Optimal mitigation of fish passage barriers in the Big Lake watershed, AK

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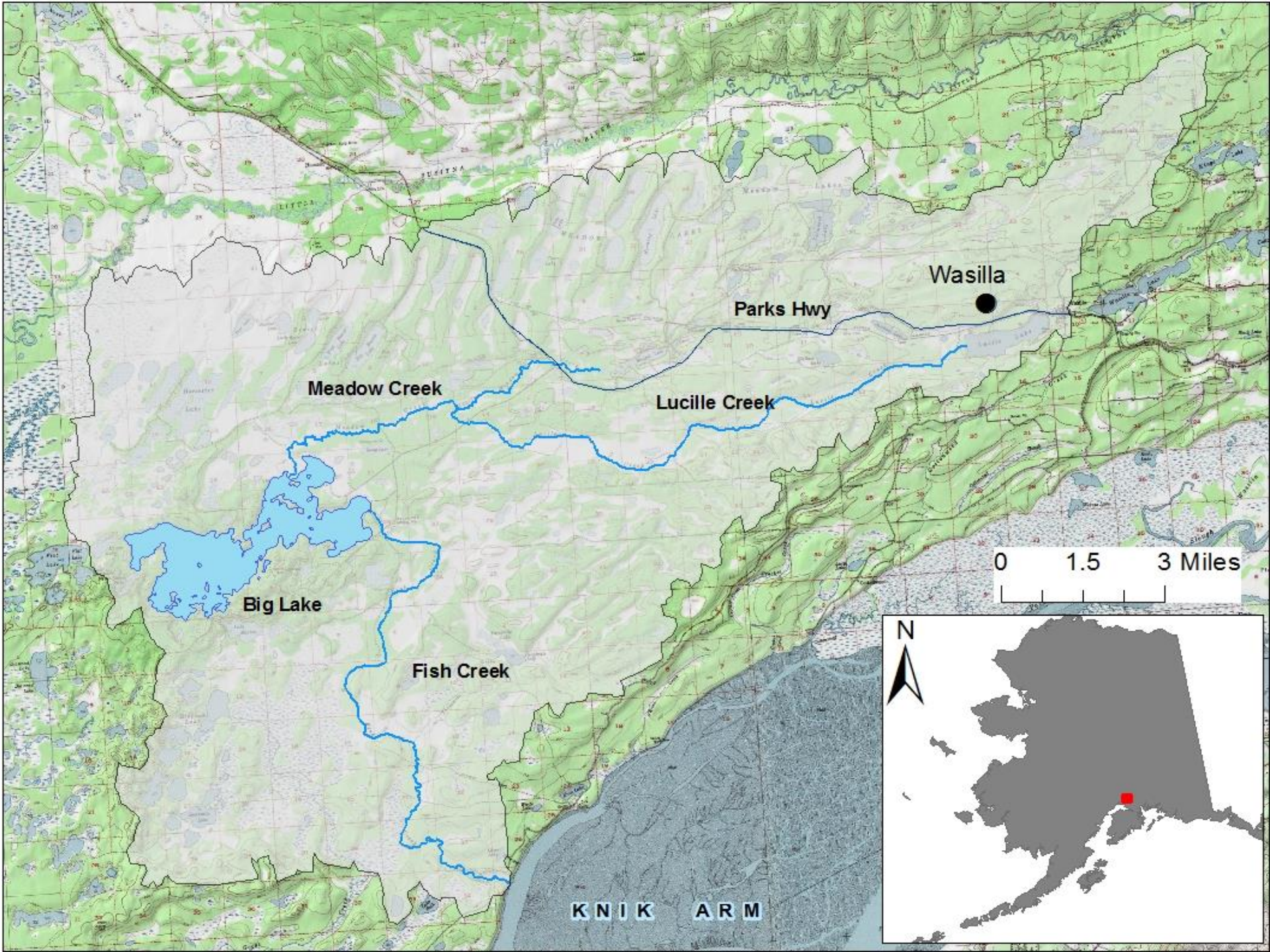
Outline

