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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
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U.S. DEPARTMENT OF COMMERCE
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Preface

Just what is the value of a salmon or steelhead? Certainly, one can receive a number of different replies from the commercial fisherman who has thousands of dollars invested in his gear and boat, the avid sport angler who vows he would not sell his rights for any price, the tribal Indian whose rights to fish are guaranteed by treaty. All of these users would place some value on anadromous fish, but they most likely wouldn't agree.

Economic valuation of fisheries is especially complex because different techniques are necessary to evaluate the aforementioned kinds of fisheries. Most economic models have fairly simple working parts especially where market prices can be clearly demonstrated, but evaluation of sport fisheries must necessarily depend upon particular circumstances and no single method is appropriate for all. The layman, meanwhile, often remains confused about valuation issues.

Surprisingly much of the recent fishery valuation work in this country has been in the Northwest. The valuation of anadromous fish runs, especially in a river system as large as the Columbia River, is a very complex demanding project. The river at the turn of the century supplied consumers with nearly 50 million pounds of fish annually. Over the years, destruction and elimination of spawning and rearing habitat, overharvesting, and losses of young fish to hydroprojects and irrigation, have reduced the annual harvest to between 20 and 30 million pounds. This decline has generally retarded fishery production - hence value also. Much effort is now being made to restore the runs to former levels.

The users of these stocks are numerous and varied. Over 12,000 commercial vessels along the Pacific Coast are in search of these fish. Charterboats, which can fish from six to fifteen anglers, number over 1,000. Licensed sport anglers along the coastal areas, seeking both salmon and steelhead, number in excess of 1.2 million. After the runs reach the river on their spawning migration, they still face the gamut of hundreds of commercial gillnets, hordes of anglers on the main river and larger tributaries, before they reach the upper river where tribal fishermen and still more sport anglers fish for the dwindling numbers.

Harvest data and other information needed for evaluation procedures must be garnered from many sources and scattered places. Columbia-bound ocean fish are taken from California to Alaskan waters. Investigators at all coastal ports play a part in identifying fish of Columbia origin, from the total catch, by sampling a part of both commercial and sport catches. Before leaving fresh water, millions of juveniles have been marked each year in order to determine their eventual contribution, whether in an ocean or river fishery, or as a returning spawner. Their numbers are counted at the river fishways and on the spawning grounds and hatcheries to continue the effort necessary to obtain catch/escapement ratios, which are useful in value determinations and management of the runs.

The report which follows attempts to strike a balance between economic theory and real-world facts. The methodology and narrative is designed for

the general readership, but numerous citations are included to satisfy economists' queries. The values developed should be useful in assessing restoration of fisheries in the near term, and in providing techniques for enhancement of fisheries in the longer term. The present report is largely a refinement and update of the widely-used "Partial Net Economic Values for Salmon and Steelhead for the Columbia River System" (Tuttle et al., 1975).

Economic values in this report are intended for use in evaluating wild stocks - not hatchery-produced fish. The report is not intended, nor is it useable for allocating harvest to user groups. The report provides a "state of the art" analysis in an evolving discipline of fishery economics. When better economic procedures or data are developed, they should be used.

Helpful comments and review were provided by James A Crutchfield (University of Washington), Jack Richards (National Marine Fisheries Service), and fisheries staff technicians from the U.S. Fish and Wildlife Service, Columbia River Inter-Tribal Fish Commission, Washington Department of Fisheries, Idaho Department of Fish and Game, and the Oregon Department of Fish and Wildlife.

Reino O. Koski

Philip A. Meyer

The author of this document, Philip A. Meyer, is President of Meyer Resources, Inc. of Davis, California—a natural resources consulting firm. Mr. Meyer has broad experience in fisheries economics, in both the United States and Canada—and has previously served as Economic Policy Advisor to the California Water Policy Center, U.S. Fish and Wildlife Service, Sacramento, and as Chief Economic Advisor on Fishery Habitat, Canadian Department of Fisheries, Vancouver.

He is currently active in Commercial, Recreational, and Indian fishery issues concerning the Columbia River system—as well as in associated analysis of power generation benefits and costs.

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I. Introduction

The objective of this report is to provide an improved procedure, and where appropriate, more up-to-date values, for application to salmon and steelhead of the Columbia River by analysts who may become involved in benefit cost analysis, impact assessment, or similar processes. Consequently, it takes a "manual" or "handbook" approach, and builds upon "Partial Net Economic Values for Salmon and Steelhead for the Columbia River System" (Tuttle, et al. 1975). The present document is based upon appropriate economic theory, has considered a number of empirical studies of relevance for Columbia fisheries, and has also benefitted from the recent review of economic procedures by the U.S. Water Resources Council (hereafter WRC). It does not contain extensive economic elaboration, however, but is rather directed at an audience that will be largely composed of non-economists. Our analysis extends the report of Tuttle et al. in two areas.

i. It provides net economic treatment of commercial fisheries beyond exvessel stage to processing levels.

ii. It incorporates commercial figures for sockeye, as well as for chinook, coho, and steelhead.

Those not familiar with salmonids of the Columbia systems are referred to Tuttle, et al. for a useful general description.

II. Basis for Analysis

A. The Commercial Fishery

Where factors of production (labor and capital) have alternative opportunities, it is the value of fishery products minus the cost of factor inputs involved in catching, processing, and distribution that can be considered as an addition to national wealth. The term "net value" utilized to differentiate between gross expenditures and gross expenditures net of factor costs. It is net value that is required for economic procedures.

Appropriate consideration of benefits related to locked in capital and labor, and of social benefits, is however mandated by economic theory, and for example, in the recent WRC review. Capital and labor can be locked into fish catching and processing due to internal or external forces. Typical internal forces relate to the inability of fishing or processing personnel to obtain alternative employment due to lack of skill training, chosen area of domicile (i.e., a small coastal community) and chosen way of life. With respect to capital, undepreciated prior investment in major catching or processing facilities may similarly tend to lock capacity in. Further, as those who labor also often own the capital, immobility of one factor may affect the other. Externally generated forces will also tend to affect mobility. First, where general economic conditions are depressed and/or alternative vocational opportunities are limited or unavailable, factors of production engaged in fishing may not be able to move elsewhere.1/ This is the standard

1/ Water Resources Council, Procedures for evaluation of National Economic Development (NED) benefits and Costs in Water Resources Planning (Level C); Final Rule, Federal Register, December 14, 1979, pp. 72892-72976.

"unemployment" case. Second, where fish availability has declined, these conditions may be aggravated, and both capital and labor previously committed to the fishery may find itself trapped for reasons beyond own control. Economic theory treats the "unemployment" case in anything but the short run as abnormal. It cannot, therefore simply be assumed, but must be empirically verified.

Where inquiry is not into the net economic value of the fishery as a whole, but simply concerns what the economic effect of an increment or decrement to fish stocks will be, the reasons for existence of overcapacity become immaterial—all that matters is whether or not it exists over project life.

> "The excess capacity that will normally exist will make it difficult to obtain a proper estimate of changes in costs associated with changes in harvests. In some instances, idle boats will be available and the only additional costs will be operating costs. In other instances, vessels that are already operating will be able to harvest the extra catch without significant change in variable costs" (Water Resources Council, 1979).

Consequently, empirical verification of the chronic status of employment/unemployment in fishing sectors is an important component of net value analysis.

Where fluctuations in stock levels are such that, for decrements, a whole fishing fleet and/or processing sector would be eliminated, or for increments, new catching and processing capability would be immediately required, the previous discussion will not apply. Here, the issue is not incremental (or decremental) impact, but the value of the fishery infrastructure involved. Here, the degree of tradeoff between economic and social goals must be examined.

Economic evaluation is not competent to capture the full richness of social values associated with commercial fishing. However, in certain circumstances, economic evaluation can provide a lower bound dollar estimate, as one indicator among others of social importance. The rationale for such an estimate, was stated in 1973, in a report resulting from two National Marine Fisheries Service (NMFS) sponsored fishery evaluation workshops—one in Moscow, Idaho, and the other in Madison, Wisconsin.

> "It might be argued that the cost of the inefficiencies associated with the current over-capitalization of the industry is a choice by society, and that if society were to so choose, there could be substantial net economic rent generated. However, there is no possibility that anyone can capture this potential net economic rent until institutional changes in the market system are made. If these institutional changes are made, there will be important regional effects and "social effects" (i.e., fishing ports, etc.). Since these changes have not been made, one might assume that the value of these "social

effects" is at least equal to the net economic rent that could be generated from the fishery."2/

Where explicit social choices have been made, net economic rent is analogous with value returns under a hypothetical "most efficient" mode of catching (and processing). Such a mode, at the landings level, might involve, for instance, the utilization of fish traps or seiners. In essence, the argument is that society forgoes these potential economic efficiencies for socio-cultural objectives such as employment, life style, and sub-regional viability—and that these socio-cultural objectives must, in consequences, be worth at least as much as the economic efficiencies foregone. As the above quotation also stipulates, however, it must be demonstrable that such decisions were (are) explicit, and not simply accidental.

