PREDICTING EFFECTS OF MANAGEMENT ALTERNATIVES ON FISHERIES RESOURCES

Paul Brouha
USFS, Shasta-Trinity National Forest
2400 Washington Avenue
Redding, California 96001

ABSTRACT.

Fisheries concerns in resource planning on National Forests include: increased sedimentation, increased turbidity, water temperature changes, flow regime alteration, increased probability of mass movement, and current harvest regulations. Several habitat assessment methods have been developed that describe fisheries habitat capability, limiting factors on production, and potential for improvement. Methods that predict effects on fisheries habitat of alternative management scenarious through time (suitability), however, have not been refined. Several methods of relating changed land management practices to improvement or degradation of fishery habitat and therefore to fishery production potential are discussed and evaluated. At present there is no completely defensible predictive system but some current efforts hold promise of quantifying independent variables and how they interact to measurably change fish habitat.

INTRODUCTION

Joe Harn, Forest Supervisor, Six Rivers National Forest, was quoted a year ago in the National Audubon Society magazine article saying "Nobody used to care what the Forest Service did." Several events related to fisheries have helped change that public apathy. Since 1945, California has experienced approximately a 70 percent decline in anadromous fisheries. In conjunction with these resource declines there has been an increase in demand because of increased population and leisure time. As the subjects of this session and the recent Cal-Trout Symposium attest, management of National Forest resources has become an important public issue. People really care today - and they readily consider litigation if they are not satisfied that Forest Service managment plans comply with Federal laws (witness the present RARE II suit by the California Resources Agency and the Fox Planning Unit out of court settlement agreement, Six Rivers National Forest).

Fisheries concerns in resource planning on National Forests are varied, but among the most important is answering the question, "How does logging and road building affect the fisheries resource?" In the past it has harmed it in several ways:

1. Increased sedimentation has resulted in the physical loss of spawning, holding, and rearing areas. Food availability has been reduced because of declines in invertebrate populations. Developing embryos have smothered or been ground up because of reduced intragravel oxygen availability or increased bedload mobility.

2. Logging has also increased turbidity which seldom kills young fish but reduced growth rates and resistance to disease. Further, it reduces visibility and results in more inefficient foraging by young fish. Finally, it reduced fishability of the waters for anglers.

3. When stream canopies are reduced, water temperature increases result because of increased solar radiation. Temperature also increases from channels becoming shallow and widened by agradation.

4. Apparent flow-regime alterations (timing and volume) have resulted from intensive timbering operations in certain areas. Increased peak flows in agraded channels may increase streambank erosion and undercutting of support for critically stable, adjacent hill slopes. Low flows apparently have often decreased due to the flow becoming subsurface in heavily agraded streams, resulting in loss of juvenile-fish-rearing, and adult-fish stream habitat.

5. Timber harvest and road building in certain ciritical areas has increased frequency of mass earth movement from steep unstable slopes and overloaded road fillslopes, through loss of root-binding capacity, increased soil-water pressure due to tree removal, and concentration of drainage in unstable areas.

So much for physical changes; another fisheries concern is the effect of regulations through time. If there is inadequate spawning escapement of wild anadromous fish as is apparently the present case in the Klamath River system or if there is over harvest of juvenile fish no amount of habitat maintenance or improvement will result in improved fishery production.

PREDICTING EFFECTS

National Forest resource management plans are to comply with the spirit and letter of the law (National Environmental Policy Act of 1969, Endangered Species Act of 1973, Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976, specifically amended by 36 CFR Part 219). Under this amendment each forest resource must be assessed as to its capability - the innate potential of the land area to produce that resource, and as to its suitability - "the appropriateness of applying certain resource management practices to a particular area of land, as determined by an analysis of the economics and environmental consequences, and the alternative uses foregone."

Several definable habitat inventory and assessment methods have been developed that describe capability (Collotzi, 1980; Evans, 1979; Brouha, 1979; Western Energy and Land Use Team, in preparation; Herrington and Dunham, 1967; Instream Flow Group, 1977, 1978). Methods of assessing suitability, however, have not been well developed or accepted. We may well be able to describe optimum habitat conditions, but the reaction of each watershed to manipulation, and the resulting effects on fish habitat in each, will be different. (Figure 1.)