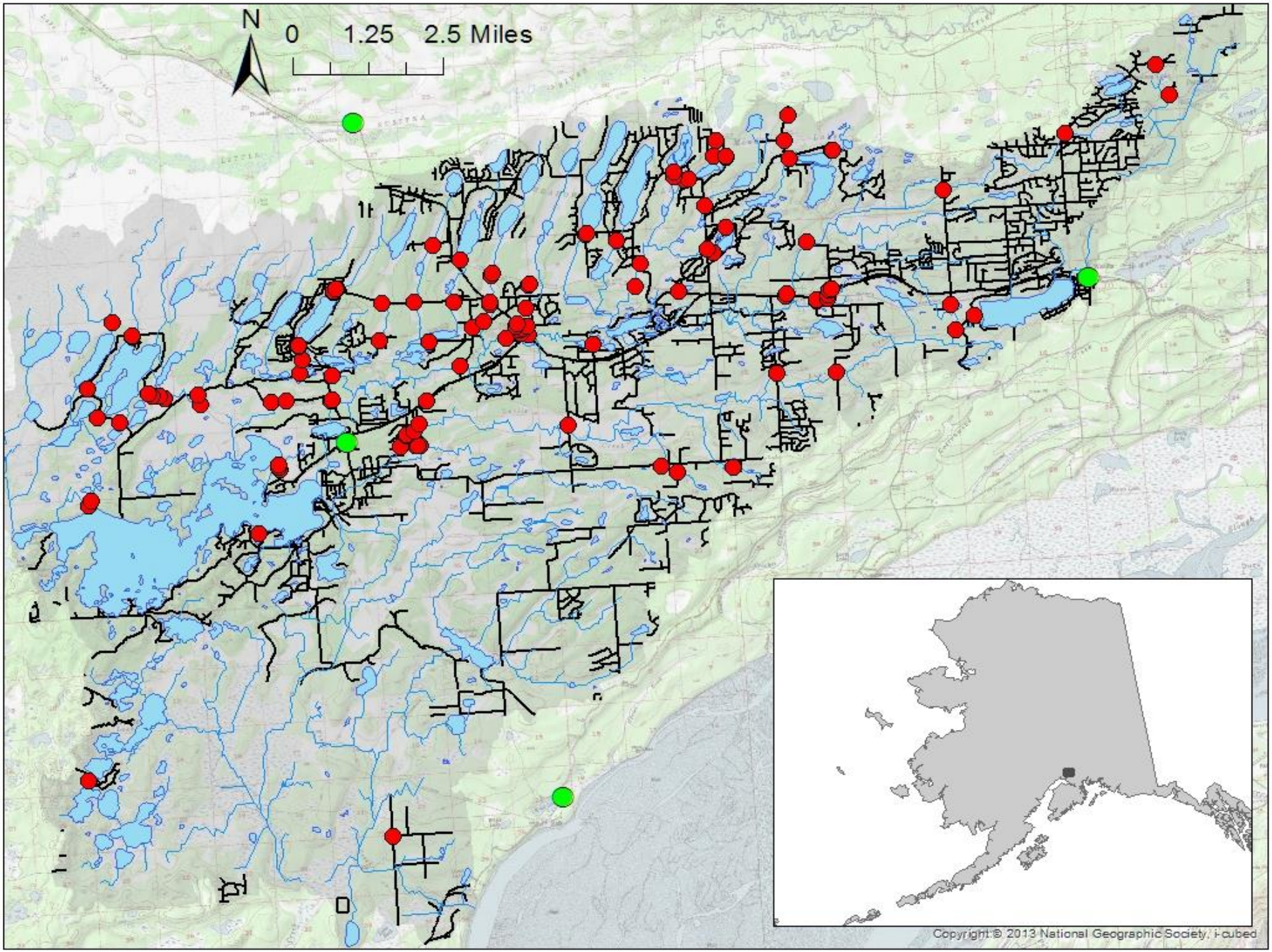
Background: fish passage issues in the Big Lake area

The barrier mitigation optimization problem

Big Lake watershed case study—customized ecological salmon info

Big Lake barrier mitigtion optimization


Wasilla
Parks Hwy
Meadow Creek
Lucille Creek
Big Lake
Fish Creek
KNIK ARM
0 1.5 3 Miles
N


N
0 1.25 2.5 Miles
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Motivation: ecological study to inform best management decisions

Culverts pose a threat to salmon habitat by blocking passage and fragmenting habitat.

