

TRENDS AND FORECASTS
FROM WINTER-RUN STEELHEAD
AT THE KEOGH RIVER

by

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ABSTRACT

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Trends in Keogh River smolt production and adult returns were utilized to develop predictive models for forecasting run sizes. A broad variation in smolt (6 fold) and adult (13 fold) numbers has been observed since 1975. Similarly, age structure of smolts and adults and marine survival rates have varied. It was shown that variation in adult return was related to smolt number, age and size. These relationships were used to estimate about average wild returns (approx 1000 fish) over the next two seasons. Comments on hatchery returns to the Keogh River are included.

The Fisheries Research and Development Section has monitored the wild steelhead population of the Keogh River since 1975. Various components of steelhead life history were examined. The goal was to develop methods for use by fisheries biologists in forecasting run sizes of steelhead in years ahead.

Fish populations were monitored by operating a fish counting fence at the mouth of the Keogh River. Steelhead adults were trapped as they entered the river to spawn and again as they returned to sea as kelts. Steelhead smolts, migrating to the ocean in the spring, were also captured. A comparison of the information over the years showed trends in both steelhead smolt and adult migrants. Furthermore, the relationship between smolt yield and adult return was examined in reference to smolt number and size, as well as age at return. Although preliminary, these results have been used in developing mathematical models used to forecast adult run sizes.

SMOLTS

Smolt numbers from the Keogh River have varied widely from lows of about 2000 fish in the late 1970's to current levels averaging 10,000 (Fig. 1). Recent increases in smolt numbers were apparent on other rivers as well (e.g. Quisam River).

The average size (fork length) of smolts varied from year to year (Fig. 2) and was closely associated with their age. The reasons for natural changes in age of smolts remain vague. Association with pink salmon run size is suggested. Pink salmon spawning runs fluctuate every second year. On the North Island, the run is plentiful during even years and weak during odd years. This means an abundance of pink salmon eggs for juvenile steelhead to feed on every second year which may improve growth and overwinter survival.

Stream enrichment experiments on the Keogh River have caused an increase in stream nutrient levels, production of algae and the number of aquatic insects on which fish feed. This, in turn, has resulted in a change in smolt size and age. Before enrichment, 30% of the smolts spent two years in the river. After enrichment, 70% of smolts were age two. This is evidence that, prior to enrichment, food supply was limited.

The Keogh has not been typical of North Vancouver Island streams in recent years because of the alterations to stream trophic levels induced by nutrient addition. Smolt output has been above average, but the end of stream fertilization experiments combined with a drought in 1987 will likely result in relatively fewer smolts for the next few years .

