# FISHERY MANAGEMENT PLAN

# FOR PULGAS LAKE

# CAMP PENDLETON, CALIFORNIA

AFR-FRO-95-01

PREPARED FOR:

ASSISTANT CHIEF OF STAFF, ENVIRONMENTAL SECURITY
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## DISCLAIMER

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# INTRODUCTION

The Marine Corps Base, Camp Pendleton, California, (Base) maintains a natural resource program for conserving and managing fish and wildlife resources under their jurisdiction. Providing quality recreational opportunities for military personnel and their families is an important component of natural resources management activities on the Base. Although active wildlife management programs for promoting wildlife related activities exist, fishery related efforts have been minimal.

The Assistant Chief of Staff, Environmental Security (AC/S, ES) has recognized the need for coordinated, scientifically based fishery management planning and has funded the U.S. Fish and Wildlife Service (USFWS) through its Coastal California Fish and Wildlife Office to begin developing fishery management options for selected Base waters. Pulgas Lake is a small body of freshwater on Camp Pendleton which offers the potential of significant recreational opportunities with relatively easy access to Base personnel. This potential makes it a logical choice to be promoted and managed as a "trophy" fishing experience to complement its other aesthetic values.

The specific purposes of USFWS activities on Pulgas Lake are to describe the past and current fishery resources of the lake in regards to the suitability of the lake for fish populations and to provide a plan (options) for managing its recreational fishing. A major emphasis of the study was to collect contaminant data to help determine the suitability of the lake as a sport fishery. The results of this data were reviewed by State of California Department of Human Health Services in regards to any human health concerns associated with harvesting of fish from the lake. Base personnel investigated an "unauthorized release" into the lake and reported the observation of a blue-green material on the water surface in 1991. This incident led them to do some preliminary contaminant testing. The lake was immediately closed to all recreational uses to protect the users. These preliminary testing results were inconclusive and thus did not warrant opening the lake for recreation. More aggressive contaminant testing has been done as part of this study to determine if the lake can be reopened to recreational uses, including some level of sport fishing.

A comprehensive fishery management plan (FMP) is detailed in this report in anticipation of a catch and release fishery, based in part on recommendations from the State of California Department of Human Health Services.

The appropriateness of USFWS involvement on Camp Pendleton is delineated through the authorizations granted by the Sikes Act (P.L. 86-797) as amended and the Fish and Wildlife Coordination Act (P.L. 85-624) as amended. The work is also consistent with the USFWS Recreational Fisheries Policy.

## STUDY AREA

Camp Pendleton Marine Corps Base (CPMCB) is located along the southern California coastline approximately 84 kilometers (km) north of San Diego (Figure 1). The boundaries of the Base enclose approximately 50,586 hectares of a variety of habitats including; costal strand, salt water estuary/fresh water marsh, riparian woodland, coastal sage scrub (≈35,000 acres), oak woodland/savannah, annual and perennial grassland, and chaparral. Coastal plain areas of southern California exhibit a subtropical climate characterized by warm, dry summers, moderate winters, and frequent fog. Temperatures are moderate, with an average monthly maximum temperature of 23 degrees centigrade(°C). The coldest month is January and the warmest is September. Temperatures are rarely freezing and few days exceed 32 °C. Precipitation averages 34.5 centimeters (cm) (13.6 inches) per year, with most rain (84%) occurring between November and March. January is the wettest month, while July is the driest.

The U.S. Government acquired the land (and its associated water rights) from the Rancho Santa Margarita, a large cattle ranch. This land acquisition took place in 1942-1943 for use as a military installation.

Pulgas Lake is a manmade impoundment of about three surface hectares (7.4 surface acres) located in Piedra de Lumbre Canyon. Pulgas Lake is formed by an earthen dam that was constructed with a concrete overflow spillway in 1948. The lake retains runoff water from three small unnamed headwater drainages (Figure 2). Since runoff is the only source of water, Pulgas Lake water level fluctuates according to annual weather conditions.

Pulgas Lake has primarily been utilized as a training site for various military training exercises and recreation for military personnel. Full capacity of the lake is estimated to be 147,600 cubic meters (120 acre feet). The lake can be characterized as a shallow, productive pond, with a high shoreline to volume ratio. Maximum depths occur along the center of the lake and are slightly over 6 meters (m). Surface water temperatures range from about 5° C in the winter, to 30° C in summer, although comprehensive year-round data is lacking.

Pulgas Lake is an important recreational area on Camp Pendleton. It offers fishing, bird watching, picnicking, boating, jogging, and other recreational opportunities. Many shorebirds use the lake because of its available food supply and protected inland location. Some waterfowl may nest and rear young in the lake area but their numbers are unquantified. The lake also provides habitat for other bird species and numerous mammals.

Fish species known to be present or that have been identified in the past include: largemouth bass (*Micropterus salmoides*); black crappie (*Pomoxis nigromaculatus*); bluegill (*Lepomis macrochirus*); redear sunfish (*Lepomis microlophus*); channel catfish (*Ictalurus punctatus*); brown bullhead (*Ictalurus nebulosus*); white crappie (*Pomoxis annularis*); green sunfish (*Lepomis cyanellus*); and rainbow trout (*Oncorhynchus mykiss*). The dominant aquatic plant present is rush (*Scirpus sp.*).

A FMP was developed in 1968 for Camp Pendleton as a cooperative effort by Camp Pendleton, California Department of Fish and Game (CDFG), and USFWS. The work associated with this FMP was the first biological sampling documented in Pulgas Lake.

Fish stocking history for Pulgas Lake dates back to an initial planting in 1960. Warmwater fish species were stocked at least twice since 1960 and many species are present today. Rainbow trout were stocked in Pulgas Lake from 1969 to 1976 but are not believed to have survived throughout the years.

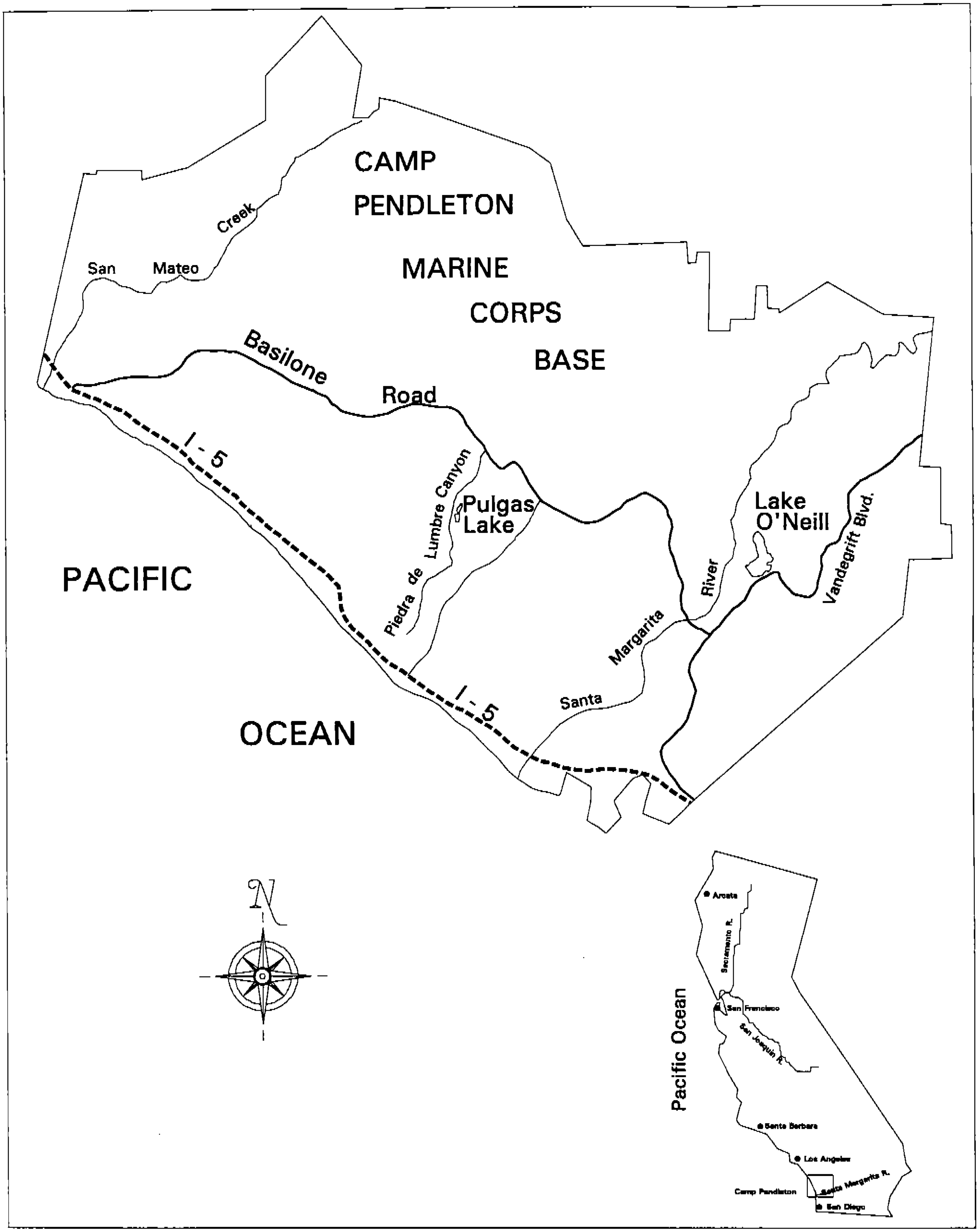


Figure 1. Camp Pendleton Marine Corps Base map and location within California.

Figure 2. Headwater drainages which flow into Pulgas Lake, which is shown in lower left corner of photo.

## METHODS

### Water Quality

CPMCB's AC/S, ES maintains historical water quality records for Pulgas Lake. These records were reviewed and summarized in this report. Methods used to obtain these past results were not reported by the original authors.

Current water quality data for Pulgas Lake were obtained by sampling at two sites in June 1994. Water samples were collected at the surface and on the bottom using a Lamotte water sampler. Bottom samples were collected allowing clear lake water only to enter the sampler without any muddy bottom debris. Water samples were immediately taken to the Quality Assurance Laboratory in San Diego for analysis. Each sample was tested for a variety of factors, including hardness, nitrate-nitrogen, nitrite-nitrogen, ammonia-nitrogen, total-phosphate-P, ortho-phosphate-P, total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity, bicarbonate, silicon, sulfate and carbon dioxide. A complete list of specific analyses requested and the analysis methods utilized by the lab are shown in the lab report (Appendix A).

Temperatures and dissolved oxygen (D.O.) levels were taken by USFWS personnel utilizing a YSI Model 51B probe. These measurements were taken on the surface, at each meter depth and on the bottom. Measurements were taken at two sites in June 1994 and three sites in July and September 1994.

A Cole-Parmer DSPH-1 handheld meter was used to measure pH and conductivity on the surface and the bottom. Conductivity values were standardized to ambient water temperature with the formula, $\delta_a=\delta_s/\langle 1.02^{(T_s-T_A)}\rangle$ where, $\delta_a$ = ambient conductivity (micromhos/cm); $\delta_s$ = specific conductivity (micromhos/cm); $T_s$ = instrument calibration temperature (25° C); and $T_A$ = ambient temperature (°C). Samples were collected with the LaMotte water sampler at two sites in June 1994 and then expanded to three sites in July and September 1994.

Depth sounding and surface area measurements were collected by USFWS personnel using a 65 meter Keson fiberglass measuring tape.

The Training Scheduling Office on Base provided information on the type of military training activities that occur in the training areas "Papa One and Papa Two". These two areas encompass Pulgas Lake and its associated drainage upstream of the lake.

Contaminants

CPMCB's AC/S, ES maintains historical water contaminant records for Pulgas Lake. These data were reviewed and are summarized in this report.

All samples for 1994 water contaminant testing were collected at the same three sites previously identified for 1994 water quality testing. All samples were immediately taken to the Quality Assurance Laboratory in San Diego for analysis of residual chlorine, methyl blue active substance (MBAS), formaldehyde, copper, BOD, coliform and fecal coliform. A complete list of specific analysis methods used by the lab are shown in the lab report (Appendix B).

Water contaminant samples were collected on the surface and on the bottom using a Lamotte water sampler.

Sediment samples were collected in the same areas previously identified for testing using a petite ponar sampler. All samples were composites of three subsamples taken within a 20 m radius of each collection site. Each subsample was placed in a stainless steel bowl lined with aluminum foil with the dull side of the foil exposed to the sample. These subsamples were thoroughly mixed to a uniform consistency using a large plastic spoon also covered with aluminum foil. Equal parts of each subsample were then mixed in an additional bowl resulting in the final sediment sample to be tested. All equipment was rinsed in lake water and wrapped with new aluminum foil after each sample was collected. All sediment samples were tested for Title-22 metals, total petroleum hydrocarbons (TPH), organochlorine pesticides and PCB's.

Largemouth bass, black crappie, bluegill and channel catfish were collected for contaminant testing of Title-22 metals. These fish were captured by use of either a gill net or conventional rod and reel methods. Larger size fish were chosen for fillet analysis and immediately prepared with skin removed. Fillet samples were taken from the fishes right side unless its size warranted sampling both fillets of the same fish. Smaller sized fish were chosen to be analyzed as whole fish samples.

The State of California Department of Human Health Services used these heavy metal test results of fish fillets to make recommendations in regards to the suitability of Pulgas Lake fish for human consumption (official documentation is pending).

Biological Collections

Fish sampling was accomplished by use of gill nets and conventional rod and reel. Each net was 1.8 m high and 38.1 m long with 5 panels, each 7.6 m long. The stretched mesh graduated in size with each panel; 2.5 cm, 3.8 cm, 5.0 cm, 6.4 cm, and 7.6 cm. Each net had a weighted bottom line and a floating top. The end of the net with the smallest mesh was secured to the shore and stretched (perpendicular to the shore) into the lake. Site selections were based on the probability of catching fish and the length of time since the area was last sampled. Because fish learn to avoid nets that are set in the same area on consecutive days, nets were set in areas that had not been sampled for at least two days. Rod and reel sampling methods used crank bait on ultra light tackle at locations all around the lake.

Two gill nets were fished both day and night on June 8 to 11, July 20 to 22 and September 20 to 23, 26, 27, 1994. The nets effectively reached from the bottom to within 0.5 to 1.5 m of the surface. Net sample sites are shown in Figure 4. Nets were fished from just before dark (around 1700 hours) until about 0830 and reset at 0930 and fished until about 1600 hours each day.

Nets were retrieved in the morning and evening starting at the end farthest from the shore. Fish were removed from the net and immediately placed in a container of fresh pond water. After all fish were removed from the net we measured total length (mm) and weight (g) and took a scale sample. Live fish were released back into the lake immediately after measurements were taken.

Fish length data was entered into a computer data base. These data were used to create length frequency histograms to aid in age class determinations.

Scales were taken from the first ten fish of each species within every 10 mm size group (i.e. 60 to 69 mm, etc.). Scales were cleaned and mounted on slides with cover slips. A microfiche card reader was used to magnify the scale image for visual interpretation of age for individual fish.

We chose the method of proportional stock density (PSD) to measure the quality and relative balance of the fishery community. PSD is measured by dividing the number of quality-size fish by the number of stock-size fish. Minimum quality length falls within 36 to 41% of the world record length. Minimum stock length falls within 20 to 26% of the world record length (Flickinger, 1985).

## RESULTS AND DISCUSSION

### Water Supply

Three small drainages supply all water inflow (Figure 2). Typically, fall and winter precipitation (Figure 3) fills Pulgas Lake to capacity by April. In 1994, the lake remained at high water line capacity until mid-June. Evaporation caused the lake level to drop 30 cm or 6% of its total volume from June 11 to July 20, 1994. Another 34 cm or 7% of the total volume was lost to evaporation from July 22 to September 20 1994. Annual rains refill the lake to capacity as part of the normal cycle. This cycle is beneficial and will support a healthy fishery as long as the annual rains continue to replenish the lake water level. Problems may occur if and when a severe multi-year drought condition occurs.

The near-shore waters of Pulgas Lake are conducive to the growth of aquatic vegetation along the shoreline. Considerable growths of rush (*Scirpus sp.*) are present with smaller amounts of cattail (*Typha sp.*) and burrhead (*Echinodorus sp.*) intermixed. A map of the lake, aquatic plant distribution, and significant study areas are shown in Figure 4.

Rush, which surrounds the entire lake, is the dominant plant species present. These rushes extend out into the lake as much as eight meters in some areas and in water one to two meters deep. This provides excellent structural habitat for fish of all sizes and in areas all around the lake. Smaller sized fish can use the densest part of the vegetation for cover while the larger fish can hide along the edges to feed on the smaller fish when they venture out of their safe havens.

### Water Quality

Historical water quality data collected in Pulgas Lake are limited and all are surface water samples. Collections were made on eight separate occasions in 1973; July 30, 1980; and January 16, 1985. The resulting values are shown in Table 1. These data allow us to view a very narrow window of Pulgas Lake water quality in past years with limited comparison to current results.

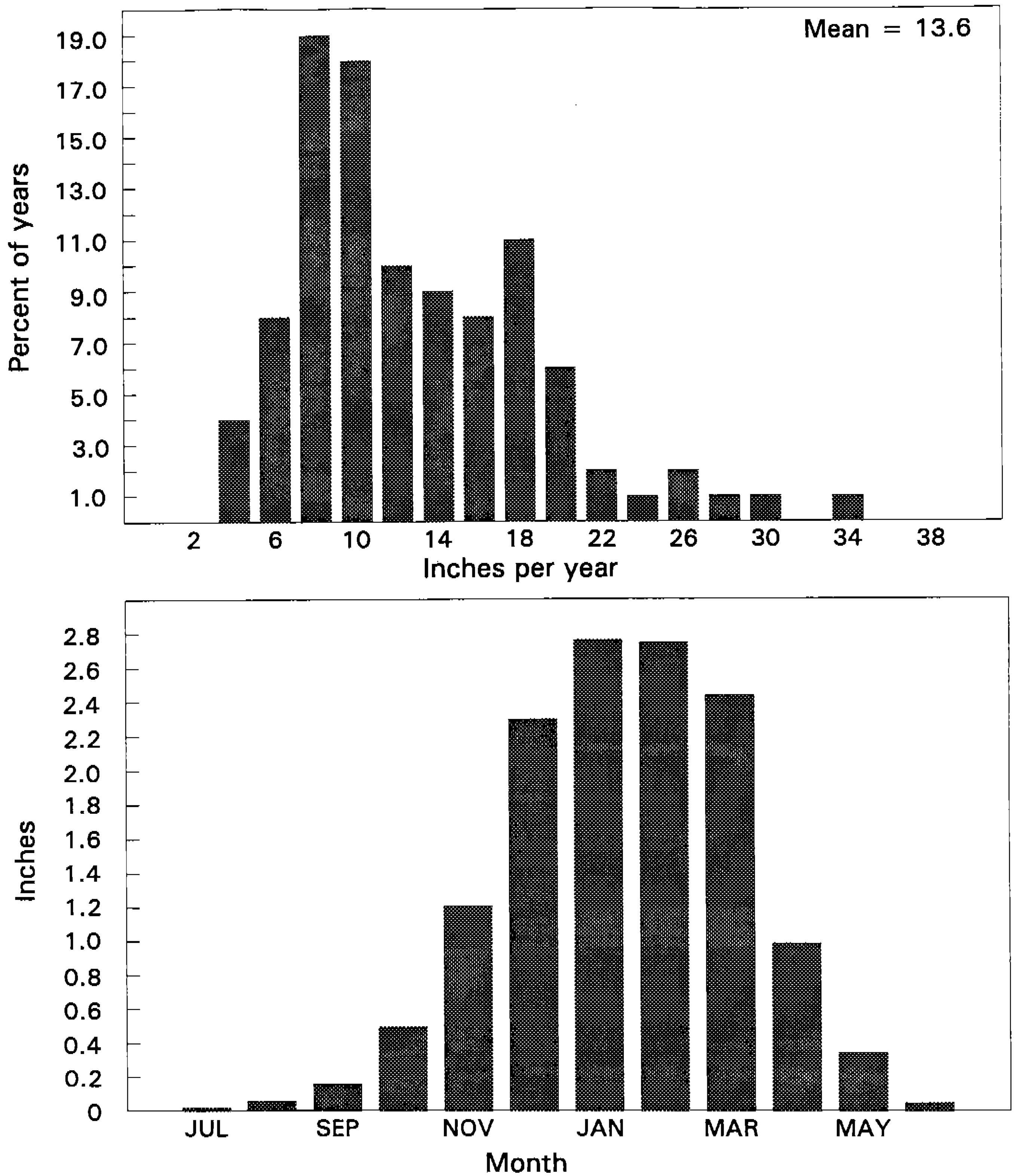


Figure 3. Mean local precipitation collected near Lake O'Neill from 1876-1990. The bottom graph is the average monthly precipitation and the top graph is total annual precipitation.

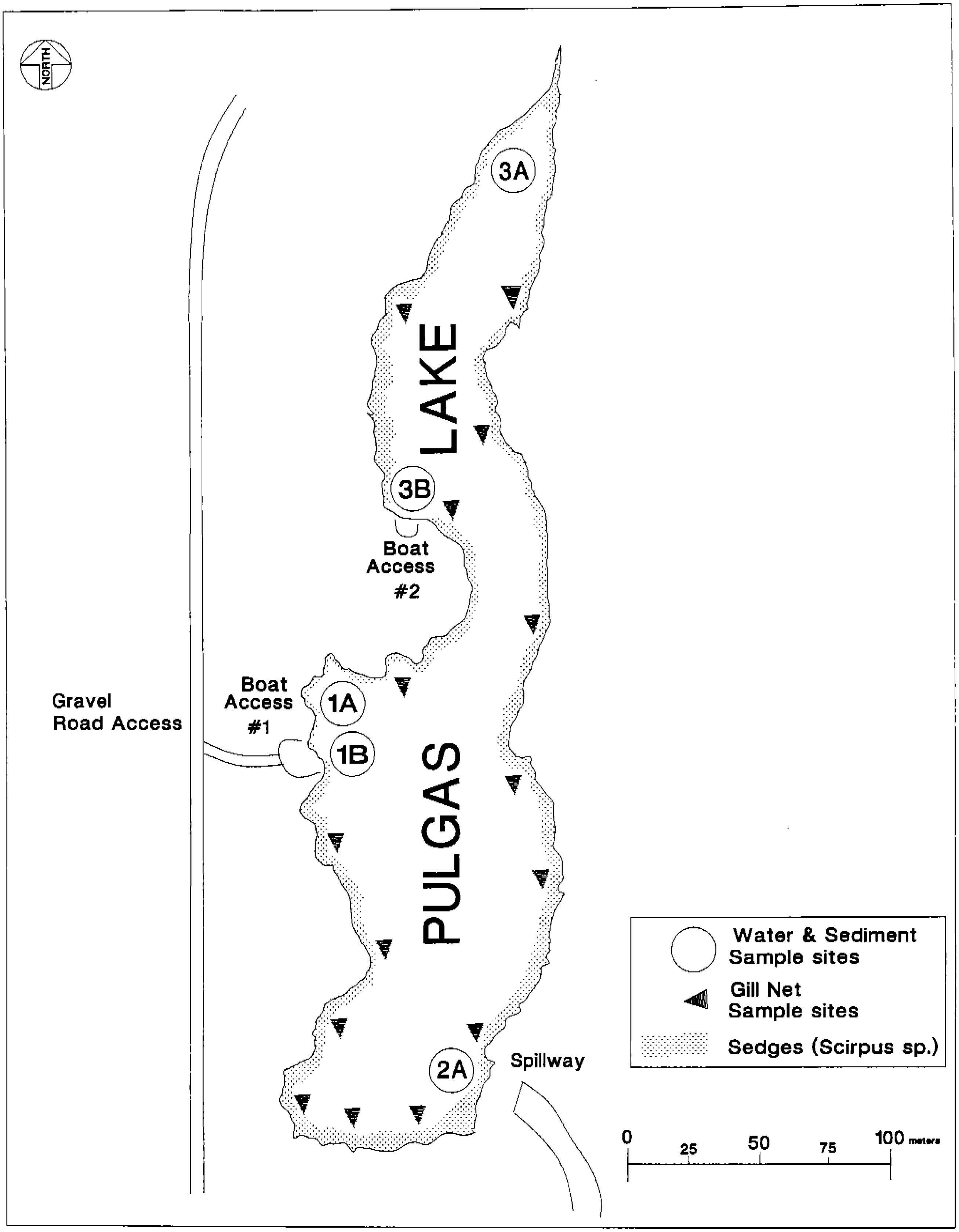


Figure 4. Pulgas Lake sample sites and aquatic vegetation areas identified.

Table 1. Historical water quality data collected in Pulgas Lake. Location of sample sites and units of measure were unavailable.

**1973**

| | | |
|---|---|---|
| **June 19** | | |
| Temperature (surface @1500 hours) | 26.1° C | |
| Dissolved Oxygen | 9.0 mg/L | |
| **June 20** | | |
| Temperature (surface @1000 hours) | 24.4° C | |
| Temperature (surface @1500 hours) | 26.7° C | |
| Dissolved Oxygen | 8.0 mg/L | |
| **June 21** | | |
| Temperature (surface @0830 hours) | 25.5° C | |
| **July 26 & 26** | | |
| Temperature (surface @1000 hours) | 24.4° C | |
| Dissolved Oxygen | 9.0 mg/L | |
| Turbidity (JTU) | 8 | |
| pH | 8.3 | |
| Nitrate-Nitrogen | 0.06 | |
| Phosphate | 0.2 | |
| **September 28** | | |
| Temperature (surface @0900 hours) | 21.9° C | |
| Dissolved Oxygen | 9.0 mg/L | |
| **October 15** | | |
| Temperature (surface @1600 hours) | 20.5° C | |
| **December 3** | | |
| Temperature (surface @1130 hours) | 15.0° C | |
| **December 6** | | |
| Temperature (surface @1010 hours) | 13.3° C | |
| **December 11** | | |
| Temperature (surface @1500 hours) | 13.3° C | |

**1980**

| **July 30** | | |
|---|---|---|
| **Site** | **A** | **B** |
| Depth (feet) | 23.5(7.2m) | |
| Temperature | 21° C | 25° C |
| pH Field/Lab | 7.8/7.75 | 7.8/7.98 |
| Total Dissolved Solids | 564 | 596 |
| Specific Conductivity | 880 | 880 |
| Suspended Solids | 5.7 | 27.9 |
| Total Hardness | 272 | 220 |
| P Alkalinity | 22 | 18 |
| M Alkalinity | 304 | 252 |
| Chlorides | 110 | 116 |

**1985**

| **January 16** | |
|---|---|
| Temperature C | 11.0 |
| pH | 8.0 |
| Dissolved Oxygen (ppm) | 12.1 |

Past results and the literature often report values as mg/L or ppm. This difference in reporting is irrelevant since mg/L is equal to ppm.

Current water quality results from samples taken in Pulgas Lake on June 9, 1994 are shown in Table 2. The bottom sample taken at site #1 was contaminated with substrate material (suspended) and thus cannot be compared with other values. Water temperatures, dissolved oxygen, ph and conductivity levels from samples taken on June 9, July 21 and September 21, 1994 are shown in Table 3.

Historical water temperatures ranged from 11.0° C in January 1985 to 26.1° C in June 1973 (Table 1). Surface and subsurface temperatures in July 1994 reached 28° C (Table 3), exceeding trout tolerance limits. Trout can tolerate temperatures in the neighborhood of 26° C, but prefer 10° to 16° C (Piper, et. al., 1986). Preferred temperatures for largemouth bass (24° to 29° C), bluegill (16° to 27° C), black crappie (18° to 29° C), and channel catfish (21° to 27° C) indicate Pulgas Lake summer temperatures should be favorable for these species (Reininger, 1984). Water temperatures observed at all sample sites were suitable for warmwater fish but were quite marginal for trout.

D.O. is critically important in determining the suitability of waters for fish. Minimum limiting D.O. concentrations for each species' survival depends on a wide variety of physical and chemical factors. The minimum limiting D.O. concentration is not an absolute value. It is dependent upon temperature, atmospheric pressure and the related metabolic rate of the fish. The inherent metabolic rate associated with age, health of the fish, especially health of gill tissue through which oxygen must diffuse, activity of the fish and subsequent oxygen requirements to sustain that activity (Post, 1987) are critically important.

Water surface D.O. readings taken prior to this study (Table 1) were saturated at the given ambient temperatures. No bottom D.O. samples were reported prior to this study.

In 1994 D.O. concentrations measured in surface waters were near saturation at 5.4 to 6.9 ppm (Table 3). These midday D.O. levels are suitable for warmwater fish species. However, subsurface D.O. levels of 0.2 to 4.8 ppm measured in September are well below saturation at the reported temperatures (24.5°C & 25.0°C, respectively) and could lead to slowed growth, basic survival, or even death for some fish. A prolonged D.O. concentration of 0.2 ppm also has the potential to constrict the available habitat, as well as kill fish. Post (1987) lists a D.O. concentration of 5.5 ppm for summer months and 4.7 ppm in winter months for survival of all individuals of largemouth bass and black crappie. Swingle (1969) suggests that D.O. concentrations greater than 5 ppm are in the desirable range for warmwater species, concentrations in the 1 to 5 ppm range are survival levels for warmwater fish but growth is slowed with prolonged exposure. Concentrations below 1 ppm are considered lethal if exposure is prolonged. The lowest safe level for trout is approximately 5 ppm (Piper et al., 1986).

Historically, pH measurements taken by Base personnel in the lake have ranged from 7.8 to 8.3 during the period 1973-1985 (Table 1). However, measurements were infrequent and were made during summer months, except for one reading of 8.0 in January 1985.

The 1994 pH levels observed in the lake ranged from 5.9 to 7.3 with a mean of 6.6 (Table 3). These pH levels are slightly acidic but are within suitable ranges for warmwater and coldwater fish species. The lower pH values ranged from 5.9 to 6.5 which are only slightly below the lowest ideal value of 6.5. These measurements are well within the ideal range for freshwater fish.

