VALUE OF THE FISHERIES RESOURCES IN THE BULKLEY RIVER SYSTEM

DENISE MULLEN
PLANNING AND ASSESSMENT BRANCH
MINISTRY OF ENVIRONMENT AND PARKS

JULY 1987

ACKNOWLEDGEMENTS

A number of individuals have been involved in this study. Special thanks go to Cindy Brown of the Planning and Assessment Branch, Ministry of Environment and Parks, for her undaunting help and guidance in writing this report. Regional Fisheries Biologists, Bob Hooton, Bill Chudyk and Mike Lough of the Ministry of Environment and Parks, Smithers, for their technical support. Paul Kopas of the Department of Fisheries and Oceans, Vancouver, for his contribution to the salmon evaluation. Finally, all those individuals who reviewed the report at various stages of its development and the comments provided.

EXECUTIVE SUMMARY

The various fisheries in the Bulkley River System contribute considerable benefit and tourist dollars to the residents of the Bulkley Valley. Steelhead and salmon are of major economic importance, with resident species catering primarily to area residents' recreational activity. There is also an extensive native fishery for both sport and subsistence.

The 1986 net economic value of all the fisheries in the Bulkley system is estimated at $1.6 million. This includes $950K for all recreational and resident species angling activity; $574K for all salmon fisheries; and $88K for "commercial" and native steelhead. The present value for all fisheries over a 60 year time span, calculated at 6, 8 and 10% is $38M, $29M and $23M respectively (1986 dollars).

These values give only a partial picture of the resources at risk in the event of unregulated acid mine drainage from the Equity Silver Mine. Other uses of the river system include a broad range of water based recreational activities, domestic water supplies, irrigation and wildlife support. In order to get a full idea of the magnitude of the potential losses these other uses of the Bulkley River must be considered in addition to the fisheries resource.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

A. INTRODUCTION

The Bulkley river system in the Skeena region supports one of the most intense steelhead trout fisheries in B.C. The Bulkley River, the major component of the study area, flows in a northwesterly direction for 110 miles from its source at Bulkley Lake until its confluence with the Skeena River at Hazelton (see Figure 1). Included in the Bulkley system is its major tributary, the Morice River, which joins the Bulkley 6 km northwest of Houston. The river system is used as a migration route by all salmon types except chum.

Equity Silver Mine is located 32 kilometers southeast of Houston at the headwaters of the Buck and Foxy creeks, tributaries of the Upper Bulkley River (see Figure 2). Through its production process, Equity Silver generates acid mine drainage. The contaminated water is treated and released into the surrounding freshwater system. If untreated, acid mine drainage and other by-products (i.e. heavy metals) will detrimentally affect water quality and thus aquatic life in the Bulkley system. This could have major impacts on recreational and commercial fisheries in the area.

The purpose of this report is to provide an indication of the net economic value of the fisheries stocks in the Bulkley river system. This is done by assessing current and future values of recreational, commercial and, to some degree, native fishing activities assuming preservation of the present levels of water quality in the system. It provides a general indication of the net economic value of the fisheries resources at risk in the face of potential acid mine drainage problems. The actual losses associated with acid mine drainage will depend on the water quality impacts and the resultant effects on fish production.

The fisheries-related activities analysed in this report represent only a portion of the uses, and therefore the value of the Bulkley river system. In addition to a healthy fishing sector, the river's floodplain has the highest agricultural capability in the Skeena-Nass planning unit. The Bulkley Valley supports a variety of wildlife species and a broad range of water-based recreational activities other than fishing. The Bulkley River

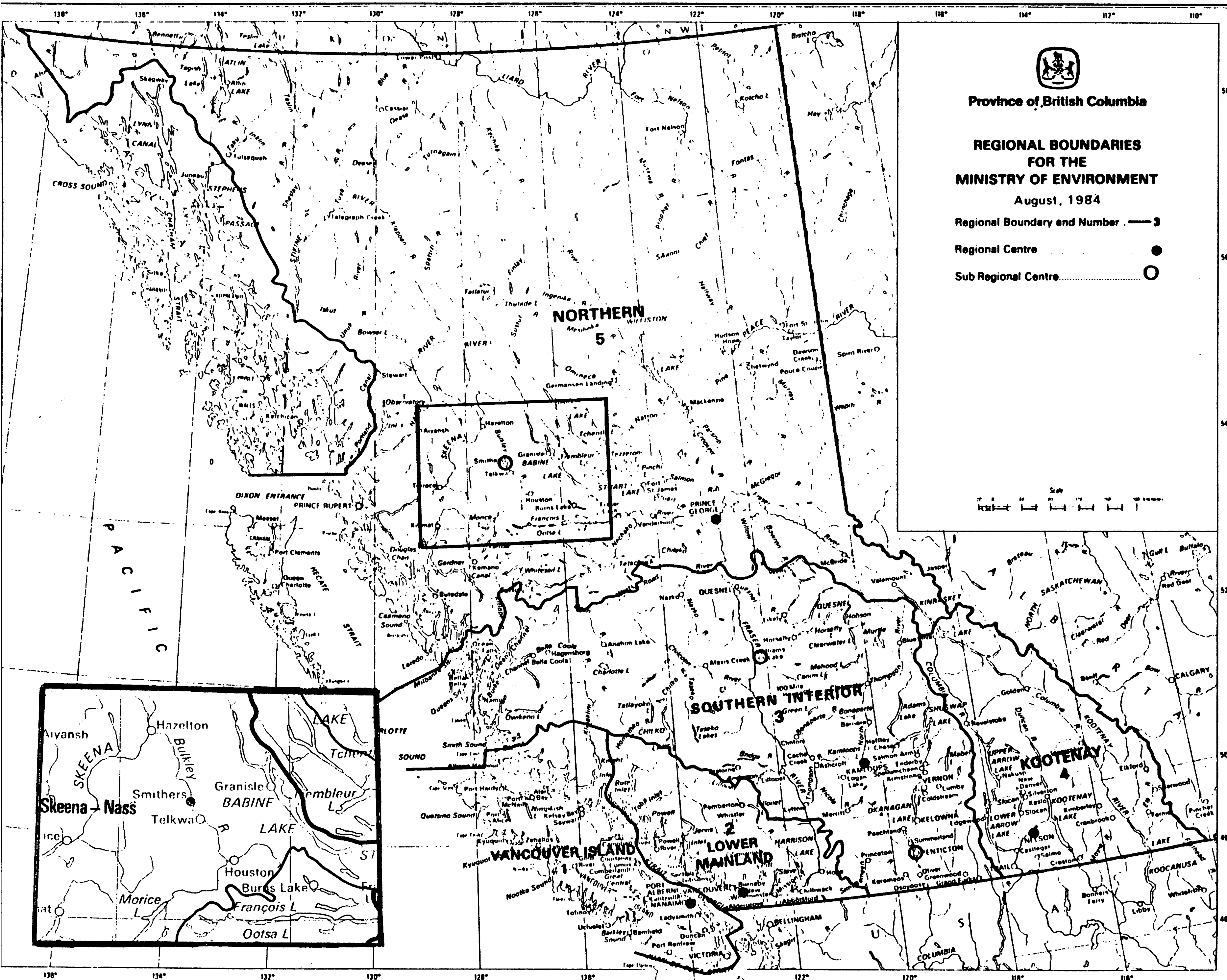
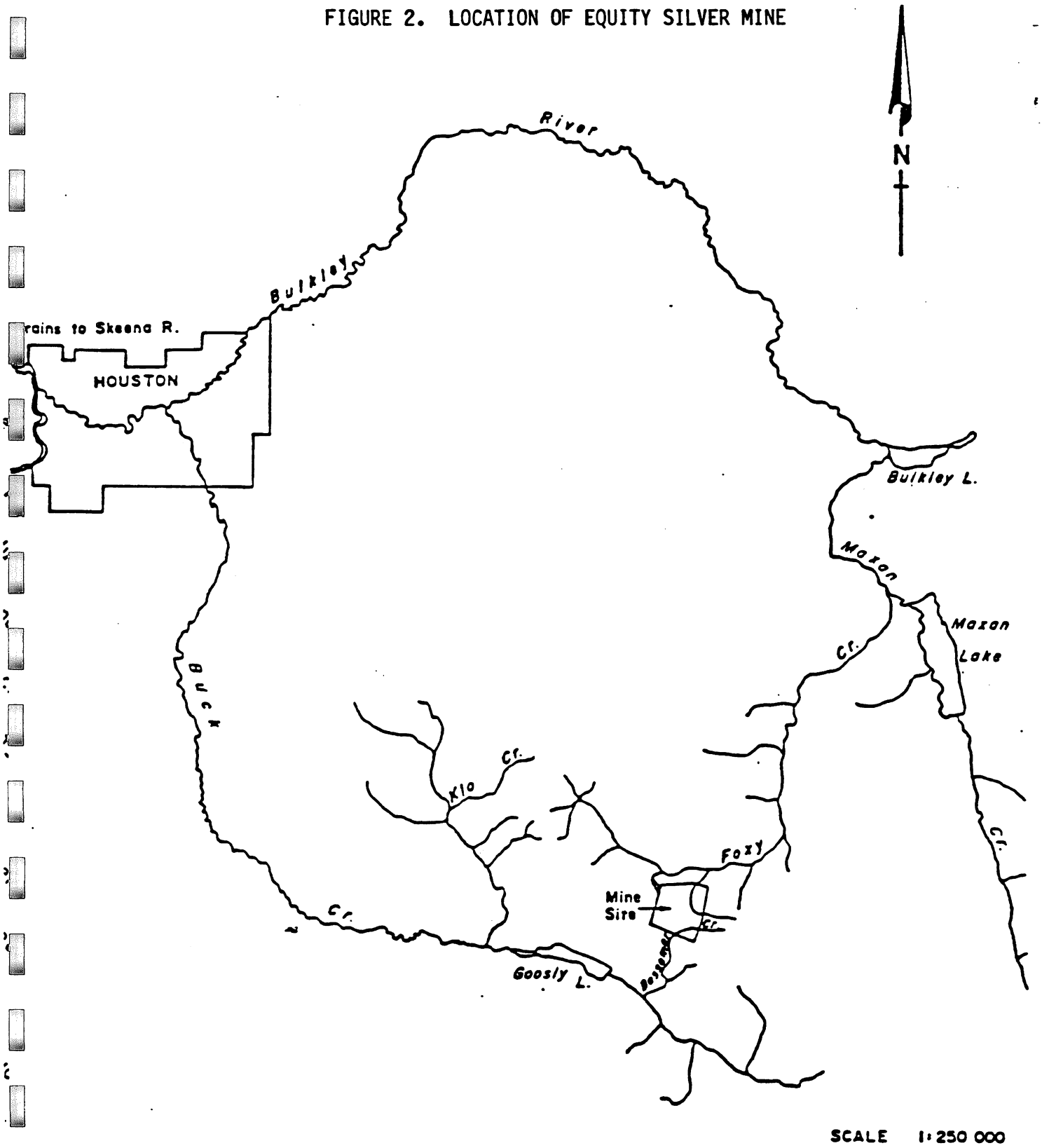

