Water Faucets, Back Alleys and Haul Outs:

Groundwater Guiding Salmon Through Warm Streams

Heather Leba, Cook Inletkeeper
Jon Gerken, U.S. FWS
Sue Mauger, Cook Inletkeeper

Previous work on the lower Kenai Peninsula

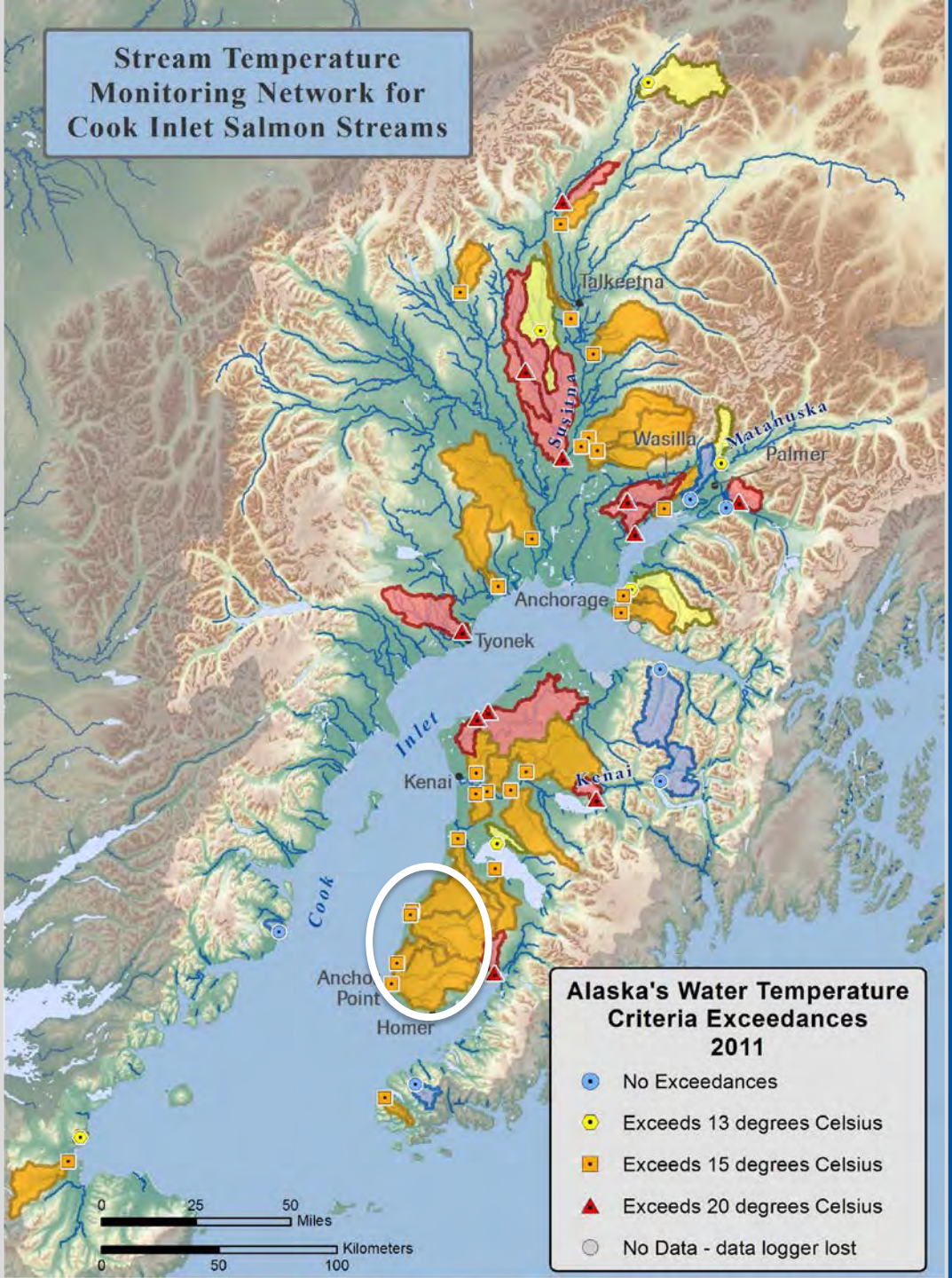
Thermal imagery

Current work in the Big Lake Basin

Juvenile Coho study

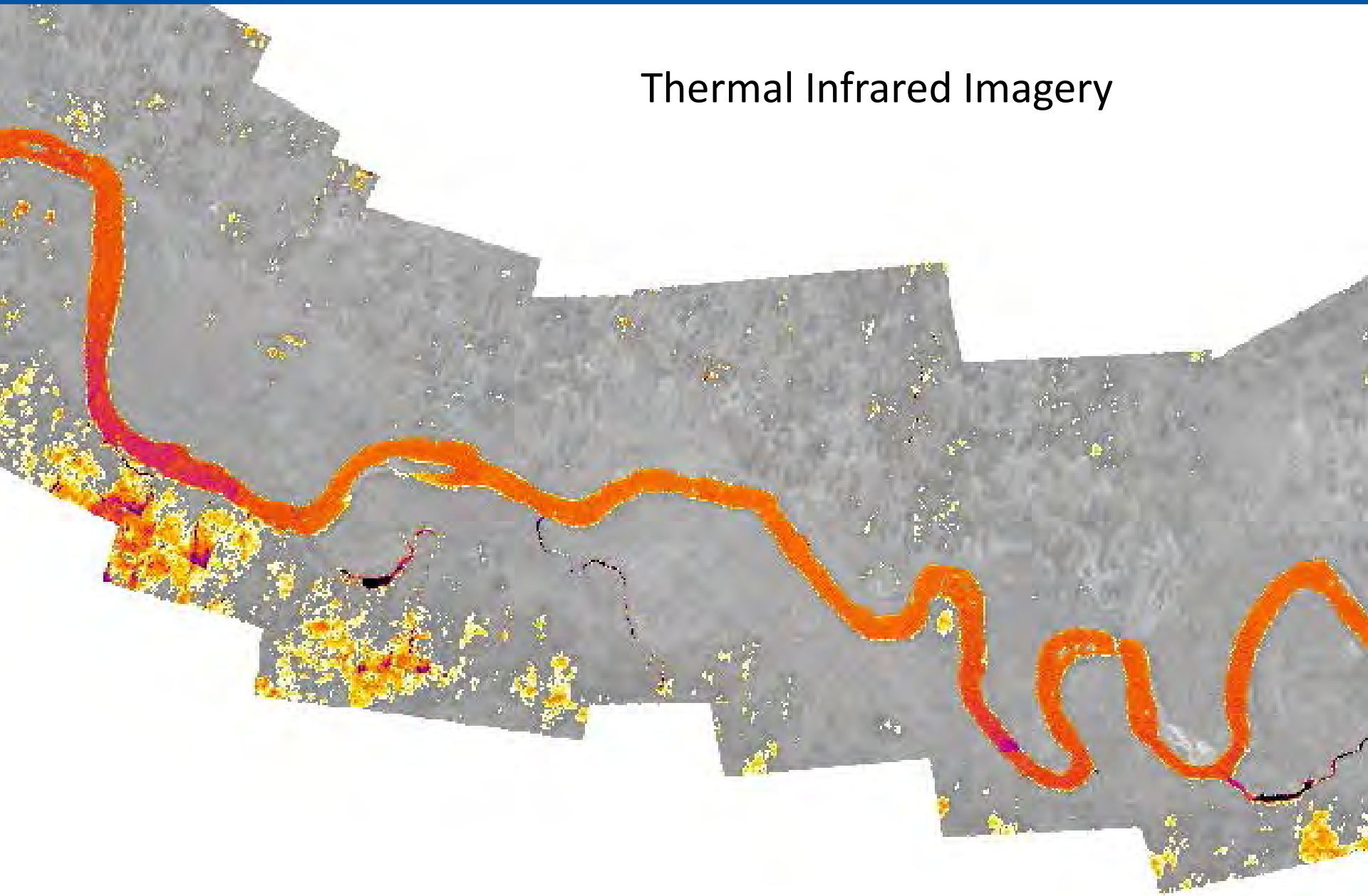
What we found

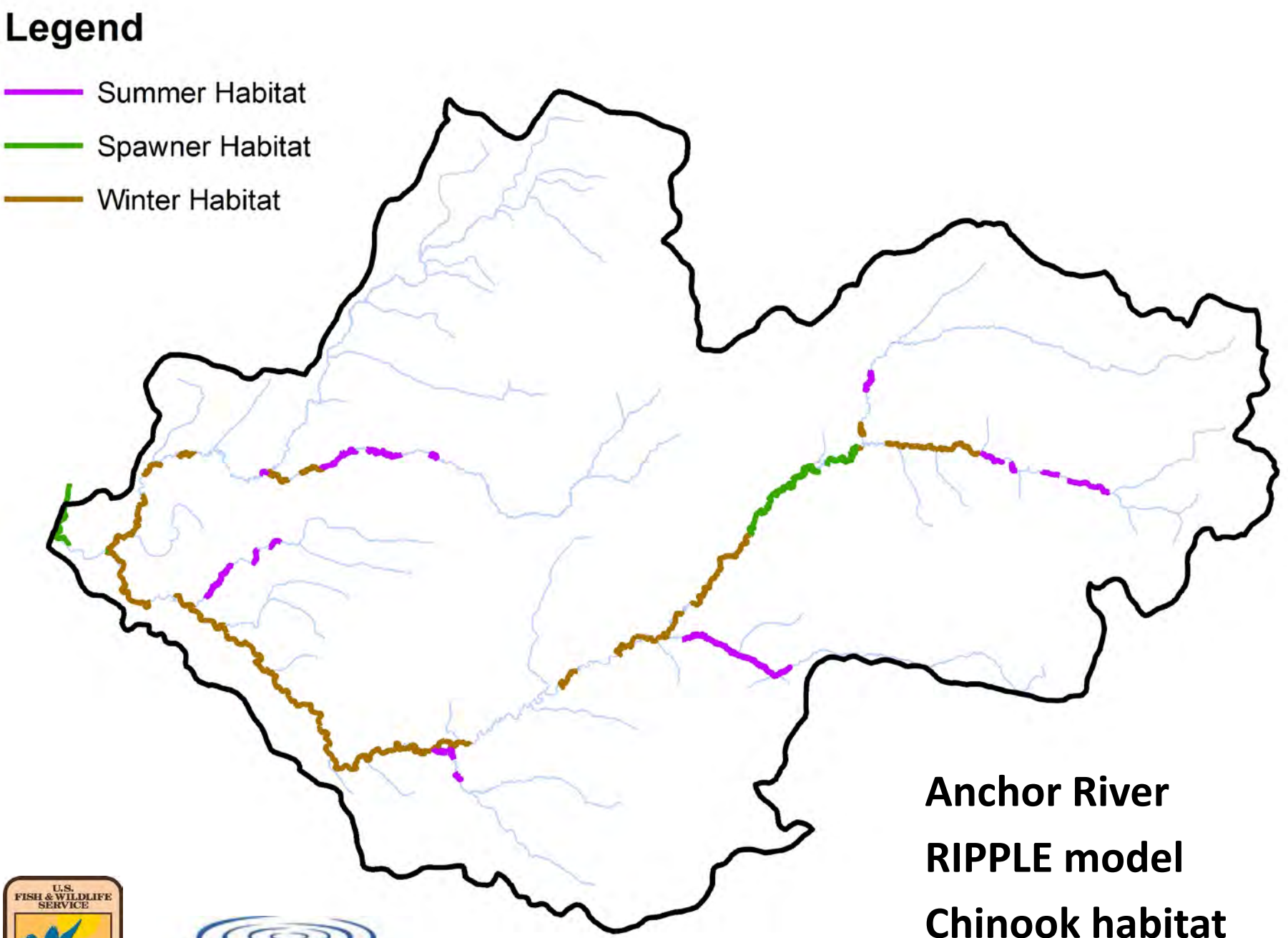
Why it matters



Mauger, S., R. Shaftel, J.C. Leppi, and D. J. Rinella. 2017. Summer temperature regimes in southcentral Alaska streams: watershed drivers of variation and potential implications for Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences doi. 10.1139/cjfas-2016-0076.

Thermal Infrared Imagery





