## APPENDIX I

A Model of the Effect of Incremental Increases in Sport Fishing on Population Structure of Arctic Grayling above Devil Canyon
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The opening of access roads into the proposed impoundment area can be expected to create a substantial Arctic grayling sport fishery in this previously seldom fished drainage. This study was initiated to examine the effects of increased mortality rates (due to fishing pressure) on the age structure and abundance of the Arctic grayling populations in the clear water tributaries studied to date. The resuits of the analysis can suggest management strategies and should be useful in the impact analysis. The predicted increased access and corresponding fishing pressure can be used with this data set to predict the cnanges that may be expected in these unexploited populations of grayling.

## METHODS

Hook and line sampling methods were used to collect grayling for mark and recapture and age/length data over two open water seasons at eight major clear water tributaries to the Susitna River in the proposed impoundment. Field collection methods and data summaries are presented in ADF\&G (1981) and ADF\&G (1983) and are not reported here. Because hook and line methods were used to collect the data, the effects of fishing pressure can be projected from these catch records and population estimates.

The theoretical analysis of the data was developed using equations described by Ricker (1975). The equations used show the relationships between mortality, population size and age structure. The Arctic
grayling population structure in the proposed impoundment is presently assumed to be unexploited and to have natural mortality rates in a state of equilibrium.

The following equations were used to project population changes:
(1) $N_{t+1}=N_{t} \times S_{t n}$
where:
$N_{t+1}=\begin{aligned} & \text { Population number of age } \\ & \text { class } t \text { plus one year. }\end{aligned}$
$N_{t}=\begin{aligned} & \text { Population number of age } \\ & \text { class } t \text { fish }\end{aligned}$
$\mathrm{N}_{\mathrm{t}}$ and $\mathrm{N}_{\mathrm{t}+1}$ are known $S_{t n}=\underset{\text { age } t \text { fish }}{\text { Natural survival rate of }}$ for each age class and give estimates for $S_{t n}$
for each age class.

In an exploited fishery then,
(2) $N_{t+1}=N_{t} \times S_{t n+F}$

The anrual total mortality rate, $A$, is related to $S$, as:
(3) $A_{t n+F}=1-S_{t n+F}$ and,
(4) $S_{t n+F}=e^{-Z_{t}}$ and, where: $\quad Z_{t}=\begin{aligned} & \text { Instantaneous rate of total } \\ & \text { mortalities of age } t \text { fish. }\end{aligned}$
(5) $Z_{t}=F_{t}+M_{t}$ and, where: $\quad F_{t}=$ Instantaneous rate of fishing mortality of age class $t$ fish.
(6) $M_{t}=-\ln S_{t n}$
where: $\quad M_{t}=$ Instantaneous rate of natural mortalities of age class t fish.

Since $M_{t}$ is available from $N_{t}$ and $N_{t+1}$ data, it is possible to substitute (model) values of $F_{t}$ for a hypothetical fishery and predict the resulting age structure of the population with time. To do this, the following assumptions are made. (1) The rate of catch for each age class of fish per unit of fishing effort experienced by ADF\&G will hold true for the general public. (2) Only grayling of age III and older are subject to increased mortality by (hook and line) fishing. (3) Recruitment of age II class fish is constant.

In an exploited system then, $\mathrm{F}_{\mathrm{t}}$ is viewed as:
(7) $F_{t}=q_{t} \times f$ where: $\quad \begin{aligned} q_{t}= & \begin{array}{l}\text { catchability of age } \\ \\ \text { class } t ; \text { proportioned } \\ \\ \\ \text { fish per unit time fished. }\end{array} \\ f= & \begin{array}{l}\text { fishing effort, }(98.25 \\ \\ \text { hrs or } 6.05 \mathrm{hrs} / \mathrm{mile} \\ \text { stream }) .\end{array}\end{aligned}$
and $q_{t}$ is estimated from:
(8) $q_{t}=-\ln \left(1-u_{t}\right)$ using,
(9) $u_{t}=\frac{R_{t}}{M_{t}^{\prime}}$
where: $\quad R_{t}=\begin{aligned} & \text { number of grayling marked in } \\ & \text { July } 1982 \text { that were recaptured }\end{aligned}$ in August 1982 by age class $t$.
$M_{t}=\begin{aligned} & \text { number of grayling marked in } \\ & \text { July } 1982 \text {, by age class } t .\end{aligned}$

The term $u_{t}$ is called the rate of exploitation and was calculated from the mark-recapture fishing data found in ADF\&G (1983).