Culverts are expensive to restore.

To be effective, we need information to prioritize which culverts to restore.

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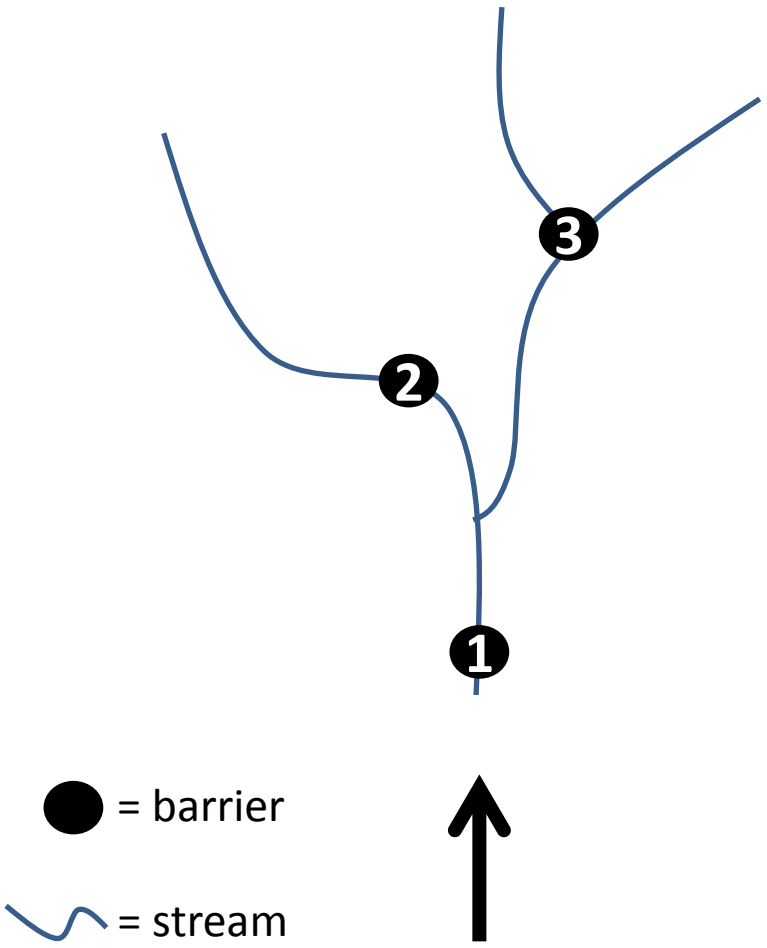
Problem: You have a budget or 5M$; choose the best barrier(s) to mitigate to maximize open habitat.



