C-5 Chapman

Visiting Hours Only, or: Catch and Release Revisited[1]

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This paper reviews concepts of participant entry limitation in fisheries. I contend that entry control should lead to highest net annual return to society, hence maximize fishery values in competitive resource allocation. I suggest that managers could limit entry in sport fisheries by sale of weekly permits, odd or even day fishing controlled by ending license number, drawings, or check stations. I argue that entry control will prove necessary even in catch and release fisheries.

We rarely acknowledge that catch-and-release fisheries limit entry in sport fishing. I review here the concept of entry limitation and the connection to non-consumptive regulations. I discuss the role of entry limitation in natural resource allocation, and more direct means of entry limitation that would permit harvests.

Entry limitation originated in commercial fishery management. Crutchfield's (1962) landmark paper on "Economic aspects of the Pacific halibut fishery" first treated the concept of excess capital investment and fishing capacity. Crutchfield pointed out that the problem of policy in halibut management turned on the necessity of conserving the halibut resource. He noted that in pre-regulation days, halibut were treated as a completely free good, open to all comers without restriction. Overfishing resulted. The quota system for halibut, which allowed a fixed harvest each year, prevented overfishing, but promoted overcapitalization and inefficiency, encouraging investment in faster vessels that could travel to and from the fishing grounds rapidly to obtain a greater share of the quota. Engine sizes increased accordingly, for example. The regulations led to dissipation of potential net economic gain in excessive costs.

What has the halibut fishery to do with sport fishery management, especially with <u>Wild Trout IV</u>? The answer requires review of some basic truths in fish population responses to harvest, as well as some simple ideas from economics.

An unharvested fish population will contain a relatively large number of large, older animals and will have somewhat low survival in the early life history stages. It will also have a low population growth rate, in the sense of tissue elaboration or production because the larger animals have a higher requirement for maintenance energy. They do not convert energy to tissue as efficiently as do young, rapidly growing animals.

As fishing mortality increases, the population for a time becomes more efficient because the large, slowly-growing population components die sooner, "releasing" younger fish to produce efficiently. Reproductive success and survival of young fish increase as competition relaxes. As a result, total weight yield in the fishery reaches a peak at moderate rates of fishing mortality (Figure 1).

Total weight (biomass) yield to the fishery does not occur without other effects. For example, the mean weight of fish in the population decreases with increased fishing mortality because the large, slowly-growing fish disappear (Figure 1). This result, anathema to many sport fishermen, must occur in consumptive fisheries.

Finally, aggregate weight of the population declines with increased fishing mortality (Figure 1). In spite of this, the

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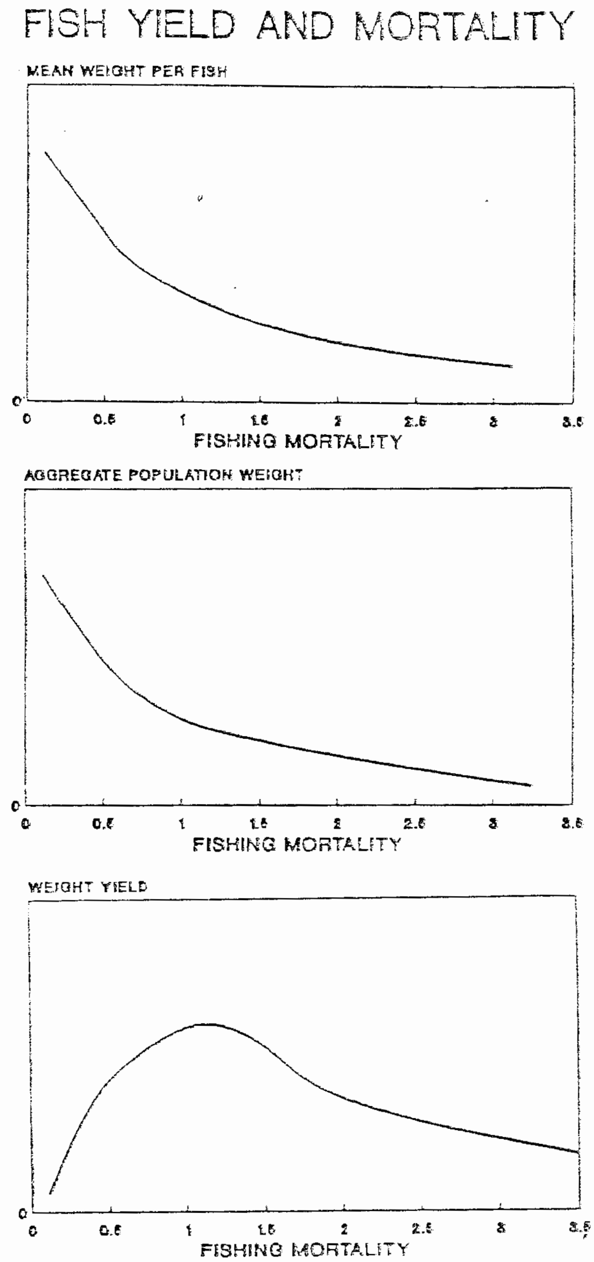

