



# Science-based Land Conservation

## Conservation Strategies to Protect Key Salmon Habitat in Lower Kenai Peninsula Watersheds

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Kachemak Heritage Land Trust



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## **SCIENCE-BASED LAND CONSERVATION**

### **BACKGROUND**

Lower Kenai Peninsula salmon streams already exceed temperatures known to be stressful to Pacific salmon based on water temperature monitoring over the last decade. And climate models show continuing warming trends throughout Alaska for the next 100 years and more. Since water temperature plays such a critical role in the salmon lifecycle, the ability for salmon to find cooler water in a warming environment may be an important key to their survival. Cold water refuges – areas within a stream which are persistently colder than adjacent areas during the summer – will be critical for the productivity and persistence of salmon and other cold-water fish species in the decades ahead.

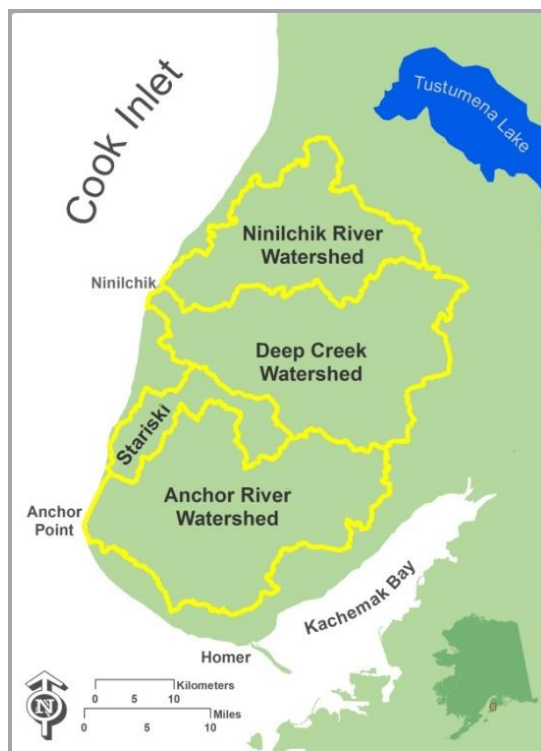
Cook Inletkeeper, Kachemak Heritage Land Trust and Kenai Watershed Forum developed the Science-based Land Conservation project with a goal of improving landscape-scale resilience for salmon on Alaska's lower Kenai Peninsula. Project objectives were to:

- identify critical salmon habitat in the Anchor River, Stariski Creek, Deep Creek, and Ninilchik River watersheds;
- create land conservation strategies for riparian areas on the lower Kenai Peninsula based upon local research for the protection of salmon habitat;
- educate landowners of priority conservation land about conservation options available to them; and
- work with public and private landowners to protect land determined to be significant for salmon habitat on the lower Kenai Peninsula.

This report describes the information and methods used to identify key Chinook and coho salmon habitat to determine which parcels are the highest priorities for permanent conservation. In addition, multiple conservation strategies are outlined as next steps to address the findings of this project. The three project partners will work together as appropriate for each of their organizational missions to follow through with these future strategies as funding allows. This project has provided a unique opportunity to link state-of-the-art science with conservation planning and land protection strategies designed for perpetual habitat conservation to benefit salmon.

## STUDY AREA

Salmon streams on the lower Kenai Peninsula - Anchor River, Stariski Creek, Deep Creek, and Ninilchik River - support sport and commercial fisheries, and provide important subsistence resources for Alaska Natives and other groups. Flowing into Cook Inlet, these streams have populations of Chinook, coho and pink salmon, Dolly Varden char, and steelhead (anadromous) and rainbow (resident) trout. Prior to 1990, these watersheds were relatively undeveloped with access into the backcountry provided only by trails along seismic lines. Land use has rapidly changed over the last twenty-five years with increased residential development, road building, logging, gravel extraction and ATV use. After a spruce bark beetle infestation devastated the forested lands of this area, local community concern led to more focused research, restoration, and monitoring efforts. In the last decade, significant research has occurred in the Anchor River watershed particularly. Due to similarities in geology, hydrology and climate, our understanding of ecological processes in the Anchor River is relevant for the other three watersheds.



Land ownership varies considerably throughout each watershed (see Table 1). Private land is more prevalent in the Anchor River and Stariski Creek watersheds, but the vast majority of land is under Native and State ownership. (Note – Native land is private land also; however, we are making a distinction because Native parcels tend to be large and are typically not currently managed for residential development.) About 11% of the Deep Creek watershed is part of the Kenai National Wildlife Refuge.

Table 1. Land ownership is based on previous GIS analysis (Cook Inletkeeper, 2005)

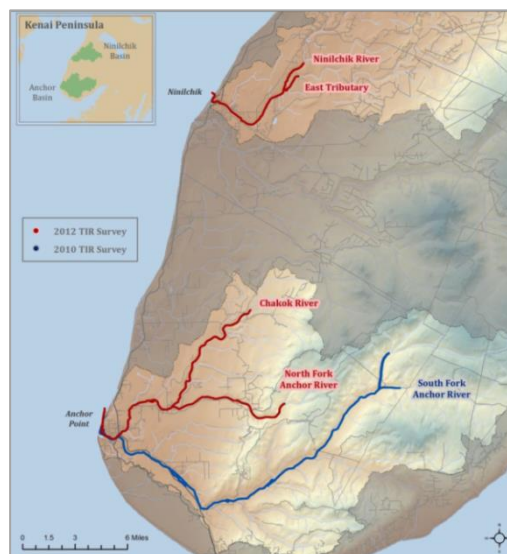
|                  | Anchor River | Stariski Creek | Deep Creek | Ninilchik River |
|------------------|--------------|----------------|------------|-----------------|
| <b>Private</b>   | 26.6%        | 29.6%          | 5.3%       | 8.1%            |
| <b>Federal</b>   | 0.3%         | 0.0%           | 11.2%      | 2.9%            |
| <b>Native</b>    | 22.0%        | 25.9%          | 38.5%      | 46.7%           |
| <b>Borough</b>   | 14.1%        | 9.5%           | 0.1%       | 0.0%            |
| <b>State</b>     | 36.8%        | 35.1%          | 44.9%      | 42.3%           |
| <b>Municipal</b> | 0.2%         | 0.0%           | 0.0%       | 0.0%            |

## METHODS

Cook Inletkeeper used remote sensing technology to identify cold water habitat and interpreted recent fish habitat research on the Anchor River. This information, described below, was then combined by the Kenai Watershed Forum into a geographic information system (GIS) with additional layers used by Kachemak Heritage Land Trust (KHLT) to prioritize parcels. KHLT then identified and prioritized parcels for long-term conservation on private lands and worked with project partners to develop conservation strategies for key parcels on both private and public lands.