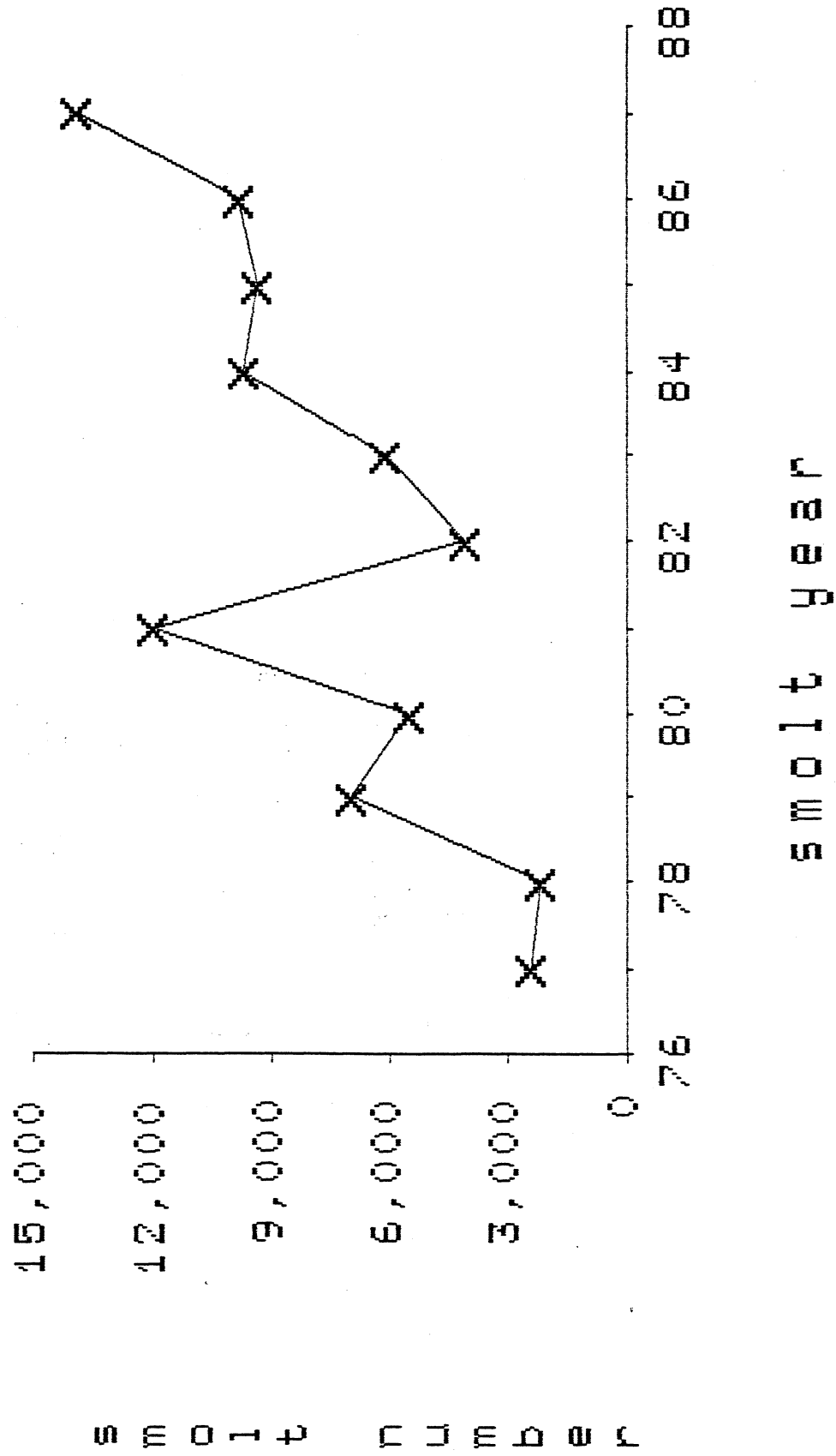


Fig. 1. Steelhead smolt yield of the Keogh River from 1977 to 1987.

ADULTS

A better than average adult run was expected for the Keogh River in 1986/87 and our population estimate was the highest observed thus far (Fig. 3). Run sizes in the mid-1980's contrast strongly with the very low spawning population of 1979 and 1980. It remains to be seen if steelhead populations on the island follow a trend in patterns of 5 or 10 years but the catch success data from past harvest analyses suggest this may be so.

For ease of comparison, returns of wild adults have been compiled by smolt year. This allowed estimation of the age composition and the survival rate from smolt to adult.