Figure 1. Generalized relationship between mean weight per fish, aggregate population weight, and population weight yield to a fishery at various levels of fishing mortality.

population actually produces the most tissue at intermediate fishing, not at zero harvest. Fishing mortality increases with fishing effort, so total weight yield from the population has a dome-shaped relationship to fishing effort (Figure 2).

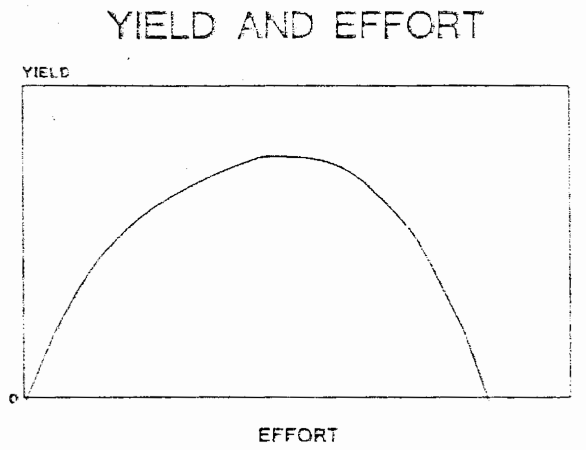

Figure 2. Yield of fish numbers or weight in relation to fishing effort.

Crutchfield (1962) connected economics to the weight yield/effort function by stating that in most fisheries, abundance of alternative foods allows us to directly convert pounds of fish to dollars, and to show that cost to the fleet increases linearly with increased effort (Figure 3). He also pointed out that in a common property fishery resource, effort will increase as long as potential entrants into the fleet perceive that they can make a net profit. This means that effort inevitably increases to point C in Figure 3; the point at which receipts

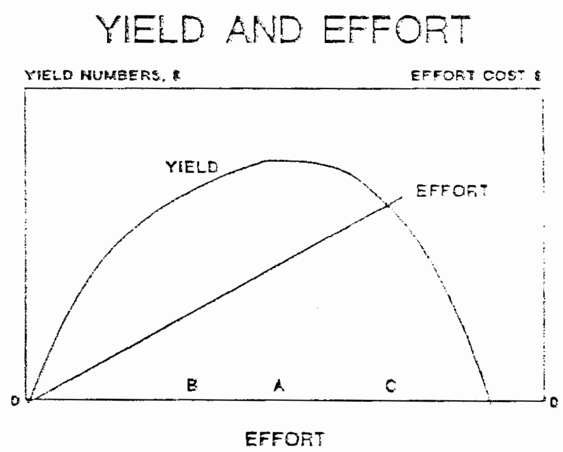

Figure 3. Yield in monetary value of numbers of fish, and cost of effort at various effort levels in a common property commercial fishery. A = effort level at maximum sustained total yield. B = effort level at maximum sustained net economic yield. C = effort level normally expected in a common property fishery.

just equal costs. Very efficient fishermen, sometimes called "highliners" continue to realize a positive net return, but many other fishermen lose money.

