Regional Operational Plan SF.3F.2014.06

# Operational Plan: Seasonal Habitats of Arctic Grayling in the Upper Goodpaster River Gold Mining District

by

**Andrew D. Gryska**

March 2015

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

## Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

| | |
|---|---|
| **Weights and measures (metric)** | |
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |
| **Weights and measures (English)** | |
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |
| **Time and temperature** | |
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |
| **Physics and chemistry** | |
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

| | |
|---|---|
| **General** | |
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat. or long. |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

| | |
|---|---|
| **Mathematics, statistics** | |
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | *e* |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | *E* |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $log_2$, etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | α |
| probability of a type II error (acceptance of the null hypothesis when false) | β |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

*REGIONAL OPERATIONAL PLAN SF.3F.2014.06*

# SEASONAL HABITATS OF ARCTIC GRAYLING IN THE UPPER GOODPASTER RIVER GOLD MINING DISTRICT


by

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## SIGNATURE PAGE

| | |
|---|---|
| Project Title: | Seasonal Habitats of Arctic grayling in the Upper Goodpaster River Gold Mining District |
| Project leader(s): | *Andrew D. Gryska* |
| Division, Region, and Area | *Sportfish, Region III, Upper Tanana* |
| Project Nomenclature: | |
| Period Covered | July 1, 2014 – December 31, 2016 |
| Field Dates: | August 11, 2014 – December 30, 2015 |
| Plan Type: | Category II |

**Approval**

| Title | Name | Signature | Date |
|---|---|---|---|
| Project leader | Andrew Gryska | [signature] | 3-4-14 |
| Biometrician | Pat Hansen | [signature] | 7/18/14 |
| Research Coordinator | Matt Evenson | [signature] | 3/4/14 |
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# ABSTRACT

The primary objective of this investigation is to identify where Upper Goodpaster River Arctic grayling over winter relative to the POGO mine. In addition, spawning reaches and summer feeding areas will be identified based on the geographic distribution of radio-tagged fish during these periods. To determine these locations, 180 Arctic grayling will be radiotagged during late summer, and over the next 15 months, the locations of the radio tagged fish will be determined by periodic aerial surveys.

Key words: Arctic grayling, *Thymallus arcticus,* Goodpaster River, radiotelemetry, and winter habitat.

# PURPOSE

Arctic grayling *Thymallus arcticus* are an important recreational species and a good indicator of river ecosystem health. Within the upper reaches of the Goodpaster River, a healthy, intact population of Arctic grayling has long existed virtually undisturbed. During the 1990s, successful gold exploration occurred in that area, and plans to construct a mine were developed. Prior to construction, Teck-Cominco (the original owner) and the Alaska Department of Fish and Game (ADF&G) agreed to proactively fund and collect baseline data on Arctic grayling to be used in the future for monitoring ecosystem health and understanding their population dynamics. ADF&G has estimated abundance for the springtime spawning population of Arctic grayling (1995–2002; Ridder 1998; Parker 2002, 2003) in the lower river and the summer population adjacent to Pogo mine (2003, 2004, and 2012; Parker 2006; Parker et al. 2007; Gryska 2013). While these estimates provided information about abundance at a specific time and place, there is little known about the migrations and seasonal locations of Arctic grayling that disperse into the Upper Goodpaster River during summer or those that may reside upriver year round.

During autumn, Arctic grayling vacate many tributaries and upper portions of the drainage because of the impending loss of habitat during winter, when river discharge reaches annual lows and some streambeds go dry while others freeze to the bottom. For winter, Arctic grayling seek out habitat that minimizes energy expenditure (e.g. low velocity water), has physiochemically suitable water (e.g. adequate depth, oxygen, and no frazzle ice), and provides cover from predators (e.g. overhead ice; Cunjak 1996). These habitat requirements may be found in a limited number of areas, and, in conjunction with reduced metabolism (i.e. less feeding and competition for food and space), large congregations of fish can occur among normally competitive fish (Cunjak 1996; Gryska *In prepa*). As winter ends, Arctic grayling migrate to spawning areas, usually located nearby, just before and after breakup. After spawning, Arctic grayling redistribute to summer feeding areas often located in the headwaters.