Table 2. Pulgas Lake water quality parameters tested at two sites on June 10, 1994.

| Measurement | Units | #1 Top | #1 ** Bottom | #2 Top | #2 Bottom |
|---|---|---|---|---|---|
| Total Alkalinity | mg/L | 265.00 | 254.00 | 258.00 | 263.00 |
| Bicarbonate ($HCO^{-3}$) | mg/L | 265.00 | 254.00 | 258.00 | 263.00 |
| BOD | mg/L | 13.50 | 14.00 | <3.00 | 3.00 |
| COD | mg/L | 16.00 | 185.00 | 15.00 | 14.00 |
| Hardness | mg/L | 365.00 | 421.00 | 328.00 | 343.00 |
| Ammonia-Nitrogen | mg/L | <0.10 | 0.34 | <0.10 | <0.10 |
| Nitrate-Nitrogen | mg/L | 0.47 | 0.67 | 0.46 | 0.52 |
| Nitrite-Nitrogen | mg/L | <0.50 | <0.50 | <0.50 | <0.50 |
| Ortho-Phosphate-P | mg/L | <0.10 | 0.28 | <0.10 | <0.10 |
| Total-Phosphate-P | mg/L | <0.10 | 2.52 | <0.10 | <0.10 |
| TDS | mg/L | 694.00 | 343.00 | 675.00 | 681.00 |
| Chloride (Cl) | mg/L | 139.00 | 137.00 | 147.00 | 145.00 |
| Sulfate ($SO_4^{-2}$) | mg/L | 135.00 | 146.00 | 129.00 | 137.00 |
| Carbon Dioxide ($CO_2$) | mg/L | 7.00 | 12.00 | 7.00 | 9.00 |
| Silicon | mg/L | 2.70 | 45.10 | 2.41 | 2.56 |

BOD = Biological Oxygen Demand
COD = Chemical Oxygen Demand
TDS = Total Dissolved Solids
** = Values not valid due to contamination

Table 3. Pulgas Lake temperature, dissolved oxygen (D.O.), pH and conductivity data collected in 1994.

| Measurement | Units | June 10 #1 | June 10 #2 | June 10 #3 | July 21 #1 | July 21 #2 | July 21 #3 | September 21 #1 | September 21 #2 | September 21 #3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample Time: | | 1150 | 1225 | NT | 1530 | 1600 | 1630 | 1500 | 1530 | 1610 |
| Bottom Depth | (meters) | 5.2 | 3.0 | NT | 3.0 | 2.75 | 3.0 | 2.75 | 2.25 | 2.5 |
| Surface Temp. | °C | 24.25 | 24.0 | NT | 27.0 | 28.0 | 27.0 | 26.0 | 26.0 | 25.0 |
| 1.0 m Temp. | °C | 24.25 | NT | NT | NT | NT | NT | 25.0 | 26.0 | 25.0 |
| 2.0 m Temp. | °C | 24.0 | NT | NT | NT | NT | NT | 25.0 | 25.5 | 24.5 |
| 3.0 m Temp. | °C | 24.0 | 23.5 | NT | NT | NT | NT | NA | NA | NA |
| Bottom Temp. | °C | 20.0 | 23.5 | NT | 27.0 | 27.0 | 26.5 | 24.5 | 25.0 | 24.5 |
| Surface D.O. | mg/L | 6.2 | 6.0 | NT | 5.8 | 6.4 | 6.2 | 6.4 | 6.9 | 6.2 |
| 1.0 m D.O. | mg/L | 6.0 | NT | NT | NT | NT | NT | 6.0 | 6.6 | 6.2 |
| 2.0 m D.O. | mg/L | 6.0 | NT | NT | NT | NT | NT | 6.1 | 6.6 | 5.4 |
| Bottom D.O. | mg/L | 5.5 | 5.6 | NT | 5.6 | 6.2 | 6.0 | 4.2 | 0.2 | 4.8 |
| Sample pH | (Surface) | 7.3 | 7.3 | NT | 6.7 | 6.7 | 6.7 | 6.3 | 5.9 | 6.2 |
| Sample pH | (Bottom) | 7.3 | 7.3 | NT | 6.5 | 6.5 | 6.8 | 6.3 | 6.3 | 6.2 |
| Conductivity (ambient) | μmho/cm | | | | 1086 | | | 1150 | 1160 | 1150 |

NA = Not Applicable
NT = Not Taken

The Environmental Protection Agency (EPA) recommends that the pH range be 6.5-9.0 to protect aquatic life (as quoted in MacDonald, et al., 1991). Post (1982) suggests a range of 6.2 to 9.2 for fish survival. Emergence of some aquatic insects, the primary food source for smaller fish, declines below pH 6.5. MacDonald et al. (1991) also state that a decline in pH can increase the mobility of heavy metal contamination.

The only conductivity measurement taken prior to this study was a reading of 813 (units unknown) in July 1980 (Table 1). Conductivity ranged from 1086 to 1160 micromhos/cm during 1994 sampling (Table 3). Although these values are moderately high they pose no problems for fish. However, we did encounter sampling problems, our electrofishing unit would not operate under these conductivity levels.

Post (1982) suggests that waters with 150-1500 μmho/cm conductivity at 25° C should have relatively good production. Boyd (1979) reports naturally occurring waters as having conductivities of 20 to 1,500 μmho/cm and distilled water with a value of 1 μmho/cm. Nielson and Johnson (1983) maintain that normal conductivities are in the range of 100-500 μmho/cm.

Crowded hatchery type conditions are most often waters that are associated with problems of high levels of nitrogen. Levels of ammonia-nitrogen, nitrate-nitrogen and nitrite nitrogen in the lake averaged <0.10 mg/L, 0.48 mg/L and <0.5 mg/L respectively in 1994 (Table 2). Results from site #1 bottom sampling are invalid due to contamination. The literature suggests that these levels of concentration are suitable for fish. However, since all nitrite values were below the level of detection (<0.5) we are unable to fully evaluate the suitability of these nitrite values for fish. There were no historical nitrogen values found in Base records.

Excessive levels of ammonia can be toxic to fish but ammonia toxicity should not be a problem in natural waters with pH below 8.0 and ammonia-nitrogen less than 1.0 mg/L (Sawyer and McCarty, 1978). Piper et al. (1986) suggests healthy water supplies should have nitrate levels in the 0 to 3.0 ppm range. Nitrite-nitrogen is the most toxic form of nitrogen for fish. Piper also states that nitrite levels of 0.15 ppm can stress yearling trout and kills them at 0.55 ppm. He goes on to say that 29 ppm nitrite can kill up to 50% of channel catfish in 48 hours.

Carbon dioxide ($CO_2$) levels ranged from 7.0 to 9.0 mg/L from samples taken in June 1994 (Table 2). These values are moderately high but within the acceptable range to support a fish population. No measurements of $CO_2$ were recorded in past years.

Fish can sense small differences in free $CO_2$ concentrations and apparently attempt to avoid areas with high $CO_2$ levels (Hoglund, 1961). High concentrations of $CO_2$ interfere with respiration (Basu, 1959). Boyd (1990) states that 10 mg/L or more of $CO_2$ may be tolerated, provided D.O. concentrations are high. Waters supporting good fish populations normally contained less than 5 mg/L of free $CO_2$ (Ellis 1937). Piper et al. (1986) suggests that $CO_2$ values in the range 0 to 15 mg/L are suitable for a warmwater fish hatchery water supply.

Phosphates represent important nutrients in aquatic systems and can often be a limiting factor. Historical records report one phosphate value of 0.2 taken in July of 1973 (Table 1). Phosphate levels in lake samples collected by USFWS in 1994 were all under the detectable level <0.10 mg/L (Table 2), except for the contaminated #1 bottom sample. Literature suggests that the detection level of 0.10 mg/L is too high to fully evaluate the suitability of phosphate levels for fish. However, values are within normal concentrations for naturally occurring waters.

Piper et al. (1986) states that soluble orthophosphate concentrations are usually no greater than 5 to 20 $\mu g/L$ and seldom exceed 0.1 mg/L even in highly eutrophic waters. Piper also states that concentrations of total phosphorus in natural waters seldom exceed 1 mg/L. Post (1982) stated that phosphate levels greater than 0.5 ppm may produce excessive plant growth. He also suggests that for waters to be productive, they should have phosphate levels greater than 0.01 ppm. Boyd (1984) recorded average values of ortho-phosphate and total-phosphate from a sample of 34 wooded watershed ponds as 0.007 mg/L and 0.092 mg/L respectively. EPA suggests that phosphate should not exceed 0.025 mg/L for any lake or reservoir. If streams enter the lake phosphate should not exceed 0.050 mg/L (McDonald, et al., 1991). Heavy algal blooms have been observed in lakes where phosphate concentration exceeds 0.03 mg/L (Bell, 1990).

COD is a measure of organic matter and often permits an estimation of the BOD. BOD of pond waters results from the respiration of plankton and bacteria. Ranges of COD and BOD values from samples taken by USFWS personnel in June 1994 were 15.0 to 16.0 mg/L and <3.0 to 13.5 mg/L respectively (Table 2). These values are conducive to supporting a good fish population for an extensively managed system. No historical COD or BOD values were found.

BOD values depend upon temperature, density of plankton, concentration of organic matter and related factors, but Boyd (1973b) demonstrated that a close positive correlation existed between COD and BOD. Observed COD values ranged from 37.1 to 83.2 mg/L from May to September in two channel catfish ponds (Boyd et al., 1978b). A COD level of 30.2 ppm was reported for an earthen catfish rearing pond while draining by Boyd (1978).

Total hardness values were recorded in July 1980 with values of 272 and 220 mg/L (mean = 246 mg/L) (Table 1). Total alkalinity and hardness values, in 1994, ranged from 258 to 265 mg/L and 328 to 365 mg/L (Table 2) respectively with averages of 262 and 345 mg/L respectively. These are healthy values for a freshwater pond fishery.

Alkalinity and hardness imply similar things about water quality. Total alkalinity is the concentration of bases in water while hardness is the concentration of alkaline earth ions such as, calcium ($Ca^{+2}$), potassium ($K^{+}$), magnesium ($Mg^{+2}$), etc. Both are expressed as mg/L of calcium carbonate ($CaCO_3$). Piper et al. (1986) also states that fish grow well over a wide range of alkalinities and hardness, but values of 120 to 400 ppm are optimum. Natural waters that contain 40 mg/L or more total alkalinity for biological purposes are considered hard waters (Moyle, 1945; Mairs, 1966). Sawyer and McCarty (1967) categorize waters with total hardness in the range of 150-300 mg/L as hard. At very low alkalinities, water loses its ability to buffer against changes in acidity, and pH may fluctuate quickly and widely to the detriment of fish. Fish are more sensitive to some toxic pollutants at low alkalinity (Murad and Boyd, 1990).

Bicarbonate ($HCO^{-3}$) combined with $Ca^{+2}$ form the base compound $CaCO_3$ which is the compound measured in alkalinity tests. Normally alkalinity results primarily from $HCO_{-3}$ and carbonate ($CO_3^{-2}$) ions which often combine with $Ca^{+2}$ and $Mg^{+2}$ ions. Since bicarbonate and alkalinity are so closely related their results and analysis are essentially the same.

Historical records from July 1980 provided two values for "suspended solids", 5.7 and 27.9 (Table 1). Total dissolved solids (TDS) measured in 1994 were 675 to 694 mg/L with an average of 683 mg/L (Table 2). Pulgas Lake is 46 years old and these results reveal an accumulation of ions in the system. The literature is limited in regards to the TDS or suspended solid tolerance levels for warmwater fish. However, these results should pose no threats to warmwater fish populations.

Total dissolved solid is the total residue remaining after evaporation of a water sample which was first filtered to remove suspended matter (Post, 1982). Boyd (1990) refers to suspended solids as suspended matter. He defines suspended matter as the total quantity of organic matter in the water sample. TDS concentration indicates the mg/L of dissolved organic and inorganic matter in a sample (Boyd 1984). The major cations associated with TDS are $Ca^{2+}$, $Mg^{2+}$, sodium ($Na^{+}$,), and $K^{+}$. The major anions are carbonates ($HCO_3$ or $CO_3^{-2}$), chloride ($Cl^{-}$) and sulfate ($SO_4^{-2}$). Post (1982) states that levels in the range of 5,000 to 10,000 mg/L should produce a good fishery depending on the amount of cations present. Post (1982) also suggests that suspended solid measurements less than 25 ppm usually have no harmful effects on fish while ranges from 25-80 ppm could maintain a good fishery only if all other factors are acceptable.

Chloride concentrations ranged from 139 to 147 mg/L in 1994 (Table 2). No tests were reported prior to this 1994 study. The 1994 values appear slightly elevated probably due to the near proximity of the ocean (approximately 5.6 km) and the high rate of evaporation in such a small drainage. However, these levels should support healthy fish populations.

Boyd (1990) states that $Cl^{-}$ concentrations are highly variable in pond waters and may range from 1 mg/L to more than 1000 mg/L. Chloride concentrations are usually greater in waters near coasts since rainfall near oceans has high concentrations of this ion (Gorham, 1961). Post (1982) states that 95% of waters in the U.S. supporting good freshwater fish populations have $Cl^{-}$ concentrations less than or equal to 170 ppm.

$SO_4^{-2}$ values in 1994 ranged from 129-137 mg/L (Table 2) with an average of 134 mg/L. Historical values were not in the records. The literature is inconclusive but it appears that these values, although elevated, are normal for a pond in such close proximity to the ocean.

The most common form of sulfur in surface waters is $SO_4^{-2}$ (Boyd, 1984). Concentrations in ponds vary with the nature of geological materials in the watershed and with hydrological conditions. In regions with waters of low salinity, concentrations of sulfate often range from 1 to 5 mg/L. However, in regions with waters of higher salinity, and particularly in arid regions, sulfate concentrations are much greater (Boyd, 1984). Post (1982) suggests that water with less than 0.5 ppm sulfate will not support algae growth. He also states that most organisms are quite tolerant to sulfate. This tolerance could be due to the existence of sulfate in the lake for such a long period of time , geologically, that the fish have adapted to those levels. Sodium sulfate ($Na_2SO_4$) at 7,500 ppm for 24 days was not harmful to perch (*Percidae*) (Post, 1982). Sulfate levels from 7,500 to 11,000 ppm seem to be lethal to most fish (Post, 1982).

Silicon levels ranged from 2.41 to 2.70 mg/L in samples collected in 1994 (Table 2). Historical records did not show any tests for silicon. The 1994 levels were low but should maintain a good fish population.

Silicon is required for growth of diatoms. There is evidence that, in some waters, silicon concentrations may regulate abundance of diatoms (Fogg, 1965). Concentrations of silicon in natural waters range from 1 to 80 mg/L (Boyd, 1990). At the pH of most inland waters, silicon is present primarily as undissociated silicic acid.

Training Activities

Training activities which could affect fishery populations in Pulgas Lake are those using mortars, pyrotechnic devices (smoke, flares), trench-clearing explosives (Appendix F) and reverse osmosis. Mortars and explosives, if detonated in the lake would result in a massive fish kill and should be avoided. Pyrotechnic devices contain chemicals that can kill fish. These devices and their spent casings should not be allowed to come into contact with Pulgas Lake or its tributary stream channels. Trench-clearing with explosives would erode stream banks and add unwanted siltation into Pulgas Lake. Do not use explosives for trench clearing in stream channels.

Reverse osmosis was not identified specifically by the training office but is a concern of the ACS, ES. Reverse osmosis is a method of extracting elements from the water such as $Na^{+}$, $Cl^{-}$, $Mg^{+2}$, etc. These basic elements are critically important to any fishery ecosystem.

Reverse osmosis would not be a problem for a fishery if small quantities of water are treated. However, if large volumes of water are treated then this will disrupt the ionic balance of the system. This imbalance is detrimental to any fishery.

The current healthy fish populations are evidence that neither mortars nor explosives have recently been used directly in the lake. However, pyrotechnic device canisters were recovered in and around the lake by USFWS personnel in 1994. No evidence was noted, in 1994, of any trench clearing activities in any of the tributaries draining into Pulgas Lake. There was also no evidence or reports of any reverse osmosis activity associated with Pulgas Lake.

Contaminants

Base records pertaining to the "investigation of the allegation of an unauthorized release into Pulgas Lake 1991", describe a blue material which smelled similar to chemicals used in portable toilets. This initial reference to these "chemicals" prompted the testing for substances listed in Table 4. The elevated levels of formaldehyde, coliform bacteria and fecal coliform bacteria reported in May and September 1991 justified closing the lake to all recreational uses until further testing could be done. The testing was duplicated in 1994 (Table 5) for comparison purposes. Results from samples taken in 1994 by USFWS personnel were within acceptable limits for all tests (Table 5).

The blue floating material reported by Base personnel was identified in June 1991 by Dr. Menga Judge PhD, staff member of America West Service Corporation (portable toilet company), as Cyanobacteria, commonly known as blue-green algae. The blue-green floating material was still present in 1994 and samples were collected by USFWS personnel. The substance initially appeared to be an oil based paint. However, upon further analysis under a microscope we too identified it as a filamentous blue-green algae (Cyanophyta). Incidentally, USFWS was unaware of the letter containing Dr. Judge's identification of the algae until after USFWS made their own identification.

To gain further knowledge of the potential contaminant status of Pulgas Lake, the bottom sediment was tested. All sediment samples were tested for title-22 metals, total petroleum hydrocarbons (TPH), organochlorine pesticides and PCB's in July 1994. Results for TPH, organochlorine pesticides and PCB's were below detection limits as shown in the lab report (Appendix B) and thus further testing of these compounds was not warranted. It is beyond the scope of this report to analyze the significance of the specific concentration of each heavy metal found in the sediment. However, title-22 heavy metal concentrations in the sediment samples (Table 6) were high enough to prompt further testing of these same metals in fish fillets and whole fish.

Title-22 heavy metal concentrations in fish fillets and whole fish from Pulgas Lake are summarized in Tables 7 and 8. The metal of greatest concern is mercury with concentrations ranging from 0.600 to 0.900 ppm in fish fillets. International standards for action on mercury range from 0.1 ppm to 1.0 ppm (EPA Technical Report 1986). Twenty-eight countries have established standards for mercury and these are listed in Appendix C. The U.S. Food and

Table 4. Pulgas Lake water contaminant data collected by Camp Pendleton personnel in 1991. Site locations are unknown.

| Measurement | Units | May 15 #1 | May 15 #2 | Sept 3 #1 | Oct 16 #1 | Oct 16 #2 | Oct 16 #3 | OCT 22 #1 |
|---|---|---|---|---|---|---|---|---|
| Chlorine Residual | mg/L | <0.1 | <0.1 | <0.1 | -- | -- | -- | -- |
| MBAS | mg/L | <0.050 | <0.050 | 0.070 | <0.05 | <0.05 | <0.05 | -- |
| Formaldehyde | mg/L | 5.820 | 0.350 | 0.640 | <0.05 | <0.05 | <0.05 | <0.05 |
| Copper | mg/L | 0.075 | <0.007 | <0.007 | -- | -- | -- | -- |
| BOD | mg/L | 2,590 | 30 | 10 | 4.30 | <3.00 | <3.00 | -- |
| Coliform | MPN/100ml | ≥16,000 | 2,400 | ≥1,600 | 130 | 240 | 240 | -- |
| Fecal Coliform | MPN/100ml | 140 | <20 | 240 | <2 | <2 | 23 | -- |

Table 5. Pulgas Lake surface water contaminant data collected in 1994.

| Measurement | Units | June 9 #1 | June 9 #2 | July 19 #1 | July 19 #2 | July 19 #3 | July 21 #1 | July 21 #2 | July 21 #3 |
|---|---|---|---|---|---|---|---|---|---|
| Chlorine Residual | mg/L | -- | -- | -- | -- | -- | 0.11 | 0.11 | 0.12 |
| MBAS | mg/L | -- | -- | <0.05 | -- | -- | -- | -- | -- |
| Formaldehyde | mg/L | <0.15 | <0.15 | -- | -- | -- | -- | -- | -- |
| BOD | mg/L | 13.5 | <3.0 | | | | | | |
| Coliform | MPN/100ml | -- | -- | 23 | 80 | 170 | -- | -- | -- |
| Fecal Coliform | MPN/100ml | -- | -- | 23 | 80 | <2 | -- | -- | -- |

MBAS = Methyl Blue Active Substance
MPN = Most probable number
-- = Not Taken

Table 6. Pulgas Lake contaminant results of composite **sediment** samples taken at five sites (Figure 4) on July 21, 1994.

| Measurement | Units | #1A | #1B | #2A | #3A | #3B |
|---|---|---|---|---|---|---|
| Antimony | mg/Kg | <5.00 | <5.00 | <5.00 | <5.00 | <5.00 |
| Arsenic | mg/Kg | 2.43 | 2.60 | 2.25 | 1.60 | 2.35 |
| Barium | mg/Kg | 73.00 | 84.70 | 111.00 | 56.10 | 98.10 |
| Beryllium | mg/Kg | 0.48 | 0.62 | 0.67 | 0.36 | 0.67 |
| Cadmium | mg/Kg | <0.80 | <0.80 | <0.80 | <0.80 | <0.80 |
| Chromium | mg/Kg | 7.23 | 8.03 | 10.80 | 5.31 | 9.62 |
| Cobalt | mg/Kg | 4.31 | 4.98 | 6.34 | 3.50 | 5.91 |
| Copper | mg/Kg | 7.74 | 8.76 | 10.30 | 5.34 | 9.44 |
| Lead | mg/Kg | 5.44 | 5.76 | 7.02 | 3.47 | 5.97 |
| **Mercury** | **mg/Kg** | **0.60** | **0.50** | **1.40** | **<0.50** | **0.80** |
| Molybdenum | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Nickel | mg/Kg | 4.08 | 4.49 | 9.58 | 4.49 | 9.58 |
| Selenium | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Silver | mg/Kg | <0.40 | <0.40 | <0.40 | <0.40 | <0.40 |
| Thallium | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Vanadium | mg/Kg | 20.00 | 23.10 | 28.70 | 15.10 | 26.80 |
| Zinc | mg/Kg | 29.50 | 35.40 | 101.00 | 23.90 | 40.60 |

Table 7. Pulgas Lake contaminant results of **fish fillet** samples taken on September 21, 1994.

| Measurement | Units | LMB1 R&L | LMB2 RIGHT | LMB3 RIGHT | BC1 R&L | BC2 R&L | BG1 R&L | CC RIGHT |
|---|---|---|---|---|---|---|---|---|
| Antimony | mg/Kg | 1.83 | <1.70 | <1.70 | 2.03 | <1.70 | 2.70 | <1.70 |
| Arsenic | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Barium | mg/Kg | <2.80 | <2.80 | <2.80 | <2.80 | <2.80 | <2.80 | <2.80 |
| Beryllium | mg/Kg | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 |
| Cadmium | mg/Kg | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 |
| Chromium | mg/Kg | <0.30 | <0.30 | <0.30 | <0.30 | <0.30 | 0.31 | <0.30 |
| Cobalt | mg/Kg | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 |
| Copper | mg/Kg | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 |
| Lead | mg/Kg | <2.00 | <2.00 | <2.00 | <2.00 | <2.00 | <2.00 | <2.00 |
| **Mercury** | **mg/Kg** | **0.90** | **0.60** | **0.90** | **0.75** | **0.85** | **<0.50** | **<0.50** |
| Molybdenum | mg/Kg | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 | <0.90 |
| Nickel | mg/Kg | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 | <1.20 |
| Selenium | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Silver | mg/Kg | 0.23 | <0.20 | 0.43 | 0.22 | 0.83 | 0.24 | 0.71 |
| Thallium | mg/Kg | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 | <0.50 |
| Vanadium | mg/Kg | <1.70 | <1.70 | <1.70 | <1.70 | <1.70 | <1.70 | <1.70 |
| Zinc | mg/Kg | 4.74 | 5.74 | 4.67 | 5.57 | 6.34 | 7.62 | 5.81 |

LMB = Largemouth bass
BC = Black crappie
BG = Bluegill
CC = Channel catfish
R&L = Right & Left fillet
Right = Right fillet only

Table 8. Pulgas Lake contaminant results of **whole fish** samples taken on September 21, 1994.

| Measurement | Units | LMB3 | BG2 |
|---|---|---|---|
| Antimony | mg/Kg | 7.15 | 4.89 |
| Arsenic | mg/Kg | <0.50 | <0.50 |
| Barium | mg/Kg | <2.80 | <2.80 |
| Beryllium | mg/Kg | <0.30 | <0.30 |
| Cadmium | mg/Kg | <0.30 | <0.30 |
| Chromium | mg/Kg | 0.61 | 0.38 |
| Cobalt | mg/Kg | <1.20 | <1.20 |
| Copper | mg/Kg | 2.02 | <0.90 |
| Lead | mg/Kg | <2.00 | <2.00 |
| **Mercury** | **mg/Kg** | **<0.50** | **<0.50** |
| Molybdenum | mg/Kg | <0.90 | <0.90 |
| Nickel | mg/Kg | <1.20 | <1.20 |
| Selenium | mg/Kg | <0.50 | <0.50 |
| Silver | mg/Kg | 0.43 | 0.45 |
| Thallium | mg/Kg | <0.50 | <0.50 |
| Vanadium | mg/Kg | <1.70 | <1.70 |
| Zinc | mg/Kg | 23.30 | 20.00 |

LMB3 = 3 Largemouth bass (90-150mm)
BG2 = 2 Bluegill (70-80mm)

Drug Administration has set an action level of 1.0 ppm for the edible portion of fish and mollusks. The median international standard is 0.5 ppm (California Water Resources Control Board, 1993). It is not the role of the USFWS to determine safe levels of heavy metal accumulation in fish for human health concerns. Therefore these test results were forwarded to California State Department of Human Health Services (DHHS) for their response regarding the safety of Pulgas Lake fish for human consumption.

The DHHS stated that the mercury levels in fish fillets from Pulgas Lake were high and appropriate precautions should be taken. They recommended that the fish in Pulgas Lake are not suitable for human consumption based on the data provided. They also stated that more testing would need to be conducted to fully evaluate the situation (official documentation is expected soon).

Fish Population

Historical Information:

Pulgas Lake has maintained a varying assemblage of fish species since at least 1960. The earliest Base records indicate that on October 25, 1960 shiners, bass and perch and/or sunfish were transplanted into Pulgas Lake from Lake O'Neill (Table 9). Judging from field notes fish were often moved from one body of water to another on Base without adequate documentation. A USFWS Fishery Management Plan (FMP) progress report for CPMCB, dated June 1965, indicates that black crappie, largemouth bass, bluegill and redear sunfish were present in Pulgas Lake and that angling pressure was "considerable" at that time (USFWS, 1966). This FMP is the first documentation of black crappie and bluegill being present in Pulgas Lake. Obviously, a substantial fish population existed in the lake prior to the 1965 sampling of these four species, probably from the 1960 transplant from Lake O'Neill.
A FMP for Camp Pendleton was developed cooperatively between Camp Pendleton, CDFG, and USFWS between 1965 and 1968. The work associated with this FMP was the first biological sampling documented in Pulgas Lake.

The documented history of fish planting into the lake since 1960 is incomplete, however the information available indicates that numerous introductions have occurred (Table 9). These fish came from other Base waters, California Department of Fish and Game (CDFG) and USFWS hatcheries.

USFWS sampled Pulgas Lake in April 1965 to gain knowledge of Base waters to write the Camp Pendleton 1965-68 FMP. During this sampling period, black crappie, largemouth bass, bluegill and redear sunfish were present (Table 10). Their FMP also mentioned that Pulgas Lake had considerable angling pressure, though fishing success was mediocre. USFWS then sampled again in June 1966 using rotenone and documented that black crappie, bass and redear sunfish were "quite scarce" with an over abundance of green sunfish. The rotenone sampling also produced a few young-of-the-year (YOY) bass, indicating that bass had spawned successfully in the spring of 1966. Rotenone was again used on October 21, 1967 to sample two small shallow bays near the dam. USFWS reported sampling "good numbers" of intermediate and small-sized sunfish and 19 small bass.

Recommendations from the 1968 FMP were to 1) remove brush from the upper end, 2) rehabilitation (rotenone and restocking) of Pulgas Lake to reduce the large numbers of small crappies and 3) begin stocking rainbow trout. The 1968 FMP and associated progress reports use the term "sunfish" without a species identification. They also mention large numbers of crappie. This mention of large numbers of sunfish and crappie may be a reference to the same species. There was an overpopulation of sunfish and/or crappie judging from the records. There are no records of any treatment, from 1968 recommendations, to "rehabilitate" the lake with rotenone or of restocking the lake with warmwater fish.

Table 9. Fish stocking history of Pulgas Lake.

| YEAR | MONTH | SPECIES | NUMBER | SIZE |
|---|---|---|---|---|
| 1960 | October | Shiners (Sp. ?) | 75 | unknown |
| | " | Perch and/or sunfish | 250 | unknown |
| | " | Bass | 2 | unknown |
| 1963 | July | Bass | 1700 | unknown |
| 1969 | February | Trout (Rainbow ?) | 600 lbs. | 2.0/lb. |
| 1973 | November | Rainbow Trout | 1,600 fish | 3.5/lb. |
| | 3 December | Rainbow Trout | 1,100 fish | 3.5/lb. |
| | 11 December | Channel Catfish | 2,640 fish | unknown |
| 1974 | January | Rainbow Trout | 2,200 fish | 3.5/lb. |
| | February | Rainbow Trout | 2,200 fish | 3.5/lb. |
| | March | Rainbow Trout | 2,200 fish | 3.5/lb. |
| 1975 | November | Rainbow Trout | 900 fish | 4/lb. |
| 1976 | January | Rainbow Trout | 1,200 fish | 4/lb. |
| | February | Rainbow Trout | 1,000 fish | 4/lb. |
| | March | Rainbow Trout | 1,000 fish | 4/lb. |

The emphasis shifted toward a rainbow trout stocking program in 1969. There was a considerable rainbow trout fishery in Pulgas Lake during the winter months of 1969 following the February stocking of approximately 1200 fish. Base personnel reported 75% of those fish stocked in 1969 were caught. This level of success suggests that a seasonal "put and take" rainbow trout fishery can be sustained in Pulgas Lake. However, the summer-time temperature and D.O. levels (Table 1 and 3) would most likely kill remaining rainbow trout.

Rainbow trout stocking did continue during winter months from 1973 to 1976 (Table 9). Base records reference the "magical alluring value" of fishing for trout as a justification for the trout stocking program. However, there are are no base records documenting rainbow trout ever being caught with biological sampling gear. This and the water quality results support our conclusion that summer water quality parameters in Pulgas Lake do not support trout populations.