Commercial fishermen (to say nothing about sport anglers!) always think the next voyage will yield the bonanza catch that will turn their fortunes around. This notorious optimism, as well as a poor market for vessels and gear and "once a fisherman, always a fisherman" inertial resistance to occupational change, keeps effort at point A. Furthermore, many fishermen tend not to think in terms of opportunity cost, the return they could realize in alternative investments. They tend also to forget to include owner/skipper labor when they calculate cost of effort. A false picture of real return on investment thus emerges when these fishermen total up income and costs at the end of the year.

If a prudent monopolist owned the fishery resource, he would manage effort at the point at which the distance between the cost and return line maximized (Figure 3, point B). Point B denotes the maximum net economic yield from the fishery. All fishery management operates under three constraints: biological, technologic, and socioeconomic. Fishery conservation should provide economic benefits to man (Crutchfield 1962). Sound conservation would control effort so as to maximize net economic return. I suggest later that we should include sport fisheries in this mandate, as Jim McFadden first suggested in 1969.

In the absence of the private entrepreneurial option to limit entry, government must control fishing in a manner that assures conservation, defined as assurance that the stock can perpetuate itself. In salmonid fisheries, this means management to assure adequate escapement. This means that government must resort to short fishing periods, single nets, certain net materials, and certain areas of fishing; in short, must make fishing more inefficient to prevent overfishing. Gear and time restrictions that assure inefficiency become extremely onerous. Most of us would agree that entrepreneurs in a capitalistic system ought to have every opportunity to become efficient.

How does one limit entry in a commercial fishery on a common-property resource? Government, authorized by legislatures, may simply stop issuing new licenses, increase the cost of annual relicensing, buy licenses from willing sellers, and even buy boats and gear with license proceeds or general tax revenues. Once the fleet reaches the desired size, licenses change hands much as private land does. Some Canadian salmon fisheries, the lower Columbia River gillnet fishery for salmon, and certain Alaskan fisheries offer examples of this approach. Oyster beds in estuaries are owned, limiting entry.

Has entry limitation worked in real time? After entry limitation, the value of a Bristol Bay gillnet license increased by at least 15-fold. When last I heard, one could buy a license for perhaps $160,000 (without boat and gear). The Bristol Bay sockeye fishery now is worth more in net annual return to investment.

What connection can we find between entry limitation and stock-recruitment relationships? The latter define the relationship between progeny numbers as adults and parent escapement. These functions developed in Pacific salmon manage- ment, especially in stocks and species with predominantly fixed generation time. Coho salmon, pink salmon, sockeye salmon, and chum salmon offer examples of mostly three, two, and four-year generation times. A generalized stock-recruitment function (Figure 4) relates parent spawners on the X axis to progeny adults in the resulting return run on the Y axis. The straight line shows where returning run just equals parent spawner numbers. At any point above the replacement line, a given escapement produces a harvestable surplus.

An escapement of about 1.3 spawners produces a maximum returning run (maximum N) of about 2.9 (Figure 4). Harvestable surplus equals about 1.5 (difference between replacement line and curve). A lower escapement of about 0.8 spawners produces only about 2.6 returnees, but will sustain a harvest of 1.7. This occurs because of reduced competition at the lower escapement; competition for spawning sites and perhaps for juvenile rearing. Still, an escapement of 0.8 "fully seeds" the available environment. We term