In the Upper Goodpaster River during early spring 2005 (A. Gryska, field notebook, Fairbanks), a sampling expedition just prior to spawning indicated substantial numbers of Arctic grayling were present between Central Creek (14.5 km Downstream of Pogo Mine) and Rock Creek (40 km upstream of Pogo Mine). These Arctic grayling likely overwintered nearby, probably between Central Creek and the Eisenmenger Fork (52 km upstream of Pogo Mine). Within this stretch of the river and its tributaries there likely are a finite number of locations suitable for winter habitat where substantial numbers of Arctic grayling aggregate from throughout the drainage. Under winter conditions, some of these locations may become isolated refugia from which fish cannot migrate. For these reasons, Arctic grayling, as well other fishes, are most vulnerable to declines in water quality and quantity during late winter. Identification of overwinter habitats and timing of migrations to and from all seasonal habitats is needed to avoid or greatly reduced impacts associated with development.

# OBJECTIVES

The objectives are to:

1. Estimate the proportion of Arctic grayling ≥330 mm FL residing in the Upper Goodpaster River during the summer that winter in the Goodpaster River
    a. between Glacier Creek and Central Creek
    b. downstream of Central Creek.

    The estimates will be within 8.5 percentage points of the true value 90% of the time
2. Describe the seasonal movements and locations of Arctic grayling ≥330 mm FL residing in the upper Goodpaster River during the summer with an emphasis on documenting overwintering, spawning and summer resident areas.

# STUDY DESIGN

## STUDY AREA

The Upper Goodpaster River study area, inclusive of all drainages beginning with Central Creek, is approximately 2,150 $km^2$ (Figure 1). All Arctic grayling will be tagged in the upper river. The telemetry survey area will be much larger, encompassing the Middle and Lower Goodpaster River, the Delta Clearwater River, the Richardson Clearwater River, Shaw Creek, and the Tanana River between each of these tributaries. Previous studies of spawning Arctic grayling in the lower river indicated migrations to all of the described survey area, and Arctic grayling tagged in the upper river have been recaptured in the Delta Clearwater River (Gryska *In prepb*; Ridder 1998; Wuttig and Gryska 2010).

## EXPERIMENTAL AND SAMPLING DESIGN

Radiotelemetry techniques will be used to collect location and movement data that will describe seasonal locations and migrations of Arctic grayling that occupy the Upper Goodpaster River drainage (Figure 1). Radio tags will be surgically implanted in 180 Arctic grayling ≥330 mm FL captured throughout the upper drainage. Although there are numerous tributaries in the upper Goodpaster River, not all are sufficiently large to reasonably expect catches of appropriate size fish. The main stem Goodpaster River (from Tibbs Creek to Central Creek) and 9 larger tributaries were selected for the distribution of tags. The core sample area of the Goodpaster River from Tibbs Creek to Central Creek has had a recent stock assessment (Gryska 2013); however, the remaining sample reaches have not had any previous stock assessments or sampling to determine densities or even presence of Arctic grayling. Radio tags will be distributed throughout the study area systematically as each sample reach will be allocated a proportion of the radio tags roughly based on the length of each reach as well as the drainage area of reach (Table 1). Due to uncertainties, some reaches may prove not to have Arctic grayling and tags for those reaches may be redistributed to other reaches. Unbiased total population inferences cannot be estimated for the Upper Goodpaster River because radio tags cannot be allocated by abundance and size composition of Arctic grayling in each sample reach. However, the systematic distribution of the tags through the drainage will minimize bias and maximize identification of seasonal habitats and migratory behavior for the majority of the population for the period from August 2013 through November 2014.