From 1970 to the fall of 1973, Base personnel undertook an active effort to inventory CPMCB lakes and ponds. These efforts provided information on fish species present, their lengths and some of the water quality measurements presented earlier in this report. All of the inventory records associated with this effort in Pulgas Lake took place in 1973 (Tables 10 and 11). The only recorded measure of success of the trout stocking program is through creel census data collected in December 1973 (Table 11).

Base game wardens conducted the 1973 creel survey on Pulgas Lake (Table 11). There was considerable effort by anglers (2.1 hours/angler) for a fair catch return of trout (0.43 fish/hour). It is difficult to make a judgement on the success of a fishery from a one month creel survey. A creel survey throughout the majority of a fishing season is the appropriate assessment needed. However, this narrow view provided by the creel survey tells us that in one month (December) anglers harvested at least 17% (456 fish) of those fish stocked (2,700 fish) prior to the survey. The idea of a put and take fishery is an expensive fishery to support since it only lasts part of the year. Channel catfish were also stocked in Pulgas Lake on December 11, 1973. Numbers of channel catfish creeled (Table 11) went up substantially after they were planted (Table 10). Water quality conditions in Pulgas Lake will support catfish populations year round.

Base personnel set gill nets in Pulgas Lake on June 19, 20, and 21, 1973. Fish captured were largemouth bass, bluegill, crappie (sp.?), redear sunfish, and brown bullhead (Table 10). Shallow areas of the lake were seined on July 26, 1973 with catches of largemouth bass and green sunfish. Gill nets and a seine were again fished on September 28, 1973 producing catches of all species previously sampled, except rainbow trout and brown bullhead. Base personnel and CDFG also utilized an electrofishing boat to sample the lake on October 15, 1973.

The length frequency data resulting from all these sampling efforts are illustrated in Figures 5 to 8. It is prudent to keep in mind that each type of sampling gear used has its own selectivity bias towards one or more size groups and/or species. Therefore, it is ideal to be able to sample with a wide variety of gear types and to alternate their usage and sample sites in order to minimize the level of bias. Fish seem to be able to learn how to avoid certain types of gear after only one or two uses.

Largemouth bass data from Pulgas Lake in 1973 indicates that there were numerous bass larger than quality size (300 mm) (Gablehouse, 1984) (Figure 5). The bass also successfully spawned that year as shown by the presence of young of the year (YOY) fingerling between 40 and 80 mm. At least four age classes of bass are evident in Figure 5, and at least one middle age class of fingerlings was missing from data collected. Actual age determination from scale analysis was not reported for any species in 1973.

Several age classes of bluegill and redear sunfish are indicated by the length frequency data in 1973 (Figures 6 and 7). Both species spawned successfully in 1973. They also both appear to have had stunted populations with very few fish larger than quality size (150 mm) (Gablehouse, 1984). The larger-sized largemouth bass should have utilized these smaller fish as prey.

The crappie sampled in 1973 (Figure 8) were not positively identified to species (black or white) but are suspected to have been all black crappie since no white crappie have been identified in Pulgas Lake. Their population appears to have been weaker than other species in 1973 according to sampling results. However, black crappie populations succeeded well in years to follow as documented by our sampling in 1994.

In 1979, technical assistance and fish planting activities provided by the USFWS to Camp Pendleton were discontinued due to budget limitations and

Table 10. Fish sampling history of Pulgas Lake.

| DATE | METHOD | SPECIES | NUMBER | SIZE(mm) | Range(mm) |
|---|---|---|---|---|---|
| **1965** | | | | | |
| February | unknown | Black Crappie | unknown | unknown | unknown |
| " | unknown | Largemouth Bass | unknown | unknown | unknown |
| " | unknown | Bluegill | unknown | unknown | unknown |
| " | unknown | Redear Sunfish | unknown | unknown | unknown |
| April | unknown | Black Crappie | unknown | unknown | unknown |
| " | unknown | Largemouth Bass | unknown | unknown | unknown |
| " | unknown | Bluegill | unknown | unknown | unknown |
| " | unknown | Redear Sunfish | unknown | unknown | unknown |
| **1966** | | | | | |
| June | Rotenone | Green Sunfish | unknown | unknown | unknown |
| " | Rotenone | Bass | a few | YOY | unknown |
| October | Rotenone | Bass | 19 | small | unknown |
| " | Rotenone | Sunfish (Sp.?) | abundant | intermed. | unknown |
| | | | | + small | unknown |
| **1973** | | | | | |
| June | Gill Net | Bluegill | 21 | Mean=123 | 95-280 |
| " | Gill Net | Crappie (Sp.?) | 2 | Mean=113 | 106-121 |
| " | Gill Net | Redear Sunfish | 5 | Mean=162 | 131-230 |
| " | Gill Net | Brown Bullhead | 1 | Mean=270 | NA |
| " | Gill Net | Largemouth Bass | 3 | Mean=421 | 388-452 |
| July | Seine | Bluegill | unknown | 51-76 | 51-76 |
| " | Seine | Largemouth Bass | unknown | 25-51 | 25-51 |
| September | Gill Net | Bluegill | 1 | 103 | NA |
| " | Gill Net | Crappie (Sp.?) | 2 | unknown | 95-230 |
| " | Gill Net | Green Sunfish | 1 | unknown | unknown |
| " | Seine | Largemouth Bass | 7 | unknown | 50-80 |
| " | Seine | Redear Sunfish | 18 | unknown | 85-150 |
| " | Seine | Bluegill | 25 | 40-150 | 40-150 |
| October | Electrofish | Largemouth Bass | 12 | Mean=374 | 255-460 |
| " | Electrofish | Bluegill | 4 | Mean=109 | 85-135 |
| " | Electrofish | Black Crappie | 3 | Mean=142 | 120-180 |
| " | Electrofish | Redear Sunfish | 4 | Mean=120 | 80-145 |
| **1994** | | | | | |
| June | Seine,Gill Net, | Largemouth Bass | 76 | Mean=122 | 23-486 |
| " | Seine,Gill Net,H+L | Bluegill | 98 | Mean= 95 | 54-234 |
| " | Seine,Gill Net,H+L | Black Crappie | 21 | Mean=220 | 120-258 |
| " | Gill Net | Channel Catfish | 1 | Mean=570 | NA |
| " | Gill Net | Redear Sunfish | 1 | Mean=209 | NA |
| July | Gill Net,H+L | Largemouth Bass | 36 | Mean=185 | 71-472 |
| " | Gill Net | Bluegill | 59 | Mean=104 | 63-218 |
| " | Gill Net | Black Crappie | 65 | Mean=187 | 68-257 |
| " | Gill Net | Redear Sunfish | 2 | Mean= 82 | 80-84 |
| September | Gill Net,H+L | Largemouth Bass | 23 | Mean=244 | 96-433 |
| " | Gill Net | Bluegill | 34 | Mean=108 | 69-200 |
| " | Gill Net | Black Crappie | 31 | Mean=189 | 152-255 |
| " | Gill Net | Brown Bullhead | 1 | Mean=335 | NA |

H+L = Hook and line; NA = Not Applicable
YOY = Young of Year (Juvenile)

Table 11. Creel census survey results from Pulgas Lake, December 1973.

| Date | # angler hours | # anglers | # fish caught | Species | CPUE |
|---|---|---|---|---|---|
| 12-6-73 | 21.1 | 21 | 5 | RBT | 0.24 |
| " | 21.1 | " | 3 | LMB | 0.14 |
| " | 21.1 | " | 2 | BG | 0.09 |
| " | 21.1 | " | 1 | C | 0.05 |
| " | 21.1 | " | 11 | ALL | 0.52 |
| 12-7-73 | 64.7 | 40 | 38 | RBT | 0.59 |
| " | 64.7 | " | 4 | BG | 0.06 |
| " | 64.7 | " | 42 | ALL | 0.65 |
| 12-8-73 | 152.5 | 96 | 60 | RBT | 0.39 |
| " | 152.5 | " | 5 | BG | 0.03 |
| " | 152.5 | " | 65 | ALL | 0.43 |
| 12-9-73 | 131.9 | 73 | 21 | RBT | 0.16 |
| " | 131.9 | " | 4 | BG | 0.03 |
| " | 131.9 | " | 25 | ALL | 0.19 |
| 12-11-73 | 3.0 | 1 | 3 | RBT | 1.00 |
| " | 3.0 | " | 10 | BG | 3.33 |
| " | 3.0 | " | 13 | ALL | 4.33 |
| 12-15-73 | 134.4 | 71 | 73 | RBT | 0.54 |
| " | 134.4 | " | 4 | CC | 0.03 |
| " | 134.4 | " | 2 | LMB | 0.01 |
| " | 134.4 | " | 79 | ALL | 0.59 |
| 12-16-73 | 100.4 | 54 | 57 | RBT | 0.57 |
| " | 100.4 | " | 18 | CC | 0.18 |
| " | 100.4 | " | 4 | C | 0.04 |
| " | 100.4 | " | 2 | BG | 0.02 |
| 12-22-73 | 73.7 | 34 | 67 | RBT | 0.91 |
| 12-23-73 | 386.5 | 128 | 132 | RBT | 0.34 |
| " | 386.5 | " | 14 | CC | 0.04 |
| " | 386.5 | " | 10 | BG | 0.03 |
| " | 386.5 | " | 156 | ALL | 0.40 |
| December 1973 **Total** | 1068.2 | 518 | 456 | RBT | 0.43 |
| " | 1068.2 | " | 37 | BG | 0.03 |
| " | 1068.2 | " | 36 | CC | 0.03 |
| " | 1068.2 | " | 5 | C | <0.01 |
| " | 1068.2 | " | 534 | ALL | 0.50 |

RBT = Rainbow Trout
LMB = Largemouth Bass
BG = Bluegill
CC = Channel Catfish
C = Crappie (Sp.?)
All = All species combined
CPUE = Catch Per Unit Effort

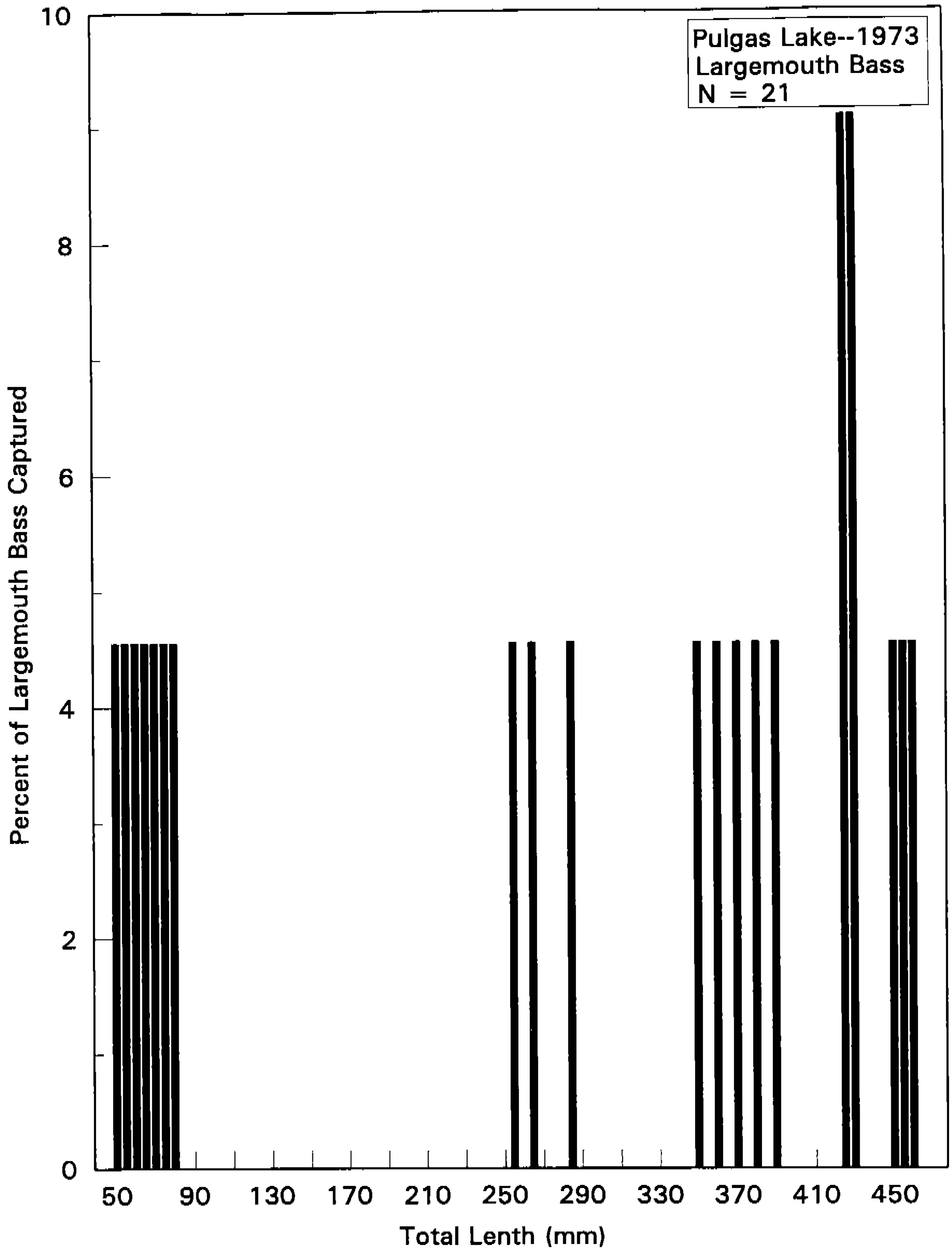


Figure 5. Length frequency histogram of largemouth bass captured in Pulgas Lake during June through October 1973 sampling.

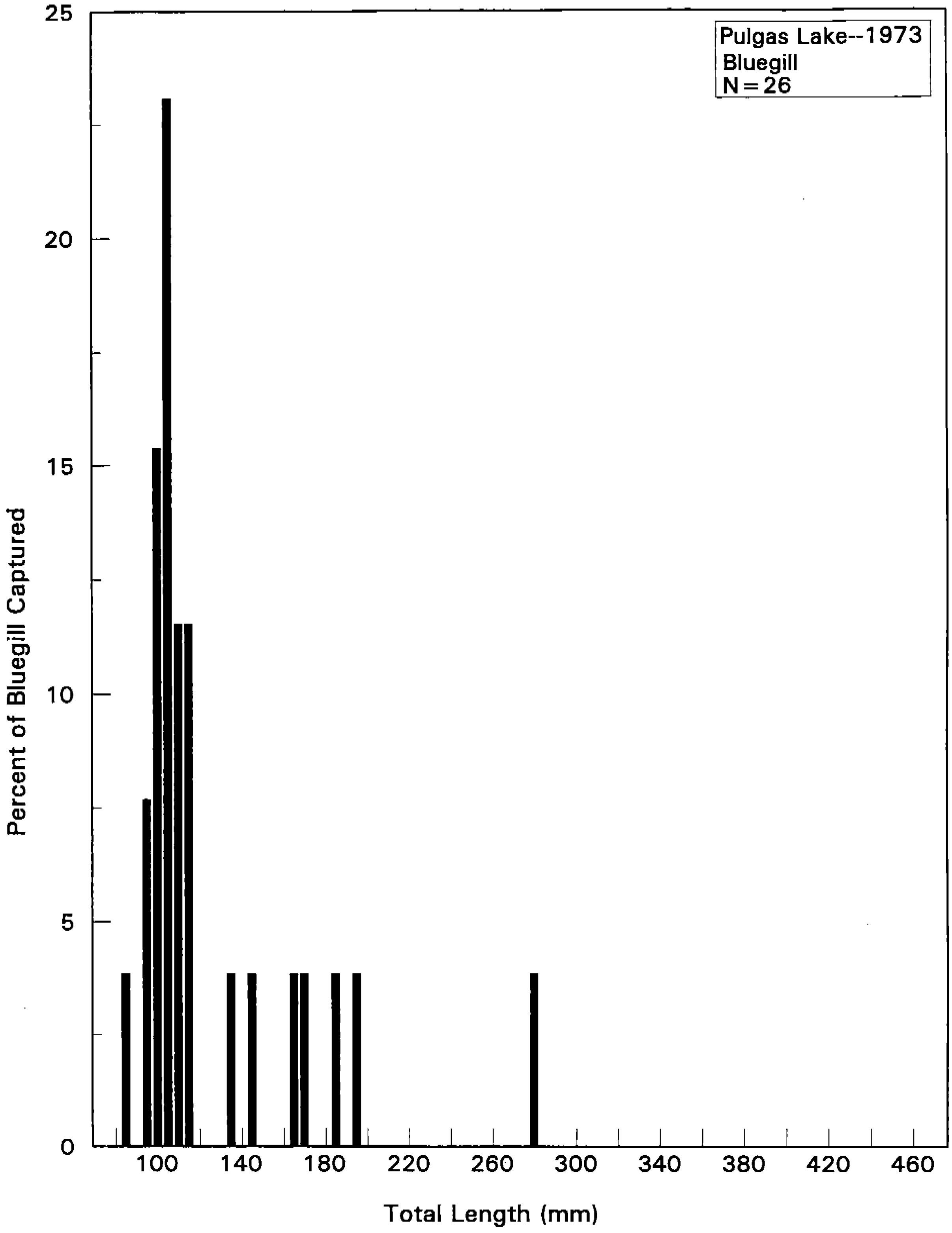


Figure 6. Length frequency histogram of bluegill captured in Pulgas Lake during during June through October 1973 sampling.

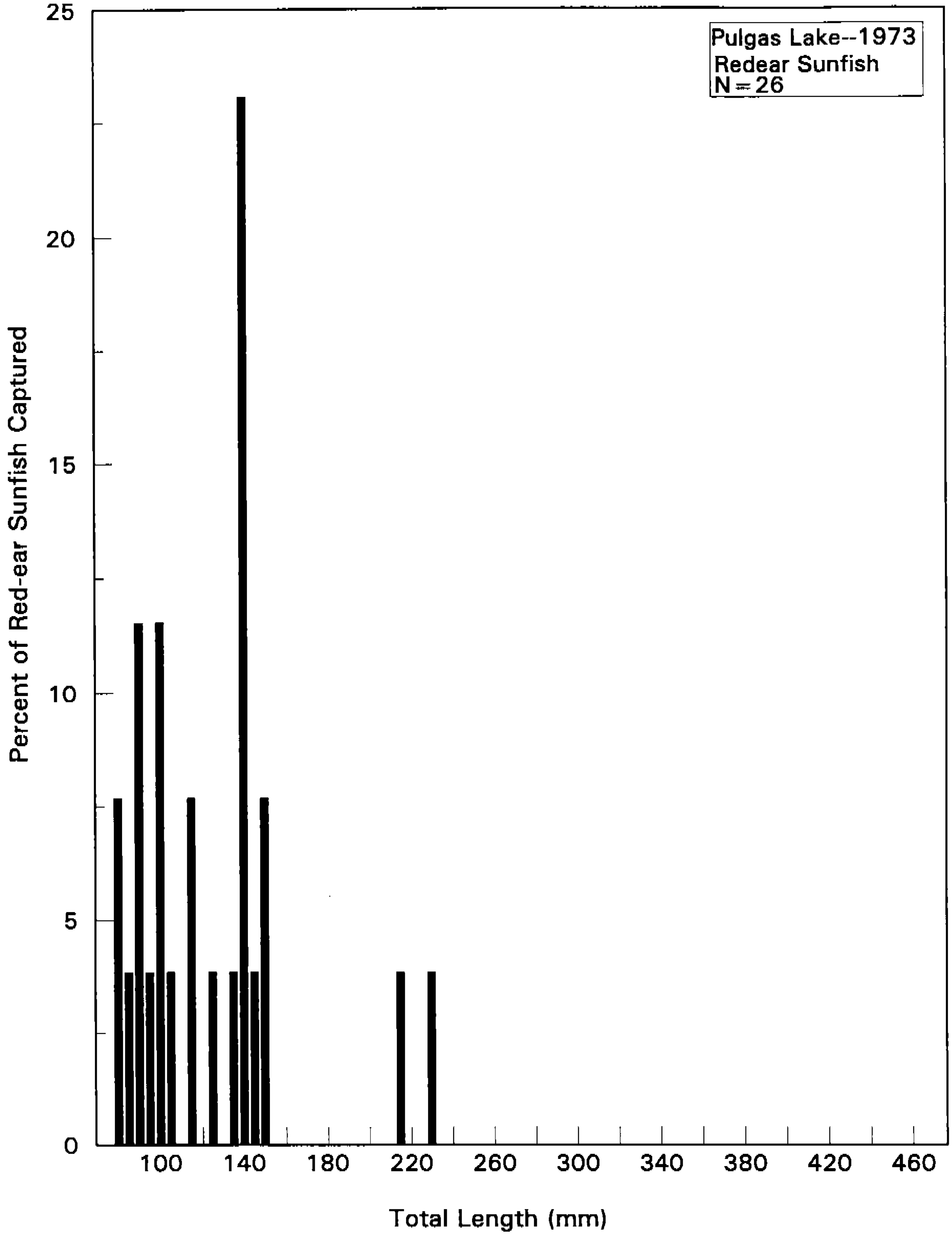


Figure 7. Length frequency histogram of redear sunfish captured in Pulgas Lake during June through October 1973 sampling.

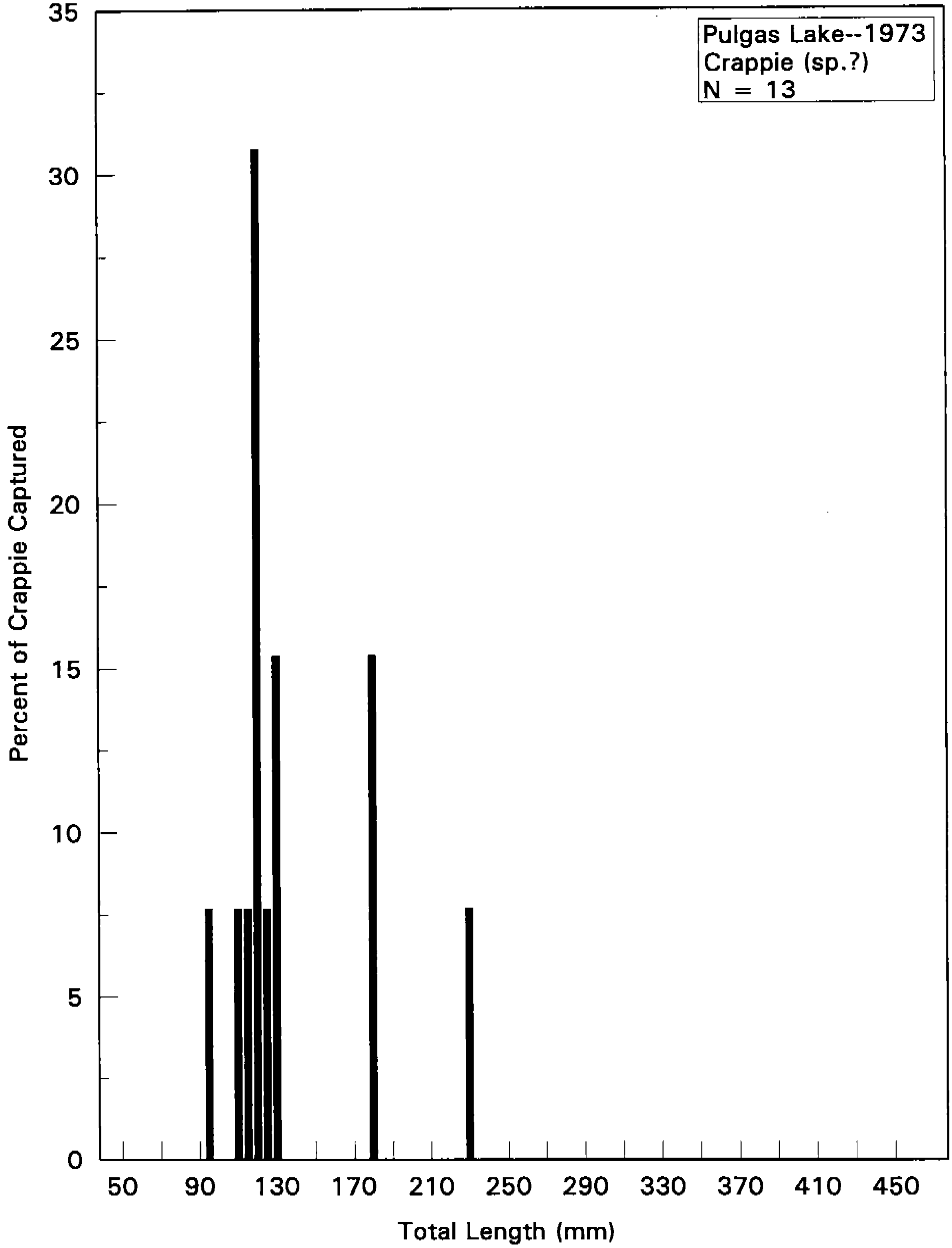


Figure 8. Length frequency histogram of crappie (sp.?) captured in Pulgas Lake during June, September and October 1973 sampling.

changing priorities. Further stocking by CDFG was discontinued because Base waters were not open to the general fishing public and state funds were lacking.

Apparently, no fish sampling activities occurred after 1973, with the exception of the water sampling done as part of the contaminant issue in 1991. Base files do contain some recommendations for fisheries management in a memo from Lieutenant Colonel Roger S. Grischkowsky, USMCR, Reserve Counterpart Training, dated January 22, 1985. Although he makes recommendations for Camp Pendleton as a whole, there are specific recommendations concerning Pulgas Lake.

LtCol. Grischkowsky recommended printing a newsletter or leaflet regularly listing fishing activities available, effective methods and locations. He also suggested establishing a call-in phone number for a pre-recorded fishing message. He went on to give a small sample of CPUE for Pulgas Lake of 0 fish/16 hours fished. He then suggested a continuation of the rainbow trout put and take stocking program. Many of his recommendations are still valid at this time.

Current Information:

USFWS sampled Pulgas Lake with gill nets and conventional hook and line during the periods June 8-11, July 20-22 and September 20-27, 1994. The total catch

Table 12. Mean length and percent survival of fish captured in Pulgas Lake during 1994 sampling.

| Species | # Sampled | Mean Length (mm) | Range (mm) | Standard Deviation | % Released Alive |
|---|---|---|---|---|---|
| Largemouth bass | | | | | |
| June | 76 | 122 | 23-486 | 91.8 | 82% |
| July | 36 | 185 | 71-472 | 86.6 | 53% |
| September | 23 | 244 | 96-433 | 80.0 | 90%* |
| All 1994 | 135 | 159 | 23-486 | 99.7 | 75%* |
| Black crappie | | | | | |
| June | 21 | 219 | 120-258 | 48.2 | 67% |
| July | 65 | 187 | 68-257 | 50.2 | 62% |
| September | 31 | 189 | 152-255 | 36.8 | 52%* |
| All 1994 | 117 | 193 | 68-258 | 47.9 | 60%* |
| Bluegill | | | | | |
| June | 98 | 95 | 54-234 | 33.1 | 52% |
| July | 59 | 104 | 63-218 | 33.3 | 66% |
| September | 34 | 108 | 69-200 | 37.7 | 62%* |
| All 1994 | 191 | 100 | 54-234 | 34.3 | 58%* |
| Brown bullhead | | | | | |
| September | 1 | 335 | - | - | 0%* |
| Channel catfish | | | | | |
| June | 1 | 570 | - | - | 100% |
| Redear sunfish | | | | | |
| June | 1 | 209 | - | - | 100% |
| July | 2 | 82 | 80-84 | - | 100% |
| All 1994 | 3 | 124 | 80-209 | 73.4 | 100% |

* = 1 to 3 fish were sacrificed for contaminant analysis.

consisted of 135 largemouth bass, 117 black crappie, 191 bluegill, 3 redear sunfish, 1 brown bullhead and 1 channel catfish (Figure 9). Most fish were released alive (64%) with most mortality attributed to the smaller weaker fish (Table 12). Mean lengths and associated data obtained from these fish are shown in Table 12. Length frequency histograms of species with more than ten fish captured are shown in Figures 10 to 12. Age class determination was best calculated using these length frequency histograms. Scale samples taken from each species (except catfish and brown bullhead, which lack scales), were difficult to analyze with the relatively warm year-round temperatures and the resultant uniform growth patterns.

Age class determination of largemouth bass by length frequency patterns shown in Figure 10 indicate at least ten age classes were present. These age classes represent fish up to nine years old. This agrees with other age class size groups identified by Davies and Rwangano (1990). They suggest that largemouth bass over 400 mm were at least eight years old.

Our sampling of black crappie populations revealed two strong year classes at ages three and six (Figure 11). It is believed that the past two years (1993 and 1994) had poor reproduction success as evidenced by a lack of age 0+ and 1+ fish (Figure 11). It is difficult to ascertain at this time what may have been the cause of reproduction failure since black crappie obviously spawned successfully in past years. However, age classes four and five were also quite low in number.

Bluegill age classes were displayed in a classic population dynamics distribution pattern. Older age classes had fewer fish than the previous younger age class (Figure 12). There were at least seven separate age classes, with the oldest fish more than six years old. This again agrees with other age class size groups identified by Davies and Rwangano (1990). They suggest that five-year old bluegill grow to a size greater than 185 mm.

The ultimate question is whether the fish populations in Pulgas Lake are in balance as a "fishery community". Swingle defines a balanced fishery community as a relationship between predator and prey which provides continued good fishing of harvestable size fish. Proportional stock density (PSD) is the index most used by fishery biologists to measure the quality of warmwater fish populations. PSD represents the percent of stock-sized fish from a specific population that have attained a quality size. PSD is calculated by dividing the number of quality-size fish (Q) by the number of stock-size fish (S). A stock-size fish is one that has survived its first winter of life and is subject to the same natural mortality as adults in the population (Anderson, 1978). Quality size, total length, was established by Anderson (1978) as 300 mm, 200 mm, and 150 mm for largemouth bass, black crappie and bluegill, respectively. Anderson also proposed a stock size of 200 mm, 127 mm, and 76 mm for the three species, respectively. Using these parameters, desirable values for PSD are 40 to 60 percent for largemouth bass and 20 to 40 percent for bluegill. The reviewed literature didn't refer to a desirable PSD for black crappie. However, it is reasonable to expect a desirable PSD for black crappie to be slightly higher than for that of bluegill. We propose a desirable PSD range of 30 to 50 percent for black crappie.