### Thermal Imagery

Airborne thermal infrared (TIR) imagery is a valuable tool for illustrating the location and thermal influence of point sources, tributaries and surface springs. In the summers of 2010 and 2012, Watershed Sciences Inc. (WSI) was contracted to map cold water habitats using TIR imagery along 70 miles of the Anchor River and 15 miles of the Ninilchik River. These river segments were selected because they include areas with the greatest amount of development and impervious surfaces. The imagery covers approximately 1,000 feet across the river channel and riparian zone. In addition to GIS layers of the imagery and corresponding aerial photos, WSI included an interpretation of the imagery in a written report. Cook Inletkeeper staff then analyzed the imagery to select “key habitats” important to Chinook and coho salmon. Results are presented for each watershed except for the Anchor River where each subwatershed is discussed separately.



### Likely Fish Use

For each key habitat identified through the thermal imagery, likely fish use of that habitat has been described. This information is based on output from the Anchor River RIPPLE model, which was developed by Stillwater Sciences in cooperation with the U.S. Fish and Wildlife Service, Kenai Office. The model characterizes geomorphic and ecological processes that create and maintain freshwater salmon habitat, predicts the distribution of fish habitat conditions, and simulates salmon population dynamics. The model estimates reach-specific carrying capacities using predicted physical variables such as channel morphology and substrate size, in conjunction with field measured maximum densities of each life stage for different slope and drainage area combinations and habitat types. RIPPLE then uses these reach-specific carrying capacities in a multistage stock-production model to predict distribution and abundance of each life stage (Table 2).

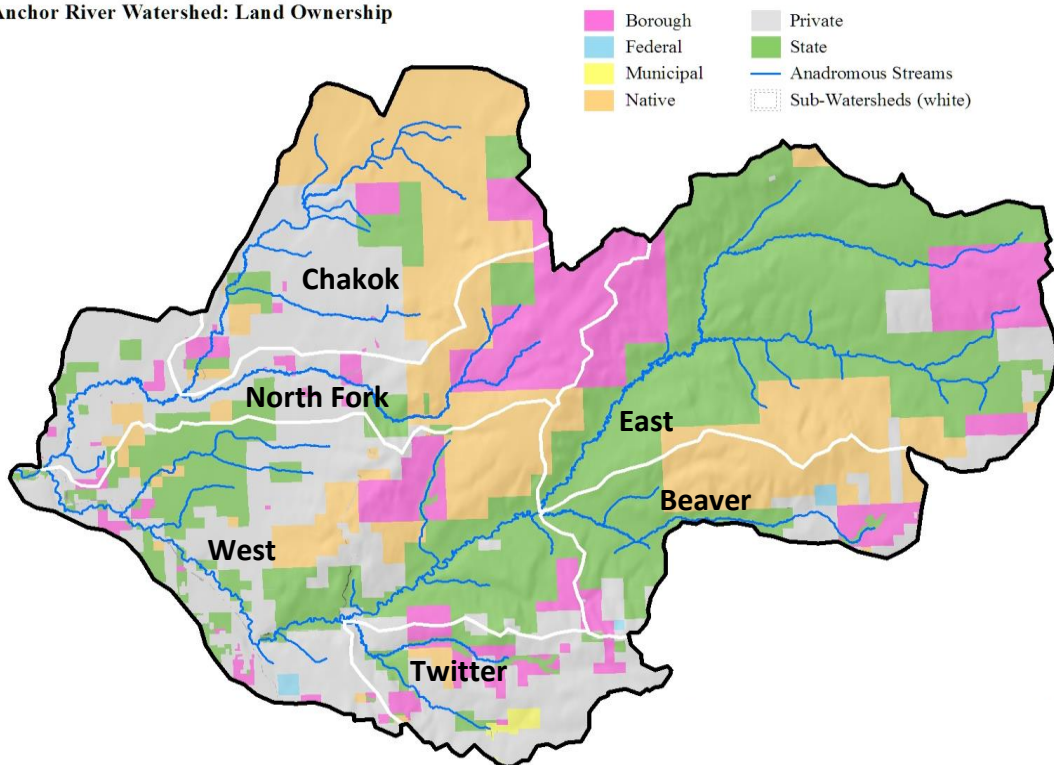
Table 2. Chinook and coho abundance categories used in this report for each life stage based on the Anchor River RIPPLE model.

| Life stage          | Abundance   | Density/100m |               |
|---------------------|-------------|--------------|---------------|
|                     |             | Chinook      | Coho          |
| Spawning            | limited     | 35-70        | 40-60         |
|                     | moderate    | 70-140       | 60-200        |
|                     | significant | 140-180      | 200-280       |
| Fall/Winter rearing | limited     | 500-1,000    | 2,700-5,500   |
|                     | moderate    | 1,000-2,000  | 5,500-11,000  |
|                     | significant | 2,000-2,500  | 11,000-13,600 |
| Summer rearing      | limited     | 175-350      | 120-240       |
|                     | moderate    | 350-700      | 240-480       |
|                     | significant | 700-875      | 480-600       |

## RESULTS – Anchor River

The Anchor River watershed has been split into six subwatersheds by the Alaska Geographic Data Committee. Subwatershed boundaries and land ownership are delineated below. The watershed covers 225 square miles and has 114 miles of catalogued salmon habitat.

Anchor River Watershed: Land Ownership



## **SUBWATERSHED: West Anchor River**

### Description

This 55 square mile subwatershed with 42.8 miles of anadromous streams encompasses the lower 23 miles of the south fork of the river including the mouth of the river below the confluence with the north fork up to the confluence with Beaver Creek.



