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THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

JUNE-JULY 1992 STREAM SURVEY REPORT OF LOWER SCOTT CREEK, SANTA CRUZ COUNTY

by

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ABSTRACT

In June/July 1992, the California Department of Fish and Game conducted a survey of the lower reach (0.5 miles) of Scott Creek, Santa Cruz County, California. The purpose of the survey was to assess the fishery population, and the available aquatic habitat present at this site in response to the chronic dewatering of this reach which had occurred for the last several decades. Survey results showed that both the lower reach, and lagoon aquatic environments of Scott Creek can be quite productive when existing in a healthy water quality state. Both areas possessed several thousand fish comprised principally of juvenile salmonids (steelhead and coho salmon), threespine sticklebacks, tidewater gobies, and fresh water sculpins. In a response to this finding, the Department of Fish and Game will determine minimum bypass flow level determinations, using Instream Flow Incremental Methodology, to sustain these highly valuable aquatic habitats in a productive state.

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INTRODUCTION

This report was generated because the Department had serious concerns that water quality conditions, both in terms of quantity and quality, in the lower Scott Creek watershed were being degraded to a point that survival of the aquatic species which inhabit this area was no longer ensured. Scott Creek is a coastal stream tributary to the Pacific Ocean. It is located in the northern portion of Santa Cruz County, and has historically been a perennial stream throughout its drainage. However in recent times, the lower one half mile reach of Scott Creek above the lagoon has dried during the late summer/early fall time period. The cause of the drying which has occurred in the lower reach is believed to be due to dewatering caused by agricultural pumping activities, via surface and subsurface means, that have occurred in this area.

A review of Department stream survey records show that the lower reach of Scott Creek has been dewatered for many years, as stream surveys which date back to 1934 state that this reach was chronically dry during the summer/fall months. Simply put, a dry stream channel precludes the presence of all fish species.

Scott Creek is of particular concern as it at present, represents the southern most drainage where there exists a self sustaining population of coho salmon. Scott Creek also supports a self sustaining population of steelhead, provides habitat for several sensitive species, and provides habitat for many aquatic species, both of vertebrate and invertebrate origin, that are indigenous to the central coastal area of California.

To determine the overall impact of the diversions, Department personnel conducted a stream survey in June/July of 1992 to assess the present status of the fishery resource in the lower Scott Creek area. Department personnel also monitored surface stream flows in this reach during the spring, summer and fall months of 1992.

Once fish species composition and abundance was determined, the question which the department needed to answer was at what minimum stream flow level(s) does there exist sufficient instream habitat for the continued survival of the aquatic species which reside in the lower reach and lagoon to survive. Since the Department was unable to conclude its instream flow evaluation, which would have objectively assessed sufficient minimum bypass flows, a subjective determination was made to formulate an interim minimum bypass flow level to sustain the aquatic resources present in the lower reach and lagoon, until a permanent flow level can be determined from the instream flow study which is scheduled to be concluded in the summer of 1993.

This report provides the results of the Department's June/July 1992 assessment of the aquatic species present in the lower Scott Creek stream reach and lagoon, and their accompanying habitats, along with recommendations to ensure the perpetuation of these aquatic species through protection of their critical habitats.

Scott Creek Lagoon Dynamics

The Scott Creek lagoon has been greatly modified by the construction of the Highway 1 bridge (1940, Al Smith pers. comm.) and by agricultural development. These modifications have resulted in the overall constriction of the lagoon by approximately fifty percent, due to the construction of a water storage reservoir on the southern lagoon side, and by construction of a bridge support ramp on the northern side. The ensuing result is that Scott Creek stream flows now enter the ocean further to the south than they historically did (Al Smith, pers. comm). With Scott Creek outflows forced farther to the north, where sand formations are their greatest, it now takes longer for the lagoon to open, as more pressure in the form of greater lagoon volume is now needed to assist breaching of the sand bar in concurrence with high tidal action. Presently, the Scott Creek lagoon is traditionally the last to open in Santa Cruz County.

The ensuing consequence of these lagoon alterations, has been that all aquatic species inhabiting the lagoon have been adversely impacted in some fashion. Especially coho salmon, as adult coho are not able to make early upstream migrations since the lagoon is closed.

The principle fish species of concern in the lagoon, and the fish species with the greatest level of legal protection at the present time, is the tide water goby. However, due to its wide salinity and temperature tolerance it is not the species upon which protective measures will be based. Salmonids, principally steelhead which have less tolerant water quality requirements than do tide water gobies, will be the indicator species to determine what the magnitude of surface flows entering the lagoon shall be in order to sustain water quality in both the lagoon and instream environments at an acceptable level.

In Scott Creek, the quality of the lagoon environment is determined by several factors including, rainfall, stream flow, ambient temperature, and saltwater tidal influx. In a healthy lagoon providing optimum habitat, the sandbar will breach during the winter rainy season, and will close at some point in the late spring or early summer when stream flows become insufficient to overcome sand deposition at the mouth. How, and when this occurs ultimately determines initially the quality of the lagoon environment. If the lagoon closes after a high tide series then the lagoon will be predominantly saltwater in nature. When this occurs much more freshwater inflow, over prolonged period of time (i.e. up to approximately 30 to 40 days) is necessary to convert the lagoon to a fresh water state (Smith 1990).

Additionally, when seawater overtops the sandbar during a high tide, seawater mixes with the freshwater present in the lagoon. Seawater has a higher molecular weight than freshwater and subsequently sinks to the bottom where, due to solar radiation, it warms raising the water temperature of the overall lagoon, including the freshwater layer. A warm bottom lagoon layer results in increased decomposition and ultimately a decreased oxygen concentration in the lower benthic layer. This severely inhibits utilization of this area by the lagoon species, especially salmonids.

It is typical to have summer time inflows to the lagoon cease due to agricultural pumping from upstream wells which tap the subsurface flow in Scott Creek, resulting in a warmer, and shallower lagoon. It is here, when the lagoon warms that impacts to gobies, and other fish species (i.e. salmonids) are their greatest. When the lagoon warms the fish species inhabiting the deeper, traditionally more cooler and well oxygenated portion of the lagoon are forced into the upper, warmer, and less oxygenated layer of the lagoon. This results ultimately in greater mortality rates, through increased predation and/or physiological stress. If conditions become degraded enough, the lagoon could potentially become devoid of aquatic life.

In order to maintain the freshwater state throughout the summer and early fall months, there must be present sufficient freshwater outflows to both sustain the quantity and the water quality of the lagoon. What has occurred in the past is that the fresh water surface flows into the lagoon begin to cease about mid-summer, resulting in a lagoon which diminishes in both quantity and quality during this time. As summer progresses, warmer ambient temperatures occur resulting in increased evaporation causing a constantly lowering lagoon water level which over time, correspondingly results in increased salinity concentrations and a warmer lagoon. In the summer of 1987, there was a documented decline in the salmonid population level in the lagoon (Smith 1987). This population reduction appears to be directly attributable to the degradation of the water quality of the lagoon due to warmer water temperatures caused by a reduction of surface flows entering the lagoon.

Therefore, sufficient surface flow is necessary to maintain the water quality of the lagoon. A survey of the water quality of several coastal lagoons showed that a range of between 1.5 and 12 cubic feet per second (cfs) would be needed to convert a predominantly saltwater lagoon to a fresh water state. The amount of flow needed was dependent upon the size of lagoon and the degree of salt water concentration at time of lagoon closure. In the case of nearby Waddell Creek, it is estimated that 1.5 to 2.0 cfs over an approximate 33 day period would be required to convert the lagoon if it were in an extremely salty state. In the case of Scott Creek lagoon, which is believed to be larger in volume than the Waddell Creek lagoon, greater surface inflow into the lagoon would be necessary for conversion to a fresh water state (Smith 1990).

The amount of surface flows to maintain the lagoon depends on how much lagoon habitat is desired. Since the lagoon is an extremely productive habitat for rearing fish, and sensitive species reside there, protective measures to ensure a full lagoon are warranted. Quantity of flow also depends upon sandbar formation, seepage rate, and the geometry of the lagoon itself. Based upon surveys of other nearby local coastal lagoons, Waddell Creek lagoon was estimated to need between .5 and .75 cfs surface flow following conversion to fresh water to sustain lagoon levels at an acceptable level for fishery utilization during the critical late summer/early fall periods (Smith 1990). Since the Scott Creek lagoon is a larger and possibly an overall deeper lagoon, greater surface flows in the order of at least 1 cfs would be warranted to sustain it at an acceptable level.

Effected Stream Reach Dynamics and Minimum Instream Flow Determination

As previously stated, the lower Scott watershed has been plagued by deficiencies in surface outflows during the late summer and early fall months for many years. As a result, fresh water instream habitats for approximately one half mile upstream from the lagoon have been adversely effected. These effects have materialized in a variety of ways and are discussed under species impacts below. However, simply stated fish need to have good water quality to survive.

In streams, such as Scott Creek, water quality for sustaining fish life is generally dependent upon the magnitude of stream flow, density of the riparian corridor, ambient air temperature, and the geologic composition of the watershed. At present, flowing water is the limiting factor to fish production in the lagoon and lower reach of Scott Creek. The question which begs to be asked, and which ultimately needs answering is, how much water is enough? The answer to this question resides in the information known to date. We know what types of fish exist here and generally, their density levels. We know the present level of surface flows, and the habitat requirements of the fish species of concern. Lastly, we know that both the instream and lagoon habitats need to be protected to ensure these species survival. The question of how much water is needed can be answered by determining both the population levels of the fish species present in the lagoon and lower reach, and by determining how much water is needed to protect both the lagoon and the instream environments.

Regulatory Implications

Scott Creek provides habitat to a myriad of aquatic species, both of invertebrate and vertebrate origin. Due to environmental degradation of wetland habitat all across California many species have had to be legally protected under the California Endangered Species Act and/or the United States Endangered Species Act, in an effort to sustain their present population status, against take of any kind, while work towards the restoration of their habitats could occur. Some of these species are found in Scott Creek.

These species include the Federally protected, and California State Species of Special Concern, tidewater goby (Eucyclogobius newberyii) and red-legged frog (Rana aurora); the coho salmon (Oncorhynchus kisutch), a California State Species of Special Concern, and the steelhead rainbow trout (Oncoryhnchus mykiss), a species also of concern to the department since this species overall population is in decline throughout its southern range. A description of these species life history requirements is given below.

It is no coincidence, with the exception of the steelhead, that these species have been nominated for State and/or Federal protection at the same time the water quality of the lagoon environments in which they are found throughout their range have been severely degraded by freshwater inflow reductions. When freshwater inflows are reduced the water volume, and available habitat, correspondingly decreases thus ultimately resulting in reduced species populations.

The flow reductions would undoubtedly have occurred with the continuation of the current drought, but the magnitude would have resulted in significantly less impact had water diversions been much less prevalent. The situation which now exists is unfortunately not unique to the Scott Creek lagoon environment. Almost every lagoon from San Francisco Bay south to the Mexico border has been severely degraded by water diversions, and by increased sedimentation due to poor land use practices. Generally speaking, the further south, the more intense the problem.

Generally, reduced flows adversely effect these species by reducing the quantity of available habitat and/or severely reducing the quality of habitat, as occurs when freshwater inflows into the Scott Creek lagoon are reduced resulting in a smaller, warmer, and saltier lagoon. The overall effect is that the populations of these species in this area are reduced, due to artificial manipulation of stream flows.

Species Description and Habitat Requirements Assessment

1. Tidewater goby:

The tidewater goby is found in the lower reaches of coastal streams in waters ranging from 0 parts per thousand (ppt), i.e. fresh water, to 34 ppt, i.e. sea water. The tide water goby is also able to survive for several months in captivity in hypersaline waters with salinity concentrations up to 50 ppt. Historically, tidewater gobies were common in lagoon environments south of the San Francisco Bay region. Today existing populations are disappearing rapidly due to degradation of lagoon environments, caused primarily by increased sedimentation, dewatering, and less frequently occurring events such as floods. The result has been that legal protection has had to be instituted to protect the goby.

Tidewater gobies are most commonly found at the upper ends of lagoons, which have been created by sandbar blockage of stream outfall. These areas are seldom subject to significant tidal influence and are characteristically slow moving. Within the stream and lagoon habitat, gobies inhabit marginal areas away from the main current. They prefer cool, well oxygenated water but can tolerate warm water with low saturated oxygen. In Scott Creek, the lagoon area can generally be defined as that area between the sandbar west of the Highway 1 bridge upstream to the lower most farm road stream crossing.

In the case of the goby we are fortunate that the Scott Creek lagoon, despite the above alterations, has retained natural features conducive to the goby. These include the presence of side channel vegetative growth, slow moving water, and water quality conditions which fall within their tolerance zones. However, conditions in the lagoon could be more favorable. Early on in the summer optimal lagoon habitat extends well into the northern side of the lower Scott Creek basin, where dense stands of tules now exist. This allows the goby the opportunity to forage and more easily escape predation. As the summer passes on, water levels recede and this area decreases significantly, especially in extremely dry years, forcing the gobies into a more concentrated area. This results in increased stress and increased predation, thus resulting in a lower overall goby population. It is fortunate that the gobie life history allows for spawning to occur throughout the year, for without this feature the goby might well be in worse shape than the coho salmon.

The habitat degradation which has occurred for at least the last 60 years (CDFG 1934, and Al Smith, pers. comm.) in conjunction with the agricultural practices employed within the Scott Creek watershed can be resolved by allowing surface flow to continue to the lagoon longer into the summer and early fall months when freshwater inflow is most critical for the survival of the goby, as well as the other lagoon aquatic species.

2. Red-legged Frog:

Rana aurora draytonii represents the southern form of the red-legged frog. Although once quite abundant this species, despite legal protection, continues to decline. In California, this species is extinct over most of its historical range (Jennings and Haynes 1990) In the Scott Creek watershed, it is present in both the lower lagoon, as well as both above, below, and in, the dewatered stream reach.

Red-legged frogs prefer deep water habitats which contain dense emergent or riparian vegetation that overhangs the aquatic environment. This cover type allows for escapement from, and non-detection by, overhead predators, and provides the frog easy access to the aquatic environment.

Impacts to this species in the lagoon area due to reduced freshwater inflows are similar in nature to those described above for the tide water goby. That is, as the summer progresses flow into the lagoon diminishes resulting in a significantly smaller lagoon. As the available aquatic habitat is reduced, the frogs are more exposed during their feeding activity and thus are susceptible to increased predation. Further upstream, a similar scenario also exists, that is when freshwater flows begin to recede the frogs again are left more exposed and susceptible to increased predation, and a reduced food source. This impact could be reduced by allowing surface outflows to continue unabated to the lagoon.

3. Coho salmon:

As you will see, describing the coho population in Scott Creek, its importance to the overall California coho population, the factors effecting this population, and the factors necessary for their continued survival is not an easy task, these issues are extremely broad and complex. Many factors are, and will continue to be in the future, contributory to the overall health and well being of this coho population.

The coho is a highly desired sport game fish species. They are angled for at both the juvenile and adult stage in the riverine environment, and at the adult stage in the ocean. While in the riverine environment, it is at the larval through juvenile stages where reduced instream flows during the summer/fall months have the greatest overall impact to the perpetuation of the coho population. It is here that they especially require clean, cool and well oxygenated water.

In California, the coho salmon is native to the streams tributary to the Pacific Ocean from the Monterey Bay area north to the Oregon Border. This species was once quite abundant throughout its range, but currently is in continual decline due to several factors such as sedimentation of pool habitat, drought, water diversions, marine mammal predation, commercial fishing, and from poaching. Coho which inhabit smaller coastal drainages, such as Scott Creek, are classified as short run coho and are highly dependent upon natural reproduction for stock maintenance. In the case of coho, hatchery reared smolts have not shown the same tenacity for producing adult returns as have naturally produced fish (McMahon 1983). Typically, adult coho return to spawn in their natal streams after 2-4 years at sea, with most females returning at age three.

In Scott Creek the adult coho migration typically occurs from mid December through the first of March, with peak migration occurring in late January to late February. Adult female coho accompanied by two year old male (grilse) coho usually precede the three year old male coho in the upstream migration, by as much as two to three weeks (D. Strieg pers. comm.) Adult coho prefer to spawn in tails of pools or heads of riffles, where the stream bottom composition is comprised of loose, silt free, coarse gravel accompanied with nearby cover. Both female and male coho die shortly after spawning. In Scott Creek, preferred spawning habitat is generally confined to the lower gradient portions of the main stem of Scott Creek, such as occurs in the dewatered zone, and the lower gradient sections of the major tributaries, Big and Mill Creeks.

Specific spawning habitat requirements include the presence of stream bottoms comprised of gravels and cobbles, with low quantities of fines. Following approximately 8 to 12 weeks of incubation, eggs hatching occurs. Alevins, or hatchlings, remain in the gravels until the yolk sacs have been absorbed, roughly 4-10 weeks post hatching. After coho fry emerge from the gravel, juvenile coho school and seek out individual territories, such as stream margins, shallow pools, back waters and eddies. As they grow, they move into deeper pools, where they become aggressive and territorial. Fry unable to compete in a specific area emigrate downstream, and may migrate as fingerlings to the ocean. However, their survival rates are poor.

The larger parr prefer the heads of pools where insect drift is the most prevalent. The smaller parr are located, or more accurately, forced due to competition to occupy the tail end of pools. As the parr mature they prefer deeper, well shaded pools containing woody debris. Here they remain until the following spring when peak flows and the vernal equinox occur which trigger smoltification, or the process by which the physiological transformation which allows migration into, and survival within, the salt water environment occurs (McMahon 1983). Generally speaking, juvenile coho spend at least one year in freshwater prior to smolting. The larger the juvenile at time of smolt, the greater the probability of seawater survival.