The PSD for largemouth bass was 52% in Pulgas Lake which is within the desirable range for a quality fishery (Table 13). PSD for bluegill was 13% which was lower than desired (20 to 40%) for a bluegill fishery but should provide for a good prey base for a large bass fishery. PSD for black crappie was 42% which is within our desirable range for a good sustained black crappie fishery (Table 13).

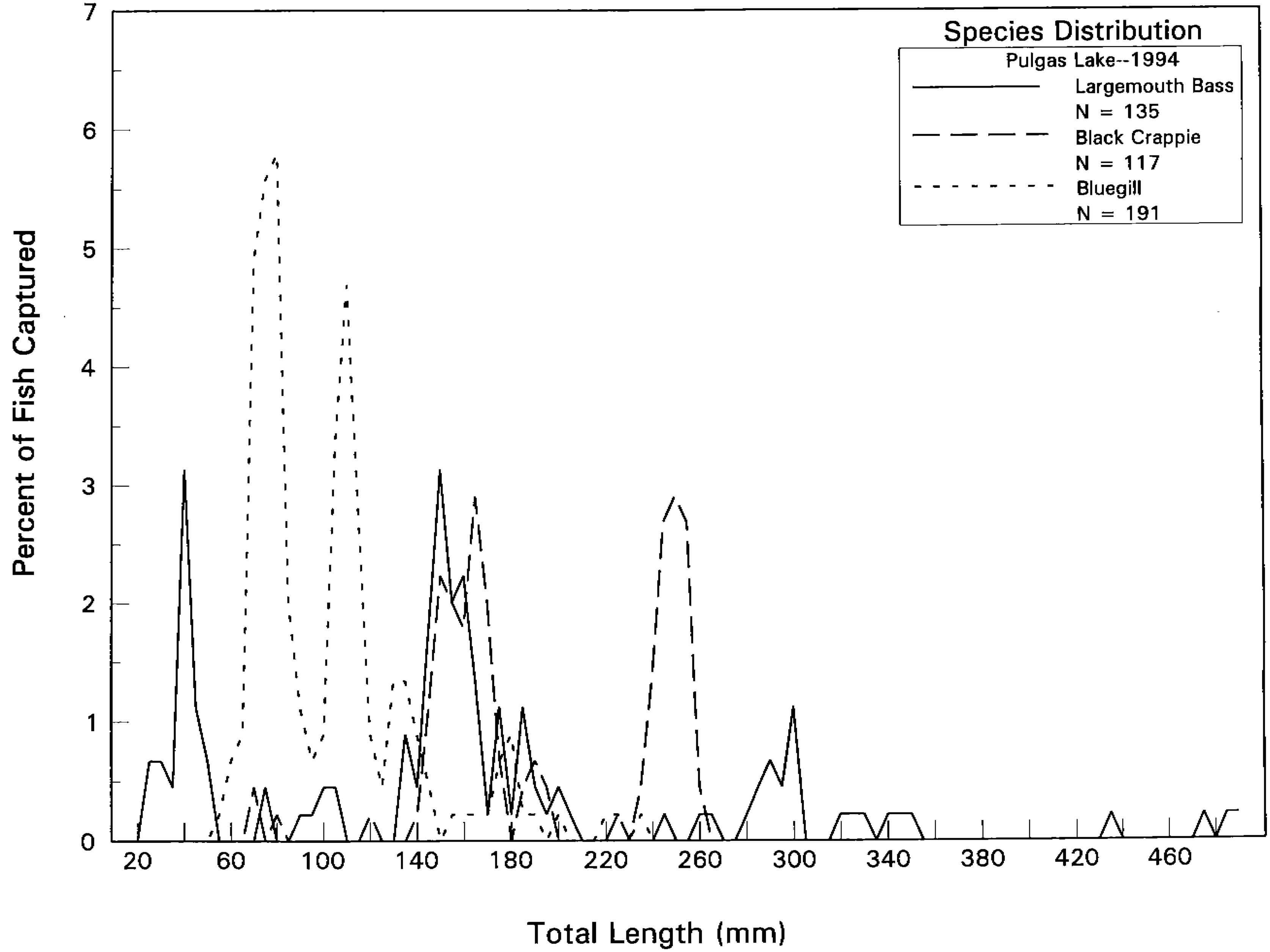


Figure 9. Length distribution by species of fish captured during Pulgas Lake sampling in June, July and September 1994.

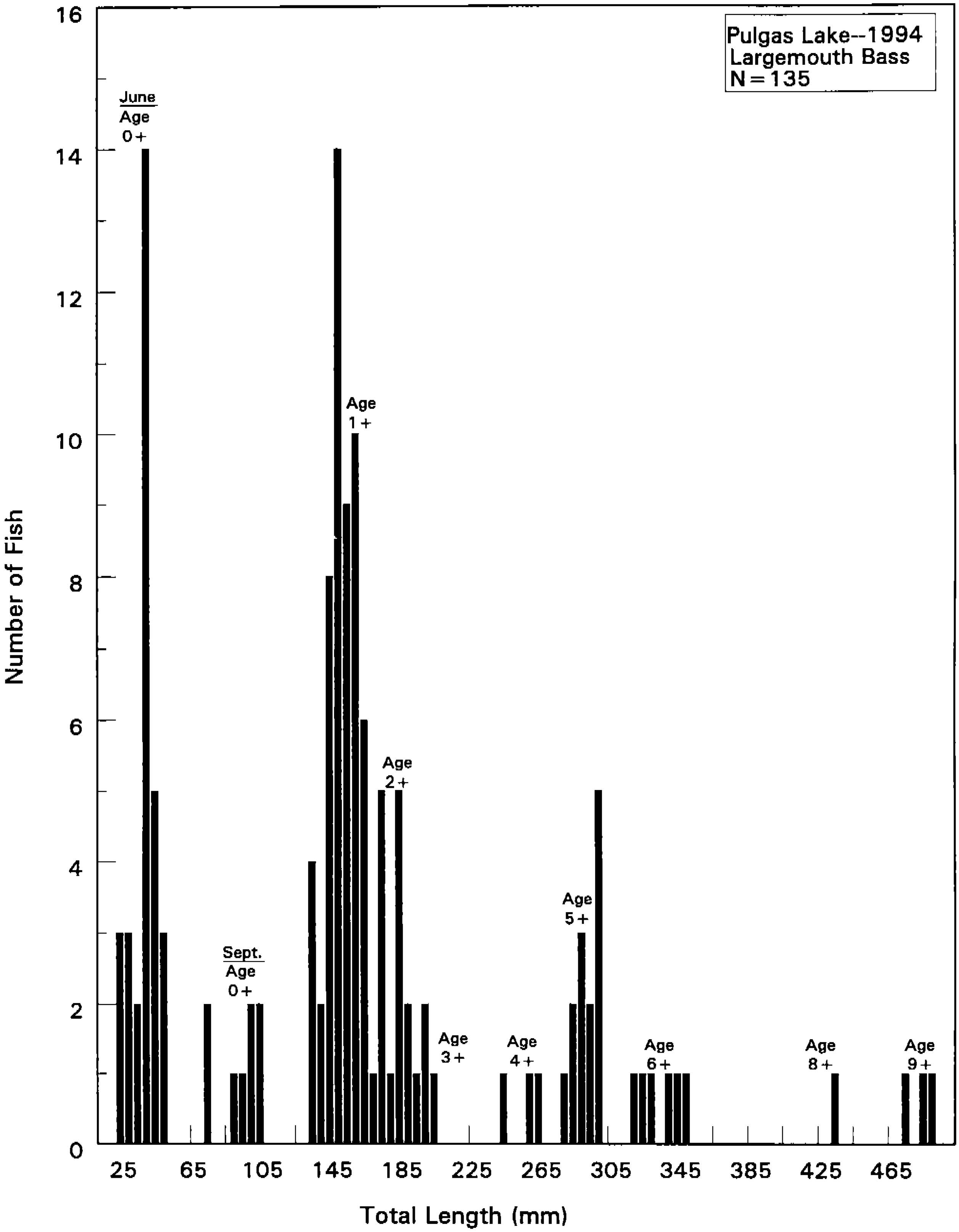


Figure 10. Length frequency histogram with associated age classes of largemouth bass captured in Pulgas Lake sampling in June, July and September 1994.

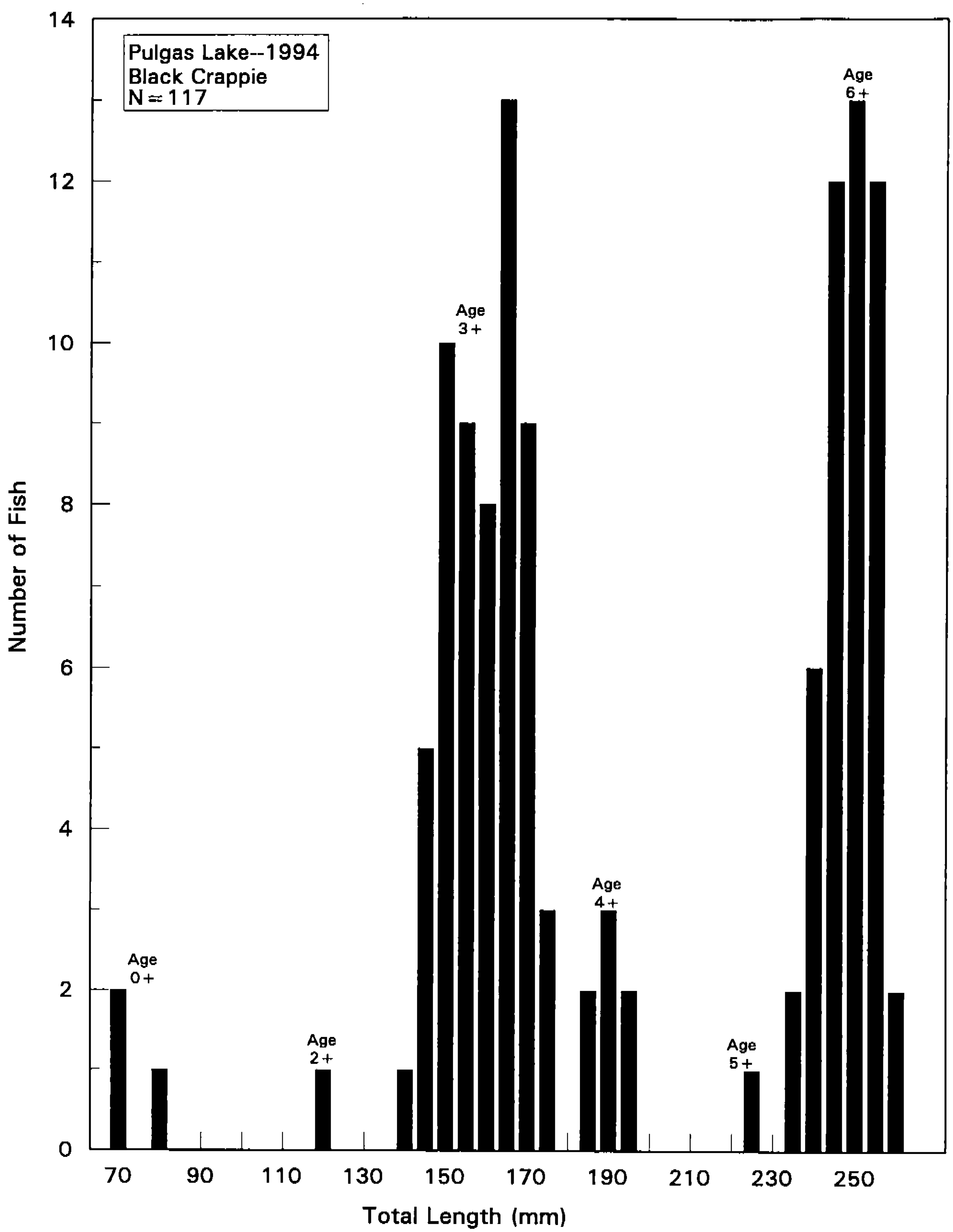


Figure 11. Length frequency histogram with associated age classes of black crappie captured in Pulgas Lake sampling in June, July and September 1994.

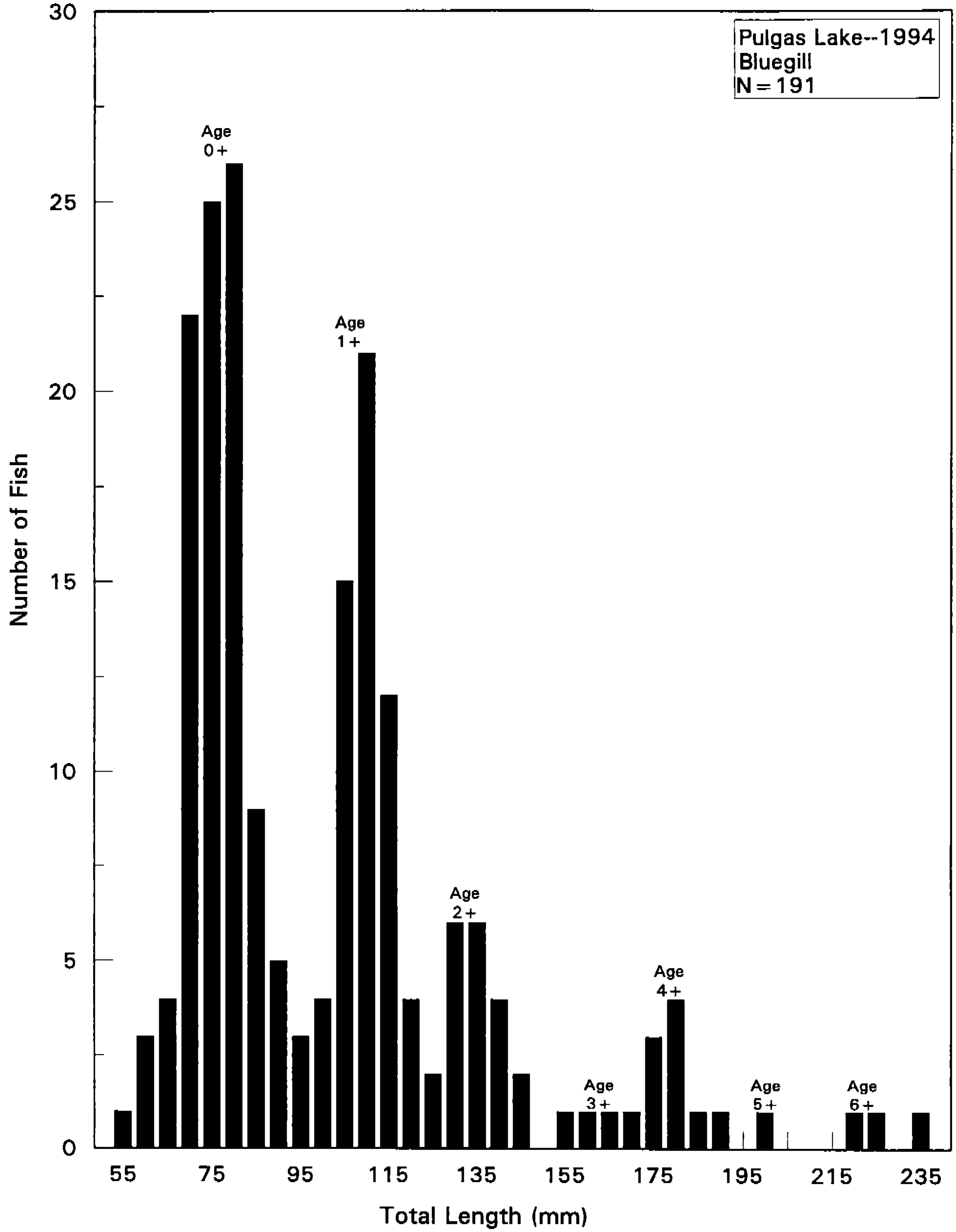


Figure 12. Length frequency histogram with associated age classes of bluegill captured during Pulgas Lake sampling in June, July and September 1994.

Table 13. Number of stock and quality size (mm) fish and their associated proportional stock densities in Pulgas Lake for 1994.

| Species | Stock Size | Quality Size | Number of Stock size | Number of Quality size | PSD |
|---|---|---|---|---|---|
| Largemouth bass | 200mm | 300mm | 29 | 15 | 52% |
| Bluegill | 76mm | 150mm | 136 | 17 | 13% |
| Black crappie | 127mm | 200mm | 113 | 48 | 42% |

Overall the fish populations in Pulgas Lake appear to be in balance with a favorable edge toward largemouth bass due to the over-abundance of small bluegills.

Recreational Fishery

The history of Pulgas Lake indicates it has (since at least the 1960's) always provided some good fishing opportunities. While many Base waters are open to sport fishing, Pulgas Lake was open to fishing until the recent (1991) incidence forcing its closure to all recreational use. Pulgas Lake is still closed to all recreational activity but it is hoped that the results of this report will allow its re-opening to some degree.

Currently, the Base fishing permit costs $ 3.00. The permit and a California State fishing license are required for active duty USFWS personnel, Base employees, and retired military personnel to fish on the Base. Children, under the age of 16, may fish Base waters with a no-fee permit. State seasons and limits also apply to Base waters. There is an exception to state regulations in that the Base allows bass to be harvested at any size. A summary of Camp Pendleton fishing regulations is shown in Appendix D.

The only estimates of angler use, effort, or catch of fish from Pulgas Lake found in the records are those previously presented for 1973 (Table 11). In 1994, a total of approximately 1800 permits were issued on the Base (Chris Stevenson, personal communication). Money collected through the sale of fishing permits is utilized to support Base fish and wildlife management including the purchase of fish for stocking.

Pulgas Lake fish populations have been allowed to grow to quality size during the nearly four year closure. This four year closure has made Pulgas Lake an anglers dream for fishing opportunity. The potential for Pulgas Lake to be managed as a "trophy" bass fishery exists. However, if the lake is not properly managed its present quality status could deteriorate quickly.

## RECOMMENDATIONS

The current weather pattern of late fall and winter rains replenishes Pulgas Lake's water level to full pool each fall. This pattern is conducive to the development of healthy fish populations. Year-round fishing, if allowed by state health officials, in Pulgas Lake would be a quality recreational experience.

As long ago as 1967 Base records indicate that biologists had recommended changes in the fishery populations through the use of rotenone and restocking. A 1985 memo, from Lt. Col. Grischkowsky, recommended continued stocking of rainbow trout to "enhance" Pulgas Lake fishing opportunities. However, this trout stocking program provides short term returns at a considerable cost.

Water Quality

Aquatic vegetation may increase in the lake at lower lake levels which may occur during drought-type conditions. However, maintaining the present steep banks at the current 1:2 ratio along the shoreline limits potential aquatic plant proliferation. We recommend that signs be posted warning the user of these steep banks as they are made of a slick clay-type material. This is a real hazard for young children or individuals who can't swim. The alternative is to reduce bank slope using heavy machinery. This would be costly, would be detrimental to fish populations, and the inevitable invasion of aquatic vegetation into the shallower areas would make fishing access very difficult.

Various methods can be used to reduce aquatic vegetation. However, we feel that at current levels the vegetation is not a problem and in fact provides good habitat for the fish and other wildlife species present.

The decomposition of aquatic vegetation during late summer and fall may lead to oxygen depletion on the lake bottom. This depletion can be toxic to fish. Sampling needs to be done to identify if this problem is a growing concern in Pulgas Lake. Our sampling did reveal some oxygen depletion at the water-mud interface on the lake bottom, but not enough to warrant concern. If excessive oxygen depletion is noted, mechanical, chemical, and biological control methods are available and can be used to counter the problem. Determine the existence and severity of the problem and develop effective counter-measures can be developed. Technical assistance from USFWS biologists and/or CDFG personnel should be available to identify to Base authorities an appropriate fish and/or aquatic vegetation control method.

Basic water quality measurements (D.O., temperature, and pH) should be taken, at a minimum, twice a year, once in summer and once in winter. These are the simplest of measurements to obtain and the most important to gauge general water quality from one year to the next.

Contaminants

Recommendations from the State of California, Department of Human Health Services (received via phone conversation) were that Pulgas Lake fish are not suitable for human consumption (official documentation is expected). Based on this information, warning signs should be posted at Pulgas Lake informing users of the fish contamination problem. This warning should inform these users of the high mercury levels in the fish.

All Base game wardens should be made aware of the heavy metal contamination. Warning signs should be posted at the game wardens office and at any other Base fishing license vender. Base fishing regulations should contain a warning for anglers informing them of the Pulgas Lake fish contamination. It would also be advisable to make public announcements using local media (i.e. radio, newspaper) to inform potential users of the contamination problem.

It may also be appropriate for Base personnel to collect more samples of fish tissue for heavy metal analysis in the future.

Fish Management

Warmwater species are the most appropriate fish for management activities in Pulgas Lake. Largemouth bass are a premier sportfish in California and their population is healthy and strong in Pulgas Lake. According to data collected for this report, they have the potential of being the primary "trophy" fishery in Pulgas Lake.

A catch and release fishery is the only fishery management option available following recommendations made by Department of Human Health Services. Physical handling of the fish would not pose a threat to human health.

This catch and release option would maintain a sufficient predator base, and limit the population of bluegill and other prey species. This regulation would also help maintain high densities of bass to effectively reduce densities of young panfish. This should reduce intra-specific competition and allow prey survivors to attain size preferred by anglers (Gablehouse, 1984). Over time this should provide a higher quality crappie, and bluegill fishery and provide a sustained quality fishery for large sized bass.

We do not recommend managing Pulgas Lake using the existing Base fishing regulations. As stated previously, warning statements should be incorporated into Base fishing regulations stating the fact of heavy metal accumulation in Pulgas Lake fish. Regulations should be changed to catch and release fishing only. We do not recommend stocking any fish into Pulgas Lake or transferring any fish from Pulgas Lake to any other waters until further testing is done. This new information could then be evaluated in regards to Pulgas Lake fish for human consumption.

Black crappie are abundant in good quality numbers and represent the primary panfish fishery for Pulgas Lake. Crappie are popular with fishermen because of their preference for concentrating around structures. This allows their locations to be identified by anglers and provides the opportunity to catch many fish. They are also a hardy, tolerant fish. Given a productive environment black crappie can grow to their potential as the largest of the "panfish". They have a preference for aquatic vegetation and thus black crappie populations should continue to thrive in Pulgas Lake.

Bluegill and the few redear sunfish present should provide an occasional quality-size panfish also. An added value of the bluegill population is their reproductive potential and associated prey food base for bass and large crappies.

The occasional channel catfish and brown bullhead caught will provide for an added surprise to the angler.

We believe the resident population of largemouth bass, black crappie, and bluegill, along with the other species present, can sustain a substantial recreational fishery. The primary fishery would be largemouth bass. A substantial panfish population also exists as an additional quality fishery.

Based on past data and our water quality information, the lake could support a winter/spring catchable trout fishery, probably from December into March, although we do not have good temperature data to know the exact length of favorable conditions. However, these fish would not survive the summer temperatures in the lake. Stocking trout is not a recommended fishery for Pulgas Lake.

Habitat Manipulation

Largemouth bass, black crappie, and bluegill have a high preference for aquatic vegetation and underwater structures (Mosher, 1984; Reininger, 1984). In addition to the existing aquatic vegetation, we recommend cover structures be placed at easy bank access areas to provide added protection for fish, and substrate for food items. These structures would mainly serve as focal points for anglers. The current fisheries literature indicates evergreen tree structures provide the best combination of cover type, fish preference, angler accessibility, and cost effectiveness (Johnson and Lynch, 1988; Mosher, 1984).

Used Christmas trees have proven to be very effective structures when arranged in circles of three or more with branches overlapping 0.1 meter. Structures placed in depths of about four meters had the best results if the metalimnion (thermocline zone) was below that point (Lynch and Johnson, 1988). Although the evergreen trees need to be replaced after several years (Johnson and Lynch, 1988), they are very inexpensive (tree collection after Christmas) and easy to construct. The Sport Fishing Institute has produced a "Guide to the Construction of Freshwater Artificial Reefs" (Phillips, 1991), which details many inexpensive designs, mostly geared to bass, panfish, and channel catfish. A copy of this booklet is attached (Appendix E).

We believe the addition of three evergreen tree structures located near 1994 water quality sample sites identified in Figures 4 and 13 may be beneficial to fish and anglers. Many used Christmas trees should be available on the Base. Construction cost would be less than $5.00 per structure if volunteer labor is used. A concrete block is required for each tree to keep it anchored on the bottom.

Location of the structures can best be placed in the deeper areas using the depth contour map provided (Figure 13). It would be advantageous to have them close enough to shore so they can be fished by bank anglers yet far enough away so as not to create a snagging hazard to them.

It would be advantageous to encourage catfish spawning in Pulgas Lake by placing spawning containers in the lake. Catfish need a dark area to successfully spawn. These containers can easily be built of wood, or could be old plastic or metal containers. An ideal example of container size is the old fashion metal milk containers. Container size should be at least 400 mm x 400 mm x 1000 mm. Place containers at depths of 1 to 1.5 m and 10 m apart. The more containers placed in the lake the higher the probability of spawning.

Since no fish have been stocked in Pulgas Lake for many years it is obvious that existing populations are self sustaining (except channel catfish and brown bullhead). This supports the assumption that spawning substrate is sufficient for those species present. Therefore, no manipulation of habitat is needed for spawning success of other species.

Fishing Access

Pulgas Lake has extensively vegetated areas around most of the lake while bank access is at two main points (Figures 4 and 13). These two access areas are the focal points for bank anglers. This allows for a quality fishing experience for small boat anglers. We recommend that boats which are allowed on Pulgas Lake be either man-powered or powered by electric motors only. The lake is too small for any gas-powered motors which would pose serious safety concerns.

The addition of a few picnic tables at the access areas would increase the value of the recreational experience at Pulgas Lake. Since not all users are anglers, these tables would attract a wide variety of users interested in enjoying the great outdoors.

The Base should also consider building a handicap fishing dock or platform near the main access point identified as site #1 (Figures 4 and 13) for year-round access. It would be close to one of the recommended evergreen cover structures. Pulgas Lake fishing would offer good therapy for disabled or otherwise handicapped people, if sufficient access were developed.

Monitoring and Program Evaluation

Although we believe our recommendations will result in a sustained quality recreational fishery in Pulgas Lake, adequate monitoring and evaluation are an

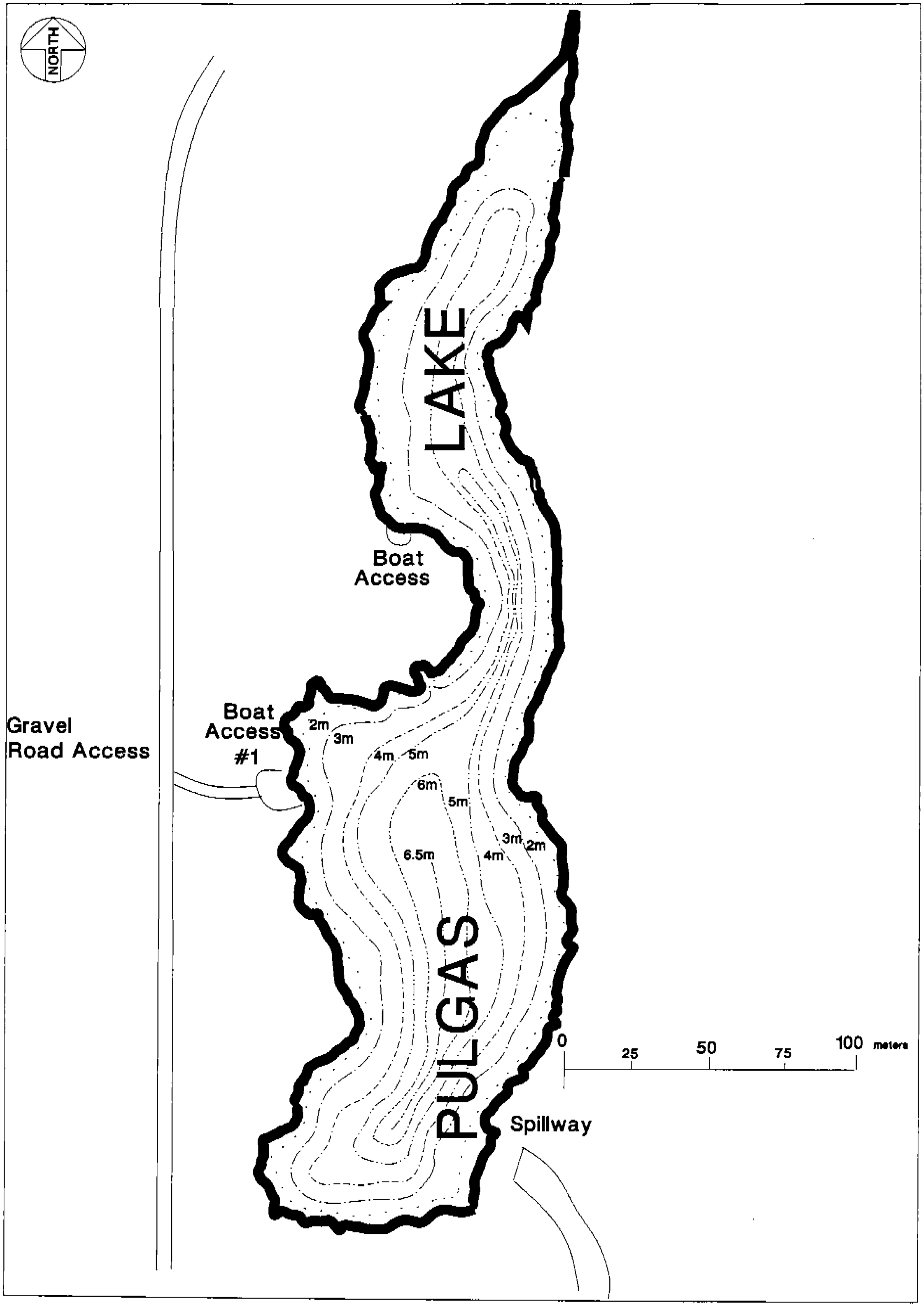


Figure 13. Contour map of Pulgas Lake with depth in meters (m).

essential part of any fishery management plan. An analysis of angler use and catch by Base personnel would yield valuable information concerning the status of sustainable fish populations. A simple census program may also identify the level of angler satisfaction with the fishery.