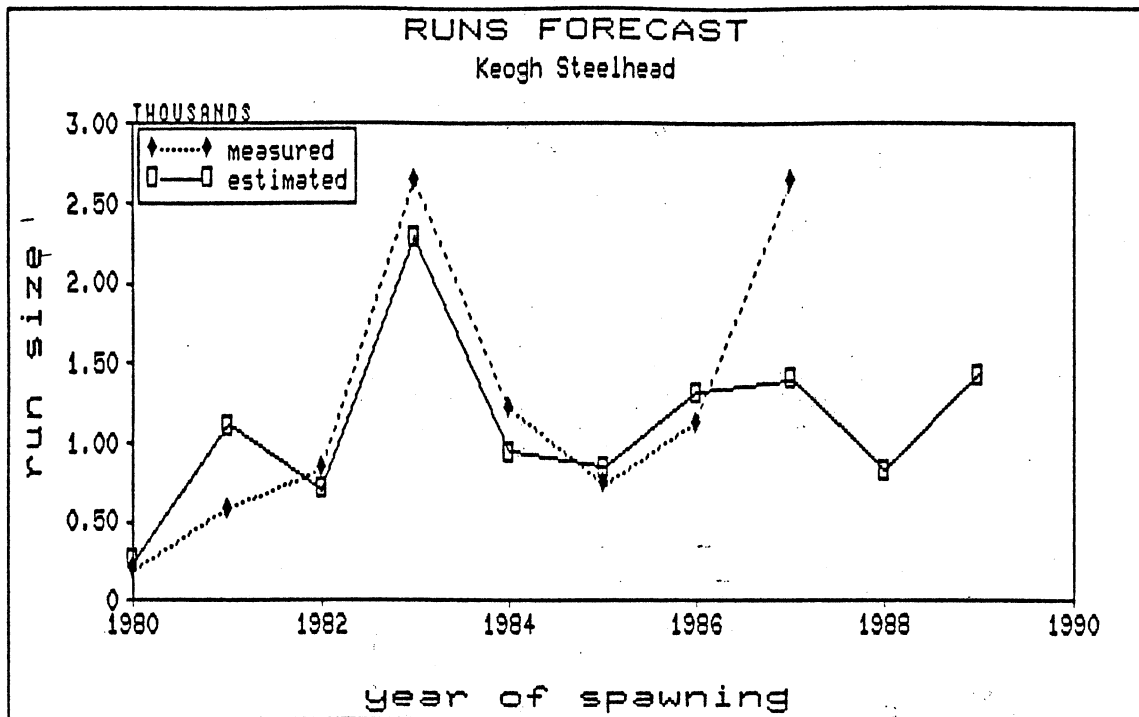


Fig. 3. Comparison of the adult run size estimates (1976 to 1987) and model predictions, with forecasts of the Keogh runs to 1989.

