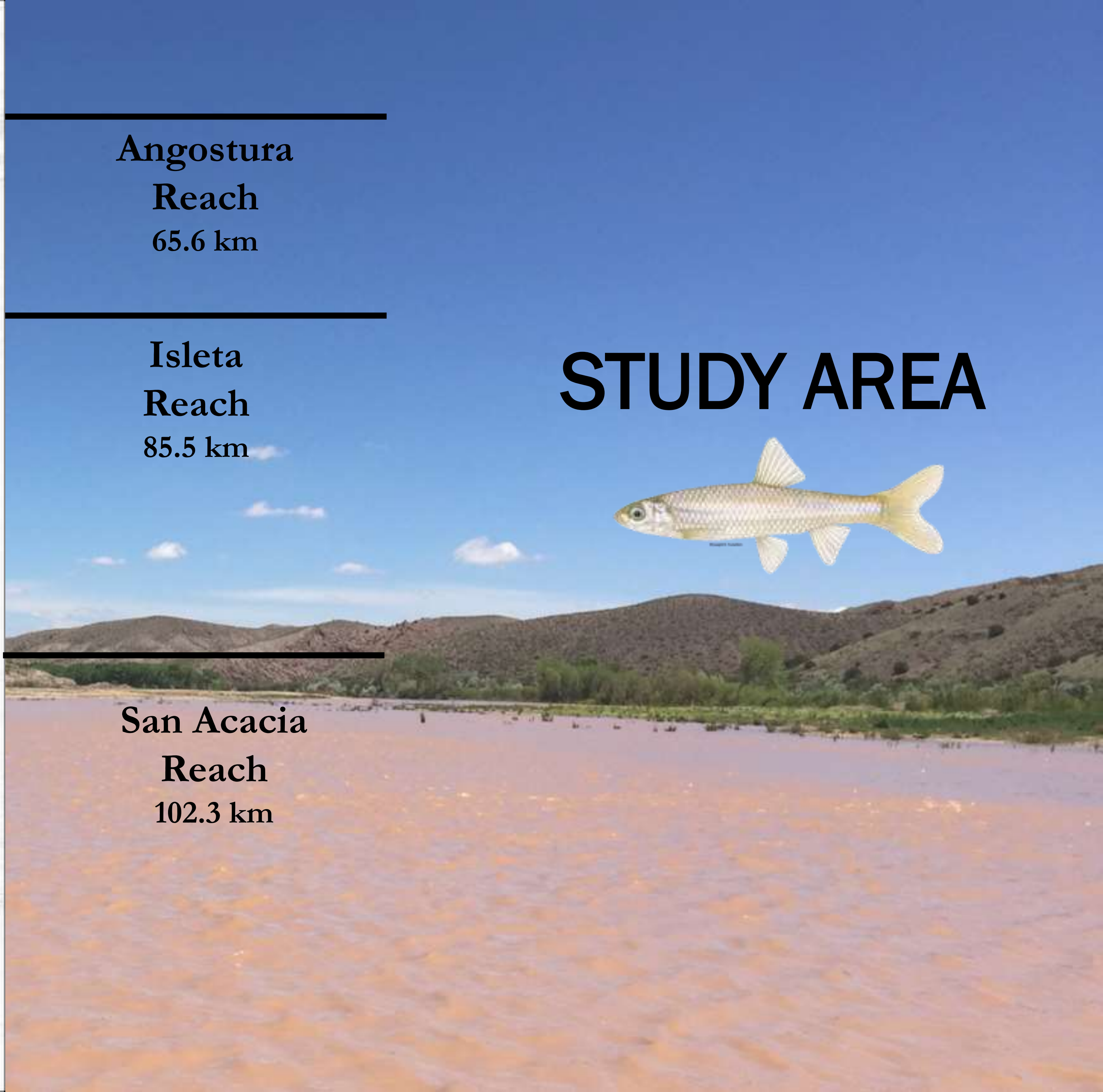
Age–0 to Age–3

Maturity <1 year

Photo by Tom Kennedy

STUDY AREA


Angostura Diversion Dam
337 (rkm)
Albuquerque
Isleta Diversion Dam
273 (rkm)
Rio Puerco
Rio Grande
San Acacia Diversion Dam
186 (rkm)
0
1.5
3 Kilometers
Dam Locations
Release Locations
Submersible Locations
2019
2020
2021
2022
Elephant Butte Reservoir
0 5 10 20 30 40 50 Kilometers
N


Angostura
Reach
65.6 km
Isleta
Reach
85.5 km
San Acacia
Reach
102.3 km

RESEARCH GOALS

- Characterize RGSM movement patterns and metrics
- Estimate reach–specific movement probabilities

APPROACH

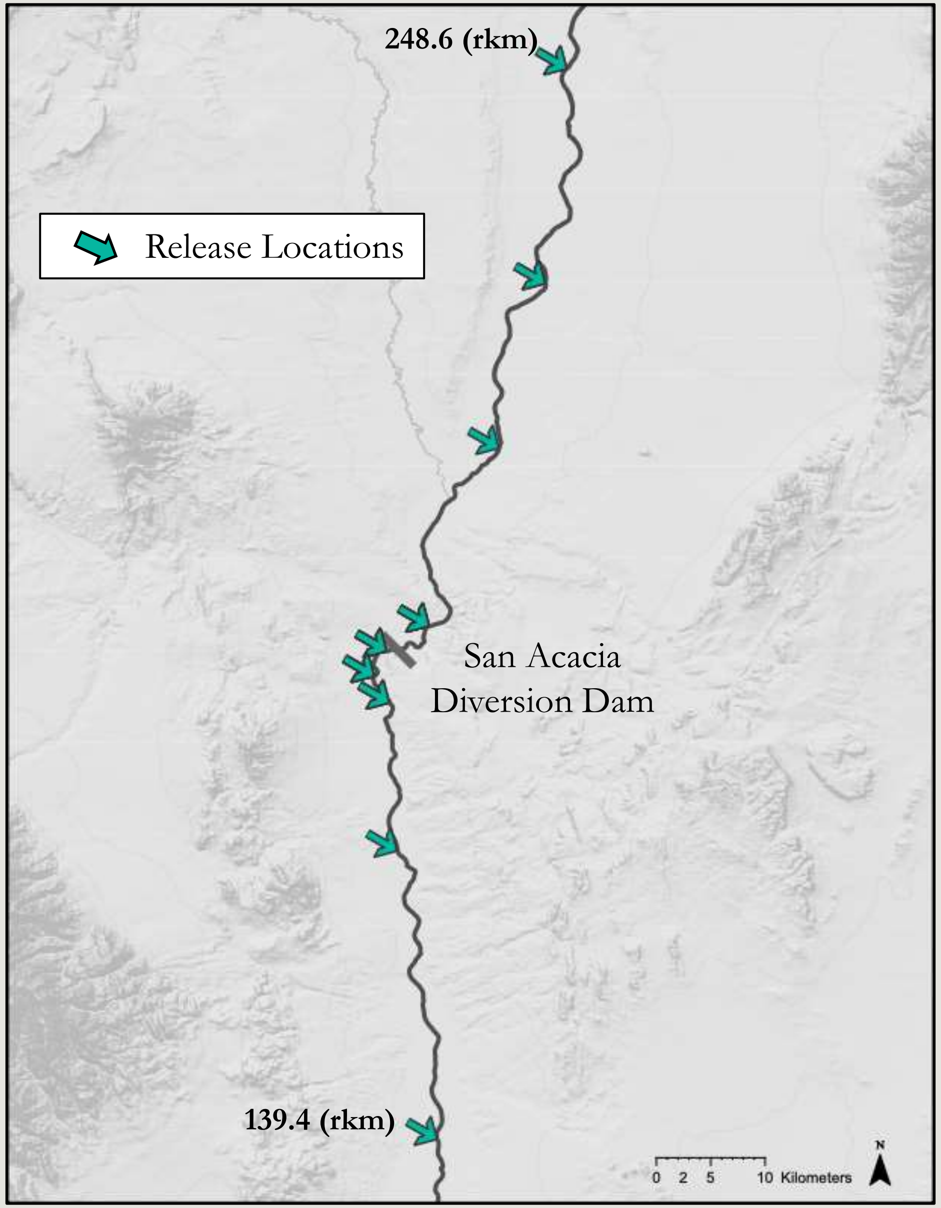
- PIT tag hatchery reared RGSM
- Detect RGSM movements using multiple antennae types
- Characterize movement patterns based on detection data