Province of British Columbia
REGIONAL BOUNDARIES
FOR THE
MINISTRY OF ENVIRONMENT
August, 1984
Regional Boundary and Number
Regional Centre
Sub Regional Centre
NORTHERN
5
SOUTHERN INTERIOR
3
KOOTENAY
4
LOWER MAINLAND
2
VANCOUVER ISLAND
1
Skeena - Nass
Hazelton
Smithers
Granisle
BABINE
LAKE
Telkwa
Houston
Burns Lake
Morice
François L
Ootsa L
PACIFIC

FIGURE 1

FIGURE 2. LOCATION OF EQUITY SILVER MINE



and its tributaries support domestic water supplies for the community of Telkwa and 17 individual licenses. Release of acid mine drainage into the Bulkley system would affect all these uses as well as aesthetics of the area for general tourist activity. These values would need to be added to the fisheries values presented below to get a total picture of what is at risk in face of potential acid mine drainage problems in the Bulkley system.

B. DESCRIPTION OF FISHERIES RESOURCES

B.1 GENERAL

The salmon and steelhead fisheries are of major economic importance to the Bulkley Valley. The sports fishing industry contributes considerable benefit and tourist dollars to the communities located along the Bulkley and Morice rivers. Commercial salmon fishing at the mouth of the Skeena River is also important in contributing to a major north coast industry. Guided sportfishing on the Bulkley system is becoming increasingly popular, catering primarily to non-Canadians. There also exists extensive native food fishing activity all along the Bulkley system. Of this activity the fisheries at Hazelton and at Moricetown Falls on the Bulkley River rely heavily on Bulkley system fish.

The most important tributaries of the Bulkley River are the Morice, Suskwa and Telkwa rivers. Treated acid mine drainage flows directly into Buck and Foxy creeks which are also used as spawning grounds by salmon and steelhead and contribute significant water flows into the upper Bulkley River. Goosly and Bulkley lakes, as the headwaters of Buck and Foxy creeks respectively, provide the stable flows and moderate temperatures both of which are prerequisites to viable salmon and steelhead stocks in the Bulkley.

Along with salmon and steelhead, the Bulkley River system also contains a variety of freshwater resident sportfish species. These include rainbow trout, cutthroat trout, Dolly Varden char and whitefish. Although less significant than steelhead and salmon, these species provide sportfishing opportunities mainly for local residents.

B.2 STEELHEAD

B.2.1 Production

Steelhead are produced in all major tributaries of the Bulkley River. Ranked in order of importance are the mainstem Bulkley and Morice rivers accounting for an average of 90 percent of production; the Suskwa 4 percent; and the Telkwa an additional 3 percent.[1]

Estimated total run sizes of the recent past have been the largest ever recorded. In 1984, the estimated run size was 27,500. Since then, the run sizes have declined slightly but have remained well above the long-term average (Table 1, Figure 3). Regional Fisheries personnel believe that the system is quite capable of sustaining at least the 1984 recorded high, if not more, annually.

Bulkley-Morice fish must pass through a number of fisheries on their way to the spawning grounds. The first major fishery they encounter is the commercial net fishery for salmon at the mouth of the Skeena. Here 48% of the total number of Bulkley system steelhead are caught incidentally to salmon. After that, there are a variety of sport and native fisheries which take 9%[2] and 6% respectively, leaving 37% to spawn (Table 2).[2]

At present, 370,000 steelhead fry are stocked into the Morice, Suskwa and Bulkley rivers. Monitoring programs are currently underway to assess the results of this stocking. Taking into consideration mortality rates and commercial fishing activity, the contribution to the sport fishery from fry stocking is thought to be marginal. Future plans will concentrate more on intensive management of the commercial fishery in order to minimize steelhead interceptions than on stocking programs.

---

[1] Skeena Steelhead Run Reconstruction, B.C.-Skeena Sub-region Fisheries Model.

[2] ibid.

TABLE 1

TOTAL ESTIMATED STEELHEAD RUN SIZES ON THE BULKLEY SYSTEM, 1975-1986

YEAR	NUMBER OF FISH	5 YEAR MOVING AVERAGE
1975	5202	
1976	7301	
1977	7664	
1978	8639	
1979	6697	7101
1980	9821	8024
1981	12827	9130
1982	15103	10617
1983	5800	10050
1984	27642	14239
1985	20993	16473
1986	18538	17615

Source: Skeena Steelhead Run Reconstruction, B.C.-Skeena Sub-region Fisheries Model.

