Fishery Data Series No. 91-65

# Annual Summary of Alaska Department of Fish and Game Instream Flow Reservation Applications

by

Christopher C. Estes

November 1991

Alaska Department of Fish and Game

Division of Sport Fish

FISHERY DATA SERIES NO. 91-65

# ANNUAL SUMMARY OF ALASKA DEPARTMENT OF FISH AND GAME INSTREAM FLOW RESERVATION APPLICATIONS[1]

By

Christopher C. Estes

Alaska Department of Fish and Game
Division of Sport Fish
Anchorage, Alaska

November 1991

[1] This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-6, Job No. RT-7.

The Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

TABLE OF CONTENTS


| | Page |
|---|---|
| LIST OF TABLES | ii |
| LIST OF FIGURES | ii |
| LIST OF APPENDICES | iii |
| ABSTRACT | 1 |
| INTRODUCTION | 2 |
| METHODS | 3 |
| Site Selection | 3 |
| Instream Flow Analysis | 3 |
| Average Annual Flow Procedures | 4 |
| Mean Monthly Flow Procedures | 5 |
| Duration Analysis Procedures | 5 |
| RESULTS | 6 |
| DISCUSSION | 8 |
| ACKNOWLEDGMENTS | 14 |
| LITERATURE CITED | 15 |
| APPENDIX A | 18 |
| APPENDIX B | 46 |

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | Status of Alaska Department of Fish and Game instream flow reservation applications, July 1, 1986 to June 30, 1991 | 10 |


## LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | Alaska Department of Fish and Game instream flow reservation application locations, July 1, 1990 to June 30, 1991 | 7 |
| 2. | Alaska Department of Fish and Game instream flow reservation application locations, July 1, 1986 to June 30, 1990 | 9 |

LIST OF APPENDICES


| Appendix | | Page |
|---|---|---|
| A1. | Reservation reach boundaries, Jim River | 19 |
| A2. | Reservation reach boundaries, Deshka River | 20 |
| A3. | Reservation reach boundaries, Deception Creek | 21 |
| A4. | Reservation reach boundaries, Mendenhall River-Reach A | 22 |
| A5. | Reservation reach boundaries, Mendenhall River-Reach B | 23 |
| A6. | Reservation reach boundaries, Auke Creek | 24 |
| A7. | Reservation reach boundaries, Baranof River-Reaches A, B, C | 25 |
| A8. | Common and scientific names of fishes identified in periodicity charts (Appendices A9-A15) | 26 |
| A9. | Species periodicity chart for Jim River | 27 |
| A10. | Species periodicity chart for Deshka River | 28 |
| A11. | Species periodicity chart for Deception Creek | 29 |
| A12. | Species periodicity chart for Mendenhall River-Reach A | 30 |
| A13. | Species periodicity chart for Mendenhall River-Reach B | 31 |
| A14. | Species periodicity chart for Auke Creek | 32 |
| A15. | Species periodicity charts for Baranof River-Reaches A, B, C | 33 |
| A16. | Example of instream flow reservation application | 34 |

LIST OF APPENDICES (Continued)


| Appendix | | Page |
| --- | --- | --- |
| A17. | Summary of hydrologic data for 1991 instream flow reservation applications | 38 |
| A18. | Tennant Method analysis for Jim River | 39 |
| A19. | Tennant Method analysis for Deshka River | 40 |
| A20. | Tennant Method analysis for Deception Creek | 41 |
| A21. | Tennant Method analysis for Mendenhall River-Reach A | 42 |
| A22. | Tennant Method analysis for Mendenhall River-Reach B | 43 |
| A23. | Tennant Method analysis for Auke Creek | 44 |
| A24. | Tennant Method analysis for Baranof River-Reaches A, B, C | 45 |
| B1. | Tennant Method background | 47 |

ABSTRACT

This report summarizes the principal activities performed during the fifth year of the Instream Flow program in Alaska and the status of instream flow applications filed in previous years.

Between July 1, 1990 and June 30, 1991, nine instream flow analyses were completed for six water bodies by the Alaska Department of Fish and Game. Reservation applications were completed for submittal to the Alaska Department of Natural Resources for the Jim River (Fairbanks area), Deshka River, Deception Creek (Susitna River Basin), two reaches of the Mendenhall River, Auke Creek (Juneau area), and three reaches of Baranof River (Baranof Island).

Ten Alaska Department of Fish and Game instream flow reservation requests filed in previous years have been granted by the Alaska Department of Natural Resources: Terror River, Willow Creek, Rabbit Creek, Little Rabbit Creek, Little Survival Creek, upper Little Susitna River, two reaches of Campbell Creek, Indian River, and Cottonwood Creek.

Applications from prior years are in various stages of the process of adjudication: Little Susitna River (middle reach), Chena River (two reaches), Fish Creek (two reaches), Meadow Creek, Sawmill Creek, Ketchikan Creek, Salcha River, Buskin River, Buskin Lake, Monashka Creek, Pillar Creek, North Fork of Campbell Creek, South Fork of Campbell Creek, Ship Creek, Anchor River, Kenai River (two reaches), Ward Creek, Chatanika River (two reaches), Delta Clearwater River (Clearwater Creek), Talkeetna River, Ninilchik River, and Montana Creek.

KEY WORDS: instream flow, flow reservation, Tennant Method, Montana Method, Willow Creek, Little Susitna River, Rabbit Creek, Little Rabbit Creek, Little Survival Creek, Terror River, Montana Creek, Chena River, Cottonwood Creek, Fish Creek, Meadow Creek, Campbell Creek, North Fork of Campbell Creek, South Fork of Campbell Creek, Chatanika River, Delta Clearwater River, Clearwater Creek, Ninilchik River, Talkeetna River, Fish Creek Sawmill Creek, Ketchikan Creek, Salcha River, Ship Creek, Kenai River, Anchor River, Buskin River, Buskin Lake, Pillar Creek, Monashka Creek, Indian River, Ward Creek, Anchorage, Fairbanks, Juneau, Jim River, Mendenhall River, Deshka River, Deception Creek, Auke Creek, Baranof River.

# INTRODUCTION

Alaska has abundant and diversified sport fisheries which are of considerable recreational importance to fishermen. In 1990, for example, an estimated 424,873 anglers took 1.9 million household trips and fished 2.5 million angler days (Mills 1991). During this period, they caught 6.0 million fish (fish harvested plus fish released) and harvested 3.0 million. These values represent significant increases over those noted in the late seventies and early eighties.

The continued production of Alaska's valuable fishery resources is, in part, dependent upon maintaining important habitat characteristics such as the quantity and quality of water within fish bearing waters. Private and commercial developments and activities (hydroelectric projects, recreation, subdivisions, mining, water marketing, interstate diversions, agriculture, aquaculture, forestry, manufacturing, oil and gas development, etc.) will contribute to negative changes in both riparian and instream habitats unless sufficient instream flows are legally protected. An instream flow is defined as the quantity of water that flows past a given point within a stream channel during one second.

The Alaska Legislature recognized the importance of instream flow protection by amending the Water Use Act (Alaska Statute, AS, 46) in 1980 (ADNR 1985). The amendments (AS 46.15.03 and AS 46.15.145) provided the opportunity for private individuals, in addition to state, federal, and local government agencies, to legally acquire instream flow water rights in rivers, streams, and lakes for one or a combination of four types of uses:

1) protection of fish and wildlife habitat, migration, and propagation;

2) recreation and parks purposes;

3) navigation and transportation purposes; and

4) sanitary and water quality purposes.

Instream flows can be requested as rates of flow, surface water elevations, or water depths.

Regulations to implement the instream flow law were adopted by the Alaska Department of Natural Resources (ADNR) in September 1983 and modified in 1990. Forms required to apply for instream flows were made available by the ADNR in November 1983.

The Fish and Game Act (AS 16) requires the Alaska Department of Fish and Game (ADFG) to, among other responsibilities, "manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS 16.05.020). One of the AS 16 provisions enables the ADFG to acquire water rights to further its objectives or purposes (AS 16.05.050). To take advantage of the new opportunities provided by the instream flow legislation and better meet its statutory mandates, the Division of Sport Fish (DSF) of the ADFG acquired funding in 1986 to initiate an ongoing program to formally acquire instream flow water rights to protect sport fish resources (Estes 1987).

This report summarizes the fifth year of this program in which the primary objective was to apply for instream flow reservations for the protection of sport fishery resources in a minimum of four Alaskan rivers.

## METHODS

### Site Selection

Locations for reserving instream flows were nominated by representatives of the Sport Fish, Commercial Fish, Fisheries Rehabilitation and Enhancement, Habitat, Subsistence, and Wildlife Conservation divisions of the ADFG (ADFG 1984; Estes 1985; Instream Flow Committee 1986). The Division of Sport Fish made final selections by evaluating the importance of nominated streams to the sport fishery, the likelihood of competition for out-of-stream appropriations, and availability and quality of existing hydrologic and biologic data necessary for the submission of an application.

Stream reach boundaries for each FY 91 instream flow application were selected to insure that flow, habitat, and fish periodicity (seasonal use of habitat for passage, spawning, incubation, and rearing) characteristics within the reach were uniform. Reaches were defined on U.S. Geological Survey (USGS) topographic maps with the assistance of ADFG biologists and USGS hydrologists. Topography, watershed, and channel patterns, fish periodicity, USGS gage site descriptions and mean daily flow data were collectively analyzed.

Fish periodicity data for stream reaches were obtained and summarized from reviews of scientific literature and interviews with fishery and habitat biologists from the ADFG and other agencies. This information was refined by ADFG biologists responsible for the areas encompassing targeted instream flow reaches. Flow data and gage site descriptions were obtained from USGS Water-Data Reports.

### Instream Flow Analysis

The Tennant Method[1] (Tennant 1972, 1976), combined with an evaluation of mean daily flow, monthly flow, and other hydrologic characteristics (Estes 1984; Estes and Orsborn 1986; Orsborn and Watts 1980; Shaw 1988), was selected as the most cost effective means to quantify instream flow needs for each reservation application. The choice of this method was based on its acceptance by both the ADNR and courts as a valid instream flow analytical procedure, and the limited availability of data, previous analyses, and financial resources required to prepare instream flow applications.

The first step of the Tennant Method required us to calculate the average annual flow, QAA, (arithmetic mean of the annual mean of mean daily flows for all years of record) for each stream reach. Next, each QAA was multiplied by

[1] Referred to as the Montana Method in earlier literature.

eight Tennant Method coefficients (percentages) to calculate instream flows for eight habitat categories. Seven of the Tennant Method habitat categories (ranging from 10% to 100% of the QAA) represent a range of poor to optimum habitat quality conditions for fish and wildlife. The eighth category (200% of the QAA) represents the short-term flushing flow that Tennant (1972) considers necessary to maintain channel substrate characteristics suitable for fish spawning and incubation and benthic invertebrate production.

Next, hydrologic analyses were performed to estimate baseline flow conditions in each stream reach. This involved calculating mean monthly flows (QAM), the arithmetic mean of the monthly mean daily discharge for a given month for the entire period of record, and flow duration estimates (the expected frequency of occurrence of mean daily flows within a particular month).

Next, seasonal instream flow requirements for individual life phases of fish for each stream reach were chosen by comparing the eight Tennant Method flows, fish periodicity data, mean monthly flows, and flow duration estimates. With the exception of flushing flows, instream flows were selected that corresponded to both fish periodicity and the highest of the other seven Tennant Method habitat categories that did not exceed flow duration estimates during that same period. Flushing flow requirements were not modified.

The above information was incorporated into formal instream flow application forms (Appendix A16) with other required information following procedures defined by the ADNR (1985).

Additional descriptions of procedures are presented in each instream flow application (ADFG 1991a, b, c, d, e, f, g, h, i) and Appendix B1.

Average Annual Flow Procedures:

Calculation of QAA, from the existing USGS mean daily flow records for the stream reaches, involved first obtaining the mean of the mean daily flows within each water year (October 1-September 30):

$$qaa_h = \frac{\sum_{i=1}^{d_h} q_{hi}}{d_h}; \qquad (1)$$

where: $qaa_h$ equaled the mean annual daily flow for each year (*h*) of record; $d_h$ equaled the number of days in each year of record (note that only complete years of record were used in this analysis; $d_h$ varied only for leap years); $q_{hi}$ equaled the daily mean flow in cubic feet per second for each day in the record.

Next, QAA was estimated as a mean of the annual mean daily flow values over all complete years of record:

$$\hat{QAA} = \frac{\sum_{h=1}^{n} qaa_h}{n} ; \qquad (2)$$

where: n equaled the years of record (with complete daily flow records for each water year).

Mean Monthly Flow Procedures:

The QAM was estimated similarly by first estimating the mean daily discharge for each complete month in the record:

$$qam_{jh} = \frac{\sum_{k=1}^{d_{jh}} q_{jhk}}{d_{jh}} ; \qquad (3)$$

where: $qam_{jh}$ equaled the monthly mean daily flow for each month (*j*) for each year of record (*h*); $d_{jh}$ equaled the number of days in each month of record (note that only complete months of record were used in this analysis); $q_{jhk}$ equaled the daily mean flow in cubic feet per second for each day in the record.