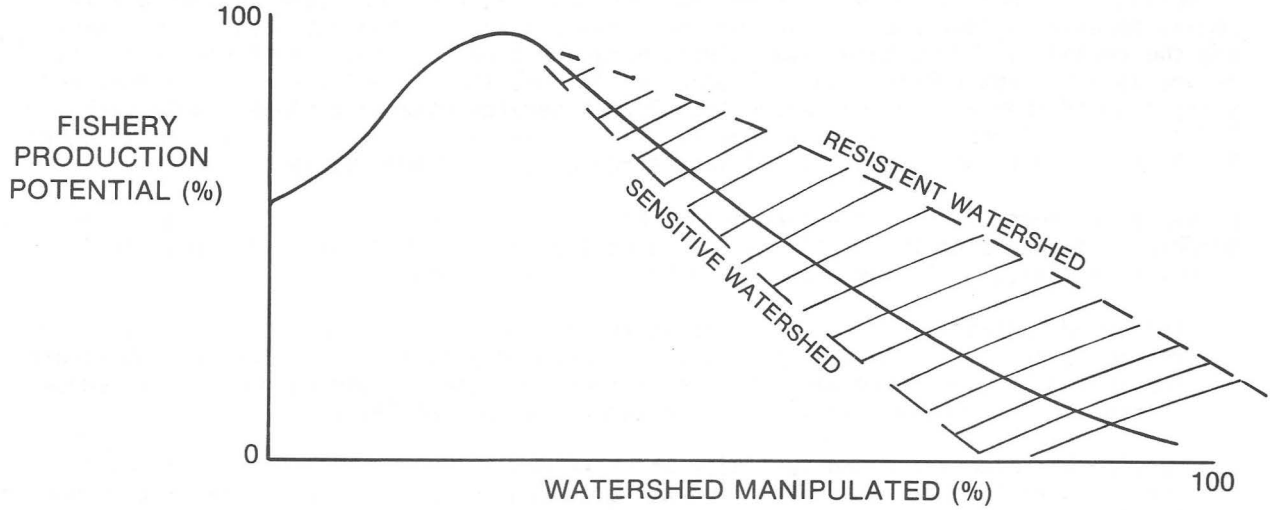

FIGURE 1. Hypothetical fishery production potential versus percentage of different hypothetical watersheds manipulated.

How then does one predict effects of land and resource planning alternatives? How sophisticated does the analysis have to be (how many independent variables should be considered)? Is it possible to relate timber harvest to fish production as in Figure 2?

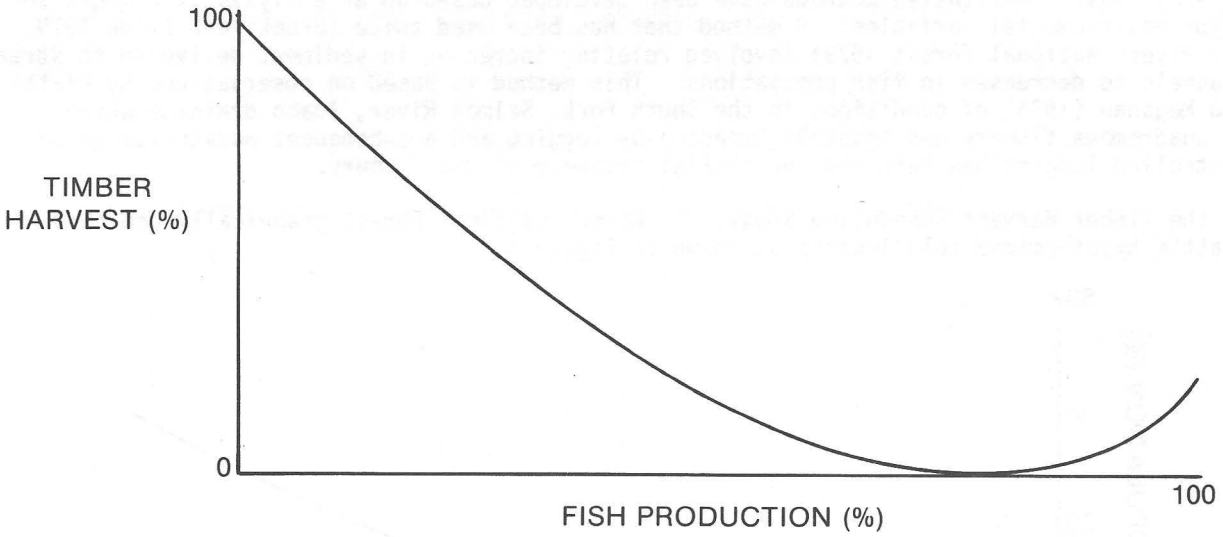

FIGURE 2. A simplistic hypothetical relationship between timber harvested in a watershed and fish production.

