

History of the Lake Davis Fishery and Management

Prior to impoundment in 1967

Before the Lake Davis reservoir was created, biologists surveyed sections of Big Grizzly and Cow Creeks that were within the proposed impoundment site to determine the species of fish present. The creeks were found to contain only rainbow trout. No other game or nongame fish species were found. Below the proposed dam site, Big Grizzly Creek contained rainbow trout, suckers, and speckled dace.

1967-mid 1970s: The early boom years

Lake Davis was impounded in 1967. The California Department of Fish and Game (Department) planted over 1.5 million rainbow trout and 100,000 cutthroat fingerlings from 1967-1968. (See Figures 1 and 2 for history of trout stocking at Lake Davis. Figure 1 compares the numbers of trout. Figure 2 compares the total pounds of trout planted each year.) The lake was opened to fishing in 1968. Until the mid 1970s, the Department managed the lake as a "put and grow" fishery. (See Figure 3 for history of management of the lake's fishery and the timeline of occurrence of fish species.) Under this type of management plan, hatcheries raised trout from egg to fingerling stage. The small fish were planted in the lake to continue growing to catchable-size. Annual stocking ranged from 700,000 to one million fingerlings and 50,000 to 100,000 sub-catchables. A small number of catchables were planted. Approximately 100,000 brook trout fingerlings were planted in the first years to establish another popular fishery. The Department experimented with a wide variety of strains and sizes of RT to find the best stock choice for growth, survival, and return to creel.

Early angler success at Lake Davis was phenomenal. Small fish planted grew rapidly on the lake's rich plankton and invertebrate "soup". Fisheries managers estimated annual yield up to 650,000 RT, with 40 pounds harvested for each pound stocked. It was not uncommon to observe 10,000 anglers enjoying fishing at Lake Davis during a weekend. Angler catch rate averaged as high as 0.60 fish per hour in some years. (See Figure 4 for history of angler catch rate and Figure 5 for comparison of angler-caught trout sizes from 1970-2003).

Mid 1970s to 1980: Troubled waters

In the mid 1970s, problems with the fishery became apparent as biologists noted dramatic decline in harvest during angler surveys. Harvest dropped steadily from an estimated 120 lbs per acre in 1970 to less than 2 lbs per acre by 1978. By 1980, a low of 0.10 fish per hour was recorded for angler success.

The lake was plagued by low survival of fish of all size classes, especially fingerling, sub-catchable sizes, and larger catchables. In some years, it appeared that winter mortality was substantial. In other years, summer mortality was the more significant factor. Fisheries managers estimated 60% winter mortality among adult trout. Sub-

catchables showed somewhat better winter survival and growth but high summer mortality. Planted fingerlings showed extremely low return to creel in subsequent years. While some natural reproduction occurred in the lake tributaries, biologists estimated the fishery to be 95% hatchery-sustained.

Speculation about the causes of the decline in the Lake Davis fishery produced several theories. It is a typical pattern for a new reservoir fishery to experience an initial high rate of return to creel and harvest during the years immediately following impoundment and filling. As the reservoir ages, the flush of high productivity from the newly inundated landscape wanes, and the fishery declines in terms of yield of fish biomass to anglers. Given specific characteristics of the productivity and basin shape of Lake Davis, biologists estimated that the yield would eventually settle out and be sustainable at about 20 lbs per acre. Consequently, some eventual decline in the fishery was anticipated. However, the extent and speed of the decline were higher expected.

The Department examined other factors that could contribute to the observed decline. Three illegally introduced fish species were discovered in Lake Davis. Golden shiners were noted in profusion in 1972. Brown bullhead began showing up in creel censuses in 1974. Large mouth bass were first reported in 1978. As the populations of the newly introduced species grew, these fish potentially could compete with trout for food and habitat. Some could also prey on small trout. By 1980 it was estimated that the reservoir's fish biomass was 70% shiners, 20% bullheads, and 10% trout.

In 1980, the Department and the University of California, Berkeley, cooperated on a two-part study. One part aimed to determine the potential for competition between trout and shiners and bullhead. Part two examined the limnological characteristics of the lake that might limit survival or distribution of trout. The study found little evidence of competition between trout and shiners and virtually none between trout and bullhead at the time of the study. However, the study covered only one year, and results were inconclusive. It was suggested that as populations grew and fluctuated with annual weather conditions, more competition could be expected.

The limnological study revealed that deeper areas of the lake do not contain enough oxygen to support trout during the summer. High water temperatures and increased ammonia levels in shallower waters also may exceed limits for trout health. During several weeks to several months in the summer each year, trout must move between deeper waters with critically low oxygen and shallow waters which present dangerous thermal and toxic conditions. The study suggested that these stressful conditions negatively affected trout survival, growth, and angling return. The largest effects on trout survival would be experienced in years of below average lake water levels. The study also suggested that erosion of lakeshore and livestock grazing contribute to the negative effects by increasing the nutrient supply in the lake.