Next, QAM was estimated as a mean of the monthly mean daily flow values over all complete years of record:

$$\hat{QAM}_j = \frac{\sum_{h=1}^{n} qam_{jh}}{n_j} ; \qquad (4)$$

where: $n_j$ equaled the years of record with complete daily flow records for each *j*.

Duration Analysis Procedures:

Flow duration estimates were calculated as percentiles of the distribution of observed values within the time periods involved over the years of record.

For example, flow duration estimates for the month of April were calculated by combining all mean daily flow values for April (for all years having complete April records). Then the empirically defined distribution (observed-combined mean daily flow values) was calculated as follows. If the quantity to be calculated was defined as the "$t^{th}$" percentile, where $p = t / 100$, then setting:

$$np = j + g$$

where: n was equal to the number of observed mean daily flow values in the combined group (for example 300 days for a 10-year record of complete months of April); j was the integer part of n times p; and g was the fractional part of n times p.[2]

Then the $t^{th}$ percentile (y) was defined as:

$$y = (x_{(j)} + x_{(j+1)}) / 2 \qquad \text{if } g = 0 \text{ ;} \tag{4a}$$

or

$$= x_{(j+1)} \qquad \text{if } g > 0 \text{ ;} \tag{4b}$$

where: $x_{(j)}$ and $x_{(j+1)}$ were the ordered (from smallest to largest) values in the combined group of mean daily flow values.

## RESULTS

Analyses and applications were completed to request instream flow protection for fish in nine stream reaches in six river systems (Figure 1, Appendices A1-A7; ADFG 1991a, b, c, d, e, f, g, h, i): Jim River (Fairbanks area), Deshka River, Deception Creek (Susitna River Basin), two reaches of the Mendenhall River, Auke Creek (Juneau area), and three reaches of Baranof River (Baranof Island).

Of the nine stream reaches, the shortest was Baranof River-Reach C (Appendix A7), less than 200 feet long, and the longest, Jim River (Appendix A1), approximately 17 miles long.

Fish periodicity for each stream is illustrated in Appendices A1-A7. Reaches A and B of the Baranof River (Appendix A7) had the least amount of fish species (two) and the Jim River (Appendix A1) and Deception Creek (Appendix A3) reaches the most, with eight species each.

Historical records of USGS mean daily flow data varied from 8 years for the Jim River reach to 26 years for the two Mendenhall River reaches (Appendix A17).

QAA, mean monthly flow, and Tennant Method results are summarized in Appendices A18-A24. QAA values ranged from 17 cubic feet per second (cfs) for the Auke Creek reach (Appendix A23) to 1,235 cfs for Mendenhall River-Reach B (Appendix A22). Mean monthly flows ranged from 7 cfs in Auke Creek during

---

2 For example, if n = 300 and we wanted to calculate the 97th percentile, then j = 291 and g = 0; or for the 2.5th percentile, then j = 7 and g = 5.

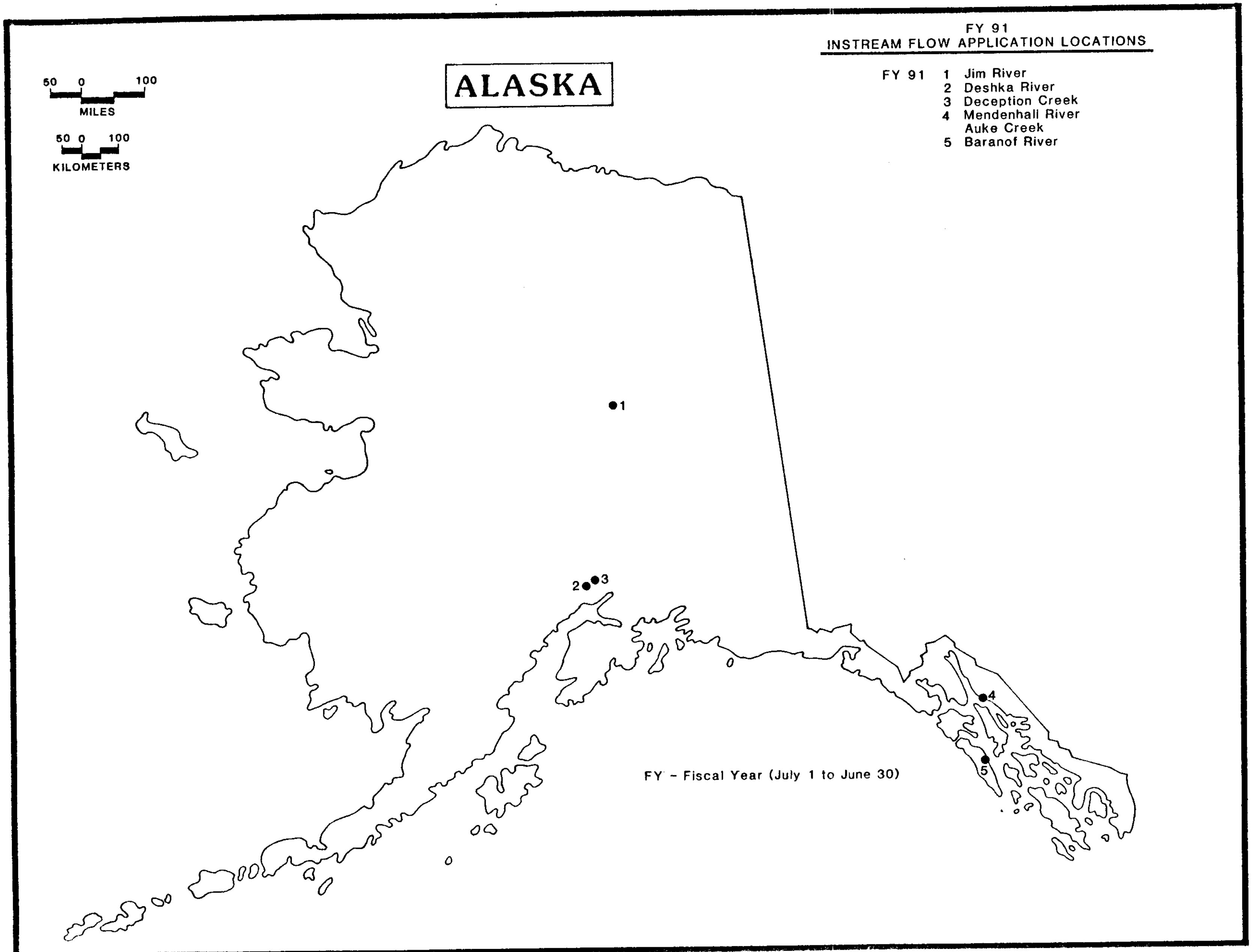



Figure 1. Alaska Department of Fish and Game instream flow reservation application locations, July 1, 1990 to June 30, 1991.

March (Appendix A23) to 3,484 cfs in Mendenhall River-Reach B during August (Appendix A22). Optimum habitat flows ranged from 10-17 cfs for the Auke Creek reach (Appendix A23) to 741-1,235 cfs (Appendix A22) for Mendenhall River-Reach B. Poor habitat flows ranged from 2 cfs for the Auke Creek Reach (Appendix A23) to 124 cfs for Mendenhall River-Reach B (Appendix A22). Flushing flows ranged from 34 cfs for the Auke Creek reach (Appendix A23) to 2,470 cfs (Appendix A22) for Mendenhall River-Reach B.

Instream flow values requested usually ranged from 60% to 100% of the QAA for the spawning and passage seasons, and 10% to 40% of the QAA for incubation and rearing seasons (ADFG 1991a, b, c, d, e, f, g, h, i). Flushing flows could not be formally requested under existing state law and regulations because flows were unregulated in each of the stream reaches. To establish the importance of protecting flushing flows (until a method acceptable to the DNR is developed) a statement was included in each application explaining that flushing flows were required to maintain fish habitat and (at a minimum) must be safeguarded whenever significant flow modifications or a structure capable of controlling flows is planned (Appendix B). Instream flow regimes requested are preliminary and not included in this report because they are subject to modification both while undergoing departmental review prior to submission to the ADNR and during the various stages of the ADNR adjudication process (administrative procedure used by the ADNR to determine whether to approve, modify, or deny an instream flow reservation request). These data will be presented in future reports following the completion of these processes.

## DISCUSSION

Nine instream flow applications were completed for FY 91. This is comparable to the previous 4-year average of 10 applications per year (Figure 2; Table 1; Estes 1987-1990). During the 5 years of this program, the ADFG developed a cost effective approach to acquire instream flow protection for fish by using the Tennant Method as the primary technique for analyzing instream flow needs. The Tennant Method requires minimal data and is one of the easiest and inexpensive procedures for quantifying instream flows. Supplemental resources were acquired when it was necessary to use the more sophisticated Instream Flow Incremental Methodology, IFIM (Bovee 1982), to evaluate fish habitat suitability for specific increments of water (Estes 1987). The IFIM is the most time consuming, data and analysis intensive, and expensive of the instream flow analytical procedures.

The ADNR has received 46 applications for instream flows since passage of the 1980 enabling legislation (Estes 1987, 1988, 1989, 1990; Harle 1988). Thirty-nine of the applications were submitted by the ADFG (Table 1), one by the U.S. Bureau of Land Management (BLM), four by the Anchorage Audobon Society, and two by private individuals. Only the 39 ADFG applications and 1 BLM application met ADNR requirements and were accepted for adjudication. The other six applications were rejected by the ADNR for a variety of reasons: two had been filed before regulations to process them were adopted in 1983, documentation was insufficient to support the reservation requests in three of

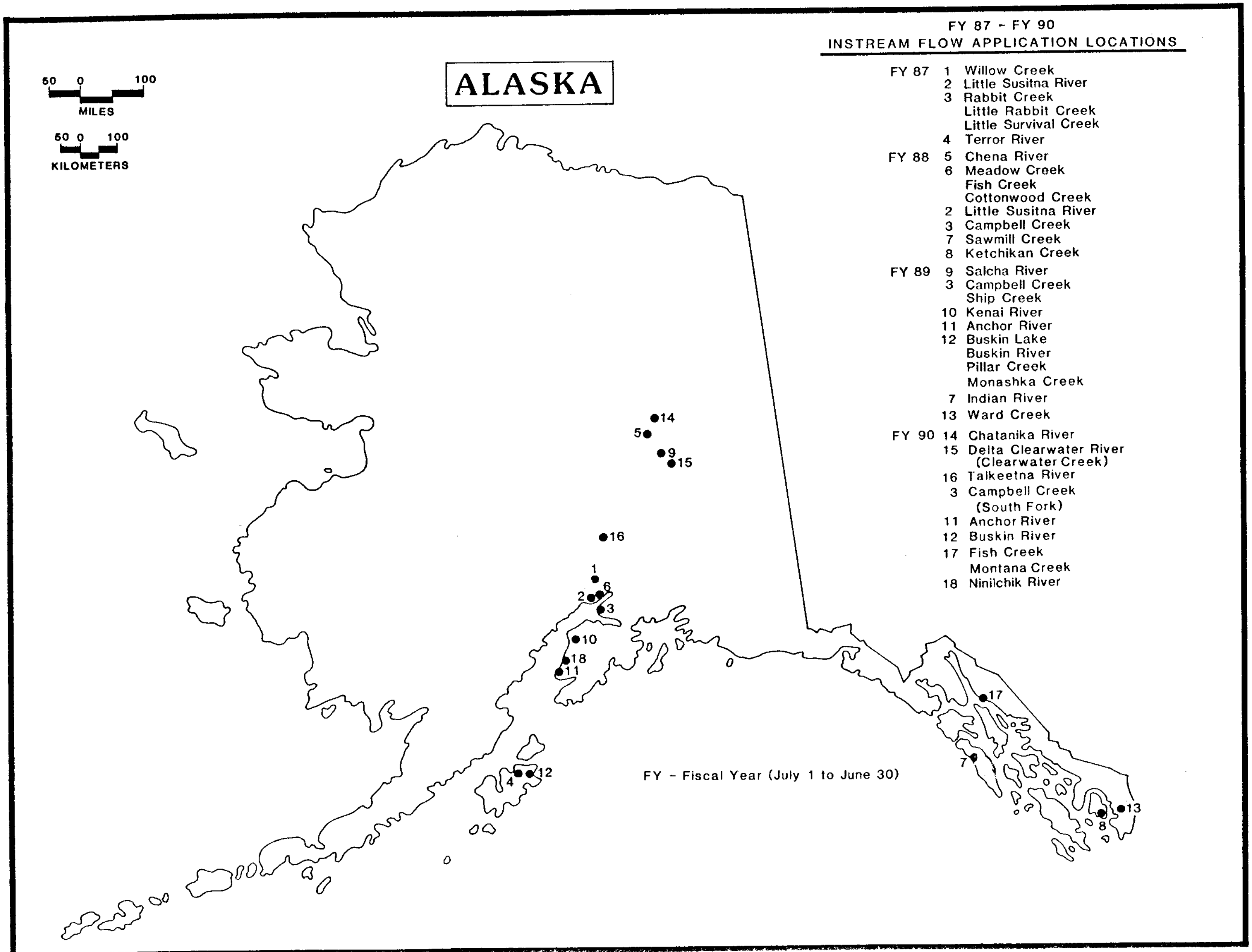



Figure 2. Alaska Department of Fish and Game instream flow reservation application locations, July 1, 1986 to June 30, 1990.