Juvenile coho size is a direct function of food availability, and water temperature. Generally speaking, the greater the food supply the larger the fish. Coho at the fry stage feed principally on insect drift. As the juvenile coho mature they become piscivorous, preying largely on other salmonid fry. When food is prevalent juvenile coho will hold in a specific rearing habitat location, when food is sparse they will emigrate.

In the late summer/early fall months, juvenile coho can survive in streams with intermittent surface flow <u>if</u> there exists enough undersurface stream flow to maintain critical pool habitats in a cool, shaded, well oxygenated state.

In the case of Scott Creek, as the stream begins to recede in late spring or early summer it triggers a series of events which result in increased mortalities to the fish populations which reside in the lower portion of Scott Creek. With reduced flows come reduced instream habitat for the coho and the fish/insect species upon which they prey. Reduced forage results in emigrating behavior resulting in coho migrating to the lagoon or being stranded in pools when stream flow becomes intermittent. Under present conditions neither of the locations they end up at is conducive to their survival through the critical late summer/early fall months as, the water quantity and quality of the lagoon diminishes to the point where it cannot provide even poor habitat for the juvenile coho. If stranded in pools, their fate is not much better since, as is currently believed, the present pumping activity prevents undersurface flow from maintaining the pool habitat, thus the juvenile coho mortalities occur by dessication.

In addition, interspecific competition with steelhead yearlings is present. The drying of the stream which results in a reduction of habitat (i.e. living space) intensifies this to the detriment of both. The greater the reduction in surface flows, the more magnified the competition becomes, resulting in survival energy spent on territorial defense and dominion of available food supplies, rather than on growth.

4. Steelhead

The steelhead is the most widespread anadromous sportfish in California. Its abundance has declined in recent years due to the presence of poor land use factors such as dam construction, water diversions, road construction, and land development projects. In totality these factors have resulted in migrational barriers, poor water quality conditions, and the degradation of spawning and rearing habitats.

Adult steelhead do not normally die after spawning as do coho, and as such are capable of spending several years at sea and may make repeated migrations into their natal stream to spawn. Adult steelhead prefer to spawn in streams possessing cool, clear, well oxygenated waters, and containing sufficient water velocities, and pool tail crest depths . Soon after spawning fry emerge and disperse as a school into the shallower and slower moving waters located in the stream margins (Barnhart 1986). Over time the schools break up and individual territories are established. Generally, juvenile steelhead spend their first year in riffle habitats where food production is high, and cover for escapement from predators is usually more prevalent.

Typically, juvenile steelhead usually spend two years in their natal stream. During their second year of growth, individual territories are expanded, and preferred stream residence is in the deeper pool or slack water areas which contain overhanging cover and/or under cut banks. With the onset of high flows coinciding with winter rainfall during the second year, juvenile steelhead begin to migrate downstream. Peak downstream migration of juvenile steelhead occurs in the spring.

During a recent downstream juvenile migrant trapping in Scott Creek conducted by Department staff (i.e. Jennifer Nelson), results showed that a significant proportion, about 50%, of the juvenile steelhead comprising the downstream migrant population consisted of fish in the 80 to 90 millimeter size class range. This indicates that one year old juveniles are also migrating in large numbers downstream. As will be discussed in greater detail later, during a seining operation of the Scott Creek lagoon by department staff in late June 1992, many fish of this size class were found in the lagoon. This potentially indicates the extreme importance of the lagoon environment, as these smaller fish are able to over summer here and attain a much greater size than would be possible if reared in the instream environment. The larger the juvenile is at time of entry into the ocean the greater the success of survival at sea, and the greater the chance that reentry into fresh water for spawning will occur.

Steelhead overall, while still greatly impacted by the current drought and stream dewatering, have not had the similar reduction in adult population as have the coho based on the prevalence of juvenile steelhead in Scott Creek and the Monterey Bay Salmon and Trout Project's (MBS&TP) adult steelhead trapping operation records over the last several years. The lagoon constrictions have not had the same impact on the steelhead, as is believed to have had on the coho, as the lagoon breach still occurs at an optimal time to allow for the full adult steelhead migration upstream.

Correspondingly, we see something in the steelhead juvenile population that we do not see in the juvenile coho population. Based on size only, indications from the Department's smolt trapping study in Scott Creek in 1992 indicates, that the yearly juvenile steelhead out migrant population may be comprised of about equal quantities of one and two year old fish. The two year old fish survive better at sea, and provide for greater adult steelhead returns. They also probably account for a fewer number of precocious males returning to Scott Creek. This is advantageous in that a greater number of adult male steelhead return providing for the transference of genetic information which codes for males to spend longer periods at sea, rather than spending only one year at sea. Also, another advantage is that more females will be produced since greater survival rates occur in juvenile steelhead that out migrate at age two rather than age one. They are more likely to attain greater size since they will spend two years at sea instead of one. Greater fecundity of the females will also exist since fecundity is a direct function of size.

Overall, an older adult female steelhead at time of upstream migration is going to be larger in size and therefore will provide for greater egg production, resulting in the potential for a larger adult steelhead population, and a population which can withstand several bad years of juvenile production and still rebound. The coho does not maintain these beneficial attributes, are highly dependent upon single year class juvenile production, and are much less able to withstand poor juvenile production for a single year, much less several, and still maintain the viability to sustain a healthy adult population level over the long run.

Another feature that steelhead possess in contrast to coho, is that both adult and juvenile steelhead show much less dependency on a particular habitat type to sustain their baseline population level as due the coho. Steelhead are less impacted by higher levels of sediment in spawning habitats than are the coho due to the less stringent oxygen requirements of steelhead eggs for survival.

Impacts by reduced surface flows are also similar to those given for coho salmon. Due to their similar habitat requirements in terms of needing the presence of cool, clear, well oxygenated water, the measures which reduce adverse impacts to coho will also correspondingly reduce impacts to the steelhead.

STREAM SAMPLING METHODS

Department personnel conducted field sampling in Scott Creek, from June 22 through July 3, 1992. Sampling included habitat typing the lower reach of Scott Creek, a distance of 3,900 feet, and electroshocking representative habitat types within this reach to both identify and quantify the fishery resources present. The lower lagoon was also qualitatively sampled, wherein a population estimate of the lagoon was subjectively quantified by the type and amount of fish captured in the seining operation. In addition, department personnel measured stream flows in this reach at different locations on several dates between May 18 and September 21, 1992. Also, lagoon water quality monitoring began in August 1992 and consisted of monitoring the salinity concentrations and water temperatures in the lagoon underneath the Highway 1 bridge.

Stream Flow Monitoring Survey

Stream flows were measured in Scott Creek between April and September 1992, using a Marsh McBirney Model 201 portable analog flow meter. Several sites were selected both in and above the historic dewatered reach. See Table 1 under Stream Flow Monitoring Results for additional information on site descriptions. Sites were selected either by ease of access, by proximity to known well sites, and by level of channel roughness. Areas within the stream containing a smooth channel bottom are preferred to obtain flow readings, areas possessing a rough channel bottom are avoided as a rough channel bottom creates turbulence within the water column as it passes over the bottom. Measurements in these areas provide false recordings, generally on the high side.

After the sites were determined flows were calculated by laying a measuring tape calibrated in feet, just above the surface of the stream creating a transect which allowed the stream width to be measured. Once the stream transect was developed, and stream width recorded, the stream was broken up into one foot long sections along the transect line. Flow determinations were made at the mid point between each one foot section located along the transect line. The measurements recorded for each cell within the transect line were combined to yield an overall stream flow measurement in cubic feet per second (cfs).

Lagoon Water Quality Survey

The water quality of the lagoon was sampled on two different occasions in August, and September 1992. Water quality parameters measured included salinity concentration, water depth, water temperature, and ambient air temperature. Measurements were obtained along a transect line located across the width of the lagoon along the Highway 1 bridge on the down stream side. Measurements were recorded with a YSI Model 33 SCT meter.

Habitat Typing Survey

Habitat typing of the effected reach followed the techniques outlined in the Department's California Salmonid Stream Habitat Restoration Manual, which represents a compilation of the U.S. Forest Service guidelines regarding this field sampling technique. Generally speaking, this technique allows for the classification of a stream into several habitat types (i.e. riffle, pool, and flat water types), and allows for quantification of each habitat type by measuring various components including the length, average width, average depth, substrate composition, and the amount and complexity of cover. The shelter rating value, substrate composition, percent total canopy cover, and bank composition were assessed for each habitat type. The shelter rating value refers to the percent of a particular habitat type unit containing areas (e.g. rocks, woody debris, or over hanging cover) for fish to seek cover from predation. Substrate composition refers to the particle size of the materials present at the stream bottom of the habitat type unit and includes the following designations, silts, sands, gravels, cobbles, boulders and bedrock. Percent total canopy cover refers to how much of each habitat type unit is covered by overhanging vegetation. Bank composition refers to the types of vegetation present, and to what extent, on the stream bank on both sides of the habitat type unit.

Fish Population Estimate Survey

To estimate the fish population within the effected reach, the overall stream reach was broken down into sub-units of a similar habitat type (i.e. types of riffles, pools, and slack water). The population for the entire reach was determined in random fashion by depletion sampling the fish population present in every fifth habitat type, i.e. every fifth pool, every fifth riffle etc., using electroshocking equipment (i.e. Smith-Root type 7 backpack electroshocker). Approximately 25 percent of the overall area of each habitat type found within this reach was sampled to determine the composition and overall fishery population present. At least three electroshocking passes were made at each site.

The population of each of the habitat types was determined using known population levels determined from the fish caught in each of the representative habitat types electroshocked. A fish population for the entire reach was also determined by linear regression analysis of the data obtained during the electroshocking sampling survey, wherein the fish population for a particular habitat type (i.e. riffle etc.) can be determined based upon the relationship of the fish removal pattern developed after three passes are made through the habitat type. For example if the following fish collection pattern (first pass=131, second pass=71, third pass=39) was achieved at the end of three electroshocking passes, the total fish population for this site would be estimated at 285 using a linear regression formula. In contrast, in determining a fish population based upon known fishery populations the fish population for this site using this method would be 241 (i.e. summation of the three values). Using these two procedures, a fish population for the entire reach could also be determined by the methods described below.

Once each of the selected habitat types identified for electroshocking had been sampled, the values obtained either from direct observation or from statistical estimation (i.e. linear regression) for each habitat type of the three habitat types were combined. With all the riffle habitat type fish populations added together, all the flat water habitat type fish populations added together, and so on for pools. Once combined, an area value in terms of fish per cubic foot could be generated for each habitat type. Once the habitat type specific fish per cubic foot rating factor was known for both the actual (i.e. based on actual number of fish captured) and estimated fish populations, the fish populations in the unknown areas of each habitat type could be determined by multiplying the rating factor for a particular habitat type by the unknown area of the remaining sites of the same habitat type, where fish sampling had not been conducted. By doing this for all three habitat types, an overall fish population for each habitat type could be determined. A fish population for the entire reach could then be determined by simply adding together the fish population values of each of the three different habitat types found within the reach. See Table 2 for additional information on habitat type specific rating factor determinations.

The result of sampling fish in this manner was that a fish population estimate could be conservatively defined by determining the fish per unit area in the known electroshocked sites, then subsequently by multiplying the resulting value by the area of the remaining, non-electroshocked sites, an estimate of the overall population for each habitat type could be obtained. The population estimates determined for each of the three habitat types was combined to give an overall population estimate for the entire reach.

By determining the fish population based on the actual number of fish captured at each habitat type, a conservative value would be generated providing a minimal estimation of the aquatic resources which are subject to adverse impacts through dewatering activities. By estimating the total fish population by the linear regression method, the full magnitude of dewatering impacts could be realized.

Once the fish had been captured at each sampling site, species composition was determined for sculpins, steelhead, coho salmon, and stickleback. Length and weight measurements were also obtained for steelhead. Population estimates for steelhead, coho salmon, and for non-salmonids collectively, were prepared. Non-salmonids include both coast range and rough sculpins, and three spine sticklebacks. The sculpins were lumped together due to ambiguities in the fishery identification literature prepared for these species to date.

Lagoon Seining Survey

A comprehensive lagoon survey was not conducted. In an effort to conservatively determine the value of the lagoon to the fishery resources present in the lagoon, a seining operation was conducted. A beach seine (100'x 6'x 1/2" mesh) was placed across the lower end of the lagoon, approximately 30 yards down stream of the Highway 1 bridge. An effort was made to herd any fish present in the lagoon by walking down the lagoon from a point about 150 yards upstream. Once the stream "walkers" came in close proximity to the beach seine, the seine was enclosed thus trapping any fish present between the walkers and the net. The seine was then pulled towards shore. The captured fish were identified, measured (total length) and returned live to the lagoon.

RESULTS

Stream Flow Monitoring Survey Results

Results from the stream flow monitoring survey show that the stream flow gradually receded as summer progressed, with one exception. The exception came during our sampling survey period on 6/30/92 in which approximately one inch of rain fell within the overall Scott Creek drainage, causing the stream flow in Scott Creek to nearly double. The flow quickly receded to levels present before 6/30/92. Table 1, next page, shows that flows were consistently greatest at station number three, and consistently lowest adjacent to, or just downstream of, Ernest Bontadelli's and Cal Poly's well site. Station number three is located just downstream of a major geologic land mass constriction, and downstream of Archibald Creek. The geologic constriction has resulted in the narrowing of the alluvium, as a ridge line located just north of the Archibald Creek confluence with Scott Creek extends well into the Scott Creek flood plain. Possibly this constriction is resulting in more surface flow to be forced towards the surface, thus resulting in elevated surface flows at site number three.

In contrast, the alluvium located adjacent to site number one is wider in nature, thus providing for under flow to in essence fan out thus providing for a reduction in surface stream flow. The presence of Archibald Creek just above station number three probably does not provide for a substantial increase in surface flows at this site, as it is a small drainage that is intermittent during a substantial portion of the summer and fall months.

Due to the types of alluvial materials removed from Cal-Poly's lower most agricultural well site, based on well drilling log reports which indicate that no impervious clay layers are present between the surface and the depths to which well water is being drawn, it is presumed that there does not exist an alluvial clay layer which would inhibit well draw from this site from resulting in reductions to surface flows present in Scott Creek, as continuous water flow throughout the alluvial deposits in this area is present.

A decision by the State Water Resources Control Board, Division of Water Rights, that well draw from Ernest Bontadelli's well site is likely impacting surface flows in Scott Creek, based upon the closeness of this well to the Scott Creek channel and the types of alluvial deposits determined from Cal-Poly's well drilling reports, has provided the stimulus to determine minimum instream flow protection standards for the lower reach of Scott Creek and the lagoon. The results from the stream monitoring survey suggest that in deed well draw from both Ernie Bontadelli's and Cal-Poly's well sites are resulting in a significant reduction of surface flows in the lower reach of Scott Creek.

Table 1

SCOTT CREEK STREAM FLOW MEASUREMENTS

Stream flow given in cubic feet per second (cfs)

STATIONS

DATE	1	2	3	3a	3b	4	5
5/18/92						7.25	
5/21/92							9.35
5/22/92			12.26			7.31	9.47
6/1/92	5.19		11.75			5.70	7.90
6/22/92	7.75						5.70
6/30/92a			11.25			6.75	11.6
7/1/92	5.85		9.70			5.10	7.80
7/2/92			8.10				6.75
7/3/92							6.30
7/6/92	4.05						4.30
7/9/92	-	4.20	5.85			3.15	4.40
7/16/92		4.10	5.50			2.50	3.15
7/31/92		2.96	3.80			1.97	2.38
8/12/92			3.09			1.14	1.14b
8/14/92c							
8/17/92			2.62			1.43	1.89b
8/27/92(A.M.)			2.47	2.56	1.41	1.66	1.36b
8/27/92(NOON)			2.42				
8/27/92			2.47	2.41	1.22	1.21	1.84b
9/1/92			2.46	2.59	1.16	1.31	1.81b
9/21/92			2.16	2.32	1.41	1.01	0.96b
10/28/92			2.04			1.36	

** Unless otherwise noted, flows taken during the mid afternoon

Station Locations:

1. Behind Cal-Poly Headquarters
2. Adjacent to CDF Station
3. Cal-Poly's Upper Road Crossing
3a. Adjacent to Cal-Poly's Lower Well Site
3b. Approximately 100 feet downstream of Station 3a
4. 30-Yards downstream of Cal-Poly's Surface Diversion Site
5. 30-Yards upstream of Cal-Poly's Lower Road Crossing

Special Notations:

a. Flows influenced by approximate 1-inch rainfall on this date
b. Flows obtained approximately 100 yards upstream
c. Bontadelli's well shut off on this date

Lagoon Water Quality Monitoring Results

On 8/14/92 and 9/3/92 water quality measurements, salinity concentration and water temperature, were recorded underneath the Highway 1 bridge. The lagoon was closed on both these dates. On 8/14/92 the ambient air temperature at 1445 hours was 64 degrees Fahrenheit. The water column of the lagoon was approximately five feet deep, with the water temperature 74 degrees Fahrenheit throughout. Salinity concentration of the water column was zero parts per thousand throughout. On 9/3/92 at 1600 hours, the ambient air temperature was 79 degrees Fahrenheit, water column temperature was 70 degrees throughout. Salinity concentration of the water column was zero parts per thousand throughout. The lagoon was approximately five feet in depth. The lagoon closed in a fresh water state and has remained in relatively good condition. This is in contrast with what Smith found in the summer of 1987, where fresh water inflows were significantly reduced during the summer and fall months, apparently significantly reducing the ability of the lagoon to maintain a cool fresh water state.

