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DEPARTMENT OF GAME
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MEMORANDUM

TO: All Parties Interested in Washington's Trout Resources

FROM: Frank R. Lockard, Director

DATE: April 10, 1984

SUBJECT: A Basic Fishery Management Strategy for Resident and Anadromous Trout in the Stream Habitats of the State of Washington

The Department of Game technical staff has been working for some time on detailed methods for managing trout populations in streams. The product of this effort is reflected in the attached draft report. We would appreciate your review and consideration of the information and recommendations provided in the document. Primary emphasis is directed toward the basic conservation requirements of self-sustaining natural trout populations. An important supporting reference entitled "A Summary of Salmonid Hooking Mortality" is available upon request from any Game Department office.

We welcome your comments on this serious and complex fishery management subject. As stated in the schedule on page 2 of the draft, a number of opportunities will be provided for public input. Testimony relative to the strategy can be given at any of the regional meetings that will be held throughout the state during the month of June. A specific schedule will be provided as soon as the times and places for these meetings are firmed-up. Additional time for public testimony will be provided when the Game Commission considers the strategy at their October 10 meeting in Clarkston. Written comments on the strategy can be provided at any time.

We believe that the proposed management strategy constitutes one of the most comprehensive treatments of self-sustaining stream trout populations ever attempted. Your interest in the conservation needs of these important natural resources is certainly appreciated.

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Attachment

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A BASIC FISHERY MANAGEMENT STRATEGY FOR RESIDENT AND ANADROMOUS TROUT IN THE STREAM HABITATS OF THE STATE OF WASHINGTON

Prepared by the Fisheries Management Division,
Washington State Department of Game

INTRODUCTION

Stream habitats in the State of Washington present an exceptionally diverse array of trout populations that challenge skills of the professional fishery manager. Intent of the following report is development of a basic stream management plan recommendation for meeting the Washington Game Commission's Title 77 legal mandate to preserve, protect, and perpetuate the wildlife of the State of Washington, while maximizing public recreational opportunities.

A Washington Department of Game staff commitment for such a plan was initially made to the Commission in August 1983. The first section of this report will present a proposed time frame for development, consideration and adoption of this plan. This will be followed by sections dealing with unique features of stream angling, its potential in Washington and the need to separate lake management of trout from stream management. Basic population management requirements will then be presented (as contrasted to "trophy" fish management) and critical genetic/habitat concerns will be discussed. The main body of the report will deal with regulatory strategies for four "groups' of trout populations - migratory resident fish, steelhead, non-migratory resident fish, and sea-run cutthroat. The proposed mechanics of implementation will follow along with a statement of need for a stream trout catch reporting system. A separate report will deal with the specific subject of gear-induced mortalities on trout.

Supporting technical data will not be presented in a comprehensive manner but will be limited to representative examples illustrating the basic factors discussed. Where different points of view were discovered, these will also be presented regardless of whether or not they agree with recommendations contained in this report. Current regulations were given serious consideration as viable options based on their respective merits but were not accorded a "special" status because of their current use or tenure.

It will be necessary to decide on a basic fishery management strategy before specific proposals for individual waters can be developed. These processes cannot be done simultaneously. For this reason, the following sequence of events is proposed:

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TIMETABLE FOR PRESENTATION OF A BASIC FISHERY MANAGEMENT STRATEGY FOR 1986 SEASON

February 1984	Division and Regional Fisheries Management staff put together basic goals and policies for total drainage fisheries management, incorporating resident and anadromous fish resources
March 1984	Administration reviews product
March 1984	Internal mailings of statewide fishery management strategy proposal to Regional and Division staffs, all Wildlife and Control Agents, all Fish Biologists, all hatchery installations, all Habitat Biologists, I & E
March 1984	Briefing of Game Commissioners
March-April 1984	Regional meetings (Division presents 1986 strategy proposal)
April 1984	Sports clubs', press, and individual mailing of 1986 strategy proposal
April-May 1984	Presentation of strategy proposal to presidents of organizations at quarterly meetings
June 1984	Public Meetings: Regions present 1985 season proposals and Division presents statewide 1986 strategy proposal.
August 1984	Commission hears 1985 season proposals only
October 1984	Presentation to Commission of statewide fishery management strategy proposal for endorsement
February 1985	Annual biologist meeting to discuss specific implementation recommendations to ensure consistency with basic fishery management strategy
March-April 1985	Develop season recommendations for 1986 based upon strategy; include other regulation changes that are needed
May 1985	Administration reviews recommendations
June 1985	Hold public review around the state on 1986 season recommendations
July 1985	Division incorporates public comment into 1986 fishing season recommendations and submits to Administration for review and approval for presentation to the Commission
August 1985	Present 1986 fishing season recommendations to the Commission. This presentation will include specific recommendations that incorporate the goals and policies for total drainage fisheries management

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THE FLOWING STREAM - A UNIQUE ANGLING EXPERIENCE

The lure of stream fishing is exemplified by the following passage from Mullan (1961):

> "To many anglers, trout fishing means stream fishing. While such anglers generally recognize the fact that bigger trout are available in ponds, and that the ponds have a better potential for producing trout fishing in this state, the lure of the streams ever calls them back. To these anglers, pond trout fishing with its implied waiting is no substitute for the charms of stream fishing. The expectation that lies just around the next bend, the feel and roar of white water, the skunk cabbage emerging from its winter sleep are but a few of the many ever-changing attractions encountered in the pursuit of trout in ocean-bent waters."

In areas where angler preference studies have been conducted, trout fishing in streams was accorded a high priority and demand typically exceeded available fishing opportunities. For example, the Idaho Department of Fish and Game (1980) states that:

> "Streams make up only one-fifth of the surface acreage of water in Idaho but they support nearly half of the fishing pressure and are preferred by nearly 60 percent of Idaho anglers." (Figure 1)

Available data indicate that Washington residents are doing a substantial amount of stream fishing in other states. For example, in four study areas on the Henrys Fork of the Snake River, non-residents comprised 60, 61, 80, and 89% of the anglers sampled (Rohrer 1983). All Idaho reports examined showed that Washington residents were the main component of their non-resident category. In spite of "losing" some stream fishing recreational benefits to other states, Washington still has an impressive volume of angler use. A 1980 national survey by the U.S. Departments of Interior and Commerce (1982) showed the following use statistics for freshwater recreational fishing:

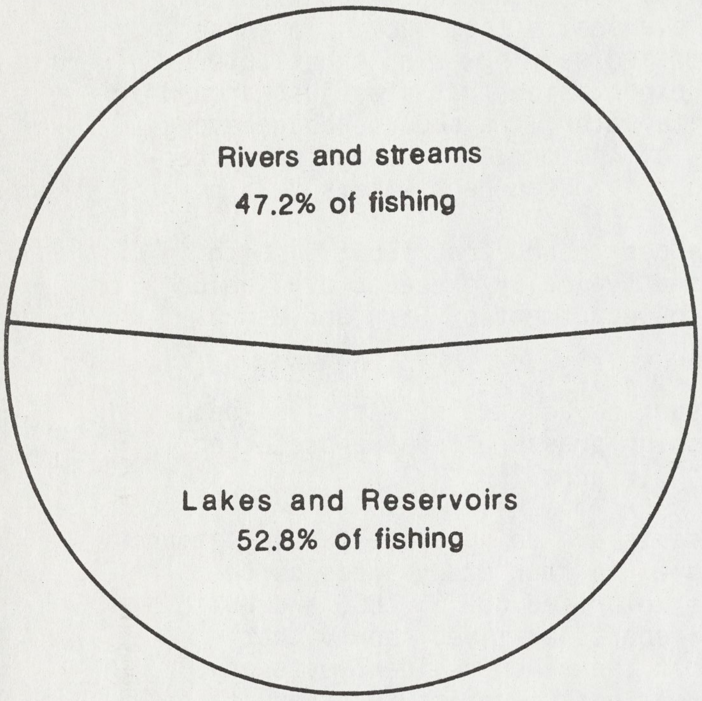
Game Department	Angler Days (16 years old or more)		
Geographic Unit	Residents	Non-residents	Total
Region I	990,300	179,800	1,170,100
Region II	2,852,700	30,600	2,883,300
Region III	424,600	100,200	524,800
Region IV	4,410,300	114,200	4,524,500
Region V	1,599,200	130,500	1,729,700
Region VI	2,849,300	129,100	2,978,400
Total	13,126,400	684,400	13,810,800

(Note: These totals include freshwater fishing for salmon and other food fish but exclude saltwater fishing for game fish. The two categories are probably of the same order of magnitude and thus "cancel" each other out.)

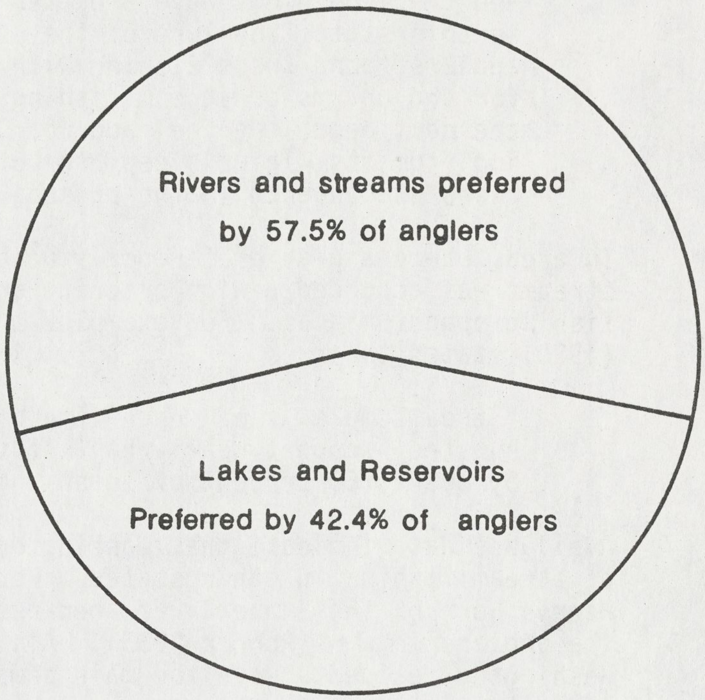
FIGURE 1

IMPORTANCE OF RIVERS AND STREAMS TO IDAHO ANGLERS

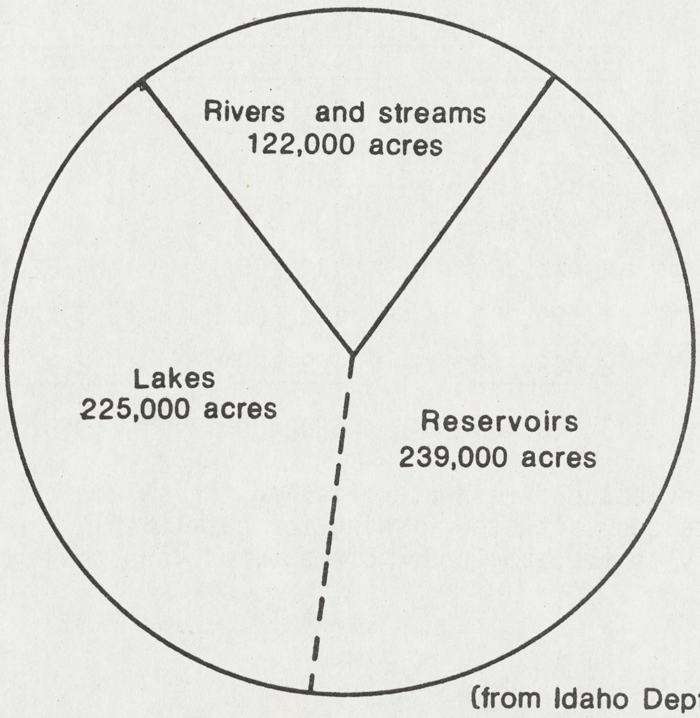
FISHING PRESSURE



FIRST PREFERENCE OF IDAHO ANGLERS



SURFACE ACRES OF WATER IN IDAHO



(from Idaho Dept. of Fish and Game 1980)

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With the addition of fishing trips by anglers less than 16 years old and a probable 3 to 5% annual rate of participation growth since 1980, current statewide trips for gamefish are at the 16 to 17 million angler trip level annually. Use by non-residents is only 5% statewide, but reaches a high of 15% in Region I. This can be attributed to the excellent lake fishing in Washington which attracts anglers from nearby Idaho. Thus, anglers are being attracted to a successful lake management program (that has been historically emphasized in Washington) but also seek the excellent stream angling currently provided in Idaho. Intent of the basic management strategy to be presented is to provide both within the State of Washington.

There is also an increasing trend of voluntary non-consumptive use for stream trout populations and this must be acknowledged in any management plan. Clark (1983) found in 1976 that anglers released 35 to 56% of the legal-sized fish they caught in sections of river restricted to fly-fishing, but released only 2% legals in sections under normal regulations. By 1979, anglers were releasing up to 85% of legal fish in the fly-only sections and as high as 25% of the legal fish in sections under normal regulations.

The reasons for recreational trout angling in streams have clearly evolved to a point where the provision of food for subsistence use can no longer be viewed as a viable fishery management objective. The results from angler interviews on Oregon's Metolius River (Griggs, MS in preparation) are typical of recent results. The top four most important reasons for fishing the Metolius were (in priority):

1. Enjoy the out-of-doors
2. Uniqueness of the area
3. Fly fishing
4. Fishing as a sport

Among the least important reasons (Number 16 in priority) was "catching a lot of fish".