PASSIVE INTEGRATED TRANSPONDER (PIT) TAGS

Combined retention and survival rate to release of **88%**

FISH RELEASES

Year	Number Released
2018	736
2019	11,576
2020	7,916
2021	13,996
2022	2,991



Total Released	37,215

DETECTIONS

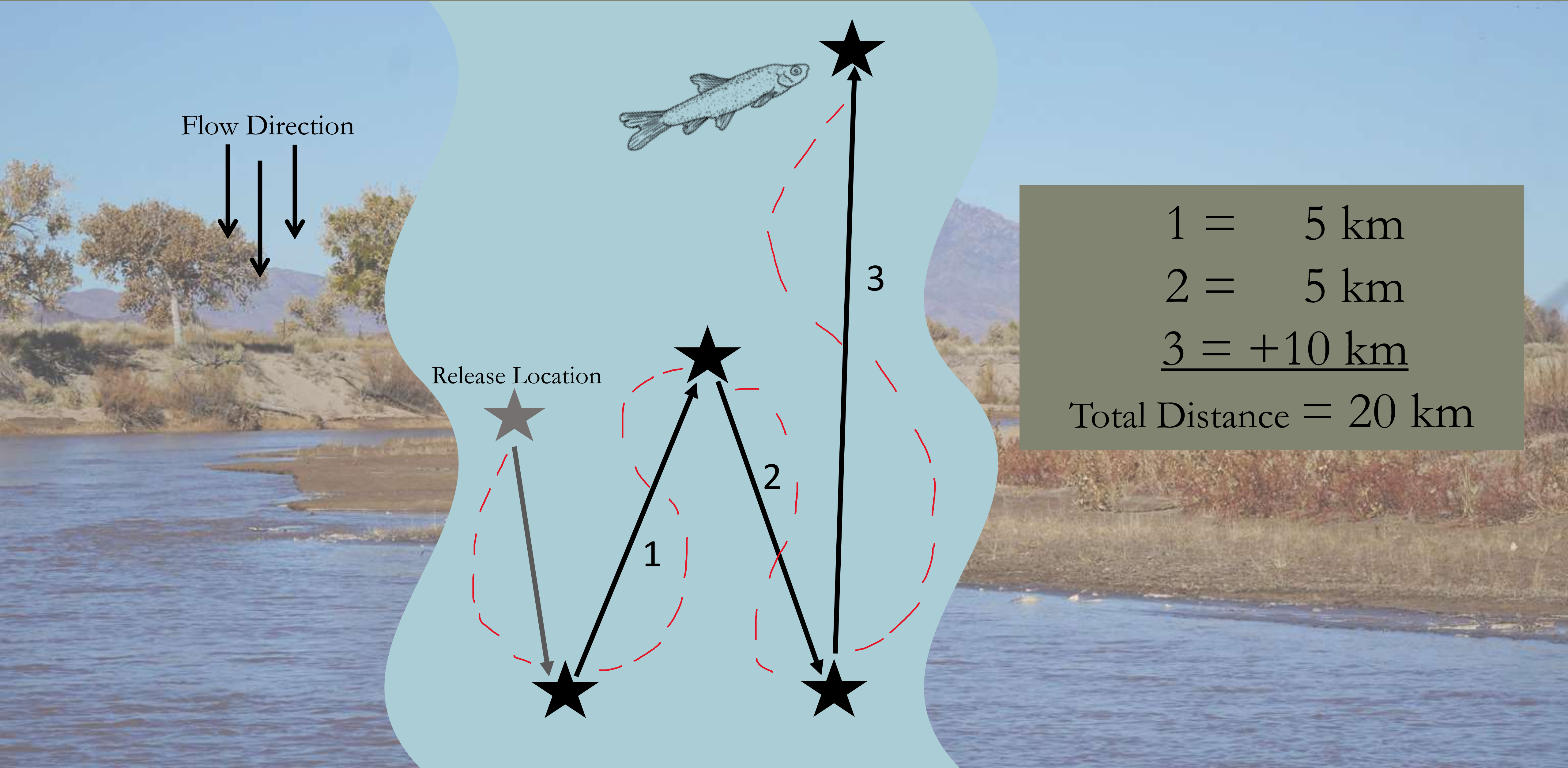
RESULTS: EFFICIENCY

Total Released	Unique Detections	Detection Rate
37,215	13,706	**36%**

RESEARCH GOALS

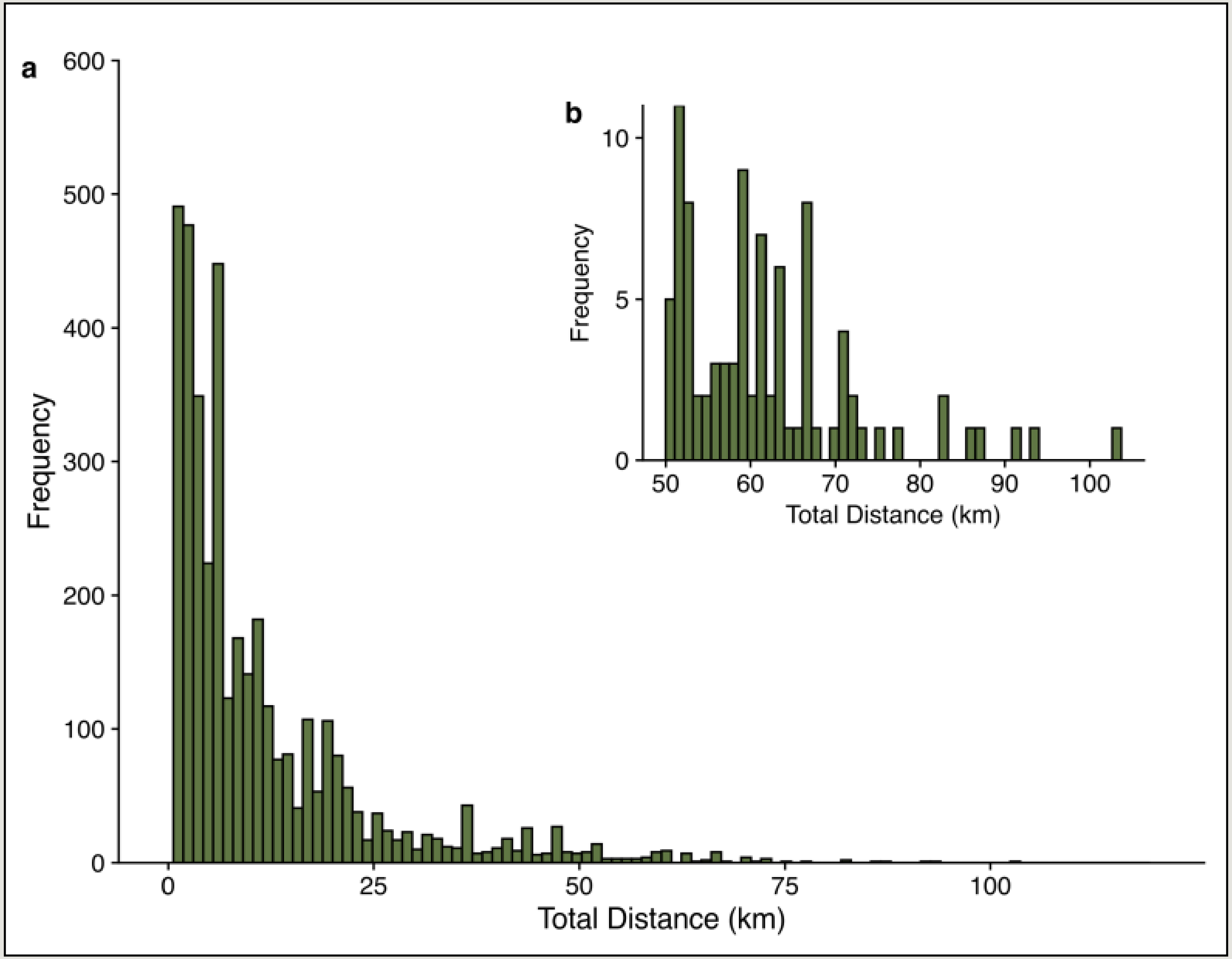
- Characterize RGSM movement patterns and metrics
- Estimate reach–specific movement probabilities