Based on an analysis of satellite photos from 2003, 2.1% of the subwatershed is covered in impervious surfaces. This is well below the amount considered to have negative impacts to water quality, but this subwatershed has high potential for more development with a high percentage of private lands.

### Subwatershed land ownership (%):

|         |      |
|---------|------|
| State   | 38.7 |
| Private | 35.1 |
| Native  | 16.5 |
| Borough | 9.2  |
| Federal | 0.5  |

### Likely fish use

This subwatershed contains the highest density of Chinook and coho spawning habitat, significant Chinook winter rearing habitat, and moderate coho fall and summer rearing habitat.

### Key habitats

Through assessment of the thermal imagery, 23 cold-water inputs were identified. (Extent of thermal imagery shown on map.) These groundwater inputs intersect with 41 parcels, which have the following land owner status:

- 1 in Kenai Peninsula Borough ownership
- 1 in Native ownership
- 5 in conservation status
- 16 in private ownership
- 18 in State ownership



### Conservation strategies

1. For the most recent prioritization work, KHLT has selected private parcels that are greater than five acres in size with minimal improvements (<\$25,000) for their outreach efforts. Of the 16 parcels with key habitat in private ownership, nine meet these criteria. KHLT mailed outreach materials to these landowners to discuss options for conserving these key habitats. KHLT is currently working with their attorney and two landowners to move forward with due diligence inquiries on a total of five parcels.

2. Seven of the 18 State (Alaska Department of Natural Resources) parcels are part of the Anchor River/Fritz Creek Critical Habitat Area. The stated purpose of the area is to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose. KHLT will provide ADNR maps of the key habitats on these parcels for informational purposes. Cook Inletkeeper will provide input about the importance of key habitats to ADNR if changes to the Critical Habitat Management Plan are proposed in the future.

3. Two of the State parcels fall within the Anchor River Recreation Area at the mouth of the river. This reach of the Anchor River provides high potential spawning habitat and is the area of greatest sport fishing access. Based on past habitat assessments by the Homer Soil and Water Conservation District, this reach also has some significant stream bank impacts. Cook Inletkeeper will re-engage with Alaska State Parks about habitat restoration and outreach potential along this reach.

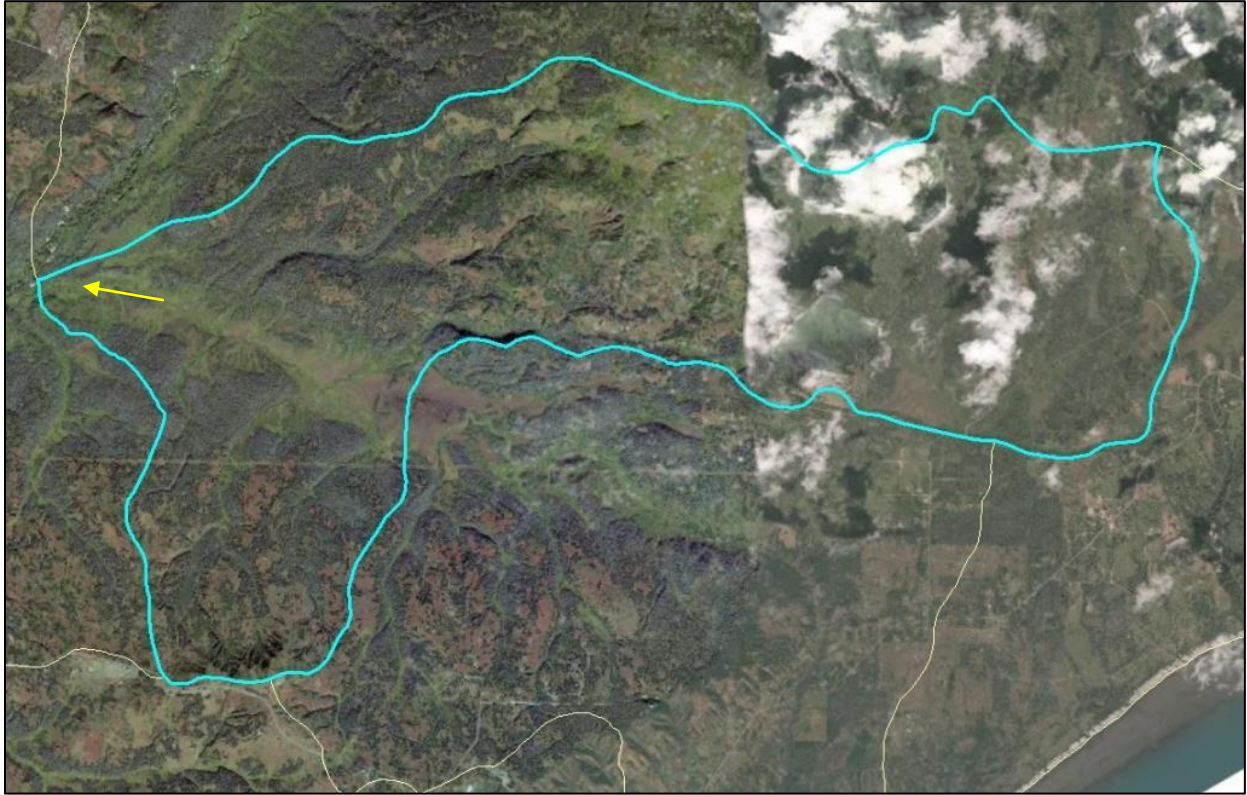


(Photo: The spring on the left brings iron-rich groundwater to the surface and contributes cold water to the main channel of the Anchor River.)

## SUBWATERSHED: Beaver Creek

### Description

This 20 square mile subwatershed includes 12.5 miles of anadromous streams and flows into the south fork of the Anchor River at river mile 23. This subwatershed has very little development with only 0.3% impervious surfaces.