Management attempts to address fisheries problems

The period of mid 1970-1980 was one of experimentation for managers at Lake Davis. Put-and-grow management was no longer working. Due to the high natural mortality of stocked fish and low return to angler creels, the Department considered different management options to address the various factors suspected in the decline of the fishery. An early step was to reduce the catch limit from ten to five trout per angler per day to share equitably the resource among anglers and to prevent overharvest while fortifying the fishery. Managers experimented with stocking various species of salmonids at different times of the year in order to select the best species and strain of trout or salmon, the best size to plant, and the best time to plant to achieve the greatest survival and return. The size of rainbows planted was adjusted to include fewer small fingerlings and more large sub-catchables. Cutthroat-rainbow crosses, German brown, and Eagle Lake trout were introduced to test if these species would show better survival and return in the conditions of Lake Davis. King and coho salmon were also planted. King salmon were planted to provide a new fishery, as well as to utilize the forage base provided by the golden shiners.

Results from the experimentation were mixed. Growth, survival, and return to creel were very low for coho and king salmon as well as for brown and cutthroat trout and cutthroat crosses. Catchable-size Eagle Lake trout showed higher winter survival. Biologists surmised that trout that converted to feeding on golden shiners had better survival.

The biomass of shiners and bullheads continued to grow. Managers were concerned over increasing competition with and negative impacts on trout. Shiner and bullhead reproduction were believed to be virtually unlimited. In order to control the populations of these species, biologists considered removal of fish by physical means. They estimated that this would require removal of 4 tons of aged stock per day for 5 months each year in order to keep up with reproduction, to exert control on the growth of shiner and bullhead populations, and to increase growth and survival of planted trout. Methods that could remove 4 tons of fish per day were not known so this idea was not further pursued.

By 1980, the Department had tried most available species and races of salmonids in planting Lake Davis. Low success in terms of yield prompted the Department to take a hard look at the future course for management of Lake Davis. Biologists considered several options. Treating the lake with a piscicide to eliminate the undesirable species and restocking with trout was one option. Abandoning trout planting and converting the lake to a warmwater fishery with some combination of bass, striped bass, catfish or sunfish species was also examined. Letters received from the public while Department biologists deliberated indicated a majority of those responding favored converting the lake from a trout lake to a bass lake or a trout and bass combination fishery.

After careful consideration, the Department decided to manage Lake Davis as a high cost, low yield trophy trout fishery. (The Department doesn't have a formal definition for management for a "trophy trout fishery", but generally this refers to planting catchable-size trout with the expectation that some would be caught in the first year and some would survive and grow, providing anglers with larger, "trophy-size" fish in subsequent years.) Due to very poor survival and return, fingerling plants of rainbows were mostly discontinued. The management plan called for stocking catchable-size trout at a rate of ten fish per surface acre, the generally accepted rate for managing trophy trout lakes. This amounted to 40,000 catchable-size trout per year for Lake Davis. Emphasis was placed on stocking Eagle Lake trout as they showed the best survival and growth among the species and races tried. Because of poor growth and returns, hatcheries discontinued the experimental stocking of other salmonids, with the exception of occasional limited plants of brown trout. Although planting brown trout resulted in very low yield and was not considered economical for the Department, a limited planting program was adopted to offer a diverse fishery.

1980 to 1994: Trophy trout lake but still a troubled fishery

Since 1980, the Department successfully worked to maintain Lake Davis as a viable trophy trout fishery but with continuing difficulty. Through the 1980s and 1990s, golden shiner and bullhead populations thrived. Large mouth bass numbers also increased and were exploited by local anglers. Other fish species that could compete with or prey upon trout found their way into the lake sometime prior to 1997. These included pumpkinseed, bluegill, black bullhead, Sacramento sucker, Lahonton redbreast, fathead minnow, speckled dace, and Sacramento perch. Until the mid 1980s, the Department stocked Lake Davis with the annual allotment of catchable-size trout and an average of 200,000 sub-catchables. A fall plant of over a million fingerlings in 1983 produced virtually zero return to anglers. In the late 1980s and 1990s, the Department cut back on sub-catchable and fingerling plants. Hatchery production was at capacity, and hatchery management shifted some production to rearing fewer fish but to larger size before planting in many waters statewide. Occasional plants of sub-catchables and fingerlings were used to augment the stock at Lake Davis. Angler harvest rates varied from year to year in this time period, with a general overall declining trend. Angler success ranged from a high of 0.37 trout per hour to a low of 0.10 trout per hour. Fish tagging studies indicated that rainbow trout returns dropped from an estimated 50% of fish stocked in 1980 to approximately 12% in 1986. The Department's requirement of a minimum of 50% return when stocking catchable-size trout was no longer being met.

In 1983 the Department and Feather River College collaborated on a project to rear trout from eggs collected from Lake Davis trout. Fry were then released back to Lake Davis. It was hoped that this could lead to development of a strain of fish more adapted to and better able to thrive in Lake Davis conditions. Tagging studies of these fish showed no improvement in performance over Eagle Lake trout from other sources.