With respect to fishers of Columbia River stocks, a substantial body of evidence exists to "reaffirm" the view that explicit tradeoffs do exist between economic and socio-cultural goals in the salmon fishery.3/ It would thus seem possible to develop lower bound dollar estimates for part of socio-cultural value. As noted at outset, however, such estimates represent only one barometer, and will be unable to capture the full richness of socio-cultural goals associated with fisheries. Such dollar values should therefore be used in concert with other non-dollar socio-cultural indicators.

B. The Sport/Recreational Fishery

Some sport/recreational pursuit of salmon/steelhead involves private enterprise (charter boats, guides, etc.). Most, however, involves opportunities that are not bought or sold in private markets. It is therefore necessary to estimate a value—using either direct or indirect assessive methods.4/ The steps in such a procedure are:

1. Define the "product" to be valued (i.e., a fishing day, a recreation day, a year of lost opportunity, etc.).

2. Choose the referent group (the group of people affected).

3. Decide whether the group(s) affected will "gain" or "lose" from the impact. Three cases must be considered.

2/ Idaho Cooperative Fishery Unit, A Report to the National Marine Fisheries Service, on Workshops in Fishery Economics at Moscow, Idaho and Madison, Wisconsin, University of Idaho, 1973, pp. 10-11.

3/ These controls are embodied in the fleet moratoria plans of Washington, Oregon, and California, in the mandate and activities of the Pacific Fishery Management Council, and in recent judicial decisions affecting Indian and non-Indian fishing in the Pacific Northwest.

4/ For a useful baseline discussion of evaluation procedures in this area, see: Idaho Cooperative Fishery Unit, op. cit.; and J.F. Dwyer et al., 1977.

a. Destruction of fishing opportunity (a loss).

b. Restoration of fishing opportunity to make up for previous losses (a value equivalent to the loss).

c. Enhancement of opportunity above normal levels (a gain).

Determination of whether increments to fishery stocks should be considered restoration or enhancement depends critically on what stock levels are considered normal for the river. Biologic definition of normal may tend to relate to historic production levels. User definitions may relate to "first contact", either as a child, or upon coming to the Columbia River area. By either criteria, present levels of Columbia fisheries are judged to be presently well below normal levels. For this analysis, all fishery improvements to pre-McNary Dam production levels will be treated as "restoration to normal levels".

"...the fishery agencies and Indian tribes have determined that the goal of the Northwest Power Planning Council's fish and wildlife program should be restoration of upriver anadromous fish production levels approximating those that could have reasonably been maintained prior to the era of extensive mainstem power development initiated by construction of McNary Dam in 1953."5/

This initial goal of establishing pre-McNary Dam production levels is extremely conservative because anadromous fish losses occurred at many hydroelectric power installations prior to 1953. NMFS will provide amendments to this procedural manual once pre-McNary levels are attained.

4. Calculate net economic value of impact via a demand related willingness/ability to pay approach for real or potential gains, and a supply related compensatory approach for real or potential losses. This calculation builds on (3) above—and follows the economic requirement that losses, (or restoration of previous losses) involve compensatory value calculations on behalf of persons adversely impacted, while fishery enhancement involves evaluation of beneficiaries' ability to pay for gains.6/

5/ Joint submission by fisheries agencies and Indian tribes to the Pacific Northwest Power Planning Council, November 16, 1981.

6/ For a theoretical discussion of this issue, see: E.J. Mishan, 1971, and E.J. Mishan, 1974. For more recent applied discussion, see: P.A. Meyer, 1979, and P.A. Meyer, 1980.

C. The Indian Fishery

It is unlikely that values associated with Indian fisheries can be fully monetized. As with social values in the non-Indian commercial fishery, economic analysis can only be expected to produce a partial estimate of value—likely not the greatest part. Value estimates developed here, and in other sections should therefore be used in concert with other social or cultural indicators. For the present, pending successful development of more effective techniques, it is recommended that the potential net economic estimating methods used for commercial sectors be applied to develop an "in part" estimate of Indian fishery value.

D. Distribution of Catch

It will be noted that under these procedures the full value of commercial, sport, and Indian fisheries is not captured—only the value that can be monetized. Consequently, while these procedures can be used to provide monetary estimates for various Columbia River impacts and projects, they cannot be used to gauge the relative worth of distribution of catch between fishing sectors.

E. Salmon Abundance in the Columbia System

Overall salmon abundance in the Columbia system can affect the values here developed in two ways. First, depending on demand distinctions in commercial and sport sectors it may alter the unit values accruing to species. Second, for commercial catching and processing, it will affect ability to deal with increments or decrements using present capacity. NMFS officials advise that, at present, Columbia River salmon and steelhead stocks are depressed to less than half of normal levels. In fact, this conclusion may prove optimistic in light of a recent report (Columbia River Fisheries Council (CRFC), 1981) suggesting present stock levels to be even more depressed—and that upriver runs may be endangered. That report supplies further justification for the restorative value approach applied here.

F. Variability in the System

The Columbia salmon or steelhead is reared in the river, or in an associated hatchery, must traverse dams on its way to the sea, encounters variable and largely undocumented survival conditions while at sea, and must then face a series of impacts (human, technological, and natural) as it returns to spawn and die. Substantially differing escapement requirements for natural and hatchery fish are permissive of differing levels of catching effort, and where stocks mix, severely threaten natural components or drive catch effort inland into rivers and their tributaries. Social concern alters fishing location for both non-Indian and Indian. As effort shifts inland, fish quality is sometimes diminished—and can affect commercial price. It follows, that if one is examining distributional questions in fisheries—i.e., how many fish each fishery or user group should be allowed—the "averages" approach presented here will not apply. Further, where more specific data is available for sub-area and/or species, it should obviously be used; but only if technicians have the capability to properly validate the data and use it correctly in economic analysis.

A strong argument exists for the present averaging approach on two fronts, however. First, in anadromous fish systems, most impacts involve a cross section of species, fisheries, and/or areas. In such cases, an averaging approach is likely to provide a signal that is both approximately reliable and decisionally useful. Second, in the financially tight 1980's, little money will be available to model every impact in ultimate detail. Consequently, a generic approach that is properly grounded in economic theory, that has considered existing empirical evidence and that provides a timely response capability, will not only prove adequate for many analyses, but also cost effective.

III. Basic Units for Estimating Value

A. Escapement

Escapement is defined as the number of salmon/steelhead needed to reproduce the race and that can actually be counted on the spawning grounds. These fish must therefore "escape" fisheries. Some reproduction will be via natural spawning—other via hatcheries. In each case, biologists will be able to determine the reproductive "escapement" needs of the system.

B. Catch

Under unimpeded conditions, all salmon/steelhead not required for escapement can be caught. Catch statistics are generally available for fisheries on Columbia River stocks, and can be distributed across several beneficiary groupings:

- Marine sport
- Freshwater sport
- Commercial
- Indian

More disaggregated breakdowns than these are often available.

C. Compensating Escapement

On the Columbia River today, additional fish must be allowed to escape from fisheries due to killing of adult salmon and steelhead during upstream passage over dams, and of smolts during downstream migration subsequent to spawning. These impacts are likely of major significance.7/ For this analysis, compensatory escapement is defined as the curtailing or retarding of

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7/ Columbia River Fisheries Council, Draft Comprehensive Plan for Production and Management of Columbia River Basin Anadromous Salmon and Steelhead, September, 1980 (unpublished). This report estimates kills of salmon migrating upstream over Columbia system dams ranging between 2 percent and 20 percent per dam, depending on flow conditions, while downstream mortalities are estimated between 15 percent and 45 percent per dam. See also, Sims and Ossiander, 1981.

the fisheries harvest and corresponding monetary value in order to assure that sufficient numbers of spawners are available for reproduction after allowing for in-river mortality of both adult fish and smolts caused by dams.

The present procedure will enable analysts to evaluate this additional compensatory escapement allowance due to dam-related fish kills, where such impacts can be identified. With correction of passage problems which cause the mortality at dams, mortality could be converted into catch with essentially no change in the number of fish reaching the spawning grounds.

D. Recreation Days

Number of fishing days affected will provide the basic unit for value measurement. These values will then be related to salmon/steelhead via catch per unit of effort data.

E. Annual Opportunity Lost

Where recreational opportunity may be permanently lost from a significant component of the Columbia system; "annual opportunity affected" for all residents of the Columbia River basin would provide the most comprehensive basis for analysis. Recent work indicates that while demand for enhanced fisheries are strongly user oriented—resistance to major declines in abundance is widespread among residents—and is not necessarily correlated with form and intensity of use. As "losses" are beyond the restorative terms of reference of the present document, they will not receive detailed treatment in sections that follow.

F. Price

For commercial fisheries, and as an estimate of the private market potential (only) of Indian fisheries, values will be expressed in dollars per pound at exvessel and processing levels. For sport/recreational fisheries, values will be expressed in dollars per recreation day, and per fish.