### Subwatershed land ownership (%):

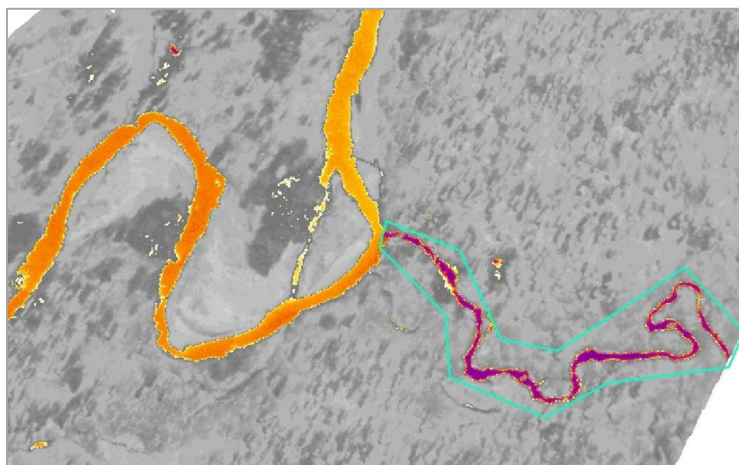
|         |      |
|---------|------|
| State   | 37.3 |
| Native  | 37.2 |
| Private | 14.1 |
| Borough | 9.9  |
| Federal | 1.6  |

### Likely fish use

This subwatershed contains significant Chinook and coho summer rearing habitat. Based on RIPPLE output this type of habitat is the limiting factor in overall salmon productivity thus making this subwatershed of critical importance.

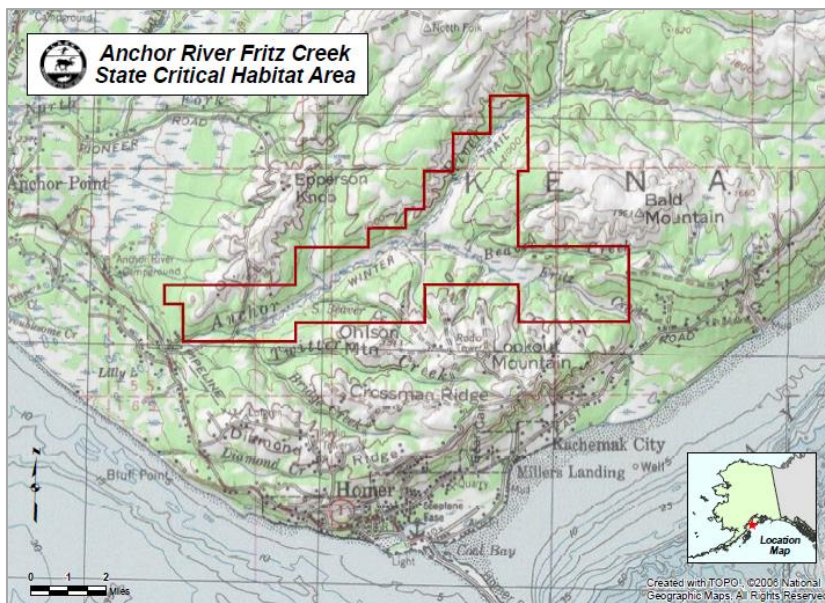
### Key habitats

Thermal imagery is only available for the lowest reach of Beaver Creek (magenta) which contributes significantly colder water to the main channel of the South Fork Anchor River (orange). This confluence may be important holding habitat for upstream migration as the reach above this confluence on the south fork is notably warmer. (Local fishermen described the two mile reach of the main channel above the confluence with Beaver Creek as the “dead zone” because they never see any fish in it. The adults hold below Beaver Creek and then move upstream quickly, presumably at night when it is cooler.)



### Conservation strategies

1. More than a third of the subwatershed and most of the main channel of Beaver Creek is part of the Anchor River/Fritz Creek Critical Habitat Area. The stated purpose of the area is to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose. KHLT will provide ADNR maps of the key habitats on these parcels for informational purposes. Cook Inletkeeper will provide input to ADNR if changes to the Critical Habitat Management Plan are proposed in the future.



2. More than a third of the subwatershed is held by Cook Inlet Region Inc. (CIRI); however, much of these lands are uplands in the Bald Mountain area. KHLT will provide CIRI with project information for a more general discussion about land conservation for salmon-bearing watersheds.

## SUBWATERSHED: East Anchor River

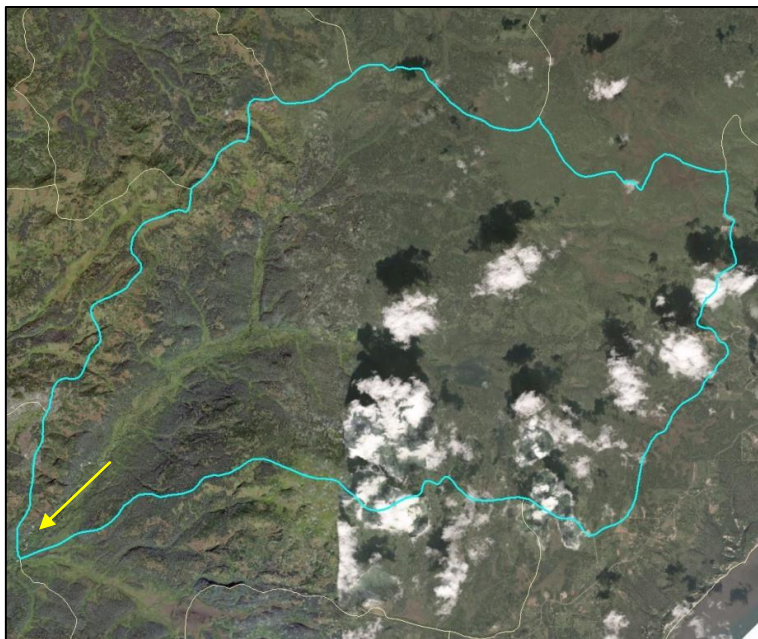
Description – This 65.2 square mile subwatershed includes 43.5 miles of anadromous streams and flows into the south fork of the Anchor River at river mile 23. There are less than 6 miles of (unpaved) roads in the subwatershed and only 0.1% impervious surfaces. This subwatershed has considerable headwater stream habitat.