Habitat Typing Results

Results from the habitat typing survey show that there exists 43 habitat units in the effected reach, totaling 3,565 linear feet. There exists four levels at which habitat types can be determined. Level one provides the least specificity, while level four gives the greatest. Broken down to level 2 habitat types, i.e. categorization by riffle, pool or flat water types, this number includes 13 riffles, 12 flat water, and 18 pool sites [Figure 1, page 18].

Upon further inspection by defining the habitat types at level 4 [Figure 2, page 18), all the riffles were of the low gradient type, with a length of 809 linear feet. Flat water types consisted of glides and runs, with a total length of 1482 linear feet. Pools consisted of main channel pools, lateral scour bedrock formed pools, and lateral scour root wad formed pools, with a total length of 1275 linear feet [Appendix A].

FIGURE 1

Habitat type percent within reach

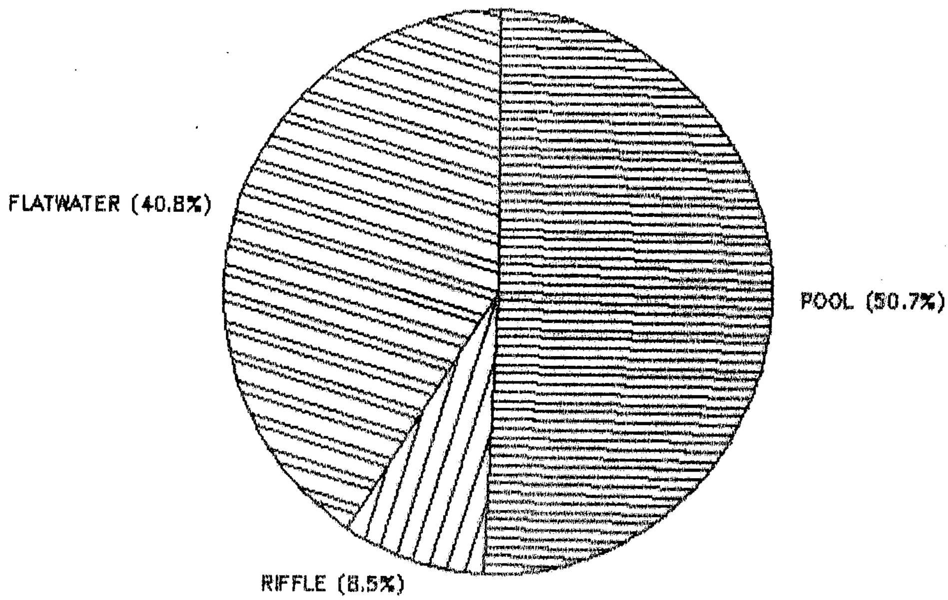
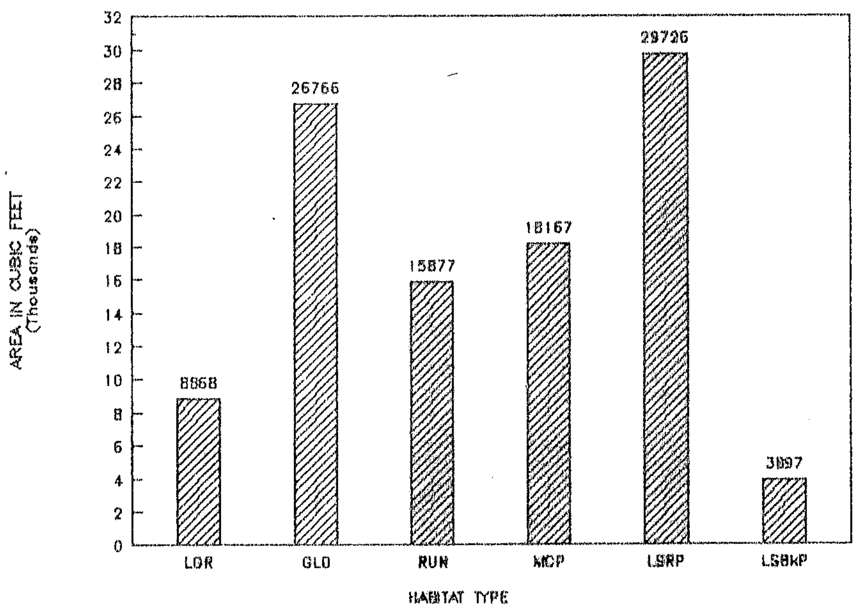


FIGURE 2



Habitat type comparison for reach

LGR=low gradient riffle; GLD=glide; RUN=run
MCP=mid channel pool; LSRP=lateralscour pool
LSBkP=lateral scour bedrock formed pool

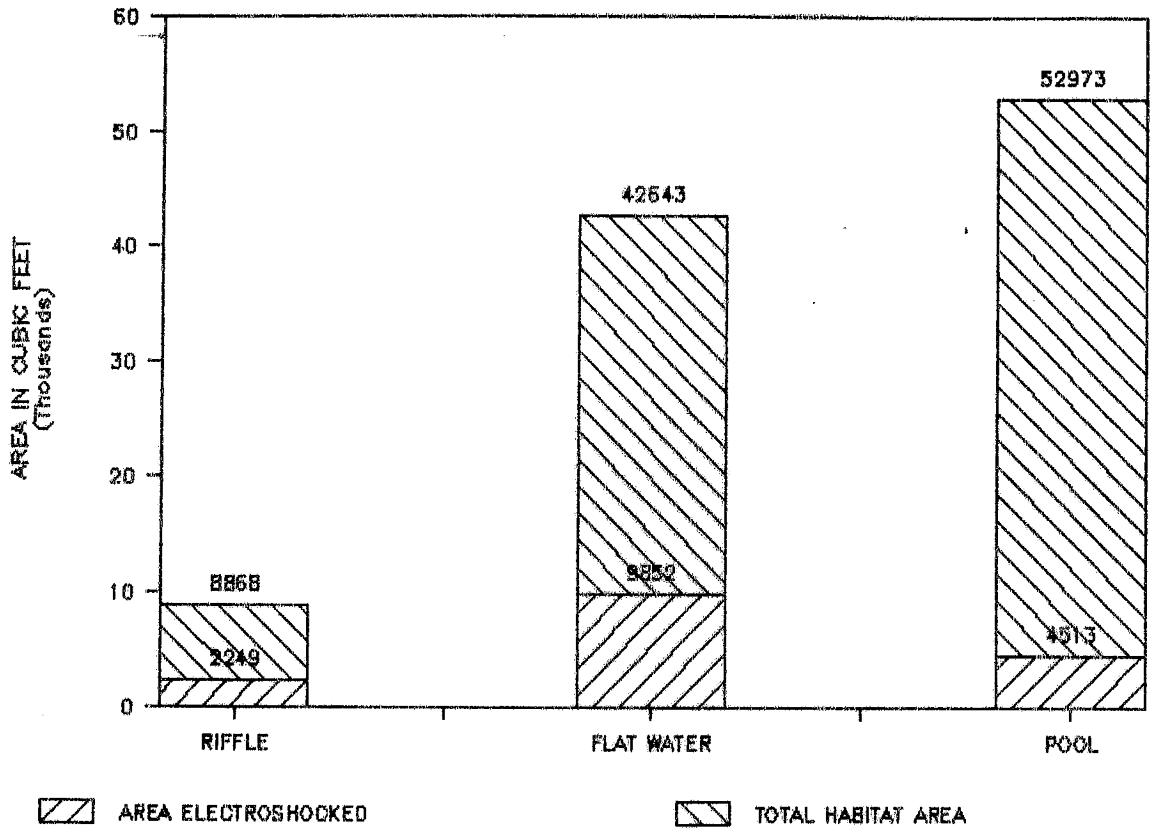
Shelter rating coverage, i.e. percent of habitat area possessing cover for fish to hide, varied little between habitat types (i.e. riffles=55%, flat water=40%, pools=45%). However the predominant cover type for each of the different habitat types varied considerably. Dominant cover in riffle areas primarily consisted of boulders, while cover in flat water areas consisted primarily of overhang woody riparian vegetation. Dominant cover in pool areas consisted primarily of over hanging woody riparian vegetation, and including both small and large woody debris. Canopy cover for all habitat types consisted entirely of deciduous trees dominated by red-alder. From general visual observations, there was not a major difference in the amount of cover provided by each stream bank side, nor was there much difference in the dominant type of vegetation present on each bank.

Substrate composition between the habitat types differed greatly. Riffles contained a larger concentration of both small and large cobbles than did the flat water or pool habitat types. Flat water types were dominated primarily by sands. Pool types were dominated by sands and cobbles. Riffle relationships to pool habitat types were mixed, of the 13 riffle units in this reach four were located upstream of a pool and four were located downstream of pool habitat units. However of the four longest riffles, three were located upstream of pool habitat types. Pools located downstream of riffles can very productive for rearing juvenile salmonids as insect drift from the upstream riffle site increases the food supply in these pool sites, thus allowing juvenile salmonids to attain greater sizes.

Fish Population Estimate Survey Results

Electroshocking surveys of the different habitat types found within the lower reach of Scott Creek showed that at least 25% of each habitat type was electrofished (i.e. riffles=26%,n=3; flat water=46%,n=4; pools=28%,n=4) through random selection of sites. However, in two flat water sites and two pool sites, excessive vegetation prevented effectively electroshocking the sites. Fish were observed being stunned, but they were not able to be captured due to the density of the vegetation. Thus, a decision to remove these sites from the population estimate was made. This reduced the areas electrofished to 23% for flat water types and 8% for pool types. No riffle sites electroshocked were removed from the population total for estimation purposes. Figure 3, page 20, depicts a comparison of the overall area electroshocked by habitat type relative to the overall area present within each habitat type. It was determined that for the purpose at hand that these values would still be valid for determining a reasonable population estimate. Overall, 17% of the entire reach was sampled to determine species composition and density. This compares well with traditional population sampling techniques in which coverage of at least 10% of the reach is desired.

FIGURE 3



Area electroshocked by habitat type in comparison to the total area present of each habitat type

Once the fish sampling data were correlated, a rating factor was generated for each habitat type based on the fish per cubic foot of wetted stream channel. Rating factors were determined based on both the actual number of fish captured at each habitat unit site, and the number of fish believed to be present at each habitat unit site based on a multiple electroshocking pass fishery depletion estimate equation given in Deventer & Platts (1989). Figure 4, page 22, shows the number of fish collected by habitat type, and the percent total catch of each habitat type relative to the reach population total. The actual number of fish captured in the reach equaled 1,180. Pools, riffles, and flat water habitat types possessed 291, 454, and 435 respectively.

The rating factors based on actual number of fish caught at each habitat type are as follows riffle types =.202218, flat water types =0.04411, pool types=0.063085 fish per cubic feet. The rating factors obtained from using the multiple pass population estimate equation are as follows, riffle types=0.21558, flat water types=0.050194, pool types= 0.073274 [Table 2, page 21].

TABLE 2

HABITAT TYPE POPULATION RATING FACTOR DETERMINATION BASED ON ACTUAL NUMBER OF FISH CAPTURED DURING ELECTROSHOCKING SURVEY

	Unit#	Type	Area	SS	SH	SCP	SB	TOTAL
Flat Water Areas:								
	030	GLD	6368.5	1	130	64	9	204
	043	RUN	3493.1	1	123	97	10	231
SUM=			9861.6	2	253	161	19	435
% OF TOTAL CATCH=				0.46	0.58	0.37	0.04	

Fish per unit area (i.e. water volume in cubic feet) in flat water habitat types = 0.04411

	Unit#	Type	Area	SS	SH	SCP	SB	TOTAL
Riffles:								
	001	LGR	451.5	0	87	76	0	163
	019	LGR	929.3	0	45	123	0	168
	037	LGR	864.3	0	45	76	2	123
SUM=			2245.1	0	177	275	2	454
% OF TOTAL CATCH=				0	0.40	0.60	<0.01	

Fish per unit area (i.e. water volume in cubic feet) in riffle habitat types = 0.202218

	Unit#	Type	Area	SS	SH	SCP	SB	TOTAL
Pools:								
	012	LSBk	3896.6	1	91	126	23	241
	036	LSR	716.2	0	37	13	0	50
SUM=			4612.8	1	128	139	23	291
% OF TOTAL CATCH=				<0.01	0.44	0.48	0.08	

Fish per unit area (i.e. water volume in cubic feet) in pool habitat types = 0.06085

Rating factors for each habitat type based on estimated fish populations, determined by linear regression, for each habitat type are:

Flat Water Areas: 0.050194
Riffles: 0.21558
Pools: 0.073274

Abbreviation definitions:
GLD = glide
RUN = run
LGR = low gradient riffle
LSBk= lateral scour pool-bedrock formed
LSR = lateral scour pool

FIGURE 4

Comparison of the total number of fish captured in each habitat type

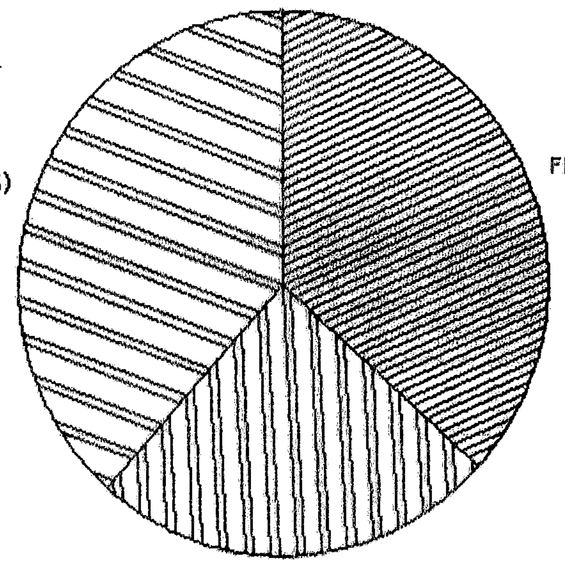


FIGURE 5

Total fish population for reach, from actual number estimation method by percent habitat type

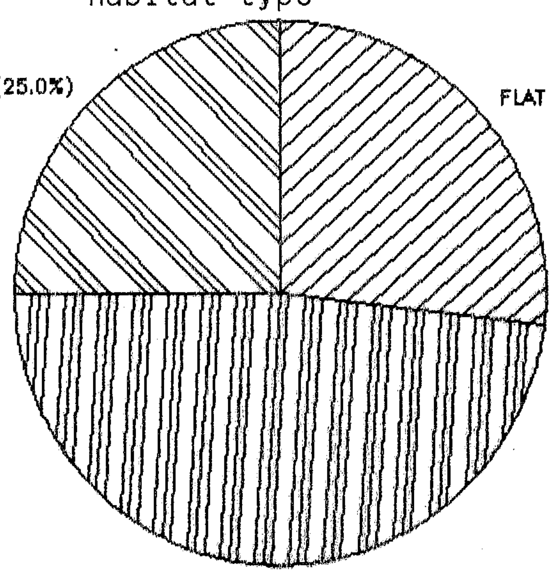
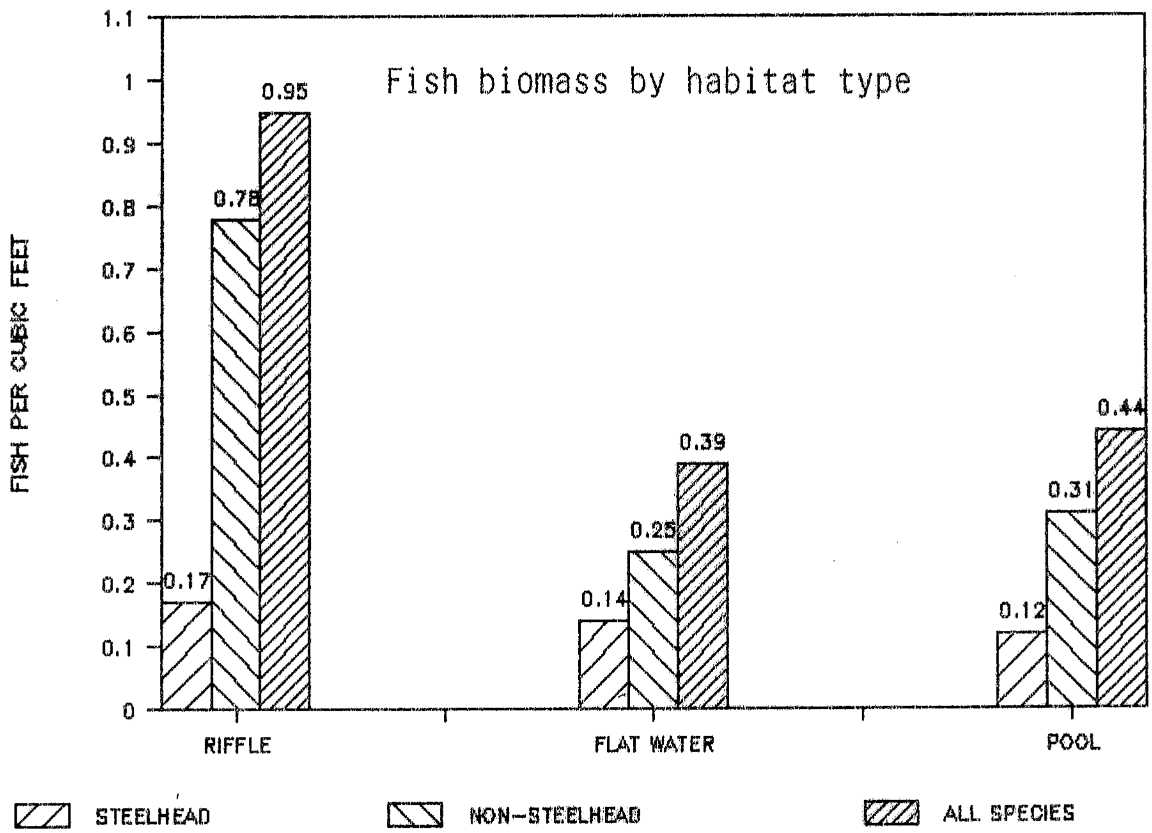


FIGURE 6



An overall population for each habitat type was estimated by multiplying the rating factor (RF) by the combined area of all the units of a specific habitat type. For example, the RF for riffles based on the actual number of fish captured at each site is 0.202218. This number times the total area (8668 cubic feet) of the habitat contained within the riffle habitat type equals 1,753. This resultant value is the estimate of the number of fish reasonably believed to reside in the riffle habitat types found within the lower reach.