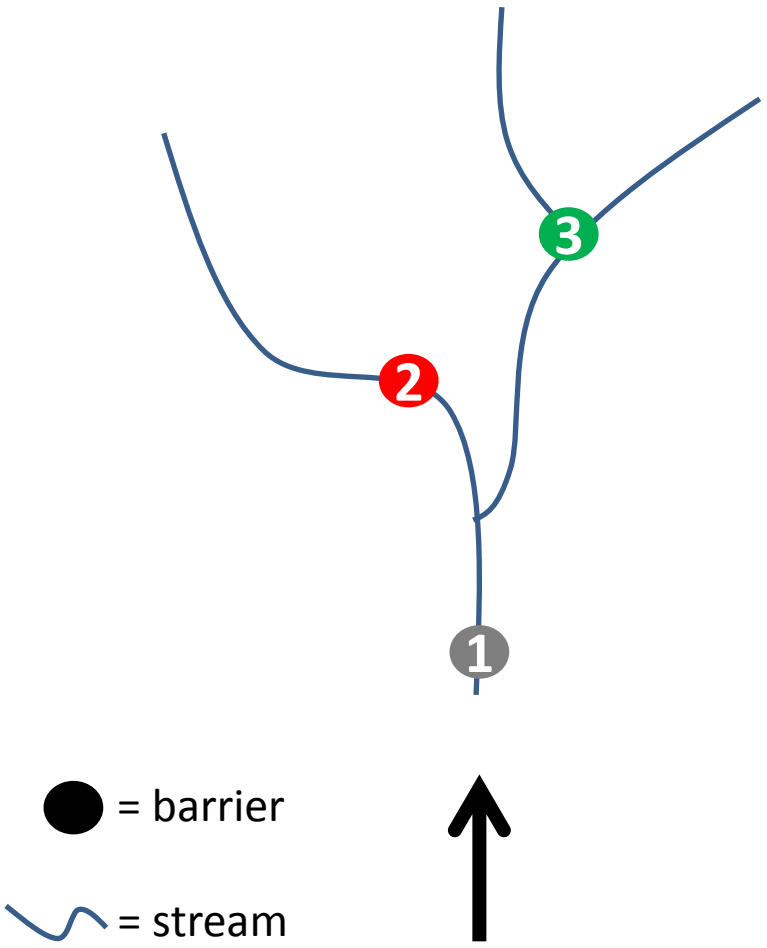
Data

Barrier	Cost	Assoc. Area
1	3	45%
2	2	20%
3	2	35%

Choices

Decision	Cost	Area unlocked
1	3	45%
2	2	0%
3	2	0%
1,2	5	65%
1,3	**5**	**80%**
2,3	4	0%
~~1,2,3~~	~~7~~	~~100%~~

Problem: You have a budget or 5M$; choose the best barrier(s) to mitigate to maximize open habitat.



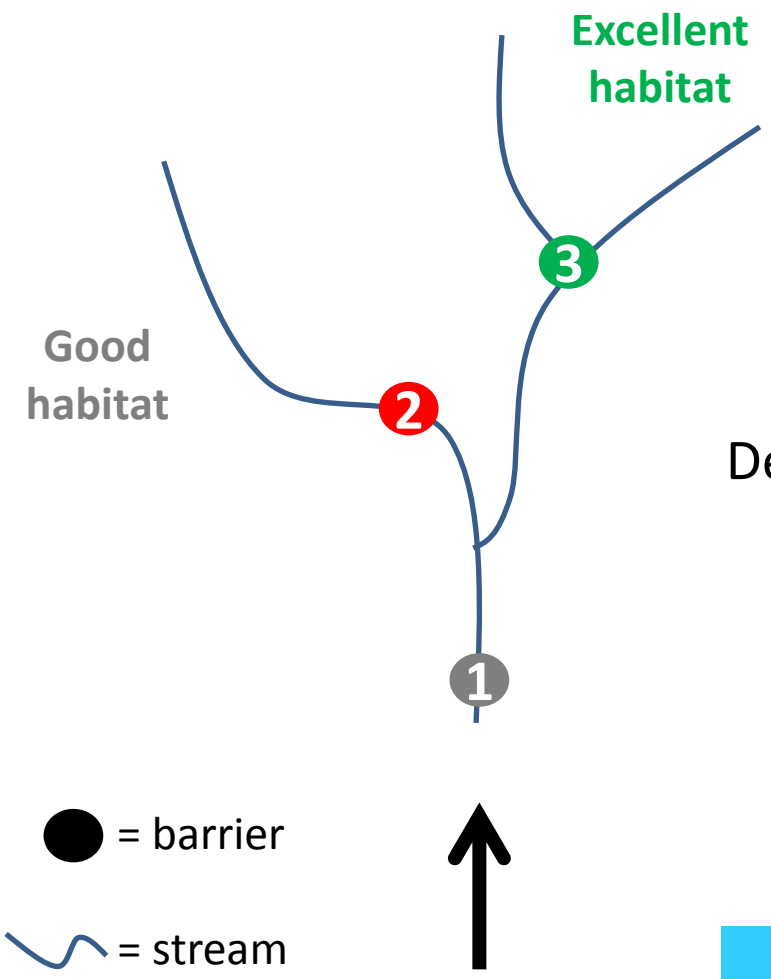
Data

Barrier	Cost	Passability	Area
1	3	50%	45%
2	2	0%	20%
3	2	75%	35%

Choices

Decision	Cost	Effective area
0	0	49%
1	3	71%
2	2	69%
3	2	58%
1,2	**5**	**91%**
1,3	***5***	***80%***
2,3	4	78%
~~1,2,3~~	~~7~~	~~100%~~

Problem: You have a budget or 5M$; choose the best barrier(s) to mitigate to maximize open habitat.