### Land ownership (%):

|         |      |
|---------|------|
| State   | 66.7 |
| Borough | 15.4 |
| Native  | 12.7 |
| Private | 5.2  |

### Likely fish use

This subwatershed contains significant Chinook and coho summer rearing habitat and moderate fall rearing habitat for coho. Based on RIPPLE output summer rearing habitat is the limiting factor in overall salmon productivity thus making this subwatershed critically important.



### Key habitats

Watershed Sciences identified nine surface inflows contributing between 1.2 and 3.3°C colder water in ten miles of thermal imagery (2010); all of which are on State lands.

### Conservation strategies

1. Most of the inflows fall within the Anchor River/Fritz Creek Critical Habitat Area. The stated purpose of the area is to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose. KHLT will provide ADNR maps of the key habitats on these parcels for informational purposes. Cook Inletkeeper will provide input to ADNR if changes to the Critical Habitat Management Plan are proposed in the future.
2. Project Partners will collaborate with Kachemak Bay Research Reserve staff, who have done considerable headwater stream work, to integrate this information into discussions with large parcel landowners (ADNR, Kenai Peninsula Borough, Cook Inlet Region Inc.) to consider groundwater flow paths and impacts from future road building, etc.

## SUBWATERSHED: Twitter Creek

Description – This 15.7 square mile subwatershed includes 9.4 miles of anadromous streams and flows into the south fork of the Anchor River at river mile 14.4. Bridge Creek reservoir is the City of Homer’s drinking water supply. Impervious coverage was 1.2% ten years ago but with a high percentage of private land and its proximity to the City of Homer, this subwatershed has a potential for significant development in the future.

### Land ownership (%):

|           |      |
|-----------|------|
| Private   | 63.0 |
| Borough   | 16.1 |
| State     | 13.8 |
| Native    | 3.6  |
| Municipal | 3.5  |

### Likely fish use

This subwatershed contains significant Chinook and coho summer rearing habitat. Based on RIPPLE output this type of habitat is the limiting factor in overall salmon productivity thus making this subwatershed of critical importance. (Note – the RIPPLE model does not take into account Bridge Creek reservoir as a fish passage blockage.)



### Key habitats

The thermal imagery does not cover this subwatershed. The confluence of Twitter Creek with the south fork channel shows only a 0.2°C difference in temperature. It is possible that the Bridge Creek reservoir in the upper reaches exposes the surface water to significant solar radiation, thus warming this body of water and reducing its potential as an important cold-water tributary farther downstream.

### Conservation strategies

1. With a high percentage of private parcels but no thermal imagery to guide specific actions, Cook Inletkeeper and the Kenai Watershed Forum may work with other entities like the Homer Soil and Water Conservation District to educate property owners about rain gardens and other green storm water technologies.
2. Bridge Creek reservoir is the City of Homer’s drinking water supply. Property owners in this basin must follow the regulations described in the Bridge Creek Watershed Protection District which restricts impervious surfaces to 4.2% of their land. Cook Inletkeeper will provide input to the City of Homer if changes to the Watershed Protection District are proposed in the future.

## SUBWATERSHED: North Fork Anchor River

Description – This 30.9 square mile subwatershed includes 25.9 miles of anadromous streams. Residential and gravel pit development bring impervious surfaces up to 2.4% in this subwatershed.



### Land ownership (%):

|         |      |
|---------|------|
| Private | 38.5 |
| Borough | 30.3 |
| Native  | 17.8 |
| State   | 13.4 |



### Likely fish use

This subwatershed contains moderate Chinook spawning and winter rearing habitat, significant Chinook and coho summer rearing habitat, and moderate coho fall rearing habitat. Based on RIPPLE output summer rearing habitat is the limiting factor in overall salmon productivity thus making this subwatershed of critical importance.

### Key habitats

Through assessment of the thermal imagery, 7 cold-water inputs were identified. These inputs intersected with 17 parcels, all in private ownership.

### Conservation strategies

1. Of the 17 parcels with key habitat in private ownership, five meet KHLT's criteria (parcels greater than five acres with minimal improvements) for their outreach efforts. KHLT mailed outreach materials to these landowners to discuss options for conserving key habitats. KHLT is working with their attorney and one landowner to move forward with due diligence inquiries on two parcels.
2. Cook Inletkeeper and the Kenai Watershed Forum may work with other entities like the Homer Soil and Water Conservation District to educate private property owners about rain gardens and other green storm water technologies.

## SUBWATERSHED: Chakok River

Description – This 38.1 square mile subwatershed includes 30 miles of anadromous streams and flows into the north fork of the Anchor River at river mile 9.6. This subwatershed has 1.1% impervious surfaces.

### Land ownership (%):

|         |      |
|---------|------|
| Native  | 48.9 |
| Private | 34.0 |
| State   | 9.8  |
| Borough | 7.3  |

### Likely fish use

This subwatershed contains significant Chinook and coho summer rearing habitat. Based on RIPPLE output this type of habitat is the limiting factor in overall salmon productivity thus making this subwatershed of critical importance.

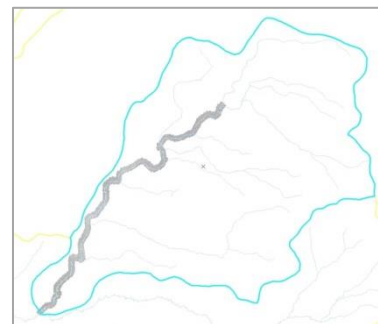
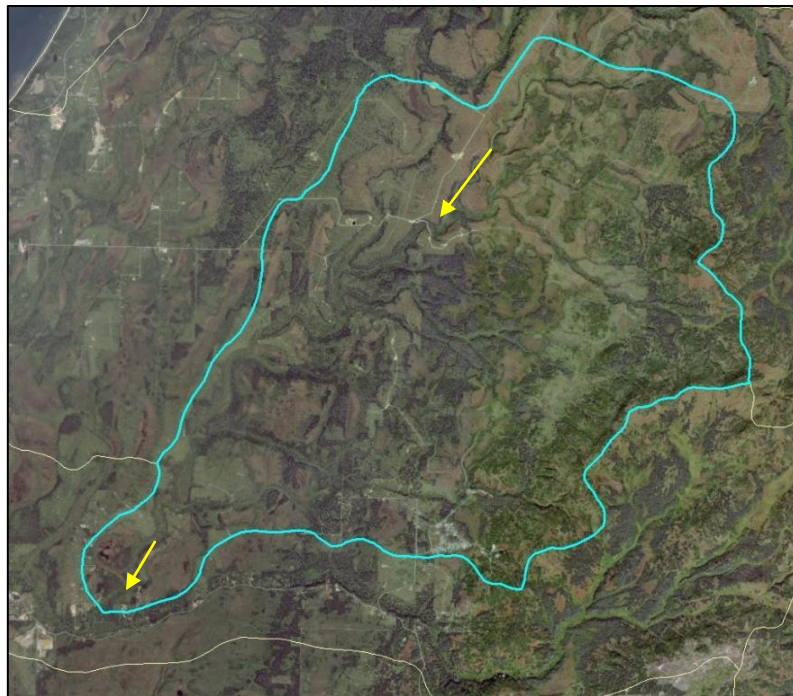
### Key habitats