Anchor River

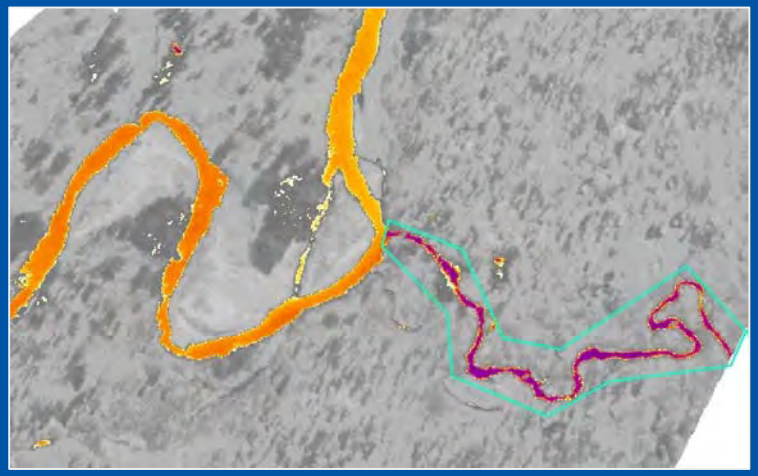
RIPPLE model

Chinook habitat

U.S. FISH & WILDLIFE SERVICE

Stillwater Sciences

Identifying critical habitat



<u>Likely fish use</u>

Chinook:

- moderate summer rearing
- moderate winter rearing

Coho:

- moderate fall rearing
- significant summer rearing

<u>Current landowner status</u>

private (2 parcels)

Science-based Land Conservation

Goal: Keep streams cold for salmon

How: identify critical salmon habitat

create land conservation strategies

work with public & private landowners to protect habitat

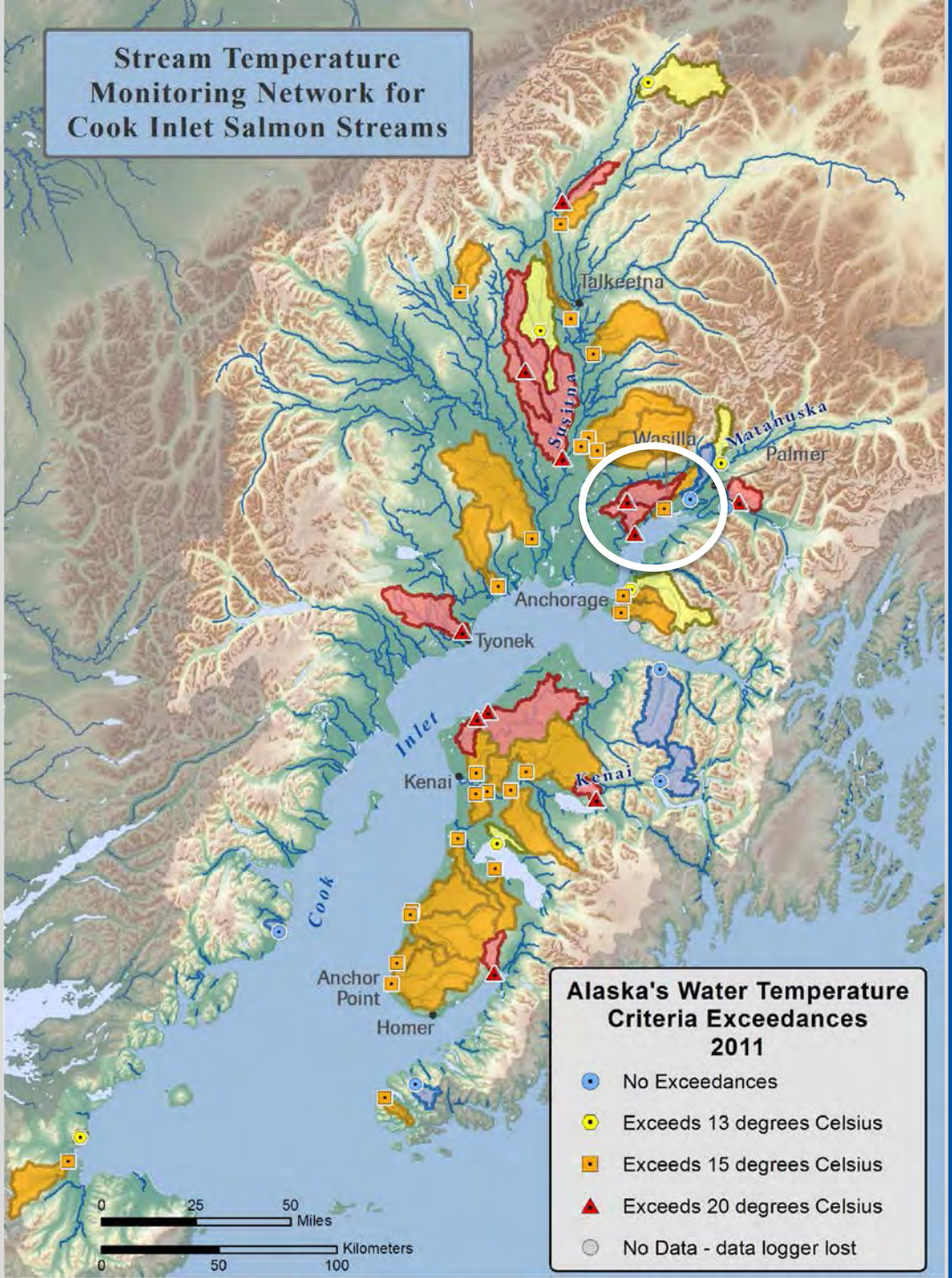
CLEAN WATER · HEALTHY SALMON
INLETKEEPER®

Kenai Watershed Forum
Working together for healthy watersheds on the Kenai Peninsula