FIGURE 3. BULKLEY SYSTEM STEELHEAD RUN SIZES

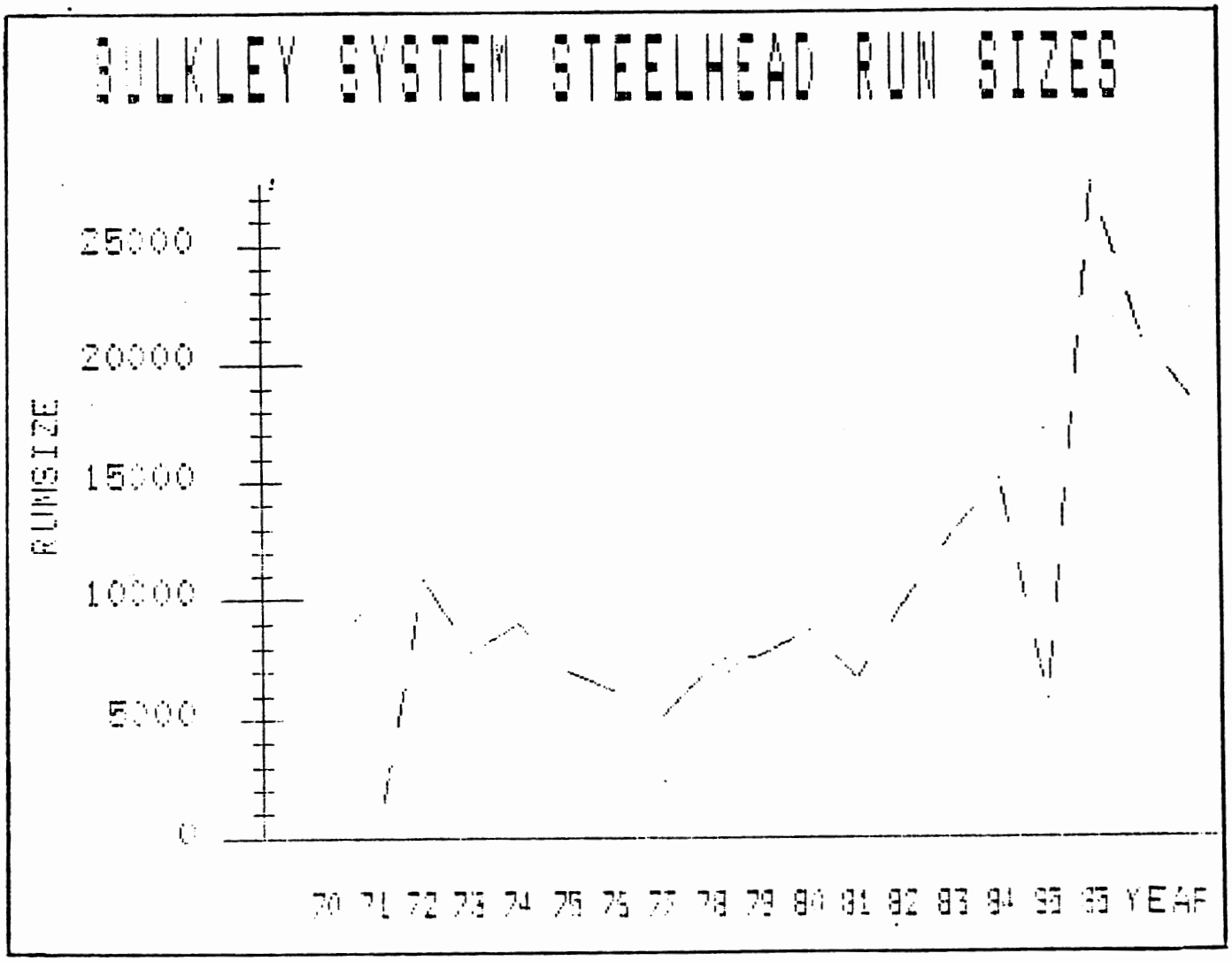


TABLE 2

FIVE YEAR AVERAGE ESTIMATES OF THE NUMBER AND PERCENT OF BULKLEY ORIGIN STEELHEAD ALLOCATED TO VARIOUS USES

FISHERY	% OF FISH AVAILABLE	# OF FISH (5 YEAR AVG.) 1982 - 1986
Commercial	48	8569
Native	6	1071
Sport	9	1607
Escapement	37	6605
Total	100%	17852

Source: Skeena Steelhead Run Reconstruction, B.C.-Skeena Sub-region Fisheries Model.

B.2.2 Recreational Activity

There are a number of steelhead sport fisheries all along the Bulkley system. In the past, the majority of fishing activity has concentrated at Hazelton and Smithers. However, increased competition has forced anglers into all areas of the system. Bulkley origin steelhead are also an important contributor to the burgeoning Skeena River bar fishery in the Terrace vicinity.

It is estimated that approximately 19400 angling days are currently supported by steelhead from the Bulkley-Morice system (Table 3). This accounts for 34% of the total effort expended in the Skeena region for steelhead and 9% of the total provincial effort. The distribution of angling activity among the various fisheries is shown in Tables 2 and 3.

A simple linear regression was performed on data from 1975 to 1986 on Bulkley system angler days. Results indicated that the number of days spent on the system is increasing (Table 4, Figure 4 and Appendix 3)). In the past few years, there has also been a general increase in the number of steelhead angling licences sales.[3] Given these trends, increases in steelhead angling activity is expected to continue.

B.C. residents account for an average of 84% of the total number of angling days on the Bulkley system. Of this, Skeena region residents have accounted for 62% of the days.[4]

---

[3] Fish and Wildlife, Licence Revenue Reports, Ministry of Environment and Parks, Province of B.C.

[4] Steelhead Harvest Analysis, Ministry of Environment and Parks.
Note: Figures based on the past 6 year average of Bulkley system days.