Within ten miles of the 16 miles of Chakok River thermal imagery, there is an extended thermal plateau (i.e. constant temperature over a significant distance) with an increase in channel sinuosity, meadow habitat and remnant oxbows along this reach, all of which can contribute to increased subsurface interactions. Groundwater is more diffuse in this type of landscape, but five distinct cold-water inputs were identified. These inputs intersected with eight parcels, seven in private ownership and one on Kenai Peninsula Borough land.

### Conservation strategies

1. Of the seven parcels with key habitat in private ownership, five meet KHLT's criteria (parcels greater than five acres with minimal improvements) for their outreach efforts. KHLT mailed outreach materials to these landowners to discuss options for conserving these key habitats. KHLT is working with their attorney and one landowner to move forward with due diligence inquiries on four parcels.

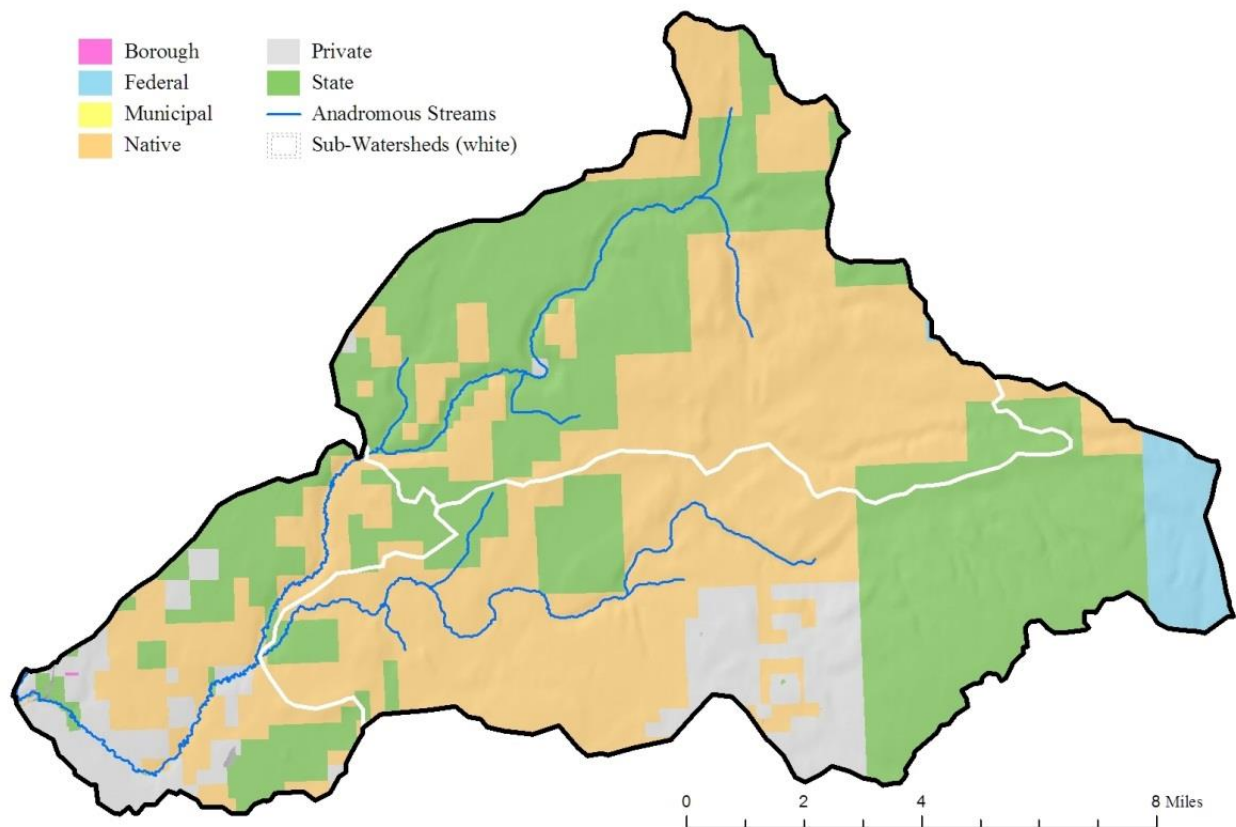
2. Project Partners will collaborate with Kachemak Bay Research Reserve staff, who have done considerable headwater stream work, to integrate this information into discussions with large parcel landowners (ADNR, Kenai Peninsula Borough, Cook Inlet Region Inc.) to consider groundwater flow paths and impacts from future road building, etc.



## RESULTS – Ninilchik River

The Ninilchik River watershed covers 135 square miles and has 52 miles of catalogued salmon habitat. The lower 10 miles of the river has the highest potential for more development with a high percentage of private lands.

### Ninilchik River Watershed: Land Ownership

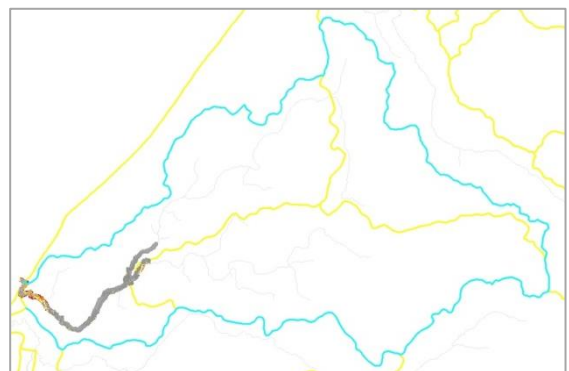


### Key habitats

Through assessment of the 15 miles of thermal imagery, 33 cold-water inputs were identified. (Extent of thermal imagery shown on the map.)