The results show that pool types obtained the greatest number of fish at 3,343 [Figure 5, page 22], while riffle types contained the greatest density of fish, at 0.2 fish per cubic foot [Figure 6, page 23]. Figure 7 and Table 3 below compare fish population totals by actual number caught at each habitat type, versus a fish population determined by linear regression based on a depletion of the fishery resource present in each habitat type by removal methods (i.e. electroshocking).

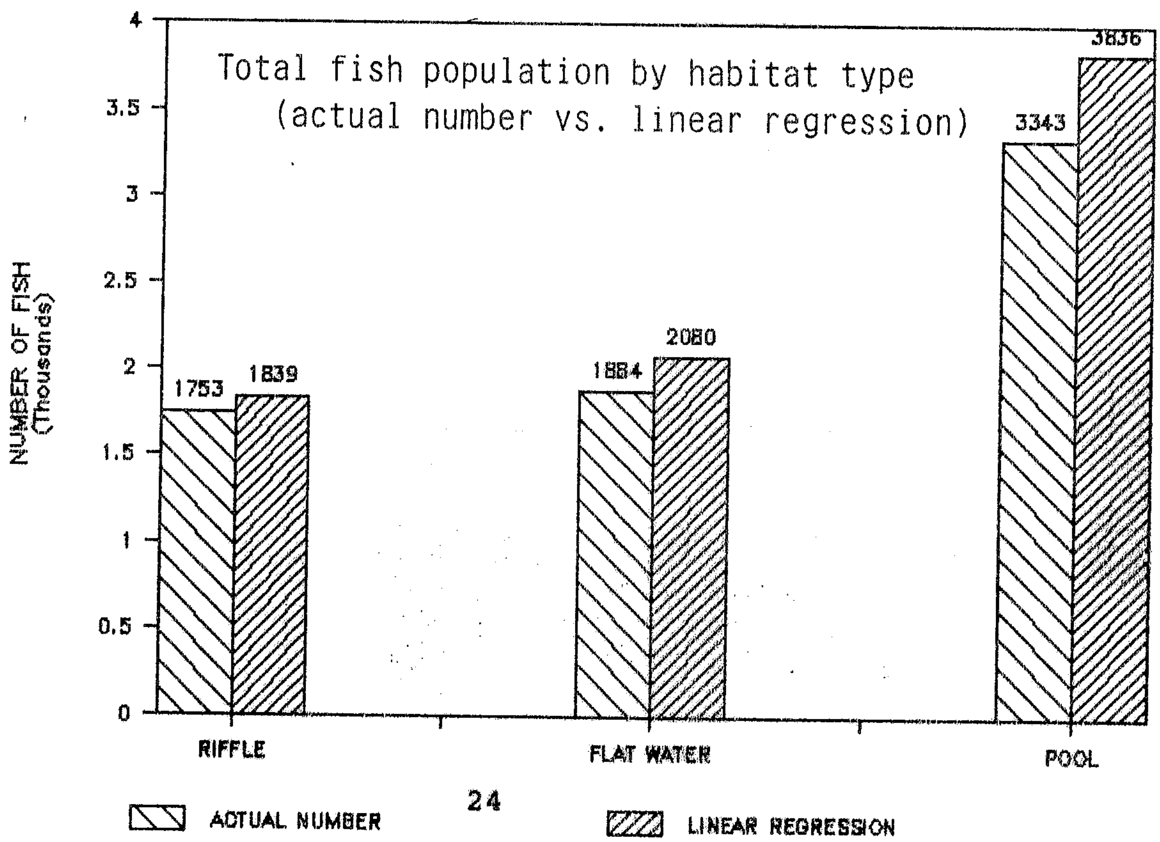
Table 3 REACH FISH POPULATION ESTIMATE

Habitat Type	Actual	Estimated
Riffles	1753	1839
Flat Water	1884	2080
Pools	3343	3836
Totals	6980	7755

Actual=Population based on actual number of fish caught at each representative habitat type site

Estimated=Population based on estimated number of fish believed to exist at each site based on multiple pass depletion estimate calculations from fish capture data collected from the representative habitat type sites

FIGURE 7



The total population by habitat type for steelhead and non-steelhead respectively is provided in Appendix B. Appendix D shows the calculated depletion fishery population estimate projections and confidence limits.

Figure 8, page 26, shows the actual number of steelhead captured at each habitat type sampled. Figure 9, page 26, depicts the actual number of non-steelhead captured at each habitat type sampled.

The coho salmon estimate for the reach is 18 by actual fish number estimate, with riffle, flat water, and pool habitat types possessing 0,8, and 10 respectively. Coho salmon population estimate for the reach based on linear regression is the same. Only three juvenile coho were actually captured, with two occurring in flat water habitat types, and one from pool habitat types. All coho were found in areas containing dense overhanging cover with moderate depths (i.e. to 1.5 to 3.1 feet). No coho were found in the lagoon. The total number of coho per 100 feet stream length equaled 0.01, n=18, total length=3566 feet.

Regarding pool quality to provide for rearing habitat for salmonids, especially juvenile coho, many of the pools encountered in this reach were both deep enough and contained overhanging stream side vegetation and/or under cut stream banks with exposed root wads. This combination is extremely valuable to attract juvenile coho to hold in these sites during the summer/fall time period. The fact that only three coho were found in this reach most likely does not reflect their true population here, as deep pools with overhanging vegetation and/or under cut banks are not conducive to effective sampling using a back pack electroshocker. A better survey technique for these habitat areas is to sample them by visual observation using snorkeling gear.

Comparison of the juvenile steelhead population by habitat type,based on sites sampled, revealed that flat water habitat types contain the greatest number with 253, with riffle and pool habitat types possessing 177 and 128 respectively [Figure 8, page 26]. No hatchery produced juvenile steelhead (i.e. presence of clipped or eroded fins) were encountered in this reach. For the purposes of this report, juvenile steelhead were determined to be smolt sized or age 1+ steelhead if they equaled or exceeded 90mm total length (TL). Figure 10, page 27, shows the overall steelhead population for the reach by habitat type. Figure 11, page 27, shows the reach non-steelhead population by habitat type.

FIGURE 8

Comparison by habitat type of number of SH captured at each site, includes both yearling and young of the year age classes

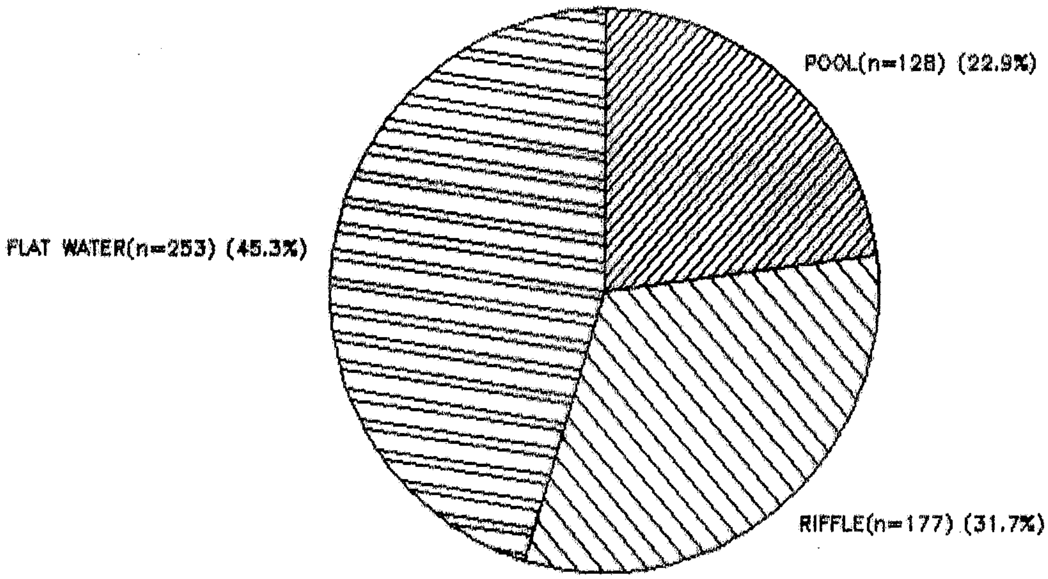


FIGURE 9

Comparison of number of non-steelhead captured at each habitat type

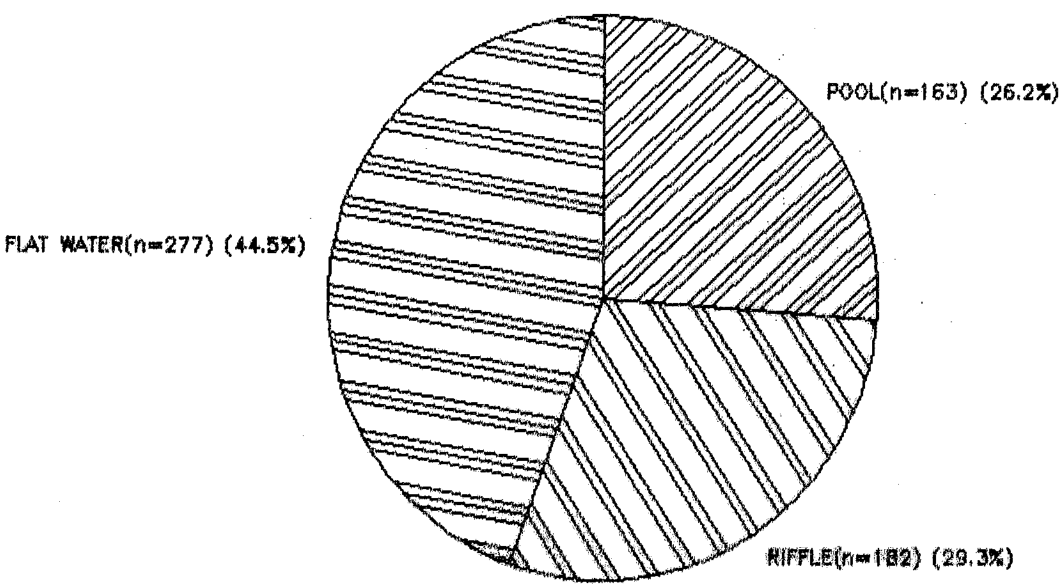


FIGURE 10

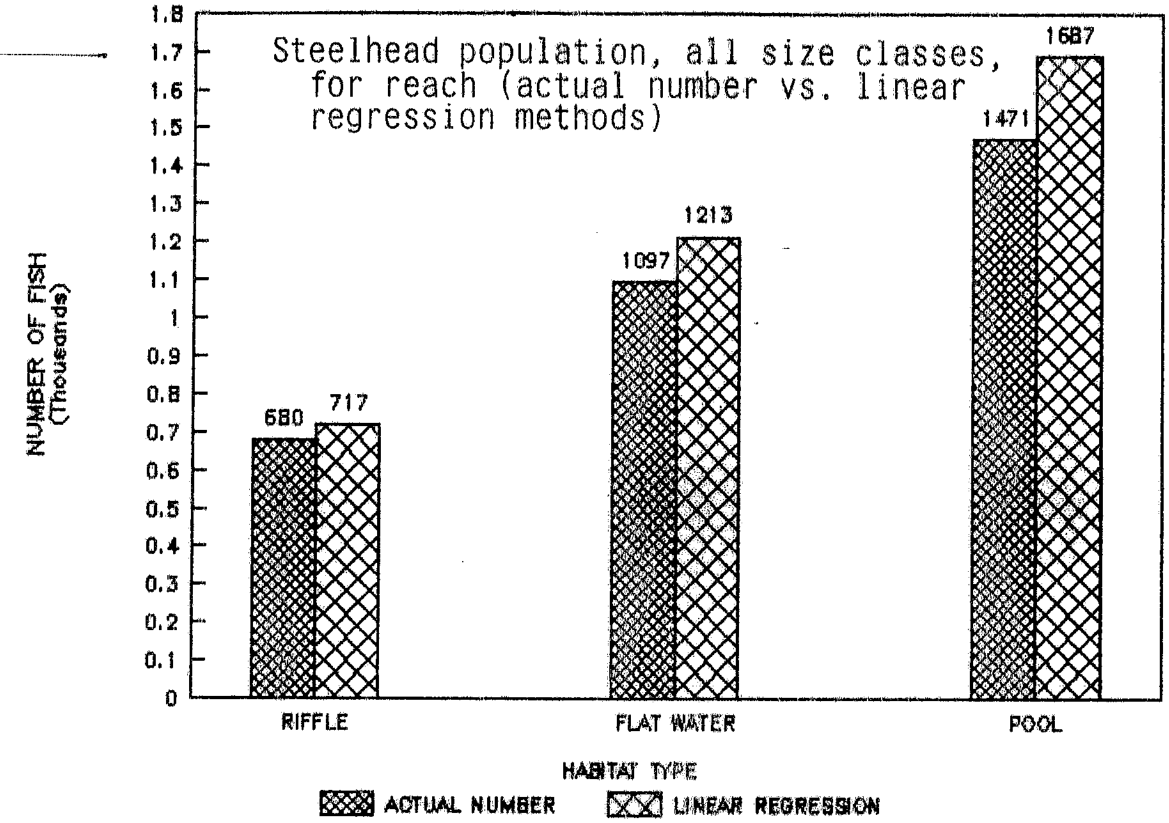
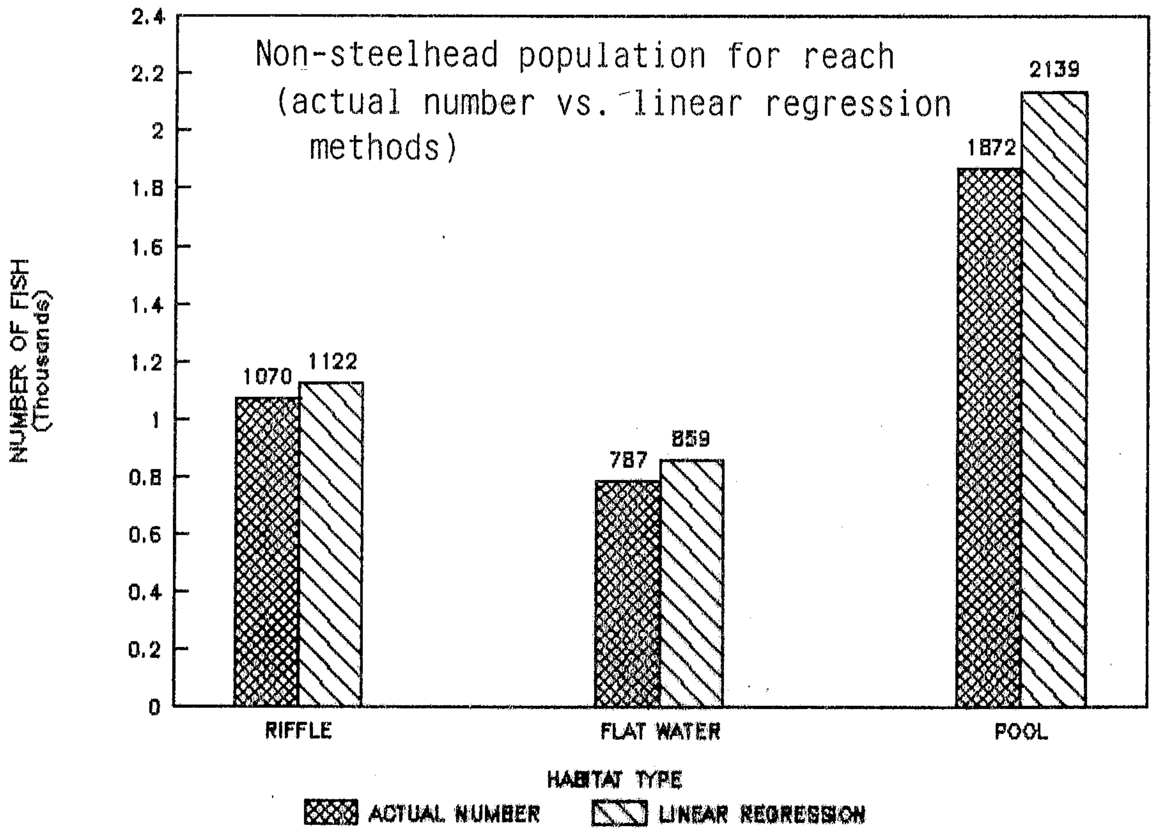
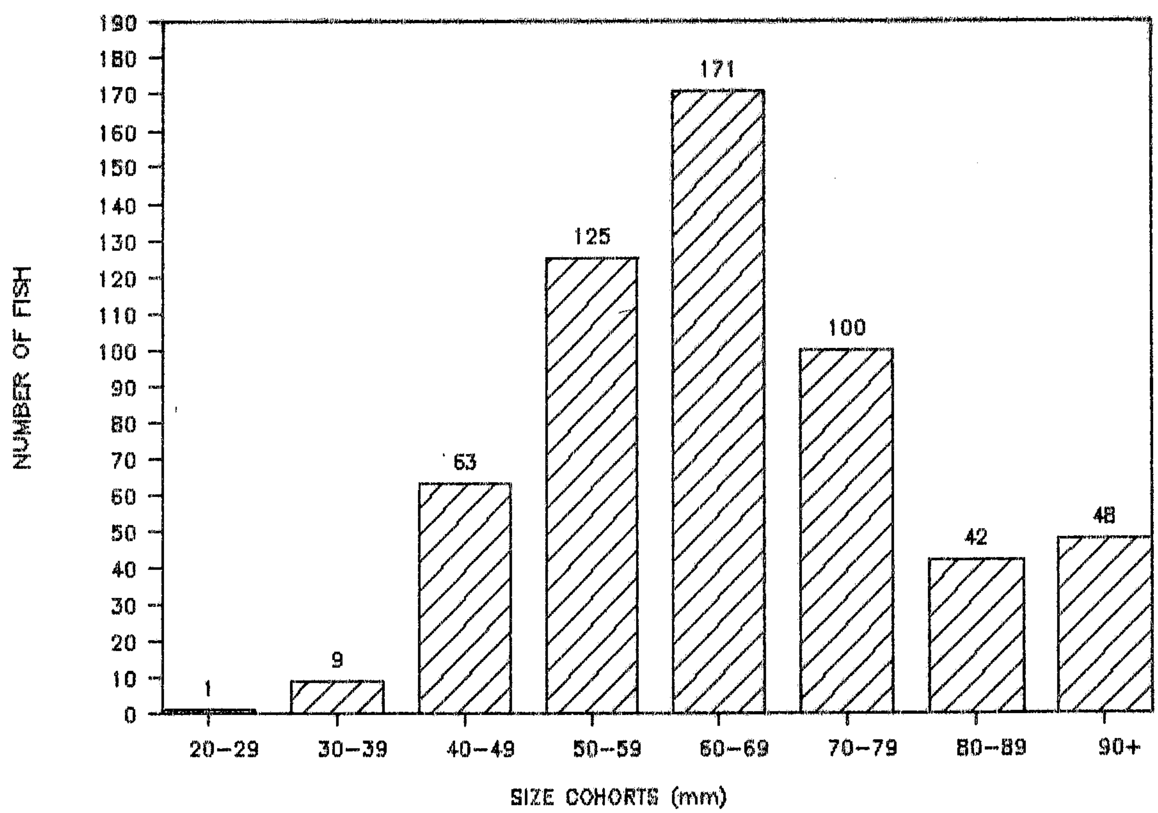