TABLE 3
NUMBER OF STEELHEAD ANGLER DAYS SUPPORTED BY BULKLEY RIVER SYSTEM FISH PRODUCTION BY RESIDENT AREA
1986

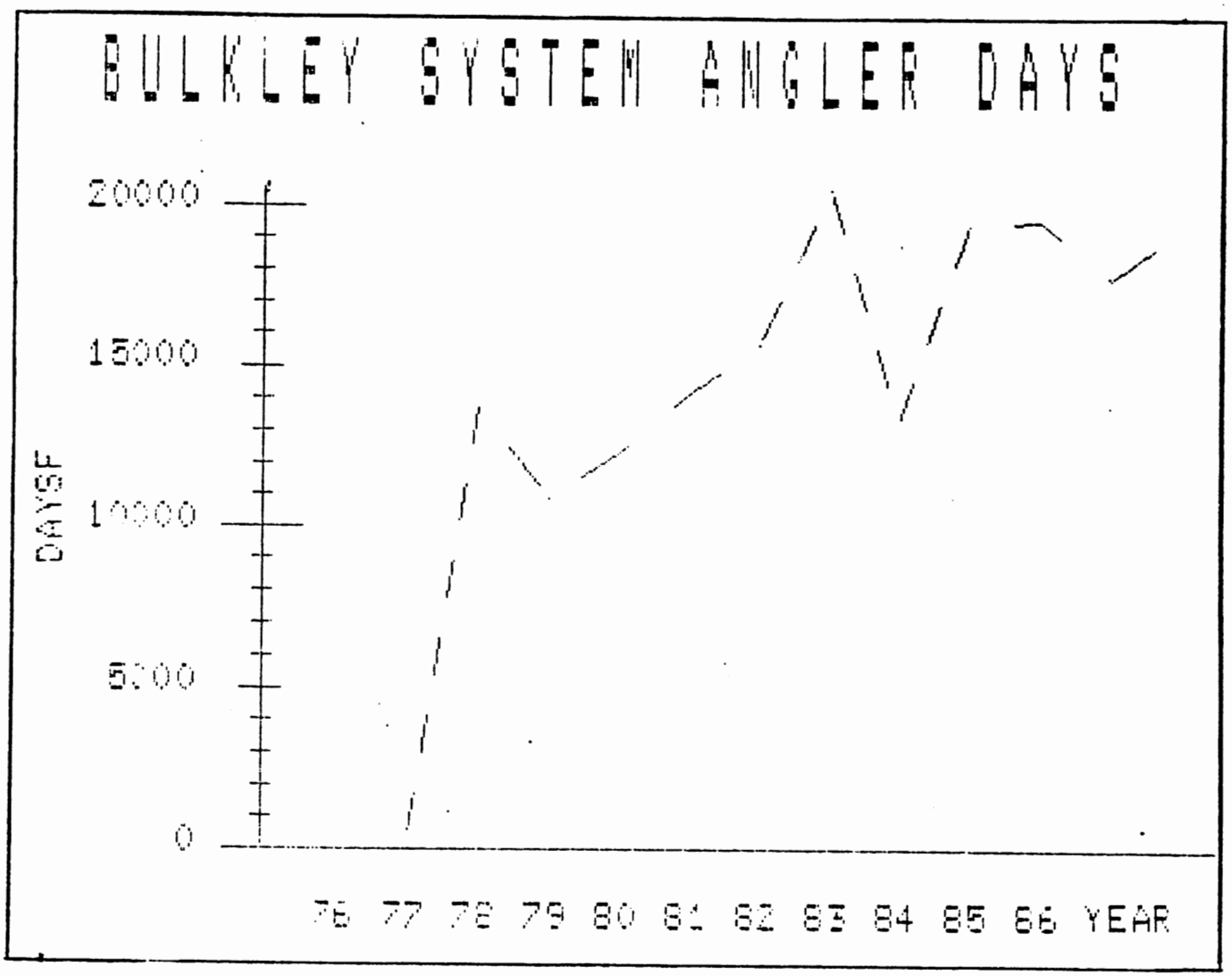
FISHERY/RIVER	RESIDENT AREA					
	SKEENA	OTHER B.C.	TOTAL B.C.	NON-RESIDENT CANADIANS	NON CANADIANS	TOTAL
Bulkley (incl. Tobog)	6557	2046	8603	635	1240	10478
Suska	135	42	177	5	33	215
Telkwa	46	27	73	0	12	85
Bulkley-Morice	121	88	209	34	70	313
Morice	2431	1390	3821	45	480	4346
Nanika	39	30	69	36	24	129
Skeena*	2378	545	2923	430	468	3821
Total Bulkley System Days	11707	4168	15875	1185	2327	19387
Skeena Region Total	36272	9683	45955	3667	7519	57141
% of Bulkley System Angler Days to Skeena Region Days	32.3%	43%	34.5%	32.3%	30.9%	33.9%

Total angler days for all regions in B.C. 219563.

* Skeena-B.C. Sub-region Fisheries Biologists estimate that 25% of Skeena steelhead angler days are attributed to Bulkley system fish.

Source: Steelhead Harvest Analysis (1985/86). Province of B.C., Ministry of Environment and Parks.

FIGURE 4. BULKLEY SYSTEM ANGLER DAYS



Note: Data plotted are actual figures taken from the Steelhead Harvest Analysis. Appendix 3 contains ANOVA tables generated by a simple linear models procedure which confirmed the increasing trend.

TABLE 4

NUMBER OF STEELHEAD ANGLER DAYS SUPPORTED BY BULKLEY SYSTEM FISH PRODUCTION

YEAR	DAYS
1975/76	13744
1976/77	10899
1977/78	12318
1978/79	14188
1979/80	16460
1980/81	20521
1981/82	13325
1982/83	19412
1983/84	19587
1984/85	17731
1985/86	19387

Source: Steelhead Harvest Analysis, Ministry of Environment and Parks, Province of B.C.

The remaining 16% is made up of non-resident Canadians and non-Canadians. The proportion of the latter group has been making notable increases in the recent past with a 53% climb in activity over the period from 1982/83 to 1985/86 as compared to a 3% increase during the two years previous to that (Table 5). Part of this growing interest by non-Canadians in the Bulkley system is related to expansion of guiding activities in the area.

The total number of Bulkley system steelhead caught in the sportfishery has been increasing steadily over the past five years as has the success rate (Table 6). This is partly a result of the large total run sizes of the past few years. This trend is expected to continue given trends in angling effort, the productive capability of the system and regional plans to concentrate on improved management of the commercial salmon fishery in the Skeena approach waters.

Guiding

Guiding activity in the study area has been increasing steadily. The availability of good fly-fishing opportunities all along the system contributes to the attractiveness of guiding. There are currently 9 licensed guides operating on the Bulkley River and there are no plans to issue additional licences. These guides account for an estimated 1100 angler days, virtually all of which are from non-Canadian anglers.

Two of the guiding operations account for the majority of guided angler days, approximately 70%[5], while the remaining seven participate on a part-time basis. Full-time guides offer a full package of guiding services which includes accommodation and meals on the river. Part-time guides only offer guiding services on the river and use accommodations and other services from the surrounding communities.

---

[5] Best estimate from Regional Fisheries Biologists, Bob Hooton, Bill Chudyk, Mike Lough, pers. comm., 1986.

Downstream from the study area at Terrace, there are an additional 15-18 guides who account for a total of 1080[6] guided angler days. It is estimated that approximately 25 percent[6] of this activity can be attributed to Bulkley fish stocks, bringing total guided angling attributable to Bulkley stocks up to a total of 1370 days. However, there is a considerable amount of unlicenced guiding activity in the Terrace area (pers. comm.). As a result estimates of total guided angler days are probably conservative.

Future Angling Activity

Angling activity on the Bulkley system is expected to increase in the future, however, the actual amount of increase is impossible to predict. There are many influencing factors including run strength, relative availability of other fishing opportunities, habits, preferences and incomes of anglers, costs associated with fishing such as transportation, license fees and accommodation, economic development in the area, anglers' income and leisure time, and so on. Past years' data show a positive relationship between the number of angler days and total run size, and number of angler days and human population in the Skeena region. Both human population and fish population are expected to increase in the future with the latter being the most difficult to predict.

For this analysis future estimates of human population in the Skeena region are used as the basis to predict future levels of angling activity on the Bulkley system by Skeena region residents who account for the majority of angling effort (62%). This method is used to the year 2006 after which time angling activity is assumed to continue at a constant level.

The same rate of increase is applied to angling effort by non-guided anglers from elsewhere in B.C., other provinces and outside Canada. The average population increase for the province is estimated to be similar to that for the Skeena region. Non-resident Canadian and alien anglers (not including guide anglers) each account for only 6% of total Bulkley angling

---

[6] Best estimate from Regional Fisheries Biologists.

TABLE 5

NUMBER OF NON-CANADIAN STEELHEAD ANGLER DAYS ON THE BULKLEY SYSTEM

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Non-Canadian Angler Days	1457	1498	1516	1567	1904	2327

1982 to 1986: % increase = 53%

Source: Steelhead Harvest Analysis, Province of B.C., Ministry of Environment & Parks.

TABLE 6

STEELHEAD CATCH SUCCESS RATES ON BULKLEY SYSTEM

	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Total Catch	8047	4380	7932	8739	8821	10075
Total Angler Days	20369	13309	19683	19384	18257	19387
Success Rate (Catch Per Angler Day)	.395	.329	.403	.451	.483	.519

Note: Total catch includes kept and released.

Source: Steelhead Harvest Analysis, Province of B.C., Ministry of Environment and Parks.

effort so the use of these assumptions as opposed to other forecasting methods will not significantly affect estimates of total future angling activity on the system.