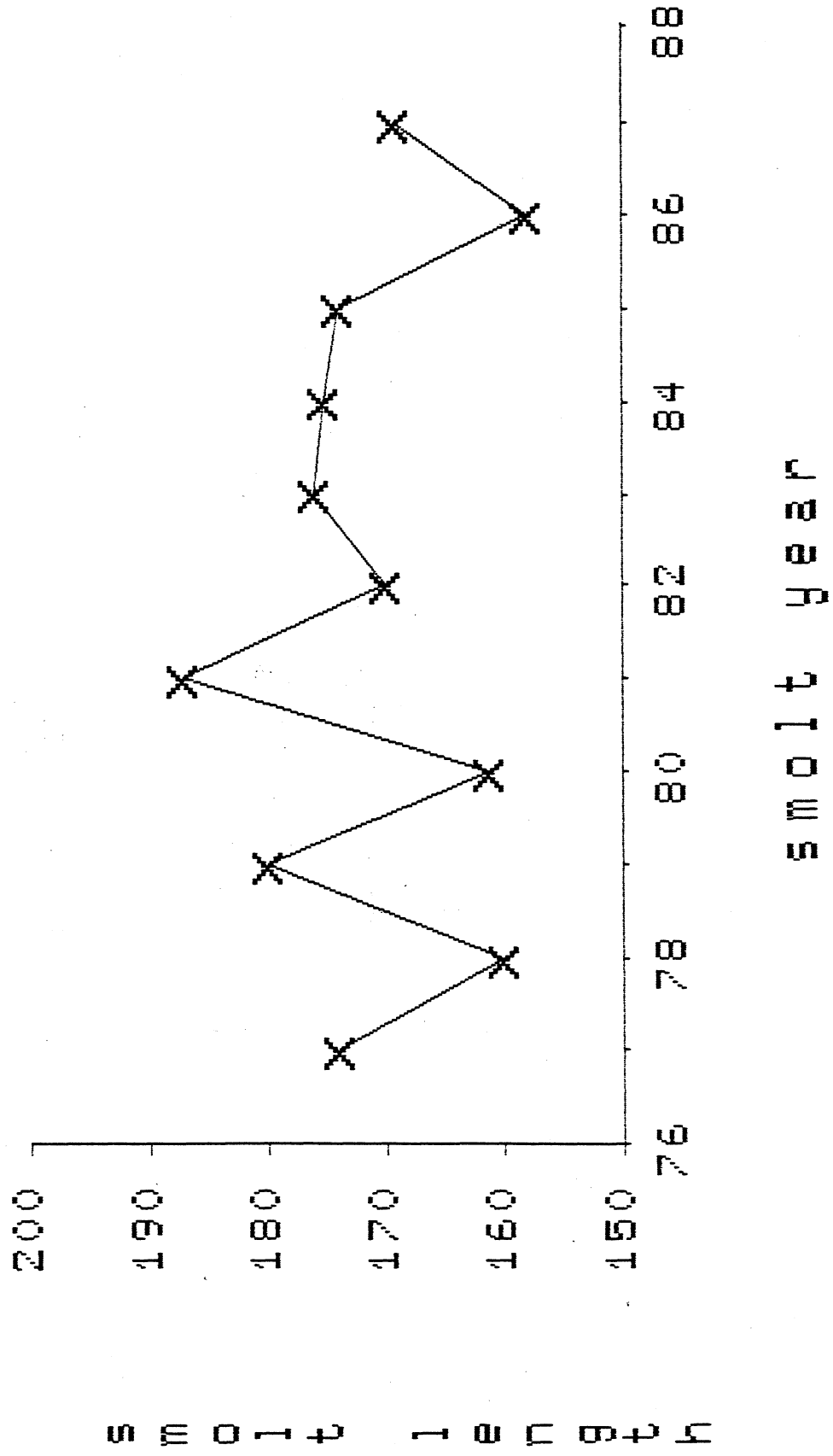


Fig. 2. Mean length (mm) of steelhead smolts during the spring migrations from 1977 to 1987.

ADULT AGE

The range observed in age composition was large (Fig. 4). For example, males aged .3 (three years in saltwater) ranged between 15% (1981 smolts) and over 60% (1983); females aged .3 ranged between 25% (1981) and almost 80% (1984) of the smolt returns. The age composition of males and females parallel each other but for two smolt years (1978 and 1983). Clearly, age composition of adults from smolt groups is not constant. Consequently, there is much variation in both age and number of spawners between steelhead runs. Reasons for the differences in the age of smolt returns are not well understood, but may be related to smolt size and age. On the average, as freshwater age increased saltwater age decreased.

MARINE SURVIVAL

The pattern of survival in the marine environment (Fig. 5) appears similar to the trend in smolt length (Fig. 2). In fact, with the exclusion of one of the points (1982), it appears that high marine survival is directly related to larger smolt size. The returns from 1982 smolts were much higher than expected based on smolt length, possibly related to better rearing conditions in the marine environment associated with the 1982-83 El Niño event.

FORECASTS

The relationships observed between smolt number and adult return, smolt size and marine survival, freshwater age (including size at freshwater age) and marine age have provided a means to forecast run sizes. These forecasts can only serve as rough guides of what to expect based on the past history. There is currently no means to predict the effects of varied marine conditions and interactions with other stocks. Climatic changes, hatchery releases and the dynamics of other salmonid stocks may alter the marine distribution and survival of steelhead in a complex manner.

Approximately 800 and 1400 wild adults are expected to constitute the runs of 1987/88 and 1988/89, respectively (Fig. 3), plus repeat spawners. This indicates about average escapement. In the past, 1000 spawners typically produced 7000 smolts which, surviving at average rates, can in turn be expected to yield about 1000 adults. Less than optimal rearing conditions in the freshwater (e.g. drought of 1987) or the marine (e.g. changes in sea-surface temperature) environments may dramatically alter this apparent equilibrium.

