1979

iii - Report on Steelhead.

Low Stream Flow and Steelhead (<u>Salmo gairdneri</u>) Production

by Hal Beecher, Washington Department of Game

Introduction

The relationship between stream flow and salmonid production has only recently received attention. Instream flow is one of many natural resources which decline in the face of an expanding human population. As in most cases of natural resource conservation, the burden of proof of the resource's value is placed, rightly or wrongly, upon the conservationists. In this paper, evidence for a dependent relationship between steelhead trout (<u>Salmo gairdneri</u>) production and late summer low flows will be analyzed and selected literature will be reviewed.

The hypotheses of interest are the null hypothesis (H_0) and the alternative hypothesis (H_A). H_0:P = 0, H_A:P   0, where P is the correlation coefficient relating lowest stream flow and one of several indices of steelhead production. The sample correlation coefficient, r, is used to estimate P.

Methods

Data on steelhead fry and juvenile abundance in tributaries of the Green River system of King County, Washington, were obtained from quarterly Steelhead Program Progress Reports and from a report by Vail and Oppermann (1977), all provided by Steelhead Data and Management, Fisheries Management Division, Washington Department of Game. Creel census data for the Green River were provided by Dr. Peter Hahn (Steelhead Data and Management). Flow data for the Green River at Auburn were obtained from publications of the U.S. Geological Survey (1974-1979).

The numbers of wild winter steelhead in Green River creel censuses for 1975-76, 1976-77, 1977-78, and 1978-79 were plotted against the lowest daily flow recorded during the summer two and a half years earlier (i.e., 1973, 1974, 1975, 1976). A sample correlation coefficient, r, was calculated. Numbers of age 0+ steelhead fry in several tributaries of the Green River (Soos Creek, upper and lower sections of Newaukum Creek, upper and lower sections of Covington Creek, and Jenkins Creek) were plotted against the lowest daily flow at Auburn during that summer and fall. Data were available for 1976, 1977, and 1978. The small sample size (n=3) at each site prevented a test of H_A v. H_0 as presented in the introduction. Instead, regression lines were fitted by eye for each stream section. Slopes were rated as positive or not positive. (The probability of a slope (b) being zero approaches zero: P(b=0)   0.) The null hypothesis of interest was that P (b   0) = P (b   0) = 0.5. A binomial probability for the frequency of positive slopes was calculated.

Results

The relationship between wild Green River steelhead catch and the lowest late summer flow two and a half years earlier is shown in Figure 1. The correlation coefficient, r, for these two variables is .78 (P .05). This r value, although not significantly different from 0, given the small sample size (n=4), is nevertheless suggestive of a positive relationship between low stream flow and steelhead production.

The relationship between summer low flow and abundance of young-of-the-year steelhead fry is shown in Figure 2. In five of the six stream segments, a positive slope was fitted by eye to the three points. The binomial probability of at least this many positive slopes, if it is assumed that no relationship exists, is .109 (P (T 5 n=6) = P (T=5) + P(T=6) = .094 + .015 = .109). This probability is not statistically significant at the generally accepted levels (.10, .05, .01). However, given the small sample size (n=6), the results suggest a relationship between stream flow and steelhead production and do not warrant outright acceptance of H_0.

Discussion

The data presented suggest a positive relationship between low flow and steelhead production, but results are not conclusive. The small sample sizes reduced the power of the statistical tests used (i.e., there is a high probability of not rejecting H_0 when H_0 is false and H_A is true). The Washington Department of Game continues to gather data on steelhead production. As additional data accumulate, more conclusive tests should be possible, and it might become feasible to elucidate the relationship, if one exists.

Study of the effects of stream flow on anadromous fish production is complicated by a number of factors, so that multivariate analysis would be preferable to univariate analysis. Flooding, as well as drought, can have a drastic impact on young fish (Bailey and Harrison, 1945; Beckman and Elrod, 1971; Hoopes, 1975; Beecher, 1979). Fish production may be limited by number of fish spawning, which may, in turn, be limited by marine survival, migration barriers, and production in previous years. Harvest can affect the number of fish spawning, but it can also be used as an index of production. Shepard (1973) has found that harvest of steelhead is affected by flow, but this effect may be independent of stream flow effects on spawning or rearing.

In the Lake Washington drainage system, multiple regression was used by the Game Department to analyze the relationship of steelhead harvest to summer low flows two and one half years earlier, smolt plant two years earlier, coho salmon troll harvest one year earlier and spring flows two years earlier. Computerized multiple regression programs normally enter the most highly correlated independent variable into the equation first (Nie, et. al., 1975).

Using steelhead harvest as the dependent variable, summer low flow was the first variable to be entered into the equation. The four-variable equation explained 74 percent of the variation in steelhead harvest.