FIGURE 11



Length frequency analysis of the steelhead captured by habitat type reveals that all habitat types possessed primarily young of the year age class size fish [Figure 12, below]. For the stream reach sampled, of the 558 juvenile steelhead captured, 22.9% originated from pools, 31.2% from riffles, and 45.3 % from flat water habitat types. Flat water habitat types, contained the largest density of juvenile steelhead at nearly all size class designations [Figures 15-17, pages 30 and 31]. The only exceptions came in the 20-29, and 80-89 size cohorts. Riffles contained the greatest density of juvenile steelhead overall at 0.079 fish per cubic foot. Flat water and pool habitat types possessed approximately the same density of juvenile steelhead at 0.026 and 0.028 fish per cubic foot respectively. For the entire reach, the greatest number of young of the year fish came in the 60-69 size cohort (n=187). Length frequency comparison of the one-plus age steelhead size cohort between habitat types is provided in Figure 18, page 31. Steelhead young of the year comparison by habitat type, reveals [Figures 13 & 14, page 29] that riffles habitats possessed the greatest number and density of juvenile steelhead young of the year.

FIGURE 12



Length frequency--Steelhead. A comparison for all habitat types within reach

FIGURE 13

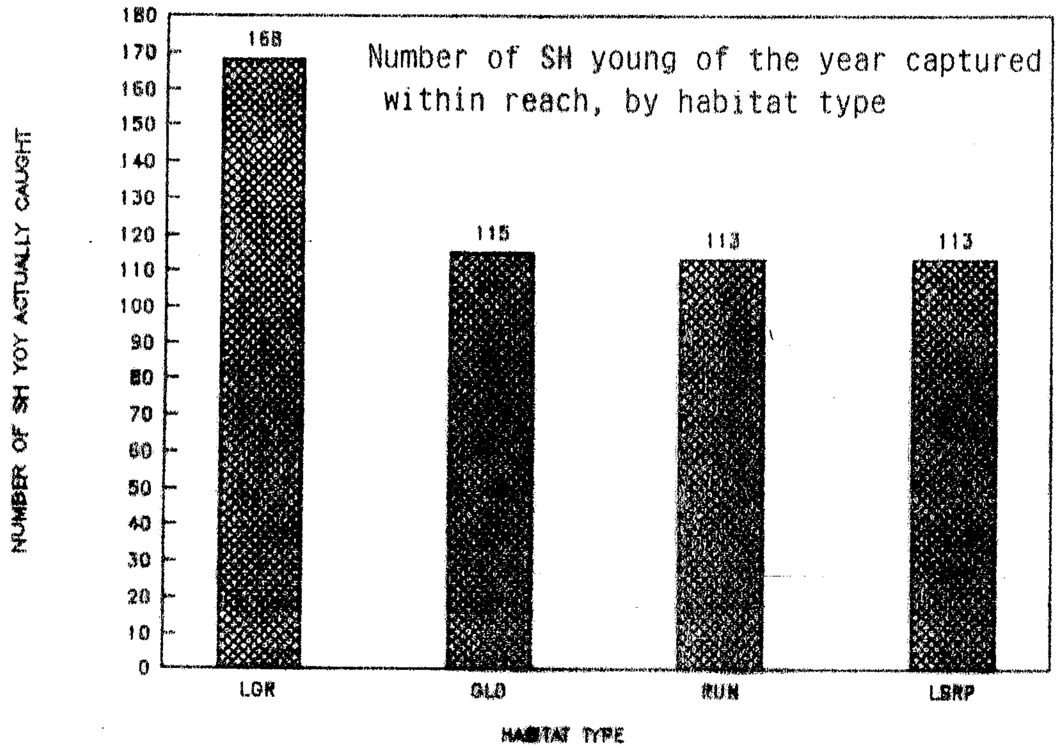
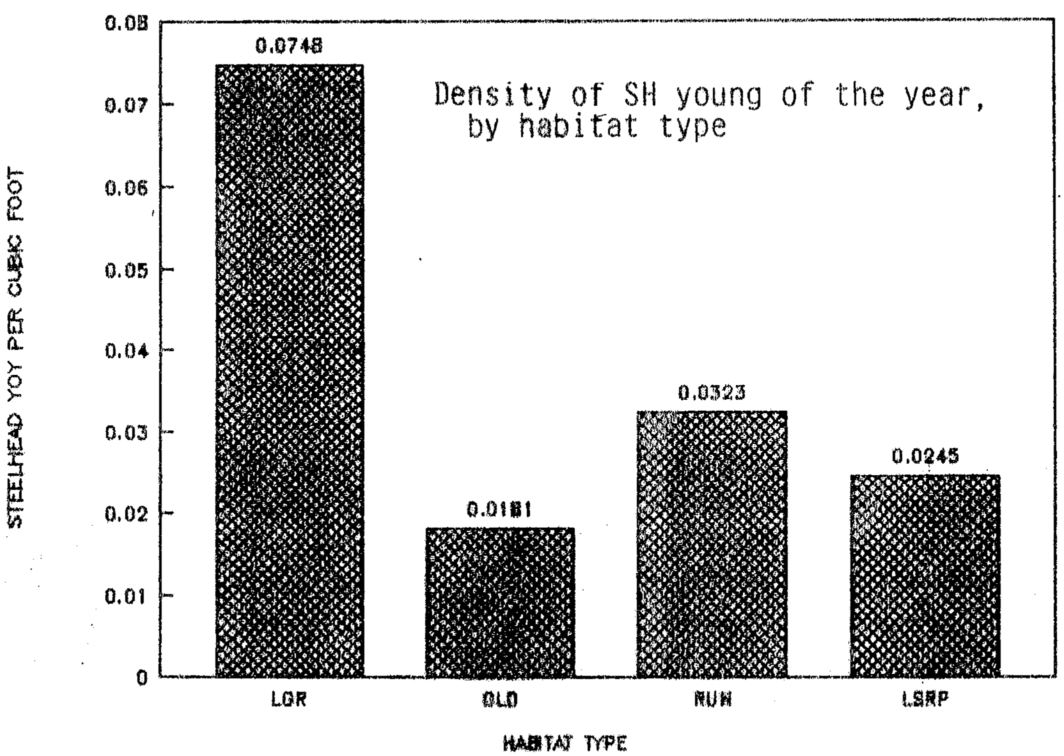
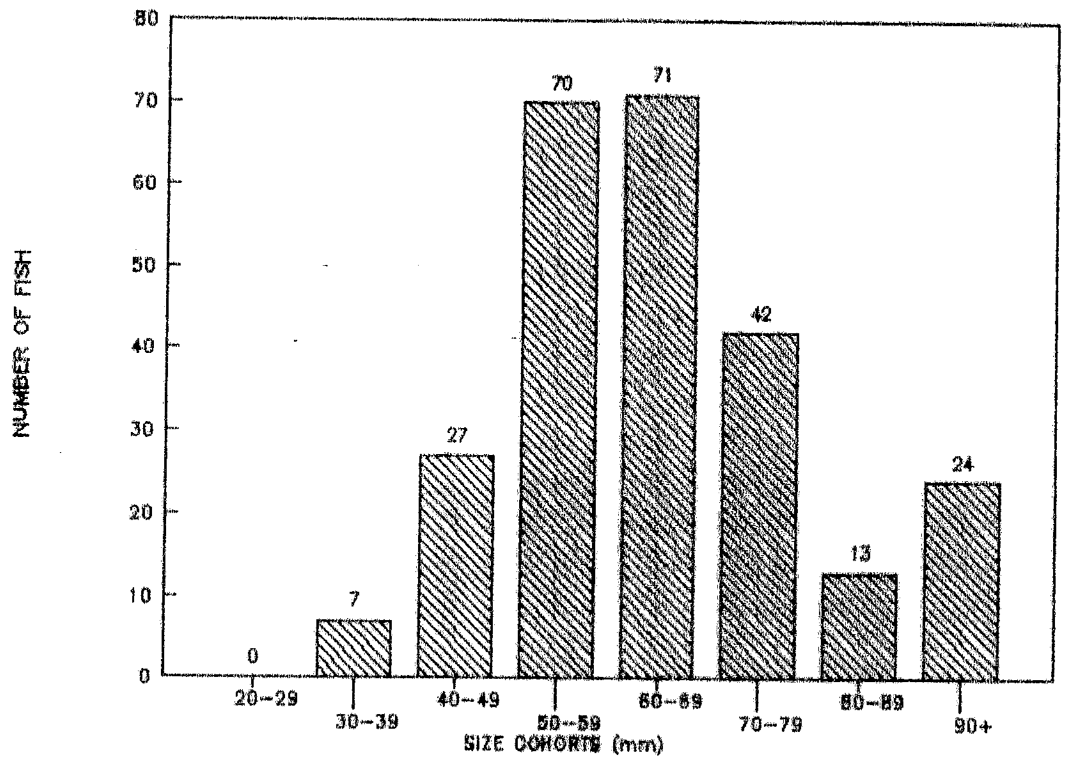


FIGURE 14



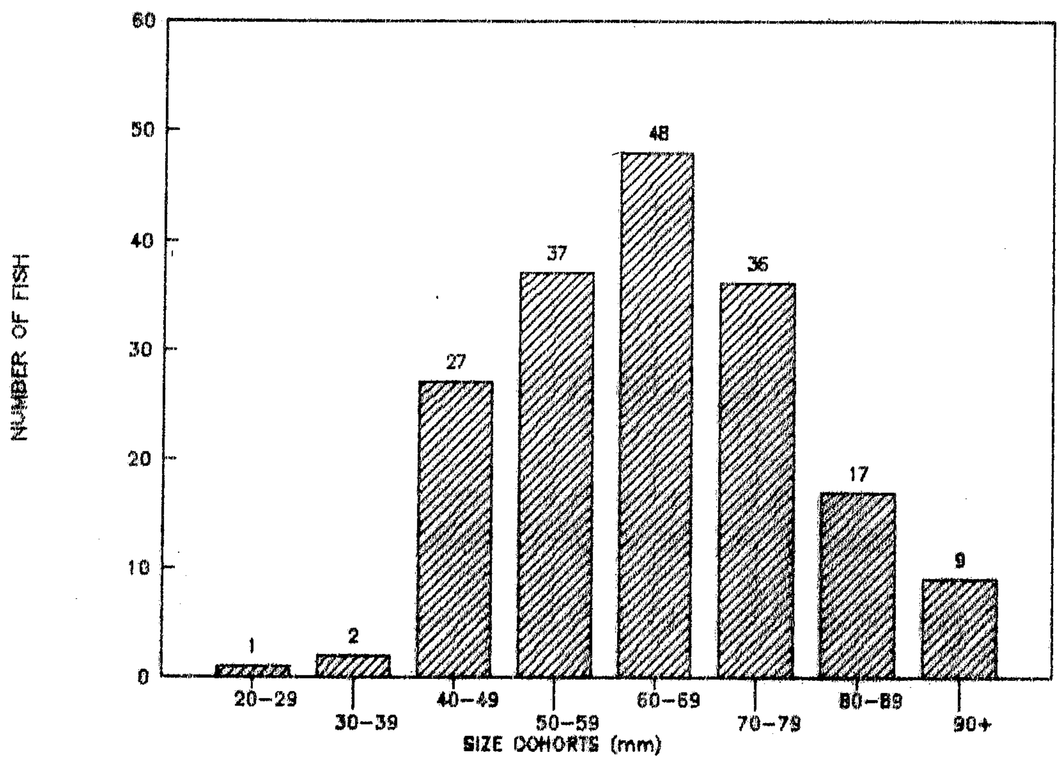
LGR=low gradient riffle; GLD=glide;
RUN=run; LSRP=lateral scour pool

FIGURE 15



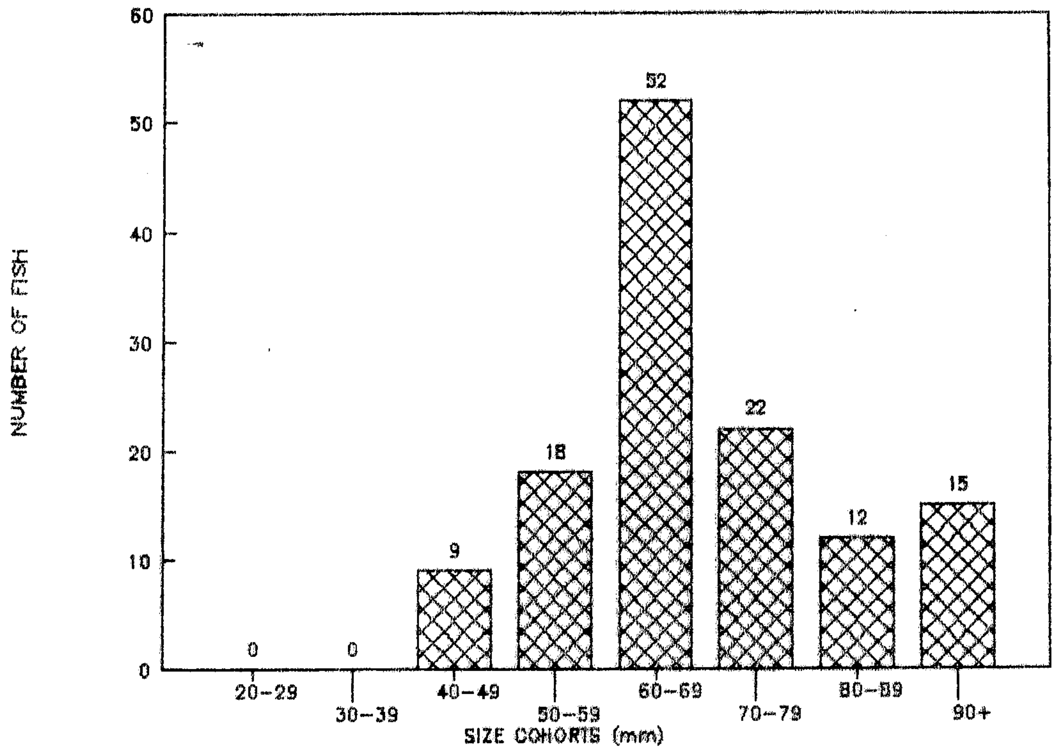
Length frequency--Steelhead (flat water habitat types)