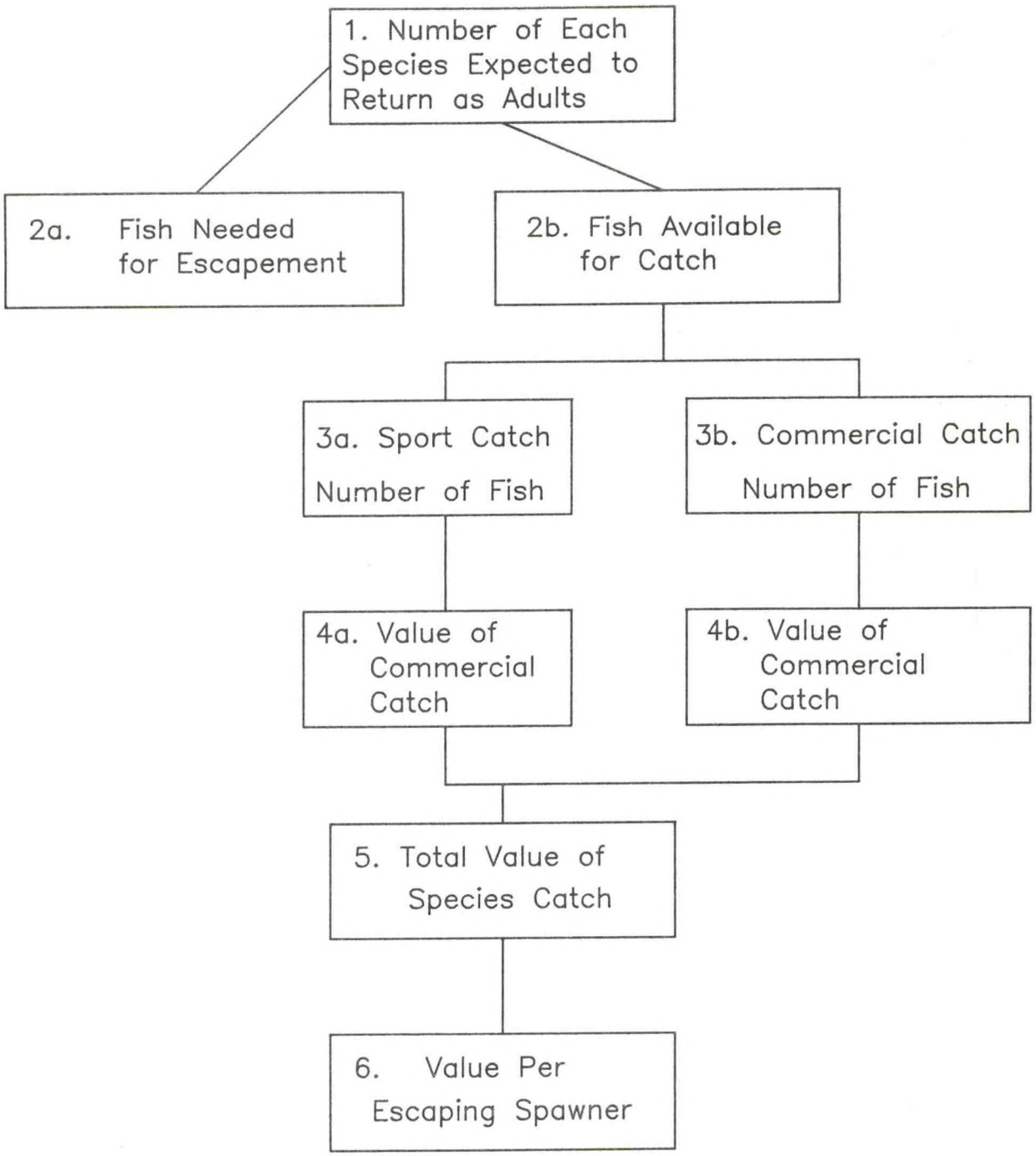
G. Fish Size

In order to obtain commercial values per fish, it is necessary to establish average weights for appropriate Columbia River species. Recent river averages have been selected. These averages may not reflect sizes at each particular productive location—and analysts may wish to substitute more explicit data where available.

IV. Estimating Procedure

The recommended procedure for estimating value is displayed in Figure I. Here, it is essential, in estimating catch, to identify whether the catch/escapement ratios you are using define only the relationship between reproductive needs and catch, or whether they also compensate for deteriorated in-river conditions. This distribution needs to be clear, for "reproductive" escapement is necessary to the continued production of salmon/steelhead in future years. Compensatory escapement on the other hand represents preemption of fishery value by other in-river users, and can

Figure I
Recommended Procedure for Estimating Value



legitimately be identified as value involuntarily foregone by fisheries each year.

V. Data Development

A. Catch/Escapement Ratios

Catch/escapement ratios for Columbia River fisheries were developed using two different procedures. First, if restoration of natural runs only is considered, present catch/escapement ratios from Bonneville pool and the lower Columbia may provide a useful reference point. Second, if higher levels of restored production are to be achieved, hatchery outplants may be utilized to augment natural productivity. These data, developed by NMFS biologists, are displayed in Table I.

Table I

Catch/Escapement Ratios, Columbia River Salmon and Steelhead

Species	Prevailing Production Only	Augmented Production
Spring/Summer Chinook	3 to 1	8 to 1
Fall Chinook (Brights)	4 to 1	8 to 1
Fall Chinook (Tules)	6 to 1	
Coho	7 to 1	14 to 1
Sockeye	2 to 1	2 to 1
Steelhead	2 to 1	4 to 1

NMFS advises that for present purposes, the lower "prevailing only" data should be used. Again, they will advise if the situation changes.

Returns actually realized by fishermen will be less than these levels—to the degree that fish are killed in-river, mainly by dams. Quantitative information on fish kill by dams is only now becoming available (see Note 7). Where information is available to analysts, Table II provides a means of determining the proportion of fish catch so preempted. To use it, simply select assumed per dam survival, and number of dams to be traversed—read off the appropriate proportionate salmon/steelhead mortality.

Table II

Salmon/Steelhead Killed by Dams
—Columbia River Fisheries—

Survival Rate Per Dam	Number of Dams Fish Traverse									
Percent	1	2	3	4	5	6	7	8	9	10
	Proportion of Run Lost									
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	.90	.99	--	--	--	--	--	--	--	--
20	.80	.96	.99	--	--	--	--	--	--	--
30	.70	.91	.97	.99	--	--	--	--	--	--
40	.60	.84	.94	.97	.99	--	--	--	--	--
50	.50	.75	.88	.94	.97	.98	.99	--	--	--
60	.40	.64	.78	.87	.92	.95	.97	.98	.99	.99
65	.35	.58	.73	.82	.88	.92	.95	.97	.98	.99
70	.30	.51	.66	.76	.83	.88	.92	.94	.96	.97
75	.25	.44	.58	.68	.76	.82	.87	.90	.92	.94
80	.20	.36	.49	.59	.67	.74	.79	.83	.87	.89
83	.17	.31	.43	.53	.60	.67	.73	.78	.81	.84
85	.15	.28	.39	.48	.56	.62	.68	.73	.77	.80
87	.13	.24	.34	.43	.50	.57	.62	.67	.71	.75
90	.10	.19	.27	.34	.41	.47	.52	.57	.61	.65
92	.08	.15	.22	.28	.34	.39	.44	.49	.53	.57
95	.05	.10	.14	.19	.23	.26	.30	.34	.37	.40
100	0	0	0	0	0	0	0	0	0	0

B. Distribution of Harvest

As noted, this procedure does not capture the full measure of social and cultural value associated with fisheries—but measures in its commercial sections, only the "potential market value" associated with non-Indian or Indian fisheries. Hence, market valuing procedures are alike, and distribution of catch between Indian and non-Indian is not necessary for commercial valuing sections. Sport/recreation value does utilize alternative valuing techniques—and thus requires (under a recreation day approach) identification of sport/recreation share of harvest. Data in this regard were developed in concert with NMFS staff, and represent historical averages, 1976-1978. No representation is made as to the socio-economic "appropriateness: of this catch division. It is simply the one that has occurred over the three most recent years of statistical record. These data are presented in Table III. 8/

8/ Salmon/steelhead production from the Columbia River is also caught by Canada. Under present "country of origin" negotiations, it is expected that such catch will be credited to the United States. Further, it is the view of fishery managers in both countries that over time, a rough all-fisheries quid-pro-quo has existed on interceptions. It is therefore deemed appropriate to value full Columbia production for analytical purposes.

Table III

Sport Fishermen Share
Of Catch—Columbia River,
1976-78*

Species	Share of Catch %
Spring/Summer Chinook	57
Fall Chinook	20
Coho	36
Steelhead	82[1]

[1] Non-Indian share
* Developed by R. Koski, National Marine Fisheries Service

C. Average Fish Sizes

Fish sizes are necessary to convert from commercial value per pound to value per fish. Weights here utilized were developed by NMFS and are presented in Table IV.

Table IV

Average Weights of Selected Species
Of the Columbia River

Species	Average Weight lb.
Chinook	18
Coho	5
Sockeye	4
Steelhead	10

D. Net Values of Commercially Caught Fish

Net values associated with commercial fisheries represent the total value received at catching, processing, and retailing levels, minus associated costs, taking into account the impact of increases or decreases in stock levels on existing capacity and variable cost inputs. 9/ As noted, pre-McNary Dam levels of production for Columbia River salmon and steelhead will be utilized as a restorative benchmark. As fishermen target different fisheries and/or

9/ As noted earlier, assumptions regarding incremental costs will depend critically on evidence regarding characteristic employment/unemployment levels in fishing, processing, and retailing.

species, it is considered appropriate to aggregate across species in establishing these levels.