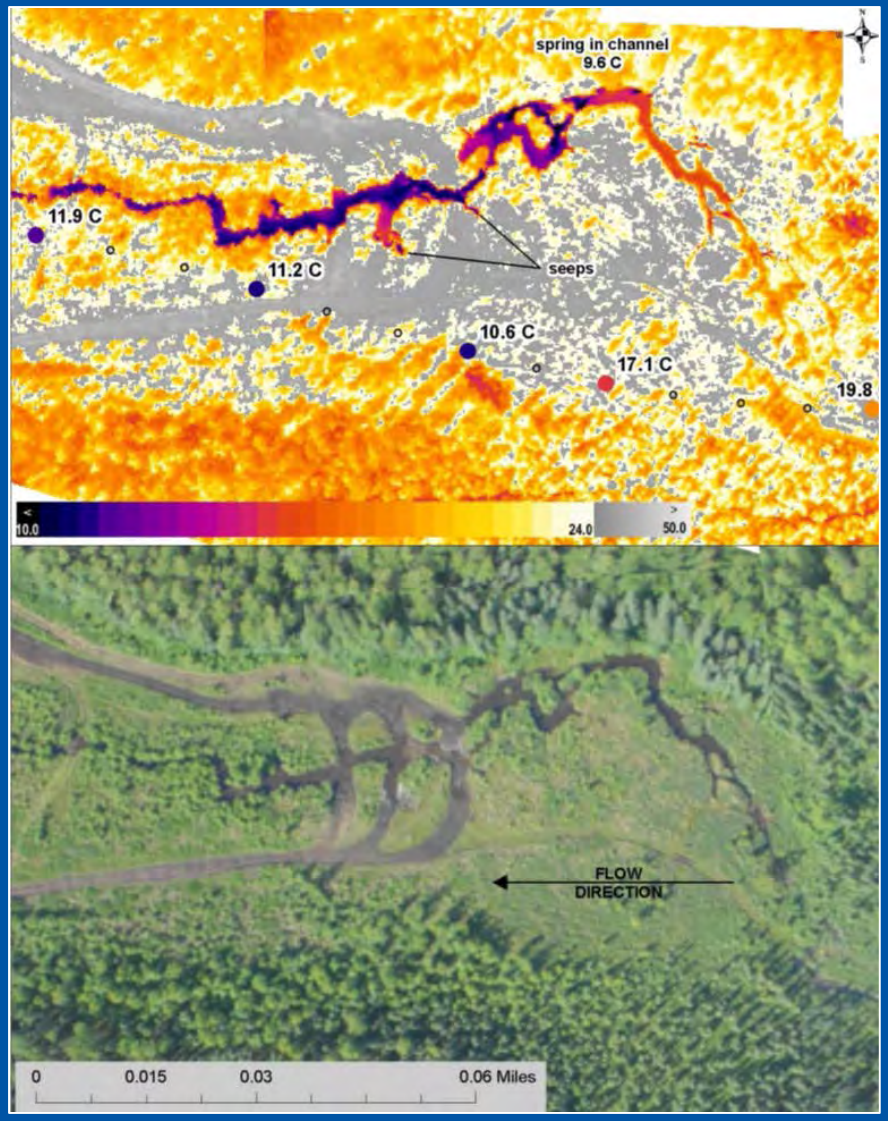
Kachemak Heritage Land Trust

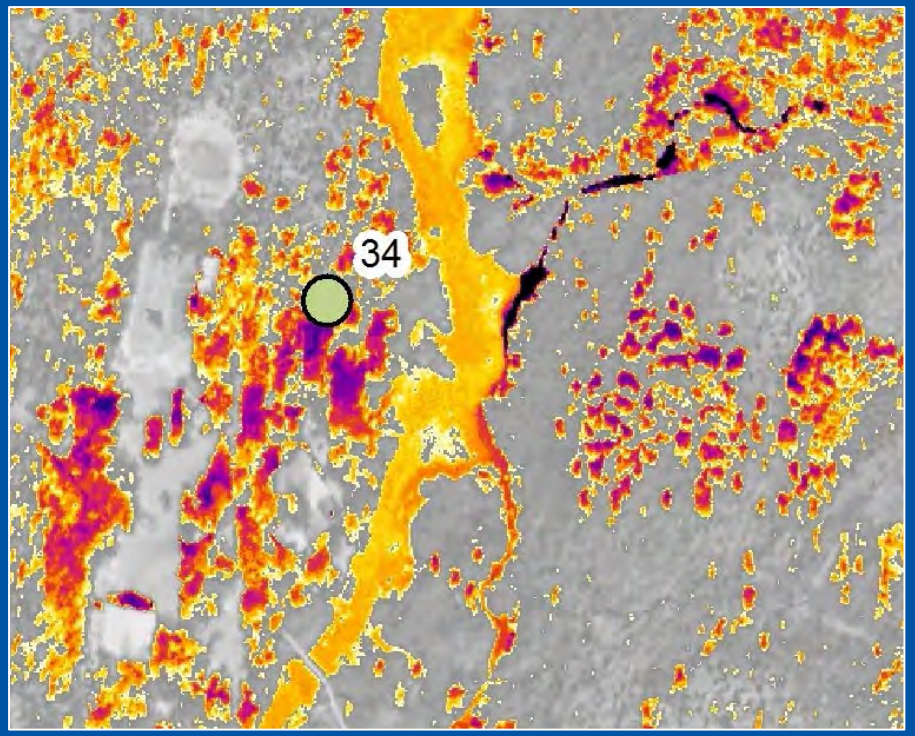
KENAI PENINSULA
FISH HABITAT PARTNERSHIP

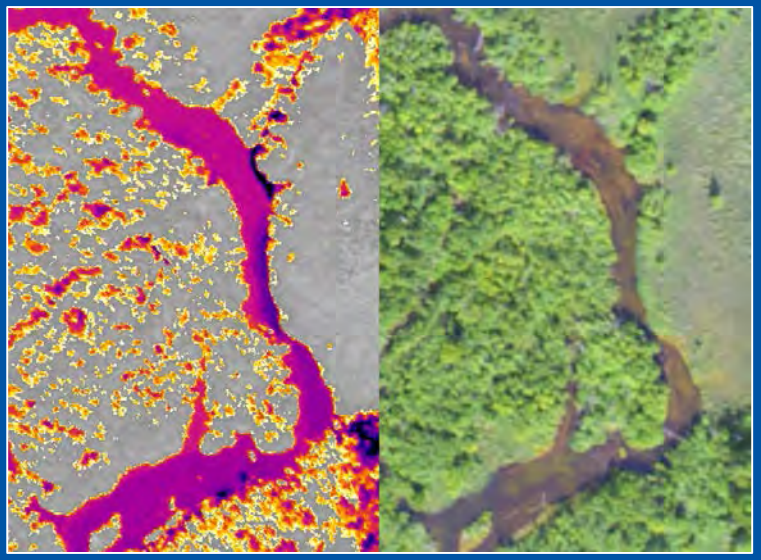
Stream Temperature Monitoring Network for Cook Inlet Salmon Streams