1994-1997: Northern pike

In 1994, the Department confirmed the presence of northern pike, a top predator fish, in Lake Davis. Because of the non-native fish's predatory nature and lack of natural enemies in western waters, biologists recognized the pike's presence in Lake Davis as a serious threat to the lake fishery and to other state waters. From 1994-1997, they tried to maintain the trout fishery at Lake Davis while they searched for solutions for eradicating pike from the lake. The Department continued with the stocking plan for trophy trout lake management by stocking only catchable-size trout. The occasional plants of sub-catchables and fingerlings were curtailed during this period to avoid increasing the food supply for pike. During this time, success of anglers fishing for trout dropped from 0.27 trout per hour in 1995, to 0.21 trout per hour in 1996, to 0.15 trout per hour in 1997. Anglers reported having pike attack hooked trout as they were being caught, and bite marks were observed on trout. However, this information was not quantified.

1997 to present: post-treatment fisheries management

The Department decided on chemical treatment as the only viable means to eradicate northern pike. Lake Davis was treated in 1997. Following the treatment, hatcheries heavily stocked the lake and tributaries with millions of fingerlings, hundreds of thousands of sub-catchables, and several hundred thousand catchable-size Eagle Lake trout, including many trophy-size fish. Fingerling and trophy-size brown trout were also planted. Many thousands of brook trout fingerlings were stocked in several tributaries. The Department did not measure angler success during the first two years following the treatment, but surveys by the Department of Water Resources showed angler catch rate averaged 0.21 trout per hour in 1998.

In 1999, biologists once again confirmed the presence of pike in Lake Davis. Golden shiner, bullhead, bass, and pumpkinseed also were back in the lake. Since then, the Department has attempted to maintain the Lake Davis trout fishery while trying to control pike numbers using a variety of physical removal methods until a more permanent solution can be determined and agreed upon. Catchable-size Eagle Lake trout are planted at an allotment of 50,000 per year. Plantings of fingerlings and sub-catchables were again discontinued in order to reduce food supply for pike and to avoid waste of valuable, limited state resources. Angler surveys show that angling success has declined significantly ($P < 0.01$) from 0.28 trout per hour in 2000 to 0.12 in 2003 (Figure 6.) Anecdotal information from anglers also indicates that pike attacks on trout on the hook, and bite marks on caught trout are being noted. The size of the trout caught by anglers has significantly increased ($P < 0.01$) (Figure 7). More study is needed to explain this trend, but in part it may be the result of pike consuming the smaller planted trout. Similar trends of decreasing angler success and increased size of rainbows caught by anglers were noted when pike occurred in the lake the first time.

Summary

The status of the Lake Davis trout fishery and angler success have varied greatly over the years since the reservoir was impounded in 1967. Angler surveys and tagging studies have shown that angling catch rate has fluctuated widely with a general downward trend. Managers have faced many challenges in trying to maintain a viable and economical fishery using state resources. The reservoir environment has presented numerous difficulties in finding the best species and strain suited to survive and grow in the harsh conditions and to offer good return to anglers. The lake's small tributaries provide little habitat for natural reproduction, requiring that the fishery be maintained almost entirely by expensive hatchery production. Illegally introduced fish species compete with and prey upon stocked trout. In past years, managers have had to look hard at tough options, such as chemical treatment, abandoning the trout fishery altogether, or establishing a warmwater fishery in a once-prized trout lake. Angler survey data indicate that the fishery is still troubled and managers face more very difficult decisions in the near future. An understanding of the history of the fishery and the results of previous management steps will be needed as biologists seek to resolve the current issues and maintain the valued trophy trout fishery of Lake Davis.

The big questions that need answering now are: 1) Are pike affecting the Lake Davis trout fishery? and 2) How long can the Department maintain a viable trout fishery in the presence of pike? Data indicate that the answer to the first question is "Yes." Angler surveys show that angler catch rate for rainbow trout has declined significantly since pike reappeared in the lake. This trend continues even though the stocking allotment of catchable-size trout has remained constantly above the prescribed rate for maintaining trophy trout lakes. The angler success rate for 2003 was barely above the all-time low recorded for the lake (0.12 vs. 0.10 trout per hour.) These data, supported by data from other monitoring measures which indicate that the pike population is growing exponentially, suggest strongly that the presence of pike is beginning to negatively impact the trout fishery of Lake Davis. The answer to the second question, "how long can the Department continue to maintain the trout fishery given this situation?" remains unanswered. Serious state budget problems and increasing public demand for equitable distribution of the limited resources of our hatcheries will play large parts in reaching that answer.