1. Below Pre-McNary Levels—The Present Case

a) Fishing Levels

Available data suggests that increased catch could be handled with virtually no increase in fleet (capital) cost.10/ Increments to variable costs would, however, be expected. Considering previous evidence11/ net value associated with catching of this increment is recommended at 91 percent of exvessel value.

b) Processing Levels

At processing levels, actual data is sparse, and analysis would benefit from further empirical study. Based on discussions with knowledgeable persons associated with the industry, it is believed that existing capacity in fish processing would be sufficient to handle additional salmon and steelhead up to pre-McNary levels.12/ Variable costs would likely increase, however. NMFS national data suggests that variable costs may range between 46 percent and 50 percent of processing value increment, exclusive of fish purchases (Penn, 1980). Here, gross value will be reduced by 48 percent, the mid-point of this range, to obtain net value in processing.

c) Retailing Levels

Here, data specific to the Pacific Northwest is even less available. It has been suggested that changes in levels of Pacific salmon stocks may have value impact at retail levels (Brown et al., 1976). However, present data is not sufficient to meet the test of "explicit demonstration" cited earlier. Therefore, no net value will be associated with retailing activities in our present analysis. This is the most conservative assumption that could be made.

2. Above Pre-McNary Levels—The Enhanced Fishery Case

a) Fishing Levels

Increased catch above pre-McNary levels would likely

10/ See, for example, Petry 1979, pp. 52-53. See also, data in: Oregon State University 1978 and Barclay and Morley 1977.

11/ From Barclay and Morley 1977, Crutchfield, et al. 1965, Richards 1968, and Environment Canada 1974.

12/ For example, W. Jensen, West Coast Fisheries Development Foundation.

require both a larger fleet (capital) and additional variable cost inputs. Using data from Petry (1979), it is recommended that exvessel value be reduced by 55 percent to obtain net value for this increment.

If partial socio-cultural values are included, and following the logic of Section IIA, work by Fry (1962), Crutchfield et al. (1965), Richards (1968), and Environment Canada (1974) suggests a recommended exvessel value of 87.5 percent of gross return.

b) Processing Levels

At processing levels, it is concluded that both capital and labor will need to increase. Again using national data (Penn 1980), a net value equivalent to 6 percent of the enhanced processing increment is recommended. This corresponds to estimated average net profit before taxes.

If partial socio-cultural values are considered, work by Environment Canada (1974) suggests a first order approximation of 50 percent of wholesale (processing) increment as an estimate of net value.

A summary of recommended procedures is provided in Table V.

Table V

Recommended Net Value Procedures for Columbia River Commercial Fisheries

Net Value Increments	Levels of Abundance Below Pre-McNary Levels	Above Pre-McNary Levels	
	Economic	Economic	Economic & Soc.-(1)
	(1)	(2)	(3)
Exvessel	-Exvessel price x .91	-Exvessel price x .45	-Exvessel price x .875
Processing	-Wholesale increment x .52	-Wholesale increment x .06	-Wholesale increment x .50

(1) Only a partial socio-cultural value is captured by this process.
* These values cannot be used to value fishery losses.

Only the procedures of column (1) are presently appropriate. As noted, NMFS will provide advice when stocks reach pre-McNary levels, rendering columns (2) and (3) appropriate.

E. Markup to Processing

No consistent set of pricing statistics exist for Columbia River salmon beyond the exvessel level. Consequently, markup factors to processing levels are provided for convenience. Markups to processing are developed via reference to Oregon State University (1978), Petry (1979), and fisheries statistics of British Columbia.13/ Recommended markups are presented in Table VI. Again, only column (1) figures are presently appropriate.

Table VI

Recommended Average Price Markups, Exvessel Price to Processing—Columbia River Fisheries

Species	Exvessel Price(1)	Wholesale Price
	---------Estimated $ Per Pound-------	
Chinook	1.65	2.48
Coho	1.47	2.35
Sockeye	1.42(2)	3.27
Steelhead	1.42	3.13

(1) These data are used on statistical averages for 1978-80, and were supplied by NMFS

(2) Estimated--Recent prices not available.

F. Commercial Value Per Fish, Columbia River Salmon and Steelhead

Combining Tables IV, V, and VI, it is now possible to provide average recommended comercial values for Columbia River salmon and steelhead. This is done in Tables VII through X.

13/ Department of Fisheries and Oceans, Fisheries Statistics of British Columbia, Vancouver, 1978.

Table VII

Average Recommended Commercial Values—Columbia Chinook

Net Value	Levels of Abundance: Below Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic & Socio-Cultural (1)
	$	$	$
Exvessel	27.03	13.36	25.99
Processing	7.77	.90	7.47
Total Commercial Value	34.80	14.26	33.46

(1) Only a portion of socio-cultural value is captured by this process.

Table VIII

Average Recommended Commercial Values —Columbia Coho

Net Value	Levels of Abundance: Below Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic & Socio-Cultural (1)
	$	$	$
Exvessel	6.69	3.31	6.43
Processing	2.29	.26	2.20
Total Commercial Value	8.89	3.57	8.63

(1) Only a portion of socio-cultural value is captured by this process.

Table IX

Average Recommended Commercial Values
—Columbia Sockeye

Net Value	Levels of Abundance: Below Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic & Socio-Cultural (1)
	$	$	$
Exvessel	5.17	2.56	4.97
Processing	3.85	.11	3.70
Total Commercial Value	9.02	2.67	8.67

(1) Only a portion of socio-cultural value is captured by this process.

Table X

Average Recommended Commercial Value
—Columbia Steelhead

Net Value	Levels of Abundance: Below Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic	Above Pre-McNary Levels, Economic & Socio-Cultural (1)
	$	$	$
Exvessel	12.92	6.39	12.42
Processing	8.89	1.03	8.55
Total Commercial Value	21.81	7.42	20.97

(1) Only a portion of socio-cultural value is captured by this process.

G. Values for Columbia River Sport Fishing/Recreation

1. Enhancement of Recreational Stock Levels

Where the issue examined involved gains to sport fishermen/recreators because existing stocks are being increased above "normal" levels (see B.3.c.), a measure of consumer demand—traditionally defined as "willingness/ability to pay" for the enhanced product—is theoretically required. As noted, at presently depressed levels for Columbia stocks, this approach will apply once pre-McNary stock levels have been reached. Common practice has been to focus such analysis upon users—and to provide values

per recreation day. That practice will be continued here.

The former U.S. Water Resources Council (1979), established as a matter of convenience, a numeric table, to be referenced for a myriad of small and relatively unimportant analyses—saving agencies the expense of conducting actual studies in each instance. Where a regional input-output model was unavailable (the usual case), WRC called for use of the numeric table; (i) where a specialized recreation activity was not involved, (ii) where less than 500,000 annual visits were affected, or (iii) where recreation-specific costs were expected to amount to 25 percent or less of all costs for the project being evaluated. Largely as a result of the first criteria, the WRC numeric tables would seem to have little application to Columbia River salmon and steelhead recreation. Further, when the values provided in the WRC's 1980 pronouncement are compared to those supplied by the same body in 1973—and inflation is considered—a drop in real value of approximately 50 percent results. This does not appear rational. The WRC 1980 values will be included in this document for completeness, but with the numbers doubled to maintain real value equivalence over the period since 1973 (see Table XV).

Where specific data is required, it may not, however, be necessary to go to the expense of original data gathering in each case. Where significant impact upon salmon and steelhead recreation from the Columbia system is expected, project-specific data should be gathered. However, where impact is judged to be potentially "important, but in a moderate range," it may be effective to rely on previous direct information of relevance to Columbia River salmon and steelhead recreation. Such reliance would recognize potential impact as significant, would be area-specific, and would provide a timely and relatively inexpensive response. It is for such a purpose that the present document has been developed.

Direct data concerning demand-related values for salmon and steelhead sport fishing in the Pacific Northwest has been produced by Brown, Singh and Castle (1964), Gordon (1969), Brown et al. (1976), Brown, Charbonneau and Hay (1978), Crutchfield and Schelle (1978), and Brown, Sorhus and Gibbs (1980). Early data was summarized by Tuttle et al. (1975). These data are arrayed in Table XI, and updated to 1980 price levels using data from the U.S. Department of Labor.

Table XI

Area Specific Estimates of Demand-Related Sport Fishing Values--Pacific Northwest

Author	Recreational Product	Year Data Collected	Base Year Value	Value in 1980 Dollars
			---$ Per Recreation Day---	
Brown/Singh/ Castle	Oregon Salmon & Steelhead	1962	13.70	39.02
Gordon	Idaho Salmon	1968	8.00	19.81
	Idaho Steelhead	1968	15.00	37.14
Brown/ Charbonneau Hay	U.S. Fishing (excluding river salmon)	1975	22.00	35.20
	River Salmon & Steelhead	1975	51.00	81.60
Tuttle/ Richards/ Wahle (Summary)	Columbia Salmon & Steelhead	1975	45.00	63.94
Brown/Sorhus/ Gibbs	Pacific Northwest Salmon & Steelhead	1977	45.00	63.94
Crutchfield/ Schelle	Washington Ocean Salmon	1978	18.19	24.01

These data diverge considerably, dependent in part on location, catch, and level of fishing effort. Assumptions used by various authors in qualifying data will also affect results.14/ In sum, it is our judgment that the estimate by Brown, Sorhus, and Gibbs, suitably updated, should be used for estimation of the value of enhancing Columbia River stocks for recreation. The data is current, is the most proximate to the area of evaluation and lies within the range of available empirical estimate. A value of $64 per recreation day is therefore recommended for sport fishing gains above normal levels, where "minimum values" are not appropriate.