Calculation of the annual total mortality rate ( $A_{t n+F}$ ) $n$ equation (3) thus allows calculation of predicted catch at different levels of exploitation.
(10) $A_{t F}=A_{t_{1}+F}-\left(1-S_{t n}\right)$
where: $A_{t F}=$ annual fishing mortality

$$
A_{t n}=1-S_{t n}=\underset{\text { mortality }}{\text { annual natural }}
$$

(11) $c_{t}=\sum_{t=\text { III }}^{t=\text { VIII }} A_{t F} \times N_{t}$ $C_{t}=$ total catch

A model of the maximum sustained yield of Arctic grayling at various levels of fishing effort was constructed. The analytical formula and data were manipulated using a microcomputer and a commercial spreadsheet software entitled SuperCalc ${ }^{R}$.

Fishing pressure, $f$, and the exploitation coefficient, $u_{(t)}$, were taken from R/M' values limited to the July and August 1982 samplings. This restriction most closely fulfills the "ciosed system assumption" (no inor outmigration) because there is little migration occurring in July and August, thus improving the level of certainty in the model.

Appendix Table I-1 summarizes the July catch and effort. The fishing pressure ( $f$ ) value, which was varied to calculate $C_{t}$ in the model, was taken as multiples of the mean effort (mean hours fished per mile $=$ 6.05) reported during this period. An $f$ value of 1.0 was set equal to an effort of 6.05 hours/mile per year.

The effects of exploitation on recruitment was also examined briefly in a separate analysis. This analysis assumed no effect of spawner reduction on recruitment of Age II grayling until the population of spawners is reduced to 10 percent of the unexploited population in year 1982. Two generations after the population of spawners is reduced to this level, the decrease in the Age II population is reduced linearly as a function of the remaining proportion of spawners.

RESULTS

Appendix Table I-2 presents the calculated maximum sustained catches resulting from differing levels of fishing pressure (f). Appendix Figure I-1 graphically illustrates these calculations. The calculated rate of fishing pressure for maximum sustained catch (of all age classes greater than II) is less than 1,000 fish/year.

Appendix Table I-1. Summary of catch and effort made during the July 1982 proposed impoundment grayling taj and recapture sampling program.

| Impoundment River Fished | Miles of River Fished | Hours <br> Fished | Catch | CPUE | Hours <br> Fished <br> Pier Mile | Fish Per Mile |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Oshetna | 2.2 | 21.25 | 288 | 13.6 | 9.66 | 1103 |
| Goose | 1.2 | 6.75 | 91 | 13.5 | 5.63 | 791 |
| Jay | 3.5 | 12.00 | 130 | $1 C 3$ | 3.43 | 455 |
| Kosina | 4.5 | 31.50 | 491 | 15.6 | 7.00 | 1232 |
| Watana | 4.0 | 18.00 | 175 | 9.7 | 4.50 | 324 |
| Deadman | 0.3 | 4.50 | 51 | 11.3 | 15.0 | 1835 |
| Tsusena | 0.4 | 3.00 | 29 | 9.7 | 7.5 |  |
| Fog | 0.2 | 1.25 | 5 | 4.0 | 6.25 | 440 |
| Total | 16.3 | 98.25 | 1260 | -- | -- | -- |
| Mean | -- | -- | -- | 12.8 | 6.05 | 665 |

Appendix Table 1-2. Results of age class and total population calculations at variable levels of fishing pressure.