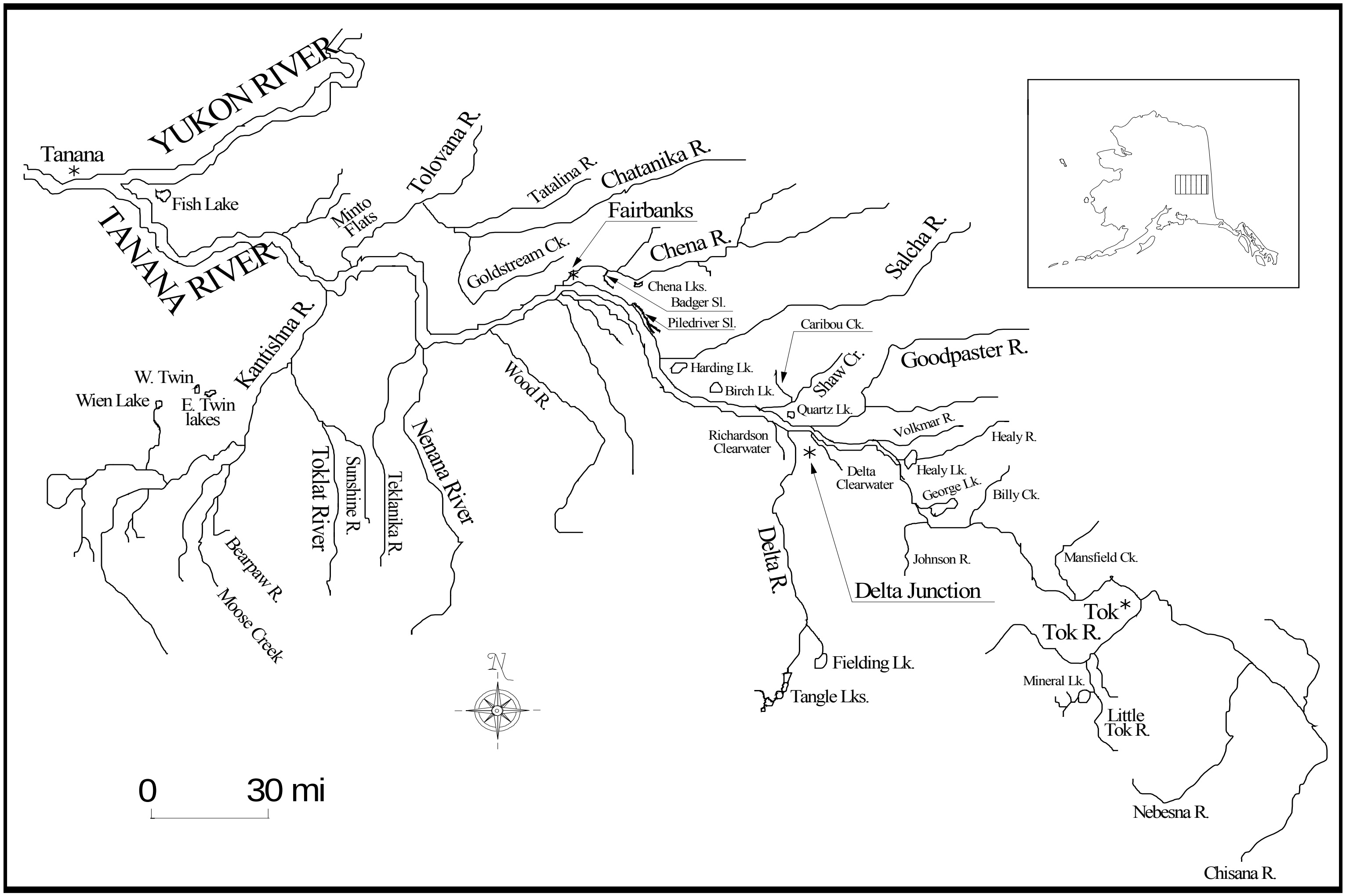


Figure 1.–Tanana River Drainage.