Conversion of sport fishing value per day to value per fish is not straight-forward. Relationship of fish value to day value will be affected by such parameters as the fish's size, meat texture and fighting qualities, catch per unit of effort, other natural attributes of the fishing site, and crowding

14/ For instance, the $500 cutoff for permitted answers used by Crutchfield and Schelle in 1978 is equivalent, in constant dollar terms, to a $232 cutoff in 1962--and is likely responsible for the relatively low values received.

(Bryan 1974). No single comprehensive data set addressing this issue has been developed in the Pacific Northwest. Such information could be developed inexpensively, and should be a high priority research target. It will therefore be necessary in this document to use judgment—utilizing such partial data as is available, and reserving more definite treatment, until a more comprehensive empirical base becomes available. Notwithstanding these difficulties, the present procedure represents a significant improvement upon the approach utilized in 1975.

Data from NMFS suggests the following effort in days expended per fish, by species.15/

	Days per Fish
- Spring chinook	6.9 to 1
- Summer chinook	6.9 to 1
- Fall Chinook	1 to 1
- Coho	1 to 1
- Steelhead	5 to 1

Sport fisheries for spring/summer chinook and for steelhead largely occur in-river, and likely provide a "roughly similar" experience in terms of environment of targetted fish. Consequently, differential catch per unit of effort may provide an approximation of relative value. Fall chinook and coho, however, are largely caught in the ocean, where the fishing environment is markedly different, where, in the case of coho, fish size is markedly different, and where catch success is much higher. Consequently, it is not possible to take catch per unit of effort as solely indicative of relative value between in-river and ocean fisheries. Rather, direct evidence on the relative value of recreation days in ocean and in-river was sought. Raw data from Brown, Sorhus, and Gibbs (1980) suggest that the value of recreation days is greater in the ocean by a factor exceeding three times. Data is not adjusted for length of trip, however, and ocean trips reported in the study are longer. Adjusting on the basis of raw data provided in that report,16/ a first estimate differential value of 2.5 will be used between day values in ocean fisheries and those in-river. Value per recreation day can now be converted to value per fish as follows.

$$(1)\quad V_{fo} = V_d D_{fi}$$

$$(2)\quad V_{fr} = \frac{V_d D_{fi}}{2.5}$$

where V_{fo} = value for fall chinook and coho, respectively.

V_{fr} = value for spring chinook, summer chinook and steelhead, respectively.

15/ Merritt E. Tuttle, by letter of February 5, 1982.

16/ Again, data was not reported in directly useable form, and adjustment can therefore only be approximate.

V_d = the selected day value = $64.00.

D_{fi} = days of effort per fish, for each species.

Applying these procedures to previous data, the following values per fish are obtained (Table XII).

Table XII

Recommended Value per Columbia River Enhanced Sport Fish

Species	Value per Fish $
Spring/Summer Chinook	177
Fall Chinook	64
Coho	64
Steelhead	128

These values attempt to capture the value conjunct of fishing quality, stock availability, fishing experience, and numbers of anglers supported at differing fishing locations. Again, it must be emphasized that these data are preliminary. While superior to those developed in 1975, immediate work should be undertaken to provide a firmer empirical basis for calculation.

Finally, because techniques used in this report are not equally comprehensive in valuing recreational, commercial and Indian fisheries, they cannot be used as a basis for reallocating fish between these fisheries. Rather, they are to be used to evaluate general enhancement of Columbia River stocks, or specific recreational enhancement that is achieved without penalty to other fishing sectors. These values will apply once pre-McNary stock levels are attained.

2. Sport Fishing/Recreational Value Associated With Restoration of Previous Losses to Columbia River Stocks

As noted, if recreational gains are to be valued by a "willingness to pay" technique, then conceptually, recreational losses or compensatory action stemming from previous losses (restoration) must be valued according to losers' required levels of compensation. With Columbia River stocks at extremely depressed levels—where present gains represent restoration of previous losses, compensatory valuation should apply. The WRC, noting a paucity in development of compensatory technology on a national basis, called for continued development of such technology, and recommended that "willingness to pay" estimates only be displayed in the net economic development (NED) account in the iterim (Water Resources Council, 1980). At the same time, its guidelines for the Environmental Quality (EQ) Account called for impact display by best available method, and in the Other Social Effects Account (OSE) by available methods including dollars.

Fortunately, while compensatory technique has had limited national application, it is well advanced in the Pacific Northwest. As early as 1970, Mathews and Brown developed compensatory estimates for Washington sport fishermen using 1967 data. More recently, Crutchfield and Schelle (1978) have produced similar data for the Washington ocean fishery. These data are reproduced, and updated to 1980 price levels, in Table XIII.17/

Table XIII

Compensatory Values for Pacific Northwest Sport Fisheries 1980 Values

Author	Recreational Product	Date of Study Data	Base Year Value --$ Per Recreation Day--	Value as of 1980
Mathews/ Brown	Washington Salmon & Steelhead	1967	47(1)	121
Crutchfield/ Schelle	Washington Ocean Fishing	1977	75(2)	107

(1) Average for ocean and fresh water.
(2) Estimate using $2,000 edit.

These data sets are not strictly comparable, with the findings of Crutchfield and Schelle more conservative in present real terms. They do, however, provide a range of value from which analysts in the Pacific Northwest can work. For present analysis, the more conservative (updated) figure of $107 per recreation day is recommended—pending further development of information.

Proceeding as for enhanced stocks (Section G, 1 and Equations (1) and (2) it is again possible to calculate compensatory values per fish (Table XIV).

17/ Further compensatory data, as yet unpublished, has been developed for the Columbia River itself.

Table XIV

Recommended Value Per Columbia River Restored Sport Fish 1980 Values

Species	Value Per Fish $
Spring/Summer Chinook	295
Fall Chinook	107
Coho	107
Steelhead	214

Finally, it should be noted that the data provided in Table XIV target restoration of fisheries only. Annual values will be much higher where one is dealing with complete loss of a recreational fishery for all time. In such a case, data on salmon and steelhead recreation from the Fraser River in British Columbia (Meyer, 1978), and the Sacramento/San Joaquin system in California (Meyer, 1980), indicate that when contemplating a permanent loss of sport fishing opportunity in their area, a majority of residents will be unwilling to tolerate such loss at any price. These findings apply not only to sport fishermen, but all residents in the area of impact.

3. Evaluation of Sport Fisheries of the Columbia River—A summary

We are now in a position to specify the various general conditions that analysts may encounter in evaluating sport fishing/recreation respecting restoration and enhancement of Columbia River salmon and steelhead and to recommend a value approach for each. This is done in Table XV.

Table XV

Recommended Value for Impacts on Sport Fishing/Recreation
Associated with Columbia River Stocks
1980 Values

Type of Impact	Value Per Fish: Spring/ Summer Chinook	Fall Chinook	Coho	Steelhead	Referent Group
	$ Per Fish Per Year				
(1) Impact is on non-specialized recreational activity and is relatively insignificant (1)	Up to 72	Up to 26	Up to 26	Up to 52	Users
(2) Impact restores significant fishery recreation previously lost	295	107	107	214	Users
(3) Impact enhances significant fishery recreation above normal levels	177	64	64	128	Users

(1) Developed from Water Resources Council, Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C; Final Rule), op. cit., p. 72962.

It should be recalled that the values of Row (2) in the Table should be used to evaluate significant impacts until pre-McNary stock levels are reached. As previously noted, should stock levels be restored to that level, the values from Row (3) would then apply.

VI. The Net Monetary Value of a Columbia River Salmon or Steelhead

Recommended commercial and sport values can now be combined with catch/escapement data from Table I and fishery share data from Table III, to provide an analysis of net value per spawner for each species. This is done in Figures II through VIII, and is appropriate for significant restorative impacts on present "below pre-McNary" stock levels.

Not all value identified here will necessarily reach fishermen. Fish kill by dams and other impediments has worked to preempt value returns. Where kill rates can be estimated, analysts can calculate the level of annual dollar

losses due to such mortalities by applying the data of Table II to figures on total value of catch, or catch per escaping fish, in Figures II through VIII.

Finally, users of this procedure are again reminded that the values developed here represent only the economic potential of Columbia salmon and steelhead. No representation is made that they adequately convey the socio-cultural importance of fisheries for commercial fishermen, sportsmen/residents, or Indians. For this reason, they are useful in presenting the average value of Columbia River fisheries as a whole—but cannot be used to compare the value of one fishery or species relative to another.