Smoker (1953) found that annual commercial landings of silver (coho) salmon (Oncorhynchus kisutch) were linearly related to the average total runoff in Western Washington two years before the catch year. Zillges (1977) further documented this relationship. Steelhead and coho salmon could be expected to respond similarly to low flows, since both fishes have similar life history patterns.

In a study of resident salmonids in a large number of Rocky Mountain streams, Binns and Eiserman (1979) found that late summer stream flow was the first variable to be entered into an equation to predict trout standing crop. Twenty-two variables were examined.

It is obvious that trout and salmon cannot live in dry streambeds. A stream stops flowing before all water is removed from it, but flowing water is a requirement of most salmonids. It is logical that increased stream flow permits increased production of anadromous salmonids. Supporting evidence (although not conclusive) for the importance of stream flow to steelhead production has been presented here. Sensible fish resource management requires protection of stream flows.

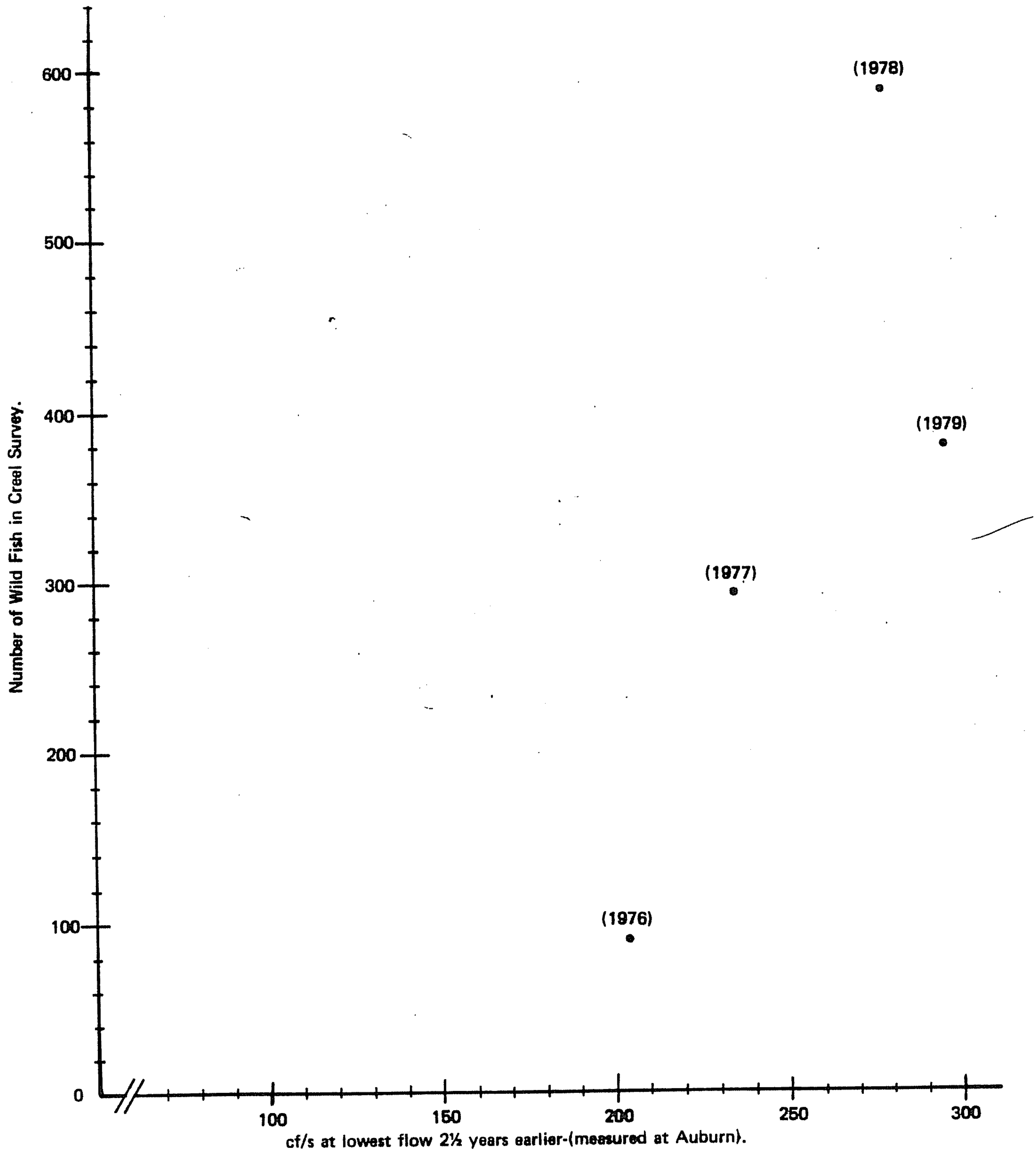

FIGURE 1. Wild Steelhead and Low Rearing Flows on the Green River.