|  | Relative fishing pressure (f) $=.00$ |  |  |  |  |  |  | Total Population Age III and 01 der Fish | Population of Spawners (Age V \& Older) |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Age Class |  |  |  |  |  |  |  |  | as a <br> Percent |
|  | 11 | 111 | IV | V | VI | VII | VIII |  |  | Population |
| Natural Instantaneous Mortality (M) |  | . 90 | . 46 | . 27 | . 77 | . 78 | 1.06 |  |  |  |
| Natural Survival (S) |  | . 41 | . 63 | . 85 | . 46 | . 46 | . 35 |  |  |  |
| Fishing Mortality (F) |  | . 00 | . 00 | . 00 | . 00 | . 00 | . 00 |  |  |  |
| Mark/Recapture (R/M') Ratio |  | . 04 | . 09 | . 14 | . 24 | . 20 | . 26 |  |  |  |
| ```Total Instantaneous Mortality (Z)``` |  | . 90 | . 46 | . 17 | . 77 | . 78 | 1.06 |  |  |  |
| Total Mortality ( $A_{11+F}$ ) |  | . 59 | . 37 | . 15 | . 54 | . 54 | . 65 |  |  |  |
| Total Survival ( $\mathrm{S}_{\mathrm{n}+\mathrm{F}}$ ) |  | . 41 | . 63 | . 85 | . 46 | . 46 | . 35 |  |  |  |
| Numbers of Fish Year |  |  |  |  |  |  |  |  |  |  |
| $\begin{aligned} & 1982 \\ & 1983 \\ & 1984 \\ & 1985 \\ & 1986 \\ & 1987 \\ & 1988 \\ & 1989 \\ & 1990 \\ & 1991 \end{aligned}$ | $\begin{aligned} & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \\ & 11363 \end{aligned}$ | 4602 4602 4602 4602 4602 4602 4602 4602 4602 4602 | $\begin{aligned} & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \\ & 2904 \end{aligned}$ | $\begin{aligned} & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \\ & 2454 \end{aligned}$ | $\begin{aligned} & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \\ & 1134 \end{aligned}$ | $\begin{aligned} & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \\ & 521 \end{aligned}$ | $\begin{aligned} & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \\ & 180 \end{aligned}$ | $\begin{aligned} & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \\ & 11795 \end{aligned}$ | $\begin{aligned} & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \\ & 4289 \end{aligned}$ | $\begin{aligned} & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \\ & 36 \end{aligned}$ |

Appendix Table 1-2 (Continued).


Appendix Table 1-2 (Continued).

|  |  | Relative fishing pressure (f) $=1.0$ |  |  |  |  |  |  | $\qquad$ | $\begin{aligned} & \text { Population } \\ & \text { of } \\ & \text { Spawners } \\ & \text { (Age V } \\ & \text { S Oider) } \\ & \hline \end{aligned}$ | Spawners <br> as a <br> Percent <br> of Total <br> Population |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Age Class |  |  |  |  |  |  |  |  |  |
|  |  | 11 | 111 | IV | V | VI | VII | V1II |  |  |  |
|  | Natural Instantaneous Mortality (M) |  | . 90 | . 46 | . 17 | . 77 | . 78 | 1.06 |  |  |  |
|  | Natural Survival (S) |  | . 41 | . 63 | . 85 | . 46 | . 46 | . 35 |  |  |  |
|  | Fishing Mortality (F) |  | . 04 | . 09 | . 15 | . 27 | . 22 | . 30 |  |  |  |
|  | Mark/Recapture (R/M') katio |  | . 04 | . 09 | . 14 | . 24 | . 20 | . 26 |  |  |  |
| $\square$ | Total Instantaneous Mortality (Z) |  | . 95 | . 55 | . 32 | 1.04 | 1.00 | 1.36 |  |  |  |
| 1 | Total Mortality ( $A_{n+F}$ ) |  | . 61 | . 42 | . 27 | . 65 | . 63 | . 74 |  |  |  |
|  | Total Survival ( $\mathrm{S}_{\mathrm{n}+\mathrm{F}}$ ) |  | . 39 | . 58 | . 73 | . 35 | . 37 | . 26 |  |  |  |
|  | Numbers of Fish Year |  |  |  |  |  |  |  |  |  |  |
|  | 1982 | 11363 | 4602 | 2904 | 2454 | 1134 | 521 | 180 | 11795 | 4289 | 36 |
|  | 1983 | 11363 | 4400 | 2648 | 2118 | 868 | 418 | 134 | 10585 | 3537 | 33 |
|  | 1984 | 11363 | 4400 | 2532 | 1931 | 749 | 320 | 107 | 10038 | 3107 | 31 |
|  | 1985 | 11363 | 4400 | 2532 | 1846 | 683 | 276 | 82 | 9819 | 2887 | 29 |
|  | 1986 | 11363 | 4400 | 2532 | 1846 | 653 | 252 | 71 | 9753 | 2822 | 29 |
|  | 1987 | 11363 | 4400 | 2532 | 1846 | 653 | 241 | 65 | 9736 | 2804 | 29 |
|  | 1988 | 11363 | 4400 | 2532 | 1846 | 653 | 241 | 62 | 9733 | 2801 | 29 |
|  | 1989 | 11363 | 4400 | 2532 | 1846 | 653 | 241 | 62 | 9733 | 2801 | 29 |
|  | 1990 | 11363 | 4400 | 2532 | 1846 | 653 | 241 | 62 | 9733 | 2801 | 29 |
|  | 1991 | 11363 | 4400 | 2532 | 1846 | 653 | 241 | 62 | 9733 | 2801 | 29 |