Table 1. Status of Alaska Department of Fish and Game instream flow reservation applications, July 1, 1986 to June 30, 1991.

| Instream Flow Application Location | Status |
|---|---|
| Willow Creek | Granted (July 8, 1988) |
| Little Susitna River (Upper Reach) | Granted (November 1, 1988) |
| Rabbit Creek | Granted (February 19, 1988) |
| Little Rabbit Creek | Granted (February 19, 1988) |
| Little Survival Creek | Granted (November 19, 1988) |
| Terror River | Granted (May 20, 1987) |
| Chena River (Lower Reach) | In Process of Adjudication |
| Chena River (Middle Reach) | In Process of Adjudication |
| Meadow Creek | In Process of Adjudication |
| Fish Creek (Upper Reach) | In Process of Adjudication |
| Fish Creek (Lower Reach) | In Process of Adjudication |
| Cottonwood Creek | Granted (May 15, 1991) |
| Little Susitna River (Middle Reach) | In Process of Adjudication |
| Campbell Creek (Middle Reach) | Granted (May 15, 1991) |
| Sawmill Creek | Pending Adjudication |
| Ketchikan Creek | Pending Adjudication |
| Salcha River | Pending Adjudication |
| Campbell Creek (Lower Reach) | Granted (June 28, 1990) |
| Campbell Creek (North Fork) | Pending Adjudication |
| Ship Creek | Pending Adjudication |
| Kenai River (Reach A) | Pending Adjudication |
| Kenai River (Reach B) | Pending Adjudication |
| Anchor River (Lower Reach) | Pending Adjudication |
| Buskin Lake | Pending Adjudication |
| Buskin River (Lower Reach) | Pending Adjudication |
| Pillar Creek | Pending Adjudication |
| Monashka Creek | Pending Adjudication |
| Indian River | Granted (August 3, 1990) |
| Ward Creek | Pending Adjudication |
| Chatanika River-Reach A | Pending Adjudication |
| Chatanika River-Reach B | Pending Adjudication |
| Delta Clearwater River | Pending Adjudication |
| (Clearwater Creek) | Pending Adjudication |
| Talkeetna River-Reach A | Pending Adjudication |
| Campbell Creek (South Fork) | Pending Adjudication |
| Buskin River-Reach B | Pending Adjudication |
| Anchor River-Reach B | Pending Adjudication |
| Fish Creek (near Juneau) | Pending Adjudication |
| Montana Creek (near Juneau) | Pending Adjudication |
| Ninilchik River-Reach A | Pending Adjudication |
| Jim River | In Preparation |
| Deshka River | In Preparation |
| Deception Creek | In Preparation |
| Mendenhall River-Reach A | In Preparation |
| Mendenhall River-Reach B | In Preparation |
| Auke Creek | In Preparation |
| Baranof River-(Reach A) | In Preparation |
| Baranof River-(Reach B) | In Preparation |
| Baranof River-(Reach C) | In Preparation |

the applications, and the instream flow reservation desired was not specified in one of them (Harle 1988).

Instream flow water rights have been granted for 10 of the ADFG applications and the BLM application; the remainder of the ADFG applications are in various stages of the process of adjudication (Table 1).

Although Alaska's instream flow law and regulations are among the most progressive in the country, there is an obvious need for improvement. Considering there are more than 12,000 fish bearing water bodies in Alaska (ADFG 1985, 1989), the significance of fish to recreation, subsistence, and our economy, and that private citizens (in addition to agencies) can request instream flow water rights, one may question why more applications have not been filed. There are several reasons: insufficient hydrologic data, costly and lengthy administrative processes, insufficient public education, and in some instances, application fees.

The dearth of hydrologic data in Alaska is perhaps the most limiting factor governing our ability to define instream flow and other water uses. There are only 316 USGS stream gaging sites in Alaska, an average of one stream gage per 7,000 square miles (Emery 1987). The average is one gage per 400 square miles in the lower forty-eight states. One hundred seventy-one of the Alaskan gages have continuous flow records of 10 or more years, 55 have records of 5 to 9 years, and 90 have records shorter than 4 years (Emery 1989). To apply for instream flow water rights at ungaged stream reaches, one must use regional hydrologic models to estimate flow characteristics. These models limit one's ability to evaluate naturally occurring hydrologic patterns at these sites with confidence[3]. It is also more time consuming to estimate flow characteristics for streams having a limited or non-existent data base as opposed to summarizing data for a stream having an adequate historical record. Therefore, it is obvious that additional gaging stations are required to improve the accuracy of the data base used to define instream flow requirements, as well as improve one's efficiency.

Administrative processes are, in many instances, a deterrent to potential instream flow applicants, including the ADFG. Without additional staffing and financial resources, these processes could hamper the ability of the ADFG to maintain its average production rate of 10 applications per year. The backlog of 29 ADFG applications and the additional FY 91 applications will each require from 1 to 3 weeks of time by ADFG personnel to participate in the various phases of the ADNR adjudication. Additionally, there are no fixed schedules because the ADNR has a backlog of water rights applications[4]. If

[3] The U.S. Geological Survey (USGS) considers a 10-year record as the minimum data base required to support a statistically reliable regional flow analysis. Reliability of flow estimates calculated with these models is usually best for models developed for regions having a greater concentration of gaging stations.

[4] A priority date and time is assigned to each application at the time it is accepted by the ADNR. This protects applicants by establishing the order of priority for the allocation of water, regardless of when the adjudication process is completed.

too many adjudications were scheduled by the ADNR (at any one time), the added resource and time requirements would overtax existing levels of ADFG resources.

Alaskan law requires the ADNR to review instream flow water rights once every 10 years to evaluate whether flow modifications are warranted. Consequently, proprietors of instream flow water rights must maintain a permanent storage system for the original data and analyses. Documentation must be sufficient to enable original applicants (or representatives) to defend their instream flow water rights if challenged. This data storage requirement is costly in terms of space and serves as an impediment to private applicants with limited resources. It is also unclear whether owners of instream flow water rights must fund their own participation in 10-year reviews. There are no equivalent provisions for automatic reviews of out-of-stream or diversionary water rights.

Formal programs to educate and assist the public to file for instream flow water rights are nonexistent. Procedural and background publications to aid instream flow applicants are inadequate.

Fees charged by the ADNR for instream flow applications are a deterrent to applicants. With the exception of state agencies, all instream flow applicants are charged $500 per application. There is no charge to state agencies. This fee is expensive relative to application fees charged by the ADNR for most other water rights and (unlike other water rights) is not based on the amount of water requested.

The above factors and the complexity of water law all contribute to the low number of applications filed. There also appears to be a legal loop hole which allows diversions of water from a stream without a permit (if the water being diverted is not put to a beneficial use and there are no existing appropriations). Fish, wildlife, and other instream uses could be negatively impacted by non-permitted water diversions.

Some of these and related concerns have been improved or eliminated by modifications to the ADNR water management regulations (Alaska Administrative Code 1990) adopted in November 1990. Others are being addressed by the Alaska Legislature.

Among the beneficial changes is the addition of a new process that allows applicants to file an application for instream flows and acquire a priority date from the ADNR before completing all of their data collection and analyses. To qualify, an applicant must estimate instream flow requirements and is granted 3 years (from the date of filing) to complete data collection and analyses. In spite of the advantages of this provision, a lack of ADNR standards for substantiating estimates might prove to be a stumbling block for applicants.

Another regulatory revision eliminated a stipulation (associated with the mandatory 10-year review) that had granted the ADNR the option to place the burden for collecting and analyzing supplemental instream flow data on owners of instream flow water rights. This is a major improvement.

A new addition to the regulations requires applicants for out-of-stream water rights to quantify baseline seasonal flows when requesting more than 100,000 gallons per day (.05 cfs). A similar requirement for instream flow applicants has been in effect since 1983. This information will assist the ADNR to balance an applicant's request with water availability for other out-of-stream and instream flow needs. It will also help prevent overappropriation from streams that are ungaged.

Three pieces of legislation (House Bills 353, 354, and 355) were introduced in the spring of 1991 by Representative Cliff Davidson of the Alaska Legislature (1991a, b, c) to improve instream protection and water management processes.

House Bill (HB) 353 would provide funding ($239,400) to the ADNR to complete the automation of its water rights data base. The successful completion of this project should improve the management of water resources by the ADNR. Presently, the ADNR must retrieve water rights information on a site by site basis. This is a time consuming process, does not allow for reach specific evaluations, and is subject to error. The automated system should enable the ADNR to retrieve water ownership and status and related information on a stream reach basis in a relatively short period of time.

HB 354 would provide pass through matching funding ($242,000) to the USGS through the ADNR to perform a surface water data network evaluation of the Alaska stream gaging program and data base. The evaluation would address adequacy of the existing stream gage network, data bases, and existing models used to estimate streamflows at ungaged sites. Recommendations and priorities for locating and maintaining existing and future gage sites would also be provided. Several gage sites would also be funded by this legislation. HB 354 should improve the ability of the ADFG and other water data users to evaluate existing water quantity information and prioritize their support and requests for gaging sites.

HB 355 would guarantee the allocation of instream flow water rights for fish and wildlife. This legislation has many similarities to instream flow legislation submitted by Representative Davidson two years ago (HB 210) which failed to pass (Estes 1990). HB 355 would not apply to public water supplies, single family domestic uses of water, non consumptive uses of water, and, in many instances, uses of groundwater of 5000 gallons per day or less. Unlike HB 210, HB 355 does not specify a formula and procedure for quantifying the amount of water that is to be reserved for fish and wildlife. HB 355 also expands guaranteed instream flow protection to wildlife. It appears HB 355 would also provide the legal mechanism for the ADNR to require water use permits for diversions from bodies of water that are fish bearing or used by wildlife.

Based on our experiences, the following five recommendations to improve the instream flow reservation process are provided:

1) Additional staff (fishery biologists and hydrologists) and financial resources should be allocated to the instream flow program to allow for a greater number of applications to be processed.

2) HB 354 or similar legislation should be enacted to improve the USGS stream gaging station network and evaluate the precision and accuracy of hydrologic models used to estimate flow characteristics for ungaged sites in Alaska. Additional data collection sites should be funded based upon the network evaluation to improve flow projection models and estimates and to determine the availability of water for out-of-stream and instream uses.

3) Out-of-stream appropriation certificates should be automatically reviewed by the ADNR once every 10 years, as are instream flow reservations.

4) Legislation similar to HB 355 should be enacted or regulations established that will guarantee a base level of instream flow protection for stream reaches that are classified as supporting fish.

5) An instream flow methods and application handbook should be prepared by the ADFG to provide sufficient guidance for the public and other interested parties to file for instream flow reservations.

In summary, the experiences gained through analysis and preparation of each ADFG application have continually improved our ability to complete the next application. Unfortunately, we are at a stage where both data requirements and lengthy adjudication processes have and will continue to limit the number of reservations completed and submitted. If we are to counter these limitations, additional resources will be required for data collection and analyses, and the preparation and defense of applications.

## ACKNOWLEDGMENTS

The author expresses his appreciation to his immediate supervisor, M. J. Mills, for continuing to support this program. Appreciation is also extended to regional and area biologists who contributed information and data for analysis: A. Townsend, J. Hallberg, G. Sanders, K. Hepler, L. Engel, and L. Bartlett. Contributions from: B. Begich who compiled and synthesized biologic data; C. Hepler for providing scientific illustration support; A. Bingham, G. Fidler, S. McHenry, A. Howe, S. Sonnichsen, G. Karcz, D. Sigurdsson, A. Armstrong and other Research and Technical Services Section staff who summarized and analyzed hydrologic data and/or provided editorial suggestions and assistance; B. Burrows, B. Lamke, G. Solin, and H. Seitz (USGS) who provided hydrologic analysis support; and D. Lehner (U.S. Soil Conservation Service), and W. T. Beck (Martech USA Inc.) who provided editorial suggestions are all appreciated.

## LITERATURE CITED

Alaska Administrative Code. 1990. 11 AAC 93. Revisions to the water management regulations. November 1990. Alaska Department of Natural Resources. Anchorage, Alaska.

ADFG (Alaska Department of Fish and Game). 1984. Instream flow work plan. Alaska Department of Fish and Game, Anchorage, Alaska.