Alternate assumptions are used to estimate future guiding activity since guided angler days are accounting for an increasing proportion of total effort on the Bulkley and strong growth is expected in this sector in the future. As indicated earlier, virtually all guided anglers on the Bulkley are thought to be non-Canadians. The level of use by non-Canadian anglers has increased by approximately 50% over the past two years (Table 5). Rapid expansion of the guiding industry is a likely explanation for this increase. Expansion of the guiding industry is evident province-wide where the number of guide licenses has increased from 163 in 1982/83 to 413 in 1986/87. As the sharp increase in guiding activity is a relatively recent and successful phenomenon, continued growth can be expected in the future. This would be supported by government policy of promoting tourism and small business development.

From local discussions regional biologists foresee significant expansion of current guiding operations on the Bulkley system and at least one operator has recently received financial assistance from the Ministry of Economic Development for this purpose. A two to three-fold increase over current levels of guiding activity is thought to be within reason for the Bulkley system.

For this analysis future guiding activity is estimated based on the above and past growth rates in angler days by non-Canadians. The average annual growth rate of 12% (from 1980/81 to 1985/86) is used to estimate guided angler days to 1996. This results in a 120% increase over a 10 year period, from 1370 days in 1986 to 3015 days in 1996. After 1996 it is assumed that the rate of growth will return to a more "normal" level. The average annual growth rate of 2.5% (from 1980/81 to 1983/84, prior to recent sharp increases in activity) is used to estimate guided angler days to 2006. This brings guided activity to 3770 days in 2006 - a 25% increase over 1996 for a total increase of 175% over current levels.

Estimates of total future steelhead angling activity on the Bulkley system, including all residence areas and guided and non-guided anglers are shown in Table 7. Total angler days for 1996 and 2006 are estimated to be 24996 and 30380 respectively which is an average annual increase of 2.8% over 20 years, or a total increase of 56.7% over current levels.

B.2.3 Native Fishery

Native fishing activity is extensive along the lower Skeena and Bulkley Rivers. The major fisheries include gillnet fisheries between Terrace and Hazelton, and the Moricetown Falls gaff fishery. Some of the major bands that use the Bulkley fisheries include the Moricetown, Kitwanga, Gitnamaax, Kitseguekla, Kispiox, Glenvowell, Hagwilget and Kitsumkalum. The total population for these bands is unknown, however, census data is available for reserve populations from Statistics Canada. The 1986 estimated reserve population in the Bulkley-Nechako region was 2441. This may be an underestimate of total native population in the region given that there are a fair number of status Indians not living on reserves.

The native people attach a tremendous importance to fisheries. It forms a large part of their social and cultural heritage. The majority of the native activity is subsistence fishing but there is also a large sport fishing contingent who rely heavily on the Bulkley River fisheries.

There is no specific information regarding the amount of native angling activity attributable to the Bulkley River. The Skeena Run Reconstruction Model places total native catch at approximately 6% of the Bulkley system steelhead which escape the commercial fishery, which is approximately 1112 fish in 1986. The total catch is likely substantially higher according to reports produced for the Gitsan Wet'Swuet'en Tribal Council but currently these reports are not available for reference.

---

[7] Skeena Steelhead Run Reconstruction, B.C. Skeena Sub-region Fisheries Model.

TABLE 7

PROJECTED STEELHEAD ANGLING ACTIVITY ON THE BULKLEY RIVER SYSTEM

YEAR	NON-GUIDED	GUIDED	TOTAL
1986	18,017	1,370	19,387
1996	21,981	3,015	24,996
2006	26,610	3,770	30,380

B.C. Population Forecast 1986-2006, Province of B.C., Ministry of Industry and Small Business Development.

For the purpose of this analysis the Skeena Run Reconstruction numbers will be used, but, given the above qualifications, these values should not be used when describing the native fishery on the Bulkley in isolation of other uses.

Future harvests of steelhead in the native food fishery would be dependent on native population growth and the resolution of native land claims. Since there is limited data available, no attempt will be made to forecast the future native steelhead catch. Therefore, a constant 1986 level will be used for valuation purposes.

B.2.4 Commercial Catch of Steelhead

Steelhead is not a targeted species in the commercial fishery. Nevertheless, 48% of the total Bulkley System steelhead are caught incidental to the commercial salmon fishery at the mouth of the Skeena. The estimated total number of Bulkley origin steelhead caught in 1986 was 8898[8].

For purposes of this analysis, no attempt will be made to forecast the future commercial catch of steelhead. Future levels depend on how the salmon fishery is managed, therefore, a constant 1986 level will be used for valuation purposes.

B.3 RESIDENT SPECIES FISHERIES

The total number of angler days for resident species is estimated at 5000 for the whole system. The majority of anglers are thought to be area residents with a high proportion of juveniles (age 16 and under) fishing for resident species. This is primarily due to the fact that the quality of angling experience and size of fish are not as attractive as that provided by steelhead and salmon. The species most commonly sought include Dolly varden char, cutthroat trout, rainbow trout and whitefish.

Maxan lake which flows into Foxy Creek, accounts for 2000[9] angler days of resident species fishing activity. The lake is a favourite spot for

---

[8] Taken from Tables 1 and 2 (.48 x 18538).
[9] Best estimate from Regional Fisheries Biologists (1986).

local residents to spend the weekend. There is a Forest Service Campsite which is used heavily during the fishing season[10]. Although Maxan Lake flows into Foxy Creek, fish populations may still be affected by acid mine drainage problems as some fish may move down into Foxy Creek at some time throughout the year.

Future angling activity for resident species is estimated using the same assumptions as for steelhead angling activity by Skeena region residents.

B.4 SALMON

The Bulkley River supports four species of Pacific salmon: sockeye, pink, coho and chinook. The river contributes over 25% of Skeena River chinook production with the Nanika-Morice tributary of the Bulkley having particularly important spawning and rearing habitat for this species.

The average 10 year escapement levels, for all four species of salmon is 23,000.[11] The actual harvestable surplus is difficult to determine because the data is incomplete. However, based on productivity rates, the average (10 year) total number of harvestable salmon is roughtly 24000[11] per year.

All four species contribute to the various fisheries in the north coast and Skeena River area. In tidal waters, there is the commercial fishery, some Indian fisheries and sportfishing for coho and chinook around Prince Rupert. There is also a freshwater salmon sport fishery all along the Bulkley System.

The commercial salmon fishery is the livelihood of a large proportion of the population who live on the coasts of British Columbia. Most of the commercial fishery for Bulkley origin stocks occurs in the tidal waters

---

[10] Pers. comm., Regional personnel (1986).

[11] Department of Fisheries and Oceans Canada.

around Prince Rupert and at the mouth of the Skeena River. Depending on the run timing and allowable catch, the number of Bulkley System salmon caught varies slightly from year to year.

The tidal water sport fishery for Skeena stocks takes place principally in Area 4 which includes Prince Rupert and the mouth of the Skeena. The sport fishery has been increasing in size and economic importance in recent years. With chinook being the preferred species in the tidal sport fishery, the contribution of the Bulkley watershed to chinook production acquires another dimension of importance.

Of major significance in the river is the native fishery which occurs in many places along the Skeena and at the famous Moricetown Falls on the Bulkley River itself. The native fisheries are an important part of the social, cultural and economic life of the Indian people. The salmon resource contributes to their subsistence fisheries as well as sport fishing activity.

The freshwater sport fishery for salmon targets on chinook and coho. Since creel census data is minimal, the number of angler days has been estimated by Skeena Sub-region Fisheries personnel (Appendix 1). It is estimated that coho account for approximately 1800-2400 angler days and chinook for 4000-5000 angler days, for a total of between 5800 and 7500 angler days attributable to Bulkley River salmon.

Harvest potential of Bulkley River salmon is based on the Department of Fisheries and Oceans Stock Rebuilding Model. The model evaluates strategies to increase salmon stocks by simulating increased returns of salmon to the spawning grounds. The major inputs into the model are recent escapements, productivity and exploitation (harvest) rates.

It is anticipated that there will be an overall increase in salmon stocks in the Bulkley system. Production within the different species varies, with chinook and pink increasing, sockeye remaining constant and coho declining.