A good example of high recreational benefits with a low consumptive yield is provided in the following data from Rohrer (1983) for one season in a 10.5 mile section of the Henrys Fork of the Snake River:

86,103 hours of angler effort
89,691 game fish released (required plus voluntary)
641 legal-sized game fish harvested (retained).

An angler opinion survey of the above fishery showed that 96% of sampled anglers considered fishing excellent or good. "Excellent" was the most common response (60%), while no anglers rated fishing as "poor".

Potential for Stream Fishing in Washington

Recent comments from an intra-Departmental memorandum illustrate several common points of view of WDG staff biologists:

> "...you will find that the majority of field biologists have explored their assigned areas long enough to have a good overall knowledge of what their streams are like and what they can and cannot do. Many of us have purposefully searched for streams or portions of streams to

sample in search of that bit of untouched stream where the fish are a product of their environment (old growth), not remnants from over harvest and logging. I can think of lots of streams where anglers never or seldom tread due to no access or extremely brushy, unfavorable angling conditions."

However, what this really means is that adequate protection of wild trout populations in Washington is often dependent upon the amount of fishing pressure being applied, not the regulatory controls in effect.

Many areas in Washington have favorable trout production potentials and, under proper management, could support a higher volume of recreational participation. Trout up to 20" in length were observed in North Fork Snoqualmie mainstem snorkeling transects, with a number of fish in the 16 to 18 inch range (Sweeney et al 1981). Recent measurements of rainbow trout in the Yakima River system indicate one of the best growth rates documented in North America. Thus, a common misnomer is that all Washington streams are unproductive and cannot produce resident trout.

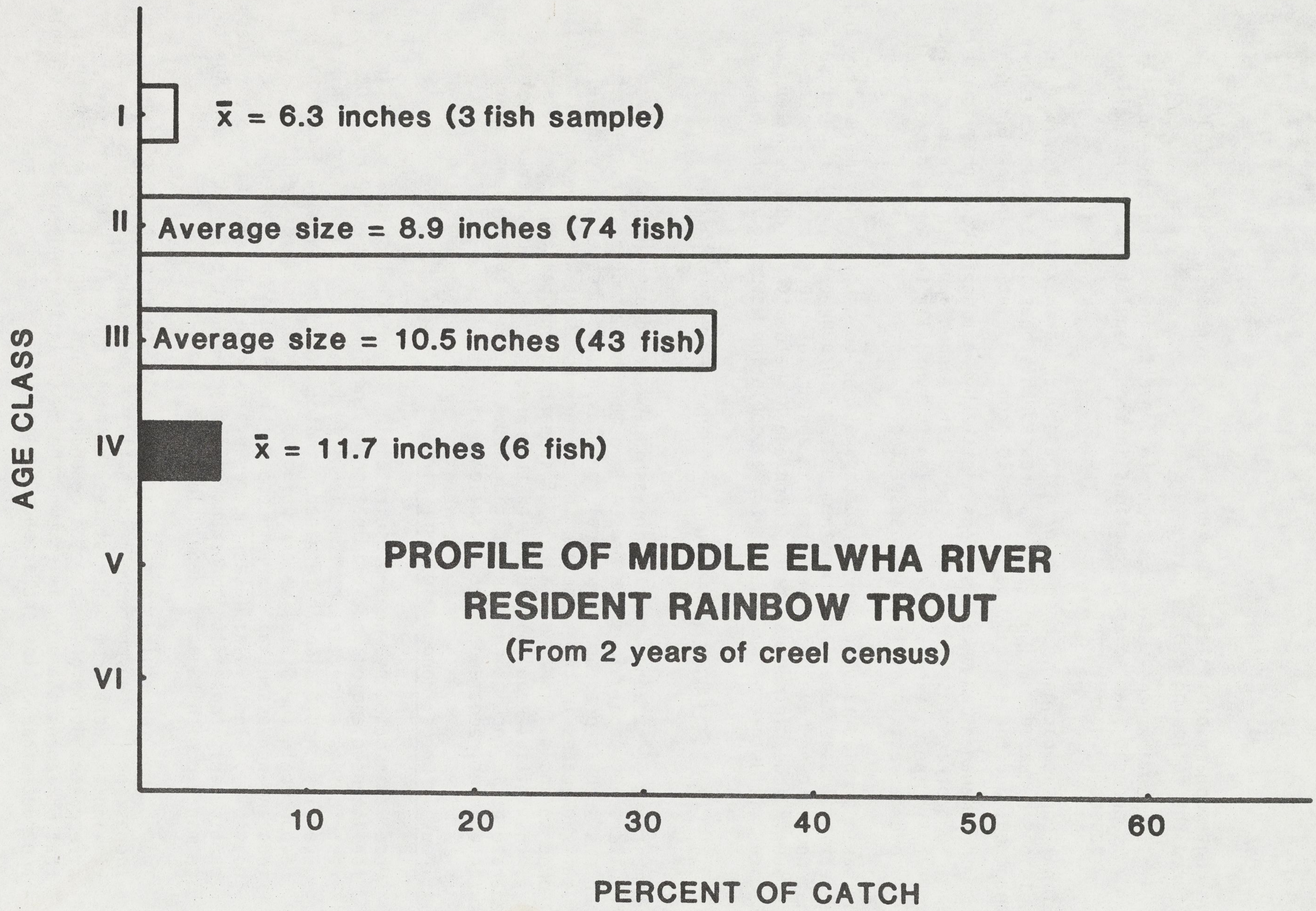
Trout populations in unproductive streams are actually more vulnerable than those in productive waters. Carlander (1969) reports that trout grow slower, live longer, and mature at an older age in unproductive streams. In addition, trout in unproductive streams typically have lower fecundity, which will provide even less resistence against effects of fishing (Royce 1975). However, success can be achieved. Three Idaho streams famous for trout fishing - St. Joe River, Kelly Creek, North Fork Clearwater River - are characterized as follows by Johnson and Bjornn (1978): "All three streams are infertile and clear."

In some cases where good standing trout populations now exist, WDG biologists express concern that the "word will get out" and the situation will be ruined by overfishing. Essentially, these populations are only being protected by this transient and unsafe approach to management. At best, this is poor resource management; at worst it is not responsive to the mandate to "preserve, protect, and perpetuate" while also "maximizing public recreational opportunities." In other stream areas, corrective action has already been taken on an individual water basis to either prevent or cure overfishing. An example of the latter case is resident rainbow in the middle part of the Elwha River system. In this instance, recent creel census work revealed all of the classic symptoms of overfishing; i.e., (1) low catch per unit effort, (2) poor angler satisfaction, (3) high annual mortality rates, (4) low overall trout population abundance, (5) lack of older age classes, and (6) a near absence of mature, spawning-age females (Figure 2).

The existing situation must be acknowledged and addressed in the same manner as recently stated by the Idaho Department of Fish and Game (1980) in their statewide plan:

> "The native species, however, are susceptible to overharvest and are sensitive to habitat alteration and many native fishes has suffered serious depletion as early as the 1930's and -40's..."
> "Since 1970, changed management philosophies have led to restoration of wild, native trout populations in a number of high quality waters through restrictive regulations."
> (Note: Title 36, Idaho code, states in part "...preserve, protect and perpetuate such wildlife.")

FIGURE 2


AGE CLASS
I
$\bar{x}$ = 6.3 inches (3 fish sample)
II
Average size = 8.9 inches (74 fish)
III
Average size = 10.5 inches (43 fish)
IV
$\bar{x}$ = 11.7 inches (6 fish)
V
VI
PROFILE OF MIDDLE ELWHA RIVER
RESIDENT RAINBOW TROUT
(From 2 years of creel census)
10
20
30
40
50
60
PERCENT OF CATCH

The contemporary biological data were recently reviewed by Mallet (1980), who offered the following conclusion:

> "In summary, most evidence seems to indicate that if suitable habitat is present that severe reductions in trout populations are normally caused by overfishing."

A final consideration is whether or not adequate data exist to even make the decisions required. Wright (1981) addressed this question in salmon fishery management and the same advice applies to trout populations in Washington:

> "...manager can make a serious mistake by waiting for enough evidence to protect himself. This may be a safe enough approach to ensure longevity in the business, but no decision is typically the wrong decision if overharvest in a fishery is suspected."

The basic problem is that overfished populations do not recover immediately and recreational uses dependent upon them must go through a very restrictive phase that would never have been needed in the absence of overfishing. The necessary "recovery" schedule depends mainly upon age at maturity and can be extensive. (Figure 3 illustrates the schedule for a population maturing at age V.)

SEPARATE LAKE MANAGEMENT FROM STREAM MANAGEMENT

The majority of stream fisheries in Washington are dependent upon self-sustaining wild trout populations and present a number of unique fishery management problems such as presence of several age classes and species of juvenile anadromous fish. Lakes in the state are the primary focus of WDG's major trout cultural program and many are not capable of supporting natural trout populations. Thus, the initial regulatory division that needs to be made is creation of separate basic regulations for managing trout in lakes and streams, respectively. New categories recommended are as follows:

I. Trout in Lakes, Ponds, and Reservoirs

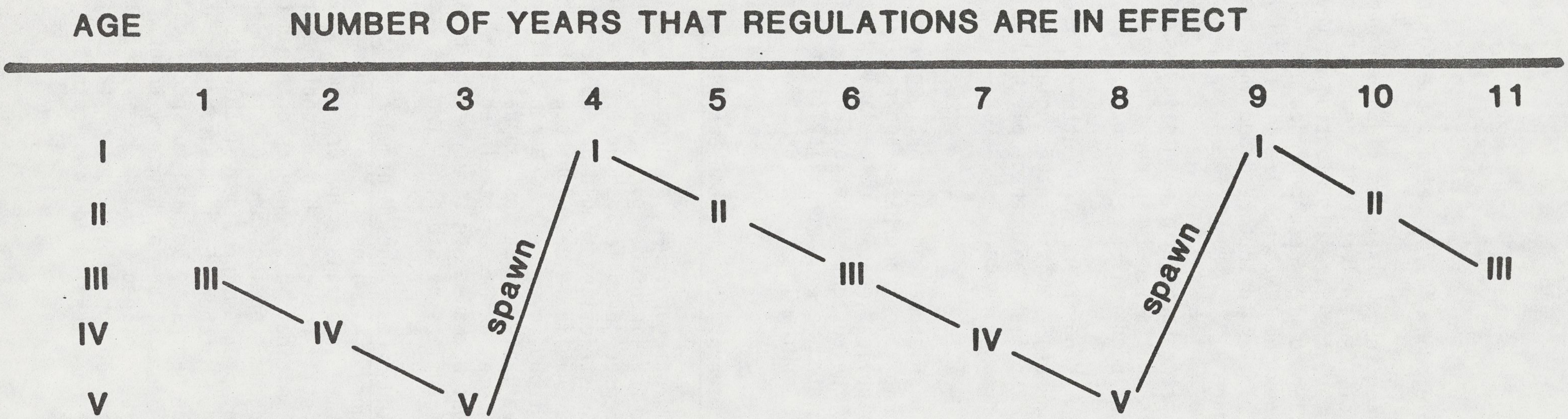
Under this category, we propose retaining the eight fish daily bag limit for licensed anglers but elimination of the 3 over 14" and 2 over 20" restrictions. The more restrictive five fish daily bag limit for unlicensed juveniles should also be retained. (Note: To properly manage game fish resources in the State, we are going to need more complex regulation, thus any non-essential current complexities should be dropped if at all possible). Individual lakes and reservoirs with different management needs, particularly those with important wild fish populations, would continue to be managed with "Special Regulations".

Two options for minimum size limits are (a) retention of the current six inches; or (b) the preferred alternative of no minimum size limit. In reviewing the data from other states, we could find little difference in the size distribution of fish retained under either regulation. It appears that 6" approximates or is somewhat below the difference between "desirable" and "undesirable" for the average angler.

FIGURE 3

RECOVERY SCHEDULE FOR A DEPRESSED TROUT POPULATION

SPAWNING AT AGE V AFTER IMPLEMENTATION OF EFFECTIVE REGULATORY CONTROLS



For example, Hunt (1970) reports the following for Wisconsin:

> "During the two seasons (1956-57) when there was no size limit in effect, few anglers kept trout less than six inches long. Consequently, the size distribution of the catch these two seasons was similar to that recorded when a six-inch limit was in effect in 1955 ...when there was no size limit, the proportion of successful trips was similar to that recorded when the six-inch limit applied." (Figure 4)

The distinct advantage of no minimum size (as cited by jurisdictions that use it) is that severely injured fish can be retained. Thurow and Bjornn (1973) concluded that:

> "Only 5% of the creeled cutthroat trout were less than 150 mm long." (6 inches) "Most of the anglers who kept these small fish stated that the fish had been deeply hooked and would have died if they had been released."

A potential disadvantage is that certain problems with "double-cropping" in lakes might be exacerbated and require attention in Special Regulations. However, application of a catch limit to all trout caught will actually eliminate the current situation where unlimited catch-and-release (with its associated hooking mortality) is permitted for all fish under six inches in length.