FIGURE 16



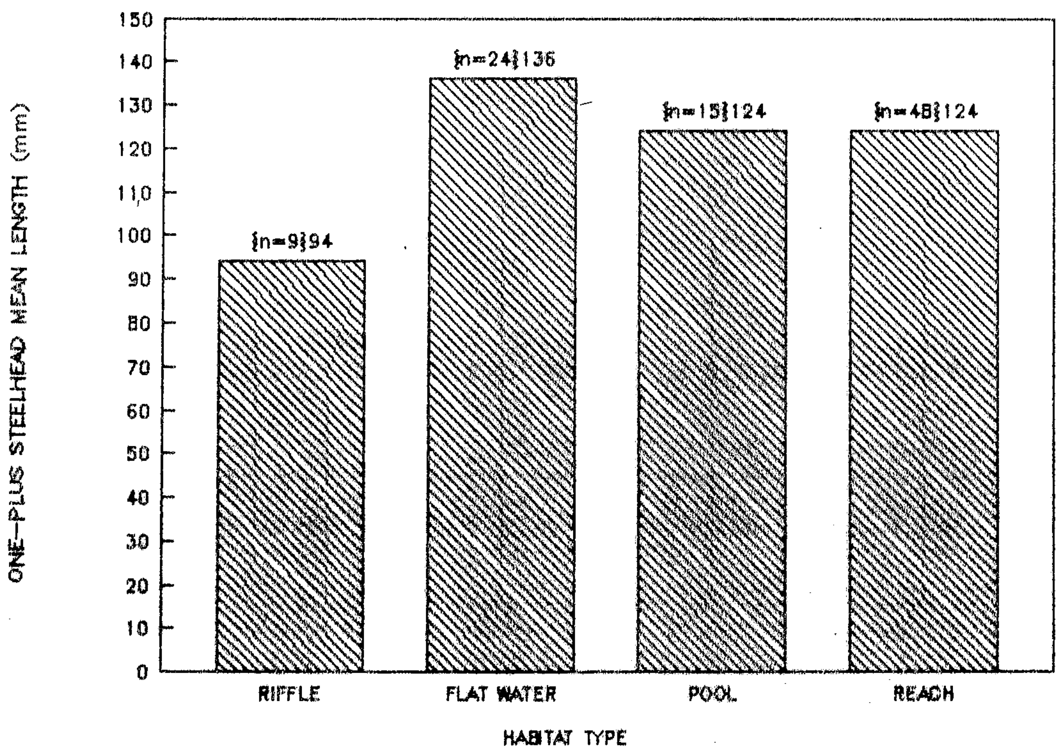
Length frequency--Steelhead (riffle habitat types)

FIGURE 17



Length frequency--Steelhead (pool habitat types)

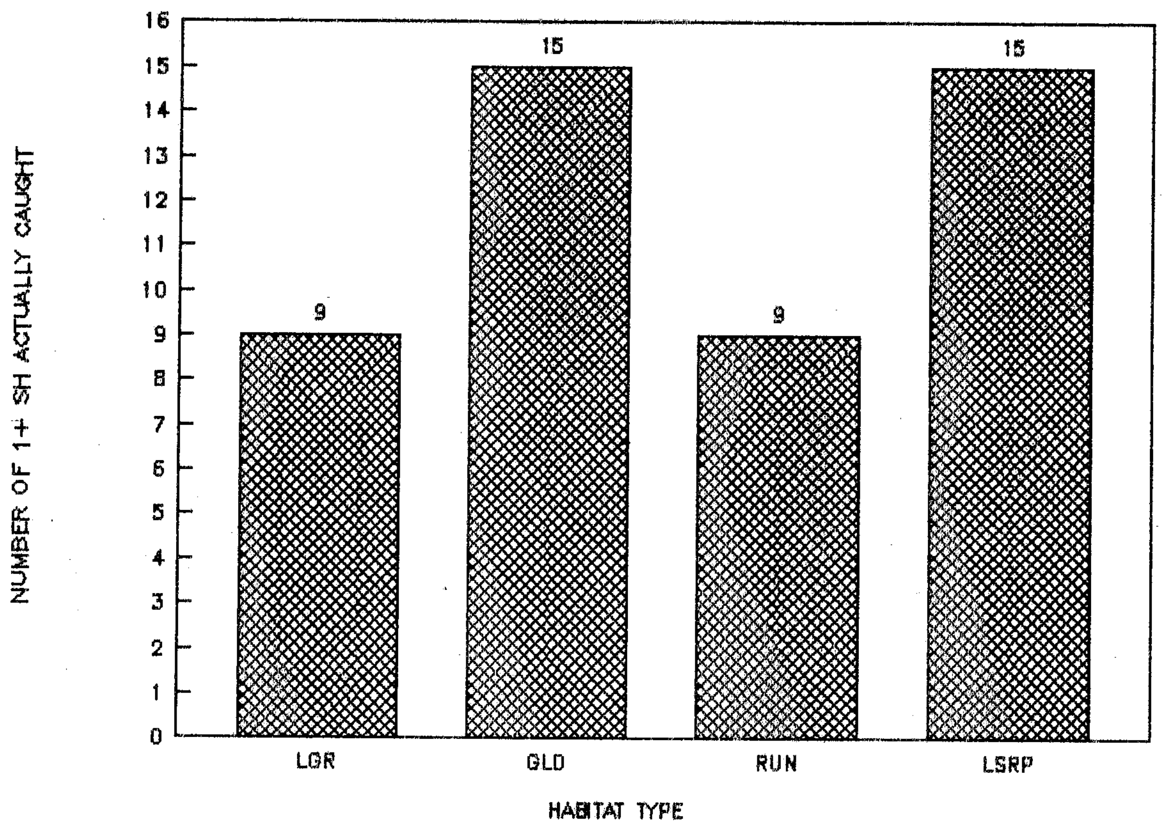
FIGURE 18



Mean length for yearling SH, by habitat type

For the one-plus size juvenile steelhead cohort group, [Figure 15, 90+mm cohort) flat water habitat types produced the greatest number of one-plus size juveniles at 24, which represents 9% (i.e. 24 of 253 total pop.) of juvenile steelhead population found in sampled flat water sites. Riffle habitat types possessed 5% one-plus size class juvenile steelhead, n=9, 177=total SH population [Figure 16, 90+mm cohort]. Pool habitat types contained the greatest percentage of one-plus cohort size juvenile steelhead (i.e.12%) possessing 15 one-plus size juveniles of the 128 total juvenile steelhead population [Figure 17, 90+mm cohort]. For the entire reach the one-plus size cohort percentage component of the overall juvenile steelhead population was 9%, i.e. 48 of 558. Figure 19 below provides comparison of the one-plus size class cohort break down by habitat type at level four, which provides the greatest specificity of separation.

FIGURE 19



Yearling steelhead captured by habitat type

Figure 20 below, shows the relationship of the lagoon, versus the reach, juvenile steelhead age one plus size class comparison. The lagoon possessed 137 steelhead, while the reach contained 48 steelhead. Figure 21 below, shows the comparison of one-plus steelhead captured in the lagoon versus that estimated for the reach based on the estimated population provided through the actual number method, where the lagoon contained 137 steelhead and the reach is believed to contain at least 293 steelhead.

FIGURE 20

Distribution of one-plus size class steelhead, a comparison between the reach and the lagoon. Based on actual number of fish captured.

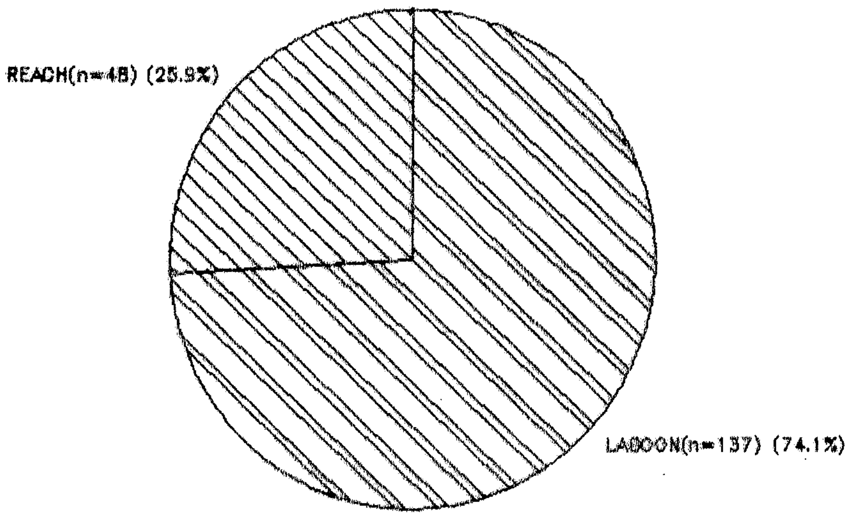
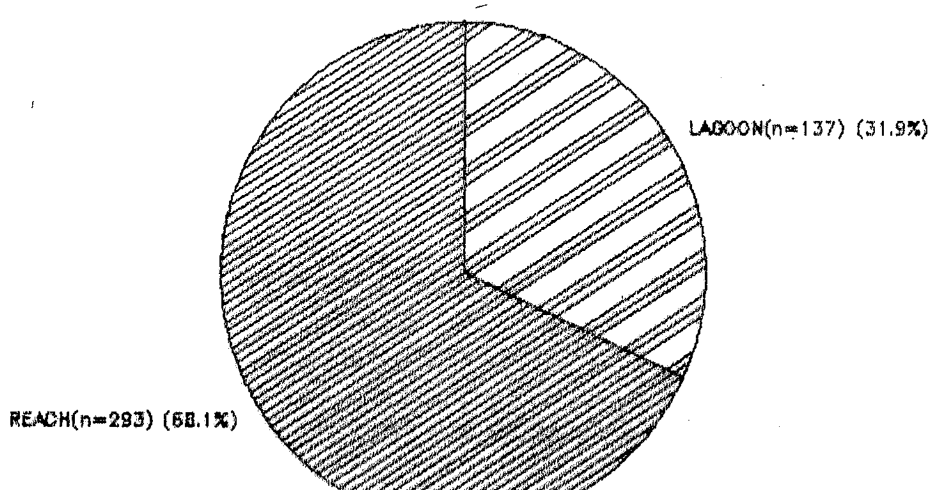


FIGURE 21



Distribution of one-plus size class juvenile steelhead, a comparison between the reach and the lagoon. The lagoon value is based on the actual number of steelhead captured in the lagoon. The reach value is from the number of one-plus size steelhead estimated to be present in the reach based on the actual number estimate method.

The number of one-plus size juvenile steelhead varied between habitat types. Riffles possessed four per 100 feet. Flat water habitats possessed 7 per 100 feet. Pools possessed the greatest density at 10 per 100 feet. Overall, this reach contained 7 one-plus size class juvenile steelhead per 100 feet. The mean total length for the riffle habitat type one-plus size cohort was 94mm TL (Range=90-97, n=9). The mean total length for flat water habitat type one-plus size cohort was 136mm TL (Range=90-190, n=24). The mean total length for pool habitat type one-plus size cohort was 124mm TL (Range=90-150, n=15). Overall, flat water types contained the largest number of juvenile steelhead, and the greatest number of age one-plus size class juvenile steelhead [Figures 23-4, page 35].

Concerning length-weight relationships of juvenile steelhead, approximately 44% of the total juvenile steelhead population for the reach were weighed (i.e. 243 of 558). Weight measurements were obtained both either volumetric displacement or by use of a gram scale (Ohaus Model CT 200). The greatest percentage of fish were weighed via the gram scale. By habitat type, riffle young of the year steelhead averaged 2.01 grams (n=86, Range=0.4-6.0). In riffle habitat types, one-plus size steelhead averaged 4.4 grams (n=8, Range=2-7 grams). Juvenile young of the year steelhead from flat water habitat types averaged 2.01 grams (n=51, Range=0.4-6 grams). In flat water habitat types, juvenile one-plus sized steelhead averaged 16.4 grams (n=2, Range=14.8-18). Juvenile young of the year steelhead in pool habitat types averaged 3.01 grams (n=80, Range=0.8-6.7 grams). In pool habitat types, juvenile one-plus size steelhead averaged 18.46 grams (n=16, Range=5-35 grams) [Figure 22, below].

FIGURE 22

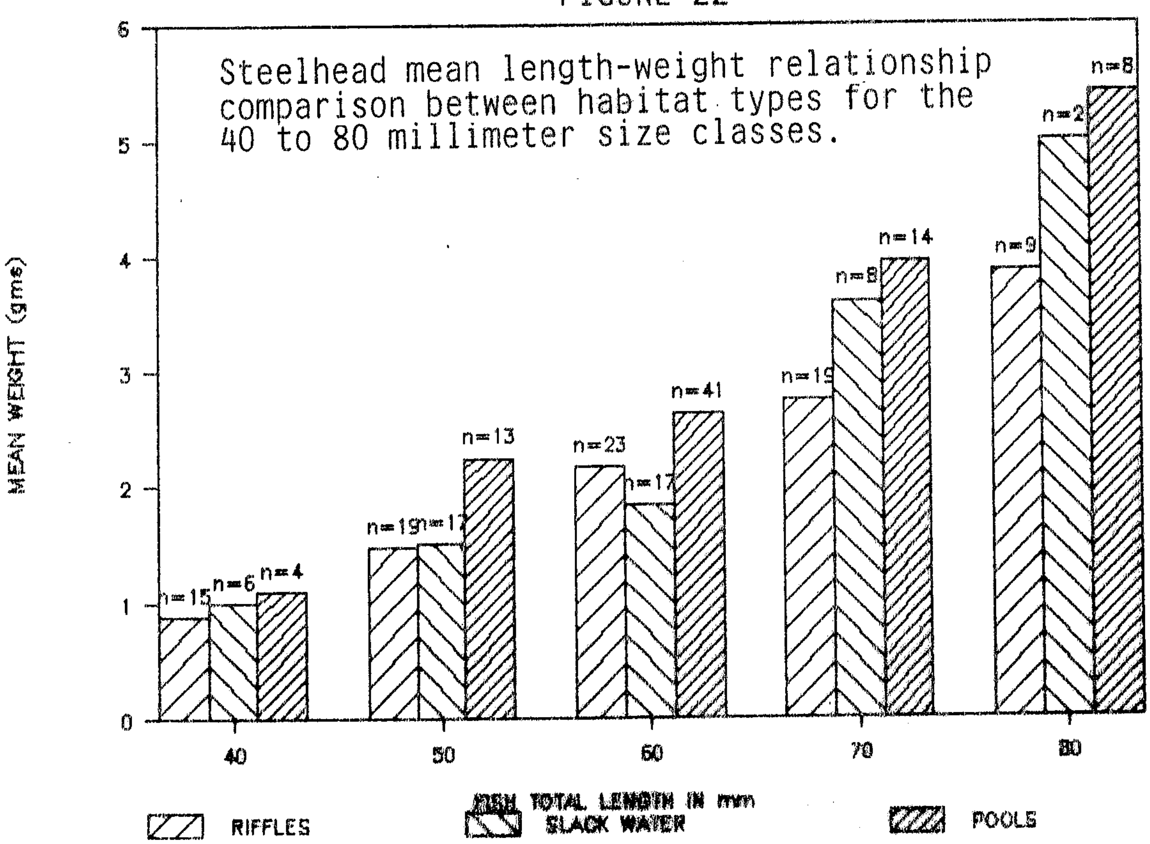
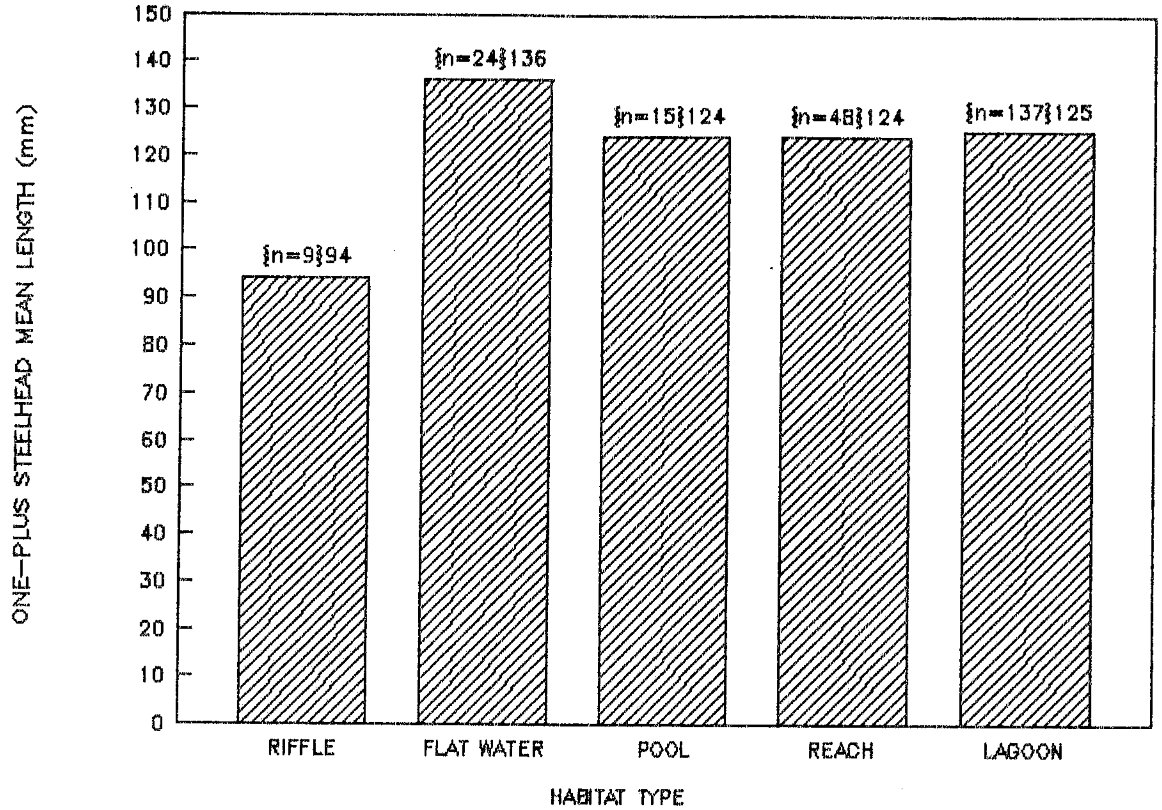
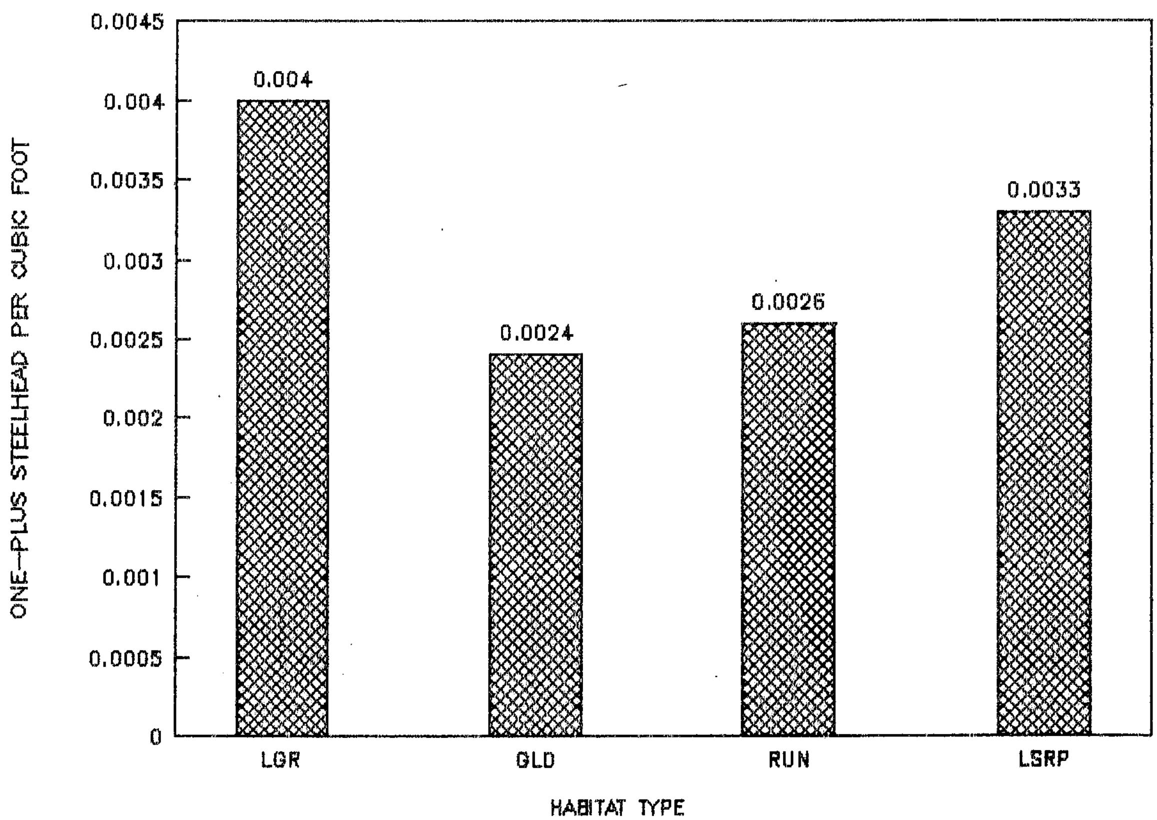