Appendix Table 1-2 (Continued).


Appendix Table 1-2 (Continued).


Appendix Table 1-2 (Continued).


## Appendix Table 1-2 (Cont;nued).



Appendix Table 1-2 (Continued).

|  |  |  | Relative fishing pressure (f) $\mathbf{= 1 0}$. |  |  |  |  |  |  | Total Population Age III and 01 der Fish | ```Population of Spawners (Age V & Older)``` | Spawners <br> as a <br> Percent <br> of Total <br> Population |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Age Class |  |  |  |  |  |  |  |  |
|  |  |  | 11 | 111 | IV | V | VI | VII | VIII |  |  |  |
|  | Natural Instanta Mortality (M) | eous |  | . 90 | . 46 | . 17 | . 77 | . 78 | 1.06 |  |  |  |
|  | Natural Survival | (S) |  | . 41 | . 63 | . 85 | . 46 | . 46 | . 35 |  |  |  |
|  | Fishing Mortality | (F) |  | . 45 | . 92 | 1.47 | 2.68 | 2.21 | 2.97 |  |  |  |
|  | Mark/Recapture Ratio | R/M' ) |  | . 04 | . 09 | . 14 | . 24 | . 20 | . 26 |  |  |  |
| $\stackrel{\square}{1}$ | Total Instantane Mortality (Z) |  |  | 1.35 | 1.38 | 1.64 | 3.45 | 2.98 | 4.03 |  |  |  |
| + | Total Mortality | $\left(A_{n+F}\right)$ |  | . 74 | . 75 | . 81 | . 97 | . 95 | . 98 |  |  |  |
|  | Total Survival ( | ${ }_{n+F}$ ) |  | . 26 | . 25 | . 19 | . 03 | . 05 | . 02 |  |  |  |
|  | Numbers of Fish | Year |  |  |  |  |  |  |  |  |  |  |
|  |  | 1982 | 11363 | 4602 | 2904 | 2454 | 1134 | 521 | 180 | 11795 | 4289 | 36 |
|  |  | 1983 | 11363 | 2934 | 1156 | 562 | 78 | 57 | 9 | 4797 | 707 | 15 |
|  |  | 1984 | 11363 | 2934 | 737 | 224 | 18 | 4 | 1 | 3918 | 247 | 6 |
|  |  | 1985 | 11363 | 2934 | 737 | 143 | 7 | 1 | 0 | 3822 | 151 | 4 |
|  |  | 1986 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 148 | 4 |
|  |  | 1987 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 147 | 4 |
|  |  | 1988 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 147 | 4 |
|  |  | 1989 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 147 | 4 |
|  |  | 1990 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 147 | 4 |
|  |  | 1991 | 11363 | 2934 | 737 | 143 | 5 | 0 | 0 | 3819 | 147 | 4 |



Appendix Figure I-1. Sustained yield of Arctic grayling for different levels of fishing pressure. The f value represents multiples of 6.05 hrs per mile of hook and line sport fishing per year.