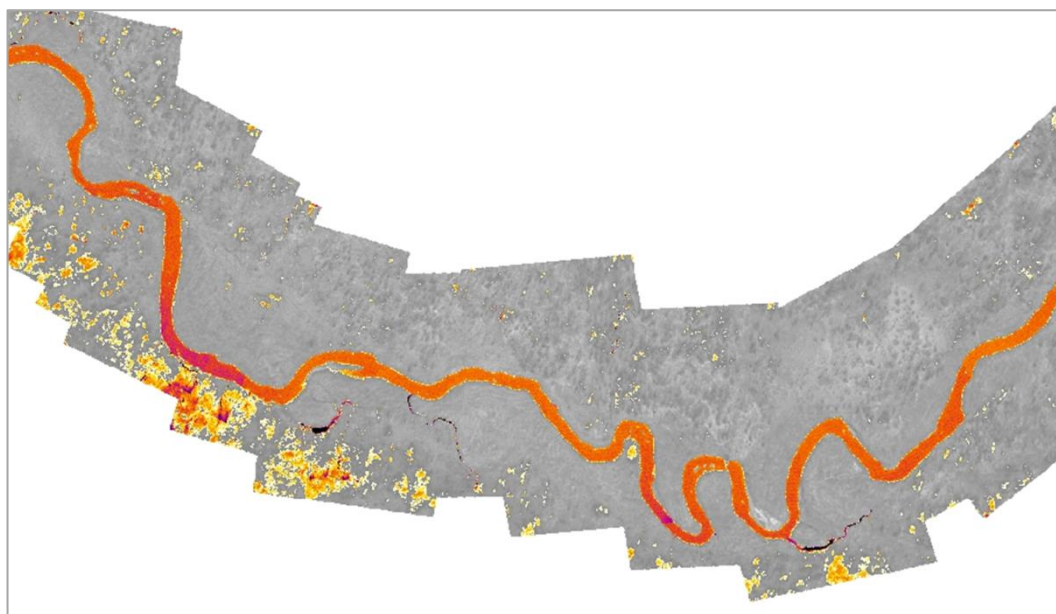
These groundwater inputs intersect with 24 parcels, which have the following land owner status:

- 8 in Native ownership
- 8 in State ownership
- 8 in private ownership



### Conservation Strategies

1. KHLT has prioritized private parcels that are greater than five acres in size with minimal improvements for their outreach efforts. Of the 8 parcels with key habitat in private ownership, six meet these criteria. KHLT mailed outreach materials to these landowners to discuss options for conserving these key habitats. KHLT is working with their attorney and one landowner to move forward with due diligence inquiries on two parcels.
2. During field work to ground truth the thermal imagery, one cold water input within the Ninilchik River State Recreational Area was found to be heavily impacted by foot traffic. State Parks staff was notified and as a result the State has applied for funding through the Kenai Peninsula Fish Habitat Partnership to rebuild a foot bridge and help with trail improvements to re-route visitors away from the outflow of the cold water habitat. In addition, Park staff will work with Cook Inletkeeper to develop outreach material and messaging and use an existing kiosk to display educational material about salmon habitat and the importance of thermal refugia.
3. Project Partners will collaborate with Kachemak Bay Research Reserve staff, who have done considerable headwater stream work, to integrate this information into discussions with large parcel landowners (ADNR, University of Alaska, Ninilchik Native Association, Cook Inlet Region Inc.) to consider groundwater flow paths and impacts from future road building, etc.
4. Cook Inletkeeper and the Kenai Watershed Forum may work with other entities like the Homer Soil and Water Conservation District to educate private property owners about rain gardens and other green storm water technologies.

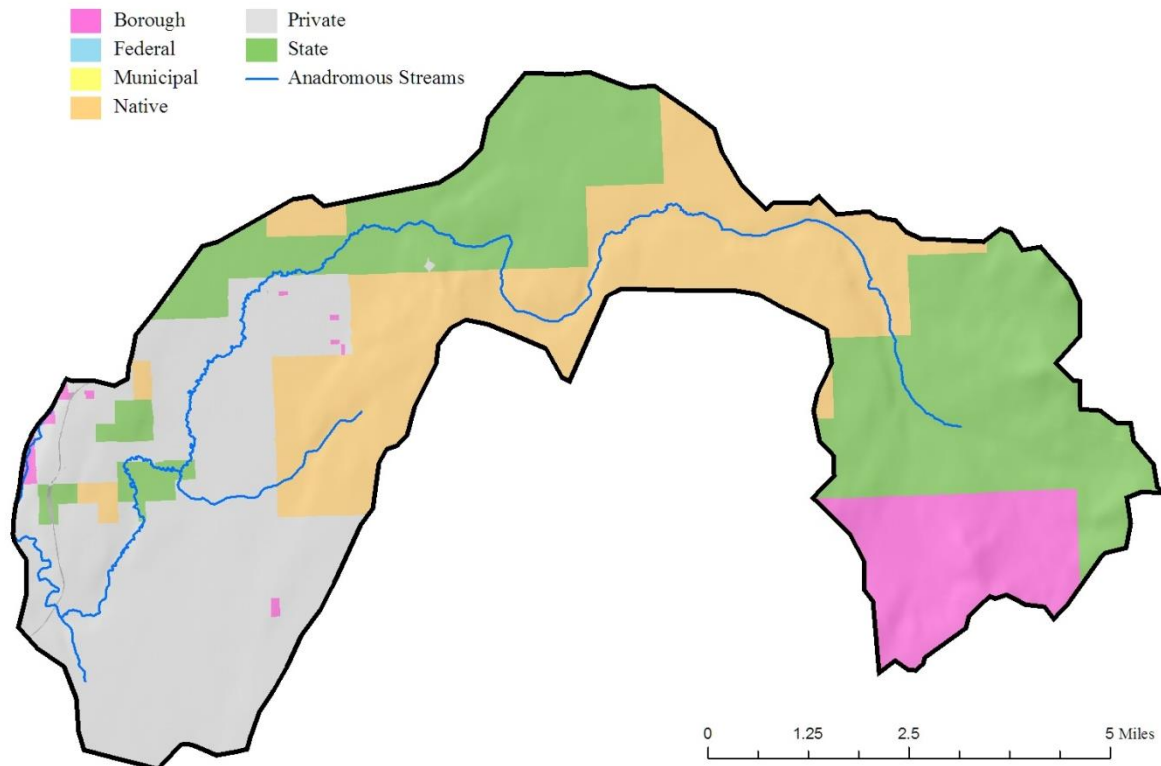


(Example of thermal imagery showing mile 4 of the Ninilchik River.)