FIGURE 23



Yearling steelhead. Mean length by habitat type.

FIGURE 24



Yearling steelhead density by habitat type

Mean length-weight analysis between habitat types by two-tailed t test mean comparison was conducted only for young of the year cohorts due to the small number of fish weighed from the one-plus size class. Based on the number of fish weighed in each cohort from each habitat type, young of the year steelhead from the 50-59 and 60-69mm size cohorts from each habitat type were compared for significance in their length-weight relationship. Figure 20, page 33, provides comparison of the mean length-weight relationships between the juvenile young of the year steelhead from riffle, flat water and pool habitat types for the 40-89mm size class cohorts. For the 50-59mm size cohort the riffle habitat type mean=1.47 grams (n=19, Range=0.9-2.1 grams), the flat water habitat type mean=1.51 grams (n=17, Range=1-2.1 grams), and the pool habitat type mean=2.25 grams (n=13, Range=1.2-3.6 grams). Comparison of the pool to both riffle and flat water habitat type means was found to be significant (P=0.95). Comparison of riffle to flat water habitat type means was not significant (P=0.95).

For the 60-69mm size cohort the riffle habitat type mean=2.17 (n=23, Range=1-5 grams), the flat water habitat type mean=1.84 grams (n=17, Range=1-3 grams), and the pool habitat type mean=2.64 grams (n=41, Range=1.9-3.6 grams). Comparison of the pool to both riffle and flat water habitat type means was found to be significant (P=0.95). Comparison of riffle to flat water habitat type means was found not to be significant (P=0.95).

For the non-steelhead population, which consists primarily of sculpins, all habitat types contained a larger non-steelhead concentration per cubic foot than for steelhead. Riffle habitat types contained the greatest quantity (n=277). Flat water and pool habitat types contained 180 and 162 fish respectively. The greatest non-steelhead density occurred in riffle habitat types with 0.123 non-steelhead per cubic foot. Flat water and pool habitat types possessed 0.018 and 0.035 non-steelhead per cubic foot respectively.

Lagoon Seining Survey Results

Results from the seining operation in the lagoon showed that a total of 384 fish were captured. Of these 273 were steelhead, no coho were captured. The remainder was comprised of sticklebacks, juvenile starry flounder, staghorn sculpins, and fresh water sculpins. A rough estimate of 1200 juvenile steelhead was estimated as the population residing in the lagoon. This estimate was based on the fact that only a small percentage of the lagoon was seined, the portions of the lagoon that were seined probably did not contain the greatest concentration of juvenile steelhead as this area was inaccessible due to emergent vegetative growth. The total fish population combined for the lagoon and stream reach, determined by the actual number of fish captured at sample sites is 8180 (6980 reach, and 1200 lagoon). The total fish population of the lower portion of Scott Creek, including the lagoon, with the fish population in the affected reach based on the population estimated through linear regression analysis is 8955 (7755 reach, 1200 lagoon).

Figure 25 provides length frequencies for steelhead captured in the lagoon. For comparison, Figure 12, page 28, provides length frequencies for steelhead captured in the reach. A much larger percentage (50%) of the steelhead population captured in the lagoon were of smolt size (>90mm TL), than that which existed in the upstream reach (9%).

Figure 26, shows the composition of young of the year and one-plus cohort sized juvenile steelhead in the lagoon. In the lagoon, many (54%) possessed the silver coloration indicative of smolts. Five of the smolt sized fish in the 80-89mm size class possessed the silvery coloration. The mean total length of the one-plus size class cohort in the lagoon is 125mm TL (Range 90-200, n=137), compared with 124 mmTL (Range 90-190, n=48) for the reach.

FIGURE 25

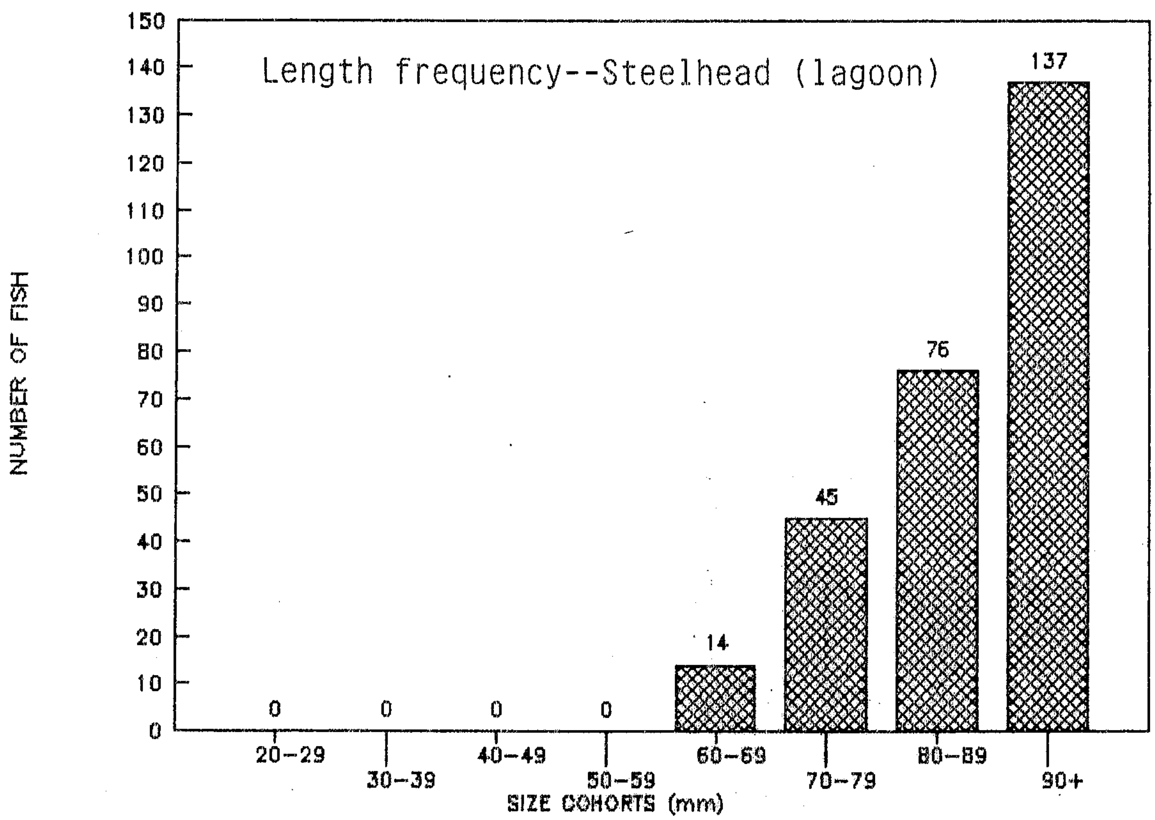
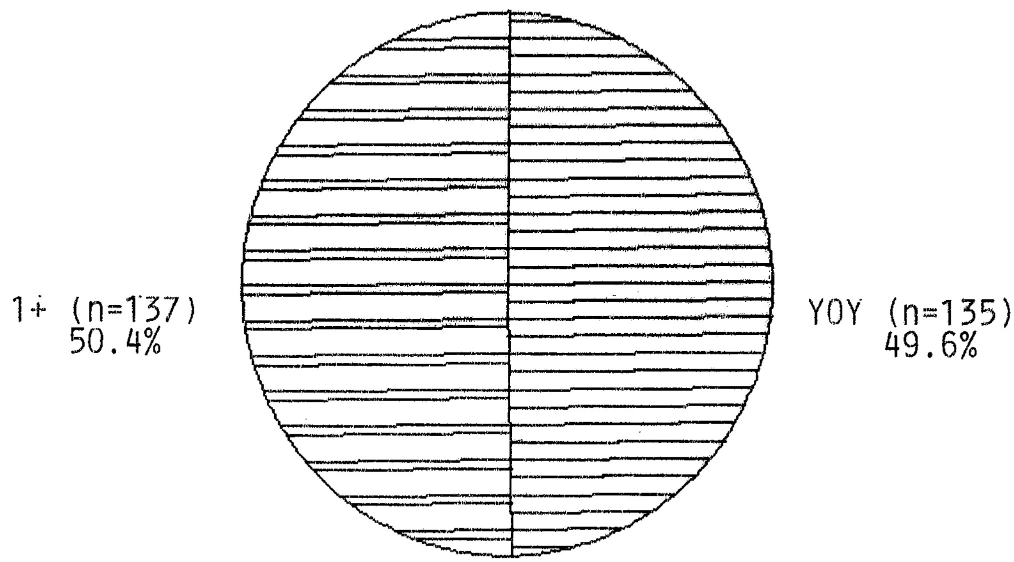


FIGURE 26

Steelhead population for the lagoon, a comparison of the YOY and 1+ size classes. Values from actual number of steelhead captured in the lagoon.



DISCUSSION

It is clear, based upon review of the data collected from the June 1992 field survey that the lower reach of Scott Creek and the lagoon support an abundance of fish life both in terms of numbers and diversity.

Results from the stream flow monitoring survey suggest that water diversions from the three major well sites located adjacent to the lower Scott Creek stream reach, i.e. one by E. Bontadelli and two by Cal-Poly, are significantly effecting surface flow. In each case, when stream flows have been recorded, sharp reductions in surface flow have resulted when monitored directly adjacent to, or just downstream of, the active well sites. It is interesting to note that when Mr. Bontadelli shut off his well pump, the stream flow adjacent to his well site went from 1.14 cubic feet per second (cfs) to 1.43 cfs in less than 72 hours. The increase would have probably been even greater had the stream flow been measured on the date he actually shut off the pump (8/14/92) rather than measured two days previously (8/12/92), as the stream flow was quickly receding and it is likely that at time of shut off, the surface flow adjacent to his well site was lower that 1.14 cfs.

From the stream flows monitored on 9/21/92, flows at the monitoring sites downstream of Cal-Poly's lower well site are all lower in magnitude than those flows obtained upstream, suggesting that Cal-Poly's well sites are also significantly effecting surface flows. With this observation, the outcome of the Department's Instream Flow Incremental Methodology (IFIM) survey which is scheduled to be completed in the summer of 1993, in which a long term instream minimum flow value will be obtained to protect the aquatic resources inhabiting the lower reach of Scott Creek, compliance by all parties diverting water from the lower Scott Creek watershed will ensure that adequate surface flows exist for the protection of the fishery resources present in the lower reach of Scott Creek.

From the habitat typing inventory it is evident that this reach of Scott Creek and the lagoon, when in a healthy condition, can and will support significant populations of aquatic wildlife. This is not surprising since Scott Creek is considered one of the best quality streams in Santa Cruz County, as little in the way of destructive land use practices, as compared with the rest of the County, have occurred here. The riparian corridor adjoining the Scott Creek stream channel is both mature and dense, thus providing much in the way of wetland habitat beneficial for the use of aquatic resources.

From the results of the electroshocking survey, much can be inferred. First, very few juvenile coho exist in this reach. There exists at least six possible explanations as to why coho production is low. First, there are very few adult coho returning to Scott Creek to spawn and thus juvenile coho production is low. Second, the streambed in this reach is not being actively selected by adult coho, thus limiting juvenile coho production. Third, this reach is being actively selected by adult coho but either the coho eggs are surviving poorly and/or their exists insufficient rearing habitat which also would lessen juvenile coho production in this reach. Fourth, coho adults are actively selecting areas within this reach and successful juvenile coho production is occurring but the juvenile coho are out migrating to sea at an early age (i.e. as is the case with chinook salmon). Fifth, since the sandbar formation has been altered due to construction of the Highway 1 bridge it no longer breaches at the same time other nearby sandbars breach (i.e. Waddell Creek) and as such, early migrating adults move into other stream systems also reducing the number of adult coho that would be available to spawn in Scott Creek.

Lastly, adults are actively selecting spawning sites within this reach, and coho egg production is good but intraspecific competition with juvenile steelhead limits coho production. I suspect that all of these factors, and surely others, play a significant role in defining why there are so few coho in this reach. Additionally, to add further complexity we are in the sixth year of a prolonged drought, which exacerbates all of the above factors.

From a habitat point of view, all the right factors are there for optimum coho production assuming one very critical factor, that is there still exists at least more than a few adult coho returning to Scott Creek to spawn to maintain a viable Scott Creek wild coho stock. Much seems to indicate that this is not the case. The Monterey Bay Salmon and Trout Project, which has reared hatchery produced juvenile coho and released them into Scott Creek and the San Lorenzo River for the last several years, has not been getting good returns. In fact, last year no female adult coho were captured by the project from Scott Creek, and only 17 female adult coho were captured from the San Lorenzo River. Of these only one, a female, was of Scott Creek origin in so far as fin clip information is concerned. The lagoon presently seems not to be an important factor in providing juvenile coho rearing habitat as none were found there. This does not preclude their existence there, but rather provides an indication of the present use of this habitat type by juvenile coho.

Absence of juvenile coho in coastal lagoons is contradictory to what is found in northern California and Oregon Coastal lagoons were coho are endemic. In these waters coho are found in great abundance in lagoon habitats. Possibly since the Scott Creek Lagoon has been altered the juvenile coho no longer actively seek it out, or in the case of early out migrants, do not find it a suitable location to over summer. Many potential answers abound as to why coho production is low. Much needs to be ascertain before drawing any concrete conclusions, other than one, that is no matter why the coho are in short supply, it is a fact that they are in deed low in numbers, and for that reason alone measures that can be instituted to ensure their continued survival are warranted.

In the case of the steelhead, the story is drastically different. There exists a tremendous amount of juvenile production in the lower reach and lagoon areas. So much so, that nothing appears to be limiting their population other than the presence of water, something which has until this year been in short order. For the last 60 plus years the lower Scott Creek area has been subject to periodic dewatering by agricultural operations, and as a result juvenile steelhead production has undoubtedly suffered here. One-plus size class production is only "fair," as compared to the rating system employed by Gilchrist (1982) in which juvenile steelhead productivity of streams in Santa Cruz County was determined by how many one-plus size juvenile steelhead were present in a particular drainage, with less than two per hundred feet equaling a very poor designation and 64 or more per hundred feet equaling an excellent rating. The "fair" rating based on the above rating system may reflect the chronic dewatering which has occurred in this area, thus hindering production of one-plus size juvenile steelhead.

When in a dewatered condition, ensuing water quality degradation inhibits juvenile steelhead from using the lagoon, as was documented in the summer of 1988 when a fish kill occurred which was attributable to poor water quality conditions. However, when water quality is good many juveniles will survive the summer months, and will be larger in size than those which exist in the stream environment at time of smoltification. Since survival at sea is largely a size dependent function, the larger the fish at time of out migration, the greater the adult return, and the larger the juvenile population, etc.