An additional calculation was made at this point to estimate the maximum sustained yield if catch (mortalities) are limited to individuals VI and older (approximately 350 mm and greater in length). The maximum sustained yield under these conditions occurs at $f=1.5$ and is estimated to be less than 100 fish per year. The total harvest of all size classes of fish older than age II is about 650 fish per year at the same level of f . By comparison, the maximum sustained yield is 950 fish per year (which occurs at $f=4.5$ ) when all age classes are harvested.

These values assume equal distribution of effort and success levels similar to those experienced in the field by the ADF\&G crews while collecting this data. If access is not limiting, the distribution of fishermen will probably parallel the relative densities of fish.

Possible effects of higher levels of exploitation on recruitment are presented in Appendix Table I-3 and illustrated in Appendix Figure I-2. Under baseline conditions, $36 \%$ of the age III and older fish are spawners. At the higher rates of exploitation, this number drops off rather rapidly. Although recruitment is probably in excess of what is required under the current conditions, the projected decrease in the number of the spawners at the high rates of exploitation is probably sufficient to affect recruitment. Using the assumptions of the model and assuming a linear decrease in recruitment following a decrease of spawning aged fish to $10 \%$ of the non-exploited population, the number of fish caught annually rapidly decreases when $f=8$ ( $48.8 \mathrm{hrs} / \mathrm{mile}$ of river).

Appendix Table 1-3. Results of analysis of effects of decreasing spawner populations caused by fishing pressure on twenty year catch rates.

|  | Numbers of Fish at Relative Fishing Pressure (f) $=\mathbf{6 . 0 0}$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Year | Totel Number of <br> Spawners (Age V \& Older) | Total Number of Age VI and Older Fish Caught | Total Catch All Age Classes (Age \||l \& Older) | Spawner s as a Percent of Total Population |
|  |  |  |  |  |  |
|  | $1983$ | 1410 | 139 | 1427 | $31$ |
|  | 1984 | 713 | 46 |  | $13$ |
|  | 1985 | 512 | 24 | 924 | 10 |
|  | 1986 | 494 | 18 | 917 | 9 |
|  | 1987 | 492 | 17 | 916 | 9 |
|  | 1988 | 492 | 17 | 916 | 9 |
|  | 1989 | 492 | 17 | 916 | 9 |
|  | 1990 | 492 | 17 | 916 | 9 |
|  | 1991 | 492 | 17 | 916 | 9 |
|  | 1992 | 492 | 17 | 916 | 9 |
|  | 1993 | 492 | 17 | 916 | 9 |
| $\stackrel{\rightharpoonup}{\nu}$ | 1994 | 492 | 17 | 916 | 9 |
|  | 1995 1996 | 492 | 17 | 916 916 | $9$ |
|  | 1996 | 492 | 17 | 916 | 9 |
|  | 1997 | 492 | 17 | 916 | 9 |
|  | 1998 | 492 | 17 | 916 | 9 |
|  | 1999 | 492 | 17 | 916 | 9 |
|  | 2000 | 492 | 17 | 916 | 9 |
|  | 2001 | 492 | 17 | 916 | 9 |
|  | 2002 | 492 | 17 | 916 | 9 |

Appendix Table 1-3 (Continued).

|  | Numbers of Fish at Relative Fishing Pressure (f) $=6.50$ |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Year | $\begin{aligned} & \text { Total Number of } \\ & \text { Spawners (Age V \& Older) } \end{aligned}$ | Total Number of Age VI and Older Fish Caught | Total Catch All Age <br> Classes (Age $111 \& 01$ der) | Spawners as a Percent of Total Population |
|  | 1982 | 4289 | 668 | 3244 | 36 |
|  | 1983 | 1291 | 127 | 1424 | 20 |
|  | 1984 | 622 | 39 | 999 | 12 |
|  | 1985 | 438 | 19 | 912 | 9 |
|  | 1986 | 423 | 14 | 906 | 8 |
|  | 1987 | 421 | 13 | 906 | 8 |
|  | 1988 | 421 | 13 | 906 | 8 |
|  | 1989 | 421 | 13 | 901 | 8 |
|  | 1990 | 421 | 13 | 894 | 8 |
|  | 1991 | 415 | 13 | 890 | 8 |
|  | 1992 | 414 | 13 | 885 | 8 |
|  | 1993 | 414 | 13 | 889 | 8 |
| $\mapsto$ | 1994 | 414 | 13 | 885 | 8 |
| $\stackrel{1}{\square}$ | 1995 | 414 | 13 | 879 | 8 |
| $\infty$ | 1996 | 408 | 13 | 875 | 8 |
|  | 1997 | 406 | 13 | 874 | 8 |
|  | 1998 | 406 | 13 | 873 | 8 |
|  | 1999 | 406 | 13 | 869 | 8 |
|  | 2000 | 406 | 13 | 863 | 8 |
|  | 2001 | 401 | 13 | 859 858 | 8 |
|  | 2002 | 399 | 13 | 858 | 8 |