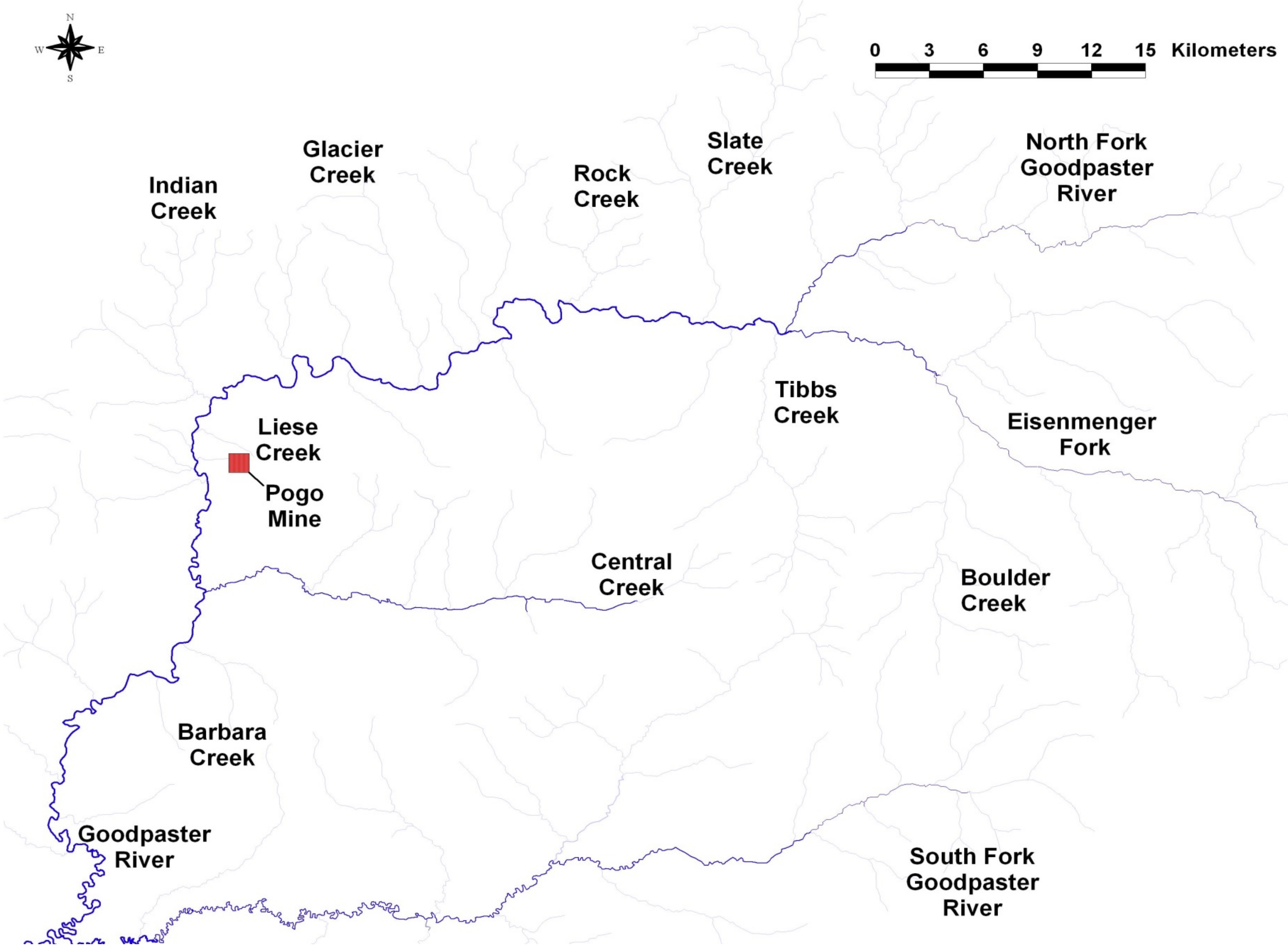


Figure 2.–The Goodpaster River study area.