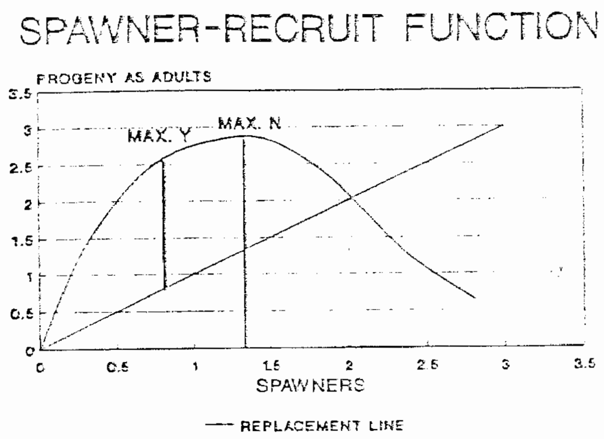

Figure 4. Progeny adults in relation to parent spawners. A spawner population of about 1.35 leads to maximum returning progeny, while a population of about 0.8 leads to maximum sustained yield (distance from replacement line to curve).

management for an escapement of 0.8 as management for maximum sustained yield (MSY). We call management at 1.3 spawners as maximum sustained numbers (MSN). A prudent monopolist would manage his fishery for MSY, where he can take about 65% of the returning run, on average, if he manages at MSY. He would harvest the surplus with limited entry so as to maximize efficiency. The connection between entry limitation and MSY in publicly owned fisheries is that both management schemes would maintain effort, hence fishing mortality, at intermediate levels that maintain the stock at highest productivity (biomass growth).

Management for MSY becomes very difficult where two or more stocks with different stock-recruitment functions mix in the fishery. The less-productive stock in Figure 5 has a harvest rate at MSY of less than 40%. Fishing at MSY at the required 70% harvest rate for the productive stock would overfish the less productive one, and may drive it to extinction, or at least to greatly underescaped levels. This has happened, and continues, on the Columbia River, where gillnet fisheries for mixed fall chinook salmon and large Idaho steelhead leads to underescaped wild steelhead. The problem would greatly decline in severity, but would not disappear, without hydro dams on the system.

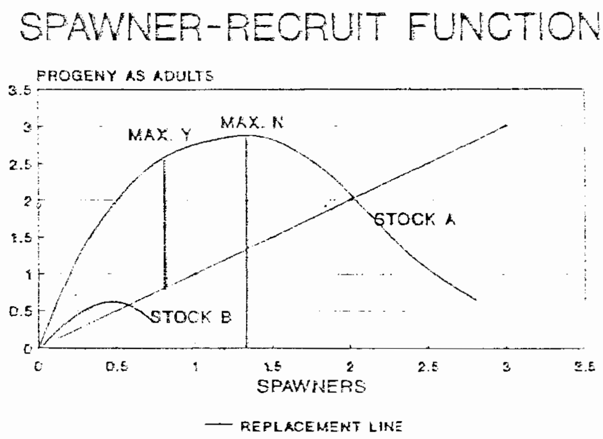

Figure 5. Spawner-recruit function for a productive population (stock A), and an unproductive population (stock B).

In sport fisheries, management may seek either MSY or MSN. Catch-and-release fisheries reduce consumptive harvest of large, slowly-growing older members of the population. Resident fish populations generally have four or more age classes, unlike most Pacific salmon stocks. Thus, the stock-recruitment function blurs. However, the relationships in Figure 1 hold. That is, multi-aged populations decline in mean size and aggregate population weight as fishing mortality increases. After the fishing mortality rate increases enough, aggregate yield declines.

Whether one manages for MSY or MSN, one must employ measures exactly like those used by the commercial fishery manager. One can limit efficient gear (no dynamite, closed areas, single lures, barbless hooks, artificial lures, etc.), or times of fishing (no night fishing, closed seasons), or size of fish kept. Or one can require that anglers release all fish. Some regulations that limit efficiency must remain in place in all fisheries. No one wants to see dynamite used to harvest fish, and snagging in spawning populations does not usually serve management well.

Biological conservation most often requires time, size, and gear restrictions to reach MSY or MSN. But what about MSYE or MSDE? These I might define as maximum sustained yield of esthetics or maximum sustained days of esthetic experiences.