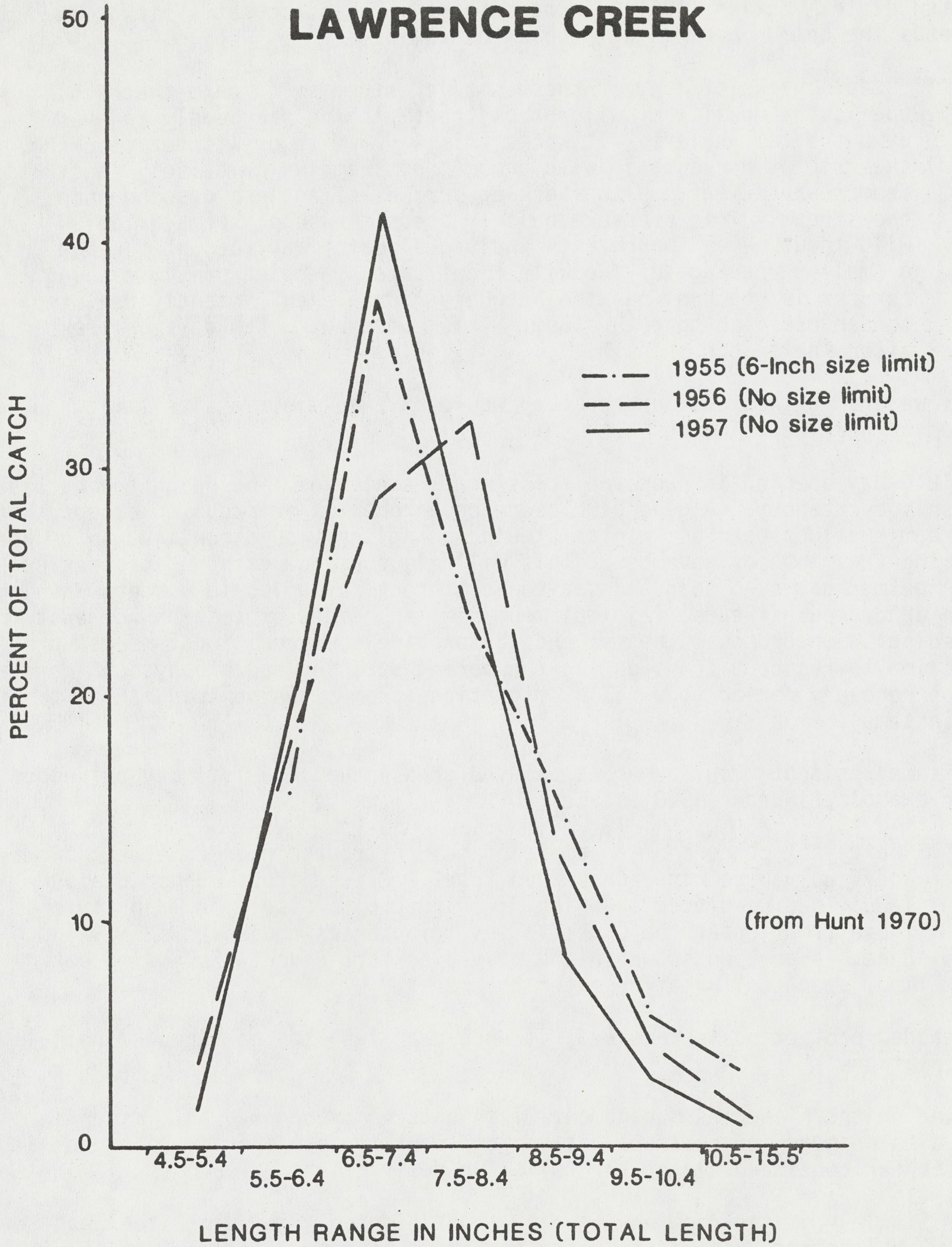
II. Trout in Rivers, Streams, and Beaver Ponds

Under this category, we also propose retaining the basic eight fish daily bag limit for licensed anglers and more restrictive five trout standard for unlicensed juveniles. However, the current three over 14" and two over 20" restrictions should be replaced with a single regulation, two over 12". Available data indicate that the aggregate number of large resident trout (over 12"), sea-run cutthroat and Dolly Varden (or bull trout) available for harvest annually on a sustained yield basis is less than the total number of steelhead available for harvest. Thus, every effort must be made to distribute the non-steelhead group among the maximum number of anglers possible. A two fish daily limit is needed.

"Designated Stream Zones Managed for Hatchery Fish" is a new proposed sub-category. Although most available hatchery production is utilized in effective lake management programs, a limited amount of stream trout planting still occurs. This is confined primarily to streams covered by formal mitigation agreements or areas of the State where alternative lake management options are poor or non-existent. These types of stream management programs provide valuable recreational benefits and should be continued. Hatchery fish management stream areas should be named in the regulation pamphlet, helping to specifically direct fishing effort toward available populations of hatchery trout. Designated hatchery zones should normally be confined to (1) stream areas where catchable trout have already been committed for mitigation; or (2) stream areas where habitat provides little or no natural production potential. (If the latter case cannot be

FIGURE 4

SIZE DISTRIBUTION OF BROOK TROUT RETAINED BY ANGLERS FROM LAWRENCE CREEK



avoided, selective fisheries for adipose-marked hatchery fish should be utilized.) The requirement to separate hatchery fish management from the needs of important wild trout populations has been documented in state after state. Mullan (1961), in describing the Massachusetts situation, states the common comingling problem as follows:

> "Creel checks of many of these smaller streams indicate that stocking spoils the quality of wild brook trout fishing previously enjoyed by but a few anglers. It works this way. With or without stocking, the crop of harvestable wild brook trout remains relatively constant from year-to-year. With stocking, crowds of anglers descend upon the stream. This pressure quickly crops the supply of available wild trout, even though each individual catch may account for but a small percentage of the wild trout take. A point of diminishing returns is reached when the hatchery fish are sufficiently depleted to depress fishing enthusiasm. This comes but a few days or weeks after the season opens."

All waters in this new sub-category would have no minimum size limit and no special gear restrictions.

A late May opening is proposed for streams statewide, including the hatchery fish sub-category. A general closure on October 31 is proposed except that stream sections open for winter steelhead angling should continue to be open during the month of November. This will (1) continue existing protection for outmigrant steelhead and sea-run cutthroat juveniles in western Washington anadromous streams; (2) implement similar needed protection for eastern Washington anadromous streams; and (3) provide some additional needed protection to resident trout during the spring spawning and/or physical condition recovery period (plus allow migrations from spawning tributaries to mainstems).

In some resident trout areas, a delayed opening until July 1 may be needed. For example, Thurow (1980) states:

> "Forty-six percent of a sample of mature trout captured between 26 May and 1 July were ripe, unspawned trout. Mature trout captured after 1 July had completed spawning." (Figure 5) Also: "A majority of these trout enter the Upper Valley tributaries and spawn in May and June. A portion spawn in the main Blackfort River. Following spawning, spent cutthroat re-enter the river."

If added protection is required, it should be implemented through Special Regulations.

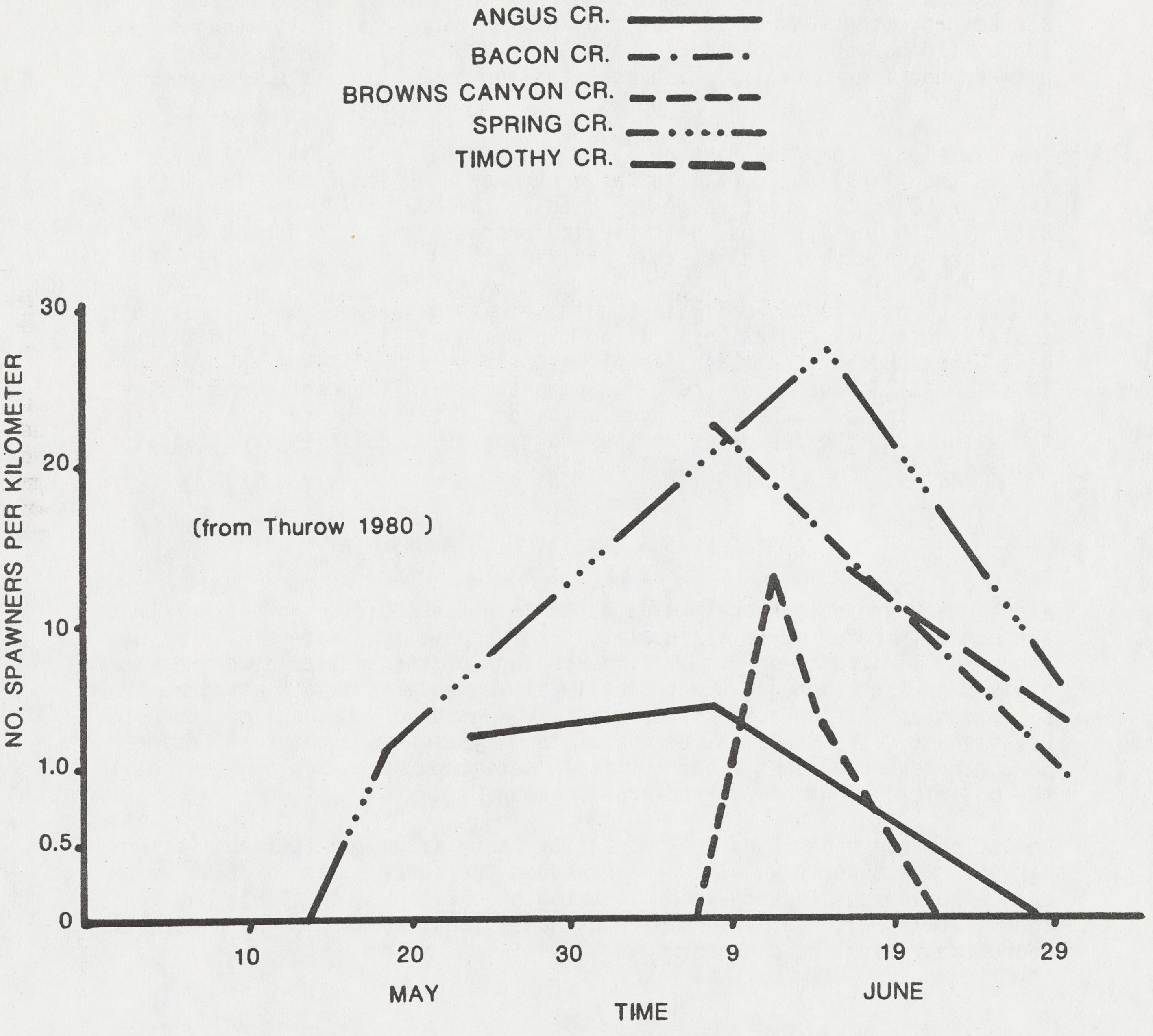
Based on the Fisheries Management Division's comprehensive analysis of studies on gear-induced mortalities for trout, we can provide no technical basis for continued use of the following restrictions:

1. Single hook restrictions for any trout fishing, including steelhead.
2. Barbless hook restrictions for any trout fishing, including steelhead.
3. Prohibition of bait for steelhead fishing.

Based on these conclusions, current SELECTIVE FISHERIES REGULATIONS should be eliminated.

FIGURE 5

OBSERVATIONS OF SPAWNING CUTTHROAT TROUT, BLACKFOOT RIVER



However, there is an equally firm technical basis for prohibiting the use of bait for general stream trout fishing. All natural production areas will have some significant degree of mandatory and/or voluntary release for several age classes of small, immature fish. A gear restriction banning the use of bait will be essential due to the high hooking mortality rate involved. The ban on bait should be coupled with an expression of daily bag limits as possession limits, not catch limits. This will have the practical effect of legalizing catch-and-release fishing in those waters so designated. In the past, a bait ban has been used sparingly in Washington under Special Regulations but it is more common in other jurisdictions. For example, current Idaho regulations ban the use of bait in 592 miles of streams and "these areas include many of the highest quality streams in Idaho" (Idaho Department of Fish and Game 1980). The general relationships between hooking mortality, fishing rates and population size are shown in Figure 6.

The Division's comprehensive analysis showed that all artificial gear types (lures and flies) would fall in the area near 0.05 (or only about 1 fish in 15 or 20 lost). Bait usage would be in the 0.30 to 0.50 range (or 3 to 5 fish in 10 lost). Thus, bait fishing produces in the order of 5 to 10 times more hooking mortality than artificials.

The use of bait is basically incompatible with management of natural self-sustaining trout populations. If no minimum size limits or minimal standards are applied, then significant mortalities can still be applied to those small fish which are released voluntarily. If higher minimum sizes are needed to meet basic conservation needs of the trout resources, then the situation is exacerbated by the addition of mortalities from mandatory release.