Table 1.–Allocation of radio tags by sample section in the Upper Goodpaster River (GPR).

| Section | Section Length (km) | Radio Tag Allocation |
|---|---|---|
| GPR Tibbs Creek to Indian Creek | 49 | 35 |
| GPR Indian Creek to Central Creek | 17 | 15 |
| North Fork GPR | 34 | 25 |
| Eisenmenger Fork | 38 | 25 |
| Tibbs Creek | 15 | 15 |
| Boulder Creek | 17 | 15 |
| Central Creek | 31 | 25 |
| Indian Creek | 10 | 7 |
| Glacier Creek | 13 | 7 |
| Slate Creek | 16 | 6 |
| Rock Creek | 10 | 5 |
| Total | 245 | 180 |

Nearly all sample reaches are extremely remote and will be reached using helicopter transport; however, the Goodpaster River between Indian and Central creeks will be accessed by a small power boat. As stated above, some reaches may not hold Arctic grayling, or may not have suitable landing terrain. The chosen sample reaches will be aerially inspected, and modifications to the distribution of tags and of the sample reaches will occur as needed.

Arctic grayling will be captured using angling methods during early August. Both spin and fly gear will be used to capture fish ≥330 mm FL. Terminal spin gear will consist of rubber-bodied jigs of varied size (1/16–1/4 oz and size 2–6 hooks) and fly gear will consist of an assortment of flies (e.g., Adams fly, Blue Dunn fly, or bead-head nymphs). The late summer sample period was selected so Arctic grayling would be handled when they remain in their upper river summer resident locations and water temperatures are beginning to cool as fall approaches. Warm water is stressful, and by avoiding it, it is expected that healing and survival will be enhanced. Only fish, that appear to be healthy, will be surgically implanted with a radio tag.

Radio tags will be surgically implanted following the basic surgical methods detailed by Brown (2006) and Morris (2003). Sex and maturity will be difficult to verify because fish will be captured 8 months prior to spawning. To ensure that most fish sampled are mature, only fish ≥330 mm FL will be radiotagged (Clark 1992). Nonetheless, an attempt to sex fish will be conducted by inspecting the gonads through the incision. The radio tags will be model MST-930 manufactured by Lotek™, which are small (9.5 mm x 26 mm), lightweight (4 g), and have at least a 15-month operational life. Each tag will emit an individual code for each fish on a single radio frequency (148.660 MHz). The radio tags will broadcast a signal 10 h/day between 8 A.M. and 6 P.M.

Locations of radiotagged Arctic grayling will be determined using periodic flights in a fixed wing aircraft. Tracking flights will utilize a Lotek SRX 600 receiver with an internal GPS that will record time and location data. Flights will occur during a 15-month period primarily to determine locations of winter refuge, pre-spawning, spawning, and subsequent summer feeding habitats. The periodicity of flights will vary between weekly and multi-monthly dependent upon typical Arctic grayling behavior (e.g. greater intensity of flights before, during, and after spawning).

To facilitate data analysis, all radiotagged Arctic grayling will be assigned a “fate” during each tracking survey. Fates (e.g. tagging mortality, post-tagging mortality, alive, and at-large) will be assigned based on information collected from aerial surveys as well as any harvested fish for which tags were returned. Following fate assignment and description, seasonal locations and migratory periods will be described and depicted on maps.

## SAMPLE SIZES

Radio transmitters will be implanted into 180 Arctic grayling. Assuming the following:

1. Tag loss rate of 25% - this includes both radio tag failure and fish mortality; and,
2. Binomial worst case scenario ($p = 0.5$).

The effective sample size of 135 working tags will allow estimates of proportions to be within the stated objective criteria.

Several actions will be taken to ensure that mortality bias are minimal. Handling mortality will be reduced by sampling when the water is cool at the end of summer, longer nights have returned, and frosts are possible in the headwaters. Only Arctic grayling ≥330 mm FL will be tagged because it is expected that they are mature and will spawn. Our distribution of radio tags will be spread out over a large area in attempt to subject most resident fish to some non-zero probability of capture. Periodic aerial surveys will be utilized to monitor timing and direction of migrations to make intuitive decisions about additional search areas.