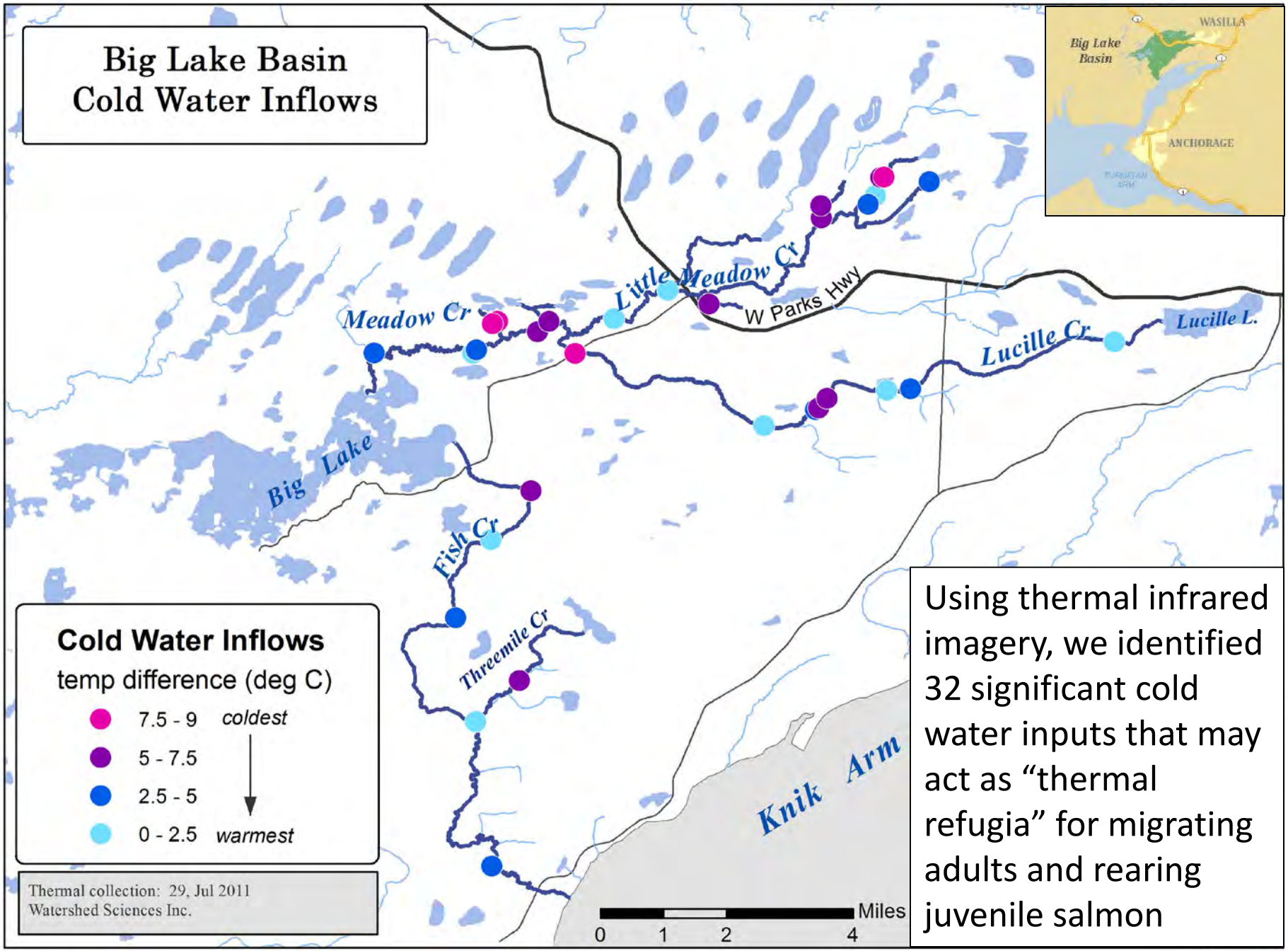


Thermal Infrared Imagery









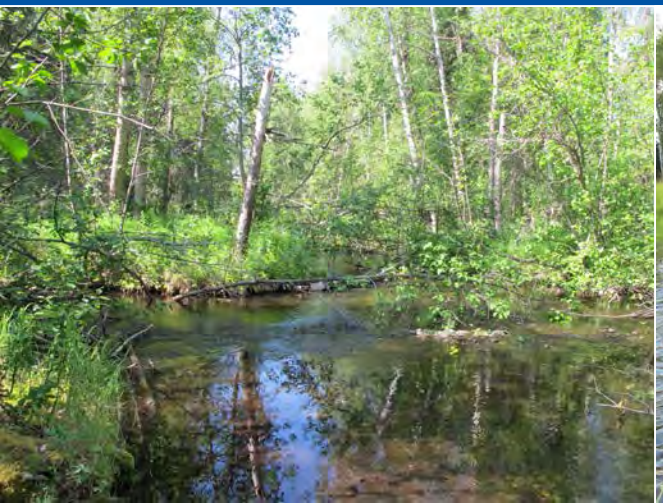
Using thermal infrared imagery, we identified 32 significant cold water inputs that may act as “thermal refugia” for migrating adults and rearing juvenile salmon

Objectives for juvenile study

1) Determine the influence of cold water inputs to stream water temperature at three sites.

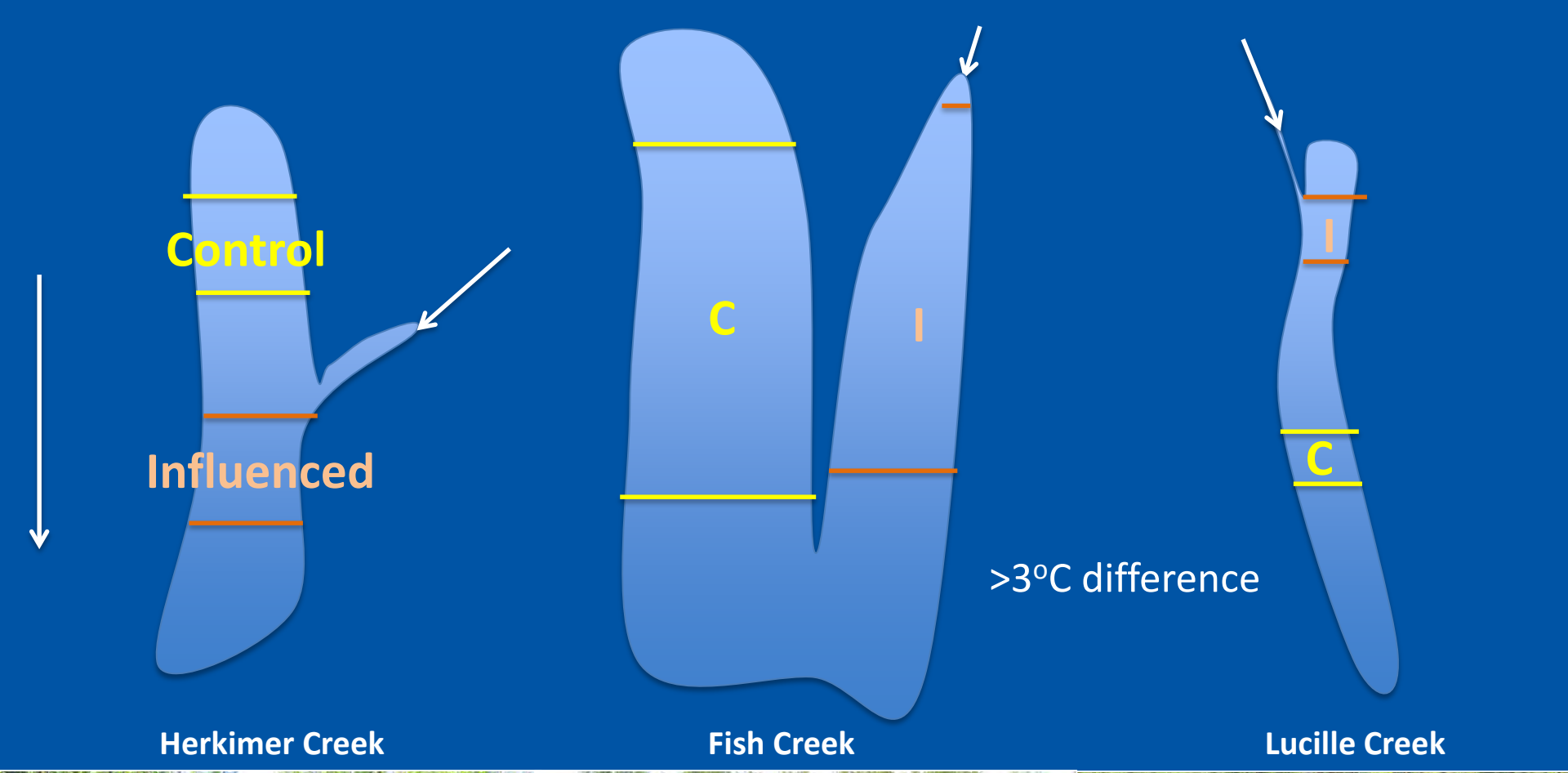
2) Determine if juvenile Coho salmon preferentially select habitats influenced by cold water inputs for summer rearing as measured by relative abundance.

Herkimer Creek



Fish Creek

Lucille Creek

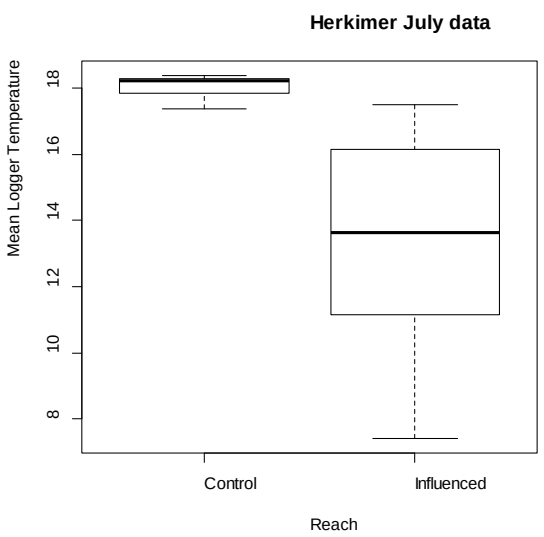

Control
Influenced
C
I
>3°C difference
I
C
Herkimer Creek
Fish Creek
Lucille Creek

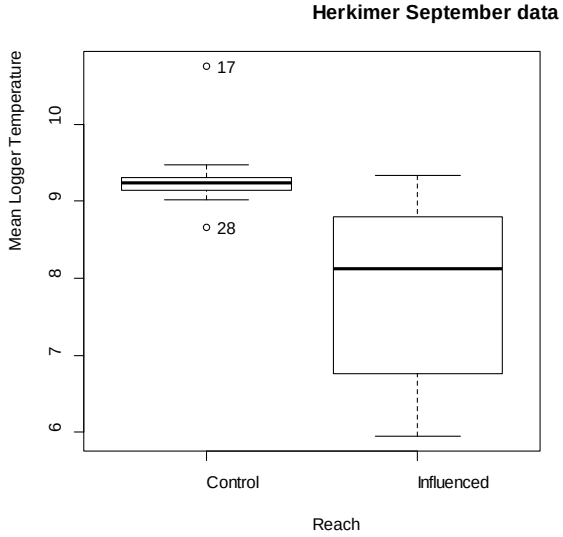
Sampling plan:

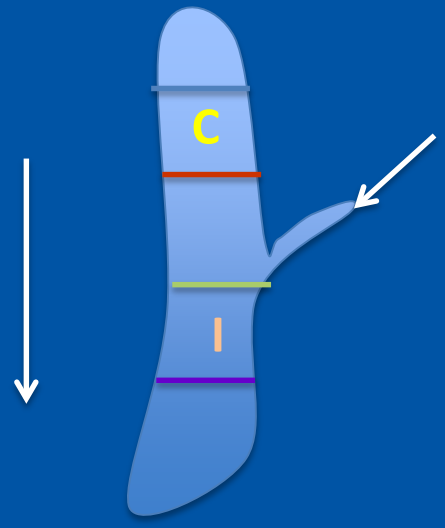
monthly sampling events from July – October, 2015

- fish sampling: electrofishing, minnow traps
- macroinvertebrate sampling
- habitat assessments
- water velocity
- temperature surveys


Herkimer Creek


Herkimer July data
Mean Logger Temperature
8
10
12
14
16
18
Control
Influenced
Reach