Future estimates of activity in the commercial, tidal sport and native fisheries are based on the Stock Rebuilding Model which attempts to take all relevant factors into consideration. The freshwater salmon sport fishery is assumed to increase at the same rate as the steelhead sport fishery. This results in 8052 angler days in 1996 and 9748 in 2006, for a total increase of 3148 days over current levels.

C. VALUE OF THE FISHERIES RESOURCES

Table 8 shows the estimated annual net economic value of fisheries supported by production from the Bulkley system. These are based on levels and use as outlined in the previous sections. The net economic value represents the benefits to British Columbians from the existence of these fisheries minus the costs of generating those benefits. The methods used to calculate these values are detailed in Appendix 2.

The value of recreational angling is calculated differently depending on the residence of anglers. For B.C. residents it is measured as their willingness to pay for a day of fishing over and above their actual expenditures. For non-residents the increase in net income to British Columbians from the expenditures of non-resident anglers is the relevant value measure. Such expenditures are generally higher if the angler uses the services of a guide. The commercial fisheries are valued at the net wholesale price of fish harvested, which is exclusive of harvesting and processing costs. The Native fisheries are the most difficult to value with their social and cultural significance. Rather than attempt to put a price on these attributes the Native harvest has been valued at the opportunity cost of purchasing the fish harvested on the commercial market. This is a minimum estimate of the Native fisheries value and should be recognized as such.

The total annual value of recreational, commercial and Native uses of Bulkley system fisheries resources is estimated to be $1.6 million (1986 dollars) based on 1986 levels of use. The annual value is estimated to increase to $2.6 million (1986 dollars) in the year 2006 based on future increases in fishing activity. Steelhead accounts for more than half the

TABLE 8

TOTAL 1986 ANNUAL VALUE OF ALL FISHERIES IN THE BULKLEY RIVER SYSTEM

SPECIES	FISHERY	1986 VALUE
Steelhead	Recreational	$807,302
	Native	9,786
	"Commercial"	78,302
TOTAL		$895,390
Resident	Recreational	$142,250
Salmon	Commercial, Native and Tidal Sport	$318,000
	Freshwater Sport	255,987
TOTAL		$573,987
TOTAL ANNUAL VALUE		$1,611,627

value due primarily to the value of recreational angling for this species. Commercial, native and sport fishing for salmon account for over one-third of the total with fishing for resident species contributing 9% of the total value.

To account for future changes in fishing activity the present value of the Bulkley system fisheries has been calculated over a 60 year timeframe. The present value expresses the stream of net benefits over time in present day terms by discounting future values to reflect their lower worth relative to values which occur in or near the present. The more highly preferred is present over future use, the higher the discount rate. Lower discount rates reflect less of a difference between present and future values. The discount rate of 8% is currently acceptable for provincial government evaluations.

Table 9 shows that the estimated value of Bulkley system fisheries over a 60 year time frame ranges from $23 to $38 million in present-day terms, depending on the discount rate used. The present value is the appropriate measure to use in benefit-cost analyses or in compensation-mitigation cases, and can be compared to a one-time present-day investment. However, caution must be emphasized when using any of the values given above. As noted earlier, they represent only a portion of the total uses of the Bulkley River and so provide only a partial indication of its real value. Even for the fisheries resource the values that are able to be quantified do not give the whole picture. The social and cultural values of the native fishery are a major omission. The trophy nature of the steelhead fishery may be underestimated. The intangible benefits to local residents also cannot be quantified. Finally, the net economic value does not estimate the total impacts of the fisheries on the regional economy. All these should be considered in the same context as those values that have been quantified above.

TABLE 9
TOTAL PRESENT VALUE OF ALL FISHERIES IN THE BULKLEY RIVER SYSTEM

(n = 60)

FISHERY	DISCOUNT RATE 6%	8%	10%
Steelhead			
Recreational	$20,917,775	$15,621,040	$12,333,057
"Commercial"	1,257,967	1,047,411	858,750
Native	167,942	130,898	107,320
TOTAL	$22,343,684	$16,799,349	$13,296,127
Resident			
Recreation	$ 3,059,367	$ 2,312,935	$ 1,847,592
Salmon			
Commercial	$ 3,309,000	$ 2,485,000	$ 1,827,000
Native	2,946,000	2,194,000	1,640,000
Tidal Sport	1,034,000	803,000	627,000
Freshwater	5,504,291	4,122,040	3,324,176
TOTAL	$12,793,291	$ 9,604,040	$ 7,418,176
GRANT TOTAL	$38,196,342	$28,716,324	$22,564,895

APPENDIX 1

FRESHWATER SPORT SALMON FISHERY

Coho and steelhead are in the river at the same time, while chinook have a different run timing. The number of coho angler days mentioned represent days that are specifically targeted on coho, therefore are in addition to total steelhead angler days.

The four major areas for coho angling effort are Anderson Flats, at the junction of the Skeena and Bulkley rivers; Toboggan Creek; the mouth of the Telkwa River; and the Forks junction of the Bulkley and Morice rivers. Anderson Flats and the mouth of the Telkwa account for a majority of the total number of coho angling days, roughly 85% leaving 15% attributable to Toboggan Creek and the Forks.

The chinook fishery is about double the size of the coho fishery and one-quarter the size of the steelhead fishery. The five major areas for chinook angling effort are Anderson Flats; Moricetown Canyon; the Forks; between the Forks and Lamprey Creek; and the local fishery around Smithers. The most important area is Moricetown canyon where approximately 75% of the effort is directed. Of the remaining 25%, Anderson Flats accounts for roughly 1% of the effort while effort in the other three fishing areas are evenly distributed at 8% each.

APPENDIX 2
VALUE CALCULATIONS METHODOLOGY

1. GENERAL

Unlike some resources, fish and wildlife are unpriced. Their use is not bought and sold in an explicit market even though they are highly valued by users. In such cases, it becomes necessary to determine an implicit price for the use of these resources. The method for inputting a value for unpriced resources usually involves simulating a market situation. In the report entitled The Value and Characteristics of Freshwater Angling in British Columbia (Reid, 1986), this method has been developed and will be used as the basis for calculating the value of recreational angling in this analysis. All values expressed in text and Appendix 2 will be expressed in 1986 dollars. All U.S. dollars will be converted to Canadian dollars using an exchange rate of 1.35.

2. RECREATIONAL STEELHEAD

Non-Guided Activity

There are two categories of angling - non-guided and guided. The value of non-guided freshwater fishing for B.C. residents is determined by their willingness-to-pay, over and above their actual expenditures, for a day spent fishing. This can be thought of as the average daily value of the resource to the users.

There is no recent specific data for either the actual value of a day spent fishing or the actual value of steelhead apart from other species on the Bulkley system. Therefore, this analysis will use the average estimated daily value of angling in the Skeena region, for all species. This value is equal to $28.45/angler day for B.C. residents.[12]

---

[12] The Value and Characteristics of Freshwater Angling in B.C. (Reid, 1986).
1981 Value = $22.00
1986 Value = $22 x 1.293 (Vancouver CPI 1981-86)
= $28.45

The value of a freshwater angling day for non-residents of B.C. (non-resident Canadians and non-Canadians) is measured as the net increase in net income to British Columbians from the expenditures of non-resident anglers. This value is estimated to be $45.77/non-resident Canadian angler day[13] and 55.99/non-Canadian angler day.[14]

The total 1986 annual value for non-guided steelhead angling activity is $559,463. The following table shows the breakdown by resident area.