Several approaches are feasible to collect this data. Because the Base issues permits to fish Pulgas Lake, an opportunity exists to incorporate an angler survey form into the permit process. The data collected from the form would include; number of anglers, hours fished, fish of each species caught, fish size, type of fishing (boat vs. shore), angler satisfaction level, etc. An angler survey box could easily be constructed at the lake with a brief explanation of the purpose of the survey. This box could provide the survey forms to be filled out and a drop box for completed angler surveys.

Better information could be collected through a consistent and accurate creel census conducted throughout the fishing season. A random sampling of days during the season is acceptable if fishing days are stratified into "high use" and "low use" days (e.g. weekends and holidays, vs. weekdays). The expansion, done on a weekly basis for days not covered, will be statistically accurate if the information collected for the days covered each week is complete. The more fishing days covered, the smaller the standard error and variance of the harvest estimates.

A creel checker must count the effort at regular time intervals during legal fishing hours. The time interval should be shorter than the average angler day. A two-hour interval is a good starting point. At the appropriate hour, the creel checker counts the number of people actually fishing. Separate counts for bank anglers and boat anglers are kept. For example:

1) Time interval is 2 hours. 2) Legal fishing is 6 a.m. to 8 p.m.

| Count Times | Angler Count |
|---|---|
| 0700 | 20 |
| 0900 | 25 |
| 1100 | 15 |
| 1300 | 5 |
| 1500 | 10 |
| 1700 | 30 |
| 1900 | 15 |
| | 120 |

120 total anglers counted x 2 hour time interval = 240 angler hours for the day.

The count for each hour represents the average effort for the hour before and the hour after the count.

During the time between the counts, the creel checker surveys the anglers. Data from "completed efforts", anglers who are finished fishing at that time, is preferred. Specific information needed is: date and time of day of interview, where did they fish (boat or bank), how many hours did each person fish (nearest 30 minutes), numbers and species of fish caught, lengths of fish caught. If the angler is checked again, only the time and fish caught since he resumed fishing will be counted. The creel checker should contact as many anglers as possible during this time. In the above example, if there was 120 hours of effort but only 20 hours accounted for by creel census the daily harvest estimate will have a large variance and standard error.

Catch per angler hour per day and total catch per week should be calculated from the data. This should be done for each species caught, by boat and bank angler, by keeping stratified days separate to expand for days not covered. The weekly totals can then be summed.

Biological sampling of the fish population is a useful tool for determining if progress is being made toward management objectives. The cost and level of expertise required to effectively sample fish is minimal. In the case of Pulgas Lake, we believe passive gear, such as gill nets (similar to those used in this study), fished at alternate sites, in a specific yearly time period, and under rigid deployment specifications, can easily provide valuable fish population information. Sampling sites at various locations in the lake each spring, during May or June, is best. Relative abundance of each species and length frequencies of fish would be useful in determining if black crappie, largemouth bass, and other fish are increasing in size and/or numbers as desired. Sampling sites should be established after cover structures have been established.

Following the gill net fishing protocol described in the methods section of this report is a simple and easy method to use.

## SUMMARY OF RECOMMENDATIONS

Water Quality:

1. Monitoring of basic water quality is recommended twice each year. Base personnel should measure oxygen, pH, and temperature every summer and winter.

2. If excessive oxygen depletion is noted, mechanical, chemical, and biological control methods can be used.

Contaminants:

1. It is advisable to take additional samples for continued monitoring of heavy metal contamination in Pulgas Lake fish. Analysis of these results would need to be done by the State of California Department of Human Health Services (Contact: Dr. Jerry Pollack; toxicologist, phone:# 619-323-9667).

2. Warning signs should be posted at Pulgas Lake informing users of heavy metal (mercury) contamination in fish.

3. Warning signs should be posted at the Base game wardens office and any other CPMCB fishing license vender informing anglers of Pulgas Lake fish contamination.

4. Base fishing regulations should contain a warning for anglers informing them of the Pulgas Lake fish contamination.

5. Public announcements should include the local media (i.e. radio, newspaper) informing potential users of the contamination (heavy metal) problem in Pulgas Lake.

6. Training activities using mortars or explosives should avoid Pulgas Lake and its tributaries as targets.

7. Training activities using pyrotechnic devices should not allow these cartridges in or around Pulgas Lake or its tributaries.

Fish Management:

1. The resident population of bass, crappie, and bluegill, along with the other species, supports a quality recreational fishery.

2. Fish in Pulgas Lake are not fit for human consumption according to State of California officials (official documentation is expected). The physical handling of these fish will not harm people. We therefore, recommend a catch and release fishery.

3. A catch and release fishing only regulation should be implemented prior to allowing any fishing in Pulgas Lake. This will also maintain a sufficient predator base to keep down the population of bluegill and other prey species.

4. Catfish spawning containers could be added in 1 to 1.5 m of water, spaced 10 m apart to promote natural catfish spawning.

5. A trout fishery would be costly with limited return to the angler. We do not recommend a trout stocking program in Pulgas Lake.

Habitat Manipulation:

1. The addition of 3 Christmas tree structures at the same areas used for water quality sampling would be beneficial to fish and anglers, especially bank anglers. These cover structures should be placed within easy reach of access points to provide protection for fish, substrate for food items, and increased fish abundance in areas used by bank anglers.

2. Warning signs should be posted at each access point warning users of the steep banks and slippery soil all around the lake.

Fishing Access:

1. The Base should consider building a handicap fishing dock or platform near the access area #1 (Figure 13) for year-round access.

2. Boat access should be limited to man-powered boats or those with electric motors only.

3. Picnic tables should be placed at both lake access areas.

Monitoring and Program Evaluation:

1. Adequate monitoring and evaluating by Base personnel or USFWS are essential for a successful fishery management plan.

2. An analysis of angler use and catch by base personnel will yield valuable information concerning the status of the fish population.

3. An angler survey box should be placed at the lake with a brief explanation of the purpose of the survey. This box will provide survey forms to be filled out and an attached drop box for completed angler surveys.

4. Information could be collected through a consistent and accurate creel census conducted throughout the fishing season.

5. Biological sampling (e.g. standardized gill net sampling, seining, electrofishing) would be a simple and useful tool in determining if progress is being made toward management objectives. Sample sites should be monitored each year in May or June.

**ACKNOWLEDGEMENTS**

This report could not have been completed without the help and support of the U.S. Marine Corps and the AC/S, ES at Camp Pendleton. A special thank you goes to Dave Boyer, Chris Stevenson, Rick Griffiths and Paul Kanonas for background information and logistical support. We would like to acknowledge the support and help of Dr. Jerry Pollack of the State of California, Department of Human Health Services. Thanks are also due to Cyndie Wolfe now with USFWS Region 7, Anchorage AK (formerly with Coastal California Fish and Wildlife Office) for her long hours of field assistance and her editing comments. Also thanks are due to Tom Kisanuki and Rick Griffiths for their editing comments.

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# APPENDICES

## APPENDIX A
## Lab Methods and Water Quality Results

RECEIVED 16 SEP 1991

QUALITY ASSURANCE LABORATORY
6605 NANCY RIDGE DRIVE
SAN DIEGO, CALIFORNIA 92121
(619) 552-3636

CAMP PENDLETON
NATURAL RESOURCES OFFICE
ATTN: HARRY KULU
MARINE CORPS BASE BLDG. 2276
CAMP PENDLETON, CA 92055-5010

| | |
|---|---|
| DATE OF REPORT | SEPTEMBER 12, 1991 |
| DATE RECEIVED | SEPTEMBER 3, 1991 |
| DATE OF SAMPLE | SEPTEMBER 3, 1991 |
| DATE COMPLETED | SEPTEMBER 11, 1991 |
| ANALYZED BY | KL MF NC PL HC |
| SAMPLE TYPE | 1 LIQUID |
| PROJECT NAME | LOS PULGAS LAKE |

ANALYSES RESULTS

LOG NUMBER: 13122-91
SAMPLE ID: P168

| ANALYSIS | METHOD | UNITS | P168 |
|---|---|---|---|
| BOD | STD 5210-B | MG/L | 10 |
| CHLORINE RESIDUAL | STD 4500-G | MG/L | <0.1 |
| MBAS | STD 5540-C | MG/L | 0.07 |
| FORMALDEHYDE | MOD 3M 4-A | MG/L | 0.64 |
| COPPER | 6010 | MG/L | <0.007 |
| COLIFORM | STD 9221-B | MPN/100ML | ≥1,600 |
| FECAL | STD 9221-C | MPN/100ML | 240 |

Same Samples Sweet
Residual Chlorine
Copper drop
— fish all three suits

Whole suit of metals
2-3 sediment samples (finest sediment possible)
PCB-A money available
total hydrocarbon
Organo-Chlorine Pesticide val
PCB - ...

PET
LAB
PS/

6-20-94

U.S. FISH AND WILDLIFE SERVICE
ANALYSES RESULTS
SAMPLE TYPE - POND WATER

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | UNITS | LOG NUMBER: 9845-9406 SAMPLE ID: PULGAS L. #1TOP | 9846-9406 PULGAS L. #1BOTTOM |
|---|---|---|---|---|
| TOTAL ALKALINITY | STD 2320-B | MG/L | 265 | 254 |
| BICARBONATE | STD 2320-B | MG/L | 265 | 254 |
| BOD | STD 5210-B | MG/L | 13.5 | 14.0 |
| COD | STD 5220-D | MG/L | 16.0 | 185 |
| ORTHO-PHOSPHATE-P | STD 4500-E | MG/L | <0.10 | 0.28 |
| TOTAL PHOSPHATE-P | STD 4500-P:E | MG/L | <0.10 | 2.52 |
| TDS | STD 2540-C | MG/L | 694 | 343 |
| TOTAL NITROGEN | CALC* | MG/L | <1.0 | 4.1 |
| AMMONIA-N | STD 4500-C | MG/L | <0.10 | 0.34 |
| NITRATE-N | EPA 300 | MG/L | 0.47 | 0.67 |
| NITRITE-N | EPA 300 | MG/L | <0.5 | <0.5 |
| TKN | STD 4500-B:C | MG/L | <1.0 | 3.4 |
| CHLORIDE | EPA 300 | MG/L | 139 | 137 |
| SULFATE | EPA 300 | MG/L | 130 | 125 |
| HARDNESS | 3020/2340-B | MG/L | 365 | 421 |
| SILICON | 3020/6010 | MG/L | 2.70 | 45.1 |

DATE EXTRACTED: 6-10-94 - BOD, HARDNESS, SILICON

DATE ANALYZED:
6-10-94 - ORTHO-PHOSPHATE-P, NITRATE-N, CHLORIDE
6-13-94 - COD, HARDNESS, SILICON
6-14-94 - TOTAL PHOSPHATE-P, TDS, AMMONIA-N
6-15-94 - TOTAL ALKALINITY, BICARBONATE, BOD, TKN
6-17-94 - TOTAL NITROGEN

* - CALCULATION BASED UPON RESULTS OF NITRATE-N, NITRITE-N, AND TKN

PETER T.L. SHEN
LABORATORY DIRECTORY

PS/dmc

QUALITY ASSURANCE
LABORATORY

6-20-94

U.S. FISH AND WILDLIFE SERVICE
ANALYSES RESULTS
SAMPLE TYPE - POND WATER

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | UNITS | LOG NUMBER: 9847-9406<br>SAMPLE ID: PULGAS L. #2 TOP | LOG NUMBER: 9848-9406<br>SAMPLE ID: PULGAS L. #2 BOTTOM |
|---|---|---|---|---|
| TOTAL ALKALINITY | STD 2320-B | MG/L | 258 | 263 |
| BICARBONATE | STD 2320-B | MG/L | 258 | 263 |
| BOD | STD 5210-B | MG/L | <3.0 | 3.0 |
| COD | STD 5220-D | MG/L | 15.0 | 14.0 |
| ORTHO-PHOSPHATE-P | STD 4500-E | MG/L | <0.10 | <0.10 |
| TOTAL PHOSPHATE-P | STD 4500-B:E | MG/L | <0.10 | <0.10 |
| TDS | STD 2540-C | MG/L | 675 | 681 |
| TOTAL NITROGEN | CALC* | MG/L | <1.0 | <1.0 |
| AMMONIA-N | STD 4500-C | MG/L | <0.10 | <0.10 |
| NITRATE-N | EPA 300 | MG/L | 0.46 | 0.52 |
| NITRITE-N | EPA 300 | MG/L | <0.5 | <0.5 |
| TKN | STD 4500-B:C | MG/L | <1.0 | <1.0 |
| CHLORIDE | EPA 300 | MG/L | 147 | 145 |
| SULFATE | EPA 300 | MG/L | 129 | 137 |
| HARDNESS | 3020/2340-B | MG/L | 328 | 343 |
| SILICON | 3020/6010 | MG/L | 2.41 | 2.56 |

DATE EXTRACTED: 6-10-94 - BOD, HARDNESS, SILICON

DATE ANALYZED:
6-10-94 - ORTHO-PHOSPHATE-P, NITRATE-N, CHLORIDE
6-13-94 - COD, HARDNESS, SILICON
6-14-94 - TOTAL PHOSPHATE-P, TDS, AMMONIA-N
6-15-94 - TOTAL ALKALINITY, BICARBONATE, BOD, TKN
6-17-94 - TOTAL NITROGEN

* - CALCULATION BASED UPON RESULTS OF NITRATE-N, NITRITE-N, AND TKN

PETER T.L. SHEN
LABORATORY DIRECTORY

PS/dmc

**QUALITY ASSURANCE**
**LABORATORY**

**WATER QUALITY**
**FIELD DATA COLLECTION SHEET**

DATE/TIME 6/10/94 WEATHER partly cloudy [illegible]
COLLECTORS [illegible] WATER SURFACE TEMPERATURE C 24.25
STEAM/LAKE [illegible] TEST LOCATION P1

| WATER PROFILE DEPTH (m) | TEMPERATURE (C) | DO(ppm) | pH | COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS |
|---|---|---|---|---|
| surface | 24.25 | 6.2 | | |
| 1 m | 24.25 | 6.0 | | |
| 2 m | 24 | 6.0 | | |
| 3 m | 24 | 6.0 | | |
| 5.2 (bottom) | 20 | 5.5 | | |
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TEST TYPE Ph (bottom) COMMENTS:
BIOLOGIST JB
RESULTS 7.25

TEST TYPE Ph (surface) COMMENTS:
BIOLOGIST JB
RESULTS 7.25

TEST TYPE Nitrite (bottom) COMMENTS:
BIOLOGIST CW
RESULTS < .05 ppm

TEST TYPE $CO_2$ COMMENTS:
BIOLOGIST JB
RESULTS 12 (bottom) 7.0 (top) ppm

TEST TYPE Nitrite (top) COMMENTS:
BIOLOGIST CW
RESULTS < .05

TEST TYPE COMMENTS:
BIOLOGIST
RESULTS

TEST TYPE COMMENTS:
BIOLOGIST
RESULTS

TEST TYPE COMMENTS:
BIOLOGIST
RESULTS

TEST TYPE COMMENTS:
BIOLOGIST
RESULTS

TEST TYPE COMMENTS:
BIOLOGIST
RESULTS

**WATER QUALITY**
**FIELD DATA COLLECTION SHEET**

DATE/TIME 6/10/94 1225 WEATHER partly cloudy, warm + breezy
COLLECTORS JB CW
STREAM/LAKE Pulgas
WATER SURFACE TEMPERATURE C 24°
TEST LOCATION P2

**WATER PROFILE**

| DEPTH (m) | TEMPERATURE (C) | DO(ppm) | pH | COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS |
|---|---|---|---|---|
| surface | 24° | 6.0 | | |
| 3rd bottom | 23.5 | 5.6 | | |
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TEST TYPE pH
BIOLOGIST JB
RESULTS 7.25 top + bottom
COMMENTS:

TEST TYPE $CO_2$
BIOLOGIST JB
RESULTS 7ppm (top) 90 (bottom)
COMMENTS:

TEST TYPE Nitrite
BIOLOGIST CW
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
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TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

WATER QUALITY
FIELD DATA COLLECTION SHEET

DATE/TIME 7/21/94 1530 WEATHER Clear Sunny warm
COLLECTORS [illegible] WATER SURFACE TEMPERATURE°C
STEAM/LAKE Pulcas TEST LOCATION

| WATER PROFILE DEPTH (m) | TEMPERATURE °C | DO(ppm) | pH | COMMENTS: i.e. METHODS, GEAR USED UNUSUAL OBSERVATIONS |
|---|---|---|---|---|
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P3 surf

TEST TYPE $O_2$ - 6.2 ppm
BIOLOGIST Temp : 27
RESULTS $CO_2$ : [illegible] ppm
COMMENTS: Ph: 6.74 D.O probe not [illegible]

P3 bottom

TEST TYPE [illegible] 6.2 ppm
BIOLOGIST [illegible] 26.5
RESULTS $CO_2$ 3 ppm
COMMENTS: Ph 6.45

P1 surf

TEST TYPE $O_2$ 5.8 ppm
BIOLOGIST temp : 27
RESULTS $CO_2$ : 4 ppm
COMMENTS: Ph 6.71

P1 bottom

TEST TYPE $O_2$ 5.6 ppm
BIOLOGIST temp 27
RESULTS [illegible]
COMMENTS: Ph 6.48

P2 surf

TEST TYPE $O_2$ 6.4 ppm
BIOLOGIST [illegible] 28
RESULTS $CO_2$ 4 [illegible]
COMMENTS: 6.67

P2 bottom

TEST TYPE [illegible] 6.[illegible]
BIOLOGIST [illegible]
RESULTS [illegible] 4 ppm
COMMENTS: 6.53

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

P1 [illegible] near parked truck
P2 [illegible] 5 [illegible] end
P3 [illegible]

## WATER QUALITY
## FIELD DATA COLLECTION SHEET

DATE/TIME 9-21-94 1530 WEATHER Sunny Warm
COLLECTORS [illegible] WATER SURFACE TEMPERATURE°C 24.0
STEAM/LAKE [illegible] Lake TEST LOCATION P1 + P3

P#3 (N end [illegible])

P1 (middle [illegible])

| WATER PROFILE DEPTH (m) | TEMPERATURE (C) | DO(ppm) | pH | COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS Conductivity |
|---|---|---|---|---|
| Surf | 25 | 6.3 | 6.18 | 1150 |
| 1m | 25 | [illegible] | | |
| 2m | 24.5 | [illegible] | | |
| | | | | |
| bottom (2.5m) | 24.5 | [illegible] | [illegible] | |
| surf | [illegible] | [illegible] | 6.33 | 1150 |
| 1m | 25 | [illegible] | | |
| 2m | 25 | [illegible] | | |
| bottom (2.75m) | 24.5 | [illegible] | 6.25 | |
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TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
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TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

TEST TYPE ____ COMMENTS:
BIOLOGIST ____
RESULTS ____

# WATER QUALITY
# FIELD DATA COLLECTION SHEET

DATE/TIME 9/21/90 [illegible] WEATHER Clear, sunny, warm
COLLECTORS [illegible] WATER SURFACE TEMPERATURE C
STEAM/LAKE Pulaski [illegible] TEST LOCATION P3/2 S. end of Lake

| | WATER PROFILE DEPTH (m) | TEMPERATURE (C) | DO(ppm) | pH | COMMENTS: i.e. METHODS, GEAR USED OBSERVATIONS Conduct |
|---|---|---|---|---|---|
| P3 | Surf | 26 | 6.9 | 5.3 | 1160 |
| | 1m | 26 | 6.6 | | |
| 2 | 2m | 25.5 | 4.6 | | |
| | bottom 2.25m | 25 | .2 | 6.5 | |
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TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

TEST TYPE
BIOLOGIST
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COMMENTS:

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TEST TYPE
BIOLOGIST
RESULTS
COMMENTS:

# APPENDIX B
## Lab Methods and Contaminant Results

Environmental Engineering Laboratory
3538 Hancock Street
San Diego, CA 92110
(619) 298-6131

QUALITY ASSURANCE LAB
6605 NANCY RIDGE DR.
SAN DIEGO , CA
92121

Formaldehyde

Comment : ATTN: MICHELE NICOL (POND WATER)

Sampled : 06/09/94 00:00 M
Received : 06/09/94 04:35 PM

| | Additional Test | | |
|---|---|---|---|
| 9854-9406 / 11:38<br>940607768 | CH2O ND mg/L | --- | --- |
| 9855 / 11:30<br>940607769 | CH2O ND mg/L | --- | --- |

Detection Limit: 0.15

ND = None Detected

Reported by

06/10/94
Date

**Quality Assurance Laboratory**
6605 NANCY RIDGE DRIVE
SAN DIEGO, CALIFORNIA 92121
(619) 552-3636



U.S. FISH & WILDLIFE SERVICE
ATTN: JERRY BERG
1125 16TH ST., ROOM 209
ARCATA, CA 95521

| | |
|---|---|
| DATE OF REPORT | 7-27-94 |
| DATE SAMPLE RECEIVED | 7-19-94 |
| SAMPLING DATE | 7-19-94 |
| ANALYZED BY | SC HC |
| SAMPLE TYPE | POND WATER |
| PROJECT NAME | PULGAS LAKE JULY 1994 |

## ANALYSES RESULTS

| LOG NUMBER | SAMPLE ID | ANALYSIS: PREP/ANALYSIS METHOD: UNITS: | MBAS STD 5540-C MG/L | COLIFORM STD 9221-B MPN/100ML | FECAL COLIFORM STD 9221-C MPN/100ML |
|---|---|---|---|---|---|
| 11892-9407 | PULGAS LAKE SITE 1 TOP | | <0.05 | 23 | 23 |
| 11893-9407 | PULGAS LAKE SITE 2 TOP | | | 80 | 80 |
| 11894-9407 | PULGAS LAKE SITE 3 TOP | | | 170 | <2 |

DATE ANALYZED: 7-19-94 - MBAS
7/19-22/94 - COLIFORM, FECAL COLIFORM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

**Quality Assurance Laboratory**
6605 NANCY RIDGE DRIVE
SAN DIEGO, CALIFORNIA 92121
(619) 552-3636



U.S. FISH & WILDLIFE SERVICE
ATTN: JERRY BERG
1125 16TH ST., ROOM 209
ARCATA, CA 95521

| | |
|---|---|
| DATE OF REPORT | 7-27-94 |
| DATE SAMPLE RECEIVED | 7-21-94 |
| SAMPLING DATE | 7-21-94 |
| ANALYZED BY | SC MM |
| SAMPLE TYPE | 3 POND WATER |
| PROJECT NAME | PULGAS LAKE |

**ANALYSES RESULTS**

| LOG NUMBER | SAMPLE ID | ANALYSIS: CHLORINE RESIDUAL<br>PREP/ANALYSIS METHOD: STD 4500-G<br>UNITS: MG/L |
|---|---|---|
| 11991-9407 | P1 794T | 0.11 |
| 11992-9407 | P2 794T | 0.11 |
| 11993-9407 | P3 794T | 0.12 |

DATE ANALYZED: 7-21-94 - CHLORINE RESIDUAL

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

8-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - SEDIMENT

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: / SAMPLE ID: / UNITS: | 11994-9407 P1A-7945 MG/KG | 11995-9407 P1B-7945 MG/KG | 11996-9407 P2A-7945 MG/KG |
|---|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | <5.00 | <5.00 | <5.00 |
| ARSENIC | 3050/7060 | | 2.43 | 2.60 | 2.25 |
| BARIUM | 3050/6010 | | 73.0 | 84.7 | 111 |
| BERYLLIUM | 3050/6010 | | 0.479 | 0.616 | 0.674 |
| CADMIUM | 3050/6010 | | <0.800 | <0.800 | <0.800 |
| CHROMIUM | 3050/6010 | | 7.23 | 8.03 | 10.8 |
| COBALT | 3050/6010 | | 4.31 | 4.98 | 6.34 |
| COPPER | 3050/6010 | | 7.74 | 8.76 | 10.3 |
| LEAD | 3050/6010 | | 5.44 | 5.76 | 7.02 |
| MERCURY | 7471 | | 0.600 | 0.500 | 1.40 |
| MOLYBDENUM | 3050/6010 | | <0.500 | <0.500 | <0.500 |
| NICKEL | 3050/6010 | | 4.08 | 4.49 | 9.58 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 | <0.500 |
| SILVER | 3050/6010 | | <0.400 | <0.400 | <0.400 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | 20.0 | 23.1 | 28.7 |
| ZINC | 3050/6010 | | 29.5 | 35.4 | 101 |

DATE EXTRACTED: 7-25-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MERCURY, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC

DATE ANALYZED: 7-26-94 - ANTIMONY, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SILVER, VANADIUM, ZINC
7-27-94 - THALLIUM
7-28-94 - ARSENIC, SELENIUM
7-29-94 - MERCURY

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

QUALITY ASSURANCE
LABORATORY

8-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - SEDIMENT

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: / SAMPLE ID: / UNITS: | 11997-9407 / P3A-7945 / MG/KG | 11998-9407 / P3B-7945 / MG/KG |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | <5.00 | <5.00 |
| ARSENIC | 3050/7060 | | 1.60 | 2.35 |
| BARIUM | 3050/6010 | | 56.1 | 98.1 |
| BERYLLIUM | 3050/6010 | | 0.361 | 0.674 |
| CADMIUM | 3050/6010 | | <0.800 | <0.800 |
| CHROMIUM | 3050/6010 | | 5.31 | 9.62 |
| COBALT | 3050/6010 | | 3.50 | 5.91 |
| COPPER | 3050/6010 | | 5.34 | 9.44 |
| LEAD | 3050/6010 | | 3.47 | 5.97 |
| MERCURY | 7471 | | <0.500 | 0.800 |
| MOLYBDENUM | 3050/6010 | | <0.500 | <0.500 |
| NICKEL | 3050/6010 | | 4.49 | 9.58 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 |
| SILVER | 3050/6010 | | <0.400 | <0.400 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | 15.1 | 26.8 |
| ZINC | 3050/6010 | | 23.9 | 40.6 |

DATE EXTRACTED: 7-25-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MERCURY, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC

DATE ANALYZED: 7-26-94 - ANTIMONY, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SILVER, VANADIUM, ZINC
7-27-94 - THALLIUM
7-28-94 - ARSENIC, SELENIUM
7-29-94 - MERCURY

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

QUALITY ASSURANCE
LABORATORY

**Quality Assurance Laboratory**
6605 NANCY RIDGE DRIVE
SAN DIEGO, CALIFORNIA 92121
(619) 552-3636

U.S. FISH & WILDLIFE SERVICE
ATTN:JERRY BERG
1125 16TH STREET, RM 209
ARCATA, CA 95521

| | |
|---|---|
| DATE OF REPORT | 8-3-94 |
| DATE SAMPLE RECEIVED | 7-21-94 |
| SAMPLING DATE | 7-21-94 |
| ANALYZED BY | EA TH DW MAC MV |
| SAMPLE TYPE | SEDIMENT |
| PROJECT NAME | PULGAS LAKE |

## ANALYSES RESULTS

| LOG NUMBER | SAMPLE ID | ANALYSIS: TPH<br>PREP/ANALYSIS METHOD: 3550/DHS *<br>UNITS: MG/KG |
|---|---|---|
| 11994-9407 | P1A-7945 | <10.0 |
| 11995-9407 | P1B-7945 | <10.0 |
| 11996-9407 | P2A-7945 | <10.0 |
| 11997-9407 | P3A-7945 | <10.0 |
| 11998-9407 | P3B-7945 | <10.0 |

TPH - TOTAL PETROLEUM HYDROCARBONS. SAMPLES ANALYZED FOR HYDROCARBON RANGE C4 - C23.

DHS - RECOMMENDED PROCEDURE FROM LEAKING UNDERGROUND FUEL TANK FIELD MANUAL, OCTOBER 1989.

* EXTRACTABLES

DATE EXTRACTED: 7-28-94 - TPH

DATE ANALYZED: 8-1-94 - TPH

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

08/03/94

U.S. FISH & WILDLIFE SERVICE
EXTRACTION METHOD: EPA 3550/3620/3660
ANALYSIS METHOD: EPA 8080
DATE EXTRACTED: 7-26-94
DATE ANALYZED: 7-27-94
ORGANOCHLORINE PESTICIDES AND PCBs
SAMPLE TYPE - SEDIMENT

| ANALYSIS | DETECTION LIMIT UG/KG | 11994-9407 P1A-7945 UG/KG | 11995-9407 P1B-7945 UG/KG | 11996-9407 P2A-7945 UG/KG |
|---|---|---|---|---|
| 4,4' - DDD | 0.5 | ND | ND | ND |
| 4,4' - DDE | 0.5 | ND | ND | ND |
| 4,4' - DDT | 0.4 | ND | ND | ND |
| ALDRIN | 0.2 | ND | ND | ND |
| ALPHA-BHC | 0.6 | ND | ND | ND |
| BETA-BHC | 0.6 | ND | ND | ND |
| CHLORDANE | 25 | ND | ND | ND |
| DELTA-BHC | 0.6 | ND | ND | ND |
| DIELDRIN | 0.3 | ND | ND | ND |
| ENDOSULFAN I | 0.3 | ND | ND | ND |
| ENDOSULFAN II | 0.5 | ND | ND | ND |
| ENDOSULFAN SULFATE | 0.4 | ND | ND | ND |
| ENDRIN | 0.4 | ND | ND | ND |
| ENDRIN ALDEHYDE | 0.5 | ND | ND | ND |
| HEPTACHLOR | 0.2 | ND | ND | ND |
| HEPTACHLOR EPOXIDE | 0.3 | ND | ND | ND |
| LINDANE | 0.3 | ND | ND | ND |
| METHOXYCHLOR | 25 | ND | ND | ND |
| TOXAPHENE | 25 | ND | ND | ND |
| AROCLOR-1016 | 50 | ND | ND | ND |
| AROCLOR-1221 | 50 | ND | ND | ND |
| AROCLOR-1232 | 50 | ND | ND | ND |
| AROCLOR-1242 | 50 | ND | ND | ND |
| AROCLOR-1248 | 50 | ND | ND | ND |
| AROCLOR-1254 | 50 | ND | ND | ND |
| AROCLOR-1260 | 50 | ND | ND | ND |

ND = NONE DETECTED
SECOND COLUMN VERIFICATION PERFORMED.