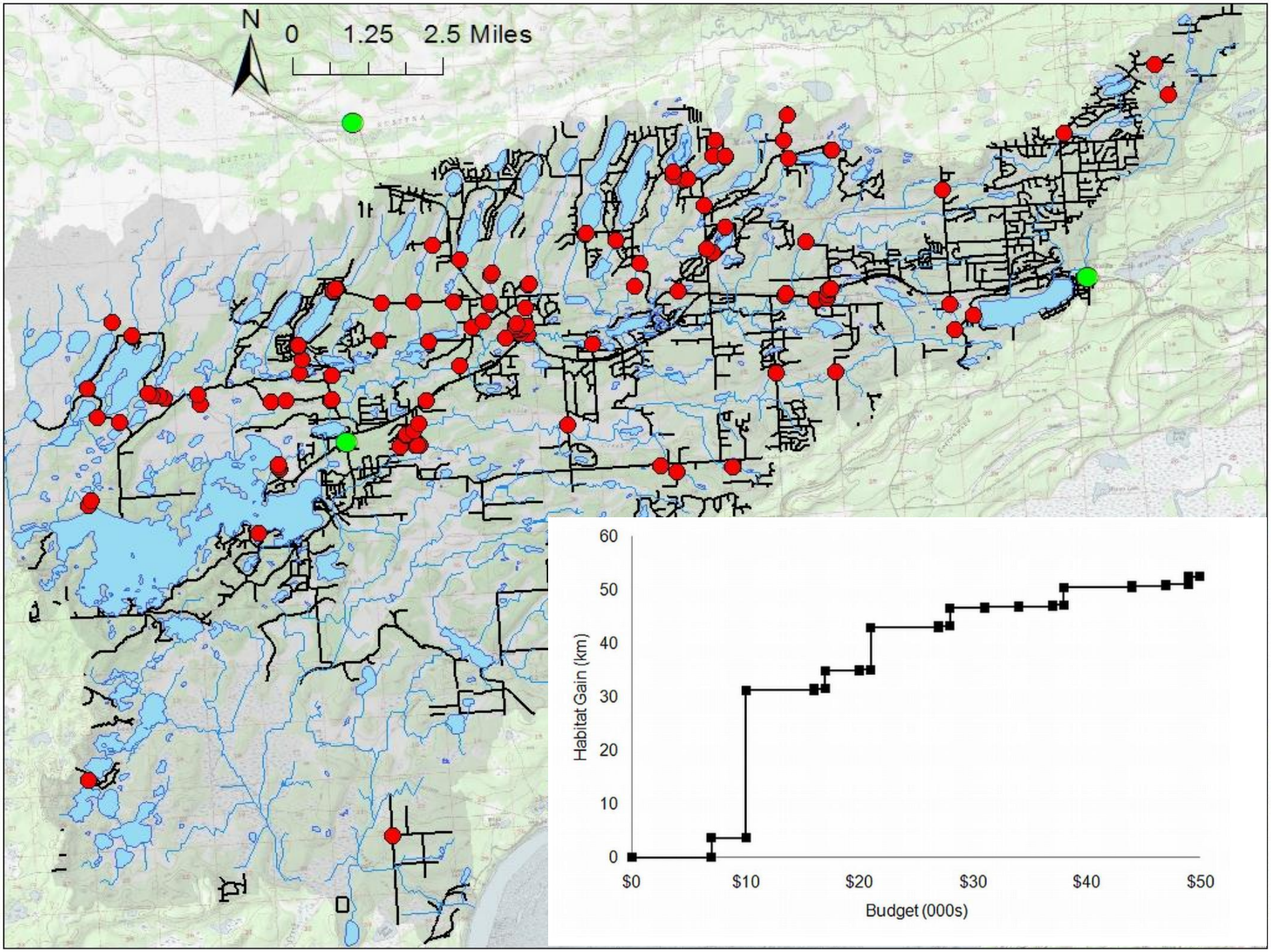


Data

Barrier	Cost	Passability	Habitat value	Area
1	3	50%	**1**	45%
2	2	0%	**3**	20%
3	2	75%	**5**	35%