Herkimer September data
Mean Logger Temperature
6
7
8
9
10
17
28
Control
Influenced
Reach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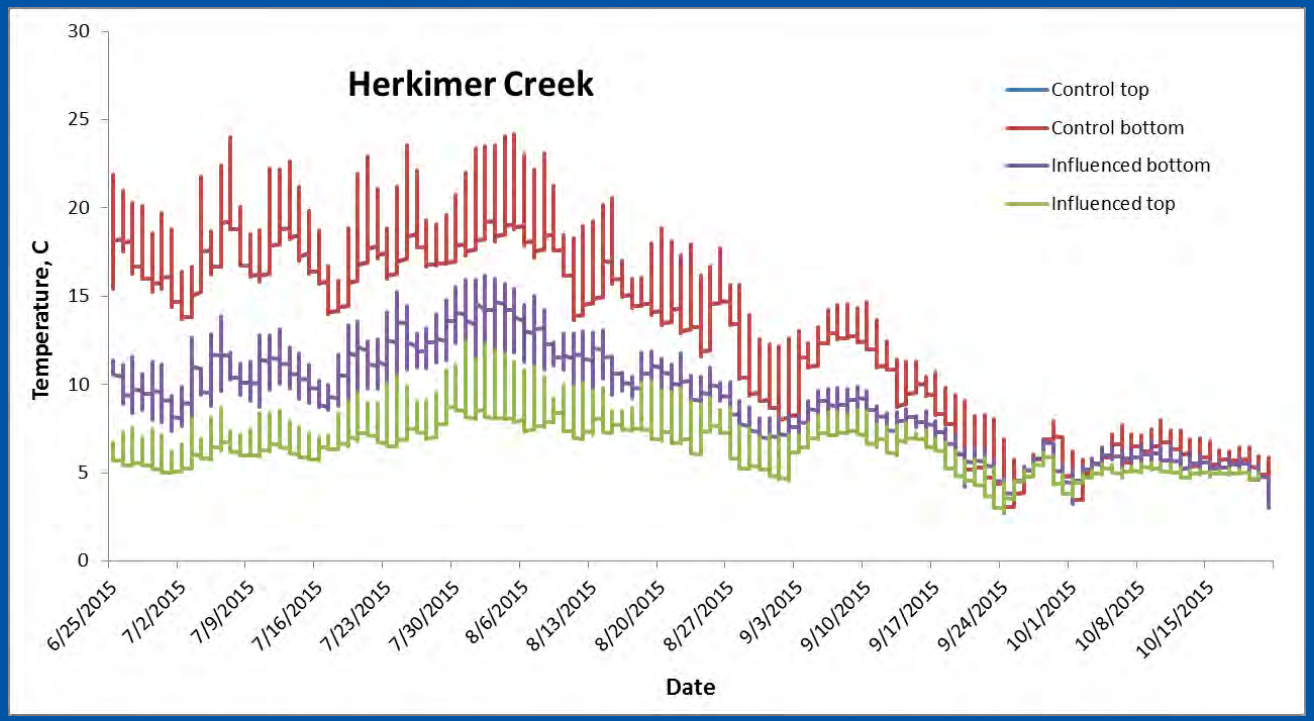
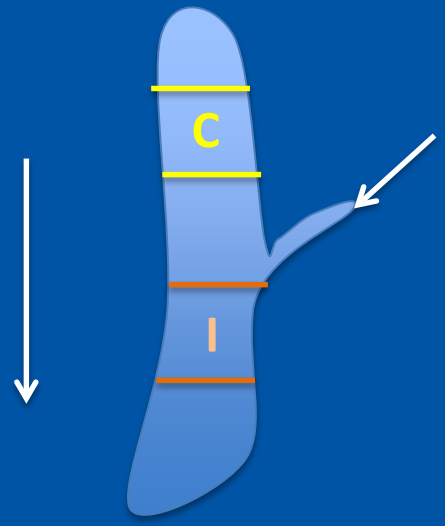
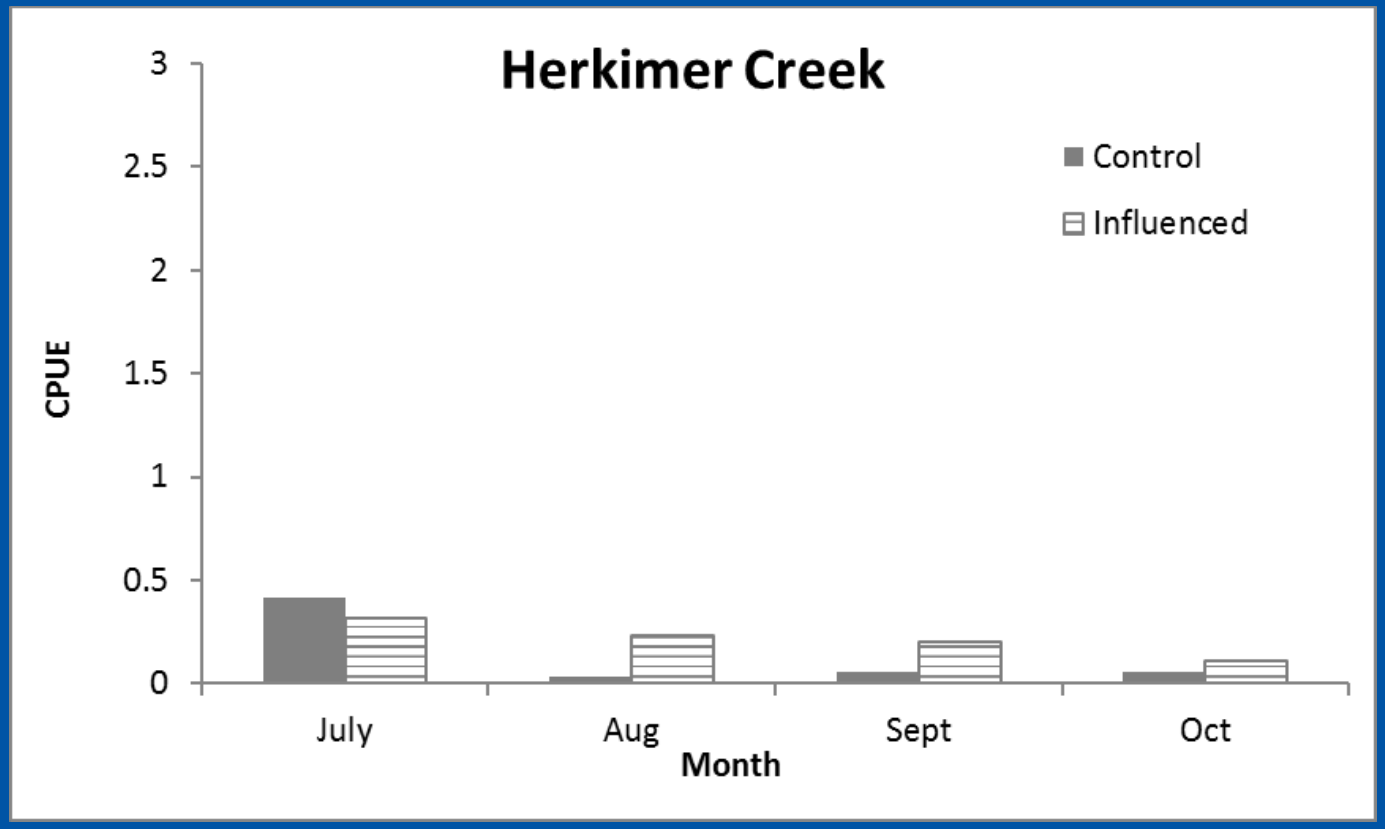
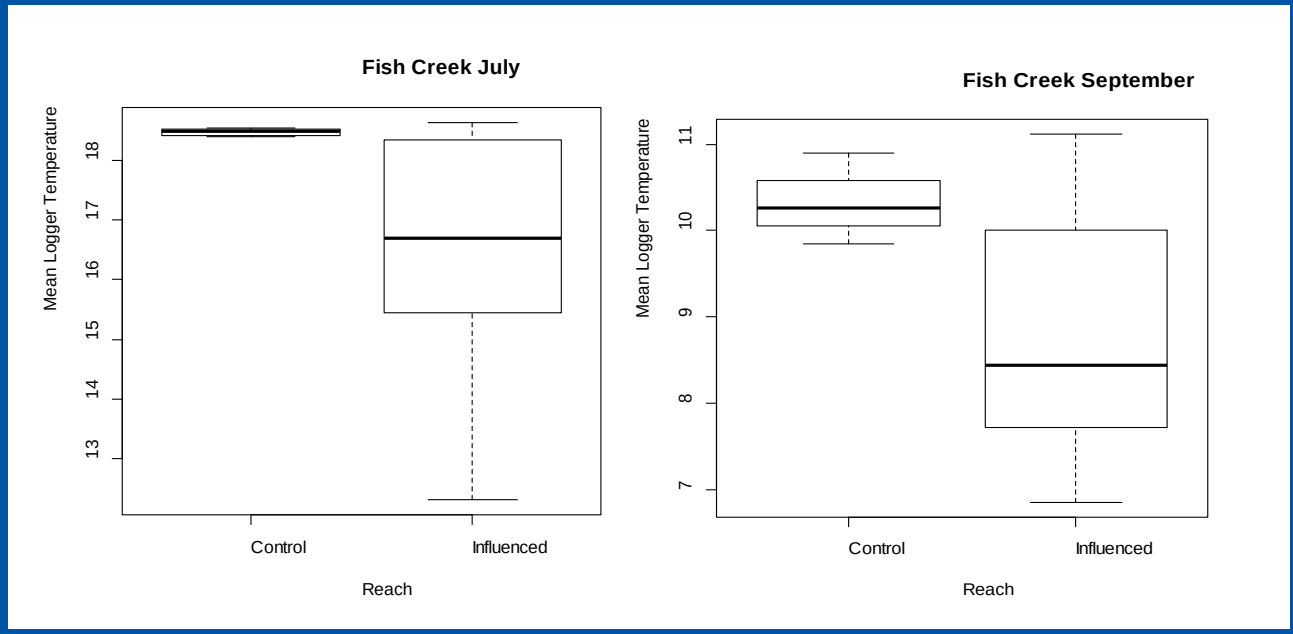