TOTAL MOVEMENT

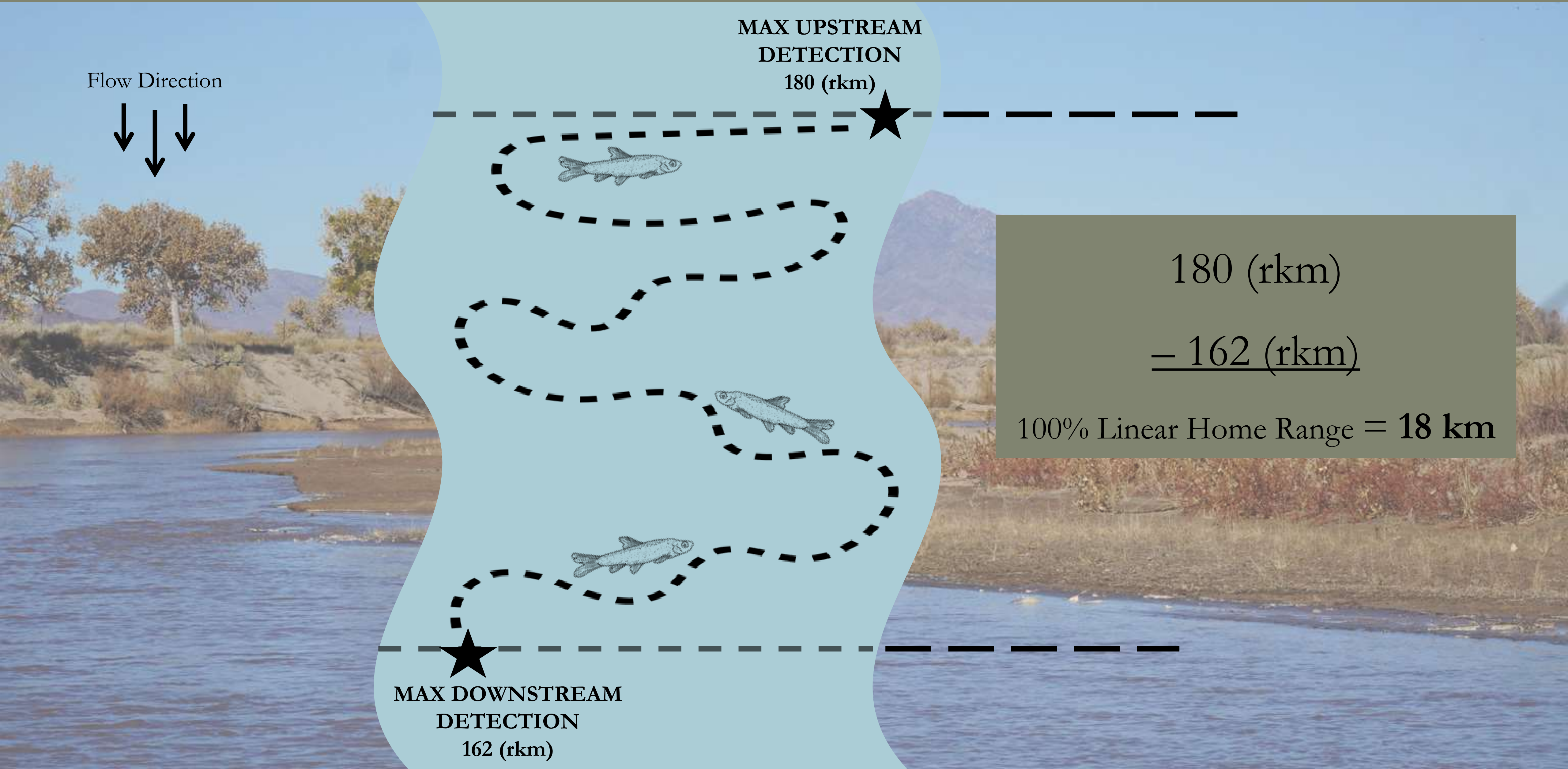


RESULTS: TOTAL DISTANCE MOVED

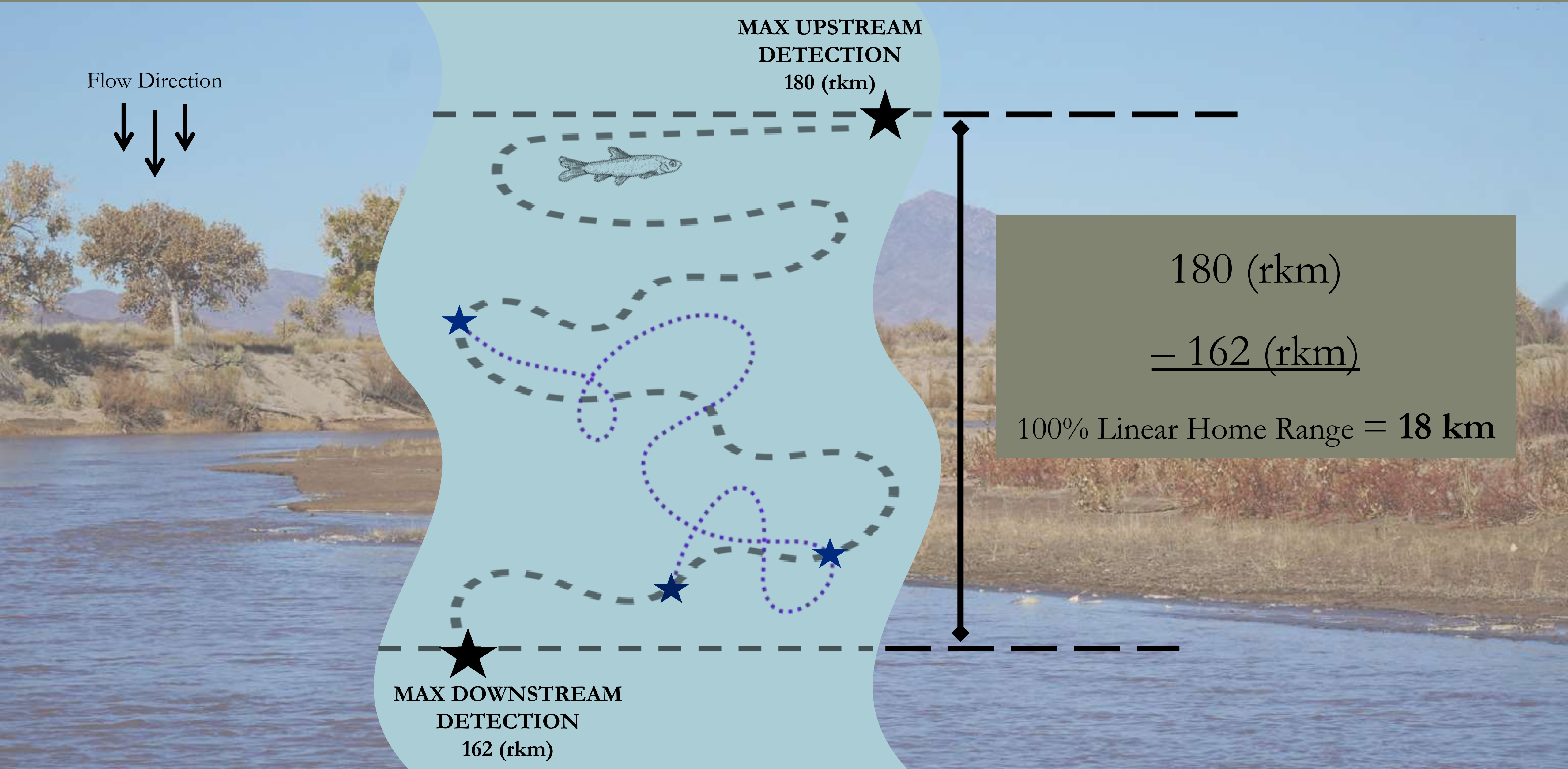
kurtosis = 8.8
z = 85.9
p-value <0.01*



100% LINEAR HOME RANGE



100% LINEAR HOME RANGE

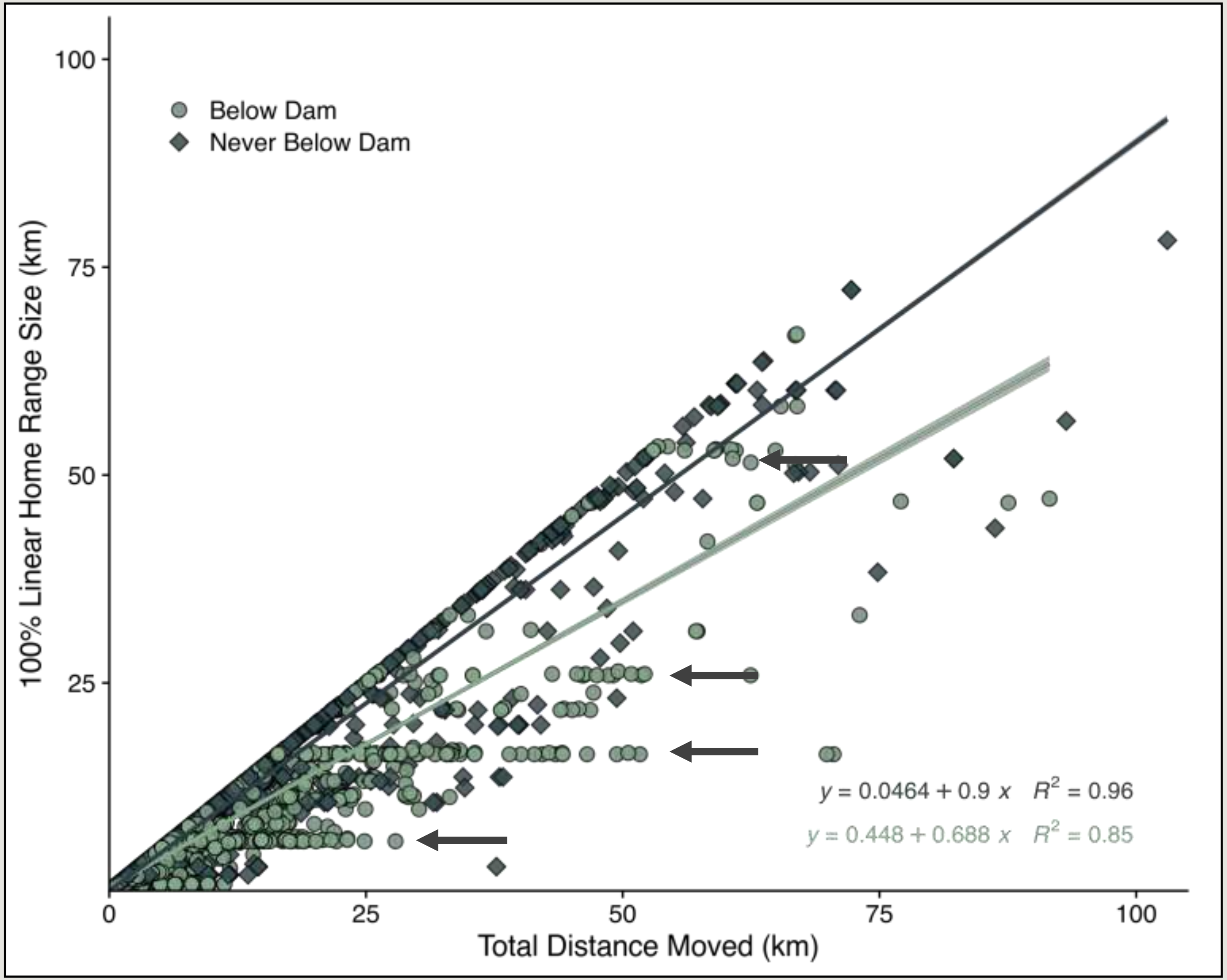


180 (rkm)

– 162 (rkm)