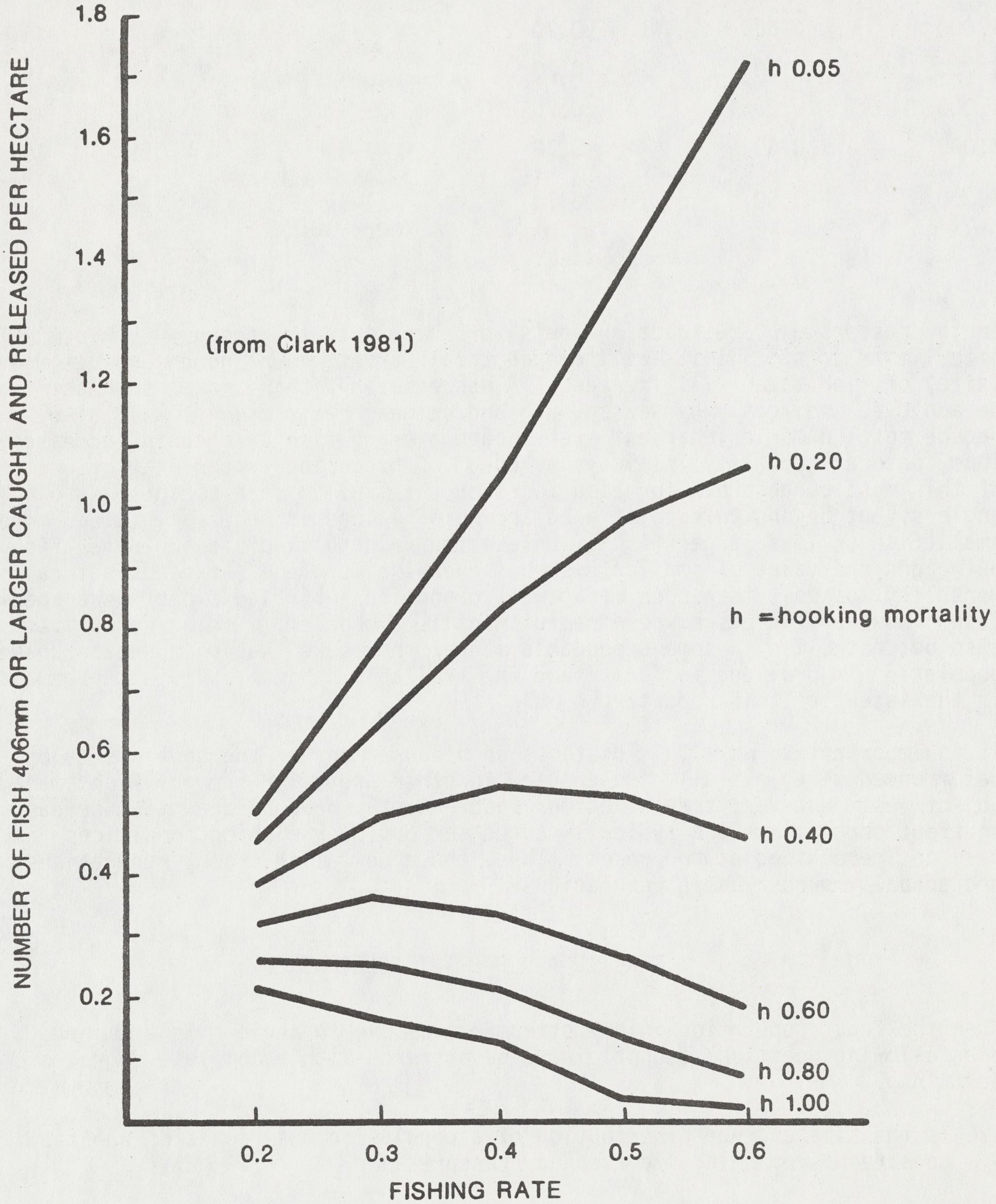
BASIC VERSUS QUALITY FISH MANAGEMENT

Areas which are deliberately managed to increase the catch of larger trout are commonly referred to as "quality" or "trophy-fish" waters. These are generally limited to only a small percentage of the available waters within a given jurisdiction and are typically viewed as a "special" management situation attracting a specific, minority segment of the angling public. Fly fishermen are the usual target of this type of management attention. Some managers view such areas as little more than necessary concessions to the political clout of a certain user group.

Due to the presence of natural mortality factors, any curtailment in the harvest of smaller fish will always reduce the total number of fish which can be harvested if recruitment is not a problem. Jensen (1981) provides the following alternative examples of how a trout population with adequate recruitment might be managed:

FIGURE 6

GENERAL RELATIONSHIPS BETWEEN CATCH, FISHING RATE, AND HOOKING MORTALITY



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Recruits	Instantaneous Fishing Mortality Coefficient	Instantaneous Natural Mortality Coefficient	Age at Entry into The Exploited Stock	Total Catch	Trophy Catch
1,000	0.50	0.70	I	417	11
1,000	0.50	0.70	II	207	19
1,000	0.25	0.70	I	263	15
1,000	0.50	0.70	I-IV (slot limit)	398	19
1,000	0.50	0.70	II-IV (slot limit)	176	31

In the cases shown, restricting age(s) of entry into the fishery by minimum size limits or slot limits will reduce total harvest even though average age (size) of fish taken will increase. A decrease in fishing rate, such as might be achieved indirectly by season, bag and/or gear restrictions, will also reduce total numerical harvest even though average fish size again increases. Thus, natural mortality is always a "cost" of producing larger fish. Some of this must be absorbed for fish to reach the minimum size acceptable to anglers, but beyond this point a balancing of values is necessary (i.e., more small fish or less larger fish). Unless the value of individual larger fish outweighs the value of smaller fish by several times (i.e., exceeds natural mortality losses), then such management cannot be justified except as a special case. However, in cases where recruitment is a problem, fishing rates must also be controlled in some dependable manner to assure that an adequate spawning population is provided to fully seed the available habitat. Basic management is the intent of this report.

It is important to make this distinction because many of the controls to be recommended were initially implemented in other areas for "trophy fish" management objectives. However, they sometimes inadvertently produce dramatic increases in trout populations and typically cured serious over-fishing conditions that were not recognized at the onset. Thus, these so-called trophy regulations are actually proper basic regulations.

GENETIC AND HABITAT CONCERNS

When the trout population in any stream accessible to anglers is examined, the following questions cannot always be answered with a complete degree of certainty:

1. Is the size and age distribution of a population the result of habitat constraints <u>or</u> selective fishing pressures?

2. Is the population abundance observed (or complete lack of fish) due to actual limitations of the habitat <u>or</u> inadequate recruitment (overfishing)?

3. Is the species composition observed reflective of habitat parameters <u>or</u> selective removal of a species more susceptible to angling pressure?

The possibility of adverse genetic consequences due to overfishing and/or gear selectivity is still being debated among trout managers. For example, in view of the strong inheritability of growth rate in salmonids, Favro, et al (1979, 1980) stated that a decline in the quality of fishing may be related to changes in the gene pool of a stock caused by selective fishing on the faster-growing individuals. A specific population, brown trout in Michigan's Au Sable River, appeared to have its growth potential reduced by selective harvest of larger fish over time. Others have characterized their findings as theoretical only, but generally agree that such changes are logical expectations. Clark et al (1980) disagree with the following conclusion:

> "But, with few exceptions, growth rates of trout in streams have remained remarkedly constant over long periods, even in heavily exploited stocks."

However, problems have been conclusively documented for closely-related species and it must be assumed that they can occur in trout populations. Any management strategy should include measures to prevent or at least minimize such long-term genetic changes.

Naiman (1982) found fishing rates of 60% and 80% on one and two ocean year Atlantic salmon, respectively and that most males (90%) are now living out their lives in freshwater and females are returning as soon as possible, sometimes after only a few months at sea. These fish are passing along their genetically controlled traits to future generations. Naiman concludes as follows:

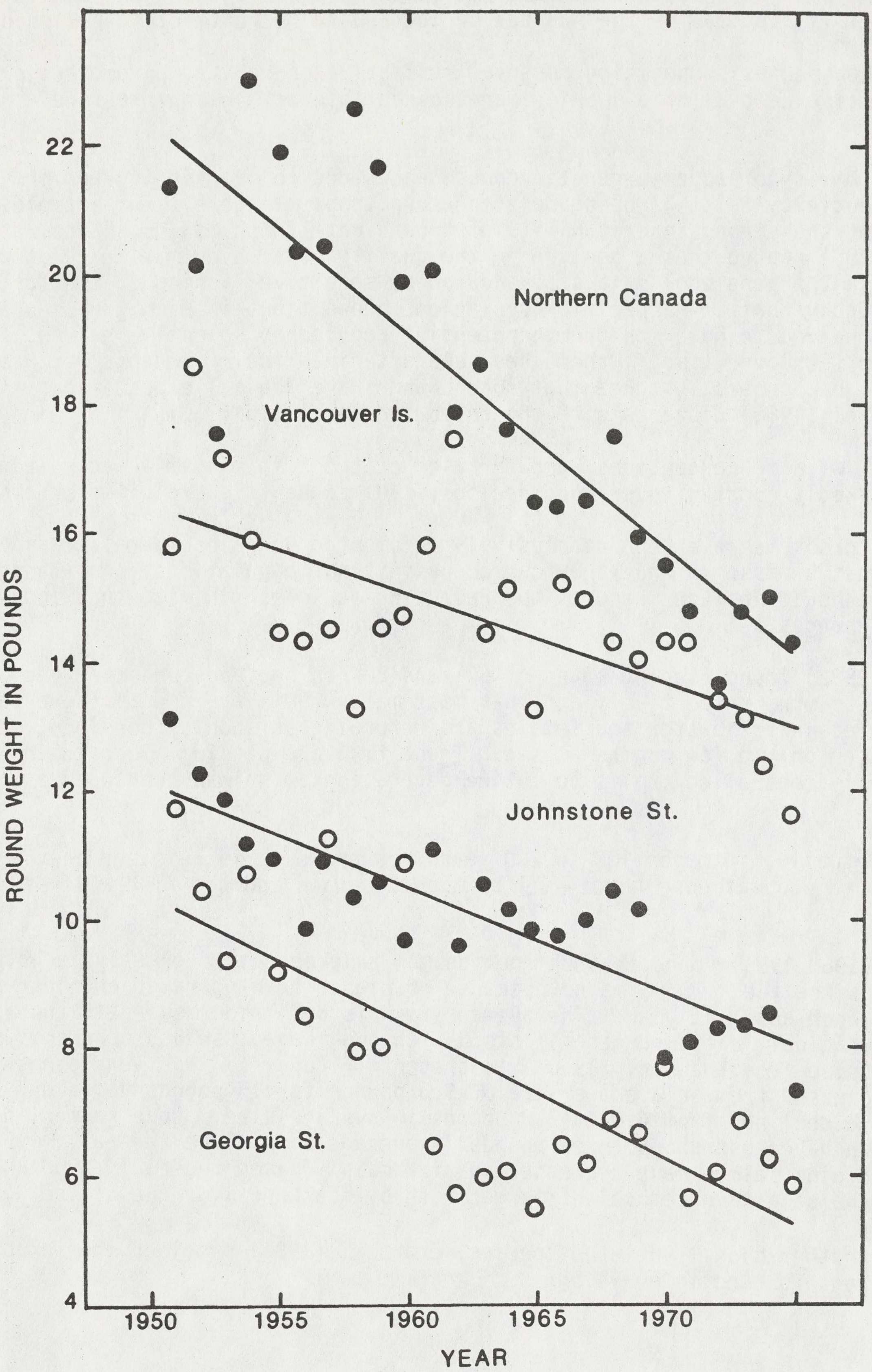
> "Eventually, in maybe 100 to 200 years, as pressure is released on the seaward populations, there will be a shift again and the fish will start going out."

Ricker (1980,1981) found that chinook salmon have decreased greatly in both size and age since the 1920's, mainly because of higher fishing rates on older fish by hook-and-line gear. The average fish is only about one-half the size of the original, unfished genetic stock. Chinook have lost 5.5 pounds in average size from the early 1950's to present (Figure 7). Odd year pinks have decreased from an average size of 5.5 pounds to 4.3 pounds and even year runs have declined from 4.6 to 3.0 pounds in average size. Coho salmon in the ocean have lost about three pounds in average size since the early 1950's. Coho and pink salmon have decreased in size mainly since the early 1950's due to the selective removal of larger fish by hook-and-line and gillnet gear.

In yet another closely-related species, Grabacki (1981) provided the following conclusions for Arctic grayling:

FIGURE 7

Sizes of Chinook salmon in four troll fishing areas



(from Ricker 1980)

"Comparisons of fish in areas of high and low accessibility to anglers, where accessibility was assumed to be proportional to fishing pressure, revealed that the average size and age, relative abundance, and individual growth rates appeared to decline as a result of fishing, while mortality rates increased. The circumstantial evidence allows the conclusion that the observed differences in population dynamics and characteristics between sections are, in fact, caused by fishing pressure."

The habitat issue is also critical since important mitigation decisions and stream protection requirements are typically based on site-specific fish population data. Any management strategy must insure that the inherent carrying capacity of available habitat is actually being utilized. Cutthroat trout are by far the most important species due to their widespread use of small streams as both anadromous and resident fish.

The initial assumptions from a paper by Burns (1971) illustrate where many habitat evaluations begin:

"Carrying capacity is defined as the greatest weight of fishes that a stream can naturally support during the period of least available habitat. It should be considered a mean value, around which populations fluctuate. Spawning salmonids in coastal streams are thought to produce enough progeny to fill streams to carrying capacity. This assumption is supported by observations of high rates of emigration and mortality of fry shortly after emergence from the spawning bed. Since a section of stream can accommodate only a limited number of territories, surplus fish are displaced... Displacement distributes fish to parts of the system remote from the spawning grounds, thus insuring that most of the area and productivity of the system is utilized. Even in the absence of excess fry production, receding summer streamflow limits habitat and practically insures that streams are filled to carrying capacity. Survival and growth of fishes in these streams are density dependent, or have density dependent components. The stream's carrying capacity limits the number and weight of salmonid smolts ultimately produced."