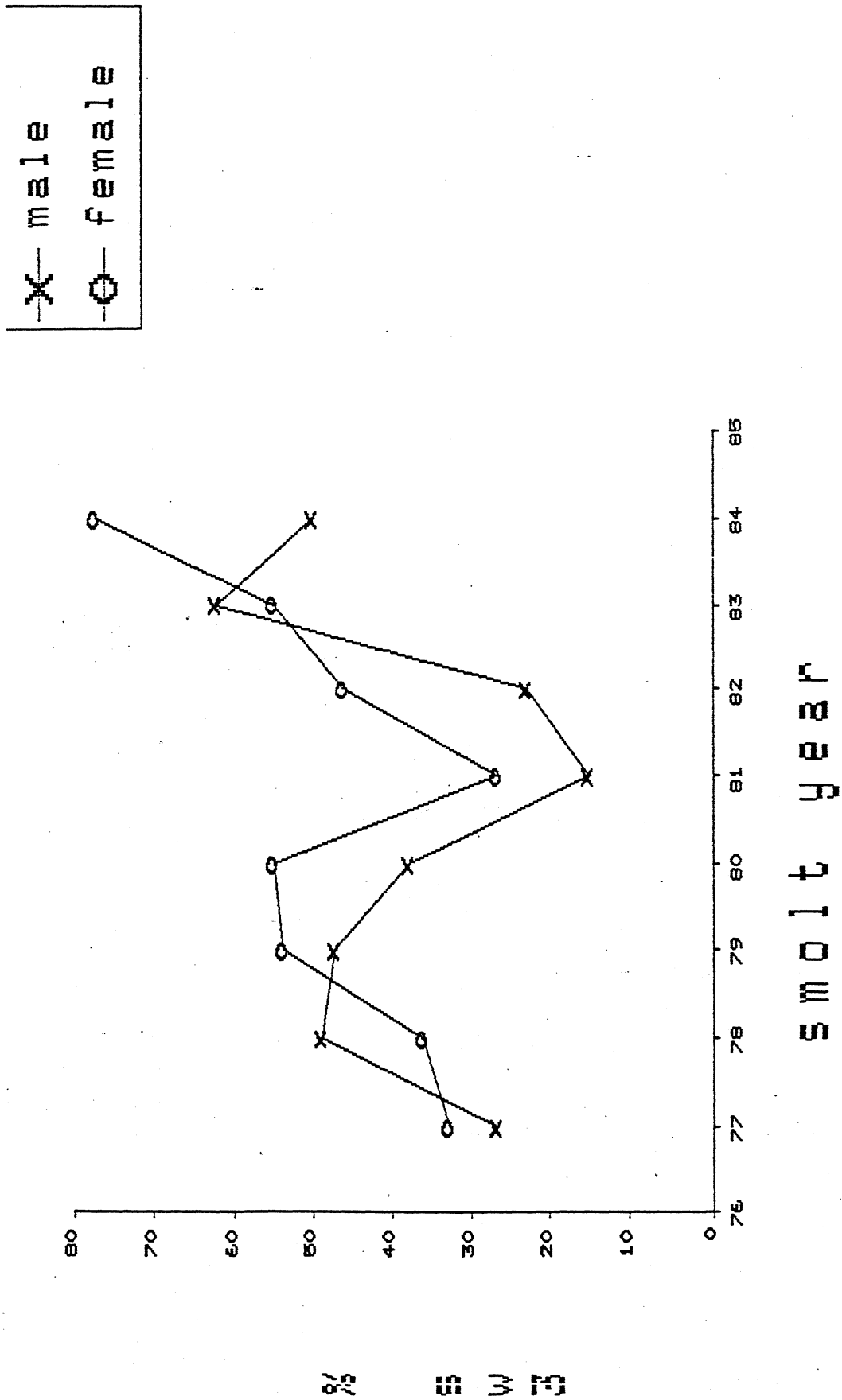


Fig. 4. The per cent composition of saltwater age 3 adult returns from Keogh smolts emigrating from 1977 to 1984.