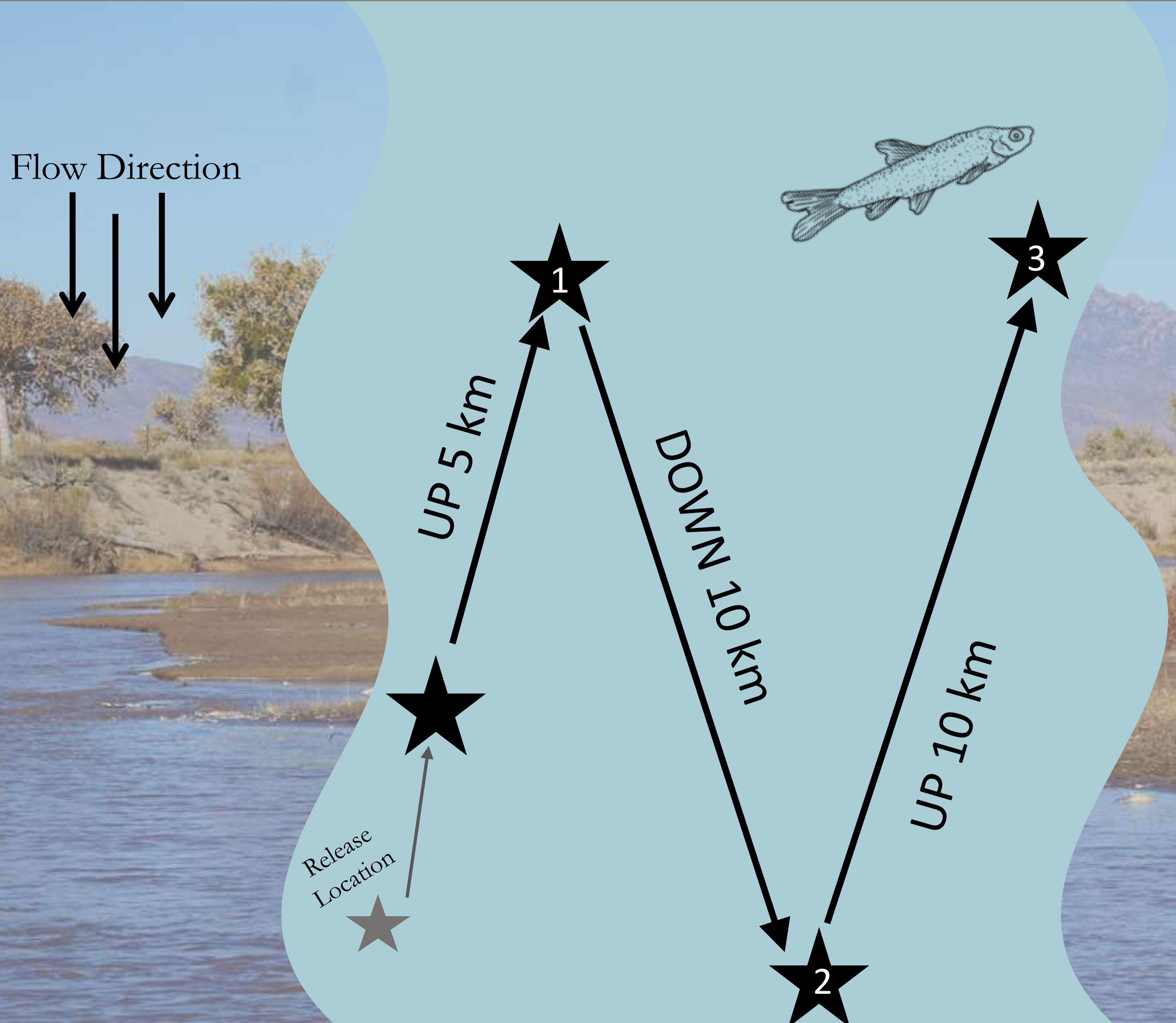
100% Linear Home Range = **18 km**

RESULTS: LINEAR HOME RANGE



Total distances moved larger than home range sizes

NET DIRECTIONAL MOVEMENT

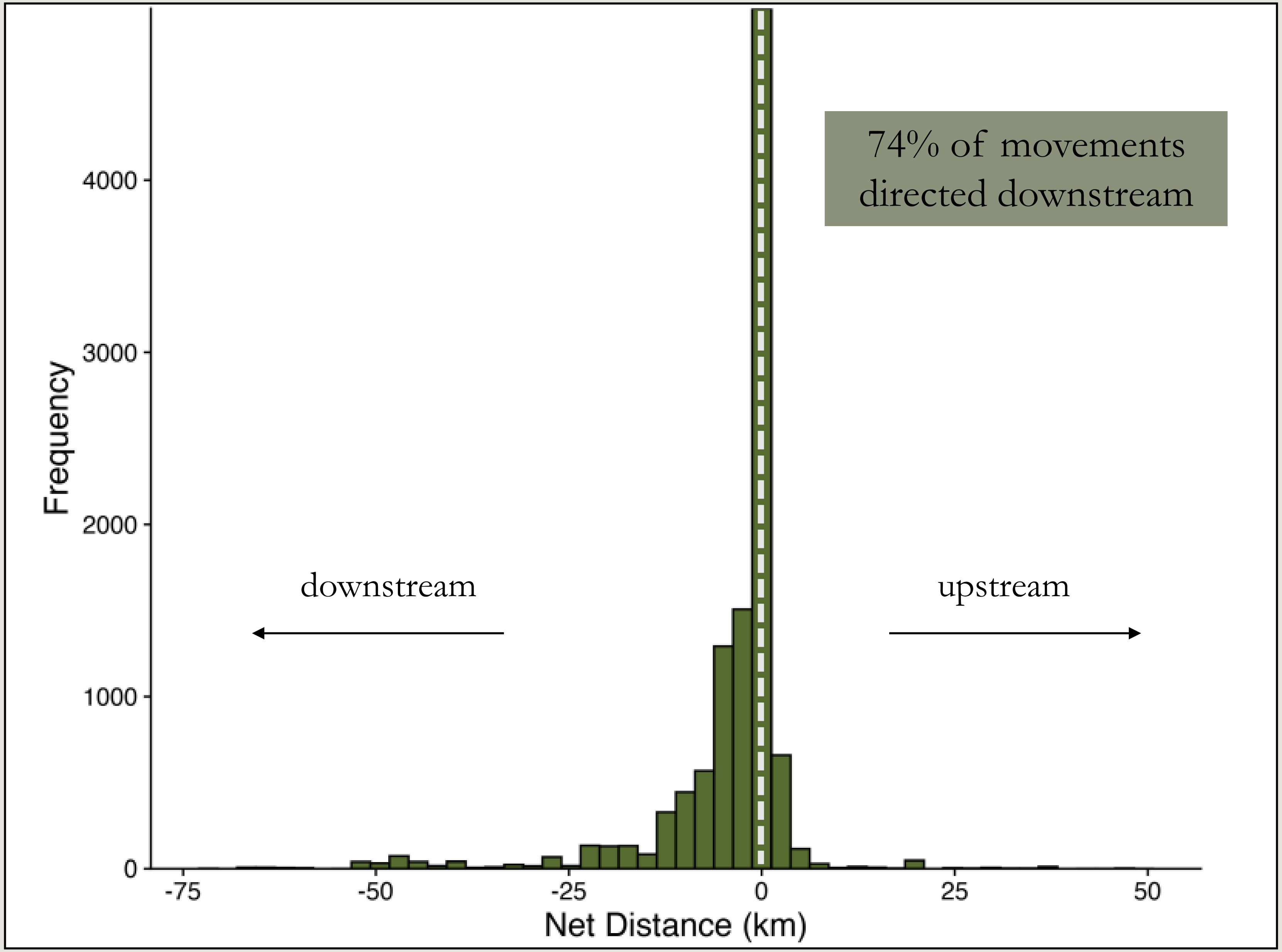


1 = +5 km
2 = -10 km
3 = +10 km

5 km

RESULTS: NET DIRECTIONAL MOVEMENT

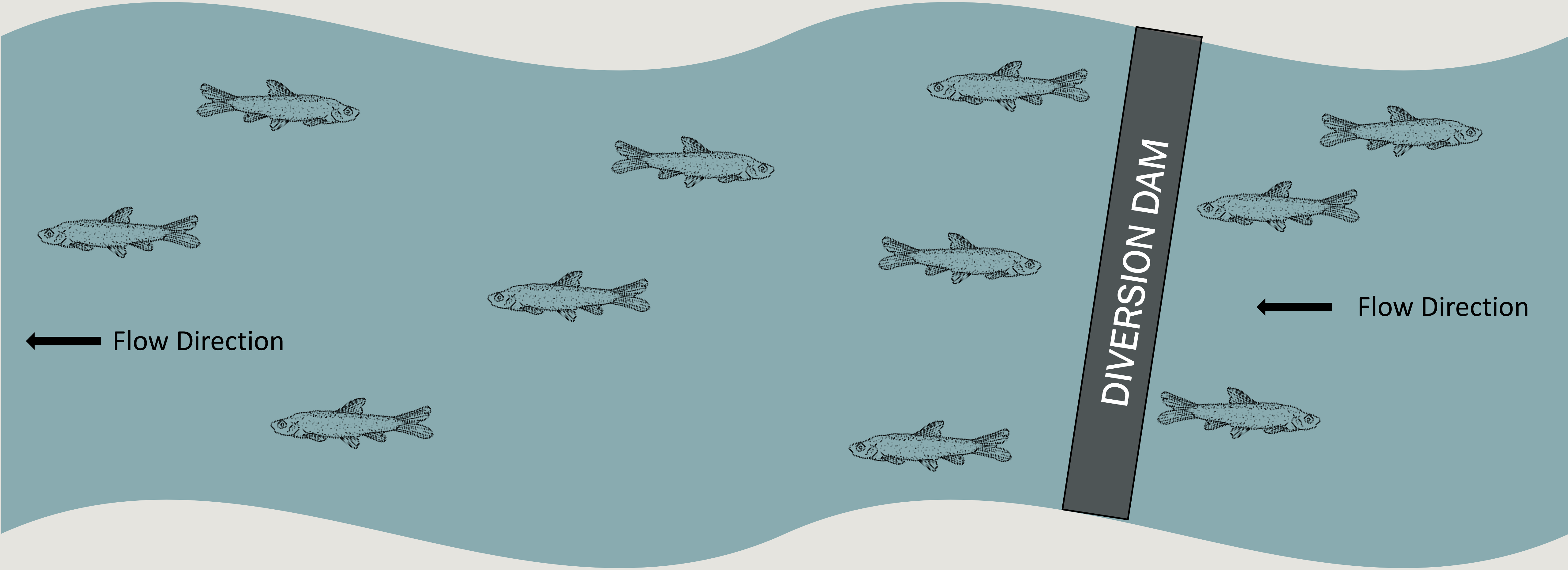
skewness = -2.6



CONCLUSIONS

- RGSM displayed a strong predilection to make long distance movements
  - Documented RGSM moving farther than previously recorded
- No upstream bias

NOMADIC MOVEMENT



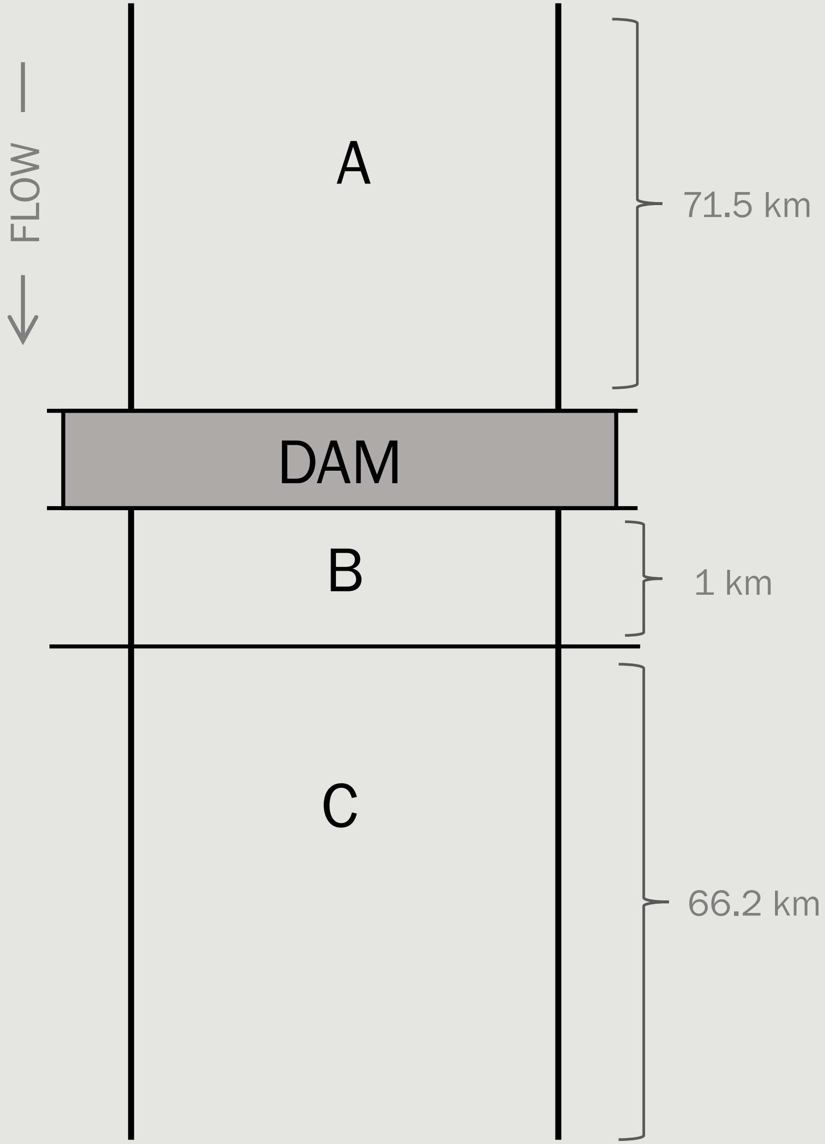
Illustrations by Tansy Remiszewski

RESEARCH GOALS

- Characterize RGSM movement patterns and metrics
- Estimate reach–specific movement probabilities