_____. 1985. Alaska habitat management guides. Alaska Department of Fish and Game, Division of Habitat. Anchorage, Alaska.

_____. 1989. An atlas to the catalog of waters important for spawning, rearing or migration of anadromous fishes. Alaska Department of Fish and Game, Division of Habitat. Anchorage, Alaska.

_____. 1991a. Application for reservation of water. *In Prep*. Jim River. Sport Fish RTS No. I.700.300.3100. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991b. Application for reservation of water. *In Prep* . Deshka River. Sport Fish RTS No. I.700.300.1070. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991c. Application for reservation of water. *In Prep*. Deception Creek. Sport Fish RTS No. I.700.300.1053. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991d. Application for reservation of water. *In Prep*. Mendenhall River-Reach A. Sport Fish RTS No. I.700.300.6300. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991e. Application for reservation of water. *In Prep*. Mendenhall River-Reach B. Sport Fish RTS No. I.700.300.6301. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991f. Application for reservation of water. *In Prep*. Auke Creek. Sport Fish RTS No. I.700.300.160. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991g. Application for reservation of water. *In Prep*. Baranof River-Reach A. Sport Fish RTS No. I.700.300.181. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991h. Application for reservation of water. *In Prep*. Baranof River-Reach B. Sport Fish RTS No. I.700.300.182. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

_____. 1991i. Application for reservation of water. *In Prep*. Baranof River-Reach C. Sport Fish RTS No. I.700.300.183. Located at the Alaska Department of Fish and Game. Anchorage, Alaska.

ADNR (Alaska Department of Natural Resources). 1985. State of Alaska instream flow handbook. Alaska Department of Natural Resources, Anchorage, Alaska.

Bovee, K. D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Flow methodology. Instream Flow Information Paper No. 122. FWS/OBS/82/26. U.S. Fish and Wildlife Service. Ft. Collins, Colorado.

Davidson, C. 1991a. House Bill No. 353. A bill for an act entitled " An Act making an appropriation to the Department of Natural Resources for completion of water appropriation data automation and update; and providing for an effective date." May 21, 1991. Alaska State Legislature. Juneau, Alaska.

_____. 1991b. House Bill No. 354. A bill for an act entitled "An act making an appropriation to the Department of Natural Resources for payment as a matching grant for completion of a surface-water data network evaluation for Alaska; and providing for an effective date." May 21, 1991. Alaska State Legislature. Juneau, Alaska.

_____. 1991c. House Bill No. 355. A bill for an act entitled "An act relating to the reservation of instream flows for fish and wildlife; and providing for an effective date." May 21, 1991. Alaska State Legislature. Juneau, Alaska.

Emery, P. A. 1987. Letter to Christopher Estes (Alaska Department of Fish and Game), November 9, 1987 regarding U.S. Geological Survey requirements to calculate stream flows. U.S. Geological Survey. Water Resources Division. Anchorage, Alaska.

_____. 1989. Letter to Christopher Estes (Alaska Department of Fish and Game), March 6, 1989, regarding U.S. Geological Survey stream flow gaging stations. U.S. Geological Survey. Water Resources Division. Anchorage, Alaska.

Estes, C. C. 1984. Evaluation of methods for recommending instream flows to support spawning by salmon. Master's thesis, Washington State University, Pullman, Washington.

_____. 1985. Organization of departmental instream flow program. Memorandum to Richard Logan, September 12, 1985. Alaska Department of Fish and Game, Anchorage, Alaska.

_____. 1987. Instream flow. Alaska Department of Fish and Game, Fishery Data Series No. 23, Juneau, Alaska.

_____. 1988. Annual summary of statewide instream flow reservation applications. Alaska Department of Fish and Game, Fishery Data Series No. 55, Juneau, Alaska.

_____. 1989. Annual summary of statewide instream flow reservation applications. Alaska Department of Fish and Game, Fishery Data Series No. 121, Juneau, Alaska.

______. 1990. Annual summary of statewide instream flow reservation applications. Alaska Department of Fish and Game, Fishery Data Series No. 90-43, Anchorage, Alaska.

Estes, C. C. and M. L. Harle. 1987. Alaska's instream flow program. Instream Flow Chronicle. Colorado State University. Ft. Collins, Colorado. IV(1):1-2.

Estes, C. C. and J. F. Orsborn. 1986. Review and analysis of methods for quantifying instream flow requirements. Water Resources Bulletin. 22(3):389-398.

Harle, M. L. 1988. Private appropriations of instream flows in Alaska. In: Instream Flow Protection in the Western United States: A Practical Symposium. Natural Resources Law Center. March 31 - April 1, 1988. University of Colorado School of Law. Boulder, Colorado.

Harrison, G. S. 1982. A citizen's guide to the constitution of Alaska. Institute of Social and Economic Research. University of Alaska. Anchorage, Alaska.

Instream Flow Committee. 1986. Memorandum to directors, October 1, 1986. Alaska Department of Fish and Game, Anchorage, Alaska.

Mills, M. J. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage, Alaska.

Mills, M. J. 1991. Harvest, catch, and participation in Alaska sport fisheries in 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage, Alaska.

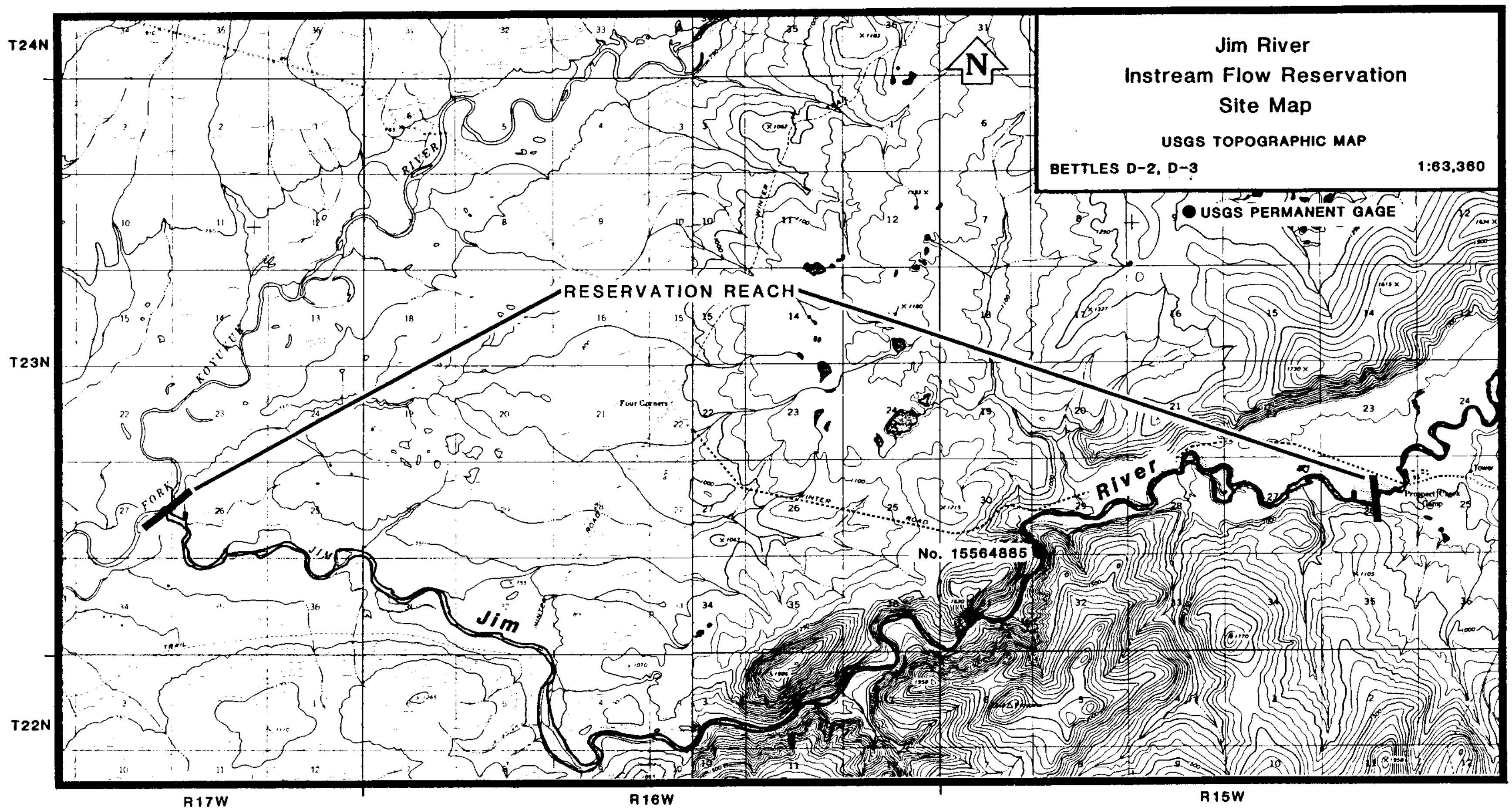
Orsborn, J. F. and F. J. Watts. 1980. Hydraulics and hydrology for fisheries biologists. U.S. Fish and Wildlife Service, Fisheries Academy, Kearneysville, Virginia.

Shaw, E. M., editor. 1988. Hydrology in practice. Van Nostrand Reinhold Co. Ltd., London, England.

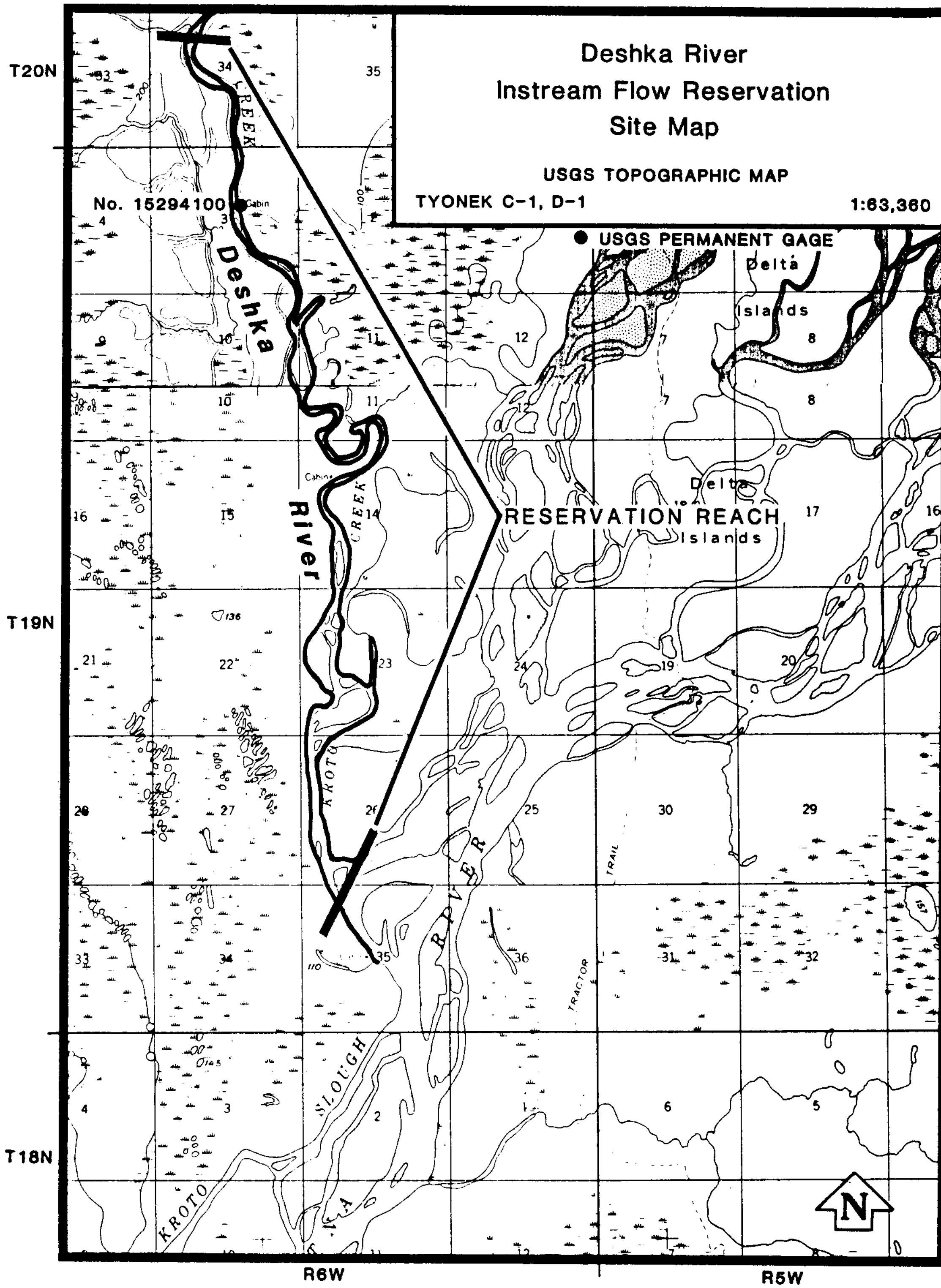
Tennant, D. L. 1972. A method for determining instream flow requirements for fish, wildlife and aquatic environment. Pages 3-11 *in* Pacific Northwest River Basin Commission Transcript of Proceedings of Instream Flow Requirements Workshop, March 15-16, 1972. Pacific Northwest River Basin Commission, Portland, Oregon.