Or is it more appropriate to use a family of graphs comparing different independent variables and their effect on dependent instream variables affecting fish production (lists are not exhaustive) as in Figure 3?

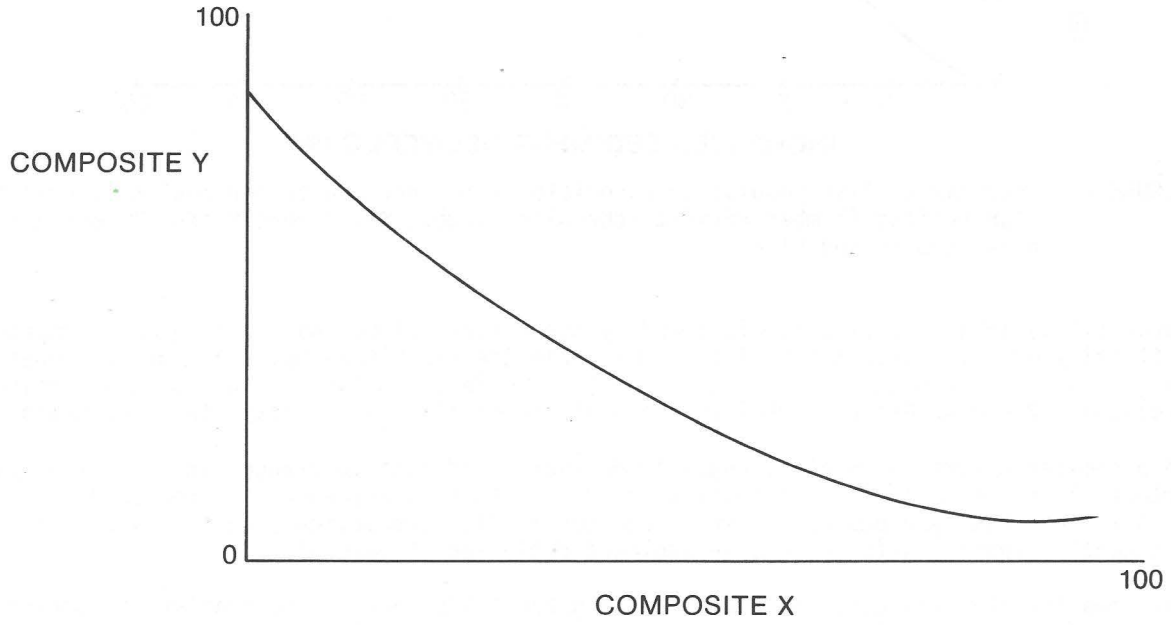

FIGURE 3. A hypothetical combined family of graphs comparing different independent variables and their effect on dependent instream variables affecting fish production.

Y = acres disturbed
slope
aspect
geological stability
erosion hazard of harvest
rainfall
method and quality of harvest
sediment delivery coefficient
hydrodynamic energy of stream

X = instream cover
intragravel permeability
temperature
dissolved oxygen
food availability

Several quasi-quantitative methods have been developed based on an analysis if changes in major environmental variables. A method that has been used twice (Brooks and Cline 1979, Six Rivers National Forest 1979) involved relating increases in sediment delivered to stream channels to decreases in fish populations. This method is based on observations by Platts and Megahan (1975) of conditions in the South Fork, Salmon River, Idaho drainage where an anadromous fishery was severely impacted by logging and a subsequent moratorium on uncontrolled logging has permited substantial recovery of the fishery.

In the Timber Harvest Scheduling Study, Six Rivers National Forest graphically depicted Platt's hypothesized relationship as shown in Figure 4.