However, the following results proved that these assumptions were not valid and that Burn's study was measuring overfishing, not habitat capability:

"Salmonid biomass in Godwood Creek was exceptionally low, ranging from 16.68 kg/ha in 1967 to 8.48 in 1969. Prairie Creek, to which Godwood Creek is a tributary, had a salmonid biomass of 21.95 kg/ha in 1969, suggesting that Godwood Creek probably wasn't at carrying capacity. Low population densities in Godwood Creek in 1968 and 1969 apparently reduced competition, for fish attained greater average lengths than in 1969, when densities were greater. Increased growth, however, apparently did not compensate for lowered density and carrying capacity was not reached in 1968 and 1969. To test if Godwood Creek was at carrying capacity in 1969, I transplanted the salmonids captured in Prairie Creek in July into a 366-m section of Godwood Creek in sufficient numbers to increase the biomass to 27.98 kg/ha. Two months later the same section of Godwood Creek was censused to determine if the biomass had remained above the July 1969 value of 7.36 kg/ha. It was 18.08 kg/ha at the second census. This experiment demonstrated that the stream had been below carrying capacity before transplanting the Prairie Creek fish. There were no obvious reasons for the low number of salmonids in 1968 and 1969, except that young-of-the-year coho were exceptionally scarce then, suggesting that the spawning run had not seeded the stream to carrying capacity. There were no significant changes in spawning bed sediments to explain reduced survival of incubating embryos and fry."

Similar results were obtained when researchers attempted to measure the effects of logging and road building practices on Washington's Clearwater River. Such findings are relatively rare but only because very few habitat workers are able to actually test their initial assumptions about use of potential carrying capacity.

Species replacement has been documented in a number of other states and is the logical result of any mixed stock fishery where one species can support a high fishing rate and/or is less vulnerable to angling. For example, in one Ontario study, brook trout were less able to withstand angling pressure than brown trout in the same stream and differences in age composisiton of the two species were directly related to innate differences in exploitability (Marshall and MacCrimmon 1970). Mullan (1961) reached the same conclusion as follows:

> "In many streams, the German brown trout has usurped the native brook trout. This has not come about because of the cannibalistic inclination of the brown. The brown trout, merely by being harder to catch, has taken over for the brookie."

(Note: Additional data will be presented in a subsequent section of the report concerning relative susceptibility to angling).

RECOMMENDED BASIC STRATEGY

Manage Natural Trout Populations for Assured Recruitment (full utilization of existing carrying capacity)

There are only two basic methods of assuring that adequate recruitment of juvenile fish occurs on a dependable, sustained basis. The first approach is that currently utilized for steelhead, which requires that the population be quantified and actively managed to achieve a specific spawning escapement objective each season. This same approach would be technically feasible for all trout populations in the state but would entail prohibitive costs and extremely complicated emergency regulations. The same end result of assured recruitment can be achieved by making sure that one age class of mature females is allowed to spawn at least once. For fishery management purposes, this should be defined as the majority (more than 50%) of the female individuals in a given age class. The actual management process for an individual stream should parallel the following steps used by Johnson and Bjornn (1978) to determine that a 12" minimum size was the optimum solution for Idaho's St. Joe River cutthroat trout:

"The setting of a size limit can be delicate in situations where most spawners are needed to maintain an abundant population. By lowering the size limit from 13 to 12 inches, an additional 3.6% of the 1975 population would be legal-sized during the summer, but only about 5% of the cutthroat would reach the minimum size by the end of the fishing season and be available for harvest before spawning at least once. By lowering the size limit from 13 to 11 inches, an additional 8.6% of the 1975 population would be legal size during the summer, but about half of the cutthroat would reach the minimum size by the end of the fishing season and be available for harvest before spawning the first time."

If possible, it is important to avoid any size limit that "cuts across" the central or dominant portion of an age class size distribution curve. For example, if an eleven inch minimum size limit was applied to the St. Joe River cutthroat population, the resultant fishery would be strongly selective toward larger individuals of the same age/maturity class. Conversely, the remaining spawning population would be composed of smaller fish due to the prior removal of larger individuals. The general relationships are depicted in Figure 8. The fact that this actually happens is illustrated in Figure 9. It is important to distinguish between (1) a standing crop (population); (2) that portion which can be taken by certain gear; and (3) the part that can be retained under a specific regulation. Trout managers must assure adequate recruitment and minimize selective fishing pressures.

With the management approach described, dependence on a single age class in any one spawning cycle will usually be avoided since some significant percentage of this same age group will spawn at an earlier age. Others will survive and spawn a second time. For example, if 70% of the females spawn at age 4 and are adequately protected until that time, then the contribution from age 3 and age 5 spawners will help "buffer" any weak brood years.

The need to avoid single age class spawning success dependence (if possible) is illustrated by coho salmon data from Washington's Queets River (Figure 10). In this case, a relative constant rate of in-river fishing was being applied to a resource subjected to continually increasing ocean fishing rates. The single age class spawning dependence could not be avoided since virtually all coho salmon spawn at age 3 in the southern part of their geographic range. In this example, a single cycle became depressed in 1960 (No. 1) and was never able to recover (No.'s 2 through 6). The two other cycles took much longer to show symptoms of overfishing.

Manage with the Proper Tools

Bag limits (daily or seasonal) should be used primarily for the purpose that they are intended; i.e., to distribute the allowable harvest among anglers (the basic separation from commercial fishing). They do not provide a positive control for assured recruitment. Managers typically over-estimate the potential of bag limit reductions by (1) analyzing data on an individual angler basis versus "party" limits; and (2) calculating potential reductions as annual fish-

FIGURE 8

EFFECTS OF FISHING ON A POPULATION

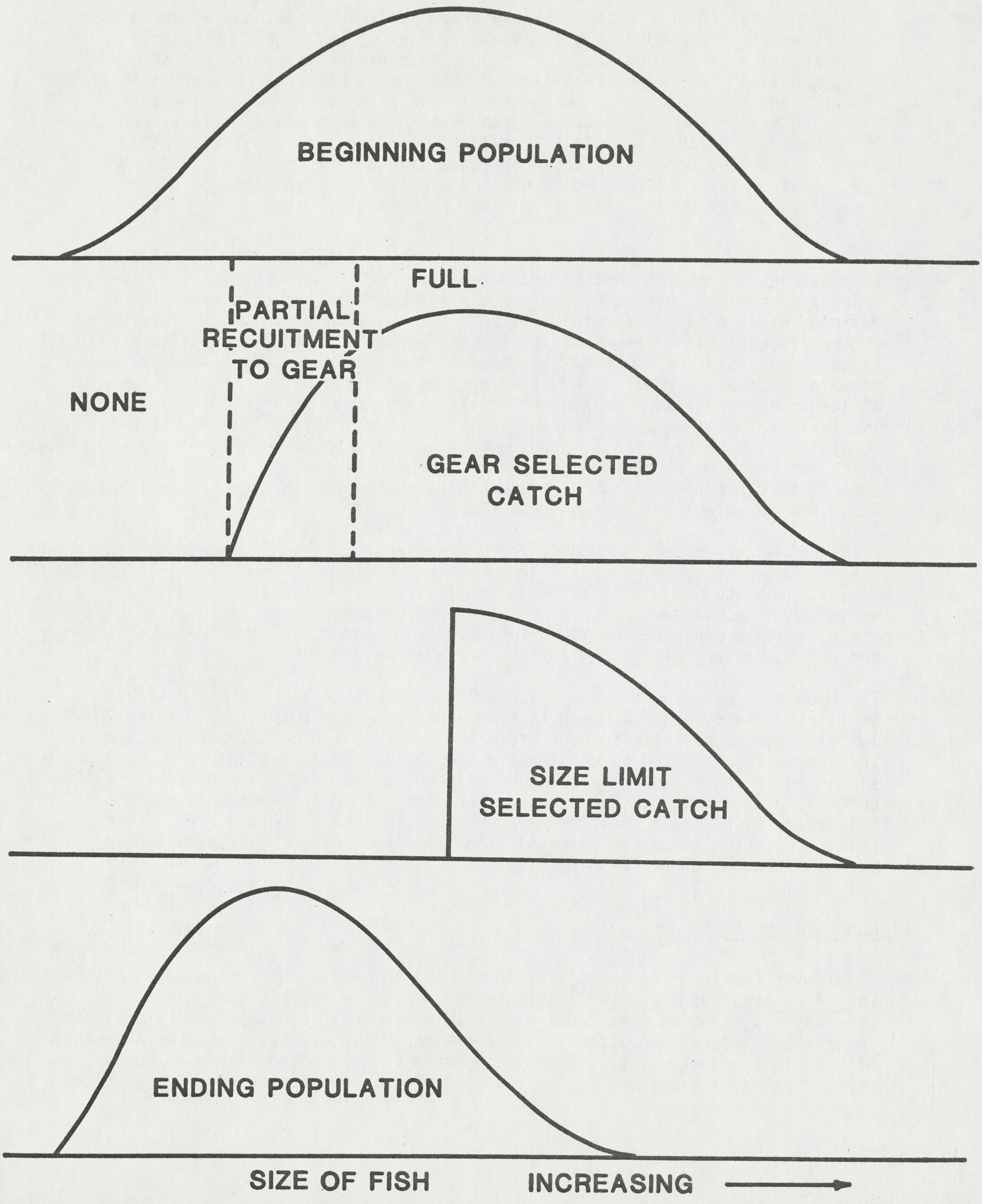


FIGURE 9

COMPARATIVE CATCHES OF CHINOOK SALMON IN THE SAME SOUTH PUGET SOUND MARINE AREA

(from Eames 1979)