Figure 1. Numbers of rainbow trout planted annually to Lake Davis 1967-2003

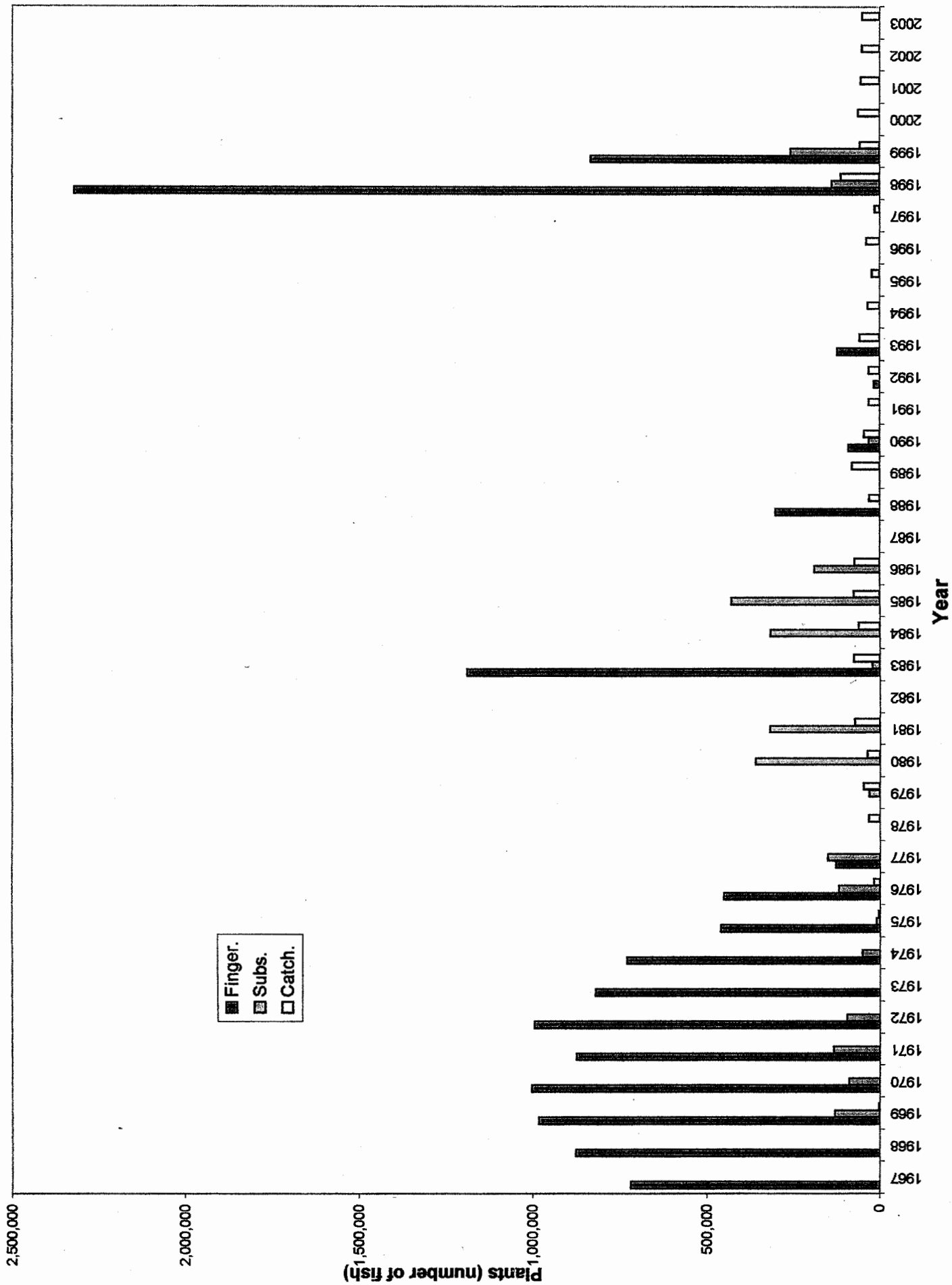


Figure 2. Total weight of rainbow trout planted to Lake Davis annually 1969-2003

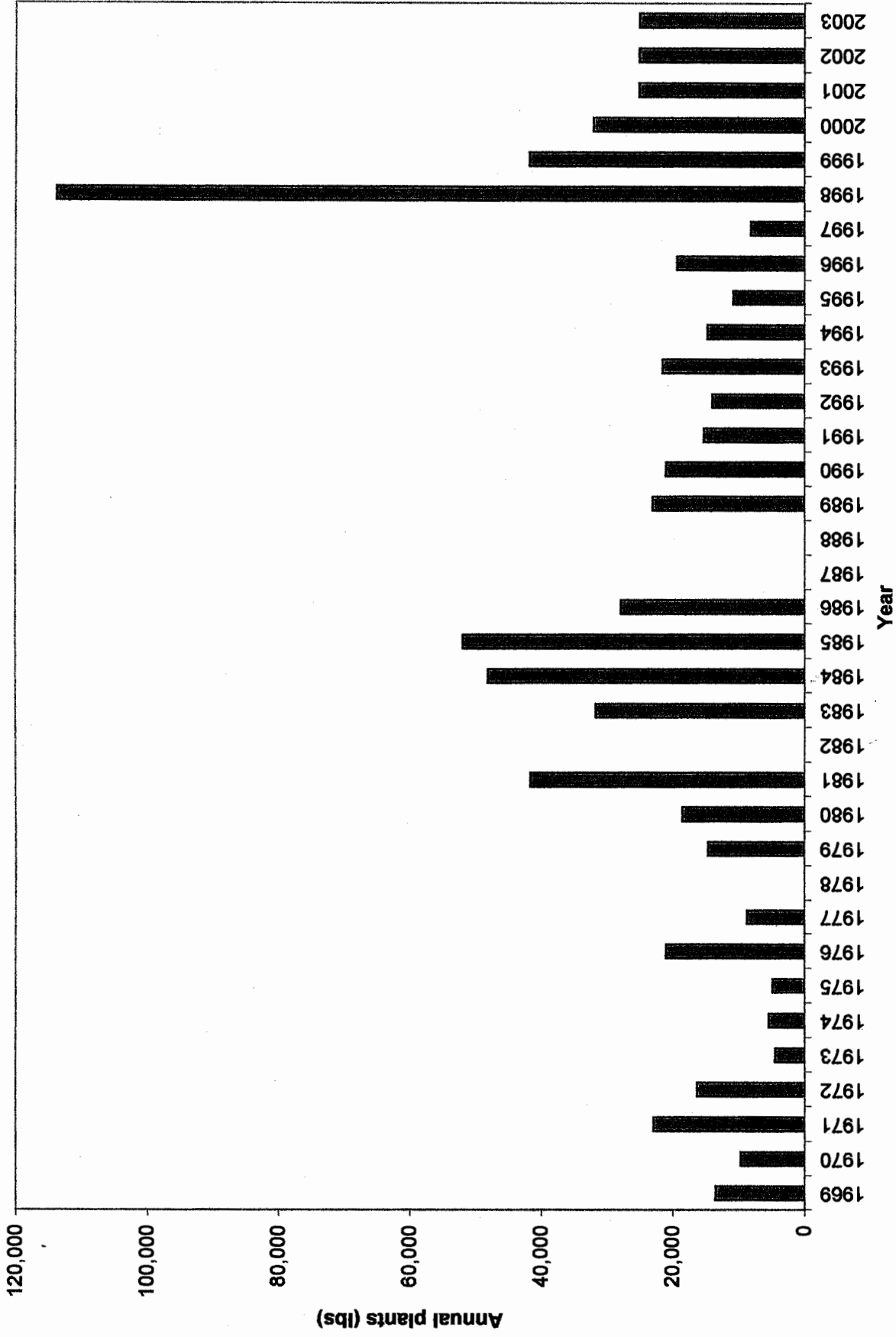


Figure 3. Timeline of management and fish species occurrence in Lake Davis 1967-1997

YEAR

1967	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	1997
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Management:

Put and Grow Experimental

Species planted:

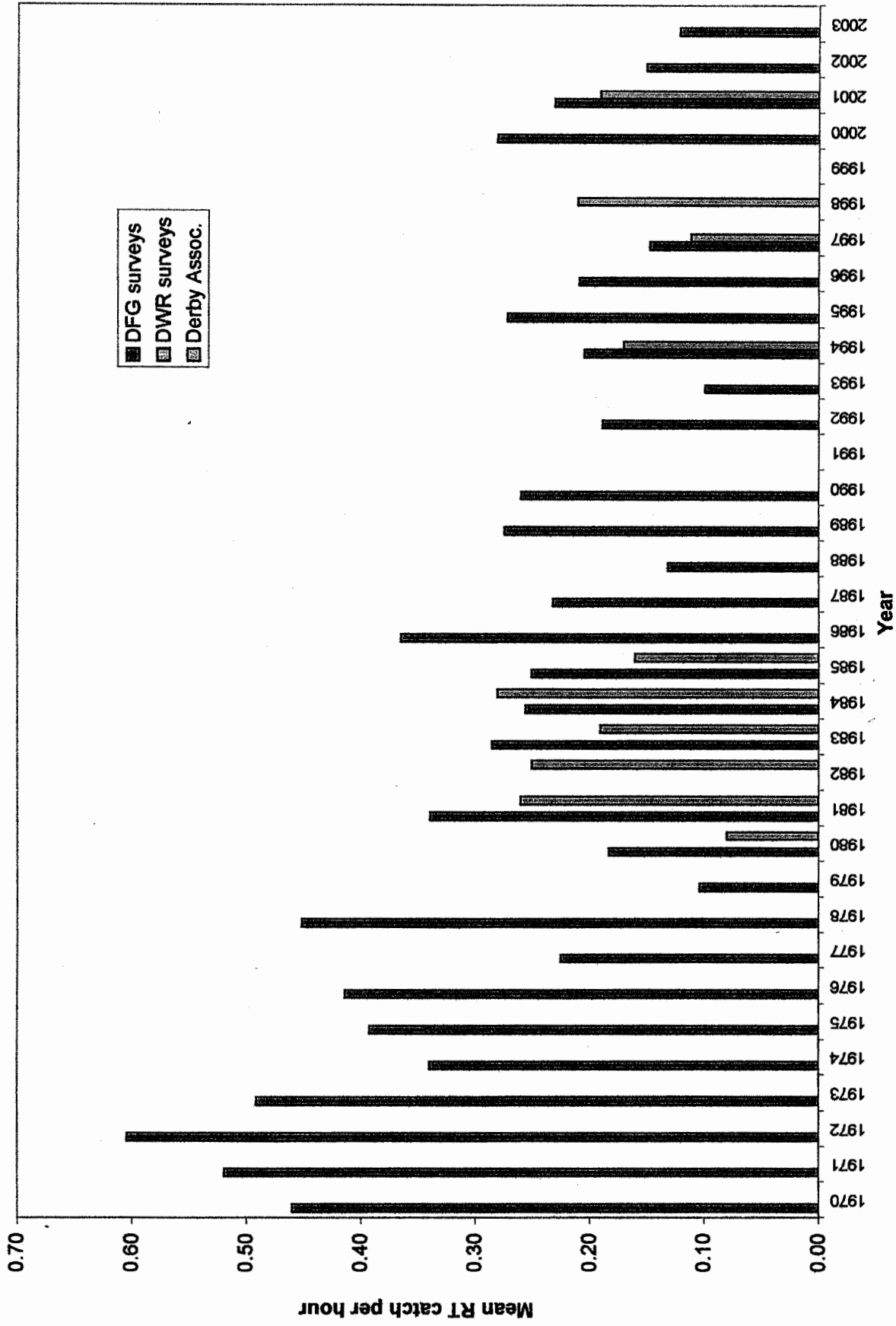
RT many strains
 CT and CTXRT
 BK
 Coho
 BN
 King

Species illegally introduced:

GSH
 BBH
 LMB
 ?<--PSD and other species-->
 NP

RT rainbow, ELT Eagle Lake, CT cutthroat, CTxRT cutthroat-rainbow crosses, BK brook, BN brown, GSH golden shiners, BBH brown bullhead, LMB large mouth bass, PSD pumpkinseed, NP northern pike

Figure 4. Comparison of angler catch per hour for rainbow trout 1970-2003



CA Dept. of Water Resources and Davis Derby Assoc. provided angler survey data to the CDFG. CDFG, Portola Field Office, Draft 11/24/03, subject to revision