Choices

Decision	Cost	Effective area	Habitat benefit
0	0	49%	1.54
1	3	71%	1.76
2	2	69%	2.14
3	2	58%	1.98
1,2	***5***	***91%***	***2.36***
1,3	***5***	***80%***	***2.20***
2,3	**4**	**78%**	**2.58**
~~1,2,3~~	~~7~~	~~100%~~	~~2.80~~


N
0
1.25
2.5 Miles
Habitat Gain (km)
60
50
40
30
20
10
0
$0
$10
$20
$30
$40
$50
Budget (000s)

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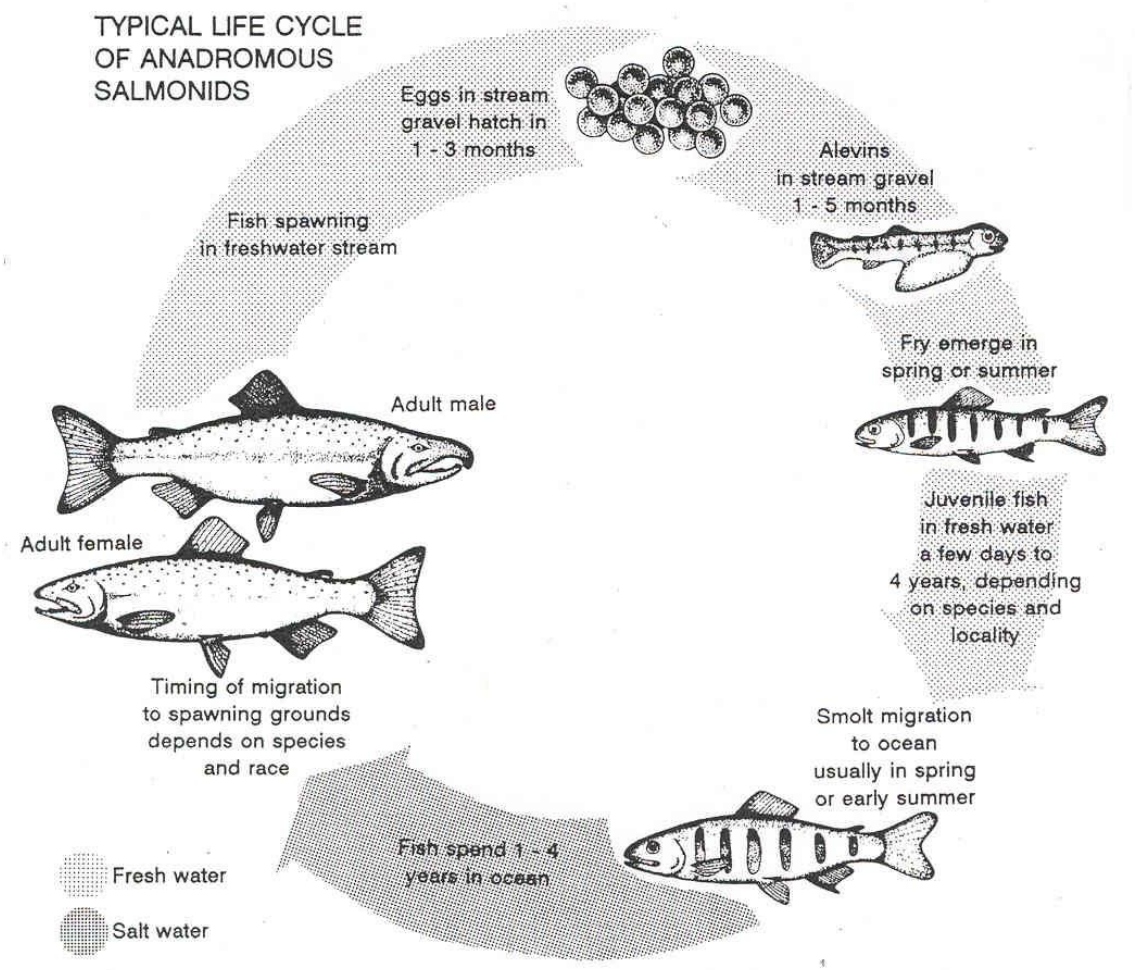
Coho as a model: ecological studies to inform habitat use