Figure II

Net Monetary Value Per Escaping Columbia River Spring Chinook

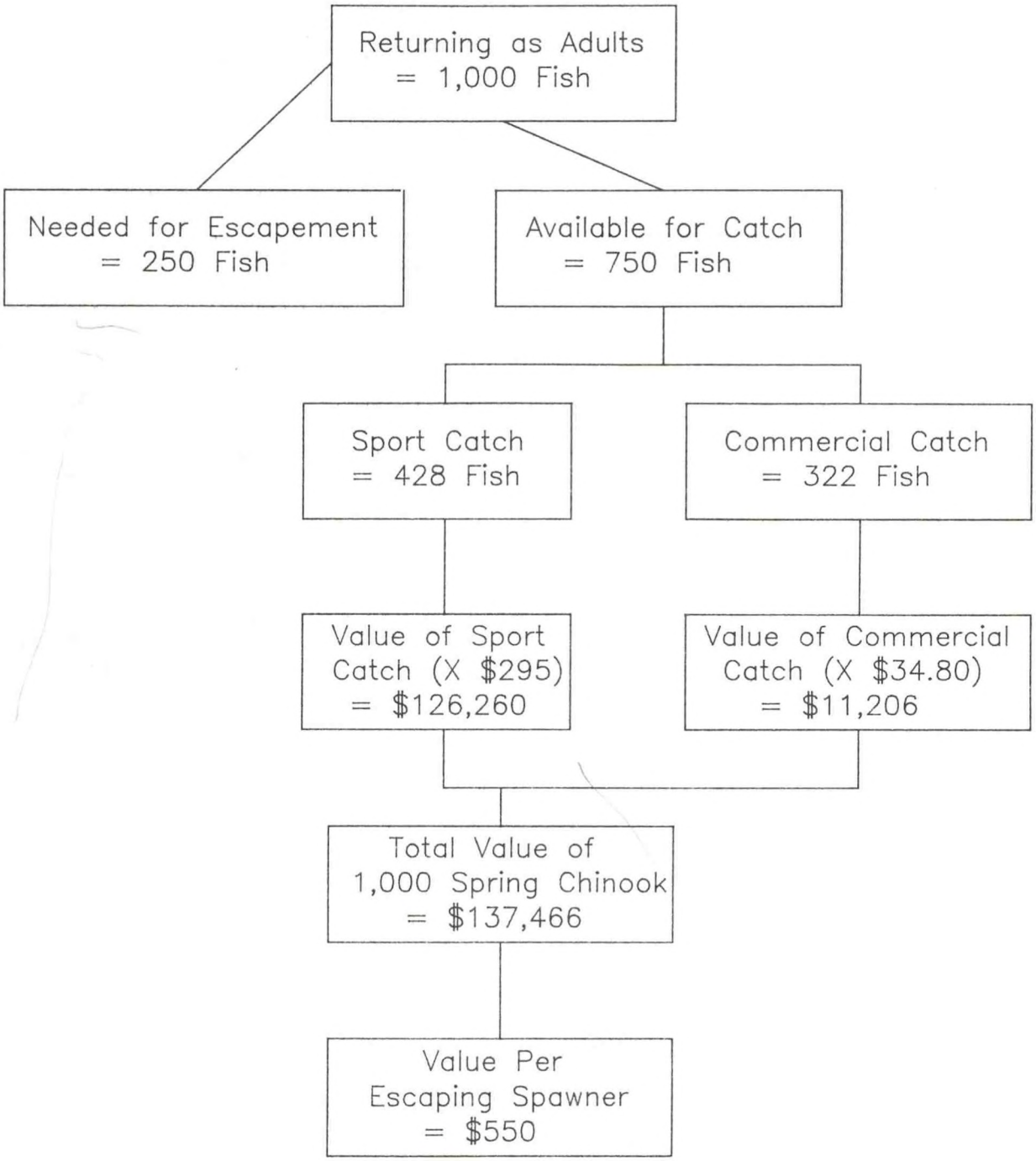


Figure III

Net Monetary Value Per Escaping Columbia River Summer Chinook

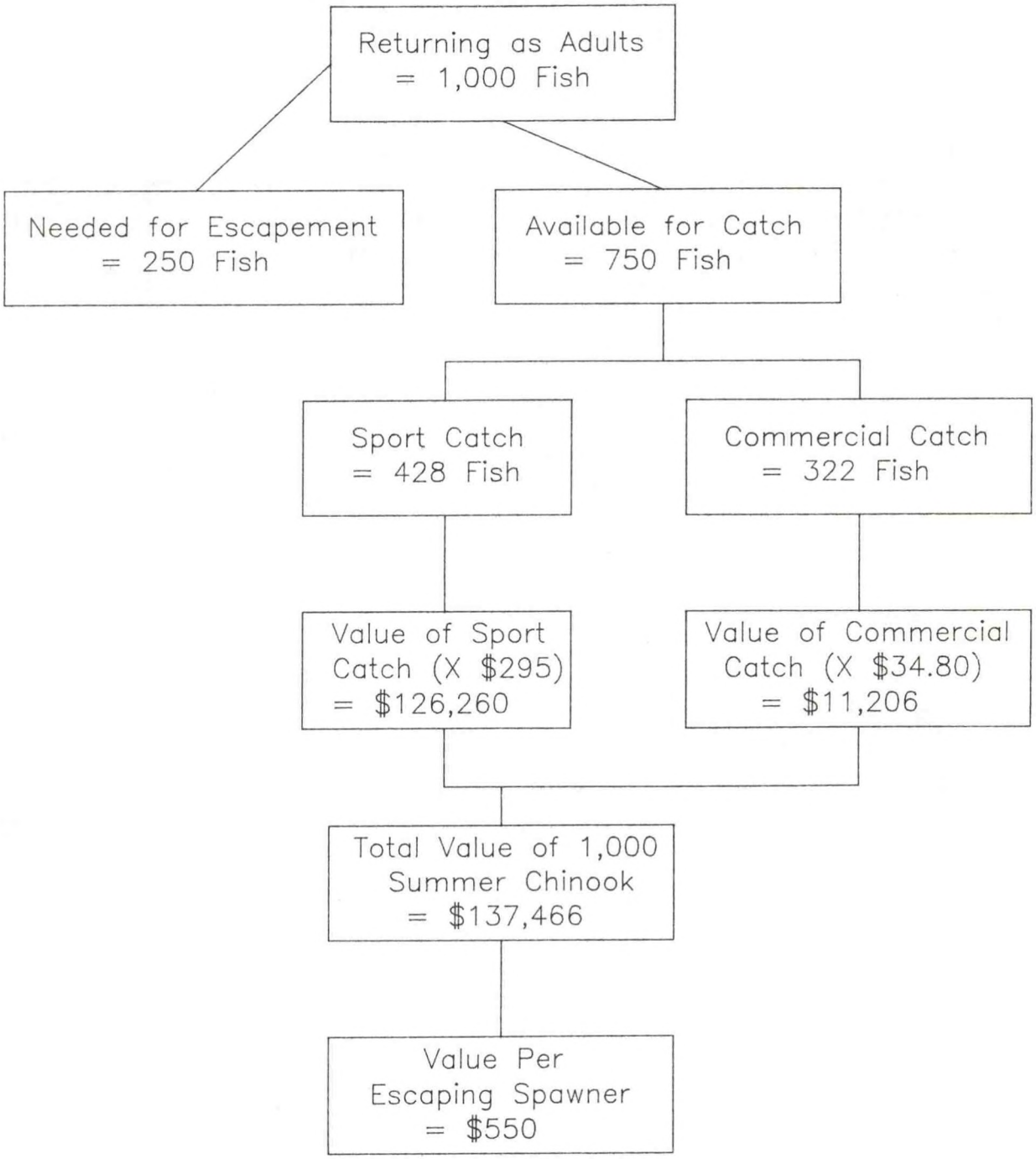


Figure IV

Net Monetary Value Per Escaping Columbia River Bright Fall Chinook