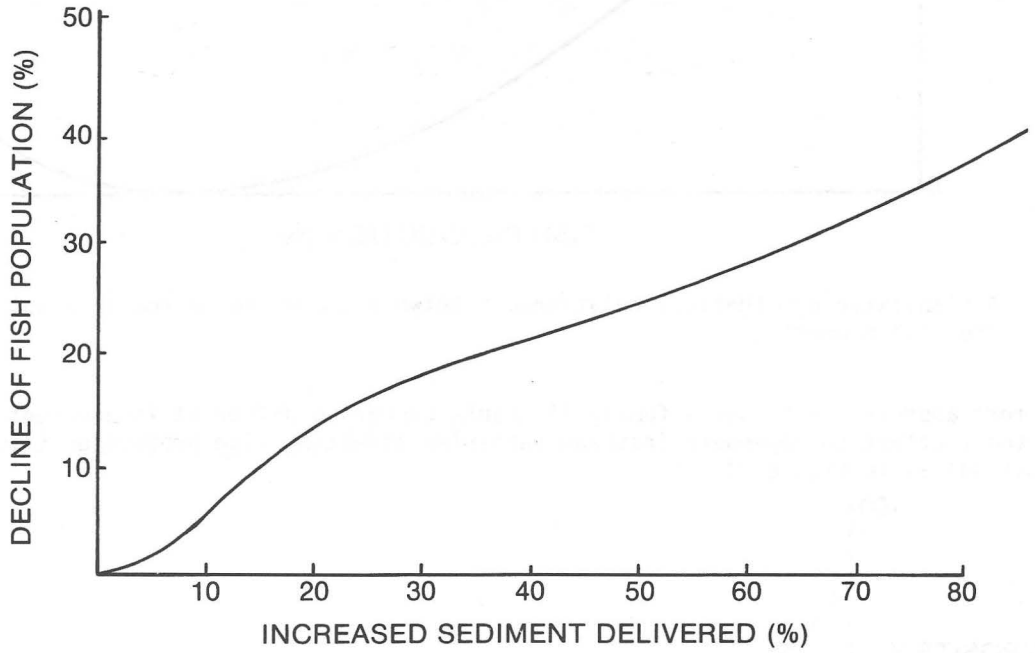

FIGURE 4. Decrease of fish population associated with increase of sediment delivered to fish habitat (Timber Harvest scheduling study, Six Rivers National Forest - after Brooks and Cline.)

Royce (1979) in an analysis commissioned by the Western Timber Association has commented critically on the shortcomings of this method in the Six Rivers National Forest Timber Harvest Scheduling Study. Wooldridge (1979) has made a similar critique of the hyrological analysis. Dr. John Grobey (1980) in the next presentation will detail these comments.

In a similar effort to relate changes in delivered sediment to changes in fish production potential in the South Fork, Trinity River Draft EIS (now permanently withdrawn), a relationship was hypothesized in which changes in fish production potential varied in an exponential fashion with changes in sediment delivered (Figure 5).

The idea for this was based on Platts and Megahan (1975) and on observations by Bjornn et al. (1977) of reductions in fish carrying capacity as pool volume was decreased by addition of fine granitic sediments. He observed the abundance of juvenile salmon in pools of small rearing streams declines in almost direct proportion to the amount of pool area or volume lost to fine sediment deposited in the pool. Intuitively this direct relationship would hold up to a point, however when conditions deteriorated to a critical point, production potential would begin to decline drastically. Conversely, fish production potential might be expected to improve exponentially until another critical point was reached and a different limiting factor was imposed which limited production within the system. Should this hypothesized relationship be tested and found to hold true, the shape of the curve would undoubtedly vary for each watershed. The South Fork, Trinity River was inundated by bedload during the 1964 flood and has remained at or over its bedload transport budget to the present. For this reason an exponent of 1.5 was selected. In low yield/high transport watersheds more sedimentation might be tolerated with less adverse consequences.