Most of us would probably argue, for example, that the value per fish as meat declines with each steelhead caught. That is, we do not value the fourth steelhead caught as highly as the first. We must, for it usually ends up a year later with locker burn. I also argue that the first steelhead caught has high esthetic value, but that additional fish add less per fish to the esthetic experience (Figure 6). I hurriedly note that the total value of the esthetic experience increases for each added fish caught. The marginal value decreases. I have, a few times, reached the point of zero marginal benefit, where the next fish was not worth the effort required to catch it. Some would call that nirvana; nonetheless it fits with economic theory.

I can combine the discussion so far by depicting a yield function for recreational fishing where meat and esthetics values exist (Figure 7). I take the liberty here of assuming that a day of fishing has a dollar value, as many economists have shown indirectly (Mathews and Wendler 1968, Brown et al. 1964). Suppose we eliminate meat yield, at whatever cost in the spectrum of participants and nutrition. Certainly those who remain or come to fish in a catch-and-release fishery differ in characteristics from those who participate in a harvest-oriented fishery. And certainly most stocks could contribute to human nutrition to some degree; a value lost in catch and release fisheries. Ignoring those factors, I suggest that catch

VALUE PER FISH

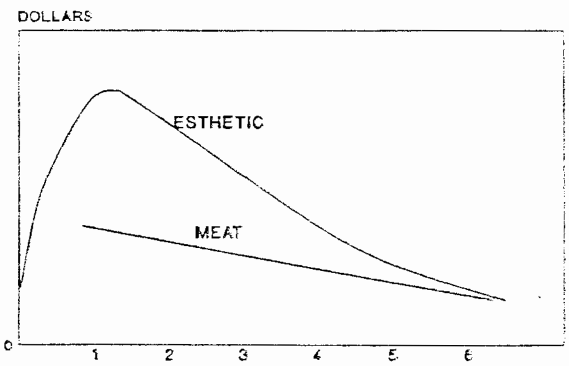

Figure 6. Value per fish for esthetics and meat as related to number of steelhead caught.

YIELD AND EFFORT

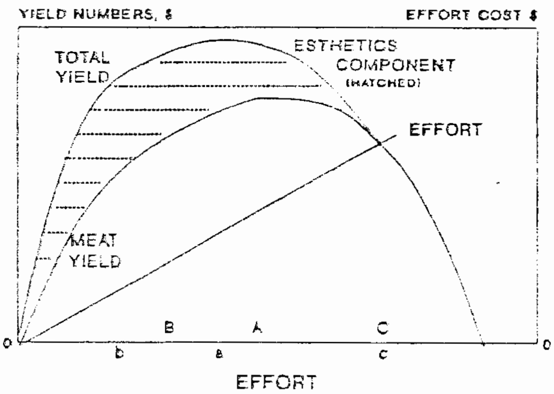

Figure 7. Yield value in a sport fishery at various effort levels. Hatched area shows esthetics component, additive to the meat yield value. Effort cost increases linearly with increased effort. A, B, C defined as in Figure 3. a = effort that maximizes total economic yield of esthetics and meat. b = effort that maximizes net economic return to society from combined esthetics and meat. c = effort reached eventually in a common property sport fishery.

and release fishing for esthetics will take a functional shape (Figure 7) much like that for commercial fishing. This implies, in a publicly-owned resource, that effort will increase until the net return of esthetics declines to zero. This means that entry will tend to point C in Figure 7.

Why does net return decline? First, it does so because catch-and-release regulations, ironically, attract too many "elitists." Many of these anglers prefer to see no other angler, and want unrestricted access to each favored casting spot. They develop a certain resistance to crowding. Participation of more and more fishermen eventually must decrease the "return" per angler. Secondly, even catch-and-release angling causes some mortality, which may, in heavily used fisheries, lead to a reduced fishable population that offers less catch opportunity even where the fishery objective is to maintain a large population of big fish. For example, a study of steelhead catch and release in British Columbia showed a mortality rate of 3.4% for 3,715 fish caught with bait and barbed hooks; (Barnhart and Roelofs 1987). Where anglers may capture steelhead more than once, the rate may rise, especially where fish take the lure, even a barbless one, deeply. I think this describes Idaho's catch and release program for wild fish on the Salmon River.