TOTAL 1986 ANNUAL VALUE OF NON-GUIDED RECREATIONAL STEELHEAD ANGLING ACTIVITY

RESIDENT AREA	DAYS	VALUE/DAY	TOTAL VALUE
Skeena	11,707	28.45	333,064
Other B.C.	4,168	28.45	118,580
Total	15,875		451,644
Non-Resident Canadians	1,185	45.77	54,237
Non-Canadians	957	55.99	53,582
Total Non-B.C.			107,819
GRAND TOTAL			559,463

Guiding Activity

There is some specific information available about the costs of guiding services over and above those provided by Reid (1986). Both sources of information have been used to estimate the value of guided activities on the Bulkley System. Additionally, for purposes of this analysis, all guided anglers on the system are assumed to be non-Canadian (pers. comm.).

---

[13] The Value and Characteristics of Freshwater Angling in B.C. (Reid, 1986).
1981 Value = $35.40
1986 Value = $35.40 x 1.293 (Vancouver CPI 1981-86)
= $45.77

[14] The Value and Characteristics of Freshwater Angling in B.C. (Reid, 1986).
1981 Value = $43.30
1986 Value = $43.30 x 1.293 (Vancouver CPI 1981-86)
= $55.99

Non-Canadian anglers fishing in the Skeena region spend an average of $137/day in B.C. (Reid, 1986). Guided anglers spend more per day than do non-guided anglers. The expenditures associated with guiding activity depend on whether services offered are partial or full.

1. PARTIAL SERVICES

i) Guide fees $150 U.S./day ($202.50 Cdn./day).

ii) It is assumed that guide fees cover boat rentals, fuel, maintenance and miscellaneous costs which is 18% of total expenditures (see Table 8).

[(1,736,000 + 2,687,900)/24,709,800] = 18%

This leaves 82% to be spent on food, lodging, transportation and so on, in addition to guide fees.

Therefore, anglers using partial guiding services spend $112.00/day (82% of 137.00) on top of the $202.50 Cdn./day in guide fees.

The total expenditures by anglers receiving partial guiding services is $314.50/day.

iii) In order to calculate the daily value of guiding activity, an estimate of net income to British Columbians from guided angler expenditures is required. From The Value and Characteristics of Freshwater Angling in B.C., $1.00 of expenditure from non-Canadian anglers fishing in the Skeena generates 41¢ of net income to British Columbians (55.99/137.00 = average daily value ÷ average daily expenditure). Therefore, the estimated daily value of partial service guided angling activity on the Bulkley system is $128.95 ($314.50 x .41).

2. FULL SERVICE

i) Guide fees $350 U.S./day (472.50 Cdn./day).

ii) It is assumed that guide fees cover food, lodging, boat rentals, fuel, maintenance and miscellaneous costs which is 57% of total expenditures (see Table 8).

[(9,561,900 + 1,736,000 + 2,687,900)/24,709,000] = 57%.

This leaves 43% to be spent on transportation, tackle, bait, other equipment and so on in addition to guide fees.

Therefore, anglers using full guiding services spend $59.00 (43% of 137.00) on top of the $472.50 Cdn./day in guide fees.

Total expenditures by anglers receiving full guiding services is $531.50/day.

iii) Calculations for the daily value of full service guided angling activity is the same as for partial service. Therefore, the daily value is estimated to be $217.92 ($531.50 x .41).

The total 1986 annual value for guided steelhead angling activity is $247,838 or 30% of the total annual value of <u>all</u> recreational steelhead angling activity ($247,838 ÷ $807,302).

TOTAL 1986 ANNUAL VALUE OF GUIDED STEELHEAD ANGLING ACTIVITY

	DAYS	VALUE/DAY	TOTAL VALUE
Partial Guiding	570	128.95	73,502
Full Guiding	800	217.92	174,336
			247,838

TABLE 10

ESTIMATED EXPENDITURES BY NON-RESIDENT ANGLERS

(1981 Canadian Dollars)

EXPENDITURE CATEGORY	EXPENDITURES IN B.C. Alien Anglers
1. Travel and Transportation	9,517,100
2. Food and Lodging	9,561,900
3. Tackle, bait and other equipment	1,128,200
4. Fish canning or smoking	78,700
5. Boat rentals, fuel, maintenance	1,736,000
6. Other costs	2,687,900
TOTALS	24,709,800

Source: The Value and Characteristics of Freshwater Angling in B.C., 1986.

3. COMMERCIAL STEELHEAD

The annual value of "commercial" steelhead is based on estimates of catch (.48 x 18538 = 8898) and information from the Department of Fisheries and Oceans, Economic Division on the net commercial value for steelhead. The estimated annual net value for commercially caught steelhead is $78302. This is calculated using an average weight per fish of 10 pounds (pers. comm.) and a net value of 88¢ per pound.

4. NATIVE STEELHEAD

The same assumptions apply to native steelhead catch as do for "commercial" steelhead. The value is estimated by using the "commercial" opportunity cost of steelhead which is 88¢ per pound. Total native catch in 1986 was approximately 1112 fish. This gives a total 1986 annual value of $9,786.

5. RESIDENT SPECIES

Area residents, most often juveniles (age 16 and under), are the primary users of this resource. There are no guiding activities associated with resident species angling activity and since neither non-resident Canadians nor non-Canadians actively participate in this fishery, the value of a day spent fishing is determined by their willingness-to-pay. As previously mentioned, this is equal to $28.45/angler day. Therefore, the total 1986 annual value is $142,250 (5000 days x $28.45).

6. SPORT FRESHWATER SALMON

Non-Guiding Activity

Similar assumptions and nethodologies were applied to the non-guided freshwater sport salmon fishery as for steelhead. The same proportion of total days spent fishing for steelhead by resident area was used for salmon. This resulted in a total 1986 annual value of $193,936.

TOTAL 1986 ANNUAL VALUE OF NON-GUIDED FRESHWATER SPORT SALMON ANGLING ACTIVITY

RESIDENT AREA	PROPORTION OF RESIDENT AREA	DAYS	VALUE/DAY	TOTAL VALUE
Skeena	.62	4,092	28.45	116,417
Other B.C.	.22	1,452	28.45	41,309
Total B.C.	.84			157,726
Non-Resident Canadians	.06	396	45.77	18,125
Non-Canadians	.049 (.49 x .10)[1]	323	55.99	18,085
Total Non-B.C.				36,210
GRAND TOTAL				193,936

Guiding Activity

Again similar assumptions and methodologies were applied to the guided freshwater sport salmon fishery as for steelhead.

The total 1986 annual value for guided freshwater sport salmon activity is:

TOTAL 1986 ANNUAL VALUE OF GUIDED FRESHWATER SPORT SALMON ANGLING ACTIVITY

	DAYS	VALUE/DAY	TOTAL VALUE
Partial Guiding	128	128.95	16,506
Full Guiding	209	217.92	45,545
			62,051

[1] Guided activity makes up the other 5.1% for a total non-Canadian freshwater salmon of 10%.

7. SALMON

The economic values calculated for this report are based on probable future harvests as projected by the Stock Rebuilding Model of the Department of Fisheries and Oceans. This model was developed to consider various fisheries management strategies and allows for estimates of future harvests that result from various biological and management conditions. Such things as the chinook conservation program can be taken into account to estimate the future value of chinook harvest.

The salmon resource in the Bulkley watershed has been valued at approximately $318,000 annually which includes commercial, native and recreational tidal angling values.

The commercial values were derived by the Department of Fisheries and Oceans, Economic Division, and take into account anticipated future prices. Furthermore, these figures use the net wholesale value for salmon which represents the minimum value of salmon in the marketplace.

The most economically valuable species of salmon is the chinook which makes up more than half of the value of the Bulkley River salmon. However, pink is also an important species and together these two species account for a significant portion of the total value of harvested Bulkley River salmon.

The values for the Indian fishery are based on commercial fishery values and do not include any estimates for the social and cultural value that Indian people associate with the salmon resource. As such, these values represent a minimum value of these harvests by indicating the value they would have in the commercial fishery. At this minimum value, the Indian fishery harvests amount to 80% of the value of the commercial harvest. Since the fish harvested in the Indian fishery are therefore not available to the commercial fishery, their commercial value represents at least the commercial opportunity cost.