	FW	SW
Sockeye	1-3	1-4
Chinook	1-2	1-4
Coho	***1-3***	***1***
Pink	0	1
Chum	0	1-4

Summer rearing: habitat use studies

Movement, overwintering, smolting: PIT tagging

Spawning beds: stream surveys and telemetry

Big Lake Coho ecology: main points

Spawning (and thus emergence)

- Discrete spawning reaches in mainstem habitats.

Summer rearing

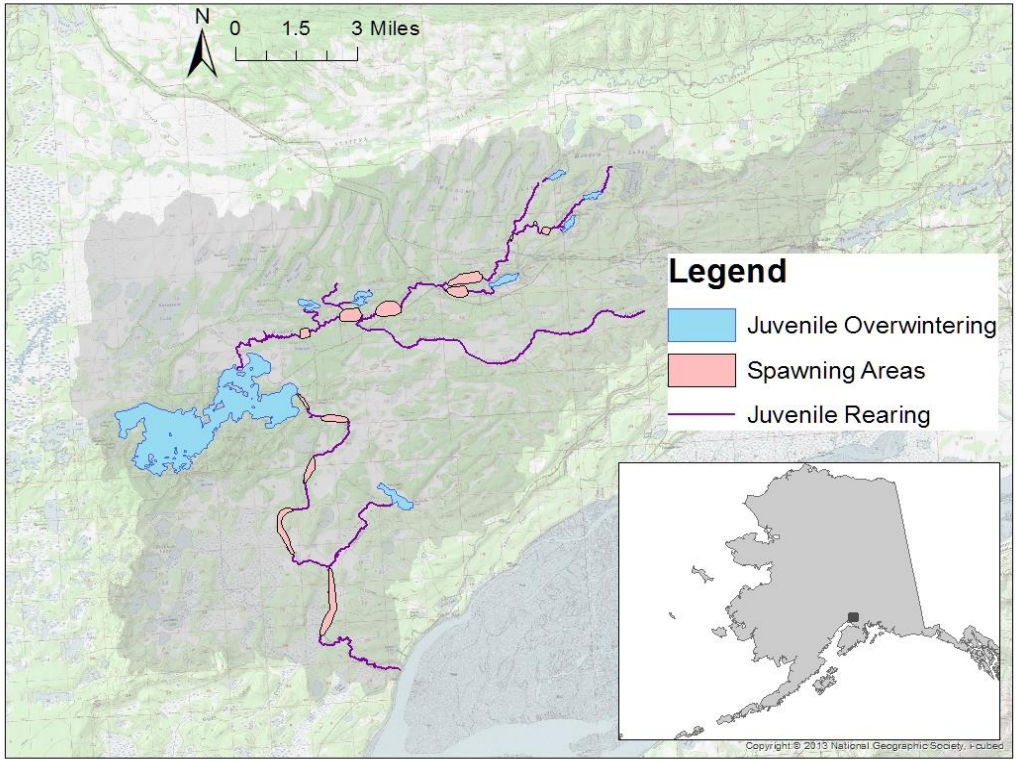
- Deeper and wider reaches preferred.

Overwintering

- Lakes are key.

Smolt migration

- Perilous journey—mortality scales with distance.