______. 1976. Instream flow regimes for fish, wildlife, recreation, and related environmental resources. Pages 359-373 *in* J. F. Orsborn and C. H. Allman, editors. Instream Flow Needs, Volume II, American Fisheries Society, Bethesda, Maryland.

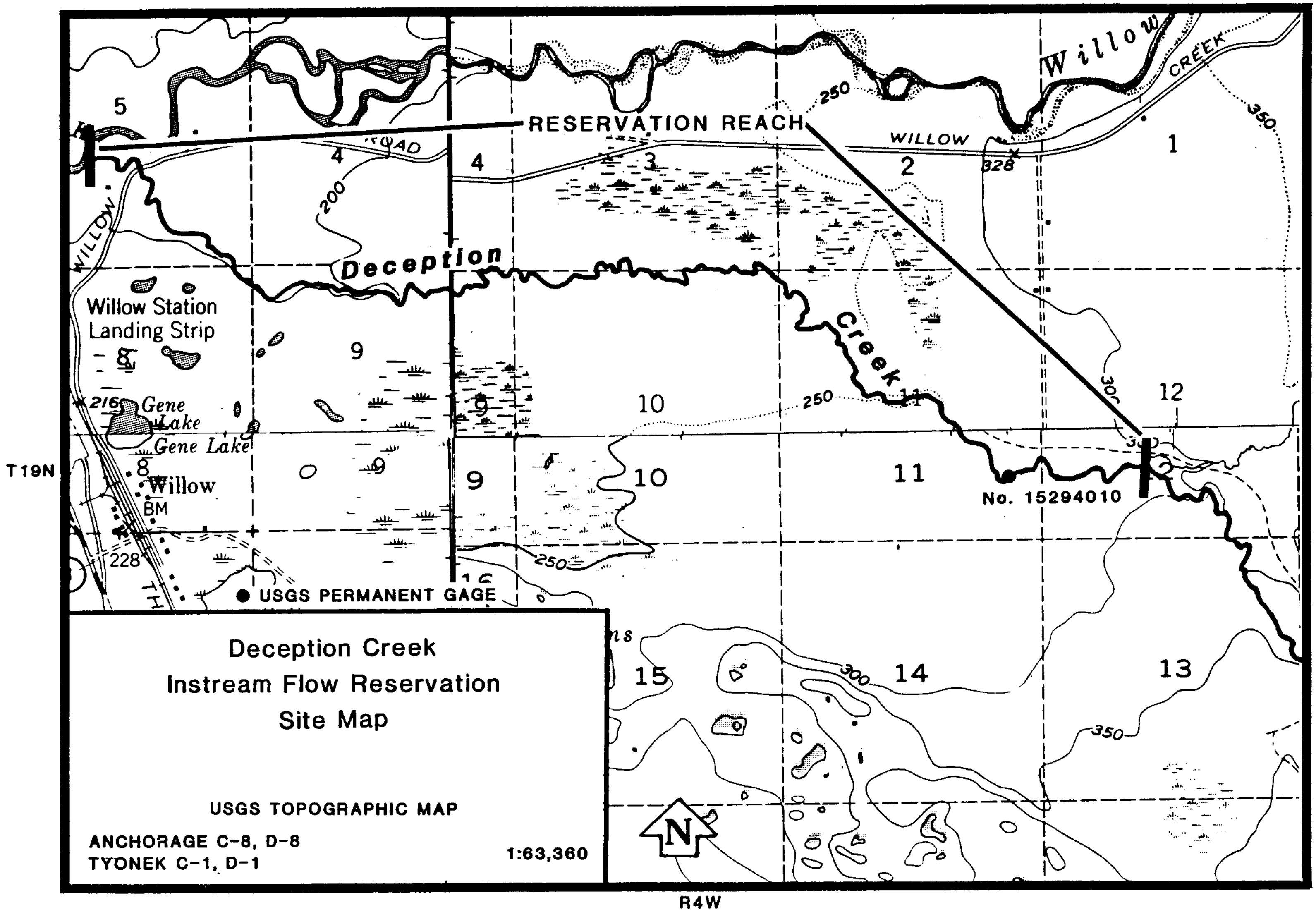
# APPENDIX A



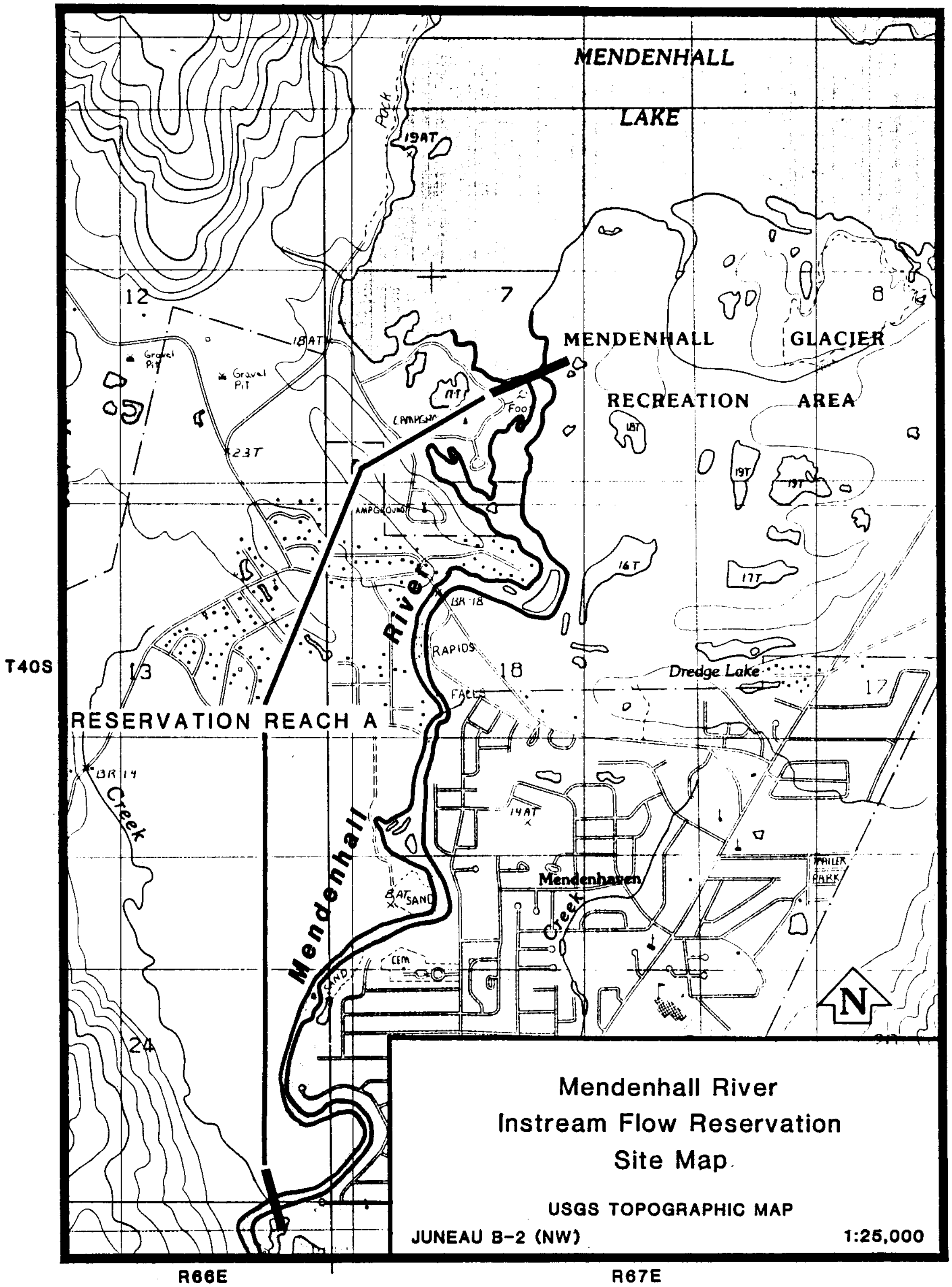

Appendix A1. Reservation reach boundaries, Jim River.



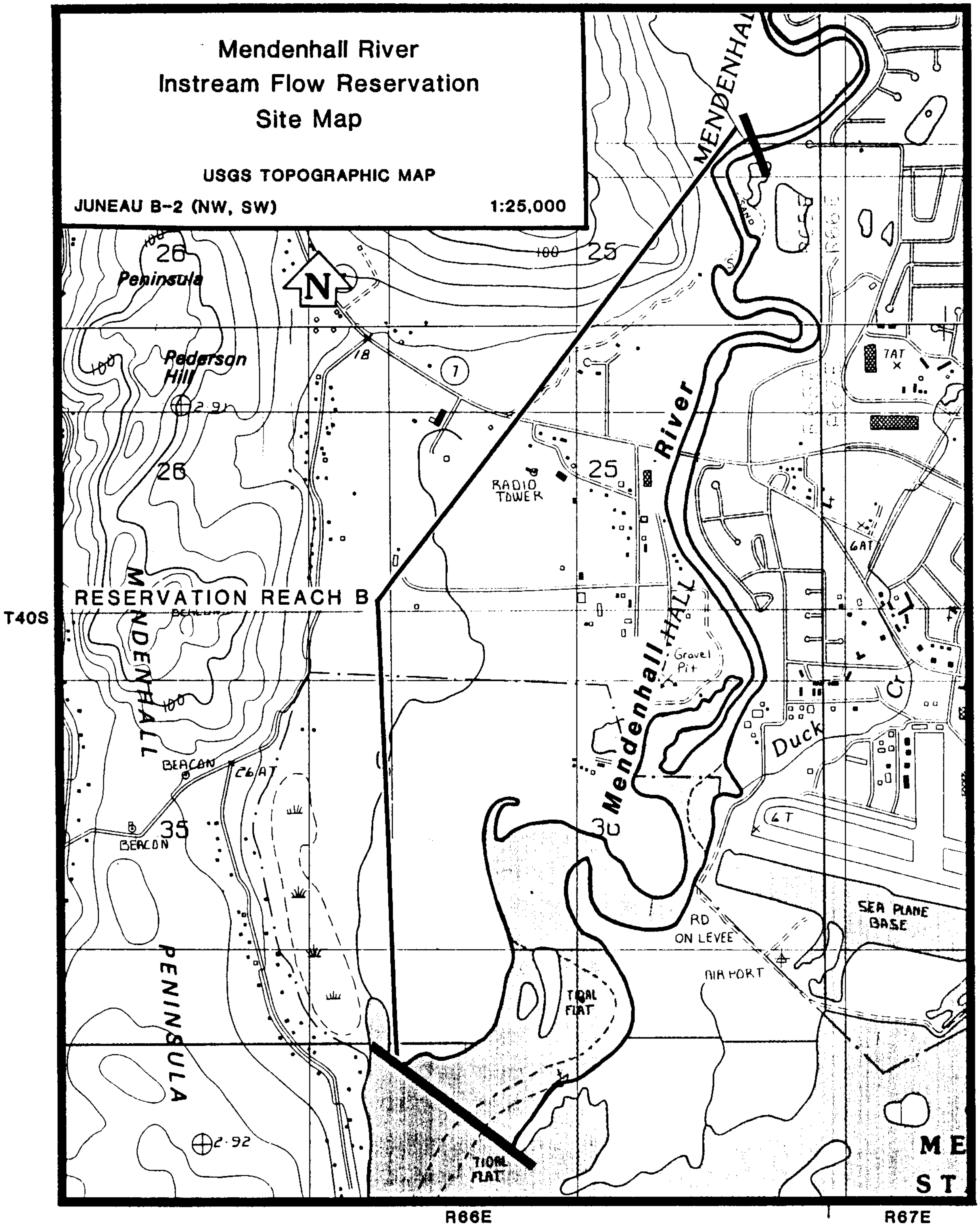

Appendix A2. Reservation reach boundaries, Deshka River.