The tidal sport fishery is small by comparison but has a substantial value nonetheless. The value of this fishery is based on anglers' average willingness-to-pay for a days fishing, currently valued at approximately $40.00.

The tidal sport fishery has been steadily increasing in size and economic importance in recent years. With chinook being the preferred species in the tidal sport fishery the 25% contribution of Bulkley chinook to total Skeena production makes this watershed of particular importance.

8. TOTAL ANNUAL VALUE OF ALL BULKLEY FISHERIES

The total annual value for all fisheries in the Bulkley system is $1,611,627. The following table shows a breakdown by species.

TOTAL 1986 ANNUAL VALUE OF ALL BULKLEY FISHERIES

Species	Fishery	1986 Value	
Steelhead	Recreational	807,302	
	Commercial	78,302	
	Native	9,786	
			895,390
Resident species	Recreational		142,250
Salmon	Commercial, Native and Tidal Sport	318,000	
	Freshwater Sport	255,987	
			573,987
TOTAL ANNUAL VALUE			1,611,627

9. PRESENT VALUE OF THE BULKLEY FISHERIES BY FISHERY

The values used in this report are discounted to the present at 8 and 10% discount rates over a period of 60 years. Discounting expresses all values in present year terms since values further into the future are felt to be of less relative value than those in or near the present. The discount rate reflects the reduction in relative future values - the lower discount rate reflects higher future values. Discounting is done to calculate a "lump sum" value for comparison with one time investments.

Recreational Angling for Steelhead and Resident Species

The total present value of all recreational steelhead and resident species activity is estimated to be between $24M and $14M (also see Table 11).

TOTAL PRESENT VALUE OF ALL RECREATIONAL STEELHEAD AND RESIDENT SPECIES ANGLING ACTIVITY

FISHERY	DISCOUNT RATE		
	6%	8%	10%
Steelhead	$20,917,775	$15,621,040	$12,333,057
Resident	$ 3,059,367	$ 2,312,935	$ 1,847,592
	$23,977,142	$17,933,975	$14,180,649

The total present value of "commercial" steelhead is estimated to be between $1.3M and $.86M. Similar assumptions were applied to native steelhead, yielding a total present value of $1.7M and $.107M.

The total present value of all salmon activity is estimated to be between $12.9M and $7.4M. A breakdown by fishery and species is shown in Table 12.

Present value calculations for freshwater sport activity were similar to those used for steelhead and resident species.

TABLE 11

TOTAL PRESENT VALUE OF RECREATIONAL ANGLING ACTIVITY IN THE BULKLEY RIVER SYSTEM OVER 60 YEARS (excluding salmon), 1986 DOLLARS (increasing growth of activity to 2006)

$\dot{n}$ = 60

RESIDENCE AREA	TOTAL DISCOUNTED VALUE @ 6%	@ 8%	@ 10%
Steelhead			
Skeena	$ 7,163,225	$ 5,415,505	$ 4,325,953
Other B.C.	2,550,319	1,928,062	1,540,153
Total B.C.	$ 9,713,544	$ 7,343,567	$ 5,866,106
Non-resident Canadians	$ 1,166,438	$ 881,882	$ 704,455
Non-Canadians	1,152,287	871,231	696,020
Partial Guiding	2,650,874	1,945,821	1,510,535
Full Guiding	6,234,632	4,578,539	3,555,941
Resident Species	$ 3,059,367	$ 2,312,935	$ 1,847,592
TOTAL	$23,977,142	$17,933,975	$14,180,649

TABLE 12
PRESENT VALUE OF THE VARIOUS SALMON FISHERIES IN THE BULKLEY SYSTEM
(in 000's)

SPECIES	INDIAN	TIDAL SPORT	COMMERCIAL	TOTAL	FISHERY FRESHWATER SPORT (not broken down by species)
n = 60 r = 6%					
Sockeye	845	-	282	1127	-
Pink	519	-	1209	1728	-
Coho	108	164	56	328	-
Chinook	1474	870	1843	4187	-
TOTAL	2946	1034	3390	7370	5504
GRAND TOTAL					12874
n = 60 r = 8%					
Sockeye	645	-	215	860	-
Pink	376	-	876	1252	-
Coho	97	149	49	1547	-
Chinook	1076	654	1345	3075	-
TOTAL	2194	803	2485	6734	4122
GRAND TOTAL					9604
n = 60 r = 10%					
Sockeye	493	-	164	657	-
Pink	272	-	635	907	-
Coho	87	135	43	265	-
Chinook	788	492	985	2265	
TOTAL	1640	627	1827	4094	3324
GRAND TOTAL					7418

The total present value of all fisheries using the Bulkley River System at 6%, 8% and 10% are $38 m, $29 m and $23 m respectively.

TABLE 13

TOTAL PRESENT VALUE FOR ALL FISHERIES IN THE BULKLEY RIVER SYSTEM

	DISCOUNT RATE		
FISHERY	6%	8%	10%
Recreational			
- Steelhead, freshwater and tidal tidal salmon and resident species	$30,515,433	$22,859,015	$18,131,825
Native			
- Steelhead, salmon	$ 3,113,942	$ 2,324,898	$ 1,747,320
Commercial			
- Salmon, steelhead	$ 4,566,967	$ 3,532,411	$ 2,685,750
Total all fisheries	$38,196,342	$28,716,324	$22,564,895
SPECIES			
Steelhead			
- recreational, native, commercial	$22,343,684	$16,799,349	$13,296,127
Salmon			
- recreational (tidal and fresh), native, commercial	$12,793,291	$ 9,604,040	$ 7,418,176
Resident	$ 3,059,367	$ 2,312,935	$ 1,847,592
Total all fisheries	$38,196,342	$28,716,324	$22,564,895

APPENDIX 3

ANOVA TABLES FOR BULKLEY STEELHEAD ANGLER DAYS VS. POPULATION AND TIME (YEAR)

1) Bulkley Angler Days Vs. Skeena-Nass Population

SAS

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: SANGDAYS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	54244261.26600698	54244261.26600698	8.04	0.0220	0.501306	15.9424
ERROR	8	53961680.83399304	6745210.10424913		ROOT MSE		SANGDAYS MEAN
CORRECTED TOTAL	9	108205942.10000002			2597.15423189		16393.70000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
SNPOP	1	54244261.26600698	8.04	0.0220	1	54244261.26600698	8.04	0.0220

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	-21947.29307666	-1.62	0.1438	13545.15561263
SNPOP	0.51060596	2.84	0.0220	0.18005564

2) Bulkley Angler Days Vs. Skeena Population

SAS

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: ANGDAYS

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	56025542.85626676	56025542.85626676	8.59	0.0190	0.517782	15.5791
ERROR	8	52177316.74373320	6522164.59296665		ROOT MSE		ANGDAYS MEAN
CORRECTED TOTAL	9	108202859.59999996			2553.85289180		16392.80000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
SKPOP	1	56025542.85626676	8.59	0.0190	1	56025542.85626676	8.59	0.0190

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	-25777.10469805	-1.79	0.1115	14410.81388094
SKPOP	0.17635723	2.93	0.0190	0.16253077

APPENDIX 3 (Cont'd)

3) ANOVA Table for Bulkley Steelhead Angler Days Vs. Year

SAS

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: DYSFISH

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	61908684.06272396	61908684.06272396	10.58	0.0100	0.540304	11.9777
ERROR	9	52672485.93727604	5852498.43747512		ROOT MSE		DYSFISH MEAN
CORRECTED TOTAL	10	114581170.00000000			2419.19375774		16152.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
YEAR	1	61908684.06272396	10.58	0.0100	1	61908684.06272395	10.58	0.0100

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	-1518676.70129695	-3.22	0.0105	471905.78092468
YEAR	77.49569823	3.25	0.0100	23.82714228