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

08/03/94

U.S. FISH & WILDLIFE SERVICE
EXTRACTION METHOD: EPA 3550/3620/3660
ANALYSIS METHOD: EPA 8080
DATE EXTRACTED: 7-26-94
DATE ANALYZED: 7-27-94
ORGANOCHLORINE PESTICIDES AND PCBs
SAMPLE TYPE - SEDIMENT

| ANALYSIS | DETECTION LIMIT UG/KG | 11997-9407 P3A-7945 UG/KG | 11998-9407 P3B-7945 UG/KG |
|---|---|---|---|
| 4,4' - DDD | 0.5 | ND | ND |
| 4,4' - DDE | 0.5 | ND | ND |
| 4,4' - DDT | 0.4 | ND | ND |
| ALDRIN | 0.2 | ND | ND |
| ALPHA-BHC | 0.6 | ND | ND |
| BETA-BHC | 0.6 | ND | ND |
| CHLORDANE | 25 | ND | ND |
| DELTA-BHC | 0.6 | ND | ND |
| DIELDRIN | 0.3 | ND | ND |
| ENDOSULFAN I | 0.3 | ND | ND |
| ENDOSULFAN II | 0.5 | ND | ND |
| ENDOSULFAN SULFATE | 0.4 | ND | ND |
| ENDRIN | 0.4 | ND | ND |
| ENDRIN ALDEHYDE | 0.5 | ND | ND |
| HEPTACHLOR | 0.2 | ND | ND |
| HEPTACHLOR EPOXIDE | 0.3 | ND | ND |
| LINDANE | 0.3 | ND | ND |
| METHOXYCHLOR | 25 | ND | ND |
| TOXAPHENE | 25 | ND | ND |
| AROCLOR-1016 | 50 | ND | ND |
| AROCLOR-1221 | 50 | ND | ND |
| AROCLOR-1232 | 50 | ND | ND |
| AROCLOR-1242 | 50 | ND | ND |
| AROCLOR-1248 | 50 | ND | ND |
| AROCLOR-1254 | 50 | ND | ND |
| AROCLOR-1260 | 50 | ND | ND |

ND = NONE DETECTED
SECOND COLUMN VERIFICATION PERFORMED.

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

QUALITY ASSURANCE
LABORATORY

# QUALITY ASSURANCE LABORATORY

## QUALITY CONTROL DATA REPORT

August 3, 1994
**U.S. FISH AND WILDLIFE SERVICE**
LOG #11994-9407 THROUGH 11998-9407

**DATE EXTRACTED:**
JULY 25, 1994- ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MERCURY, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC

| ANALYSES | PREP/ANALYSIS METHOD | LCS % RECOVERY | SPIKE %RECOVERY | DUPLICATE RPD |
|---|---|---|---|---|
| **METALS ANALYSIS (TITTLE 22 - TTLC)** | | | | |
| ANTIMONY | 3050/6010 | 93% | 100% | 0% |
| ARSENIC | 3050/7060 | 88% | 71% | 25% |
| BARIUM | 3050/6010 | 95% | 100% | 1% |
| BERYLLIUM | 3050/6010 | 98% | 104% | 1% |
| CADMIUM | 3050/6010 | 94% | 104% | <1% |
| CHROMIUM | 3050/6010 | 96% | 102% | <1% |
| COBALT | 3050/6010 | 96% | 103% | 1% |
| COPPER | 3050/6010 | 97% | 102% | <1% |
| LEAD | 3050/6010 | 94% | 101% | <1% |
| MERCURY | 7471 | 88% | 100% | 0% |
| MOLYBDENUM | 3050/6010 | 96% | 102% | 1% |
| NICKEL | 3050/6010 | 95% | 104% | 2% |
| SELENIUM | 3050/7740 | 97% | 74% | 3% |
| SILVER | 3050/6010 | 94% | 102% | 1% |
| THALLIUM | 3050/7841 | 84% | 84% | 1% |
| VANADIUM | 3050/6010 | 96% | 102% | 1% |
| ZINC | 3050/6010 | 100% | 103% | 2% |

Rebecca L. Rush
REBECCA L. RUSH
QA/QC SPECIALIST

QUALITY CONTROL TERMINOLOGY

LCS - LABORATORY CONTROL STANDARD. REPORTED AS % RECOVERY OF AN INDEPENDENT STANDARD CARRIED THROUGH ALL SAMPLE PREPARATION PROCEDURES TO VERIFY METHOD PERFORMANCE. ACCEPTABLE RANGE IS BASED ON HISTORICAL LABORATORY CONTROL DATA AND EPA REQUIREMENTS. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SPIKE - ENVIRONMENTAL SAMPLE IS MATRIX SPIKED WITH METHOD COMPOUNDS AND % RECOVERY OF CONCENTRATION SPIKED INTO SAMPLE IS CALCULATED. REPORTED AS % RECOVERY. ACCEPTABLE RANGE FOR "NORMAL MATRIX SAMPLE" IS BASED ON HISTORICAL LABORATORY CONTROL DATA. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SURROGATES - COMPOUNDS REPRESENTATIVE OF A GROUP OF COMPOUNDS. SURROGATES ARE SPIKED INTO ENVIRONMENTAL SAMPLES AND % RECOVERY OF CONCENTRATION SPIKED IS CALCULATED AND REPORTED. ACCEPTABLE RANCE VARIES DEPENDING ON SAMPLE MATRIX AND ANALYSIS METHOD. ANY OUT OF CONTROL DATA IS CLEARLY INDICATED.

# QUALITY ASSURANCE LABORATORY

## QUALITY CONTROL DATA REPORT

August 3, 1994

**U.S. FISH AND WILDLIFE SERVICE**
LOG #11994-9407 THROUGH 11998-9407

**DATE EXTRACTED:**
JULY 28, 1994- TPH

| ANALYSES | PREP/ANALYSIS METHOD | LCS %RECOVERY | SPIKE %RECOVERY | DUPLICATE RPD |
|---|---|---|---|---|
| TPH | 3550/DHS | 90% | 85% | 0% |

Rebecca L. Rush
REBECCA L. RUSH
QA/QC SPECIALIST

QUALITY CONTROL TERMINOLOGY

LCS - LABORATORY CONTROL STANDARD. REPORTED AS % RECOVERY OF AN INDEPENDENT STANDARD CARRIED THROUGH ALL SAMPLE PREPARATION PROCEDURES TO VERIFY METHOD PERFORMANCE. ACCEPTABLE RANGE IS BASED ON HISTORICAL LABORATORY CONTROL DATA AND EPA REQUIREMENTS. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SPIKE - ENVIRONMENTAL SAMPLE IS MATRIX SPIKED WITH METHOD COMPOUNDS AND % RECOVERY OF CONCENTRATION SPIKED INTO SAMPLE IS CALCULATED. REPORTED AS % RECOVERY. ACCEPTABLE RANGE FOR "NORMAL MATRIX SAMPLE" IS BASED ON HISTORICAL LABORATORY CONTROL DATA. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SURROGATES - COMPOUNDS REPRESENTATIVE OF A GROUP OF COMPOUNDS. SURROGATES ARE SPIKED INTO ENVIRONMENTAL SAMPLES AND % RECOVERY OF CONCENTRATION SPIKED IS CALCULATED AND REPORTED. ACCEPTABLE RANGE VARIES DEPENDING ON SAMPLE MATRIX AND ANALYSIS METHOD. ANY OUT-OF-CONTROL DATA IS CLEARLY INDICATED.

# QUALITY ASSURANCE LABORATORY

## QUALITY CONTROL DATA REPORT

August 3, 1994
**U.S. FISH AND WILDLIFE SERVICE**
LOG #11994-9407 THROUGH 11998-9407
DATE EXTRACTED: JULY 26, 1994
DATE ANALYZED: JULY 27, 1994
EXTRACTION METHOD: 3550/3620/3660
ANALYSIS METHOD: 8080

**METHOD BLANK**

NO TARGET ANALYTES WERE DETECTED IN THE METHOD BLANK.

**LABORATORY CONTROL SAMPLE**

| COMPOUNDS | % RECOVERY |
|---|---|
| gamma-BHC | 91% |
| Heptachlor | 89% |
| Aldrin | 90% |
| Dieldrin | 96% |
| Endrin | 99% |
| 4,4-DDT | 94% |

**SPIKE DATA**

| COMPOUND | SPIKE % RECOVERY | DUPLICATE RPD |
|---|---|---|
| gamma-BHC | 35% | 3% |
| Heptachlor | 51% | 19% |
| Aldrin | 55% | 4% |
| Dieldrin | 69% | 8% |
| Endrin | 78% | 9% |
| 4,4-DDT | 85% | 9% |

Rebecca L. Rush

REBECCA L. RUSH
QA/QC SPECIALIST

QUALITY CONTROL TERMINOLOGY

LCS - LABORATORY CONTROL STANDARD. REPORTED AS % RECOVERY OF AN INDEPENDENT STANDARD CARRIED THROUGH ALL SAMPLE PREPARATION PROCEDURES TO VERIFY METHOD PERFORMANCE. ACCEPTABLE RANGE IS BASED ON HISTORICAL LABORATORY CONTROL DATA AND EPA REQUIREMENTS. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.

SPIKE - ENVIRONMENTAL SAMPLE IS MATRIX SPIKED WITH METHOD COMPOUNDS AND % RECOVERY OF CONCENTRATION SPIKED INTO SAMPLE IS CALCULATED. REPORTED AS % RECOVERY. ACCEPTABLE RANGE FOR "NORMAL MATRIX SAMPLE" IS BASED ON HISTORICAL LABORATORY CONTROL DATA. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.

SURROGATES - COMPOUNDS REPRESENTATIVE OF A GROUP OF COMPOUNDS. SURROGATES ARE SPIKED INTO ENVIRONMENTAL SAMPLES AND % RECOVERY OF CONCENTRATION SPIKED IS CALCULATED AND REPORTED. ACCEPTABLE RANGE VARIES DEPENDING ON SAMPLE MATRIX AND ANALYSIS METHOD. ANY OUT-OF-CONTROL DATA IS CLEARLY INDICATED.

10-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - FISH FILLET

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: / SAMPLE ID: / UNITS: | 15423-9409 PFB1FRL MG/KG | 15424-9409 PFB2FR MG/KG |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | 1.83 | <1.70 |
| ARSENIC | 3050/7060 | | <0.500 | <0.500 |
| BARIUM | 3050/6010 | | <2.80 | <2.80 |
| BERYLLIUM | 3050/6010 | | <0.300 | <0.300 |
| CADMIUM | 3050/6010 | | <0.300 | <0.300 |
| CHROMIUM | 3050/6010 | | <0.300 | <0.300 |
| COBALT | 3050/6010 | | <1.20 | <1.20 |
| COPPER | 3050/6010 | | <0.900 | <0.900 |
| LEAD | 3050/6010 | | <2.00 | <2.00 |
| MERCURY | 7471 | | 0.900 | 0.600 |
| MOLYBDENUM | 3050/6010 | | <0.900 | <0.900 |
| NICKEL | 3050/6010 | | <1.20 | <1.20 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 |
| SILVER | 3050/6010 | | 0.230 | <0.200 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | <1.70 | <1.70 |
| ZINC | 3050/6010 | | 4.74 | 5.74 |

DATE EXTRACTED: 9-27-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
9-29-94 - MERCURY

DATE ANALYZED: 9-28-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, VANADIUM, ZINC
9-29-94 - MERCURY, THALLIUM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

10-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - FISH FILLET

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: SAMPLE ID: UNITS: | 15425-9409 PFCR1FRL MG/KG | 15426-9409 PFCR2FRL MG/KG |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | 2.03 | <1.70 |
| ARSENIC | 3050/7060 | | <0.500 | <0.500 |
| BARIUM | 3050/6010 | | <2.80 | <2.80 |
| BERYLLIUM | 3050/6010 | | <0.300 | <0.300 |
| CADMIUM | 3050/6010 | | <0.300 | <0.300 |
| CHROMIUM | 3050/6010 | | <0.300 | <0.300 |
| COBALT | 3050/6010 | | <1.20 | <1.20 |
| COPPER | 3050/6010 | | <0.900 | <0.900 |
| LEAD | 3050/6010 | | <2.00 | <2.00 |
| MERCURY | 7471 | | 0.750 | 0.850 |
| MOLYBDENUM | 3050/6010 | | <0.900 | <0.900 |
| NICKEL | 3050/6010 | | <1.20 | <1.20 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 |
| SILVER | 3050/6010 | | 0.218 | 0.834 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | <1.70 | <1.70 |
| ZINC | 3050/6010 | | 5.57 | 6.34 |

DATE EXTRACTED: 9-27-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
9-29-94 - MERCURY

DATE ANALYZED: 9-28-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, VANADIUM, ZINC
9-29-94 - MERCURY, THALLIUM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

QUALITY ASSURANCE
LABORATORY

10-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - FISH FILLET

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: SAMPLE ID: UNITS: | 15427-9409 PFCT1FR MG/KG | 15428-9409 PFB3FR MG/KG |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | <1.70 | <1.70 |
| ARSENIC | 3050/7060 | | <0.500 | <0.500 |
| BARIUM | 3050/6010 | | <2.80 | <2.80 |
| BERYLLIUM | 3050/6010 | | <0.300 | <0.300 |
| CADMIUM | 3050/6010 | | <0.300 | <0.300 |
| CHROMIUM | 3050/6010 | | <0.300 | <0.300 |
| COBALT | 3050/6010 | | <1.20 | <1.20 |
| COPPER | 3050/6010 | | <0.900 | <0.900 |
| LEAD | 3050/6010 | | <2.00 | <2.00 |
| MERCURY | 7471 | | <0.500 | 0.900 |
| MOLYBDENUM | 3050/6010 | | <0.900 | <0.900 |
| NICKEL | 3050/6010 | | <1.20 | <1.20 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 |
| SILVER | 3050/6010 | | 0.713 | 0.435 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | <1.70 | <1.70 |
| ZINC | 3050/6010 | | 5.81 | 4.67 |

DATE EXTRACTED: 9-27-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
9-29-94 - MERCURY

DATE ANALYZED: 9-28-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, VANADIUM, ZINC
9-29-94 - MERCURY, THALLIUM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

10-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - FISH FILLET

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: 15429-9409<br>SAMPLE ID: PFB61FRL<br>UNITS: MG/KG |
|---|---|---|
| ANTIMONY | 3050/6010 | 2.70 |
| ARSENIC | 3050/7060 | <0.500 |
| BARIUM | 3050/6010 | <2.80 |
| BERYLLIUM | 3050/6010 | <0.300 |
| CADMIUM | 3050/6010 | <0.300 |
| CHROMIUM | 3050/6010 | 0.308 |
| COBALT | 3050/6010 | <1.20 |
| COPPER | 3050/6010 | <0.900 |
| LEAD | 3050/6010 | <2.00 |
| MERCURY | 7471 | <0.500 |
| MOLYBDENUM | 3050/6010 | <0.900 |
| NICKEL | 3050/6010 | <1.20 |
| SELENIUM | 3050/7740 | <0.500 |
| SILVER | 3050/6010 | 0.242 |
| THALLIUM | 3050/7841 | <0.500 |
| VANADIUM | 3050/6010 | <1.70 |
| ZINC | 3050/6010 | 7.62 |

DATE EXTRACTED: 9-27-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
9-29-94 - MERCURY

DATE ANALYZED: 9-28-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, VANADIUM, ZINC
9-29-94 - MERCURY, THALLIUM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

QUALITY ASSURANCE
LABORATORY

# QUALITY ASSURANCE LABORATORY

## QUALITY CONTROL DATA REPORT

October 3, 1994

**U.S. FISH & WILDLIFE SERVICE**
LOG #15423-9409 THROUGH 15429-9409

**DATE EXTRACTED:**

SEPTEMBER 27, 1994- ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
SEPTEMBER 29, 1994- MERCURY

### TITLE 22 METALS ANALYSIS

| ANALYSES | PREP/ANALYSIS METHOD | LCS % RECOVERY | SPIKE % RECOVERY | DUPLICATE RPD |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | 95% | 89% | 1% |
| ARSENIC | 3050/7060 | 103% | 90% | 2% |
| BARIUM | 3050/6010 | 96% | 96% | 1% |
| BERYLLIUM | 3050/6010 | 101% | 102% | 2% |
| CADMIUM | 3050/6010 | 92% | 88% | <1% |
| CHROMIUM | 3050/6010 | 98% | 97% | 1% |
| COBALT | 3050/6010 | 97% | 94% | <1% |
| COPPER | 3050/6010 | 96% | 96% | <1% |
| LEAD | 3050/6010 | 91% | 87% | 0% |
| MERCURY | 7471 | 98% | 93% | 0% |
| MOLYBDENUM | 3050/6010 | 98% | 95% | 2% |
| NICKEL | 3050/6010 | 95% | 93% | 1% |
| SELENIUM | 3050/7740 | 99% | 95% | 4% |
| SILVER | 3050/6010 | 88% | 75% | 6% |
| THALLIUM | 3050/7841 | 98% | 93% | 2% |
| VANADIUM | 3050/6010 | 99% | 97% | <1% |
| ZINC | 3050/6010 | 93% | 90% | <1% |

Valerie Shen
VALERIE SHEN
QA/QC ANALYST

QUALITY CONTROL TERMINOLOGY

LCS - LABORATORY CONTROL STANDARD. REPORTED AS % RECOVERY OF AN INDEPENDENT STANDARD CARRIED THROUGH ALL SAMPLE PREPARATION PROCEDURES TO VERIFY METHOD PERFORMANCE. ACCEPTABLE RANGE IS BASED ON HISTORICAL LABORATORY CONTROL DATA AND EPA REQUIREMENTS. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SPIKE - ENVIRONMENTAL SAMPLE IS MATRIX SPIKED WITH METHOD COMPOUNDS AND % RECOVERY OF CONCENTRATION SPIKED INTO SAMPLE IS CALCULATED. REPORTED AS % RECOVERY. ACCEPTABLE RANGE FOR "NORMAL MATRIX SAMPLE" IS BASED ON HISTORICAL LABORATORY CONTROL DATA. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SURROGATES - COMPOUNDS REPRESENTATIVE OF A GROUP OF COMPOUNDS. SURROGATES ARE SPIKED INTO ENVIRONMENTAL SAMPLES AND % RECOVERY OF CONCENTRATION SPIKED IS CALCULATED AND REPORTED. ACCEPTABLE RANGE VARIES DEPENDING ON SAMPLE MATRIX AND ANALYSIS METHOD. ANY OUT-OF-CONTROL DATA IS CLEARLY INDICATED.

10-3-94

U.S. FISH & WILDLIFE SERVICE
TITLE 22 - METALS
SAMPLE TYPE - WHOLE FISH

## ANALYSES RESULTS

| ANALYSIS | PREP/ANALYSIS METHOD | LOG NUMBER: SAMPLE ID: UNITS: | 15430-9409 PFB1W35S MG/KG | 15431-9409 PFB6W25S MG/KG |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | | 7.15 | 4.89 |
| ARSENIC | 3050/7060 | | <0.500 | <0.500 |
| BARIUM | 3050/6010 | | <2.80 | <2.80 |
| BERYLLIUM | 3050/6010 | | <0.300 | <0.300 |
| CADMIUM | 3050/6010 | | <0.300 | <0.300 |
| CHROMIUM | 3050/6010 | | 0.610 | 0.376 |
| COBALT | 3050/6010 | | <1.20 | <1.20 |
| COPPER | 3050/6010 | | 2.02 | <0.900 |
| LEAD | 3050/6010 | | <2.00 | <2.00 |
| MERCURY | 7471 | | <0.500 | <0.500 |
| MOLYBDENUM | 3050/6010 | | <0.900 | <0.900 |
| NICKEL | 3050/6010 | | <1.20 | <1.20 |
| SELENIUM | 3050/7740 | | <0.500 | <0.500 |
| SILVER | 3050/6010 | | 0.435 | 0.447 |
| THALLIUM | 3050/7841 | | <0.500 | <0.500 |
| VANADIUM | 3050/6010 | | <1.70 | <1.70 |
| ZINC | 3050/6010 | | 23.3 | 20.0 |

DATE EXTRACTED: 9-27-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
9-29-94 - MERCURY

DATE ANALYZED: 9-28-94 - ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, VANADIUM, ZINC
9-29-94 - MERCURY, THALLIUM

PETER T.L. SHEN
LABORATORY DIRECTOR

PS/jb

# QUALITY ASSURANCE LABORATORY

## QUALITY CONTROL DATA REPORT

October 3, 1994

**U.S. FISH & WILDLIFE SERVICE**
LOG #15430-9409 THROUGH 15431-9409

**DATE EXTRACTED:**

SEPTEMBER 27, 1994- ANTIMONY, ARSENIC, BARIUM, BERYLLIUM, CADMIUM, CHROMIUM, COBALT, COPPER, LEAD, MOLYBDENUM, NICKEL, SELENIUM, SILVER, THALLIUM, VANADIUM, ZINC
SEPTEMBER 29, 1994- MERCURY

**TITLE 22 METALS ANALYSIS**

| ANALYSES | PREP/ANALYSIS METHOD | LCS % RECOVERY | SPIKE % RECOVERY | DUPLICATE RPD |
|---|---|---|---|---|
| ANTIMONY | 3050/6010 | 95% | 89% | 1% |
| ARSENIC | 3050/7060 | 103% | 90% | 2% |
| BARIUM | 3050/6010 | 96% | 96% | 1% |
| BERYLLIUM | 3050/6010 | 101% | 102% | 2% |
| CADMIUM | 3050/6010 | 92% | 88% | <1% |
| CHROMIUM | 3050/6010 | 98% | 97% | 1% |
| COBALT | 3050/6010 | 97% | 94% | <1% |
| COPPER | 3050/6010 | 96% | 96% | <1% |
| LEAD | 3050/6010 | 91% | 87% | 0% |
| MERCURY | 7471 | 98% | 93% | 0% |
| MOLYBDENUM | 3050/6010 | 98% | 95% | 2% |
| NICKEL | 3050/6010 | 95% | 93% | 1% |
| SELENIUM | 3050/7740 | 99% | 95% | 4% |
| SILVER | 3050/6010 | 88% | 75% | 6% |
| THALLIUM | 3050/7841 | 98% | 93% | 2% |
| VANADIUM | 3050/6010 | 99% | 97% | <1% |
| ZINC | 3050/6010 | 93% | 90% | <1% |

VALERIE SHEN
QA/QC ANALYST

QUALITY CONTROL TERMINOLOGY

LCS - LABORATORY CONTROL STANDARD. REPORTED AS % RECOVERY OF AN INDEPENDENT STANDARD CARRIED THROUGH ALL SAMPLE PREPARATION PROCEDURES TO VERIFY METHOD PERFORMANCE. ACCEPTABLE RANGE IS BASED ON HISTORICAL LABORATORY CONTROL DATA AND EPA REQUIREMENTS. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SPIKE - ENVIRONMENTAL SAMPLE IS MATRIX SPIKED WITH METHOD COMPOUNDS AND % RECOVERY OF CONCENTRATION SPIKED INTO SAMPLE IS CALCULATED. REPORTED AS % RECOVERY. ACCEPTABLE RANGE FOR "NORMAL MATRIX SAMPLE" IS BASED ON HISTORICAL LABORATORY CONTROL DATA. ANY OUT-OF-CONTROL QC DATA IS CLEARLY INDICATED.
SURROGATES - COMPOUNDS REPRESENTATIVE OF A GROUP OF COMPOUNDS. SURROGATES ARE SPIKED INTO ENVIRONMENTAL SAMPLES AND % RECOVERY OF CONCENTRATION SPIKED IS CALCULATED AND REPORTED. ACCEPTABLE RANGE VARIES DEPENDING ON SAMPLE MATRIX AND ANALYSIS METHOD. ANY OUT-OF-CONTROL DATA IS CLEARLY INDICATED.

# APPENDIX C
# EPA Standard Guidelines for Toxic Substances

# TOXIC SUBSTANCES MONITORING PROGRAM

## Ten Year Summary Report 1978 - 1987

90 - 1WQ
August 1990

*Reprinted January 1993*

WATER RESOURCES CONTROL BOARD
STATE OF CALIFORNIA

Chapter 3

# ADMINISTRATIVE AND COMPARATIVE CRITERIA

In this report, as in previous annual reports, the terms "selected criteria" or "criteria" are used to refer to the criteria against which a particular metal or organic chemical is being compared. As more than one criteria may apply to any one metal or organic compound, a hierarchy was established. The intent of the hierarchy is to compare data against the more important criteria. In general, human health-related criteria such as the FDA action levels and the "Median International Standards" (MIS) are considered more important or critical. Following human health criteria are predator protection criteria, such as the NAS guidelines. Last in the hierarchy is "elevated data levels" (EDL). The following is a description of the above mentioned criteria.

## FDA Action Levels and NAS Guidelines

The U.S. Food and Drug Administration (FDA) has established maximum concentration levels for some toxic substances in human foods (USFDA, 1985). The levels are based on specific assumptions of the quantities of food consumed by humans and upon the frequency of their consumption. The FDA limits are intended to protect humans from the chronic effects of toxic substances consumed in foodstuffs. The National Academy of Sciences (NAS) has established recommended maximum concentrations of toxic substance concentrations in fish tissue (NAS, 1973). They were established not only to protect the organisms containing the toxic compounds, but also to protect the species that consume these contaminated organisms. The specific action levels and guidelines used in this report are shown in Table 3.

## Median International Standards (MIS) for Trace Elements

The Food and Agriculture Organization of the United Nations has published a survey of health protection criteria used by member nations (Nauen, 1983). These criteria vary somewhat in the tissues to be analyzed or the level of protection desired, but may be compared qualitatively. Table 4 summarizes these standards as an indication of what other countries have determined to be unsafe levels of trace elements. Though the standards do not apply within the United States, they provide an indication of what other nations consider to be an elevated concentration of trace elements in fish tissues. Even so, the reader is reminded that most TSMP metal analyses are done in liver, rather than in edible portions. To date, only mercury and selenium are routinely measured in edible portions in the TSMP. Measurements in liver should not be compared to Median International Standards. A description of how the Median International Standards were compiled is provided in Appendix I.

## Elevated Data Levels

The "elevated data level" (EDL) was introduced in 1983 as an internal comparative measure which ranks a given concentration of a particular substance with previous data from the TSMP. The EDL is calculated by

## TABLE 3

Guidelines and Action Levels for Toxic Chemicals in Fish
(wet weight)

| Chemical | NAS[a] Recommended Guideline (Whole Fish) ug/g (ppm) | NAS[a] Recommended Guideline (Whole Fish) ng/g (ppb) | FDA[b] Action Level (Edible Portion) ug/g (ppm) | FDA[b] Action Level (Edible Portion) ng/g (ppb) |
|---|---|---|---|---|
| Mercury | 0.5 | 500 | 1.0[d] | 1,000 |
| DDT (total) | 1.0 | 1,000 | 5.0 | 5,000 |
| PCB (total) | 0.5 | 500 | 2.0[e] | 2,000 |
| aldrin | 0.1[c] | 100 | 0.3 | 300 |
| dieldrin | 0.1[c] | 100 | 0.3 | 300 |
| endrin | 0.1[c] | 100 | 0.3 | 300 |
| heptachlor | 0.1[c] | 100 | 0.3 | 300 |
| heptachlor epoxide | 0.1[c] | 100 | 0.3 | 300 |
| chlordane (total) | 0.1[c] | 100 | 0.3 | 300 |
| lindane | 0.1 | 100 | - | - |
| hexachlorocyclo-hexane (total) | 0.1[c] | 100 | - | - |
| endosulfan (total) | 0.1[c] | 100 | - | - |
| toxaphene | 0.1[c] | 100 | 5.0 | 5,000 |

a National Academy of Sciences-National Academy of Engineering, 1973. Water Quality Criteria, 1972 (Blue Book). U.S. Environmental Protection Agency, Ecological Research Series.

b U. S. Food and Drug Administration. 1984. Shellfish Sanitation Interpretation: Action Levels for Chemical and Poisonous Substances, June 21, 1984. U.S.F.D.A., Shellfish Sanitation Branch, Washington, D.C.

c Individually or in combination. Chemicals in this group under NAS Guidelines are referred to as Chemical Group A in this report.

d As methyl mercury.

e A tolerance, rather than an action level, has been established for PCBs (21CFR 109, published May 29, 1984). An action level is revoked when a regulation establishes a tolerance for the same substance and use.

TABLE C-1. COMPILATION OF LEGAL LIMITS FOR HAZARDOUS METALS IN FISH AND FISHERY PRODUCTS

| Country | Metals (ppm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | As | Cd | Cr | Cu | Hg | Pb | Sb | Se | Zn |
| Australia[a] | 1.0,1.5[b] | 0.2-5.5 | | 10-70 | 0.5,1.0 | 1.5-5.5 | 1.5 | 1.0,2.0 | 40-1,000 |
| Brazil | | | | | 0.5[c] | | | | |
| Canada | 3.5 | | | | 0.5 | 0.5 | | | |
| Chile | 0.12,1.0 | 0.5 | | 10 | | 2.0 | | 0.05,0.3 | 100 |
| Denmark | | | | | 0.5 | | | | |
| Ecuador | 1.0 | | | 10 | 1.0 | 5.0 | | | |
| Finland | 5.0 | | | | 1.0 | 2.0 | | | |
| France | | | | | 0.5,0.7 | | | | |
| Germany | | 0.5 | | | 1.0 | 0.5 | | | |
| Greece | | | | | 0.7 | | | | |
| Hong Kong | 1.4-10 | 2.0 | 1.0 | | 0.5 | 6.0 | 1.0 | | |
| India | 1.0 | | | 10 | 0.5[c] | 5.0 | | | 50 |
| Israel | | | | | 0.5 | | | | |
| Italy | | | | | 0.7[c] | 2.0 | | | |
| Japan | | | | | 0.3,0.4[c] | | | | |
| Korea | | | | | 0.5 | | | | |
| Netherlands | | 0.05-1.0 | | | 1.0[c] | 0.5,2.0 | | | |
| New Zealand | 1.0 | 1.0 | | 30 | 0.5[c] | 2.0 | 1.0 | 2.0 | 40 |
| Philippines | 3.0 | | | | 0.5 | 0.5 | | | |
| Poland | 4.0 | | | 10-30 | | 1.0-2.0 | | | 30-50 |
| Spain | | | | | 0.5 | | | | |
| Sweden | | | | | 1.0[c] | 1.0-2.0 | | | |
| Switzerland | | 0.1 | | | 0.5 | 1.0 | | | |
| Thailand | 2.0 | | | 20 | 0.5 | 1.0 | | | |
| United Kingdom | 1.0 | | | 20 | | 2.0-10 | | | 50 |
| United States | | | | | 1.0[c] | | | | |
| U.S.S.R. | | | | | 0.2-1.0 | | | | |
| Venezuela | 0.1 | 0,0.1 | | 10 | 0.1-0.5 | 2.0 | | | |
| Zambia | 3.5-5.0 | | | 100 | 0.2-0.3 | 0.5-10 | | | 100 |
| Range | | | | | | | | | |
| Minimum | 0.1 | 0 | 1.0 | 10 | 0.1 | 0.5 | 1.0 | 0.05 | 30 |
| Maximum | 10 | 5.5 | 1.0 | 100 | 1.0 | 10 | 1.5 | 2.0 | 1,000 |

[a] Limit varies among states.