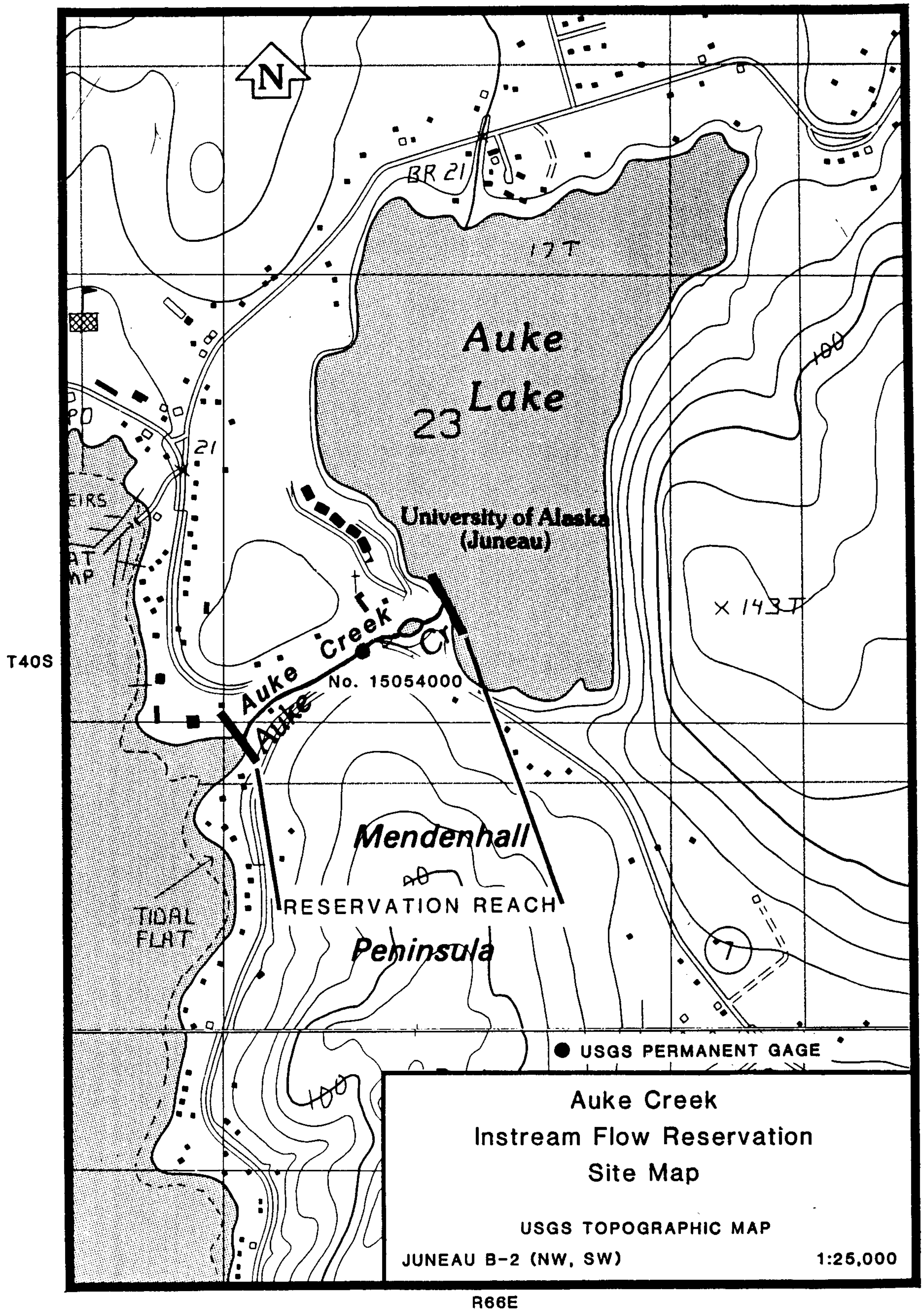

Appendix A3. Reservation reach boundaries, Deception Creek.



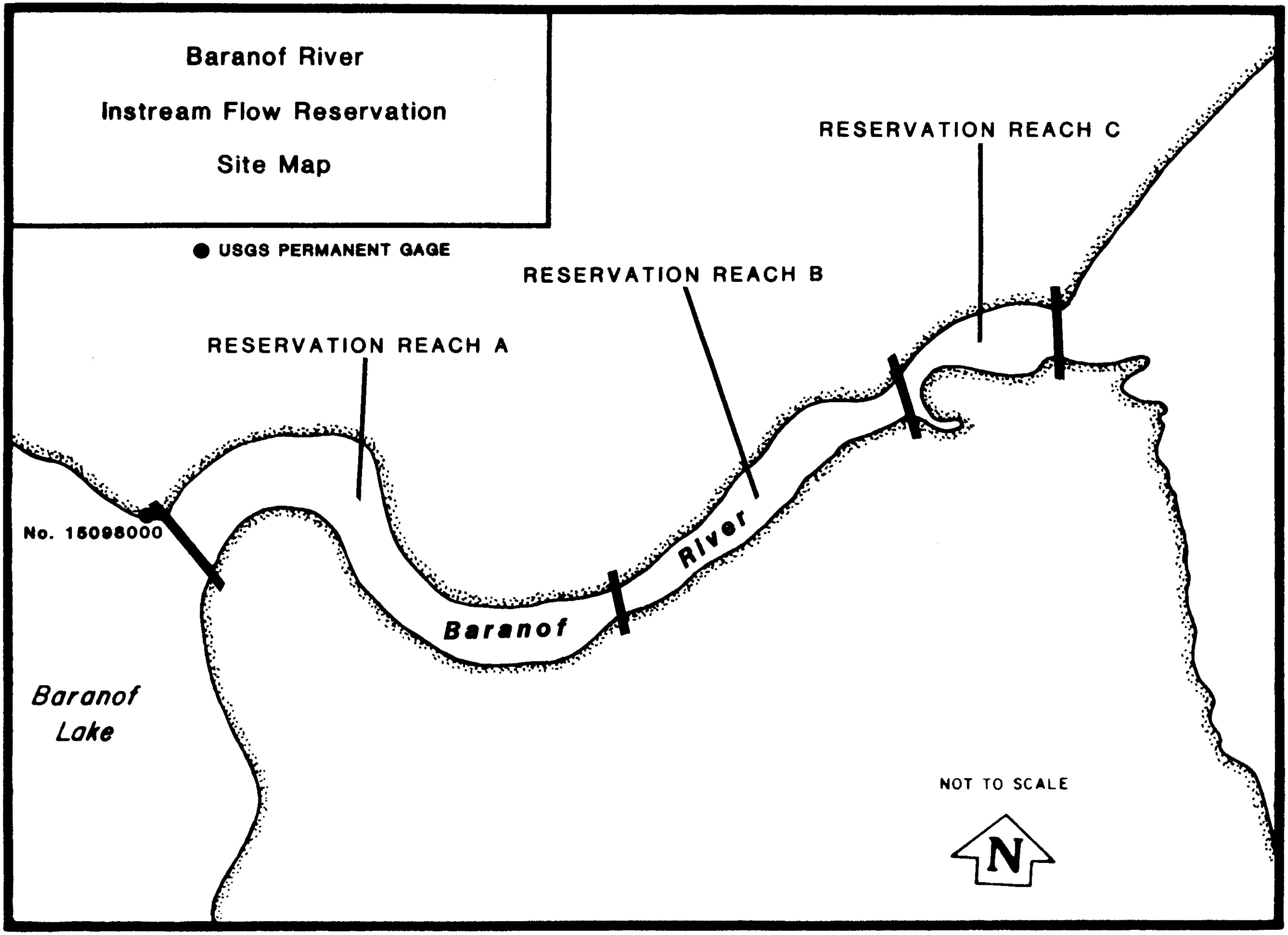

Appendix A4. Reservation reach boundaries, Mendenhall River - Reach A.




Appendix A5. Reservation reach boundaries, Mendenhall River - Reach B.




Appendix A6. Reservation reach boundaries, Auke Creek.




Appendix A7. Reservation reach boundaries, Baranof River - Reaches A, B, C.

Appendix A8. Common and scientific names of fishes identified in periodicity charts (Appendices A9-A15).

| COMMON NAME | SCIENTIFIC NAME |
| --- | --- |
| Arctic grayling | *Thymallus arcticus* |
| Burbot | *Lota lota* |
| Chinook salmon | *Oncorhynchus tshawytscha* |
| Chum salmon | *Oncorhynchus keta* |
| Coho salmon | *Oncorhynchus kisutch* |
| Cutthroat trout | *Oncorhynchus clarki* |
| Dolly Varden | *Salvelinus malma* |
| Longnose sucker | *Catostomus catostomus* |
| Northern pike | *Esox lucius* |
| Pink salmon | *Oncorhynchus gorbuscha* |
| Rainbow trout | *Oncorhynchus mykiss* |
| Round whitefish | *Prosopium cylindraceum* |
| Sockeye salmon | *Oncorhynchus nerka* |
| Steelhead | *Oncorhynchus mykiss* |

Appendix A9. Species periodicity chart for Jim River.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CHINOOK SALMON** | | | | | | | | | | | | |
| Passage | | | | | | XXX | XXXX | XX | | | | |
| Spawning | | | | | | | XXX | XXXX | X | | | |
| Incubation | XXXX | XXXX | XXXX | XXX | | | XXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **CHUM SALMON** | | | | | | | | | | | | |
| Passage | | | | | | XXX | XXXX | XXXX | | | | |
| Spawning | | | | | | | XXX | XXXX | XX | | | |
| Incubation | XXXX | XXXX | XXXX | XXXX | | | XXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | | XXXX | XXXX | XXXX | XXX | | | | | |
| **ROUND WHITEFISH** | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | XXXX | XXX | |
| Spawning | | | | | | | | XX | XXXX | XXXX | | |
| Incubation | XXXX | XXXX | XXXX | XXXX | | | | XX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **ARCTIC GRAYLING** | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning | | | | XX | XXXX | XX | | | | | | |
| Incubation | | | | XX | XXXX | XXXX | XXX | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **BURBOT** | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning | XXXX | XXXX | | | | | | | | | | XXXX |
| Incubation | XXXX | XXXX | XXXX | XXXX | XXXX | | | | | | | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **NORTHERN PIKE** | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning | | | | XXX | XXXX | XX | | | | | | |
| Incubation | | | | XXX | XXXX | XXXX | XXXX | XXX | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **SLIMY SCULPIN** | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning ? | | | | | | | | | | | | |
| Incubation ? | | | | | | | | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **LONGNOSE SUCKER** | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning ? | | | | XX | XXXX | XXX | | | | | | |
| Incubation ? | | | | XX | XXXX | XXXX | XXXX | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A10. Species periodicity chart for Deshka River.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHINOOK SALMON | | | | | | | | | | | | |
| Passage | | | | | XXXX | XXXX | XXXX | X | | | | |
| Spawning | | | | | | | XX | XXXX | | | | |
| Incubation | XXXX | XXXX | XXXX | XX | | | XX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| COHO SALMON | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | | | |
| Spawning | | | | | | | | XXXX | XXXX | XX | | |
| Incubation | XXXX | XXXX | XXXX | XX | | | | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| PINK SALMON | | | | | | | | | | | | |
| Passage | | | | | | | XX | XXXX | | | | |
| Spawning | | | | | | | XX | XXXX | XX | | | |
| Incubation | XXXX | XXXX | XXXX | XX | | | XX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | | | | | | | | | | |
| SOCKEYE SALMON | | | | | | | | | | | | |
| Passage ? | | | | | | | | | | | | |
| Spawning ? | | | | | | | | | | | | |
| Incubation ? | | | | | | | | | | | | |
| Rearing ? | | | | | | | | | | | | |
| RAINBOW TROUT | | | | | | | | | | | | |
| Passage | | | | ?X | XXXX | X? | | | | | | |
| Spawning | | | | ?X | XXXX | X? | | | | | | |
| Incubation | | | | ?X | XXXX | XXXX | XXXX | X? | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| BURBOT | | | | | | | | | | | | |
| Spawning | XXXX | XX | | | | | | | | | | XXXX |
| Incubation | XXXX | XXXX | XXXX | ? | | | | | | | | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| ARCTIC GRAYLING | | | | | | | | | | | | |
| Spawning ? | | | | | | | | | | | | |
| Incubation ? | | | | | | | | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A11. Species periodicity chart for Deception Creek.

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CHINOOK SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXX | | | | | |
| Spawning | | | | | | | | XX | XXX | | | | |
| Incubation | | XXXX | XXXX | XXXX | | | | XX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **COHO SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | | X | XXXX | XX | | | |
| Spawning | | | | | | | | | | XXXX | XX | | |
| Incubation | | XXXX | XXXX | XXXX | | | | | | XXXX | XXXX | XXXX | XXXX |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **PINK SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | | XX | XXX | | | | |
| Spawning | | | | | | | | X | XXXX | | | | |
| Incubation | | XXXX | XXXX | XXXX | | | | X | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | | XXX | XXXX | X | | | | | | | |
| **CHUM SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | | XX | XXX | | | | |
| Spawning | | | | | | | | X | XXXX | | | | |
| Incubation | | XXXX | XXXX | XXXX | | | | X | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | | XXX | XXXX | X | | | | | | | |
| **RAINBOW TROUT** | | | | | | | | | | | | | |
| Passage | ? | | | | | | | | | | | | |
| Spawning | | | | | XX | XXXX | XX | | | | | | |
| Incubation | | | | | XX | XXXX | XXXX | XXXX | | | | | |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **DOLLY VARDEN** | | | | | | | | | | | | | |
| Passage | ? | | | | | | | | | | | | XXXX |
| Spawning | | XXXX | XX | | | | | | | XXXX | XXXX | XXXX | |
| Incubation | | XXXX | XXXX | XXXX | | | | | | XXXX | XXXX | XXXX | XXXX |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **ARCTIC GRAYLING** | | | | | | | | | | | | | |
| Passage | ? | | | | | | | | | | | | |
| Spawning | ? | | | | XXXX | XXXX | XXXX | | | | | | |
| Incubation | ? | | | | XXXX | XXXX | XXXX | XXX | | | | | |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **BURBOT** | | | | | | | | | | | | | |
| Passage | ? | | | | | | | | | | | | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A12. Species periodicity chart for Mendenhall River-Reach A.