## Results – Stariski Creek

The Stariski Creek watershed covers 49 square miles and has 28 miles of catalogued salmon habitat. This watershed has high potential for more residential development with the greatest percentage of private land on the lower Kenai Peninsula.

### Stariski Creek Watershed: Land Ownership



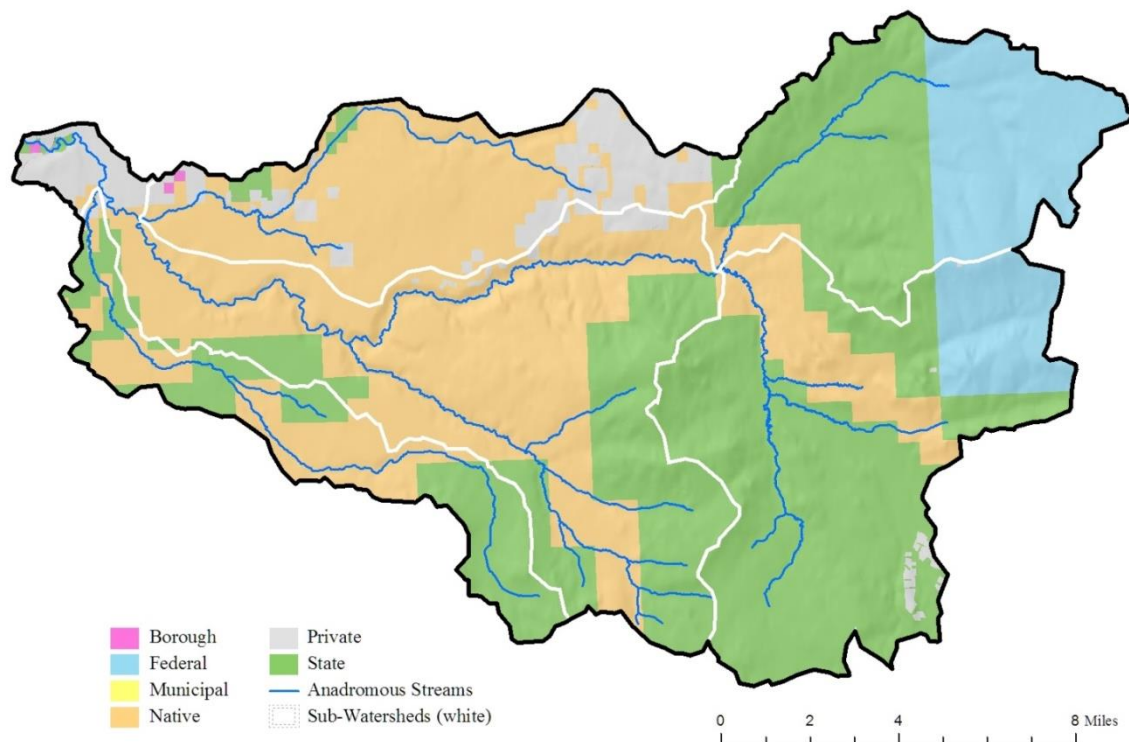
### Conservation strategies

1. With a high percentage of private parcels but no thermal imagery to guide specific actions, Cook Inletkeeper and the Kenai Watershed Forum may work with other entities like the Homer Soil and Water Conservation District to educate property owners about rain gardens and other green storm water technologies.
2. Project Partners will collaborate with Kachemak Bay Research Reserve staff, who have done considerable headwater stream work, to integrate this information into discussions with large parcel landowners (ADNR, Ninilchik Native Association, Cook Inlet Region Inc.) to consider groundwater flow paths and impacts from future road building, etc.

## Results – Deep Creek

The Deep Creek watershed covers 211 square miles and has 106 miles of catalogued salmon habitat. The headwaters of the north fork of Deep Creek flow out of the Kenai National Wildlife Refuge, but the vast majority of the watershed is in large parcels owned by the Alaska Department of Natural Resources, Cook Inlet Regional, Inc., and the Ninilchik Native Association, Inc. Non-Native owned private parcels are found in the lower part of the watershed and the mouth of the river is within the Deep Creek State Recreation Area.

Deep Creek Watershed: Land Ownership



### Conservation strategies

1. Project Partners will collaborate with Kachemak Bay Research Reserve staff, who have done considerable headwater stream work, to integrate this information into discussions with large parcel landowners to consider groundwater flow paths and impacts from future road building.
2. Project Partners are involved in another land conservation strategic effort called “Kenai Mountains to Sea” which is specifically targeted in watersheds like Deep Creek that are connected to the Kenai National Wildlife Refuge. Through that effort additional strategies are being developed such as voluntary compliance, perpetual easements, land agreements/exchanges with tribal and local governments, and short-term agreements on private parcels as part of publicly-funded restoration projects.

## **SUMMARY**

Through the process of identifying key salmon habitat on lower Kenai Peninsula streams, project partners have developed a set of strategies for working with public and private landowners with the aim of improving landscape-scale resilience for salmon. Some of these strategies, like contacting specific private landowners with key habitat are ongoing. Some strategies will require more time to build relationships with large landowners and will likely require more partners to join in these conversations. Nonetheless, the availability of thermal data and current fisheries research has enabled us to revisit and enhance previous conservation priorities and establish new strategies to help protect salmon in a time of rapid climate and land-use change.