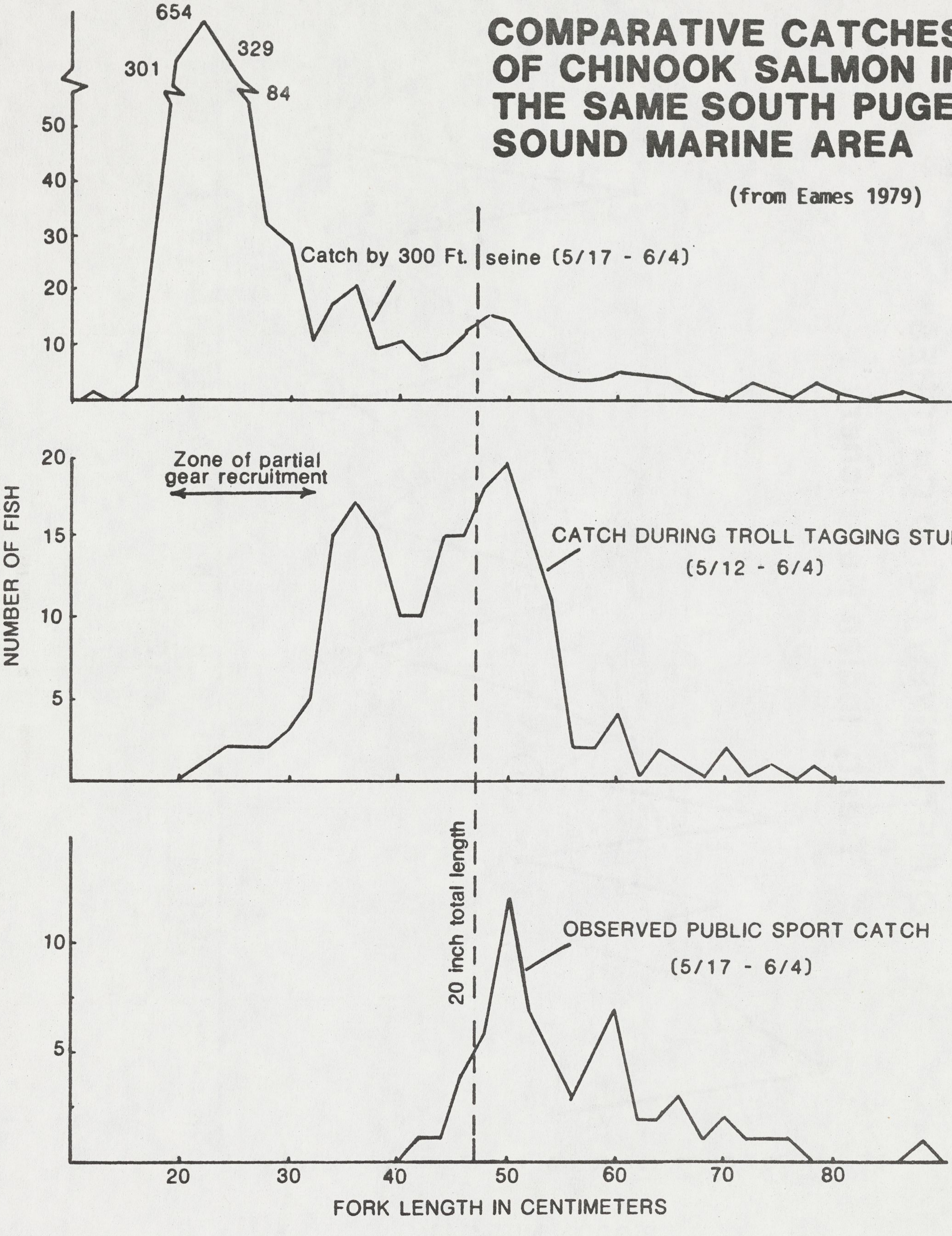
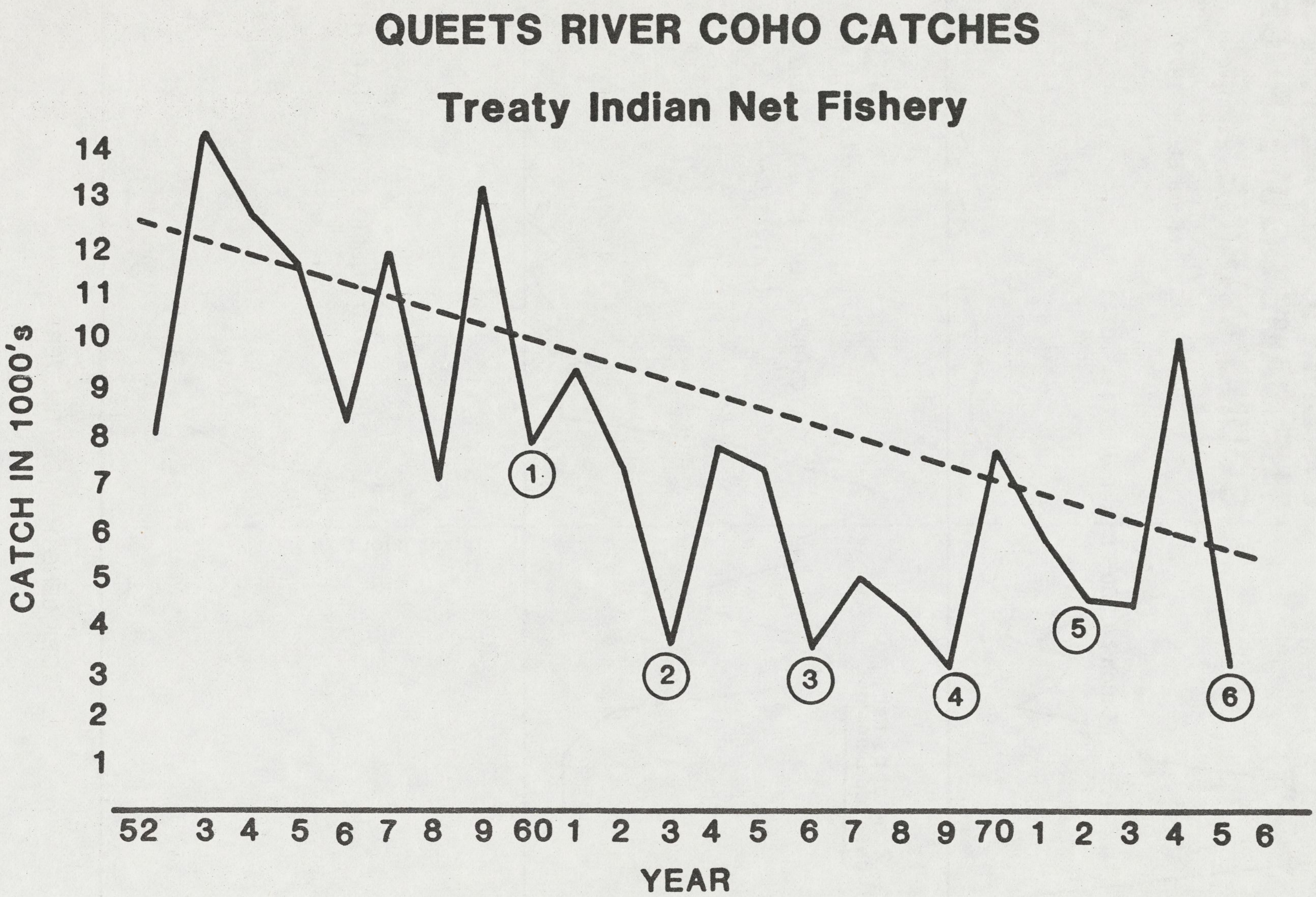


FIGURE 10


QUEETS RIVER COHO CATCHES
Treaty Indian Net Fishery
CATCH IN 1000's
14
13
12
11
10
9
8
7
6
5
4
3
2
1
52 3 4 5 6 7 8 9 60 1 2 3 4 5 6 7 8 9 70 1 2 3 4 5 6
YEAR
1
2
3
4
5
6

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ing rates instead of instantaneous rates. Temporary successes, even for extended periods, can be achieved by reducing instantaneous fishing rates and/or simply discouraging fishing activity. However, both of these elements can be negated by increased participation in the fishery (a workable alternative which we do not propose for general use is limited entry). In most fishery management case histories, managers have not picked-up the problem of effort increases in a timely manner and overfishing has occurred before more positive controls could be implemented.

In other cases, bag limit reductions have failed to even temporarily correct problems. Studies by Johnson and Bjornn (1978) demonstrated for westslope cutthroat that a restrictive bag limit (three fish versus the previous 15) did not protect the population until adequate numbers of females had spawned at least once and thus did not increase population size to rebuild from overfishing. Hunt (1970), in comprehensive studies with different regulations found that:

> "During all seasons and regardless of the bag limit allowed, most of the harvest was accounted for by catches of 1-3 trout/trip. ...During all seasons and regardless of the liberality of the bag and size limits, more than 50% of the anglers failed to catch a single wild brook trout."

Hunt concluded that bag limits were not effective in altering trout population structure.

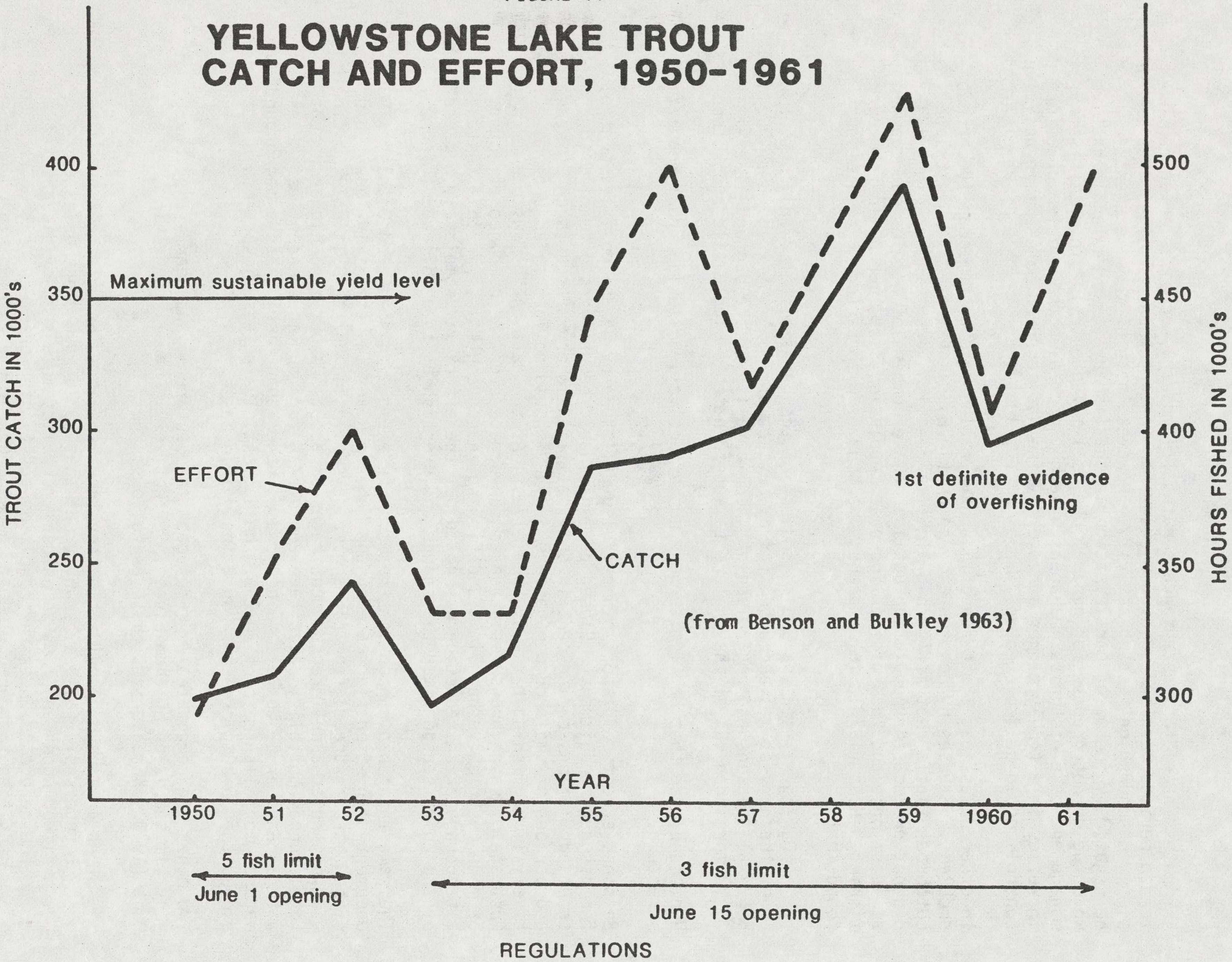
Seasons (except complete closures) also fail to provide any positive control for assured recruitment. Closed periods should be utilized primarily to protect trout populations during certain critical life history stages (such as spawning and periods of smolt concentrations). They should not be relied upon to effectively limit fishing rates by themselves. As the data on Yellowstone Lake illustrate, fishing pressure increases can negate even the combined effects of more restrictive bag limit and fishing season controls. In this instance, a temporary catch reduction was noted but the effect was completely negated by the third season after the change and overfishing soon followed (Figure 11).

The same thing can happen in streams. For example, Vincent and Clancey (1980) documented an effort increase in the Madison River (a nationally-known "blue ribbon" trout stream) from 215 angler days/mile in 1952 to 953 in 1975. Their studies showed annual recruitment rates of about 50% but much higher recent total annual mortality rates (average of 71% for four independent estimates with a range of 62 to 75). Since causes other than fishing had a background natural mortality rate of 20-25%, the harvest plus release losses could not exceed the 25-30% level on a sustained yield basis.

Two other management tools - "refuges" (closed areas) and gear - also have very limited value by themselves in effectively controlling fishing rates. Hunt (1970) characterizes these as follows:

> "As a means of providing better trout fishing, the mile-long headwater refuge was a failure. Many trout that could have been harvested or fished upon were lost to natural mortality because they did not leave the refuge....Under the conditions of fishing pressure, catch, and trout densities that prevailed at Lawrence Creek, fly fishing had no uniquely beneficial biological effects that could be detected. Changes in standing crops, survival rates, reproduction, and growth of the trout popula-

FIGURE 11


YELLOWSTONE LAKE TROUT
CATCH AND EFFORT, 1950-1961
TROUT CATCH IN 1000's
400
350
300
250
200
Maximum sustainable yield level
EFFORT
CATCH
1st definite evidence
of overfishing
(from Benson and Bulkley 1963)
HOURS FISHED IN 1000's
500
450
400
350
300
YEAR
1950
51
52
53
54
55
56
57
58
59
1960
61
5 fish limit
June 1 opening
3 fish limit
June 15 opening
REGULATIONS

tions in the two fishing zones appeared to be independent of the methods of angler harvest."

Shetter (1968) studied the fly fishing only situation in Hunt Creek, Michigan, and reached the following conclusion:

> "...provided data for assessment of the effects of a fly fishing only restriction (instead of any lure) on the brook trout population. The restriction (in effect 1955-59) did not affect the total mortality rate or the population structure of the brook trout."

Hunt (1970) goes on to describe the critical management tool as follows:

> "The size limit, if wisely applied, is the best single regulation for preventing excessive angler harvest of brook trout populations. The size limit applies to every trout caught, and it can be related to a rather stable biological parameter, growth rates of the trout populations."

When the tested regulatory "package" included a higher minimum size, work by Shetter (1968) showed the following response:

> "Total mortality and angling mortality rates for brook trout were significantly higher in the less restricted stream area."

However, regulations can only cure overfishing if it actually exists - not environmental limitations. Klein (1974), for example, reported such a failure for the Cache La Poudre River in Colorado. This high elevation stream was relatively unproductive and contained populations of slow-growing rainbow and brown trout. Management changes, including a 12" minimum size limit, did not increase the abundance of rainbow trout although the mean size increased by two inches and reversed when the minimum size limit was removed. In addition, overfishing of one species is not a sure indication of the same problem for another species. Thus, Shetter (1968) observed a positive response for brook trout but the same regulations in the same study area did not change the population structure of brown trout.