## DATA COLLECTION

During the fieldwork, data will be recorded into all-weather field notebooks. For each Arctic grayling captured, data collected will include:

1) measurement of fish length to the nearest 5 mm FL;
2) sex (if possible);
3) radio tag frequency and code;
4) location (river-kilometer and GPS coordinate); and,
5) date.

During each aerial or boat tracking survey, data collected for each fish will include frequency, code, latitude, and longitude.

Following all fieldwork, data will be transcribed into an EXCEL workbook. Specifically, an EXCEL worksheet will be made with column headings related to the field data form and comments. A brief project description in a text box will be provided for added clarity. Coordinates will be plotted on USGS maps (represented in Alaska NAD27 Datum) using ArcGIS software after converting Lotek data with Franson Coordtrans software from WGS84

Datum to Alaska NAD27 Datum. Final copies of the Excel and Arcview ArcGIS files will be provided archived in the Sport Fish Division Docushare website with the completed report when it is submitted for review. The file name and directory location will be presented in the final report.

## DATA ANALYSIS

### Objective 1 – Winter location of Arctic grayling

The proportion of Arctic grayling that reside in the Goodpaster River between Glacier and Central creeks during winter will be estimated as a binomial proportion:

$$\hat{p}_l = \frac{n_l}{n}; \qquad (1)$$

where:

$n_l$ = the number of Arctic grayling radio tagged throughout the Upper Goodpaster River determined to have spent the winter in location *l*. Possible locations are:

- between Glacier Creek and Central Creek
- downstream of Central Creek
- other

$n$ = the number of working radio tags at the time of winter surveys.

The variance of the proportion will be estimated by (Cochran 1977):

$$\text{var}(\hat{p}_l) = \frac{\hat{p}_l(1-\hat{p}_l)}{n_l - 1} \qquad (2)$$

### Objective 2- Seasonal distributions of Arctic grayling

Data analysis will consist of plotting locations of radiotagged Arctic grayling on maps and constructing a data profile of each radio-tagged fish. Maps will be constructed using ArcGIS software, and will depict locations of interest: tagging, summer residence, spawning, and over-winter residence. Final fates of each tagged fish will be fully determined by project completion.

Profiles will include all relevant data collected from each radio-tagged fish: length at capture, sex, capture location, GPS location during each survey, time past tracking station, and the status (fate) of each fish during each survey. Fates will be determined from a combination of information collected during aerial and boat tracking surveys (Table 2). Because Arctic grayling are highly migratory, mortality can be easily inferred if an Arctic grayling is located more than once and fails to move a significant distance (5 km) over a period of one month or greater. The unknown fate is usually a temporary designation for radiotagged fish for which there is insufficient data to determine if the fish was alive or not. For example, if a fish is tagged during August and not located again until spawning surveys amongst a spawning aggregation during the following spring, then it would have been temporarily assigned an unknown fate until found spawning, when it would be designated a spawner. At the end of the 15-month study, final fates will be determined.

Table 2.–List of possible fates of radio-tagged Arctic grayling.

| Fate | Description |
|---|---|
| Unknown (U) | A fish that that may be dead or alive but its status cannot be determined because there was insufficient data (e.g., a fish was not located or moved very little). |
| Mortality (M) | A fish that dies in response to tag implantation, fishing, or natural causes. |
| Spawner (S) | A fish that is alive and displayed an obvious migration pattern towards a known or typical spawning area in conjunction with other radio tagged Arctic grayling. |
| Non-Spawner (NS) | A fish that is alive and is located at least once during the summer, but did not display an obvious migration pattern toward a known or typical broad whitefish spawning habitat in conjunction with other radio tagged Arctic grayling. |

# SCHEDULE AND DELIVERABLES

A Fisheries Data Series (FDS) Report will be submitted to the research coordinator by May 1, 2017. This report will summarize all capture and tagging information from summer 2014 and all telemetry data from aerial and boat surveys. Probable dates for sampling activities are summarized below.

| Date | Activity |
| --- | --- |
| June 2014 | Aerial survey of study area |
| July 2014 | Mobilizations |
| August 11–16, 2014 | Sampling with helicopter |
| August 18–22, 2014 | Sampling with boat |
| September 2014–December 2015 | Periodic Survey Flights |
| November 2017 | Analysis |
| January 2018 | Draft Report |
| May 2018 | Final FDS Report |

# RESPONSIBILITIES

## List of Personnel and Duties

Andrew Gryska, *Fisheries Biologist II*. Project Leader.
Responsible for supervision of all aspects of this project, data analysis, managing the project budget, and writing the final report.