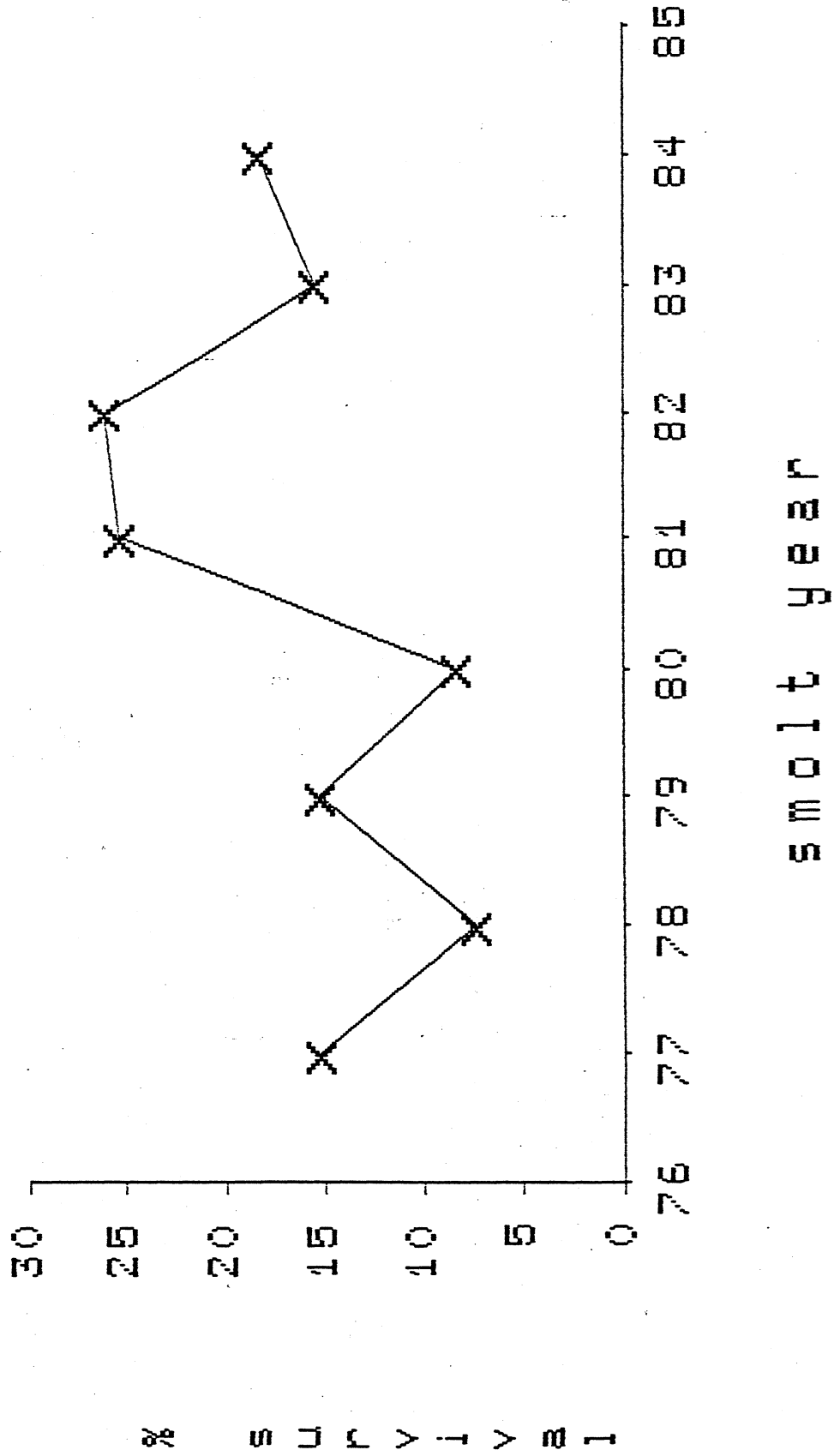


Fig. 5. Smolt-to-adult survival rates (%) for Keogh adult returns from the smolts of 1977 to 1984.

HATCHERY RETURNS

Fewer hatchery fish will spawn in the Keogh during the 1987-88 and 1988-89 seasons. From the Keogh River, about 16% of wild smolts survive to return as adults. Survival of hatchery releases from smolt to returning adult has averaged less than half that (only 6.5%). Based on these percentages, about 1100 adults can be expected to return from the hatchery smolts released in 1986.

On average, an equal proportion of hatchery fish returning to the Keogh spend two and three years in salt water. We therefore expect about 550 hatchery returns in 1988 (plus repeats from 1987 spawners) of saltwater age 2. There were no hatchery smolts released in 1985 so there will be no large hatchery adults (saltwater age 3) in the 1988 run. The release of pen-reared smolts in 1987 was intentionally reduced in number but still should provide for a reasonable catch of hatchery fish from 1989 on.