Herkimer Creek
Temperature, C
0
5
10
15
20
25
30
Control top
Control bottom
Influenced bottom
Influenced top
6/25/2015
7/2/2015
7/9/2015
7/16/2015
7/23/2015
7/30/2015
8/6/2015
8/13/2015
8/20/2015
8/27/2015
9/3/2015
9/10/2015
9/17/2015
9/24/2015
10/1/2015
10/8/2015
10/15/2015
Date

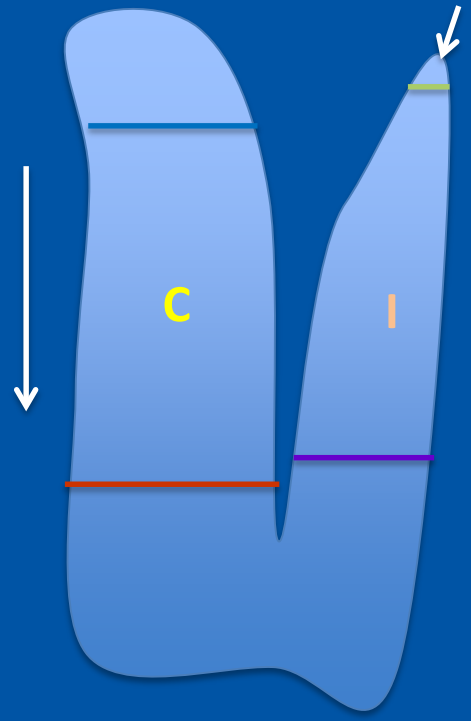
August data	Control	Influenced
mean temperature (°C)	15.8	12.4
discharge (cfs)	3.1	4.6
total invertebrate abundance	3068	168
mean fork length (mm)	58.4	69.5






Fish Creek


Fish Creek July
Mean Logger Temperature
13
14
15
16
17
18
Control
Influenced
Reach
Fish Creek September
Mean Logger Temperature
7
8
9
10
11
Control
Influenced
Reach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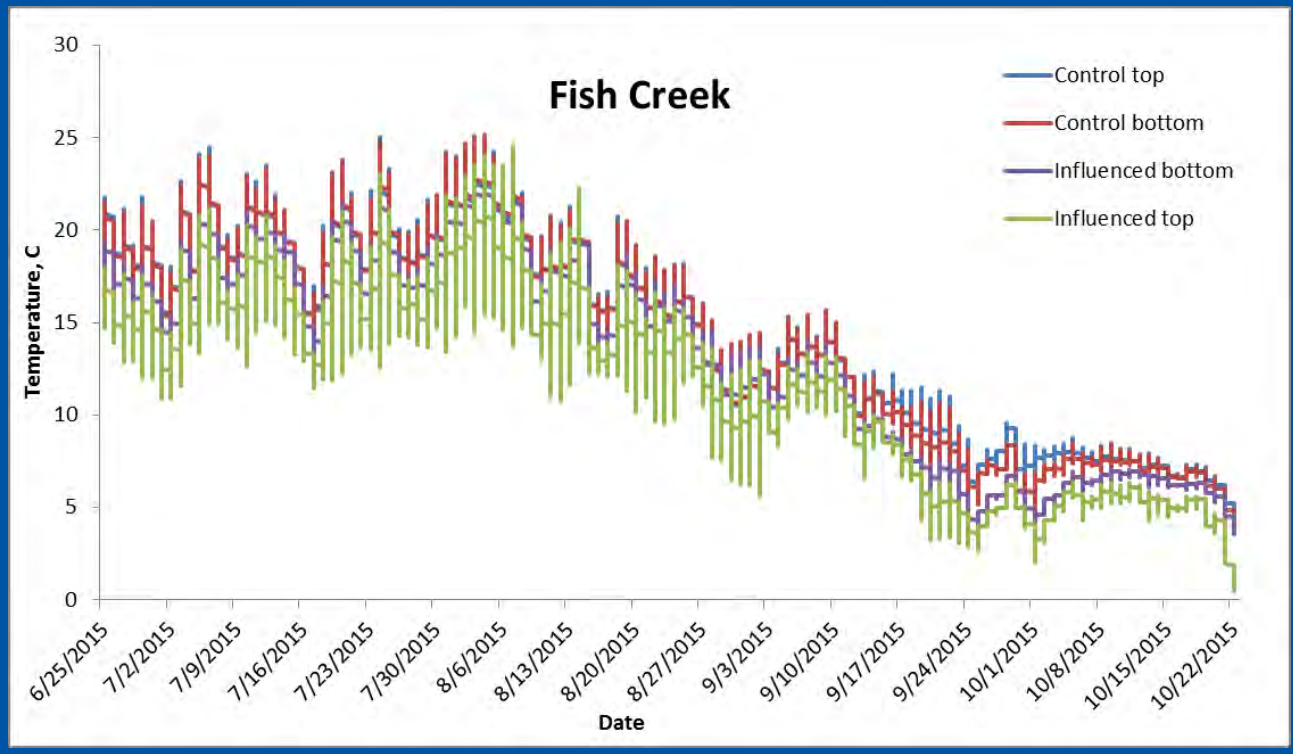
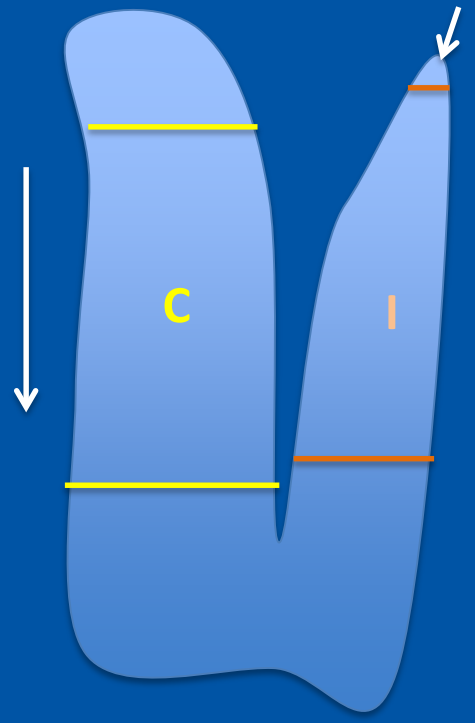
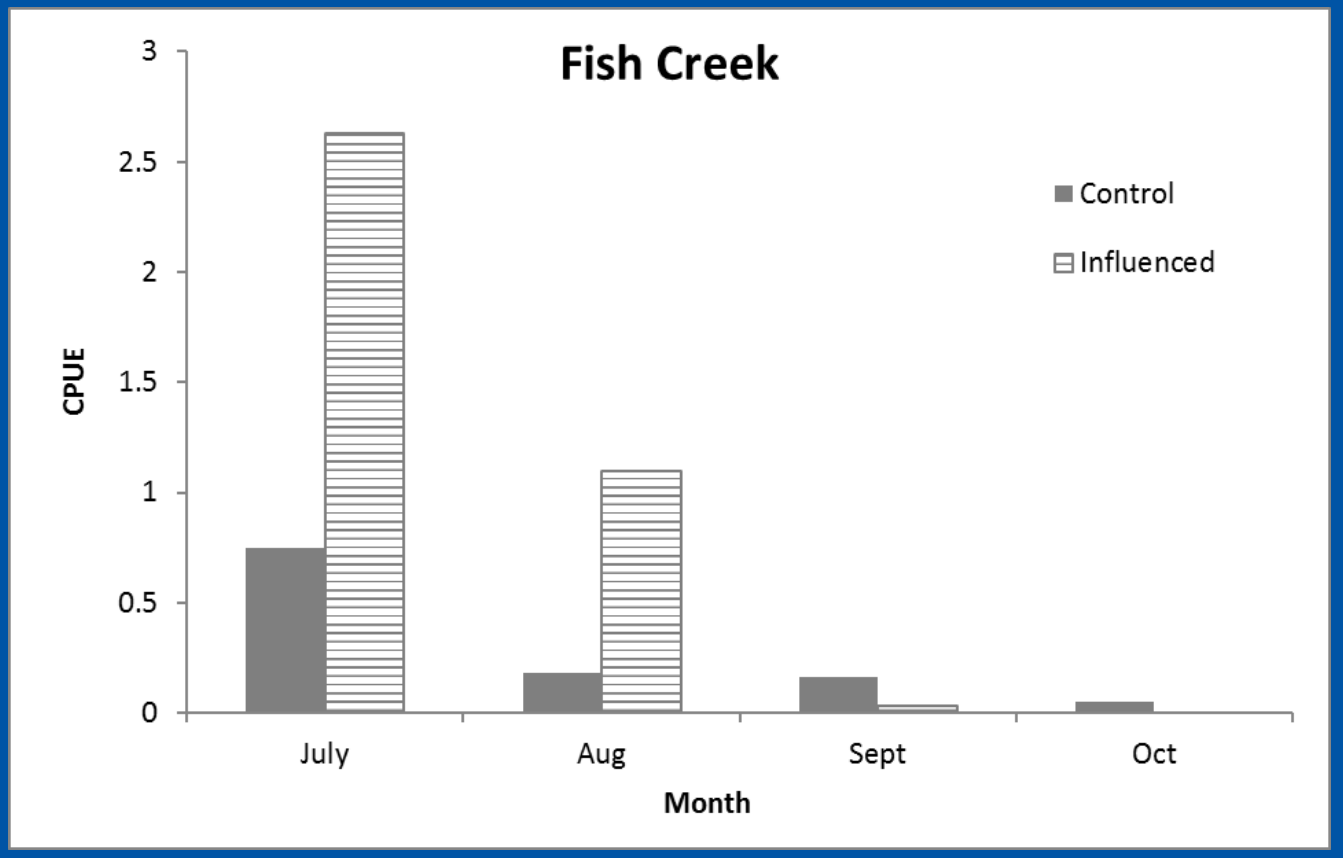