The point of MSY for esthetics lies at effort level b in Figure 7. A prudent monopolist who charged for access to his fishery resource would limit entry at b so that his net return maximizes. Can society do the same? If so, why?

On some public shooting grounds, a limited number of blinds are available to duck hunters who must apply in advance and receive a blind for a given day, or who must line up at the entrance to the shooting ground well before dawn on a first-come, first-served basis. Why must one use only the established blinds? The answer is that decoy shooting for ducks offers a classic case of decreased net benefits with increased effort. Too many hunters too close to each other completely spoil hunting for everyone as ducks never have a chance to work to the decoys.

Golf offers a fine example of limited entry. In fact, I golf more than I fish, in part because of golf's entry limitation. Tee times every 8 minutes or so guarantee spacing on the course. Certain rules permit fast golfers to move through slow ones. The amazing feature of the system is that conflicts between good and poor golfers are so few. The system usually offers a pleasant and rewarding experience to all entrants (although some would argue that golf's very virtue is that it offers pain and suffering to willing masochists!).

On the popular Middle Fork Salmon River, one can only begin a float (of 5 days or so) if in possession of a permit that was applied-for in January and issued on a random selection basis as part of a numerical quota (or one can float with commercial outfitters who automatically get about half of all permits; a problem outside the thrust of my paper). Over 8,000 floaters use the river each summer. A catch and release regulation for the stream, together with the float quota, guarantees a quality experience. If too many floaters used the stream, solitude would disappear, campgrounds on the few available areas in the deep canyon would not offer sufficient space, and the cutthroat trout fishing would suffer.

How can some of these resource partitioning programs apply to fisheries, even to catch and release? All angling licenses end with a digit. Regulations might allow anglers with odd-ending license digits to fish only on 26 of the available 52 weeks; even digits would fish on the alternate weeks. One might obtain a special permit to fish two weeks (actually three) in a row. A block of these permits could be made available to anglers in a drawing. Alternatively, regulations on popular catch and release streams would require a fishing permit obtained from a drawing each winter, with unused permits available on a second drawing. We already manage many big game harvests in this manner. In some cases governments collect significant revenue from limited-entry drawings. Less desirably, entry checkpoints might allow a quota of anglers into given stream reaches, with no more entrants until someone departs.

This all sounds rather Draconian. Why should we go to such lengths? I think that our objective should be to maximize net return, at least for many salmonid fisheries. This maximization increases the annual "rent" from the resource, whether society actually collects that rent or gives it away to anglers. I would maximize rent from harvest as well as catch and release fisheries. Once the obligation of full and adequate seeding by adults is assured, society should then maximize net benefits from fishing harvest and/or opportunity. My reasoning is that net benefit maximization provides a high-quality experience for participants and assures the most competitive role possible in resource allocation. Not all allocation decisions (kayaking v. fishing, timber production v. fish habitat, grazing v. riparian zones) will or should be made on economic criteria. However, fisheries will get the most consideration possible from resource owners or managers by having the greatest economic "clout" possible. Sport fisheries will have least clout if managers dissipate rent by excessive entry.

In a paper called "Economic criteria for division of catch between sport and commercial fisheries with special reference to Columbia River chinook salmon," Mathews and Wendler (1968) examined net rent from sport and commercial fisheries. They concluded that the coefficient of catchability in the sport fishery on the Columbia River is 5 times as high on the spring chinook run as on the fall run. Since net value of sport fishing depends on the average level of angling success, the spring fish are potentially more valuable for sport fishing. The authors showed that only if the commercial fleet were reduced to increase net economic value could a continued commercial fishery be justified. On the basis of the economic criteria examined, the authors stated that resource managers should consider managing the spring chinook stocks with more favor toward the sport fishery unless the commercial fleet were reduced in size (made more economically efficient). They suggested no change in the fall season fishery, although entry limitation would substantially increase economic rent in that fishery.