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COHO SALMON** | | | | | | | | | | | | | |
| Passage | | XXXX | | | | | | | XX | XXXX | XXXX | XXXX | XXXX |
| Spawning | | XXXX | | | | | | | | | XXXX | XXXX | XXXX |
| Incubation | | XXXX | XXXX | XXXX | | | | | | | XXXX | XXXX | XXXX |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **SOCKEYE SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | | | | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **DOLLY VARDEN** | | | | | | | | | | | | | |
| Spawning | | | | | | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XX |
| Incubation | ? | | | | | | | | | | | | |
| Passage | ? | | | | | | | | | | | | |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A13. Species periodicity chart for Mendenhall River-Reach B.

| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COHO SALMON** | | | | | | | | | | | | | |
| Passage | | XXXX | | | | | | | XX | XXXX | XXXX | XXXX | XXXX |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **PINK SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | XX | XXXX | XXXX | XXX | | | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **SOCKEYE SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | | | | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **CHUM SALMON** | | | | | | | | | | | | | |
| Passage | | | | | | | XX | XXXX | XXXX | XXX | | | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **STEELHEAD TROUT** | | | | | | | | | | | | | |
| Passage | | XXXX | XXXX | XXXX | XXXX | XXXX | XX | | XX | XXXX | XXXX | XXXX | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **CUTTHROAT TROUT** | | | | | | | | | | | | | |
| Passage | | | | | | | | XXXX | XXXX | XXXX | XXXX | XXXX | |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | ? | | | | | | | | | | | | |
| **DOLLY VARDEN** | | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XX |
| Spawning | ? | | | | | | | | | | | | |
| Incubation | ? | | | | | | | | | | | | |
| Rearing | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A14. Species periodicity chart for Auke Creek.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COHO SALMON** | | | | | | | | | | | | |
| Passage | | | | | | | XX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Spawning | XXXX | | | | | | | | | XXXX | XXXX | XXXX |
| Incubation | XXXX | XXXX | XX | | | | | | | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **PINK SALMON** | | | | | | | | | | | | |
| Passage | | | | | | XX | XXXX | XXXX | XXXX | | | |
| Spawning | | | | | | | XXXX | XXXX | XXXX | | | |
| Incubation | XXXX | XXXX | XX | | | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | XXXX | | | | | | | | | |
| **SOCKEYE SALMON** | | | | | | | | | | | | |
| Passage | | | | | | XXXX | XXXX | XXXX | | | | |
| Spawning | | | | | | | | XXXX | XXXX | | | |
| Incubation | XXXX | XXXX | XXXX | | | | | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **CHUM SALMON** | | | | | | | | | | | | |
| Passage | | | | | | XX | XXXX | XXXX | XXXX | | | |
| Spawning | | | | | | | XXXX | XXXX | XXXX | | | |
| Incubation | XXXX | XXXX | XXXX | | | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | XXXX | | | | | | | | | |
| **DOLLY VARDEN** | | | | | | | | | | | | |
| Passage | | | | | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| Spawning | | | | | | | | | XX | XXXX | XXXX | XXXX |
| Incubation | XXXX | XXXX | XXXX | XXXX | | | | | XX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| **CUTTHROAT TROUT** | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXXX | XXXX | XXXX | |
| Spawning | | | | | | | | | XX | XXXX | XXXX | XXXX |
| Incubation | XXXX | XXXX | XXXX | XXXX | | | | | XX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A15. Species periodicity charts for Baranof River-Reaches A, B, C.

Reach A.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CUTTHROAT TROUT | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXX | | | |
| Spawning | | | | | | | | XXXX | XXX | | | |
| Incubation | XXXX | XXXX | XXXX | | | | | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Reach B.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CUTTHROAT TROUT | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXX | | | |
| Spawning | | | | | | | | | | | | |
| Incubation | | | | | | | | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Reach C.

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CUTTHROAT TROUT | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXX | | | |
| Spawning | | | | | | | | | | | | |
| Incubation | | | | | | | | | | | | |
| Rearing | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX |
| PINK SALMON | | | | | | | | | | | | |
| Passage | | | | | | | XXXX | XXXX | XXX | | | |
| Spawning | | | | | | | | XXXX | XXX | | | |
| Incubation | XXXX | XXXX | XXXX | | | | | XXXX | XXXX | XXXX | XXXX | XXXX |
| Rearing | | | XXX | XXXX | XXXX | XXX | | | | | | |

Based on professional judgment of ADF&G biologists.
Passage life phase for anadromous fish is immigration.
Passage life phase for resident fish includes immigration and emigration.
Incubation life phase includes period from egg deposition to fry emergence.
? = Data not available.

Appendix A16. Example of instream flow reservation application.

**STATE OF ALASKA**
**DEPARTMENT OF NATURAL RESOURCES**
**DIVISION OF LAND AND WATER MANAGEMENT**

☐ Northcentral District
4420 Airport Way
Fairbanks, Alaska 99701
(907) 479-2243

☐ Southcentral District
Pouch 7-005
Anchorage, Alaska 99510
(907) 276-2653

☐ Southeastern District
230 S. Franklin, Room 407
Juneau, Alaska 99801
(907) 465-3400

OFFICE USE ONLY

LAS

**APPLICATION FOR RESERVATION OF WATER**

INSTRUCTIONS: This is an application to reserve a specific instream flow or level of water under AS 46.15.145 and 11 AAC 93.141-147. This application must be filled out completely and all requested attachments submitted with it. Failure to complete all parts of the application may result in return of the application. Attach extra pages to fully answer questions. If a report is attached as part of this application, indicate appropriate page numbers following each question. Submit this application to the district in which the proposed reservation is located (identified above). Please type or print in ink.

1. Full legal name of applicant(s): ______________________

   ______________________

2. Mailing Address: ______________________

   City: ______________ State: ____________ Zip: __________

   Business Phone: ______________ Home Phone: ______________

3. Name of the stream or water body in which water is proposed to be reserved:

   ______________________

4. Location of the proposed reservation of water:

   (a) List ALL sections, townships, ranges and meridians from the beginning to the end of the stream segment and for all parts of the lake or waterbody in which water is requested to be reserved. (Attach extra pages if needed.)

   ______________________

   ______________________

   ______________________

   ______________________

p. 1 of 4

10-1151 (11/83)

(b) Describe the location of the point or points defining the boundary of the proposed reservation of water by river mile index, river mile, geographical or cultural landmark, etc., on the stream or water body. (Attach extra pages if needed.) ______________________________

______________________________

______________________________

______________________________

______________________________

(c) ATTACH a U.S. Geological Survey map at 1:63,360 scale, or 1:250,000 scale if 1:63,360 scale is unavailable for the area, clearly identifying the following for the proposed reservation of water:

(1) Sections, townships, ranges and meridians

(2) The stream or water body in which the reservation of water is proposed

(3) Specific point or points defining the boundary of the proposed reservation of water

(4) Permanent, temporary or planned locations of water measurement devices (such as gaging stations, weirs, staff gages)

(5) Permanent, temporary or planned bench marks

5. (a) Identify the purpose(s) of the proposed reservation of water by checking the appropriate box(es).

[ ] protection of fish and wildlife habitat, migration, and propagation

[ ] recreation and park purposes

[ ] navigation and transportation purposes

[ ] sanitary and water quality purposes

(b) Describe in detail the purpose(s) of the proposed reservation, including, when appropriate; species and life stage, type of recreation, vehicle, or water quality parameter, or other relevant information. (Attach extra page if needed.) ______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

6. Is the water currently being used for the purpose(s) applied for?

[ ] Yes.

[ ] No. If no, when will use for this purpose begin? Specify approximate date. ______________________

7. (a) Water requested to be reserved (check one):

[ ] to maintain a specific instream flow rate, measured in cubic feet per second

[ ] to maintain a specific level of surface water, measured in cubic feet or acre feet

[ ] to maintain a specific surface water elevation, measured in relation to a permanent benchmark

(b) Quantify the specific amount of water requested to be reserved: Identify and quantify, as appropriate; flow rates, quantities, surface water elevations, depths, etc., as they relate to the daily durations and months of the year during which the reservation is proposed. Include any flow release schedules from projects upstream of the proposed reservation that would apply. (Attach extra pages if needed.)

______________________

______________________

______________________

______________________

______________________

______________________

______________________

______________________

______________________

______________________

______________________

______________________

8. Attach and submit with this application documentation or reports showing facts to support the following:

(a) The need for the proposed reservation of water, including reasons why the reservation is being requested.

(b) Identify and describe the methodology, data, and data analysis used to substantiate the need for and the quantity of water requested for the proposed reservation of water, including:

(1) Name and description of method used,

(2) Who conducted the study and analysis,

(3) Schedule of when data collection and analysis occurred,

(4) Type(s) of instrument(s) used to collect and analyze data,

(5) Description of data and how the data was collected, including when applicable, (A) selection of stream reach, study site and transect selection, (B) flow, survey, elevation, and depth measurements, (C) pertinent physical, biological, water chemistry and socio-economic data,

(6) Description of how data was analyzed, and

(7) Maps, photos, aerial photos, calculations, and any other documents supporting this application.

9. If there are provisions for monitoring this proposed reservation of water, include the following:

(a) Description of monitoring equipment (such as gaging stations, staff gages, weirs)
(b) Location of monitoring equipment
(c) Provisions for payment of monitoring
(d) Reporting system

**Statements contained in this application are true and correct to the best of my knowledge.**

**Signed** ______________________________
**Applicant(s) Full Legal Name(s)**

**Date** ______________________________

Appendix A17. Summary of hydrologic data for 1991 instream flow reservation applications.

| Stream/Reach | U.S. Geological Survey Site Number | Years of Daily Flow Record |
|---|---|---|
| Jim River | 15564885 | 1970-1977 |
| Deception Creek | 15294010 | 1978-1985 |
| Deshka River | 15294100 | 1978-1986 |
| Mendenhall River-Reach A | 15052500 | 1965-Present |
| Mendenhall River-Reach B | | |
| Mendenhall River | 15052500 | 1965-Present |
| Montana Creek | 15052800 | 1965-1975 |
| | | 1983-1987 |
| Auke Creek | 15054000 | 1962-1975 |
| Baranof River-Reach A | 15098000 | 1957-1974 |
| Baranof River-Reach B | 15098000 | 1957-1974 |
| Baranof River-Reach C | 15098000 | 1957-1974 |

Appendix A18. Tennant Method analysis for Jim River.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Jim River | |
| | % of QAA | Flow (cfs) |
| Month | Oct.- Apr. | |
| QAA | 100 | 436 |
| Flushing or Maximum | 200 | 872 |
| Optimum Range | 60-100 | 262-436 |
| Outstanding | 40 | 174 |
| Excellent | 30 | 131 |
| Good | 20 | 87 |
| Fair or Degrading | 10 | 44 |
| Poor or Minimum | 10 | 44 |
| Severe Degredation | <10 | <44 |
| Month | May - Sep. | |
| QAA | 100 | 436 |
| Flushing or Maximum | 200 | 872 |
| Optimum Range | 60-100 | 262-436 |
| Outstanding | 60 | 262 |
| Excellent | 50 | 218 |
| Good | 40 | 174 |
| Fair or Degrading | 30 | 131 |
| Poor or Minimum | 10 | 44 |
| Severe Degredation | <10 | <44 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 29 |
| Feb | 23 |
| Mar | 22 |
| Apr | 29 |
| May | 1659 |
| Jun | 1358 |
| Jul | 417 |
| Aug | 674 |
| Sep | 713 |
| Oct | 176 |
| Nov | 70 |
| Dec | 41 |