Fish Creek
Temperature, C
0
5
10
15
20
25
30
Control top
Control bottom
Influenced bottom
Influenced top
6/25/2015
7/2/2015
7/9/2015
7/16/2015
7/23/2015
7/30/2015
8/6/2015
8/13/2015
8/20/2015
8/27/2015
9/3/2015
9/10/2015
9/17/2015
9/24/2015
10/1/2015
10/8/2015
10/15/2015
10/22/2015
Date

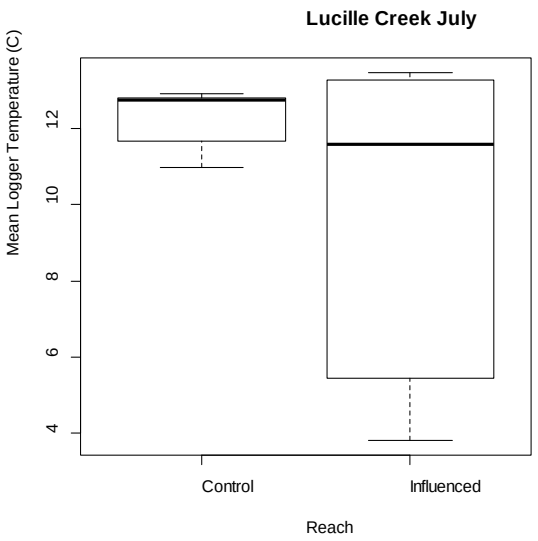
August data	Control	Influenced
mean temperature (°C)	16.7	15.0
discharge (cfs)	7.5	0.6
total invertebrate abundance	5,263	2,398
mean fork length (mm)	65.3	64.4

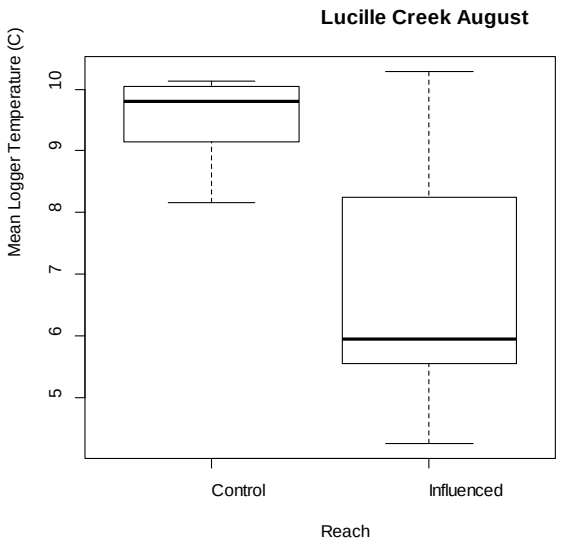


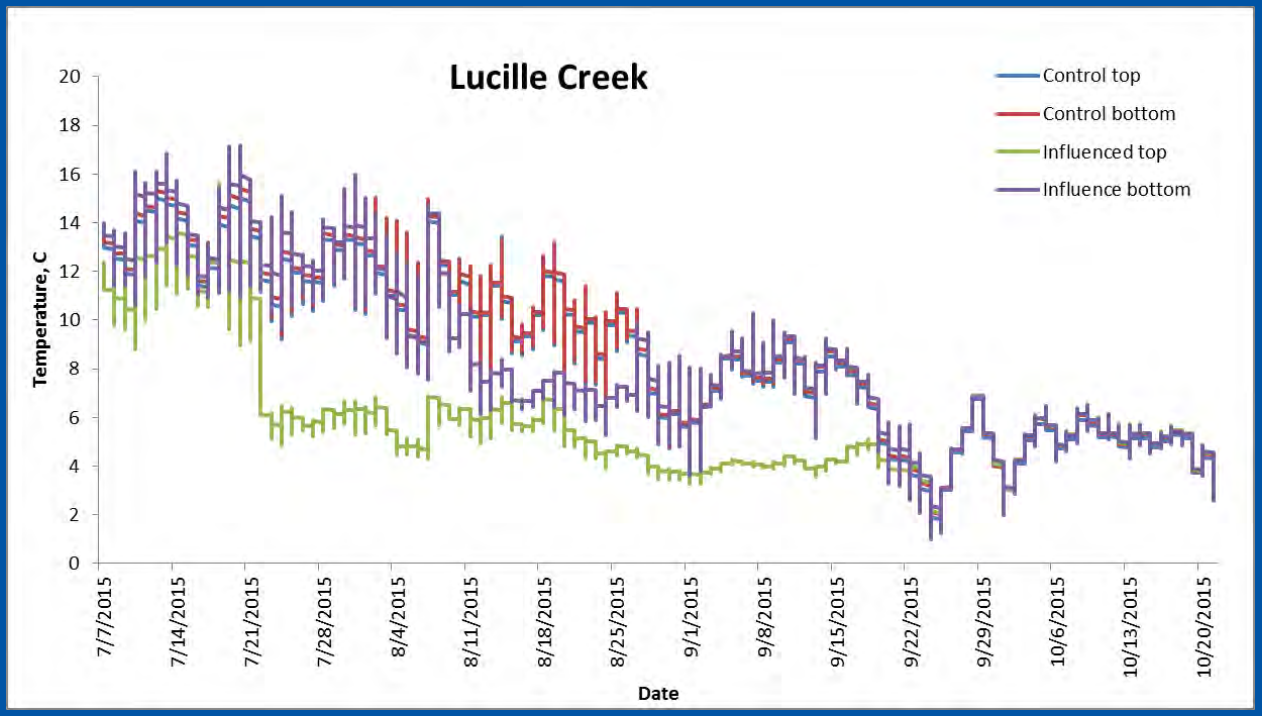



Lucille Creek

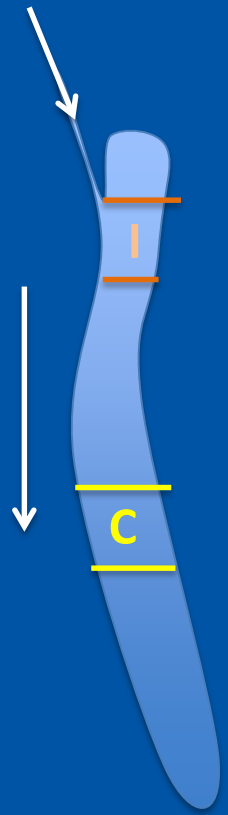

I
C

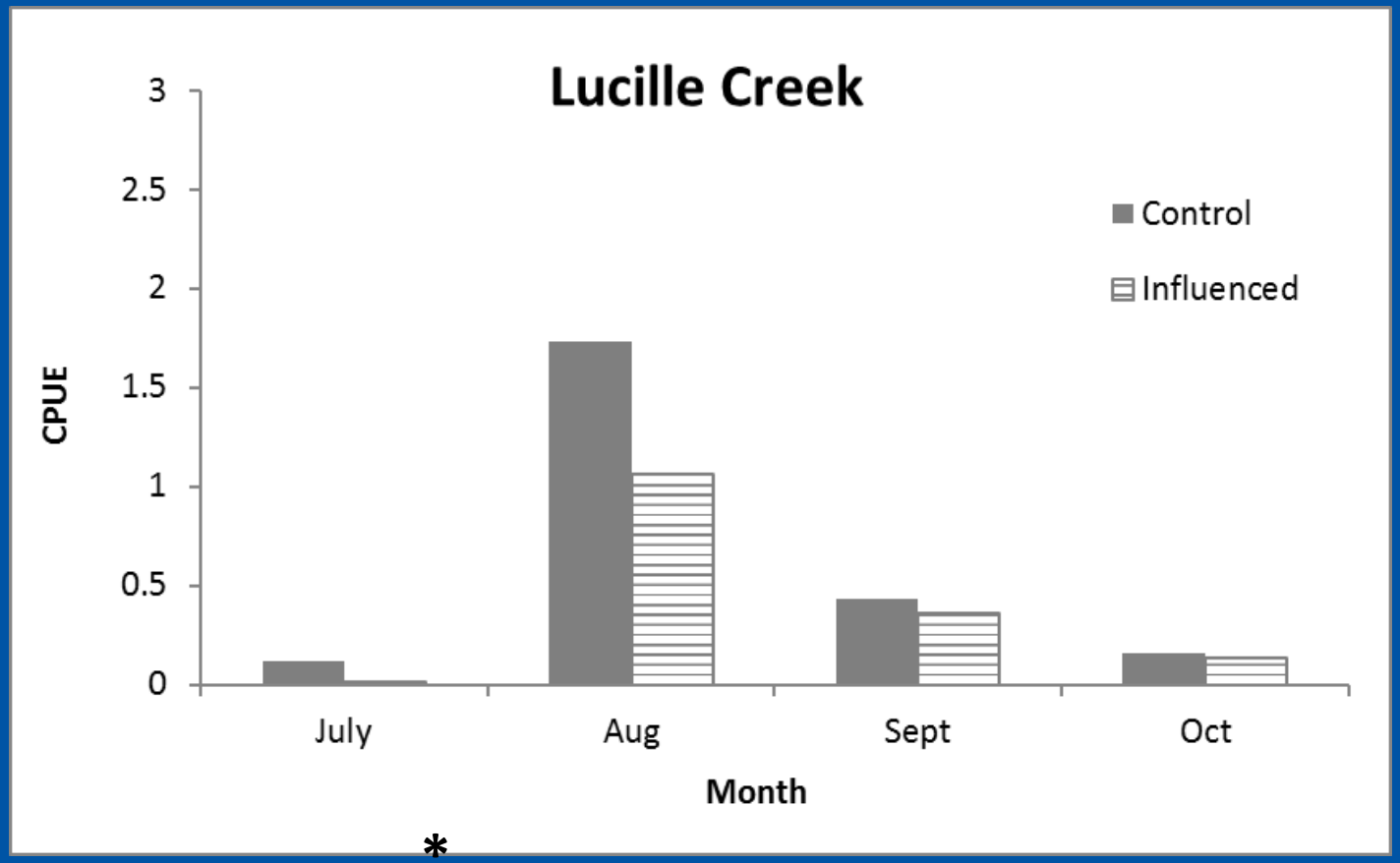

Lucille Creek July
Mean Logger Temperature (C)
4
6
8
10
12
Control
Influenced
Reach