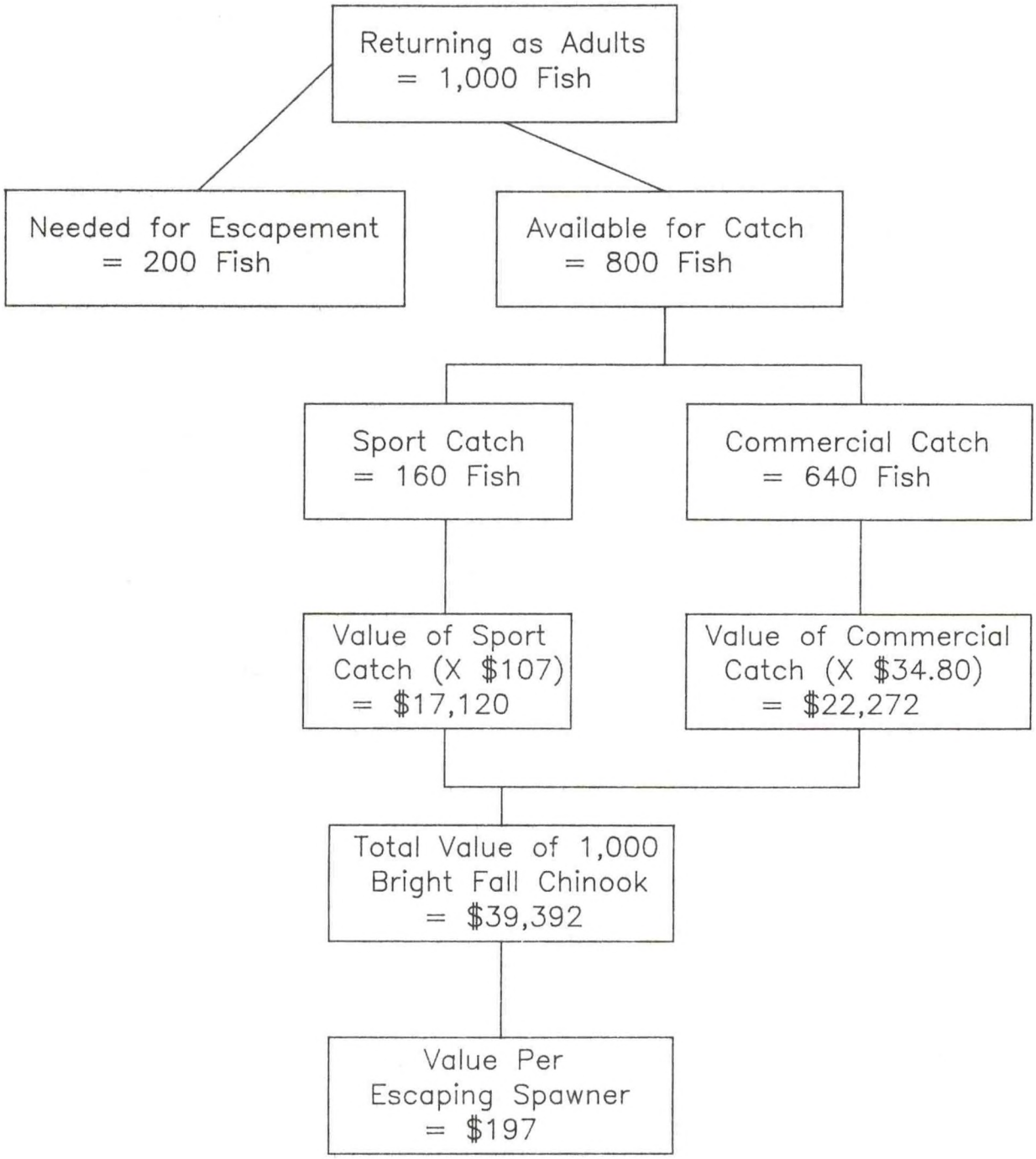


Figure V

Net Monetary Value Per Escaping Columbia River Fall Chinook Tules

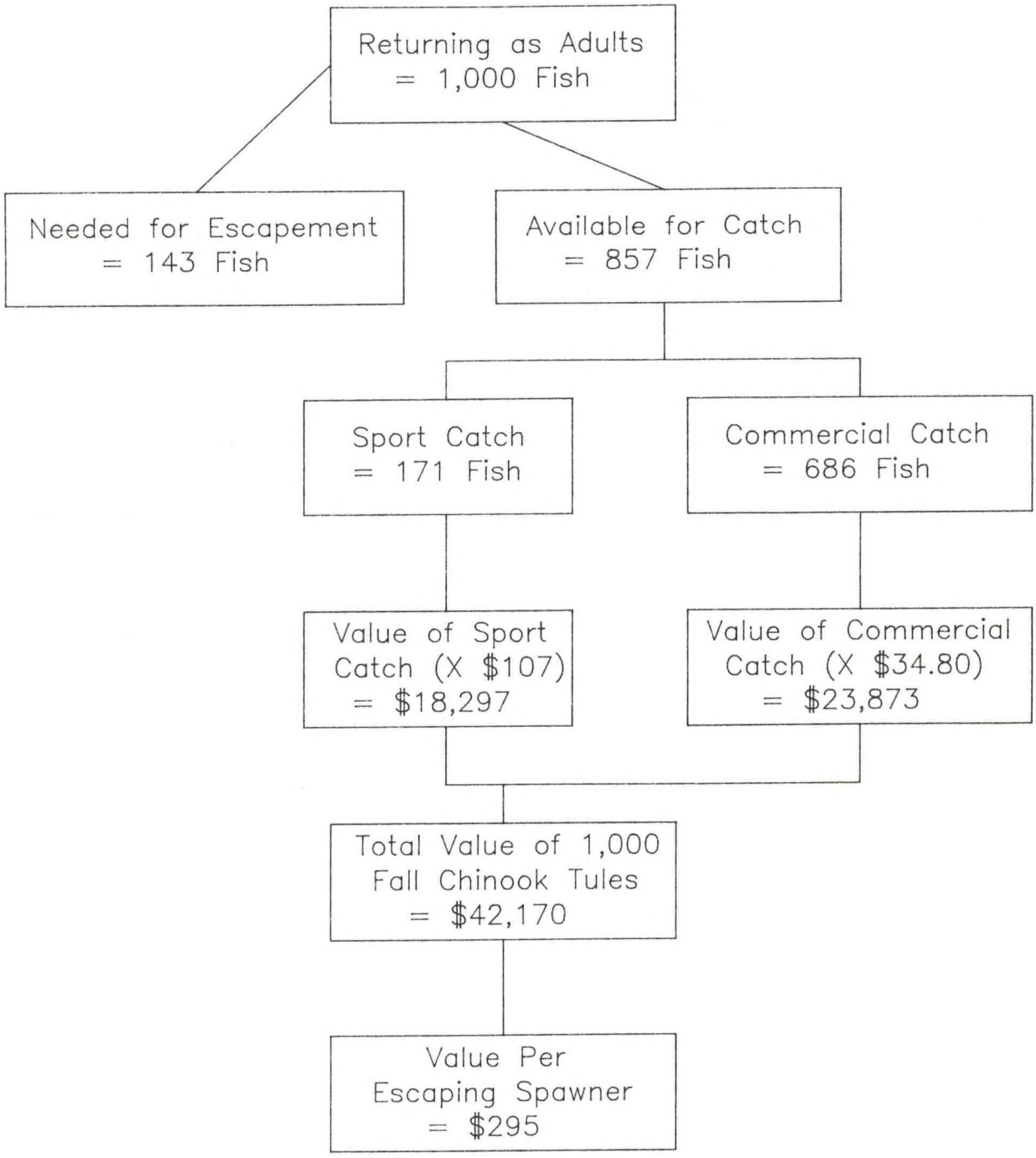


Figure VI

Net Monetary Value Per Escaping Columbia River Coho

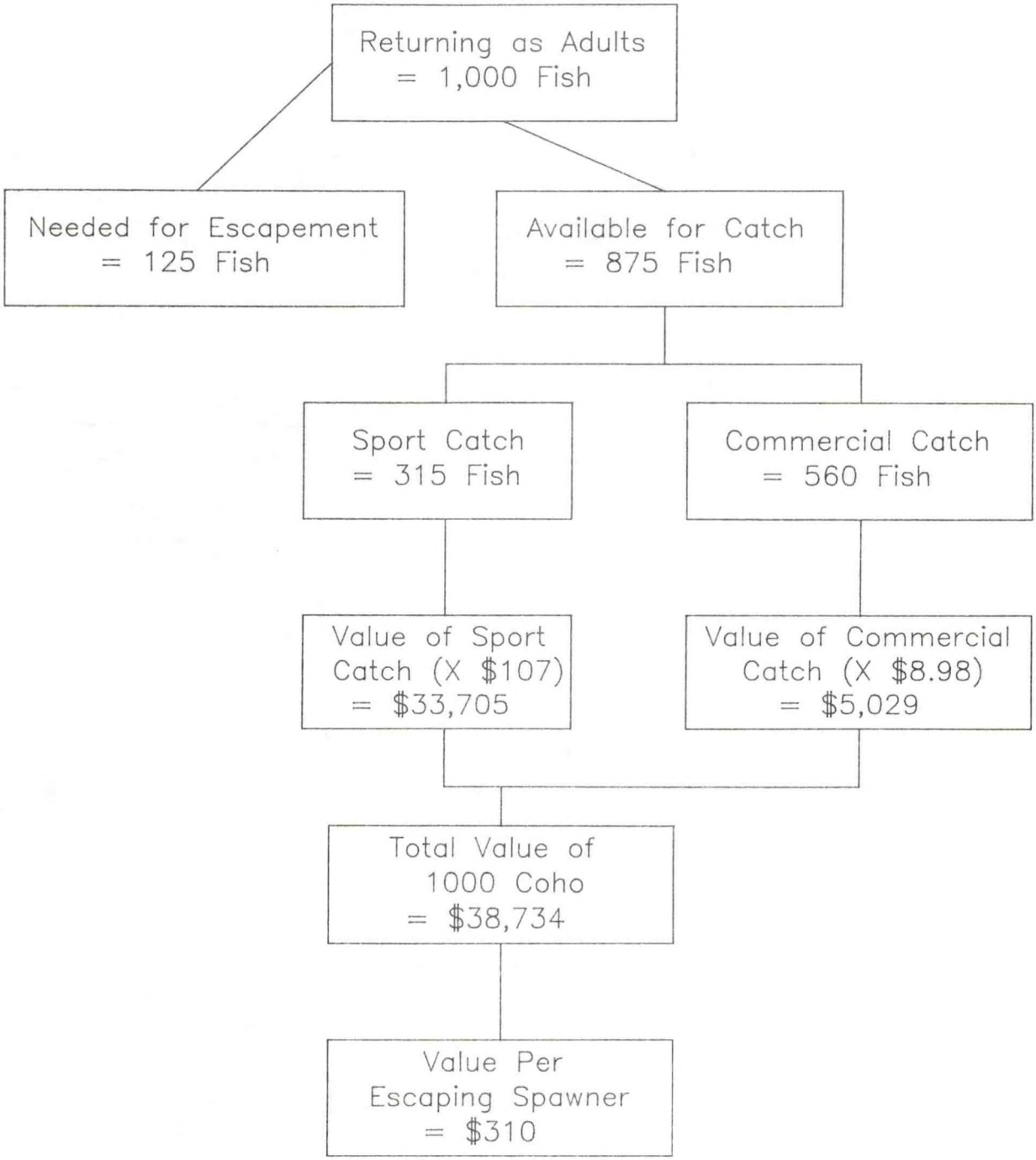