I suggest that as fuel costs rise, making ocean trolling even less economic, and as more salmon reared in net pens reach the market at low prices, management of salmon for sport fisheries becomes much more appropriate. Furthermore, even if terminal commercial fisheries continue to harvest important quantities of salmon, regional economic returns from salmon would increase substantially. More biomass would reach the mouths of parent streams. Ocean harvesters (sport and commercial) take salmon that are growing new tissue faster than natural mortality consumes it. Furthermore, hooking mortality is very high, wasting more biomass. About 117,000 coho salmon were wasted in hooking mortality during a chinook-only fishery off Oregon last year, or about 17% of the legal harvest of coho salmon in all-species seasons. An additional hooking mortality is associated with the latter fishery. I estimate that every hundred coho in the legal harvest off Oregon represents 30 more fish killed and lost. Coho salmon could be taken in terminal or sport fisheries with great increases in net rent.

Will the angling public support limited entry? To answer this question, I examined a 1988 angler opinion survey of Idaho fishermen (Idaho Fish and Game News, March-April 1989). In 8,599 usable returns, 56% of respondents would be willing to restrict number and size of harvest to maintain fishable wild populations; 54% would manage streams and lakes to provide larger than average trout at increased catch rates, even where methods, numbers and size would need restriction; and 48% would continue to fish a favorite trout stream if the water were managed for trophy trout with catch and release. When asked whether they considered it important to avoid angler crowding, 89% of the respondents said it was important (22.4%), very important (34.2%), or crucial (26.2%). From these data, I conclude that anglers want to maintain wild trout and would accept catch restrictions, including catch-and-release regulations, to do so. The respondents do not want crowding, so limited entry appears acceptable in some form.

Limited entry certainly would control crowding. It would also lead to increases in fish size, if coupled with such measures as catch and release. For the respondents who would not support large fish management through catch and release, the latter would likely limit <u>their</u> entry. The May 15, 1989 Idaho Statesman shows one response in an article titled: "Sportsmen may sue over Big Wood fishing rules." The Idaho Fish and Game commissioners had voted 3 to 2 to restrict 17 miles of the Big Wood River above Deer Creek to catch and release fishing with artificial lures. Protestors called for a "fish-in" on opening day, with one ring-leader stating: "I've already told the Fish and Game where I'll be opening day, and I told them to bring their handcuffs." Presumably, this individual would form part of the approximately half of questionnaire respondents who would not support catch and release as a measure to increase fish size or protect wild trout! On the other hand, I think that respondents who support such protective measures in general, sometimes or often would not support them if applied to their favorite stream.

The time may not yet have arrived for wide support of limited entry, whether accomplished by catch-and-release or other measures. But it will. One need only visit trout streams close to metropolitan areas, or the growth of tourism in the mountains of the western United States, to see the developing pattern. I have watched the West change for 35 years as a professional biologist and fisherman. I know that 25 years ago very few fly anglers fished for steelhead on the Clearwater River in Idaho. One could fish all day without seeing another rod. Today one often cannot find a known holding spot for steelhead that does not contain a fly fisherman. Where the lower Deschutes was little used, it now is super-saturated with steelheaders. I think it is time to initiate entry limitation on certain popular waters to increased net benefits.

Apart from direct benefits to anglers, high net rents from resident fisheries, whether oriented to harvest or catch-and-release, provide ammunition to allow Forest Service and BLM administrators to more easily justify livestock reductions on public riparian zones. They give the manager justifications to improve stream habitat, better land husbandry, and to compare social benefits of roading and timber harvest to those from fisheries and other resources not traditionally considered as commodities. Should the fishery manager fear economic comparisons? I do not think so. From the ranks of contented anglers come informed and participating publics.

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