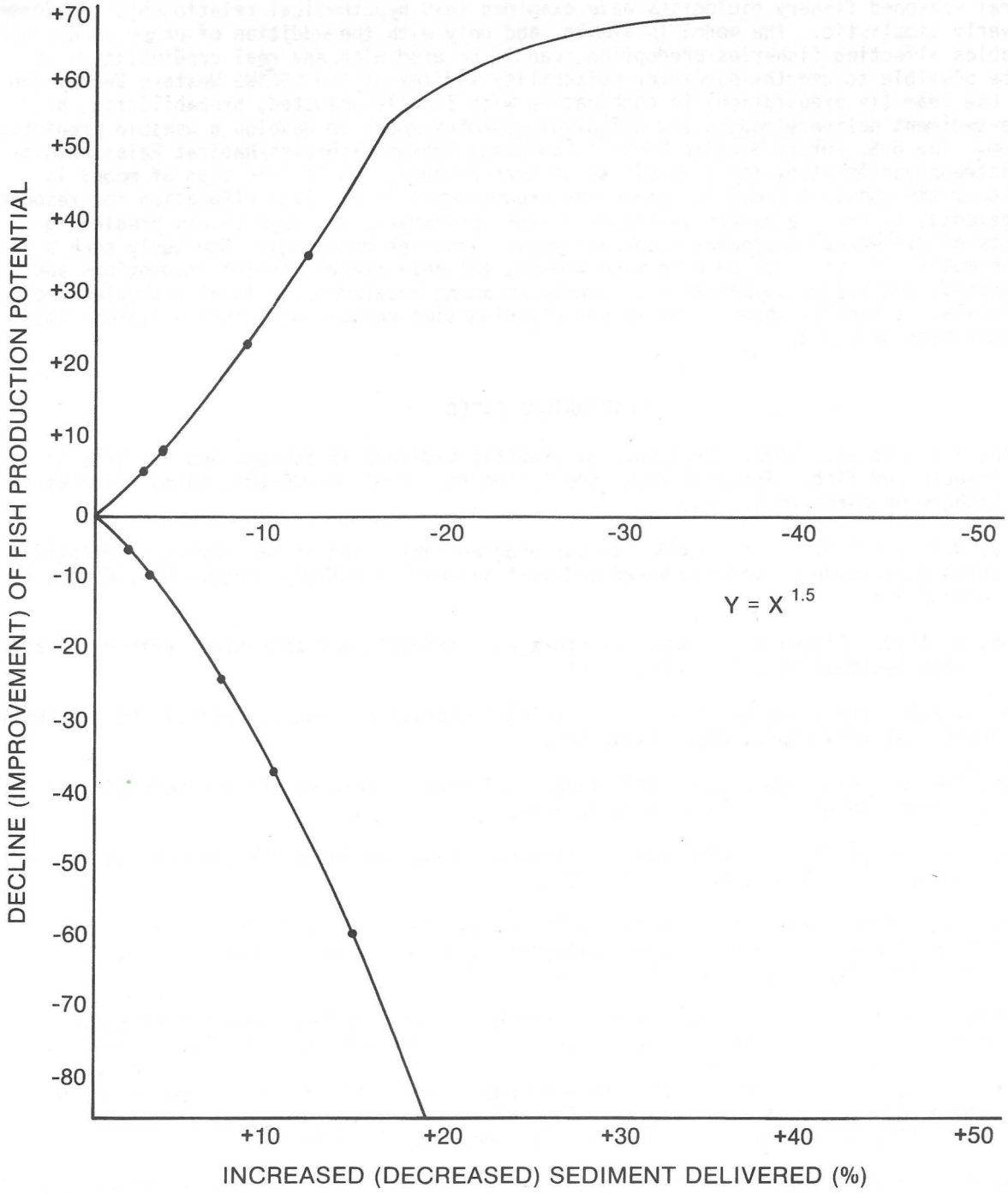

FIGURE 5. Hypothetical South Fork, Trinity River fishery production potential model, as a result of percentage change in delivered sediment.

DISCUSSION

Several seasoned fishery biologists have examined this hypothetical relationship and deemed it overly simplistic. The model is simple, and only with the addition of other independent variables affecting fisheries production, can it be used with any real credibility. It may be possible to use the parameter suitability indices of the USF&WS Western Energy and Land Use Team (in preparation) in combination with locally-adjusted, probabilistic, hill-slope-sediment delivery models and a fluvial dynamics model to develop a useable predictive system. The U.S. Forest Service Pacific Southwest Region Fisheries/Habitat Relationships Committee plans to study the feasibility of such a model. Until this type of model is developed the question remains: given the proposed use (i.e., land allocation for resource management), is there a better system of either objectively or subjectively predicting effects of different management alternatives on fisheries resources? Obviously such a system must: (1) be tempered with much widsom, (2) have clearly stated assumptions and weaknesses, and (3) be supportable by concensus among knowledgeable local fisheries professionals. I submit, however, given our planning time constraints, that a present its the poor best we can do.

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