Figure VII

Net Monetary Value Per Escaping Columbia River Sockeye

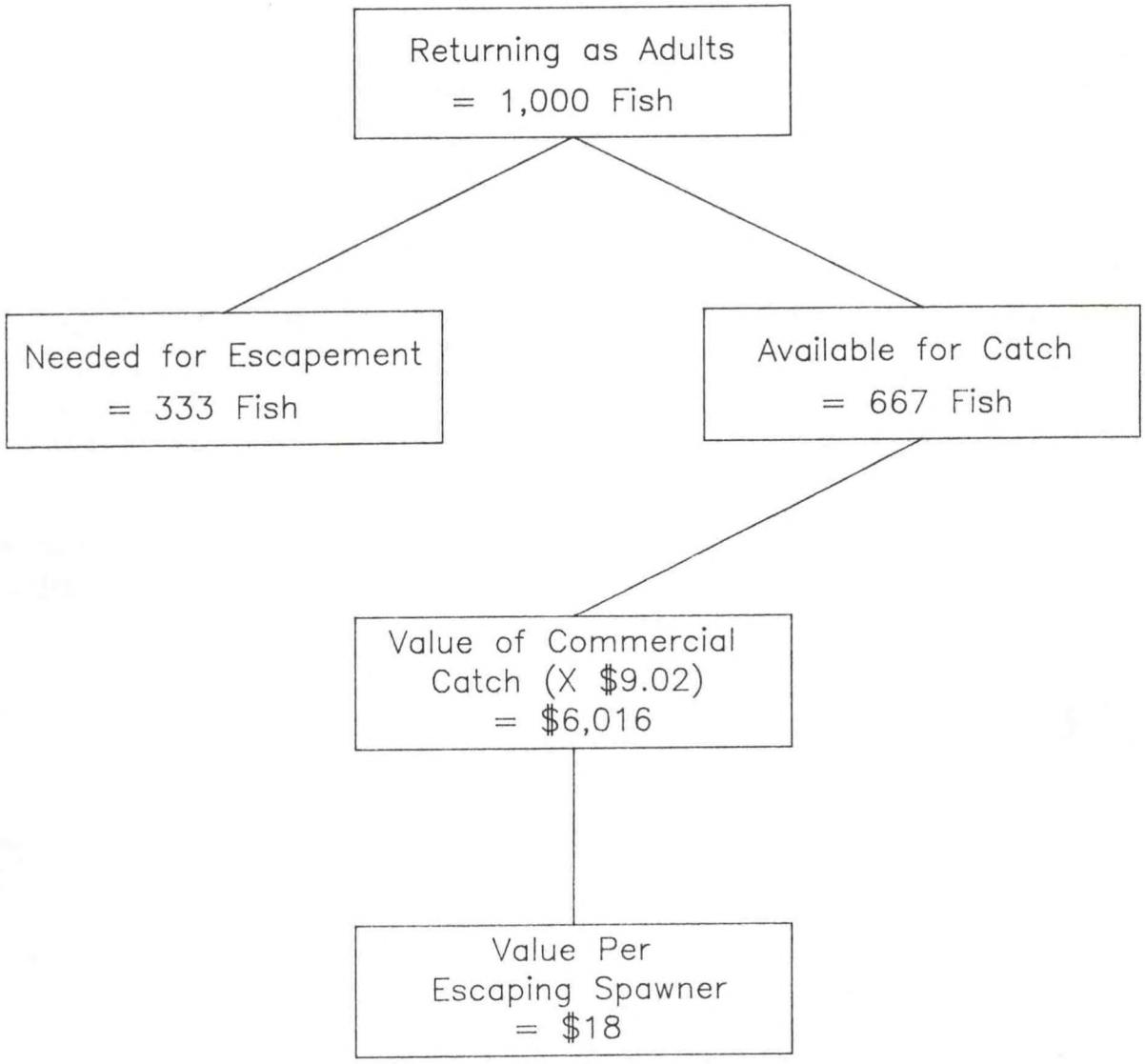
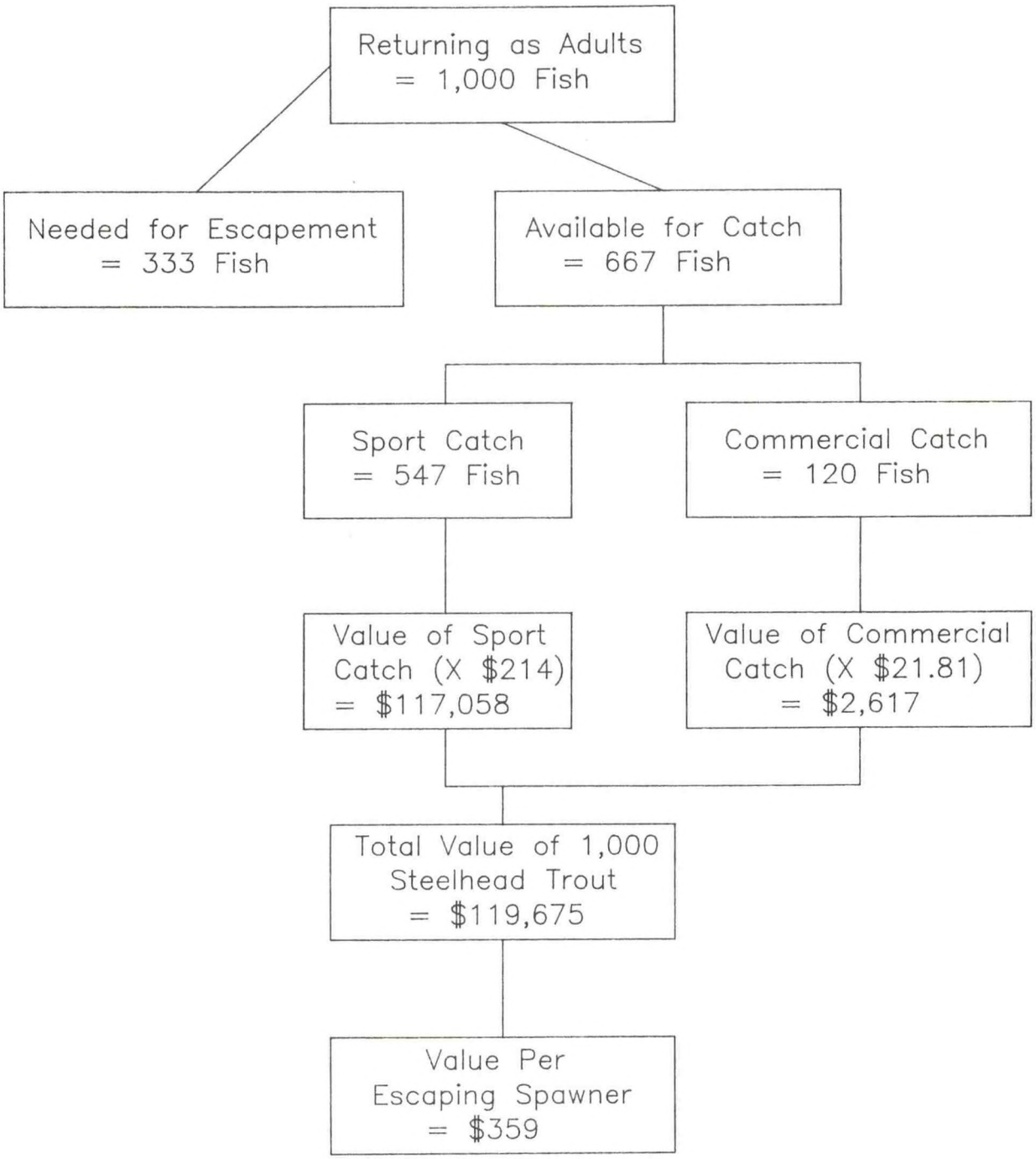


Figure VIII

Net Monetary Value Per Escaping Columbia River Steelhead Trout



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