TIMESTEPS & REACHES

TIMESTEP	Spring	March to June	Peak discharge
TIMESTEP	Summer	July to October	Low discharge, River drying
TIMESTEP	Winter	November to February	Continuous discharge



FISH RELEASES

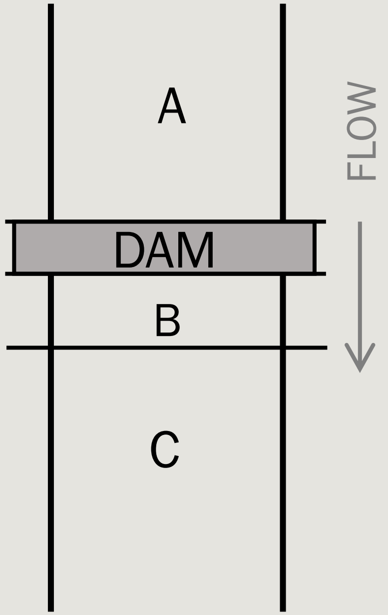
SPRING RELEASE			WINTER RELEASE		
Year	State	Number Released	Year	State	Number Released
2019	A	0	2019	A	2,604
	B	550		B	2,428
	C	1,151		C	4,846
2020	A	1,746	2020	A	0
	B	2,192		B	0
	C	3,979		C	0
2021	A	1,980	2021	A	5,730
	B	0		B	0
	C	2,885		C	3,422

MULTISTATE MODEL

$$\varphi(\text{state})\ p((\text{state}\times g\times \text{season})+(g\times t)+\text{yr})\ \psi((\text{state}\times \text{updownstay}\times \text{season})+(g\times t)+\text{yr})$$