Figure 5. Comparison of mode length of angler-caught rainbow trout 1970-2003

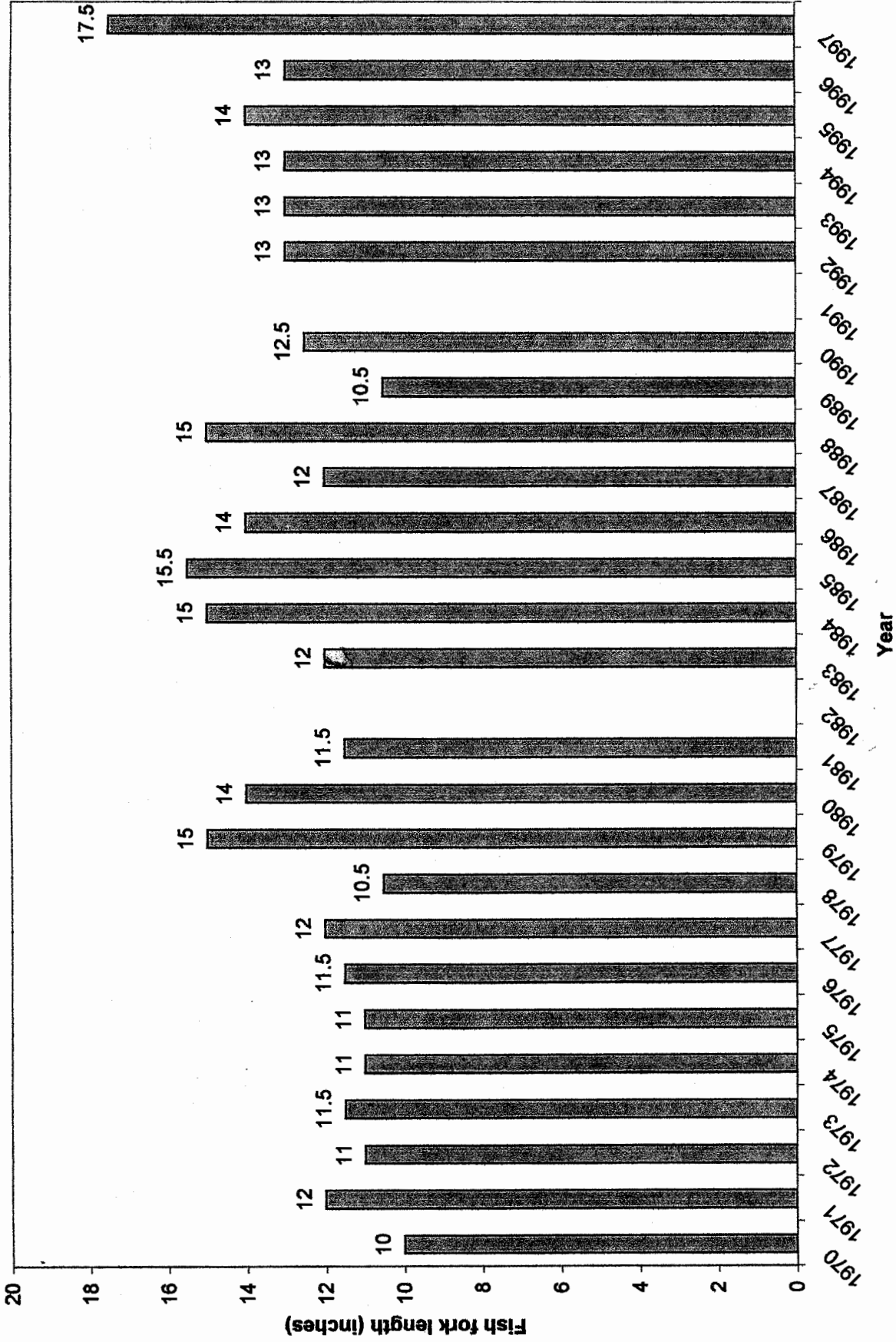
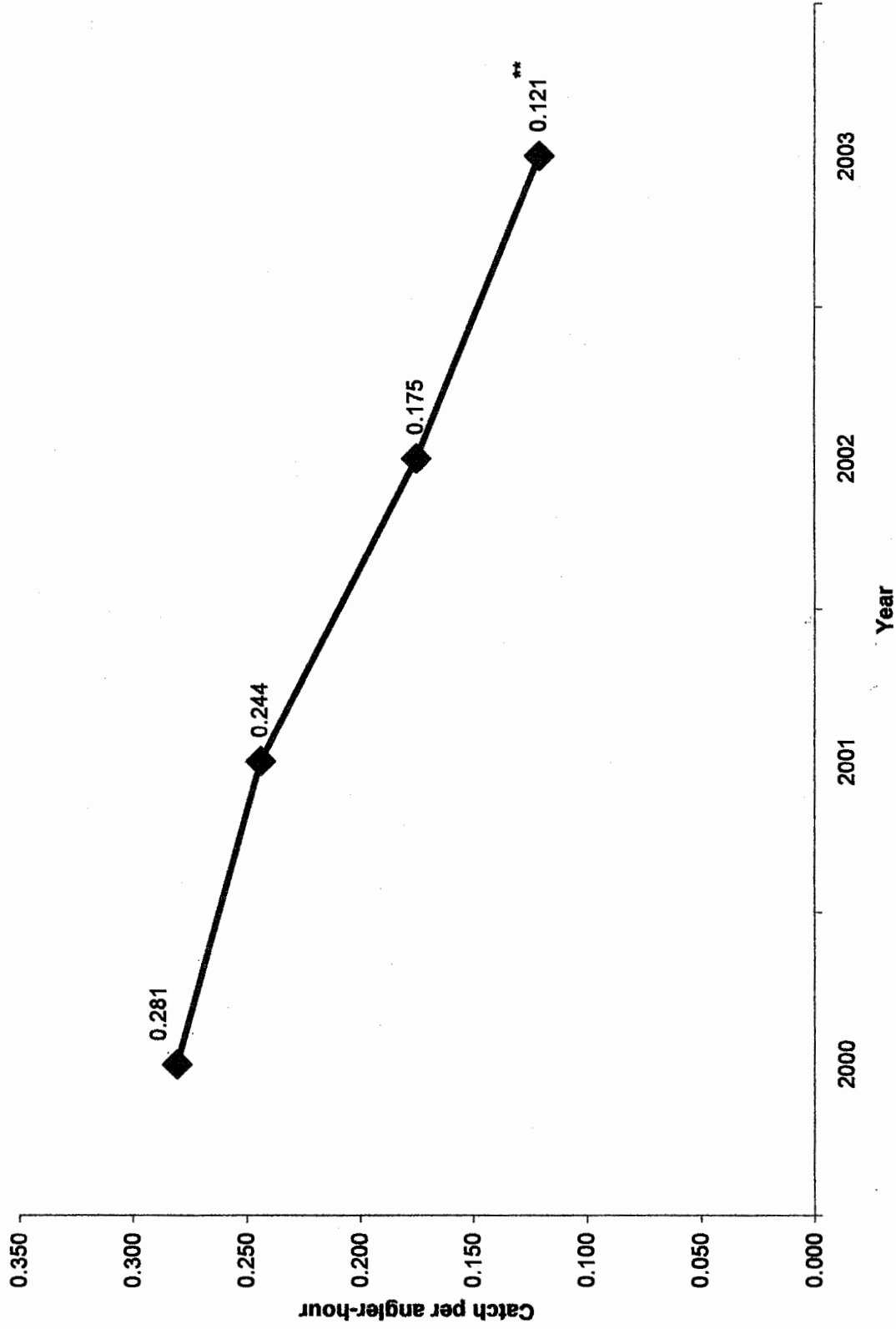
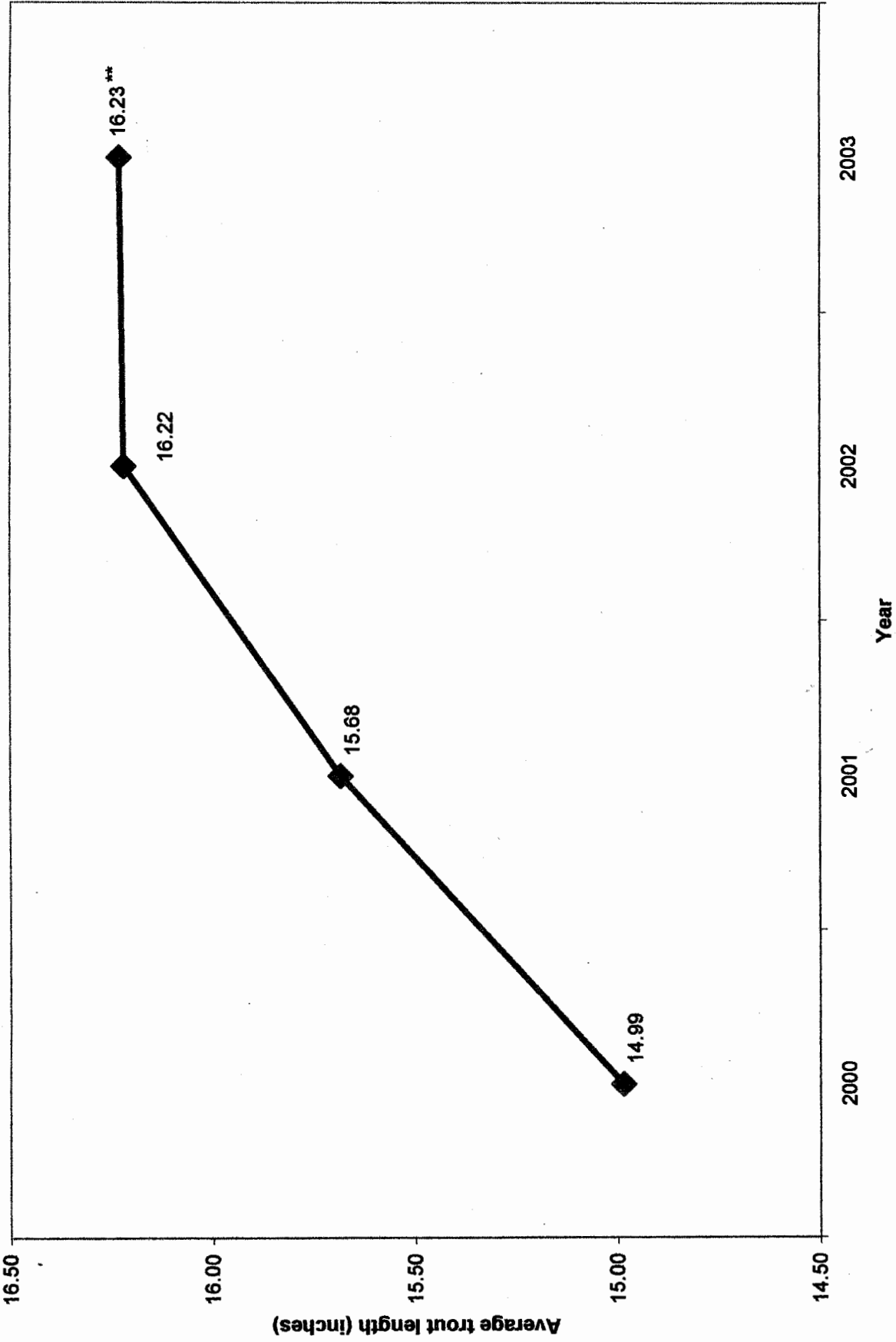


Figure 6. Comparison of angler catch rate for rainbow trout since the reappearance of pike in 1999.



** Statistically significant decline: $F_{(3, 1631)} = 9.28299$, $P < 0.01$
CDFG, Portola Field Office, Draft 11/24/03, subject to revision

Figure 7. Comparison of angler-caught rainbow trout lengths since the reappearance of pike in 1999.



** Statistically significant increase: $F_{(3, 1578)} = 36.82784$, $P < 0.01$
CDFG, Portola Field Office, Draft 11/24/03, subject to revision