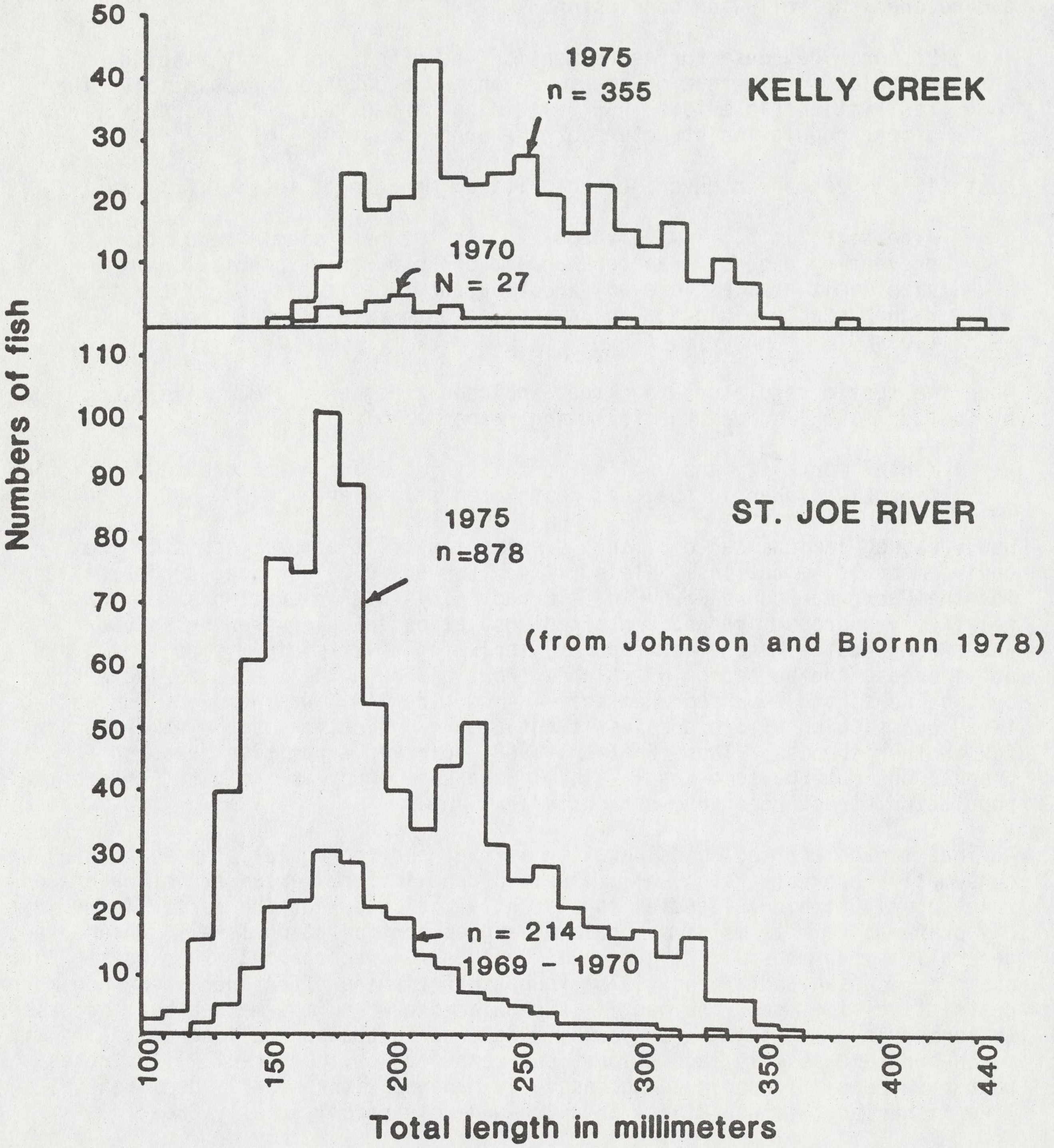
A final management tool consideration is the need to regulate for some level of consumptive harvest (retention), albeit often limited, versus strict catch-and-release only fishing. Studies consistently indicate that the former is definitely preferable in terms of maintaining angler participation levels, which are generally synonymous with the economic values for recreational resources. For example, Johnson and Bjornn (1978) found that fishing effort declined when more restrictive size, gear and bag limit regulations were implemented but increased to former levels within three years. Angler effort also declined initially with catch-and-release only regulations, but remained low. Figure 12 illustrates that fish populations can be successfully managed with properly designed selective fisheries (St. Joe River) or catch-and-release only (Kelly Creek).

<u>Basic Management for the Needs of Cutthroat and Rainbow Trout, including Steelhead</u>

Due to their basic life history characteristics, Dolly Varden or bull trout (at least as resident fish) are the most susceptible species to overfishing

FIGURE 12

SIZE AND ABUNDANCE OF CUTTHROAT TROUT BEFORE AND AFTER EFFECTIVE REGULATION



and are probably in a depressed status throughout most or all of the State. However, their potential and extent of distribution is much less than cutthroat or rainbow, thus Dollies (or bull trout) cannot be the focal point for basic regulations. Needed protection must be provided on a Regional or Special Regulation basis.

All applicable studies examined agreed that cutthroat trout were the most susceptible trout species in terms of catchability and must be accorded the title of most "vulnerable". Shetter and Alexander (1965) and Lantiegne (1974) found brook trout much easier to catch than brown trout and MacPhee (1966) found cutthroat trout about twice as susceptible to angling as brook trout. Under normal angling regulations, the annual rate of exploitation of cutthroat longer than 150 mm ranged from 0.70 to 0.76 or higher in Alberta (Radford 1975a, 1975b).

The gullible nature of cutthroat is aptly described by the following paragraph from Rohrer (1983):

> "Angler effort increased significantly in 1981 in Section 10 compared to previous years. However, as a result of implementation of special regulations in 1978, harvest has been greatly reduced. About 8,000 trout per 1.6 km reach were released in 1981. The population estimate for this reach was 4,500 trout per 1.6 km (1 mi). It is obvious that many trout are being caught-and-released several times." (The average trout was caught and released 1.8 times in a single season.)

Rainbow trout appeared to be somewhat less vulnerable to anglers since most relevant studies examined (i.e., comingled populations) showed a tendency for rainbow to partially replace cutthroat in the presence of heavy fishing, with a reversal occurring when cutthroat were given adequate protection from overfishing. Mullan (1961) rated hatchery brook trout more susceptible to angling than hatchery rainbow because the latter were "slower starters" in the spring due to cold water temperatures. However, the rainbow's vulnerability to anglers is perhaps best illustrated in the following passage from Pollard (1978):

> "A large proportion of juvenile steelhead trout in a stream can be removed with a moderate amount of angling. Age II steelhead are especially susceptible to angling, and 70 to 100% of those present in my 30 m study sections were removed with four man-hours of angling."

Vincent and Clancey (1980), in working with a combination of rainbow and brown trout, documented single season catch-and-release fishing rates that ranged from 83 to 101% of previous spring population estimates. This and other studies indicate that rainbow trout probably fall just below cutthroat in terms of potential for overfishing. In any case, rainbow and cutthroat are the most abundant and widespread trout species in the state, which requires that basic regulations be focused on their specific needs. Brook and brown trout angling can be liberalized by species-specific Regional or Special Regulations in some cases but their higher inherent resistence to angling pressure should not be used as a rationale for avoiding proper management of rainbow and cutthroat trout.

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Meet Resource Needs of Four Distinct Groups of Cutthroat/Rainbow Trout.

The weight of technical evidence available from the literature suggests that trout populations must be divided into at least four groups for purposes of developing a successful, statewide regulatory strategy. These groups and their needed control measures are as follows:

Migratory Resident Fish

Resident fish populations in the medium and larger-sized rivers of the state fall into this category. Typical characteristics are extensive upstream and downstream migrations plus significant mainstem and tributary interchanges. Substantial spawning often occurs in the tributaries where much of the juvenile rearing can also take place. The general situation is stated as follows by Johnson and Bjornn (1978):

> "Returns of fish tagged and released in the three study streams indicate that cutthroat trout migrated upstream into the upper drainages" (study areas) "in the spring and early summer, few cutthroat moved during the summer, and cutthroat migrated downstream to lower portions of the drainages in the fall. Downstream fall migrations of cutthroat trout probably increased their overwinter survival."

The following specifics for an individual system were provided by Thurow (1980):

> "Wild cutthroat trout exhibit the following movement patterns based on tag recoveries and trapping operations. Mature trout migrate from Blackfoot Reservoir and ascend the Blackfoot River during March, April and May. A majority of these trout enter the Upper Valley tributaries and spawn in May and June and a portion spawn in the main Blackfoot River. Following spawning, spent trout re-enter the river. Progeny of these spawners rear in tributaries of the Blackfoot River for varying periods of less than one year to two years. Juvenile cutthroat eventually enter Blackfoot Reservoir where they mature as age class III+, IV+ or V+ trout. Both juvenile and adult cutthroat migrate down the Blackfoot River in the fall to deep-water areas of the river and reservoir."

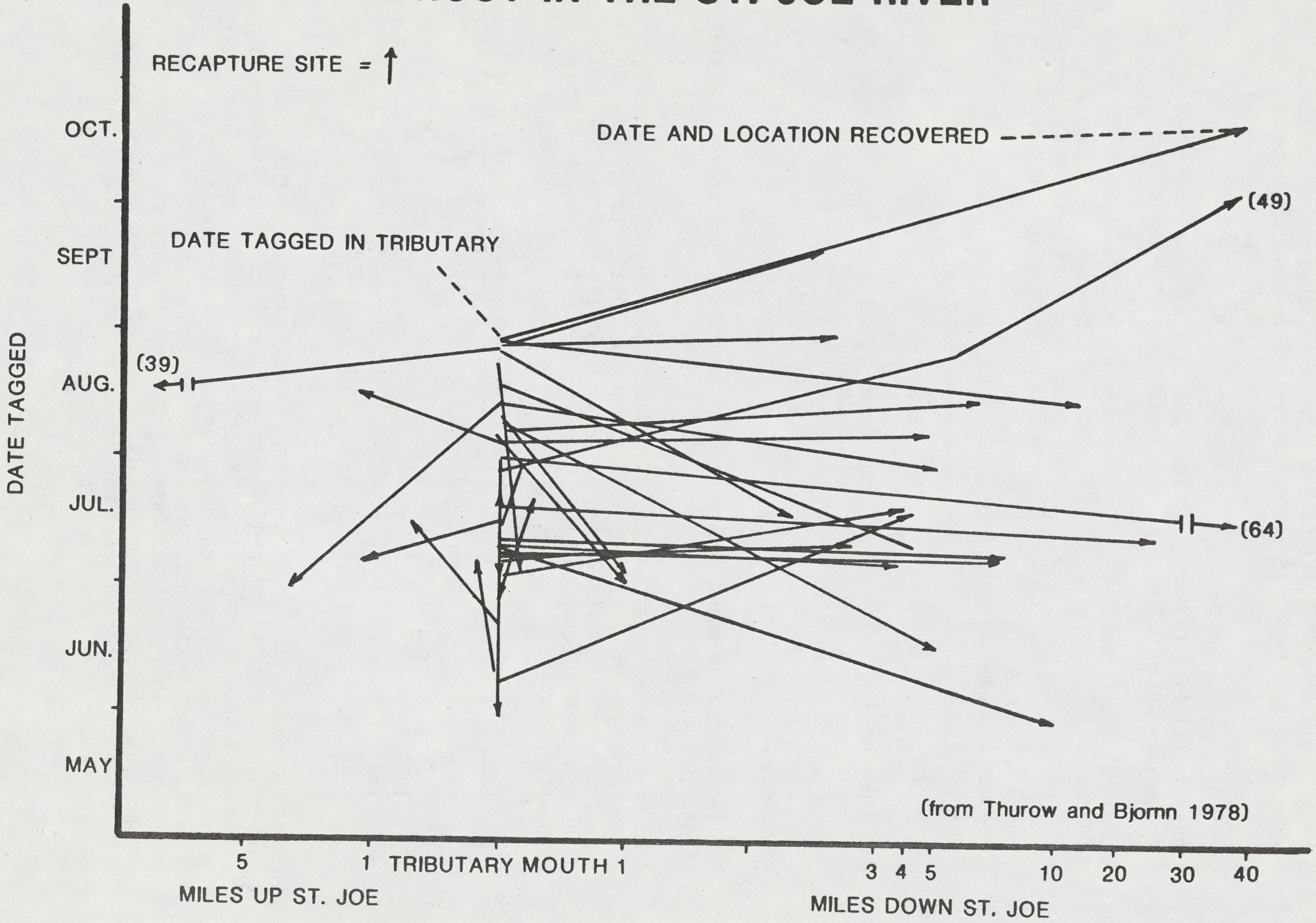
Other studies produced similar findings regardless of whether the population involved utilized a reservoir, lake or only a river mainstem. Figure 13 illustrates the extensive migration potentials for individual fish.

Homing of mature adults is strong, since Ball (1955) reports that 96.8 percent of the returns from a tagged sample of 17,836 fish were later recovered in the same stream as tagged. Homing for immatures is also strong, with Benson and Bulkley (1963) stating that 19.9 percent of 644 fin-clipped trout survived and returned to the same stream as marked and none to any other sampled stream.

These are the types of populations that have been successfully managed in other states and Canada by 12 or 13" minimum size limits in mainstem areas, including lakes and reservoirs, if applicable. These controls were initially implemented for "trophy fish" management objectives but produced dramatic increases in trout populations and typically cured serious over-fishing condi-

FIGURE 13

TWO YEARS MIGRATIONS OF TAGGED CUTTHROAT TROUT IN THE ST. JOE RIVER



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tions that were not recognized at the onset.