[b] Inorganic.

[c] Total.

References: Nauen (1983); U.S. Food and Drug Administration (1982, 1984).

# SHELLFISH SANITATION
## interpretation

SUBJECT: Action Levels for Chemical and Poisonous Substances

NUMBER: S.S. 33



DATE: June 21, 1984

MANUAL REFERENCE: Part I- Section B.3, Section C.1(a), Section C.3(b), Section C.6(a)(1) and Section C.7(b)

ISSUE/PROBLEM

What limits have been established by the Food and Drug Administration for pesticides, toxic metals, marine biotoxins and other deleterious substances in shellfish?

INTERPRETATION

The Food and Drug Administration has established action levels, tolerances and other values for poisonous or deleterious substances in seafood. Some levels apply to fish only. Other limits apply to fish and shellfish including molluscan shellfish. Table 1 presents the levels effective on the date of issue of this interpretation. The reader is cautioned to note the applicable footnotes following Table 1.

PUBLIC HEALTH EXPLANATION

The types of poisonous or deleterious substances which have been recovered from shellfish include heavy metals, pesticides, petroleum products, polychlorinated biphenyls, and naturally occurring marine biotoxins. The source of these contaminants may be: industrial, agricultural, mining, spillage, sewage, dredging operations, sludge dumps, and naturally occurring marine organisms.

The NSSP had at one time considered the implementation of toxic metal guidelines for shellfish. However, no such guidelines have been accepted as a part of the program. The FDA has established action levels and tolerances for poisonous or deleterious substances to control the levels of contaminants in human food and animal feed, including seafood.

The action levels are established and revised according to criteria specified in the Code of Federal Regulations, (21CFR109 and 509) and are revoked when a regulation establishing a tolerance for the same substance and use becomes effective. Action levels and tolerances represent limits at or above which FDA will take legal action to remove adulterated products, including shellfish, from the market. Where no established action level or tolerance exists, FDA may take legal action against the product at the minimal detectalbe level of the contaminant. Action levels and tolerances, are established based on the unavoidability of the poisonous or deleterious substance and do not represent permissible levels of contamination where it is avoidable.

Table 1 lists action levels established by the FDA for poisonous or deleterious substances in seafood. This list is current as of June 1984. Notices will be published in the Federal Register as new action levels are estalbished or as existing action levels are revised or revoked. Should any of thises FR notices affect Table 1 FDA will issue an interpretation advising NSSP participants of this revision or addition.

Table 1. Action Levels, Tolerances and Other Values for Poisonous or Deleterious Substances in Seafood[a]

| Deleterious Substance | Level | Food Commodity[b] | Reference |
|---|---|---|---|
| Aldrin/Dieldrin[d] | 0.30 ppm | Fish & Shellfish | CPG 7120.23-A[c] |
| Chlordane | 0.30 ppm | Fish only | CPG 7120.23-C[c] |
| DDT, DDE, TDE | 5.00 ppm | Fish only | CPG 7120.23-D[c] |
| Endrin | 0.30 ppm | Fish & Shellfish | CPG 7120.23-F[c] |
| Heptachlor/ Heptachlor Epoxide | 0.30 ppm | Fish & Shellfish | CPG 7120.23-H[c] |
| Kepone | 0.30 ppm<br>0.40 ppm | Fish & Shellfish<br>Crabmeat | CPG 7120.23-I[c]<br>" " |
| Mercury[e] | 1.00 ppm | Fish & Shellfish | CPG 7108.07[c] |
| Mirex | 0.10 ppm | Fish only | CPG 7120.23-K[c] |
| Paralytic Shellfish Poison | 80mcg/100gm of meat | Fresh,frozen & canned clams,mussels & oysters | CPG 7108.20[c] |
| Polychlorinated Biphenyls (PCB's)[f] | 2.00 ppm | Fish & Shellfish | 21 CFR 109.30 |
| *Ptychodiscus brevis* toxin(s) | 20 mouse units/ 100g meat | Shellfish | APHA Lab. Procedures(14) |
| Toxaphene | 5.00 ppm | Fish only | CPG 7120.23-L[c] |

## Median International Standards

In 1982, the Food and Agricultural Organization (FAO) of the United Nations conducted a survey of standards and legal limits for metals including mercury, pesticides and other contaminants in fishery products. This was in response to frequent inquiries from institutions and companies active in international commerce that found it difficult finding such information.

The FAO surveyed nations that were members of the FAO as well as those who were not. Most nations cooperated with the survey and, in certain other cases, the standards were drawn from other sources. The FAO took all of the responses and presented them in a report entitled "Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products" (Nauen, 1983). Most of the limits were presented in a standard format and in standard units of fresh or live weight. Exceptions are clearly noted.

Nearly all of the standards for pesticides were from the United States (FDA standards). However, with the exception of mercury, the United States has no standards for trace metals in fishery products. It is this very lack of standards that makes interpretation of some of the TSM findings difficult.

Table E-1 summarizes the standards and guidelines for metals from the FAO report. The table notes whether the standards are for freshwater fish, marine fish, shellfish, or a combination of these. When more than one standard was listed by the FAO report, those values closest to a standard for "fresh weight, edible portion" were chosen. Exceptions are clearly noted in the table. Standards for each element are arranged in ascending order. The country of origin and the approximate date of adoption are also noted.

As can be seen in the Table E-1, some of the standards are not truly for edible portion, fresh weight. For example, some standards refer to canned products, or protein. In the case of India, the standards are on a dry weight basis. If the Indian standards were stated in fresh weight terms, they would be approximately one fifth or one sixth of the stated standard.

Table E-1 has many striking features. One feature is that most of the standards are surprisingly similar. Another feature is the large number of countries that have standards for metals. Also, although many of these countries are less developed nations, the standards adopted by these nations do not differ from those of the more developed nations.

The standards were not summarized for mercury because there is a USFDA standard of 1.0 ppm for methyl mercury in the edible portions of fish and shellfish. This was, incidentally, the highest limit set by any nation in the FAO study. The great majority of nations have set a mercury standard of 0.5 ppm.

Median International Standards presented in Table E-2 were calculated from the standards listed in Table E-1. The median standard was chosen for use for several reasons. The median is less influenced than the mean by outliers in the data. Also, direct comparisons of standards for fresh versus canned versus dry can be misleading. By using median standards these misleading comparisons can be more easily avoided. In most cases, the Median International Standard is actually a standard set by one or more nations rather than an average value not actually set by any country.

## TABLE E-1

### International Standards for Trace Elements in Fish and Molluscs

| Element | Standard | Freshwater Fish | Marine Fish | Molluscs/ Shellfish | Country | Approximate Date of Adoption |
|---|---|---|---|---|---|---|
| Antimony | 1.0 ppm | x | x | x | Hong Kong | 1983 |
| | 1.0 ppm | x | x | x | New Zealand | 1971 |
| | 1.5 ppm | x | x | x | Australia | 1982 |
| Arsenic | 0.1 ppm | x | x | x | Venezuela | - |
| | 1.0 ppm | x | x | x | Chile | - |
| | 1.0 ppm | d | d | x | India | - |
| | 1.0 ppm | x | x | x | New Zealand | 1971 |
| | 1.0 ppm | e | e | e | United Kingdom | 1959 |
| | 1.4 ppm | | | x | Hong Kong | 1983 |
| | 1.5 ppm | x | x | x | Australia | 1982 |
| | 1.5 ppm | c | c | c | Thailand | 1982 |
| | 3.5 ppm | p | p | | Canada | 1976 |
| | 5.0 ppm | x | x | x | Finland | 1980 |
| | 5.0 ppm | x | x | x | Zambia | 1976 |
| Cadmium | 0.05 ppm | x | x | | Netherlands | - |
| | 0.1 ppm | c | c | c | Switzerland | 1982 |
| | 0.1 ppm | | r | x | Venezuela | - |
| | 0.2 ppm | x | x | | Australia | 1982 |
| | 0.3 ppm | r | r | | Finland | - |
| | 0.5 ppm | x | | | W. Germany | 1979 |
| | 1.0 ppm | | | x | Netherlands | - |
| | 1.0 ppm | x | x | | New Zealand | 1971 |
| | 2.0 ppm | | | x | Australia | 1982 |
| | 2.0 ppm | x | x | x | Hong Kong | 1983 |
| Chromium | 1.0 ppm | x | x | x | Hong Kong | 1983 |
| Copper | 10.0 ppm | x | x | x | Chile | - |
| | 10.0 ppm | d | d | | India | - |
| | 10.0 ppm | | x | x | Venezuela | - |
| | 20.0 ppm | c | c | c | Thailand | 1982 |
| | 20.0 ppm | g | g | g | United Kingdom | 1956 |
| | 30.0 ppm | x | x | x | Australia | 1982 |
| | 30.0 ppm | x | x | x | New Zealand | 1971 |
| | 100.0 ppm | x | x | | Zambia | 1976 |
| Fluoride | 150.0 ppm | p | p | | Canada | 1979 |
| Fluorine | 10.0 ppm | x | x | | New Zealand | 1971 |
| | 25.0 ppm | x | x | | Zambia | 1976 |

p - in protein
e - except where natural levels are higher
c - in metal containers
g - recommended guideline
d - dry weight basis
r - revised limit (proposed)

## TABLE E-1 (continued)

### International Standards for Trace Elements in Fish and Molluscs

| Element | Standard | Freshwater Fish | Marine Fish | Molluscs/ Shellfish | Country | Approximate Date of Adoption |
|---|---|---|---|---|---|---|
| Lead | 0.5 ppm | p | p | | Canada | 1979 |
| | 0.5 ppm | x | | | W. Germany | 1979 |
| | 0.5 ppm | x | x | | Netherlands | - |
| | 1.0 ppm | x | x | x | Sweden | 1979 |
| | 1.0 ppm | c | c | c | Switzerland | 1982 |
| | 1.0 ppm | c | c | c | Thailand | 1982 |
| | 2.0 ppm | x | x | | Australia | 1982 |
| | 2.0 ppm | x | x | x | Chile | 1982 |
| | 2.0 ppm | | | x | Finland | 1980 |
| | 2.0 ppm | | | x | Italy | 1978 |
| | 2.0 ppm | | | x | Netherlands | - |
| | 2.0 ppm | x | x | | New Zealand | - |
| | 2.0 ppm | l | l | | Sweden | 1979 |
| | 2.0 ppm | x | x | | United Kingdom | 1980 |
| | 2.0 ppm | | x | x | Venezuela | - |
| | 2.5 ppm | | | x | Australia | 1982 |
| | 5.0 ppm | d | d | | India | - |
| | 6.0 ppm | x | x | x | Hong Kong | 1983 |
| | 10.0 ppm | x | x | | Zambia | 1976 |
| Mercury | International Standards for Mercury range from 0.1 ppm to 1.0 ppm. Twenty-eight countries have established standards for Mercury. The U. S. Food and Drug Administration has set an action level of 1.0 ppm in the edible portion of fish and molluscs. The median international standard is 0.5 ppm. | | | | | |
| Selenium | 0.3 ppm | x | x | x | Chile | 1982 |
| | 2.0 ppm | x | x | | Australia | 1982 |
| | 2.0 ppm | x | x | | New Zealand | 1971 |
| Tin | 50.0 ppm | x | x | | Australia | 1982 |
| | 100.0 ppm | | x | x | Venezuela | - |
| | 150.0 ppm | c | c | c | Finland | 1979 |
| | 150.0 ppm | x | x | | New Zealand | 1977 |
| | 230.0 ppm | x | x | x | Hong Kong | 1983 |
| | 250.0 ppm | d | d | | India | - |
| | 250.0 ppm | x | x | | Thailand | 1982 |
| | 250.0 ppm | g,c | g,c | g,c | United Kingdom | 1973 |
| Zinc | 40.0 ppm | x | x | x | Australia | 1982 |
| | 40.0 ppm | x | x | | New Zealand | 1971 |
| | 50.0 ppm | d | d | | India | - |
| | 50.0 ppm | g | g | | United Kingdom | 1953 |
| | 100.0 ppm | x | x | x | Chile | 1982 |
| | 100.0 ppm | x | x | | Zambia | 1976 |

p - in protein
e - except where natural levels are higher
c - in metal containers
l - in liver
g - recommended guideline
d - dry weight basis
r - revised limit (proposed)

TABLE E-2

Median International Standards for Trace Elements in Freshwater Fish and Marine Shellfish [a] (ppm, wet weight)

| Element | Fish | Shellfish | Range | Number of Countries with Standards |
|---|---|---|---|---|
| Antimony | 1.0 | 1.0 | 1.0 to 1.5 | 3 |
| Arsenic | 1.5 | 1.4 | 0.1 to 5.0 | 11 |
| Cadmium | 0.3 | 1.0 | 0.05 to 2.0 | 10 |
| Chromium | 1.0 | 1.0 | 1.0 | 1 |
| Copper | 20.0 | 20.0 | 10 to 100 | 8 |
| Fluoride | 150.0 | - | 150.0 | 1 |
| Fluorine | 17.5 | - | 10 to 25 | 2 |
| Lead | 2.0 | 2.0 | 0.5 to 10.0 | 19 |
| Mercury | 0.5 | 0.5 | 0.1 to 1.0 | 28 |
| Selenium | 2.0 | 0.3 | 0.3 to 2.0 | 3 |
| Tin | 150.0 | 190.0 | 50 to 250 | 8 |
| Zinc | 45.0 | 70.0 | 40 to 100 | 6 |

a Based on: Nauen, C. C., Compilation of Legal Limits for Hazardous Substances in Fish and Fishery Products, Food and Agriculture Organization of the United Nations, 1983.

The median was calculated as follows. All standards or guidelines (with the exception of the Indian standards which are based on dry weight) were considered to be more-or-less equivalent. For the purposes of calculating the median, the Indian standards were divided by five. The median was calculated as the middle value of all of the standards, (e.g., the fourth of seven values arranged in ascending order). In a few cases the number of standards was even. In this event, the two mid-values were averaged (most were not different). None of the adjusted dry-weight standards from India ended up as a median or as part of a mid-value pair.

For obvious reasons, the Median International Standards can only be used to provide a general idea of what other nations have chosen to use as a standard. The range of all values is listed in Table E-2 as a reminder of this. However, with the lack of American standards, Median International Standards can provide a guidepost for those responsible for interpreting trace metal findings in fish and shellfish tissue.

# APPENDIX D
## Camp Pendleton Fishing Regulations

NATURAL RESOURCES OFFICE
Marine Corps Base
Camp Pendleton, California 92055

11015
BF5/SGB/sgd
13 Jun 84

From: Director
To: Fishermen

Subj: CAMP PENDLETON FISHING REGULATIONS

1. The following information is provided to help you have an enjoyable fishing experience. Please read it carefully. This sheet provides only a brief summary of Camp Pendleton regulations. IT IS YOUR RESPONSIBILITY TO KNOW THE CURRENT CALIFORNIA DEPARTMENT OF FISH AND GAME FISHING REGULATIONS AS WELL AS PARAGRAPH 6105 OF BASE ORDER P5000.2F.

2. Personnel Authorized Fishing Privileges

a. Active duty military stationed on Camp Pendleton, Naval Weapons Station, Fallbrook, and Camp Pendleton Mountain Warfare Training Center, Bridgeport.

b. Retired military personnel.

c. Dependents of active duty and retired military. Dependents under 12 years of age must be accompanied by an adult.

d. Bona fide house guests of active duty or retired military who are NOT house guests for the purpose of fishing.

e. Civilian employees at Camp Pendleton, Naval Weapons Station, Fallbrook, or Camp Pendleton Mountain Warfare Training Center, Bridgeport.

f. Youth Groups. Permission must be obtained from the Director, Natural Resources Office.

g. Members of the general public are authorized surf-fishing privileges within an annual quota.

MEMBERS OF THE GENERAL PUBLIC ARE NOT ALLOWED FRESHWATER FISHING PRIVILEGES ON CAMP PENDLETON.

3. Licenses. All persons 16 years of age and older shall have in their immediate possession a current California Department of Fish and Game fishing license AND a Camp Pendleton fishing permit.

4. Check-out. All persons must call the Duty Warden, 725-3360, prior to going fishing to insure that the area is open. You need not call if you wish to fish in Lake O'Neill. Checking in from fishing is not required.

5. Available Areas.

a. Freshwater inland fishing is authorized ONLY at the following locations:

Lake O'Neill
Pulgas Lake
Case Springs, Pond No. 1
Witman Pond also called Case Springs No. 2 or "Little Case"
Ysidora Basin Infiltration Ponds
Santa Margarita Rive
Santa Margarita Slough (This area is CLOSED to fishing 1 April-1 September)
Las Flores Slough-from the I-5 bridge west to the ocean. Fishing is NOT allowed in Las Flores Marsh.
Broodmare Pond commonly called "Horse Lake" (GC 705820)
Pilgrim Creek Pond (GC 715820)

With the exception of Lake O'Neill, all freshwater lakes are located within training areas. The availability of these areas is based on military training requirements.

b. Surf-fishing, clamming and diving for fish mollusks and crusteceans is available in the following areas:

(1) The beach area extending from the southern boundary of San Onofre State Beach to the northern bank of the Santa Margarita River. This is open to military and civilian personnel.

(2) The waterfront extending from the Santa Margarita River on the north to the northern groin of the Del Mar Boat Basin, excluding the recreation beach. This is open only to military personnel, their dependents and bona fide house guests.

(3) Fishing from the northern jetty is permitted during daylight hours only.

(4) Clamming is also permitted for military personnel on San Onofre Beach.

(5) PLEASE PAY PARTICULAR ATTENTION TO THE FOLLOWING:

(a) Access to the northern beaches is authorized only through the Aliso or Las Flores underpasses and the Stuart Mesa overpass. Parking will be authorized in posted parking areas only. Operation of private motor vehicles is prohibited westerly of Interstate 5 except en route to and from approved camping or parking areas. Foot traffic will be limited to the valley and the beach frontage only. No civilian vehicles or civilian foot traffic will be allowed on the bluff areas.

(b) Swimming or surfing is prohibited in the surf-fishing area. This, however, does not apply to licensed fishermen using underwater breathing apparatus who must display proper flags and buoy.

6. <u>Fishing hours</u>

a. Freshwater - one hour before sunrise to one hour after sunset.

b. Saltwater - Fin fish - may be taken anytime day or night.

- Marine invertebrates (clams, crabs, shrimp, lobster, etc.). Check CDFG regulations.

If an area is not being used for military training or closed for other reasons, it is available for fishing.

7. **<u>Method of Take</u>**

a. **Freshwater** - Hook and line ONLY. <u>One</u> closely attended rod and line, or <u>one</u>

hand line. Other methods are allowed for frogs and crayfish. Persons interested in taking bullfrogs and/or crayfish should consult California Fish and Game regulations on legal methods of take.

b. Saltwater - Consult CDFG regulations.

8. Species/Seasons

a. Freshwater

| Species | Open-Season | Limit | Minimum Length |
|---|---|---|---|
| Black bass (includes large and small mouth bass) | All year | 5 | None |
| Trout | All year | 5 | None |
| Crappie, Sunfish (includes Bluegill) | All year | None | None |
| Catfish | All year | 20 | None |
| Bullhead | All year | None | None |
| Bullfrog | 1 July - 30 Nov | 12 | None |
| Crayfish | All year | None | None |

b. Saltwater. The variety of fin fish and marine invertebrates (clams, crab, shrimp, lobster etc.) available off Camp Pendleton are too numerous to list here. Anglers should consult current CDFG regulations for information on season length, limit, minimum length and methods of take

9. Violations. It is illegal to do any of the following. If observed by a Game Warden, you will be ISSUED A CITATION. Numbers in parenthesis refer to Title 14, California Administrative Code.

Fishing without a valid California fishing license in your immediate possession (700.0).

Refusal to show fishing licenses, fishing equipment or fish on demand. Fish and Game Code, Sec 2012

Freshwater fishing with more than one pole in the water (2.05).

Fishing with methods other than hook and line (1.14).

Having or attempting to take over the daily bag and possession limit (1.17).

Freshwater fishing at night (3.00).

Use of lights to take fin fish (2.15).

PAUL L. V. CAMPO

## APPENDIX E
## Construction of Artificial Reefs

A GUIDE TO THE CONSTRUCTION OF

# FRESHWATER ARTIFICIAL REEFS

Sport Fishing Institute

BASS

Anglers For Clean Water, Inc.

FishAmerica Foundation

**Published by**
**The Sport Fishing Institute**
**April 1991**

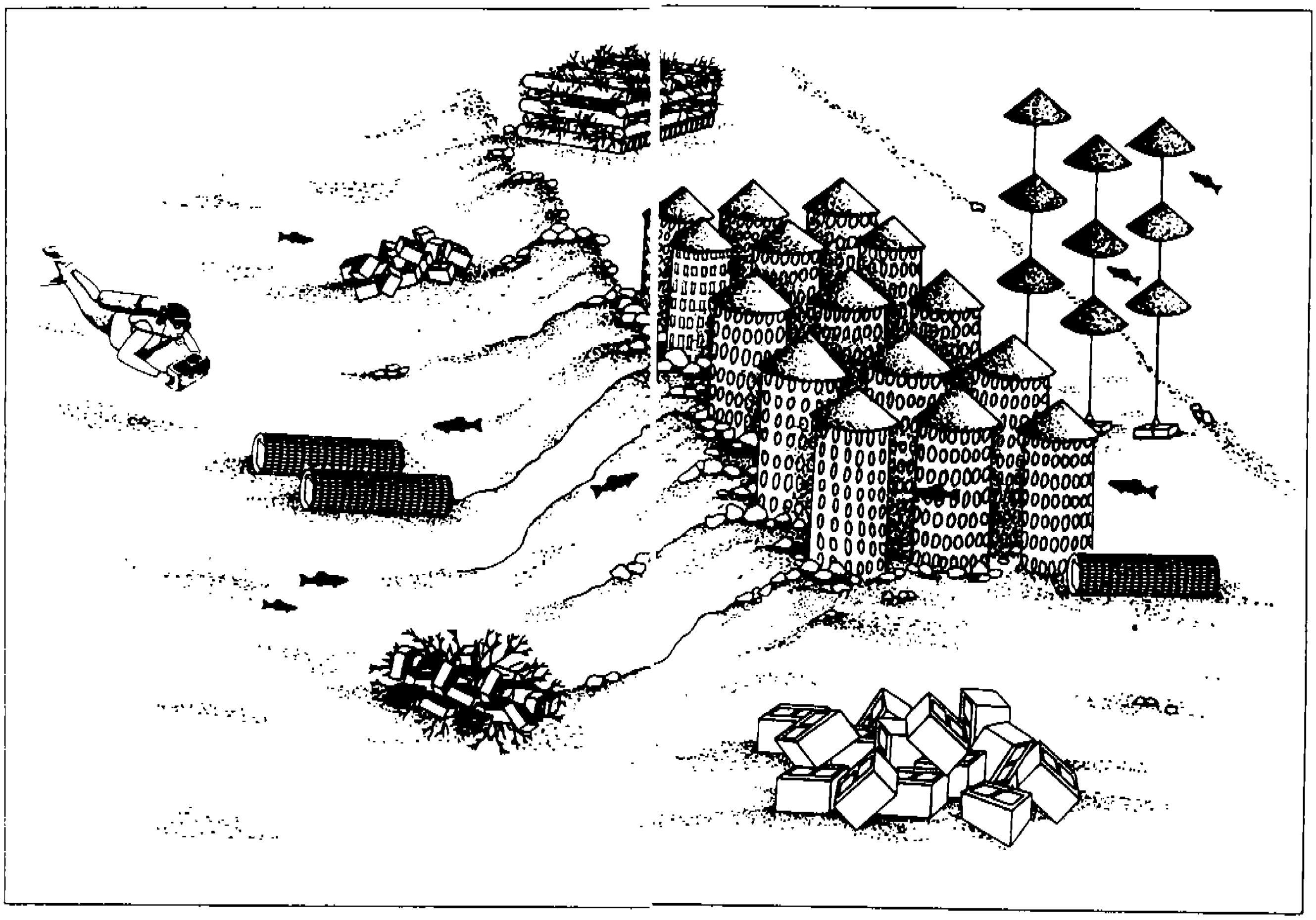
**ACW Publication 8156-22**

## I. Introduction

Fishermen have known for years that bass, crappie and panfish are usually found near cover such as submerged logs, trees, brush, rock outcroppings, boathouses, and docks. Fishery biologists have been able to imitate natural cover for fish by creating artificial cover, commonly referred to as artificial reefs. Artificial reefs have been used to improve fishing success in lakes, ponds and reservoirs for over 50 years.

Reefs are a valuable management tool, especially in older reservoirs, where natural cover (trees and shrubs), that was submerged when the impoundment was flooded, deteriorates. Cover contributes to healthy fish communities by providing substrate for food organisms, safety from predators and, in some cases, spawning habitat. Many of you who are veteran anglers in the bass and panfish haunts may more closely identify with the term "structure," instead of "cover." In this pocket manual the term "cover" will be used synonymously with "structure."

The purpose of this manual is to present proven methods for building freshwater artificial reefs. The manual is intended to illustrate: types of materials for reef construction, the cost of reef construction, and methods to construct reef habitat. The manual is intended for use by fishery resource managers, and by angling groups and civic associations interested in undertaking properly designed and constructed freshwater artificial-reef projects.



## II. Project Planning

It is vital that any reef project follow a carefully thought-out plan of action. The materials presented in this manual enable reef sponsors to develop a specific plan of action to follow in a reef deployment project. While a plan does not ensure success, it can provide a rational decision-making process from project conception to actual reef deployment. Listed below are suggestions for planning a reef project:

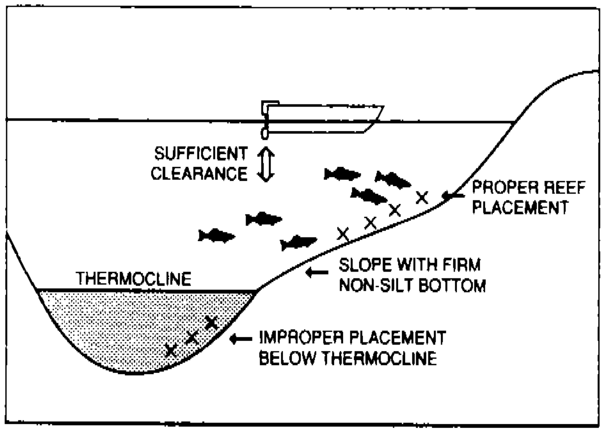
- Determine the objective of the reef project. What species and age classes are to be targeted? Do these species respond to structure? Is the reef intended for dock, shore, boat or disabled fishermen? Is the reef really needed?
- Contact personnel with the state natural resource agencies and/or Federal agency in charge of artificial-reef development. Permits may be required for the reef. Your state natural resource agency is also a valuable source of reef development information and should be a cooperator in the project.
- It is important that communication lines be opened to as many fishermen as possible to get their input and volunteer labor into the project.
- Organize a group of dedicated volunteers who are willing to set time aside to work on the project.
- Determine how much fishing pressure the reef will receive. This information is invaluable for determining the need, size and location of the reef.
- Determine what resources are available to undertake the project: financial, manpower, transportation, materials. It is strongly advised that before any individual, civic organization, or fishing club begins an artificial reef project that the appropriate state/federal natural resource agency and/or department of fisheries be contacted. They will often be of great help in undertaking reef projects and in many instances may be willing project participants.
- Take necessary safety precautions. An integral part of any artificial reef project is safety. All individuals involved in reef material fabrication and deployment should be equipped with appropriate safety equipment, such as a personal flotation device (when on a boat or barge), safety



eyeglasses or shield, heavy duty gloves and any other equipment required to prevent injury. Also, reef materials should always be deployed by at least two able-bodied persons; never work alone.

## III. Proper Placement of a Reef

Proper placement of the artificial reef is as important as selecting a good material and design. Simply put, the reef must be located where cover is lacking, where it will be utilized by




the targeted species of fish and where it will be accessible to fishermen. In some cases, placement may help in segregating various water users (i.e. skiers, anglers) and reduce conflicts.

A. *Bottom Type*

The reef location site should have a firm substrate such as sand, stone, or clay. Soft bottoms, characterized by silt and mud, are not recommended for reef placement as heavier reef materials may eventually subside and disappear. A long stick can be used as a probe to test the bottom; or better yet a diver can be used to test bottom hardness. If there is a dive club in your area, inquire if they would like to volunteer and participate in the project. It is very important that artificial reefs are not placed directly on productive bottom habitat such as natural shoals or existing submerged trees or brush.

B. *Clearance*

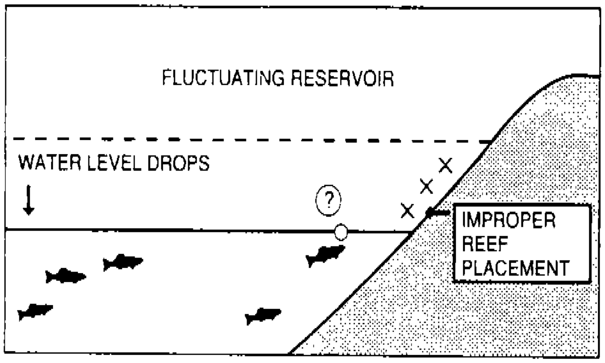
Reef placement must not pose a hazard to boat and skier traffic. Reefs should be located out of boating lanes and at a sufficient depth to allow for safe boat passage. The agency or individual with regulatory authority over the body of water must be contacted to determine permit requirements. This may be a state, federal, or private entity. In navigable waters, reefs should be clearly marked with permanent buoys as required by the U.S. Coast Guard. Some states may also have requirements for permits or buoys. For these reasons it is imperative to check with your appropriate state or federal natural resource agency before placement of reef material in public waters.