Lucille Creek August
Mean Logger Temperature (C)
5
6
7
8
9
10
Control
Influenced
Reach


Lucille Creek
Control top
Control bottom
Influenced top
Influence bottom
Temperature, C
0
2
4
6
8
10
12
14
16
18
20
7/7/2015
7/14/2015
7/21/2015
7/28/2015
8/4/2015
8/11/2015
8/18/2015
8/25/2015
9/1/2015
9/8/2015
9/15/2015
9/22/2015
9/29/2015
10/6/2015
10/13/2015
10/20/2015
Date

August data	Control	Influenced
mean temperature (°C)	9.6	6.7
discharge (cfs)	1.0	1.2
total invertebrate abundance	384	131
mean fork length (mm)	82.4	80.5





Herkimer Creek

- significant cold water inflow in warm system
- variable benthic invert abundance
- larger fork lengths in colder water

Important cold water refugia

Fish Creek

- moderate cold water inflow in warm system
- high benthic invert abundance
- variable flow
- significant adult migratory corridor

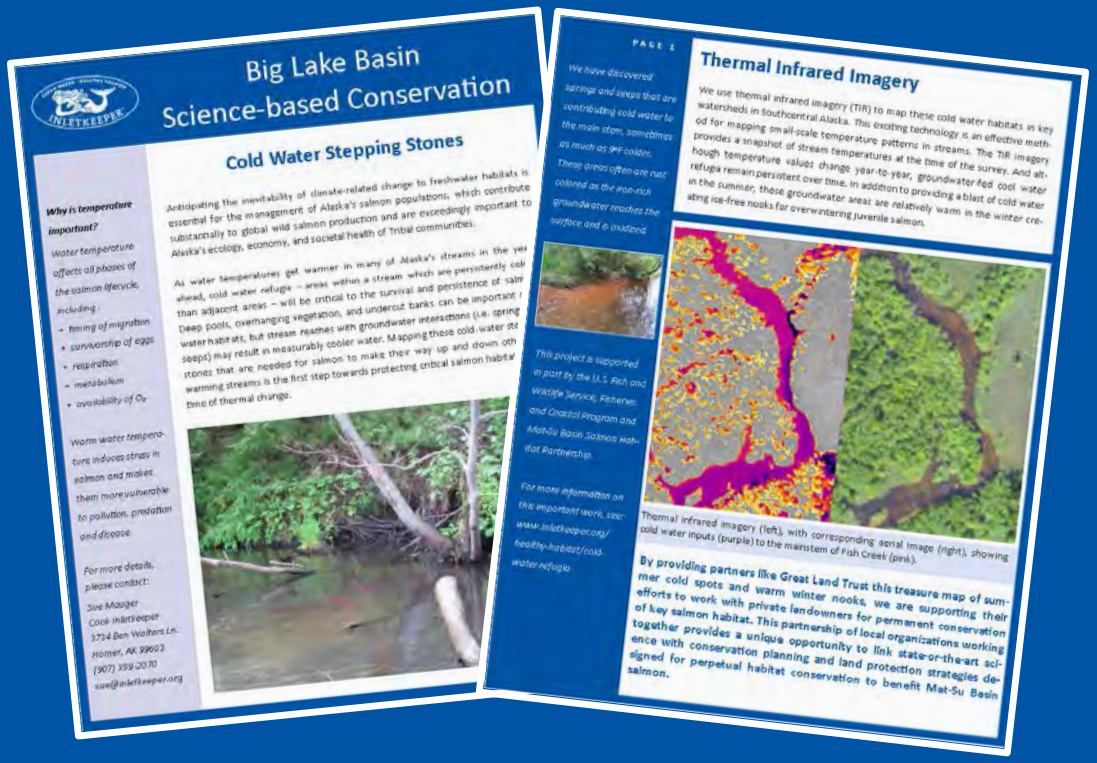
Important off-channel habitat

Lucille Creek

- variable cold water inflow in cool system
- low benthic invert abundance
- large fork lengths in both reaches

Overall tributary important rearing habitat

By documenting salmon use of habitats influenced by cold water inputs and providing partners like Great Land Trust this treasure map of summer cold spots and warm winter nooks, we are supporting their efforts to work with private landowners for permanent conservation of key salmon habitat.



Big Lake Basin
Science-based Conservation

Cold Water Stepping Stones

Why is temperature important?

Water temperature affects all phases of the salmon lifecycle, including:

- timing of migration
- survivorship of eggs
- respiration
- metabolism
- availability of Ox

Warm water temperature induces stress in salmon and makes them more vulnerable to pollution, predation and disease.

For more details, please contact:

Sue Mauger
Cook Inletkeeper
3734 Ben Walters Ln.
Homer, AK 99603
(907) 399-2070
sue@inletkeeper.org

Anticipating the inevitability of climate-related change to freshwater habitats is essential for the management of Alaska's salmon populations, which contribute substantially to global wild salmon production and are exceedingly important to Alaska's ecology, economy, and societal health of Tribal communities.

As water temperatures get warmer in many of Alaska's streams in the yea ahead, cold water refugia – areas within a stream which are persistently col than adjacent areas – will be critical to the survival and persistence of salm Deep pools, overhanging vegetation, and undercut banks can be important water habitats, but stream reaches with groundwater interactions (i.e. spring seeps) may result in measurably cooler water. Mapping these cold-water st stones that are needed for salmon to make their way up and down oth warming streams is the first step towards protecting critical salmon habitat time of thermal change.

PAGE 2

We have discovered springs and seeps that are contributing cold water to the main stem, sometimes as much as 9ºF colder. These areas often are rust-colored as the iron-rich groundwater reaches the surface and is oxidized.

This project is supported in part by the U.S. Fish and Wildlife Service, Fisheries and Coastal Program and Mat-Su Basin Salmon Habitat Partnership.

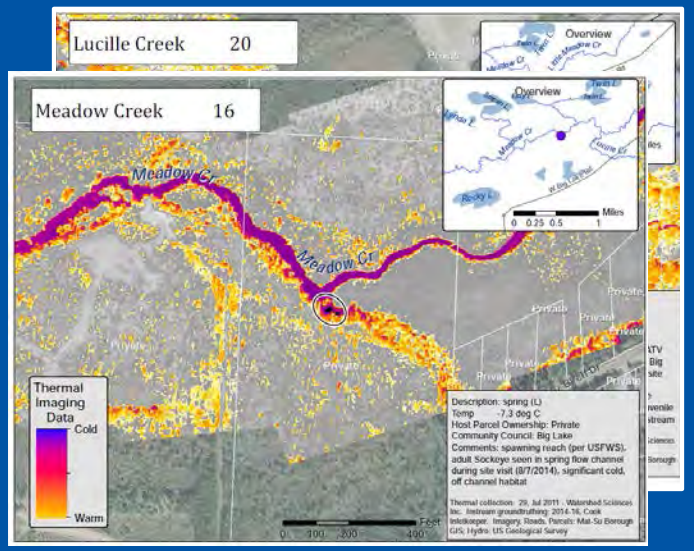
For more information on this important work, see: www.inletkeeper.org/healthy-habitat/cold-water-refugia

Thermal Infrared Imagery

We use thermal infrared imagery (TIR) to map these cold water habitats in key watersheds in Southcentral Alaska. This existing technology is an effective meth-od for mapping small-scale temperature patterns in streams. The TIR imagery provides a snapshot of stream temperatures at the time of the survey. And alt-hough temperature values change year-to-year, groundwater-fed cool water refugia remain persistent over time. In addition to providing a blast of cold water in the summer, these groundwater areas are relatively warm in the winter cre-ating ice-free nooks for overwintering juvenile salmon.

Thermal infrared imagery (left), with corresponding aerial image (right), showing cold water inputs (purple) to the mainstem of Fish Creek (pink).

By providing partners like Great Land Trust this treasure map of sum-mer cold spots and warm winter nooks, we are supporting their efforts to work with private landowners for permanent conservation of key salmon habitat. This partnership of local organizations working together provides a unique opportunity to link state-or-the-art sci-ence with conservation planning and land protection strategies de-signed for perpetual habitat conservation to benefit Mat-Su Basin salmon.



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