RESULTS: STATE CHANGES

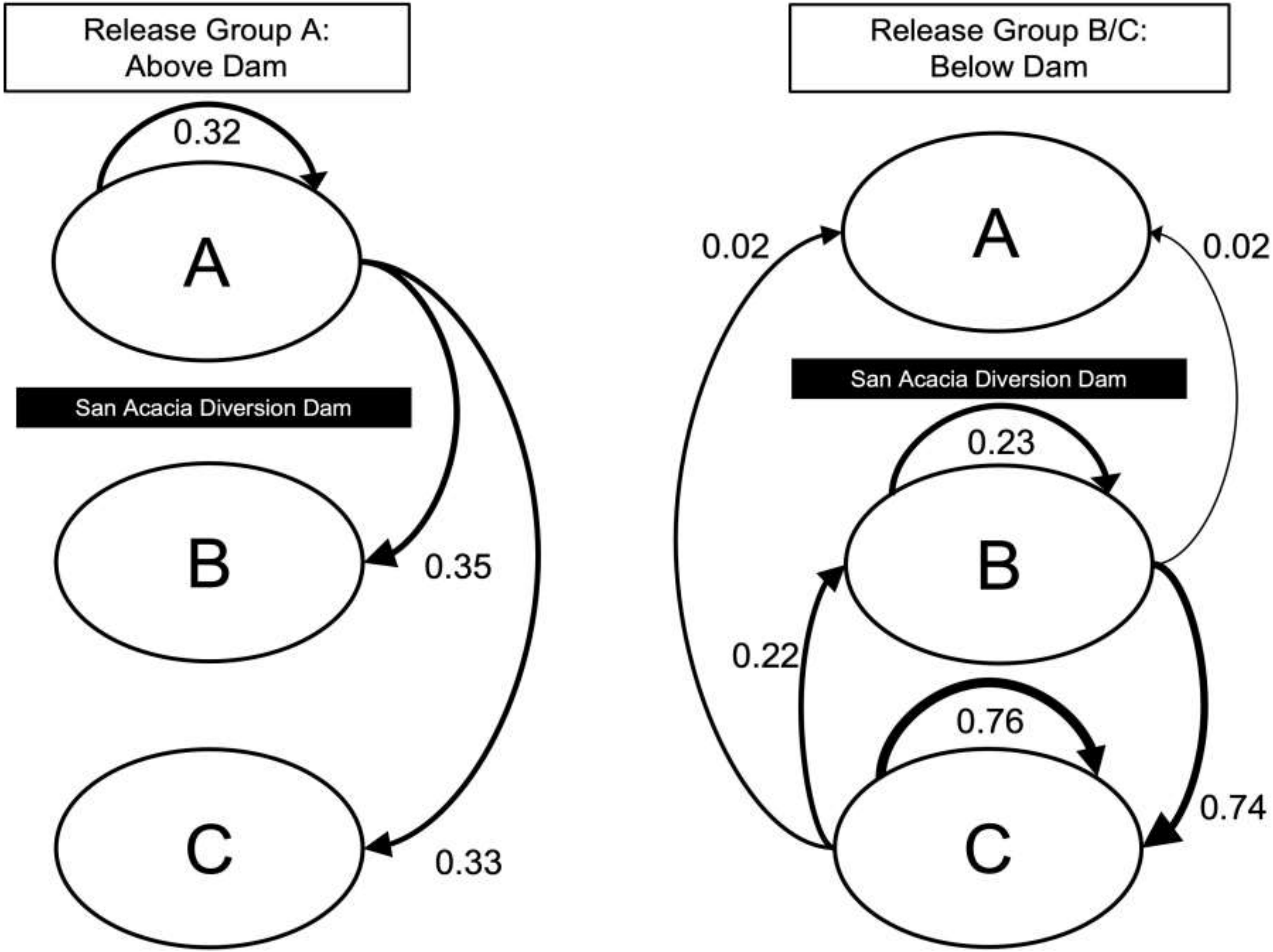
	STATE A			STATE B			STATE C		
STATE CHANGE	AA	AB	AC	BA	BB	BC	CA	CB	CC
NUMBER	37	10	8	4	123	74	1	65	114
%	**67%**	18%	15%	2%	**61%**	37%	1%	36%	**63%**