Johnson and Bjornn (1978) showed the following changes for cutthroat trout in the upper St. Joe River after implementation of a 13" minimum size limit:

Factor	Change
Annual mortality rates for age III+ cutthroat	Declined to a range of 0.47 to 0.56 from a previous range of 0.62 to 0.71.
Abundance of all sizes of cutthroat	Increased by 300% in road access areas, 600% in trail access areas. (NOTE: areas with good access will typically have higher losses from hooking mortality and poaching.)
Abundance of spawning cutthroat	Increased by 10 times.
Angler effort	No change.
Catch per hour	Increased to 2.5 fish from a previous 0.2 fish average.
Total catch (retained and released)	Increased by 500%.

The increases in numbers of larger fish observed during snorkeling transects is depicted graphically in Figure 14.

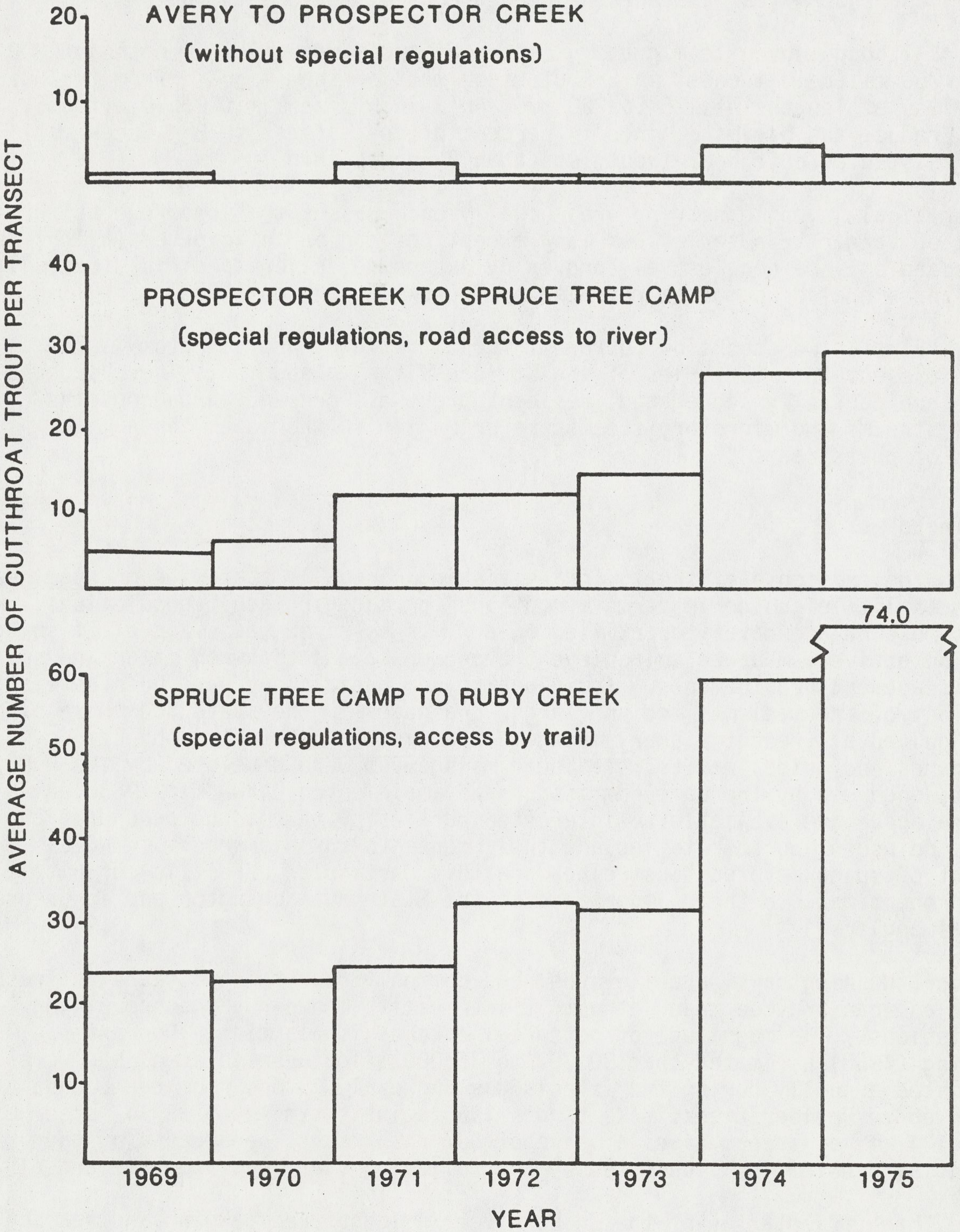
A major increase in rainbow trout abundance was recently recorded for Oregon's famous Deschutes River fishery subsequent to implementation of a 12" minimum size limit in 1979. The following data illustrate changes in abundance of fish from a 1979 low in the Neva Creek study section (Griggs 1982 and MS in preparation):

Year	Number of Rainbow Trout over 7.5"/km.
1974	812
1975	857
1979	389
1981	844
1982	2,498
1983	2,422

Fishery managers from other agencies generally recommend that controls or regulations be applied to entire mainstem areas utilized by a given trout population, including a lake or reservoir, if applicable. If only part of the system is protected by positive controls (such as 12 to 13" minimum size limits), the desired population response can be negated by in-system fish migrations. An example of this problem is seen in the work of Llewynsky and Bjornn (1983) on the Coeur d'Alene River. They found that some fish remained in the "special regulation" or protected areas throughout the year, but many others migrated through two or more regulatory zones.

FIGURE 14

AVERAGE NUMBER OF CUTTHROAT TROUT PER SNORKELING TRANSECT, ST. JOE RIVER



(from Johnson and Bjornn 1978)

Where data are available for individual systems, minimum size limits should be set specific to the data base in-hand so that one age class of females is allowed to spawn at least once. Where river-specific data are not available, a 12" minimum size limit has the best chance of success and should be applied to the mainstem fishery. In addition, it is necessary to protect juveniles rearing in the tributaries through their second year by an 8-inch minimum size limit or the assured recruitment objective can also be compromised. Thurow and Bjornn (1978) state the needed control measure as follows:

> "Although juvenile migratory cutthroat trout may attain lengths of 200-250 mm (8-10 inches) in tributaries, most of them migrate from tributaries at lengths of 120 to 220 mm. An 8-inch size limit would effectively reduce the harvest, since 74 percent of the harvest in Big Creek consisted of cutthroat trout less than 8 inches long."

The critical juvenile rearing area usually encompasses the lower one to three miles of larger tributaries but many exceptions can be anticipated (all of the above can only be conclusively proven by expensive, river-specific studies). Overlaps are also common as revealed by Thurow and Bjornn (1978):

> "First, two stocks of cutthroat trout (resident and migratory) are present in tributaries of the St. Joe River we studied. These stocks are partially segregated; resident trout are present throughout the streams and migratory stocks are primarily in the lower three miles of the streams."

Steelhead

Due to the existence of treaty Indian fishing virtually statewide on steelhead, there is little choice in terms of options for managing adult populations. Run sizes must be accurately quantified on a river-by-river basis and all fishing must be actively managed to achieve the proper balance between catch and spawning escapement requirements. Individual river basin plans have been developed for most of the medium-sized and larger drainages in the state and these plans have guided all recent fishery management decisions. Detailed objectives, standards and guidelines for steelhead management were developed by the WDG staff, endorsed by the Game Commission and implemented by WDG in 1983. All of the above are available to interested parties. It would be redundant and serve no useful purpose to include their contents in this report. (NOTE: The amount of space devoted to steelhead in this particular effort is definitely not proportional to their importance to the State of Washington and its recreational anglers.)

However, Washington's juvenile steelhead commonly rear for two years in freshwater and can provide major "trout" fisheries if allowed by the prevailing regulations. The magnitude of potential catches is alarming. For example, Keating (1968) estimated that 30,000 to 35,000 wild juvenile steelhead were harvested annually during the late 1960's and early 1970's from the Lochsa River above Boulder Creek. (Keating's 1966 point estimate of 38,141 steelhead from 124 km. of stream gives a value of 307 fish/km.) The breadth of the potential problem is illustrated by the following statement from Pollard (1978):

> "Many tributaries of the Snake River in Idaho are spawning and rearing areas for steelhead trout (Salmo gairdneri). Juvenile steelhead make

up a substantial part of the sport fishing harvest in these areas."

Quantitative assessments for Washington streams are quite limited but indicate relatively modest harvests. For example, a 1975 summer creel census on the mainstem of Puget Sound's Green River produced a seasonal harvest estimate of only 4,300 juvenile steelhead when the 6" minimum size limit was still in effect (Collins et al 1975).

More recently, a 10" minimum size limit has been widely used as a Special Regulation in larger streams of western Washington in conjunction with a delayed opening in late May to protect concentrations of steelhead smolts until they have migrated seaward. This approach has generally been very effective (particularily as contrasted to the Idaho situation of the early 1970's), although one problem still exists. The 10" minimum is not applied to many of the smaller streams where juvenile steelhead rearing occurs and some of these populations, despite their marginal attractiveness to the "average" angler, are exploited to provide summer and fall "trout" fisheries. In addition, a 10" minimum does not adequately protect any migratory resident fish populations (rainbow or cutthroat), including those that overlap with juvenile anadromous fish populations.

The necessary broad protection required for juvenile steelhead can, for practical purposes, be provided by a basic minimum size limit of 8" in streams. Only a very small percentage of juvenile steelhead will exceed 8" during times when trout fisheries are allowed.

Exceptions to the above generalization are some naturally-produced steelhead smolts that rear for three years in freshwater and hatchery-produced smolts that "hold-over" for an additional year of freshwater rearing. Normally, neither of these groups makes an important contribution to Washington steelhead runs. However, it has recently been determined that hold-over hatchery smolts are providing a significant component in adult returns to some upper Columbia River tributaries. Therefore, a 12" minimum size limit is recommended for the Columbia River mainstem and those tributary areas where this specific situation prevails.

(NOTE: In areas where migratory resident trout and/or sea-run cutthroat are also present, more restrictive controls must be utilized to meet their specific management needs. In addition, some lower mainstem areas that hold concentrations of smolts past mid-May will require delayed season openings through Special Regulations.)

Non-migratory Resident Fish

These diverse populations occur in hundreds of small stream sections throughout the State that are upstream from or overlap (permanently or intermittently) with both anadromous and migratory resident fish habitats. The various populations, which literally number in the thousands, are often isolated from each other by migratory barriers but recruitment from upstream populations can occur. This latter aspect was explained as follows by Michael (1981):

> "In populations of fish which exist upstream of an impassable barrier, any fish passing over that barrier is lost to the population. Unless the fish spawns prior to its downstream migration, the migratory urge is "lethal" as far as the population is concerned."

The potential for extremely limited ranges is described by Mullan (1961):

> "Contrary to some opinions, trout can and do carry out all the functions of life, including reproduction, within relatively limited areas of stream,

allowing that such an area meets the requirements mentioned. Several studies concur that such a territory generally approximates less than 200 feet of stream."

A good substantiation of this was provided by Hunt (1970) in describing why a closed area or "refuge" failed to increase numbers of fish available in adjacent open fishing areas. He states:

"Only 1% of the catch (45 of 4,695) consisted of trout that had emigrated from the refuge. During the fishing season when the refuge zone had been open to fishing, 21% of the total catch was made there. Most of the trout born in the refuge stayed there throughout their life."

In Gorge Creek, Alberta, Miller (1967) observed that many resident trout retained home ranges no larger than a single pool-riffle complex. The same situation was reported in tributaries of the St. Joe River by Thurow and Bjornn (1978). Their studies showed that only 7% of tagged cutthroat trout recovered in tributaries were 0.5 mile or more from the release site.

The fishery management problems that this multitude of separate trout populations generates is made virually impossible by highly variable growth rates. Purkett (1951) documented the following differences for rainbow trout in two sections of the West Gallatin River, Montana:

Year of Growth	Difference in Average Length
First	0.3 inch
Second	1.3 inch
Third	2.1 inches
Fourth	2.5 inches
Fifth	4.0 inches

Growth of cutthroat trout showed a similar trend with both species growing faster at lower elevations where the water was warmer. The average summer difference in early morning water temperature between the upper and lower studies sections was 9.6°F.

Sweeney et al (1981) checked five tributaries of the North Fork Snoqualmie River and found ranges in the average sizes of trout populations from 3.2 to 5.0 inches. Wetherbee et al (1982) reported that two study areas on Maude Creek one mile apart and 250 feet different in elevation had a 0.5 inch difference in average size of the trout population.

Proper, precise management of all non-migratory resident trout populations is simply impossible, particularly since they often overlap in distribution with juveniles from anadromous and/or migratory resident fish populations. Zones of overlap are difficult to detect in any known cost-effective manner and can change from season to season as fish passage conditions vary. As Figure 15 illustrates, there are no distinct "groups" of population size distributions to facilitate management.

However, as stated earlier, an 8-inch minimum size limit effectively protects both the juveniles from migratory resident fish populations and most juvenile steelhead. It should also yield an adequate spawning population for a majority of the non-migratory resident trout populations.