Pat Hansen, *Biometrician IV*. Assist with project design and data analysis.

Klaus Wuttig, *Fishery Biologist III.* Final report editing and project support and all aspects of field work.

Matt Albert, *Fish & Wildlife Technician III*. Crew leader. Mobilization, day-to-day project tasks, all aspects of field work, and demobilization.

Brian Collyard, *Fish & Wildlife Technician III*. Mobilization, day-to-day project tasks, all aspects of field work, and demobilization.

Rick Queen, *Fish & Wildlife Technician II*. Mobilization, day-to-day project tasks, all aspects of field work, and demobilization.

Matt Robinson, *Fish & Wildlife Technician III*. Mobilization, day-to-day project tasks, all aspects of field work, and demobilization.

Tim Viavant, *Fishery Biologist III.* All aspects of field work.

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# REFERENCES CITED


Brown, R. J. 2006. Humpback whitefish *Coregonus pidschian* of the upper Tanana River drainage. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 90, Fairbanks.

Clark, R. A. 1992. Age and size at maturity of Arctic grayling in selected waters of the Tanana drainage. Alaska Department of Fish and Game, Fishery Manuscript No. 92-5, Anchorage.

Cochran, W. G. 1977. Sampling techniques, third edition. John Wiley & Sons, New York.

Cunjak, R. A. 1996. Winter habitat of selected stream fishes and potential impacts from land-use activity. Canadian Journal of Fisheries and Aquatic Sciences 53: 267-282.

Gryska, A. D. 2013. Stock assessment of Arctic grayling in the upper Goodpaster River, 2012. Alaska Department of Fish and Game, Fishery Data Series No. 13-60, Anchorage.

Gryska, A. D. *In prep*[a]. Seasonal distribution of Arctic grayling in the upper Delta River. Alaska Department of Fish and Game, Fishery Data Series No. 14-xx, Anchorage.

Gryska, A. D. *In prep*[b]. Seasonal distributions of Arctic grayling that spawn in the lower Goodpaster River. Alaska Department of Fish and Game, Fishery Data Series No. 14-xx.

Morris, W. 2003. Seasonal movements and habitat use of Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), and broad whitefish (*Coregonus nasus*) within the Fish Creek drainage of the National Petroleum Reserve-Alaska, 2001-2002. Technical Report No. 03-02, Alaska Department of Natural Resources, Fairbanks, Alaska.

Parker, J. F. 2002. Abundance and composition of Arctic grayling in the Goodpaster River, 1999. Alaska Department of Fish and Game, Fisheries Data Series No. 02-06, Anchorage.

Parker, J. F. 2003. Abundance and age and length composition of Arctic grayling in the Goodpaster River in 2002. Alaska Department of Fish and Game, Memo to Teck-Pogo, September 10, 2003.

Parker, J. F. 2006. Abundance and age and length composition of Arctic grayling in the North Fork Goodpaster River in 2003. Alaska Department Fish and Game, Fishery Data Series No. 06-53, Anchorage.

Parker, J. F., K. W. Wuttig, and B. Taras. 2007. Abundance and age and length composition of Arctic grayling in the North Fork Goodpaster River in 2004. Alaska Department of Fish and Game, Fisheries Data Series No. 07-73, Anchorage.

Ridder, W. P. 1998. Abundance, composition, and emigration of Arctic grayling in the Goodpaster River 1995 - 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-36, Anchorage.

Wuttig K. G., and A. D, Gryska. 2010. Abundance and length composition of Arctic grayling in Delta Clearwater River, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 04-22, Anchorage.