61–67% of RGSM remained in the same state

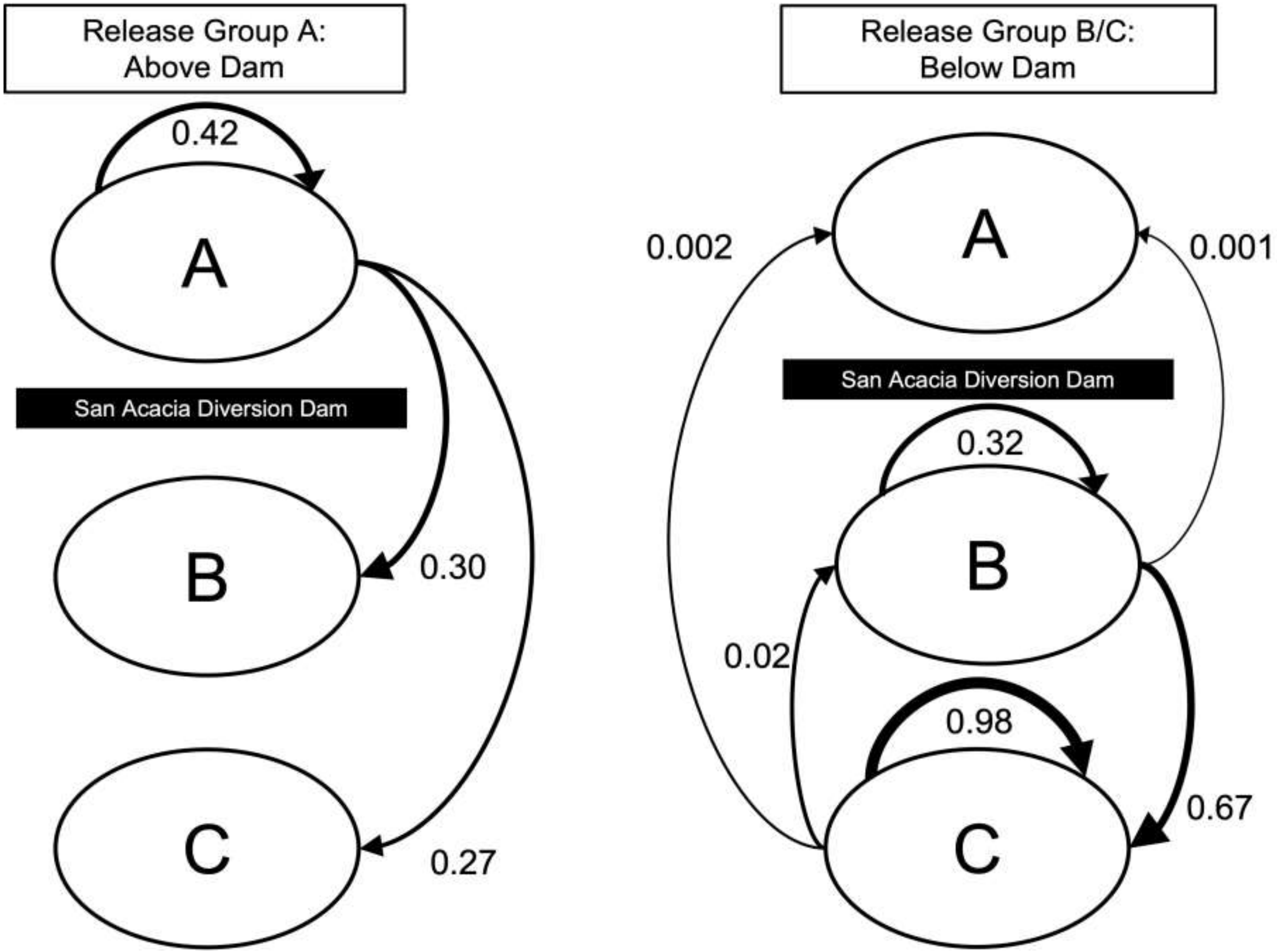
RESULTS: WINTER RELEASE

TIMESTEP 1



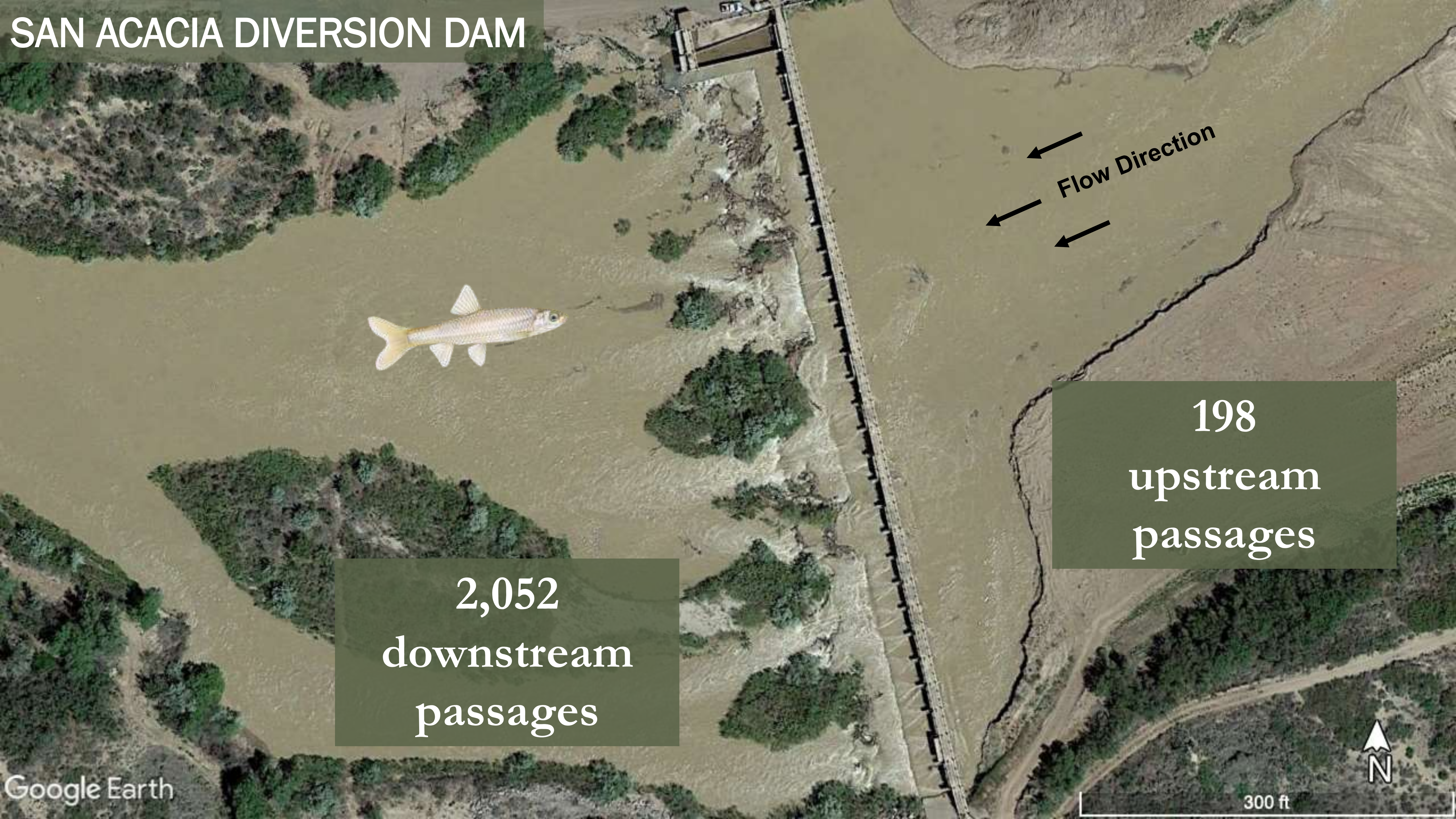
RESULTS: SPRING RELEASE

TIMESTEP 1

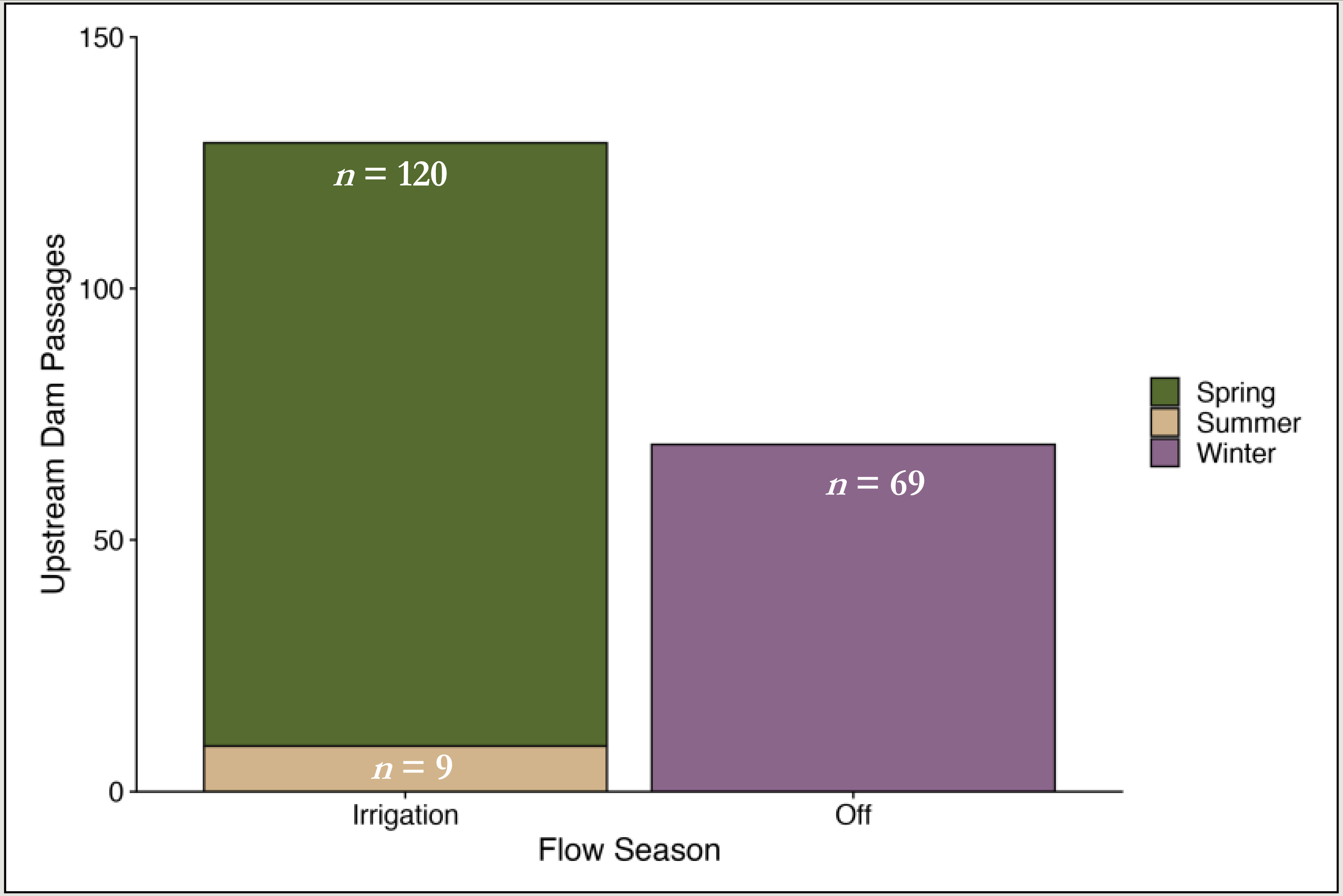


CONCLUSIONS

- Higher probabilities of upstream movement for fish released in the winter
- Transition probabilities were highest in 1st time step
- Released above dam
  - ~ 1/3 stayed above the dam (AA)
  - ~2/3 moved below the dam (AB, AC)
- Released below dam
  - Most remained below the dam (BB, CC)
  - Low transition probability upstream through dam (≤0.02)


SAN ACACIA DIVERSION DAM
Flow Direction
198
upstream
passages
2,052
downstream
passages
Google Earth
N
300 ft

RESULTS: UPSTREAM DAM PASSAGE



Most upstream passages occurred during early irrigation season (Spring: March–June)

BROADER IMPACTS

- Knowledge of movement patterns
  - Better estimates of range potential
  - Help define appropriate scale of management and monitoring efforts
- Documented long distance movements and dam passages
  - Highlight importance of connectivity
- Approach can be applied to imperiled small-bodied fishes in other fragmented systems

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Coauthors on manuscripts[1]

Questions?

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