Another interesting factor also materialized during the seining operation of the lagoon. Many of the one-plus sized juvenile steelhead were still possessing the silvery color indicative of smoltification, even in late June. The lagoon mouth was still open, so conceivably out migration could still occur. Of additional interest was that many of the juvenile steelhead found in the lagoon which possessed the silvery smoltification color, were below the 90mm traditional size class cut-off for smolt determination. This may be indicative of the overall importance of a healthy lagoon environment, as genetic selectivity may have occurred whereby juveniles purposely move downstream at a smaller length for the sole purpose of reaching the lagoon, where food sources are usually more abundant, rather than out migrating all the way to the ocean since adult returns based on ocean migration at this size is at best poor.

Looking at the juvenile steelhead population by habitat type, excluding the lagoon, rifles appear to be the most productive in terms of young of the year production. This is not surprising as this is the habitat where the greatest quantity of juvenile young of the year steelhead are typically found. This habitat type provides good cover, cool temperatures, and a large food supply. It was interesting to find that juvenile young of the year from pool habitat types possessed on average larger weights than the other habitat types. However, looking at the micro habitat conditions it makes sense. In pool areas where overhanging vegetation is not in short supply, as is the case in Scott Creek, juvenile young of the year steelhead do not have to work as hard (i.e.spend less energy) to secure food. Therefore, much more of the nutrition from the food captured is available for growth, rather than in the expenditure of finding food as is the case with juvenile steelhead young of the year located in riffle environments. Also, the presence of juvenile steelhead in the 25 to 39 mm size class cohort suggests that a late spring spawn (i.e. April) occurred in the lower reach of Scott Creek. The lagoon mouth was still open well into June.

The one-plus juvenile steelhead population sampled in the reach is predominantly found in the flat water habitat type areas. This habitat type produced the greatest number of one-plus size steelhead, and possessed the largest average size length one-plus size juvenile steelhead as well. Pools areas are traditionally thought to provide the best overall rearing habitat for one-plus size juvenile steelhead. In this reach, this is apparently not the case. This is probably due to the presence of a significant amount of overhanging vegetation present in the flat water areas found in this reach. In order to maintain the flat water habitats at their present level, in terms of the amount of available fishery habitat that they can provide, a continuous flow of water to the lagoon will most definitely be required.

Protection of the instream environment requires additional out flows into the lagoon if survival of salmonids both in the lower stream reach and lagoon, based upon the spatial and water quality requirements of the salmonid fish species which reside there, is to occur. In the winter and early spring when spawning occurs the amount of fish that will survive into the summer months is based upon many factors, including but not limited to, water quality, forage supply, and quantity of available preferred habitat. Each of these factors is directly dependent upon quantity of surface flow. As flows recede, preferred habitat space decreases, the amount of suitable cover decreases, temperatures increase, food production decreases, and the ability of the stream to deliver food to fish also decreases. The result is that fish have to work harder to maintain themselves. Ultimately, if flows recede enough, many fish will die as the competition for the necessary rearing space, and available food supply become too great to overcome. The question here is how much flow reduction can the fishery resource in Scott Creek withstand before significant losses occur.

In Scott Creek two species, the juvenile life history stage of the coho salmon and the steelhead, will dictate the level at which protective measures will be implemented. For juvenile coho which have narrow habitat requirements, the principle concern is maintaining deep pools, and maintaining riffles in suitable shape to deliver food at sufficient levels to sustain coho residing in these pools. For steelhead, maintenance of all habitat types, i.e. riffles, pools and slack water habitats, at a sufficient level is of primary concern as steelhead show the capability of having broader, i.e. less stringent, habitat requirements than the coho, and are found abundantly in all habitat types.

A fishery resources report prepared by Jones and Stokes Associates (Jones & Stokes, 1986) to assess impacts related to the proposed Big Creek Hydroelectric Project concluded that from January 1 to June 30 minimum bypass flows necessary to protect instream habitat for both coho salmon and steelhead was 9 cfs. During the period July 1 to August 31, the minimum bypass level was determined to be 6 cfs. From September 1 to November 30 the minimum bypass flow was determined to be 4 cfs. These flow determinations were made from conclusions drawn from an instream flow evaluation (i.e. IFIM) conducted by Jones and Stokes Associates in 1986.

Big Creek is the largest tributary found in the Scott Creek watershed, and confluences with Scott Creek approximately 1 mile upstream of the effected reach. The Big Creek channel is narrower in width, and steeper in gradient, than the larger main stem reach of Scott Creek. It is therefore likely that the minimum bypass flows necessary to sustain the fishery habitat in the lower Scott Creek area are going to be greater than those needed in Big Creek. In comparison, the Department has required only an interim 2 cfs bypass, whereas a minimum bypass flow exceeding 6 cfs could be justified. A 2 cfs requirement by the Department was adopted in an attitude of fairness, both to the fishery resource and to the agricultural interests at stake (i.e. Mr. Ernest Bontadelli), taking into account the present surface flow levels, the status of the fishery resource present, as well as the ongoing agricultural irrigation needs.

Finally, it goes without saying that from the data collected it is clear that tremendous aquatic wildlife value exists in the lower reach of Scott Creek and the lagoon. To degrade these habitats by whatever means is a tragic loss, especially where water utilization is concerned, as thankfully, other methods for obtaining water for agricultural use are available (i.e. off-site winter storage) besides from well sources which when active can result in the dewatering of both the stream and/or lagoon. By allowing for a continuous flow of surface water into the lagoon, all species in all habitat types found within both the lagoon and lower Scott Creek stream reach will be protected.

CONCLUSION

1. The lower reach of Scott Creek, including the lagoon, can provide much in the way of aquatic habitat if surface flows in Scott Creek are not artificially eliminated through water diversions. Therefore, water quality in this area should be maintained in a healthy condition at a level to allow for salmonids to successfully rear in this location through the late summer and early fall months.

2. The belief that water draw from the wells located adjacent to the lower reach of Scott Creek, i.e. Ernie Bontadelli's and Cal-Poly's, are resulting in significant surface flow reductions in Scott Creek thus diminishing the aquatic habitat value of both the lower stream reach and the lagoon is substantiated by the stream flow monitoring survey results.

3. The interim minimum bypass flows that the Department adopted in 1992 appear to have provided a minimal level of aquatic habitat protection, both in the lower reach and lagoon. These levels will probably be in close proximity to that which will be adopted for long term minimum aquatic habitat protection upon the completion of the instream flow survey scheduled to be completed in 1993.

4. Once determined, the long term instream flow levels adopted for the protection of both the lower reach and lagoon, will necessitate all parties currently, and any parties proposing in the future to, diverting water from Scott Creek to abide by terms and conditions associated with the final determination. This will include the cessation of water diversions from Scott Creek, and tributaries, when surface flows in the lower reach receded to the minimum instream flow levels determined by the instream flow study.

5. Presently, the flow protection level can be set at three different levels to ensure protection of the instream and lagoon aquatic habitats. These levels include minimum, maximum, and mid-point and refer to the magnitude of habitat protection desired. Thus far the Department has requested only minimal instream flow protection. _If_ the coho salmon becomes a candidate species, or a fully protected threatened species, under the California Endangered Species Act, the flow protection level could increase from the minimum level to either the mid-point or the maximum level.

6. When stream flow concerns are accurately addressed, the availability of adequate spawning and rearing habitat is probably not the limiting factor for the coho population. The likely culprits effecting the coho population in Scott Creek are the lagoon constrictions, disease prevalence, i.e. BKD, and possibly interspecific competition with steelhead at the juvenile stage for available habitat and food procurement.

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APPENDIX A

HABITAT TYPING
Habitat types found within the lower reach of Scott Creek

(all measurements recorded in feet)

	Unit#	Type	Length	Width	Mean Depth	Area
Riffles:						
	001	LGR	60.2	15.0	0.5	451.5
	008	LGR	22.0	42.0	0.5	462.0
	010	LGR	53.0	19.4	0.4	411.3
	013	LGR	47.6	14.3	0.5	340.3
	015	LGR	73.0	24.2	0.4	706.6
	019	LGR	88.0	26.4	0.4	929.3
	022	LGR	31.2	18.0	0.6	1536.1
	027	LGR	122.3	31.4	0.4	1016.2
	034	LGR	65.9	19.0	0.4	500.8
	037	LGR	73.0	29.6	0.4	864.3
	039	LGR	63.5	33.6	0.4	853.4
	042	LGR	21.8	17.0	0.7	259.4
N=13						
Sum=			809.1	318.9	6.0	8668.2
Mean=			62.3	24.5	0.5	666.8
Flat Water Areas:						
	004	GLD	160.0	35.0	1.0	5600.0
	006	GLD	43.3	25.0	0.8	866.0
	011	GLD	90.8	19.2	0.7	1220.4
	017	GLD	99.0	28.6	1.5	4247.1
	023	GLD	28.0	24.6	0.8	551.4
	025	RUN	120.0	30.0	1.1	3960.0
	028	GLD	201.0	28.5	1.3	7447.1
	030	RUN	224.4	25.8	1.1	6368.5
	032	GLD	94.4	18.2	1.2	2061.4
	035	RUN	48.5	32.6	1.3	2055.4
	038	GLD	247.0	32.2	0.6	4772.0
	043	RUN	125.2	31.0	0.9	3493.1
N=12						
Sum=			1481.6	330.7	12.3	42643.5
Mean=			123.5	27.6	1.0	3553.6

APPENDIX A CONTINUED

HABITAT TYPING

Habitat types found within the lower reach of Scott Creek

(all measurements recorded in feet)

Pools:

	Unit#	Type	Length	Width	Mean Depth	Area
	002	MCP	60.2	15.0	2.5	4991.6
	003	MCP	73.0	27.6	1.2	2417.8
	005	MCP	73.0	30.1	1.0	2417.8
	007	MCP	41.0	23.8	1.0	975.8
	009	MCP	32.8	28.4	0.7	652.1
	012	LSBk	123.0	19.8	1.6	3896.6
	014	LSR	64.6	19.0	1.8	2209.3
	016	LSR	106.4	23.3	1.8	4462.4
	018	MCP	48.4	17.4	2.0	1684.3
	020	LSR	151.0	36.6	1.0	5526.6
	021	LSR	63.8	24.0	3.5	5359.2
	024	LSR	125.5	27.0	3.0	10165.5
	026	LSR	68.8	17.0	1.1	1286.6
	031	MCP	73.3	20.0	2.1	3078.6
	033	MCP	46.7	17.0	1.5	1190.9
	036	LSR	34.6	23.0	0.9	716.2
	040	DPL	47.0	25.2	1.0	1184.4
	041	MCP	42.1	15.0	1.2	757.8
N=18						
Sum=			1275.2	409.2	28.9	52972.7
Mean=			70.9	22.7	1.6	2942.9

Abbreviation definitions:

LGR = low gradient riffle
GLD = glide
RUN = run
MCP = mid channel pool
LSBk= lateral scour pool-bedrock formed
LSR = lateral scour pool
DPL = dammed pool

APPENDIX B

Fish population breakdown for habitat types within reach based on actual number of fish captured at randomly selected habitat types located within the reach, based on the actual number of fish caught method.

* = sites electroshocked, values listed are actual numbers based on the number of fish, by species, captured at these sites

Species composition determined by multiplying the total fish population by the percent total catch for each individual species, based upon the species composition which resulted from the sampling conducted at each habitat type (i.e. see Table 2).

	Unit#	SS	SH	SCP	SB	TOTAL	
Riffles:							
	001	0	87	76	0	163	*
	008	0	36	57	0	93	
	010	0	32	51	0	83	
	013	0	27	41	0	68	
	015	0	56	86	1	143	
	019	0	45	123	0	168	*
	022	0	27	41	0	68	
	027	0	121	189	1	311	
	029	0	80	125	1	206	
	034	0	39	62	0	101	
	037	0	45	76	2	123	*
	039	0	67	105	1	173	
	042	0	21	32	0	53	
N=13							
SUM=		0	683	1064	6	1753	
MEAN=		0	52	82	<1	135	
Flat Water Areas:							
	004	1	144	91	11	247	
	006	0	22	14	2	38	
	011	0	32	20	2	54	
	017	1	109	69	8	187	
	023	0	14	9	1	24	
	025	1	102	65	8	176	
	028	2	191	122	14	329	
	030	1	130	64	9	204	*
	032	0	53	34	4	91	
	035	0	53	34	4	91	
	038	1	124	78	9	212	
	043	1	123	97	10	231	*
N=13							
SUM=		8	1097	697	82	1884	
MEAN=		<1	110	58	7	157	

APPENDIX B CONTINUED

Fish population breakdown for habitat types within reach based on actual number of fish captured at randomly selected habitat types located within the reach, based on the actual number of fish caught method.

* = sites electroshocked, values listed are actual numbers based on the number of fish, by species, captured at these sites

Species composition determined by multiplying the total fish population by the percent total catch for each individual species, based upon the species composition which resulted from the sampling conducted at each habitat type (i.e. see Table 2).

	Unit#	SS	SH	SCP	SB	TOTAL	
Pools:							
	002	1	139	150	25	315	
	003	1	67	73	12	153	
	005	1	67	73	12	153	
	007	0	27	30	5	62	
	009	0	18	20	3	41	
	012	1	91	126	23	241	*
	014	0	61	67	11	139	
	016	1	124	135	22	282	
	018	0	47	51	8	106	
	020	1	154	166	28	349	
	021	1	149	161	27	338	
	024	2	282	306	51	641	
	026	0	36	39	6	81	
	031	1	85	93	15	194	
	033	0	33	36	6	75	
	036	0	37	13	0	50	*
	040	0	33	36	6	75	
	041	0	21	23	4	48	
N=18							
SUM=		10	1471	1598	264	3343	
MEAN=		<1	82	89	15	186	

APPENDIX C

Fish population breakdown for habitat types within reach based on estimated number of fish captured at randomly selected habitat types located within the reach, based on the linear regression analysis method.

* = sites electroshocked, values listed are actual numbers based on the number of fish, by species, captured at these sites

Species composition determined by multiplying the total fish population by the percent total catch for each individual species, based upon the species composition which resulted from the sampling conducted at each habitat type (i.e. see Table 2).

	Unit#	SS	SH	SCP	SB	TOTAL	
Riffles:							
	001	0	87	76	0	163	*
	008	0	39	61	0	100	
	010	0	35	54	0	89	
	013	0	29	44	0	73	
	015	0	59	92	1	152	
	019	0	45	123	0	168	*
	022	0	28	45	0	73	
	027	0	129	201	1	331	
	029	0	85	133	1	219	
	034	0	42	66	0	108	
	037	0	45	76	2	123	*
	039	0	72	111	1	184	
	042	0	22	34	0	56	
N=13							
SUM=		0	717	1116	6	1839	
MEAN=		0	55	86	<1	141	
Flat water areas:							
	004	1	164	104	12	281	
	006	0	25	16	2	43	
	011	0	35	23	3	61	
	017	1	124	79	9	213	
	023	0	17	10	1	28	
	025	1	115	74	9	199	
	028	2	218	138	16	374	
	030	1	130	64	9	204	*
	032	0	61	38	4	103	
	035	0	61	38	4	103	
	038	1	140	89	10	240	
	043	1	123	97	10	231	*
N=12							
SUM=		8	1213	770	89	2080	
MEAN=		<1	110	64	7	173	

APPENDIX C CONTINUED

Fish population breakdown for habitat types within reach based on estimated number of fish captured at randomly selected habitat types located within the reach, based on the linear regression analysis method.

* = sites electroshocked, values listed are actual numbers based on the number of fish, by species, captured at these sites

Species composition determined by multiplying the total fish population by the percent total catch for each individual species, based upon the species composition which resulted from the sampling conducted at each habitat type (i.e. see Table 2).

	Unit#	SS	SH	SCP	SB	TOTAL	
Pools:							
	002	1	161	175	29	366	
	003	1	78	84	14	177	
	005	1	78	84	14	177	
	007	0	32	34	6	72	
	009	0	21	23	4	48	
	012	1	91	126	23	241	*
	014	0	71	78	13	162	
	016	1	144	156	26	327	
	018	0	54	59	10	123	
	020	1	178	194	32	405	
	021	1	173	188	31	393	
	024	2	328	355	60	745	
	026	0	41	45	8	94	
	031	1	99	108	18	226	
	033	0	38	42	7	87	
	036	0	37	13	0	50	*
	040	0	38	42	7	87	
	041	0	25	27	4	56	
N=18							
SUM=		10	1687	1833	306	3836	
MEAN=		<1	94	89	17	213	

APPENDIX D

Fish population estimates for individual habitat units

Unit#	Type	1P (removal	2P	3P patterns,	4P P=pass)	5P	Tot. Catch	POP. Est.
001	LGR	71	61	17	12	2	163	168
012	LSBk	131	71	39	n/a	n/a	241	285
019	LGR	100	44	24	n/a	n/a	168	187
030	RUN	116	64	24	n/a	n/a	204	228
036	LSR	31	16	6	n/a	n/a	53	57
037	LGR	79	33	11	n/a	n/a	123	129
043	run	126	73	32	n/a	n/a	231	267

Unit#	Type	CS	LCI	UCI	ER	CP
001	LGR	13.6	163	174	0.04	0.50
012	LSBk	0.02	254	316	0.05	0.46
019	LGR	0.36	170	204	8.43	0.53
030	RUN	1.35	209	247	0.05	0.53
036	LSR	0.37	53	64	3.69	0.57
037	LGR	0.33	123	137	3.94	0.05
043	run	0.85	241	293	13.1	0.05

Abbreviation definitions:

CS = chi square
LCI= population estimate-lower confidence interval
UCI= population estimate-upper confidence interval
ER = population estimate standard error
CP = capture probability