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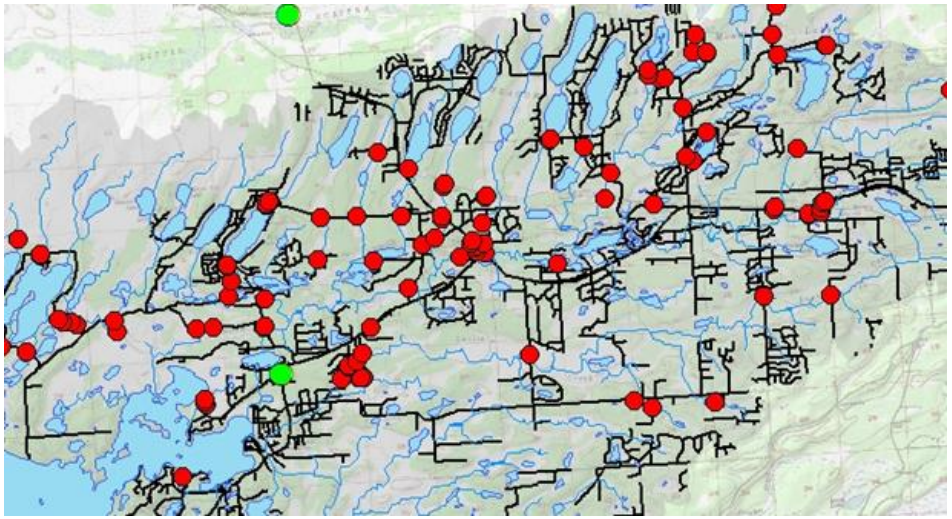
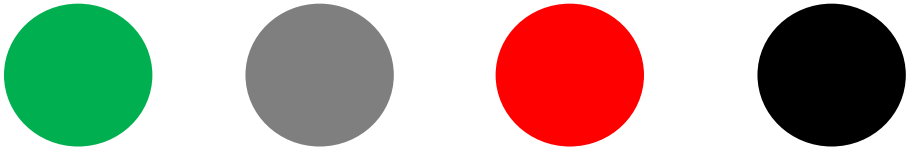
Big Lake barrier mitigation optimization: input data

Barrier locations and mitigation cost estimates



Passability



Big Lake barrier mitigation optimization: input data

Reach habitat value: adults

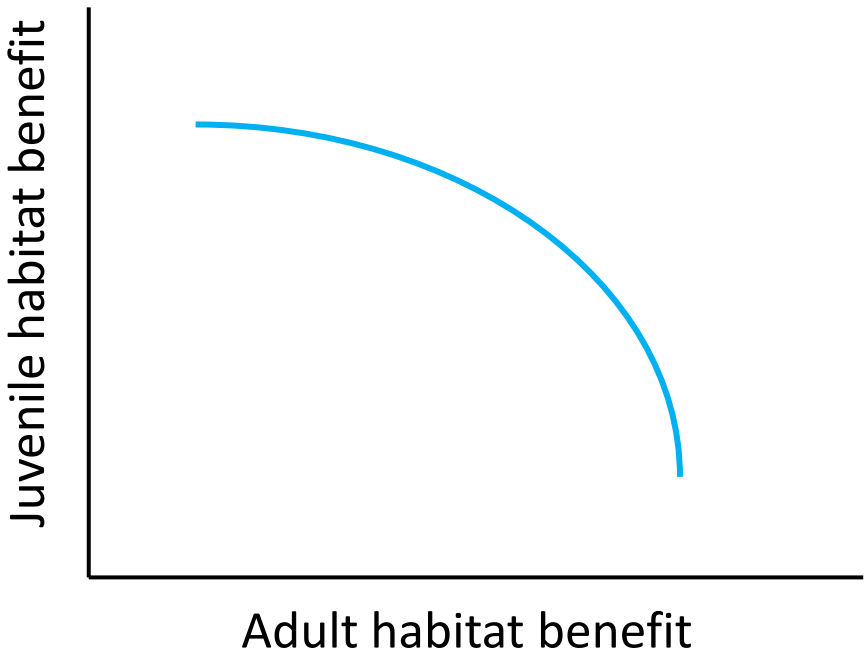
- Spawning bed? 1/0
- Migration corridor to spawning? 1/0

Reach habitat value: juveniles

- Emergence bed? 1/0
- Summer rearing preferred habitat (width-depth threshold) ? 1/0
- Winter rearing preferred habitat (lake)? 1/0
- Smolt migration distance (upper, mid, lower watershed)? 2/1/0

Big Lake barrier mitigation optimization: management recommendations

$$\text{Total benefit} = w_{juv} * \text{benefitj}_{uv} + (1-w_{juv}) * \text{benefit}_{adult}$$



Model scenarios

Adult only

Juvenile only

Equal weight

Null: linear distance only

Acknowledgments

Thank you.

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F.A.S.T. lab