Appendix A19. Tennant Method analysis for Deshka River.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Deshka River | |
| | % of QAA | Flow (cfs) |
| Month | Nov.- Apr. | |
| QAA | 100 | 892 |
| Flushing or Maximum | 200 | 1784 |
| Optimum Range | 60-100 | 535-892 |
| Outstanding | 40 | 357 |
| Excellent | 30 | 268 |
| Good | 20 | 178 |
| Fair or Degrading | 10 | 89 |
| Poor or Minimum | 10 | 89 |
| Severe Degredation | <10 | <89 |
| Month | May - Oct. | |
| QAA | 100 | 892 |
| Flushing or Maximum | 200 | 1784 |
| Optimum Range | 60-100 | 535-892 |
| Outstanding | 60 | 535 |
| Excellent | 50 | 446 |
| Good | 40 | 357 |
| Fair or Degrading | 30 | 268 |
| Poor or Minimum | 10 | 89 |
| Severe Degredation | <10 | <89 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 273 |
| Feb | 239 |
| Mar | 239 |
| Apr | 615 |
| May | 2566 |
| Jun | 970 |
| Jul | 929 |
| Aug | 1229 |
| Sep | 1336 |
| Oct | 1187 |
| Nov | 737 |
| Dec | 332 |

Appendix A20. Tennant Method analysis for Deception Creek.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Deception Creek | |
| | % of QAA | Flow (cfs) |
| Month | Nov.- Apr. | |
| QAA | 100 | 65 |
| Flushing or Maximum | 200 | 130 |
| Optimum Range | 60-100 | 39-65 |
| Outstanding | 40 | 26 |
| Excellent | 30 | 20 |
| Good | 20 | 13 |
| Fair or Degrading | 10 | 7 |
| Poor or Minimum | 10 | 7 |
| Severe Degredation | <10 | <7 |
| Month | May - Oct. | |
| QAA | 100 | 65 |
| Flushing or Maximum | 200 | 130 |
| Optimum Range | 60-100 | 39-65 |
| Outstanding | 60 | 39 |
| Excellent | 50 | 33 |
| Good | 40 | 26 |
| Fair or Degrading | 30 | 20 |
| Poor or Minimum | 10 | 7 |
| Severe Degredation | <10 | <7 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 18 |
| Feb | 15 |
| Mar | 15 |
| Apr | 39 |
| May | 169 |
| Jun | 95 |
| Jul | 89 |
| Aug | 84 |
| Sep | 91 |
| Oct | 72 |
| Nov | 47 |
| Dec | 25 |

Appendix A21. Tennant Method analysis for Mendenhall River-Reach A.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Mendenhall River-Reach A | |
| | % of QAA | Flow (cfs) |
| Month | Nov.- Apr. | |
| QAA | 100 | 1131 |
| Flushing or Maximum | 200 | 2262 |
| Optimum Range | 60-100 | 679-1131 |
| Outstanding | 40 | 452 |
| Excellent | 30 | 339 |
| Good | 20 | 226 |
| Fair or Degrading | 10 | 113 |
| Poor or Minimum | 10 | 113 |
| Severe Degredation | <10 | <113 |
| Month | May - Oct. | |
| QAA | 100 | 1131 |
| Flushing or Maximum | 200 | 2262 |
| Optimum Range | 60-100 | 679-1131 |
| Outstanding | 60 | 679 |
| Excellent | 50 | 566 |
| Good | 40 | 452 |
| Fair or Degrading | 30 | 339 |
| Poor or Minimum | 10 | 113 |
| Severe Degredation | <10 | <113 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 112 |
| Feb | 81 |
| Mar | 81 |
| Apr | 124 |
| May | 567 |
| Jun | 1773 |
| Jul | 2906 |
| Aug | 3320 |
| Sep | 2576 |
| Oct | 1366 |
| Nov | 357 |
| Dec | 143 |

Appendix A22. Tennant Method analysis for Mendenhall River-Reach B.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Mendenhall River-Reach B | |
| | % of QAA | Flow (cfs) |
| Month | Nov.- Apr. | |
| QAA | 100 | 1235 |
| Flushing or Maximum | 200 | 2470 |
| Optimum Range | 60-100 | 741-1235 |
| Outstanding | 40 | 494 |
| Excellent | 30 | 371 |
| Good | 20 | 247 |
| Fair or Degrading | 10 | 124 |
| Poor or Minimum | 10 | 124 |
| Severe Degredation | <10 | <124 |
| Month | May - Oct. | |
| QAA | 100 | 1235 |
| Flushing or Maximum | 200 | 2470 |
| Optimum Range | 60-100 | 741-1235 |
| Outstanding | 60 | 741 |
| Excellent | 50 | 618 |
| Good | 40 | 494 |
| Fair or Degrading | 30 | 371 |
| Poor or Minimum | 10 | 124 |
| Severe Degredation | <10 | <124 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) Gage # 15052500 | 15052800 | Total |
|---|---|---|---|
| Jan | 112 | 42 | 154 |
| Feb | 81 | 39 | 120 |
| Mar | 81 | 51 | 132 |
| Apr | 124 | 56 | 180 |
| May | 567 | 135 | 702 |
| Jun | 1773 | 167 | 1940 |
| Jul | 2906 | 146 | 3052 |
| Aug | 3320 | 164 | 3484 |
| Sep | 2576 | 164 | 2740 |
| Oct | 1366 | 158 | 1524 |
| Nov | 357 | 74 | 431 |
| Dec | 143 | 44 | 187 |

Appendix A23. Tennant Method analysis for Auke Creek.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Auke Creek | |
| | % of QAA | Flow (cfs) |
| Month | Nov.- Apr. | |
| QAA | 100 | 17 |
| Flushing or Maximum | 200 | 34 |
| Optimum Range | 60-100 | 10-17 |
| Outstanding | 40 | 7 |
| Excellent | 30 | 5 |
| Good | 20 | 3 |
| Fair or Degrading | 10 | 2 |
| Poor or Minimum | 10 | 2 |
| Severe Degredation | <10 | <2 |
| Month | May - Oct. | |
| QAA | 100 | 17 |
| Flushing or Maximum | 200 | 34 |
| Optimum Range | 60-100 | 10-17 |
| Outstanding | 60 | 10 |
| Excellent | 50 | 9 |
| Good | 40 | 7 |
| Fair or Degrading | 30 | 5 |
| Poor or Minimum | 10 | 2 |
| Severe Degredation | <10 | <2 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 8 |
| Feb | 8 |
| Mar | 7 |
| Apr | 13 |
| May | 32 |
| Jun | 24 |
| Jul | 15 |
| Aug | 20 |
| Sep | 26 |
| Oct | 26 |
| Nov | 15 |
| Dec | 9 |

Appendix A24. Tennant Method analysis for Baranof River-Reaches A, B, C.

Tennant Method Flow Classifications (adapted from Tennant 1975)

| Narrative Description of Flows | Seasonal Base Flow (Q) Regimens as Percentages (%) of Average Annual Flow (QAA) | |
|---|---|---|
| Location | Baranof River | |
| | % of QAA | Flow (cfs) |
| Month | Oct.- Mar. | |
| QAA | 100 | 417 |
| Flushing or Maximum | 200 | 834 |
| Optimum Range | 60-100 | 250-417 |
| Outstanding | 40 | 167 |
| Excellent | 30 | 125 |
| Good | 20 | 83 |
| Fair or Degrading | 10 | 42 |
| Poor or Minimum | 10 | 42 |
| Severe Degredation | <10 | <42 |
| Month | Apr.- Sep. | |
| QAA | 100 | 417 |
| Flushing or Maximum | 200 | 834 |
| Optimum Range | 60-100 | 250-417 |
| Outstanding | 60 | 250 |
| Excellent | 50 | 209 |
| Good | 40 | 167 |
| Fair or Degrading | 30 | 125 |
| Poor or Minimum | 10 | 42 |
| Severe Degredation | <10 | <42 |

Monthly Flow Characteristics

| Month | Long-term Mean Monthly Flow (cfs) |
|---|---|
| Jan | 155 |
| Feb | 104 |
| Mar | 96 |
| Apr 1-15 | 103 |
| Apr 16-30 | 172 |
| May | 492 |
| Jun | 793 |
| Jul | 719 |
| Aug | 599 |
| Sep | 649 |
| Oct | 632 |
| Nov 1-15 | 331 |
| Nov 16-30 | 270 |
| Dec | 204 |

APPENDIX B

Appendix B1. Tennant Method background.

To obtain an instream flow reservation for the protection of fishery resources in Alaska, an application and supplemental information (that among other requirements specifies how the flow requirements were selected) must be submitted to the Alaska Department of Natural Resources.

Specific methods for defining instream flow requirements are not designated or required by state law or regulation for supporting instream flow reservation applications. The burden of proof for choosing an instream flow analysis method is instead placed on the instream flow applicant (ADNR 1985; Estes and Harle 1987).

The selection of a specific methodology by the Alaska Department of Fish and Game will depend on the quantity and quality of hydrologic and biologic data available for each water body under study. In general, the simplest procedure is used such as a modification of the Tennant Method (Tennant 1972), also referred to as the Montana Method in earlier literature. If legally required or specific increments of water must be evaluated, the resource intensive Instream Flow Incremental Methodology, IFIM (Bovee 1982) is selected. Regardless of the method chosen, an analysis of regional hydrological characteristics is incorporated into these analyses following procedures described in Estes (1984), Orsborn and Watts (1980), and Shaw (1988) to insure flow reservation recommendations mimic natural hydrological patterns.

The Tennant Method, combined with an evaluation of hydrologic characteristics, was considered the most cost effective approach for recommending flow regimes for the applications prepared in FY 91 The choice of this approach was based on the philosophy that any valid application of an instream flow method or combination of them could be used to calculate instream flow requirements if two assumptions were met: hydrologic data were calibrated to the site or area studied; and, fish habitat criteria represented the species/life phases of fish found in the vicinity of the targeted water body (Estes 1984; Estes and Orsborn 1986). Other considerations included the availability of data, previous analyses, and financial resources.

The Tennant Method was developed by Tennant (1972, 1976). It has been successfully tested in court, requires minimal expenditures of resources and can be used with limited or extensive hydrologic and fishery data bases. The Tennant Method is considered one of the simplest techniques for selecting or qualitatively evaluating instream flows for fish and wildlife. Eight flow categories were established by Tennant by analyzing a series of field measurements and observations. Each is assigned a percentage or percentage range of the average annual flow (QAA). The QAA can be obtained from the U.S. Geological Survey (USGS) and is calculated by averaging the mean daily flow for the year (Orsborn and Watts 1980). It can also be estimated using regional hydrologic models. Seven of the Tennant categories characterize habitat quality for fish and wildlife and the eighth provides for a flushing flow. The percentages of QAA for habitat quality range from less than 10% (Severe Degradation) to 60%-100% (Optimum Range). The flushing flow category equals 200% of the QAA.

Research by Estes (1984) suggests the flushing flow value should be increased to 400% or more of the QAA for a duration of 3 to 7 days. Flushing flows are usually associated with a 1 in 2-year-period peak flood flow (Reiser, Ramey, and Lambert 1985); therefore, one cannot predict the exact timing of an event. Accordingly, flushing flows, although important to maintain fish habitat, cannot be formally reserved unless a stream system has a flow control structure. This is because an instream flow can only be reserved at a designated location for a specified time period. In an effort to compensate for this limitation, a statement was added to each application explaining that reserved flushing flows would be required if a control structure or large water withdrawals are planned for the future for a stream.

## LITERATURE CITED

ADNR (Alaska Department of Natural Resources). 1985. State of Alaska instream flow handbook. Alaska Department of Natural Resources, Anchorage, Alaska.

Bovee, K. D. 1982. A guide to stream habitat analysis using the Instream Flow Incremental Flow methodology. Instream Flow Information Paper No. 122. FWS/OBS/82/26. U.S. Fish and Wildlife Service. Ft. Collins, Colorado.

Estes, C. C. 1984. Evaluation of methods for recommending instream flows to support spawning by salmon. Master's thesis, Washington State University, Pullman, Washington. Estes, C. C. and M. L. Harle. 1987. Alaska's instream flow program. Instream Flow Chronicle. Colorado State University. Ft. Collins, Colorado. IV(1):1-2.

Estes, C. C. and J. F. Orsborn. 1986. Review and analysis of methods for quantifying instream flow requirements. Water Resources Bulletin. 22(3):389-398.

Orsborn, J. F. and F. J. Watts. 1980. Hydraulics and hydrology for fisheries biologists. U.S. Fish and Wildlife Service, Fisheries Academy, Kearneysville, Virginia.

Reiser, D. W., M. P. Ramey, and T. R. Lambert. 1985. Review of flushing flow requirements in regulated streams. Pacific Gas and Electric Company, San Ramon, Company.

Shaw, E. M., editor. 1988. Hydrology in practice. Van Nostrand Reinhold Co. Ltd., London, England.

Tennant, D. L. 1972. A method for determining instream flow requirements for fish, wildlife and aquatic environment. Pages 3-11 *in* Pacific Northwest River Basin Commission Transcript of Proceedings of Instream Flow Requirements Workshop, March 15-16, 1972. Pacific Northwest River Basin Commission, Portland, Oregon.

_____. 1976. Instream flow regimes for fish, wildlife, recreation, and related environmental resources. Pages 359-373 *in* J. F. Orsborn and C. H. Allman, editors. Instream Flow Needs, Volume II, American Fisheries Society, Bethesda, Maryland.