Appendix Table 1-3 (Continued).


Appendix Table 1-3 (Continued).

|  |  | Numbers of Fish at Relative Fishing Pressure (f) $=8.00$ |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | Year | Total Number of <br> Spawners (Age V \& Oider) | Total Number of Age VI and Older Fish Caught | Total Catch All Age Classes (Age III \& Older) | Spawners as a Percent of Total Population |
|  | 1982 | 4299 | 717 | 3672 | 36 |
|  | 1983 | 994 | 93 | 1386 | 18 |
|  | 1984 | 416 | 22 | 945 | 9 |
|  | 1985 | 275 | 9 | 869 | 6 |
|  | 1986 | 267 | 6 | 866 | 6 |
|  | 1987 | 267 | 6 | 853 | 6 |
|  | 1988 | 267 | 6 | 715 | 8 |
|  | 1989 | 259 | 6 | 599 | 9 |
|  | 1990 | 176 | 6 | 544 | 6 |
|  | 1991 | 167 | 4 | 539 | 6 |
|  | 1992 | 166 | 4 | 531 | 6 |
|  | 1993 | 166 | 4 | 450 | 8 |
| $\mapsto$ | 1994 | 161 | 4 | 377 | 9 |
| ~ | 1995 | 112 | 4 | 341 | 6 |
| 0 | 1996 | 104 | 3 | 336 | 6 |
|  | 1997 | 103 | 2 | 331 | 6 |
|  | 1998 | 103 | 2 | 283 | 8 |
|  | 1999 | 101 | 2 | 237 | 9 |
|  | 2000 | 72 | 2 | 213 | 7 |
|  | 2001 | 65 64 | 2 | 209 | 6 |
|  | 2002 | 64 | 1 | 206 | 6 |

## Appendix Table 1-3 (Continued).




Appendix Figure I-2. Effort of heavy fishing pressure on Arctic grayling catch rates assuming effort of harvest on recruitment. The f value represents multiples of 6.05 hrs per mile of hook and line sport fishing per year.

The model demonstrates that in a closed system fishery, where fisherman access is not limiting, modest levels of fishing pressure can drastically reduce grayling population. In reality, a reduction in the numbers of large fish would probably result in a decrease in fishing pressure before the population would be elininated. The residual fishery, after such an event, would probably reflect recruitment by immigration of stock from other areas.

Although the data collected pertains to the streams that will be inundated by the impoundment, the similarity in age structure among the streams (ADF\&G 1983, Table 5-3-8) suggests that this data base may be applicable to grayling fisheries in other tributaries of the upper Susitna basin. The modeling of the available data results in age/class population structures presently found in exploited grayling systems in other parts of interior Alaska (Armstrong 1982; Grabacki 1981).

The spreadsheet program used in the analysis allows very rapid changes in assumptions and output of usable information with relatively little programming effort. Projections can be made given any reasonable set of assumptions concerning harvest, recruitment, management strategies, and other aspects of the population dynamics of grayling, with minor adjustments to the model presented.

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Appendix I: A model of the Effect of Incremental Increases in Sport Fishing on Population Structure of Arctic Grayling above SuS Devil Canyon \# 185


## SUSITNA HYDRO AQUATIC STUDIES PHASE II REPORT

Synopsis of the 1982
Aquatic Studies and Analysis of Fish and Habitat Relationships


- APPENDICES -


## by

ALASKA DEPARTMENT OF FISH AND GAME Susitna Hydro Aquatic Studies 2207 Spenard Road
Anchorage, Alaska 99503