C. *Permits*

IN SOME BODIES OF WATER A PERMIT MAY BE REQUIRED FROM STATE OR FEDERAL AGENCIES TO CONSTRUCT AN ARTIFICIAL REEF. PLEASE CONTACT YOUR STATE NATURAL RESOURCE AGENCY AND INCLUDE THEM IN THE INITIAL PLANNING PROCESS.

D. *Depth of Reef Placement*

Fish are found at different water depths depending on the season of the year and corresponding water temperature. Seasonal water temperature changes and water level fluctuations can make the optimal depth of reef placement difficult because the reef may only be inhabited by fish part of the year. A reef placed in shallow water (less than 10 feet) will be inhabited in the




spring, but will go unused by adult game fish throughout most of the summer and early fall. For example, adult largemouth bass spawn in shallow water in the late spring (depending on latitude) and move into deeper water (15-20 feet) early in the summer and even deeper water as water temperatures rise through the summer.



If you have ever swam in a lake in the summer, you may have noticed that at some depth there is a sudden drop in water temperature. In the late spring through early fall many lakes and reservoirs have a warmer upper layer and colder lower layer. The portion of the water column dividing the warmer upper waters and the cooler lower waters is referred to as the thermocline. The concept of the thermocline is important because warm-water fish such as bass, crappie and bluegill prefer the warmer waters of the upper layer above the thermocline. The colder waters lying below the thermocline often suffer from declining oxygen levels as the season progresses and becomes less hospitable to most fish species. If a reef is placed below the thermocline in the colder lower layer, it may go unused. This is especially important for species such as crappie, which are found near the thermocline throughout the summer.

There are several methods you can use to properly place artificial reef materials where they will be inhabited by fish throughout most of the warmer months:

- Generally, do not place a reef deeper than 30 feet or shallower than 10 feet. There are circumstances where reefs may be placed in water shallower than 10 feet to provide fishing opportunities for bank fishermen. Also some reservoirs, especially in the western states, have widely fluctuating water levels. Be sure to contact your appropriate state/federal natural resource agency to help you determine the proper depth of placement.
- Find out the depth where fish are caught throughout the year; this can be achieved by asking local fishermen, and will be easy if you are a member of a fishing club.
- If possible, the reef units should be placed on a gradient line going from shallow to deeper water. The deepest portion of the reef should be slightly deeper than the late summer depth of the thermocline. The placement of the reef structure in rows will ensure that as water temperatures warm (and in reservoirs where water levels decline) and fish move, reef materials will continue to be inhabited.
- Consult with your state fishery biologist.

Most states have regional and/or local offices where many of these questions can be answered.

IV. **Construction Techniques**

Productive artificial reef habitats must display several general physical properties:

- Provide maximum structural complexity to provide hiding places and attachment surfaces for food organisms (periphyton).
- Have sufficient weight for stability so that the reef stays as placed.
- Be made of non-toxic materials that do not deteriorate in a short period of time.
- Be placed so as to optimize public awareness and use.

The number of fish attractors installed in a given water body should not be too large nor should they be placed in habitat where cover is already abundant. Discuss the concept of overharvest potential in the target populations with your state fisheries biologist. Some fisheries experts feel the installations of fish attractors in some instances may accentuate overharvest problems by increasing angling success.

Researchers have found that the installation of several smaller reefs are preferable to one large unit because many small reefs provide more surface area and structural diversity for food organisms. Several smaller reefs also serve to spread fishing effort over a larger area, reducing angler conflicts.

As noted earlier, artificial reef projects in reservoirs can become complicated because of rising and falling water levels. This is especially true in western states where reservoirs are drawn down to allow for storage of spring melt-off. At low pool, reefs may become exposed; posing a navigational hazard or being vulnerable to vandalism. Certain types of reefs, such as tire modules, may be impractical in reservoirs with fluctuating levels because their weight and bulk make removal very difficult. Keep in mind that innovative reef design and construction can overcome the problem of fluctuating reservoirs.

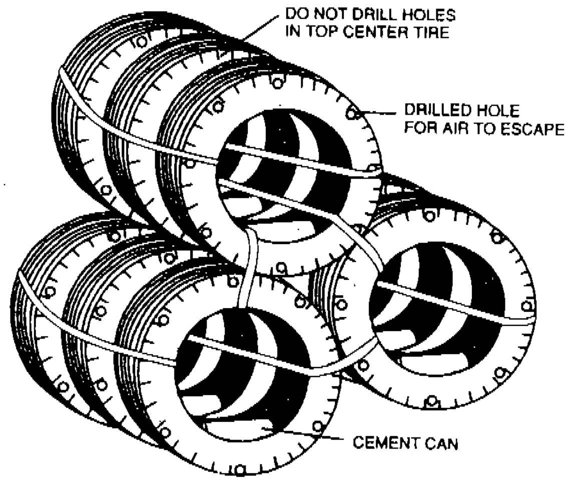
V. **Specific Materials**

It is important to select a durable, productive reef material for a successful reef project. The following pages illustrate some better known and successful artificial reef designs. Information is also provided on the cost of materials (prices will vary), as well as tips on how to construct, transport and secure reef materials in their intended locations. The reefs pictured and described have proved to be effective if properly constructed and placed. Diagrams are provided to assist the reader in constructing and deploying the reef.

1. **Tires**

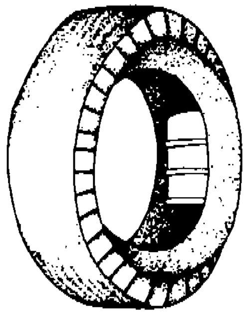
TARGET SPECIES — Catfish, largemouth bass, panfish, walleye

MATERIALS — Used tires are easily located. Tire stores are usually more than happy to donate tires to a reef project. Concrete is needed as ballast for the tires and 1/4-inch dark-color polypropylene rope is needed to tie the tires together.

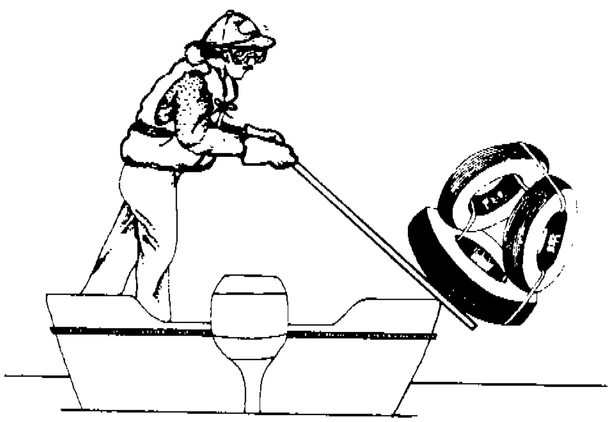



CONSTRUCTION TECHNIQUES — Tire units can be constructed in several ways. Remember the more voluminous the unit, the more it will weigh. As with all reefs, sufficient clearance must be allowed so that boat traffic can proceed safely. While high-profile, more complex reefs provide better fish habitat, keep in mind the difficulty of construction and deployment.

To construct the nine-tire nodule pictured in the diagram, three tires are fastened together to form a nine-tire pyramid configuration. To assure



stability, one No. 10 can (3-lb. coffee can) filled with cement should be placed inside each tire between the sidewalls. It is important that holes be drilled in the tires near the top to allow air escapement. However, holes should not be drilled in the middle tire of the top assembly. The trapped air in the desired space will cause the unit to lie in the desired position on the bottom.



DEPLOYMENT AND SECURING — Tire units require a barge or large, stable work boat for transportation. To deploy, tire units may be placed on plywood boards. Levers can then be used to lift up the board and slide the unit into the water. This should be done in a deliberate manner to assure that the unit does not flip over. Anchors are not required for this reef because of the concrete ballast.

COSTS —

Tires: no cost

Polypropylene rope: $.04-05/foot, or strapping material

Concrete: $4.00 per 80-pound bag

2. **BRUSHPILES**

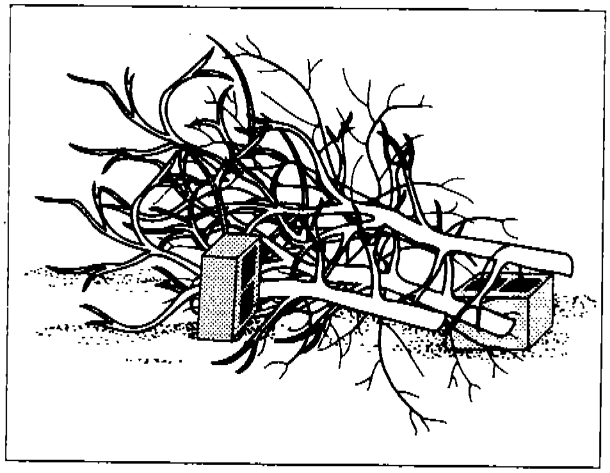
TARGET SPECIES — Largemouth bass, crappie, bluegill, other panfish

MATERIALS — Green trees and brush material



are long lasting and therefore preferable. Hardwood such as oak is also recommended. Cedar trees have commonly been used with good results.

CONSTRUCTION TECHNIQUES — Brushpiles should be built to provide high-profile and structural diversity. It is important to remember that the more complex in design the brushpile reef: the more habitat it provides. Brushpiles need thicker branches to ensure integrity, sturdiness and



longevity. Brushpiles made of thinner branches have a short submerged life because of their fragility. Probably the best technique involves the construction of a frame made out of sturdy wood, such as ironwood, or other hardwood such as oak or cherry. A metal frame can also be used. Brush can also be bundled, tied and weighted with a concrete block.

DEPLOYMENT AND SECURING — While placement of brushpiles on ice has been used, it is not recommended because it can cause the material to disperse at ice-out. It is important to secure the brush with use of concrete blocks.

COSTS —

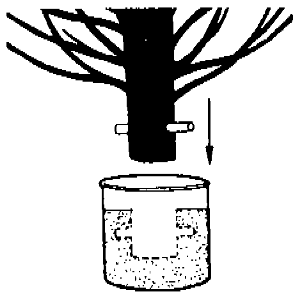
Concrete block: $.89 per block

Polypropylene rope: $.04-.05 per foot

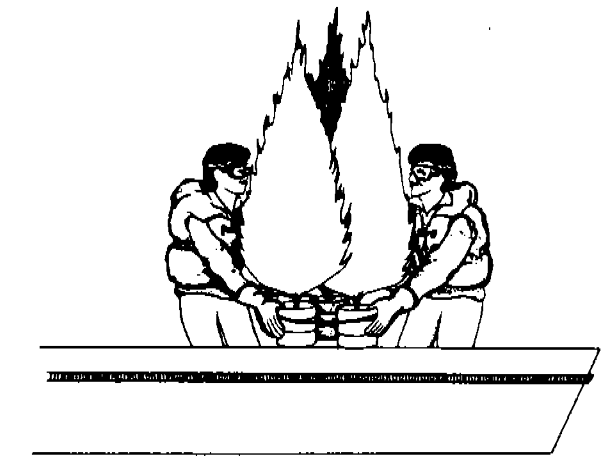
3. **CHRISTMAS TREES**

TARGET SPECIES — Largemouth bass, crappie, panfish

MATERIALS — Christmas trees, although not



particularly durable, are plentiful during the Christmas holidays at no cost. It is important to get trees that have not been chemically treated with flame retardant. Concrete in 5-gallon containers can be used for ballast. Dark-color polypropylene rope is needed to tie the trees into bundles. Metal pins are needed to secure the trees in the cement-filled cans. (Note: Though inexpensive, Christmas-tree structures are not particularly durable due to early decay.)



CONSTRUCTION TECHNIQUES — The trees can be ballasted by drilling a 3/8-inch horizontal hole in the bottom of a Christmas tree and forcing a length of 1/4-inch steel bar stock into the hole. The tree is then placed into a 5-gallon can and filled to three-quarters capacity with concrete. Trees tied together in groups of three or more are more stable than single trees. Dark-color polypropylene rope should be used to tie the trees together.

DEPLOYMENT AND SECURING — The trees are ballasted by the concrete base, so further anchoring is not required. Trees will be cumbersome, so a barge or large raft is required for deployment. Groups of trees can also be towed out to the site. Trees should either be set on the bottom in rows or placed in mounds.

COSTS —
Trees: Donated
Concrete: $4.00 per 80-lb. bag
5-gallon can: Donated
1/4-inch rebar: $2.25 per 10 feet

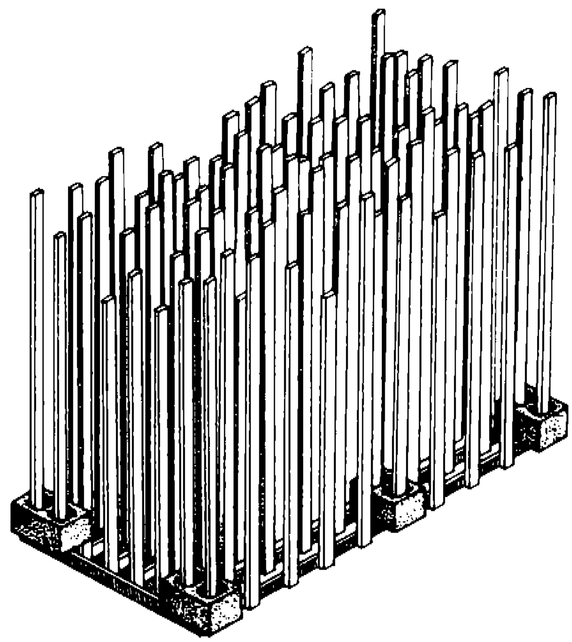


4. **STAKE BEDS**

TARGET SPECIES — Largemouth bass, crappie, panfish

MATERIALS — A lumberyard can provide the stakes necessary to construct the beds. To weigh down the stake bed, 40-pound cement construction blocks are needed. These can be found at a building materials store.

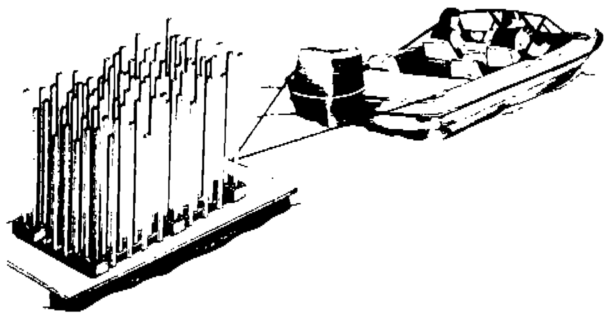
CONSTRUCTION TECHNIQUES — Fifty green sawmill stakes (4 to 7 feet long), and nine green sawmill oak lumber (2 inch by 4 inch by 8 feet



long) are required to construct a 4-foot by 8-foot stake bed. Twentypenny galvanized coated nails should be used to nail the structure together. To construct the bed, place six of the 2 by 4s six inches apart, parallel to one another. The remaining 2 by 4s are then nailed at right angles to the six boards to form the base of the bed. Stakes are then nailed into the boards 1-2 feet apart. Concrete construction blocks should be placed on each corner of the structure. Care should be taken when placing the blocks on the corners so that the bed is not damaged.

Stake beds can also be made out of PVC piping.

DEPLOYMENT AND SECURING — Stake beds can be fabricated on shore and then towed on a pontoon boat or barge. The beds require no anchoring because of the weight provided by the concrete blocks. As with the tire units, if stake beds are put on barges, they can be shoved off by hand.



COSTS —
Oak Stakes:
2" x 4" x 8' lumber: $2.00 per piece
Nails: $.79 per lb. (2 1/2-inch galvanized)
Concrete Blocks: $.89 per block

5. **PIPING**

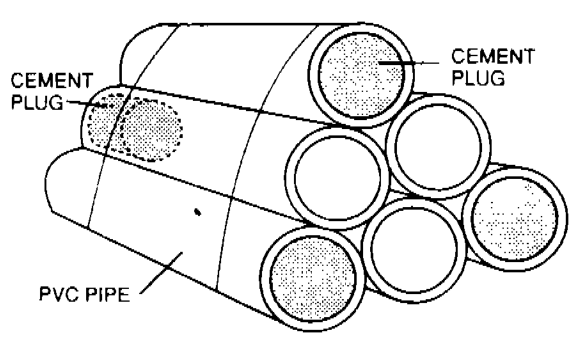
TARGET SPECIES — Catfish, bullhead

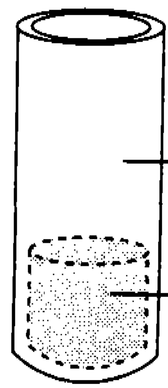
MATERIALS — Vitrified clay PVC and corrugated polyethylene pipe can be purchased at building supply stores. There are often broken pipes or seconds that can be obtained free at construction sites or from distributors.

CONSTRUCTION TECHNIQUES — Concrete and vitrified clay piping can be bundled into a pyramid shape. Plastic bundling strips may work better than polypropylene rope. PVC and corrugated polyethylene piping, because of their light weight, need to be ballasted. Pouring cement into one end of each pipe accomplishes two functions. It provides needed ballast as well as providing a shaded hiding area preferred by catfish. Ballast can also be provided by filling the bottom middle pipe wholly or partially with cement.

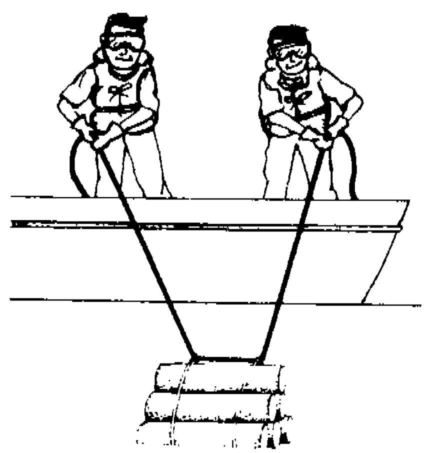


CONSTRUCTION OF PYRAMID UNIT




DEPLOYMENT AND SECURING — Use of a barge or pontoon boat allows for fewer trips to and from the shore. However, recreational fishing boats can be used to ferry the pipes to the site. Since there is sufficient weight with the vitrified



clay pipes and the ballasted PVC and corrugated polypropylene pipe, no additional anchoring is required.

COSTS —

Vitrified clay pipe: $4.96 per 100 feet (6-inch diameter)

PVC Pipe: $4.29 per 10 feet (1-inch diameter)

Corrugated polyethylene pipe: $2.16 per 20 feet (6-inch diameter)

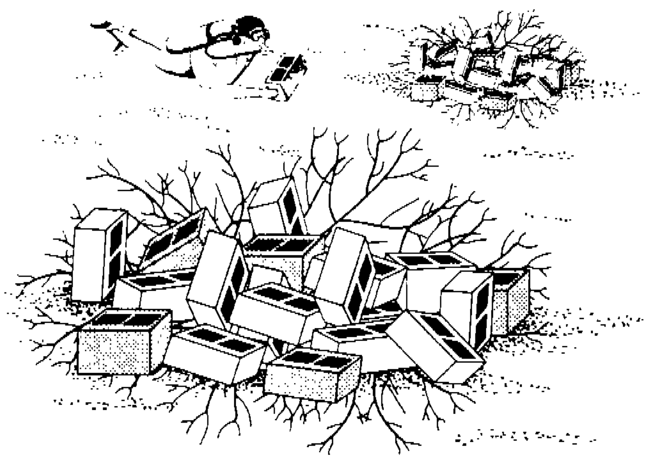
Strapping/binding material: Inquire locally

### 6. **CONCRETE Block/Rubble/Rock**

TARGET SPECIES — Rockpile reefs attract a variety of species including catfish, bass, panfish, and walleye. Rock reefs also serve as spawning substrate for smallmouth bass, largemouth bass, walleye and catfish.

MATERIALS — Broken concrete blocks can be obtained at building supply stores or at construction sites. Building rubble can also be obtained at a low cost, but it is important that the rubble material be free of any piping, asphalt or other toxic or hazardous substances. Quarry rock can also be used, however, this option is expensive and requires heavy equipment for transportation and deployment.

CONSTRUCTION TECHNIQUES — Piles of rock can be placed in conjunction with cinder blocks and brush to form a rock reef. Rock reefs should be made of different sizes of rock to ensure the creation of a variety of habitats. Placement of several small piles of rock is preferable





to one large pile. In the large pile many of the rocks are buried within the structure and are not usable by the majority of the reef inhabitants. Smaller reefs will result in more attachment surfaces and structural diversity for food organisms.

DEPLOYMENT AND SECURING — Because of their weight, rock reefs are more cumbersome and may require a barge and heavy equipment to transport. Repeated trips to a reef site can be made by pleasure boats with cinder block. However, keep in mind that the blocks may cause boat damage. A diver can be very helpful in stacking the blocks into a mound once they have been placed on the bottom. In northern states, rock can be placed on winter ice at the reef site. Upon ice-out, the rock will fall through the ice..

COSTS —

Cinder blocks: $.89 per block

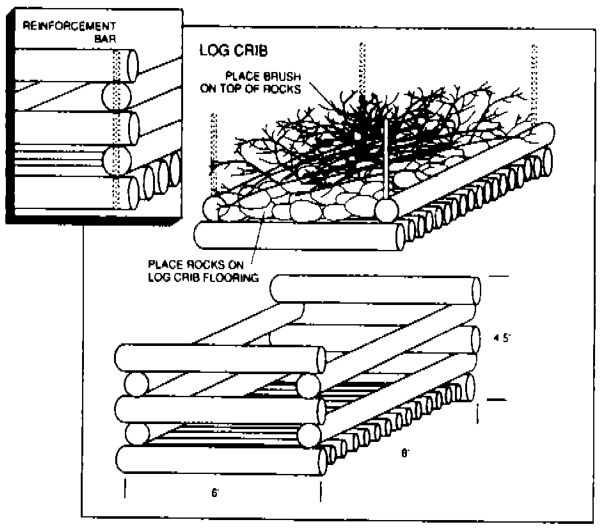
Quarry rock: Price varies locally

Building rubble: Sometimes free

### 7. **LOG CRIBS**

TARGET SPECIES — Walleye, bass, panfish, catfish

MATERIALS — Green oak is highly recommended because of its density and weight. If green oak is used, less rock ballast will be needed. Sapling poles can often be found in the woods, where allowable. Rebar can be bought at a building supply store.



CONSTRUCTION TECHNIQUES — (Note: this is an effective but labor-intensive reef). Two 8-foot logs 6 inches in diameter are placed 6 feet apart; two more logs are laid across the ends of the first two logs to permit an overhang of 8-12 inches. A 5/8-inch hole should be drilled in each corner where the logs overlap. A 1/2-inch piece of rebar is then inserted into the first log and bent over on the bottom side. Saplings are then fastened as a floor across the bottom row of logs. These saplings will serve as a floor for ballast rock and brush to be added later. To complete the structure, logs are laid crossways in "log cabin" fashion threaded onto the rebar until the structure reaches a height of approximately 5 feet. The logs are fastened together near the corners by the rebar which is bent over at the top and bottom. Ballast rocks and loosely piled brush are then placed into the interior of the crib. Several saplings and overhanging brush should be wired across the top of the crib to hold the interior brush in place.

If the crib is made out of dry wood, then additional ballast will be required in the form of rock or concrete block. The rock is placed in the bottom of the crib; this will require additional flooring below where the brush flooring is located.

DEPLOYMENT AND SECURING — Cribs must be built in place at extremely low water or built on a log ramp or pontoon boat and slid carefully into the water at the desired site. Because of the weight, extra care must be taken to place the crib on firm, hard bottom to avoid subsidence. In northern states, cribs can be constructed on ice. Once ice-out occurs, the crib will sink to the bottom.

COSTS —

Logs: Depends on availability

Rebar: $3.69 per 10 feet

8. **PLASTICS**

Structural diversity in various natural forms such as brush, logs, overhanging bank vegetation and submerged or emergent aquatic plants is highly important to adult predator fish for ambush cover. Some quantity of this structural diversity is also critical for protective cover for many juvenile and forage-fish species.



Artificial structure can be purchased ready to assemble and deploy. It can also be constructed from available materials using a little imagination and ingenuity. Some successful approaches currently in use are presented here for your project consideration.

Plastic-snow fence has been used with a great deal of success in Arizona reservoirs. Fish "Condos" and "Bass Bungalows" made from it are lightweight and easily transported and deployed. The numerous openings in the snow-fencing material provide excellent escape cover for small fish.

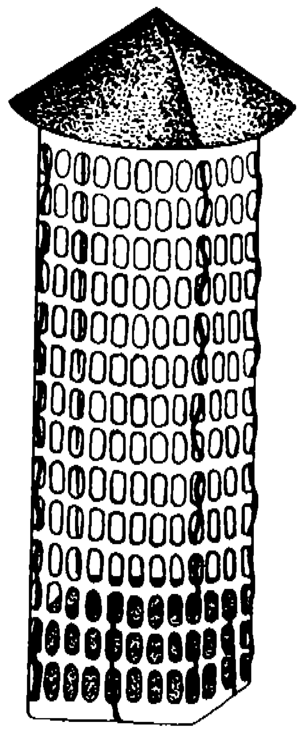
A. *FISH "CONDOS"*

A wide variety of new and innovative plastic-reef concepts and materials have been introduced in the past 10 years. One successful reef design, used by the U.S. Forest Service's Mesa Ranger District in Arizona, is presented here as an example of the new lightweight (30 to 50 lbs.) and durable artificial reef designs being used.

TARGET SPECIES —

Largemouth bass, crappie, panfish

MATERIALS — High-density polyethylene snow fence, black wire fasteners ("Zipties"), galvanized twisted wire fence stays, cement blocks for ballast. A high-denisty vacuum-formed polyethylene "hat" is required for the top.



CONSTRUCTION TECHNIQUES — A length of the snow-fence material (with 1 1/2" x 2 1/2" elongated ed holes) is formed into a 20-inch-diameter tube and held together with "Zip-ties." The tube is reinforced with four interwoven galvanized twisted wire fence stays to stiffen the tube and support it in its vertical position. One 16" x 16" x 4" cement block is "Ziptied" into the bottom of the upright snow-fence tube for ballast. The "hat" is "Ziptied" to the four fence stays at the top to cover and exclude predators from the interior of the tube

DEPLOYMENT AND SECURING — Use of a barge or pontoon boat allows for fewer trips to and from the loading site. However, recreational fishing boats can be used successfully to ferry the "condos" to the deployment site. Since the cement blocks provide sufficient ballast in the condo tubes, anchoring is not required.

COSTS —

High-density polyethylene snow fence: $40-70 per 100-foot roll.

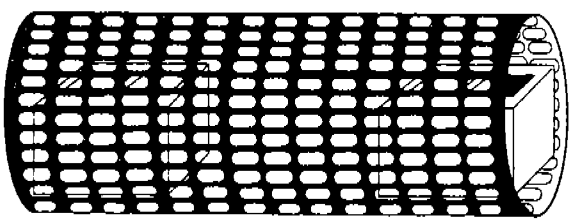
Black nylon wire fasteners (Zipties): $3.50/100 pack.

Galvanized twisted wire fence stays: $27.00/100 bundle.

Cement blocks: $.09/each.

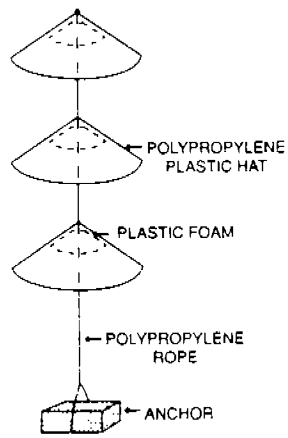
Polyethylene plastic hats: contact your local plastics manufacturer.

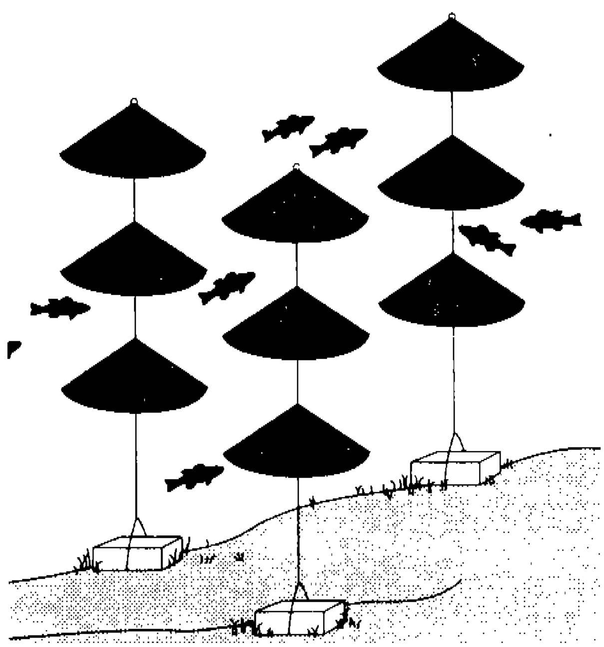
B. *"BASS BUNGALOWS"* — The "Bass Bungalow" is a slightly smaller diameter and slightly shorter version of the snow-fence tube used in the Fish Condo. It is rolled around and fastened to three spacer or support hoops which are nothing more than single sections cut from corrugated polypropylene pipe. The roll or tube is deployed horizontally on substrate where largemouth bass would be expected to spawn. It does not require the fence stays as stiffeners nor is it covered on either end. It does require two 4" x 8" x 16" cement blocks fastened interiorly for ballast. Its primary purpose is to provide desired escape cover for juvenile bass in the early and vulnerable stages of their life cycle.



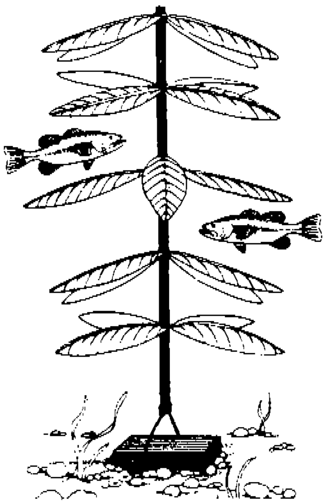


C. *"MUSHROOM HATS"* — The so-called "Mushroom Hat" is the same polypropylene plastic cover device used to cover the top of the Fish Condo. In this case it is deployed separately in a suspended but submerged configuration anchored singularly or in multiple columns at desired depths and locations. In its most simple description, the desired number of "hats" are threaded onto polypropylene rope below knots tied at the desired depths above the anchor. A block of plastic foam is threaded onto the rope immediately under the conical hat to float and suspend each hat at its desired position in the water column. Its primary purpose is to serve as ambush cover for adult predator fish near travel lanes frequented by schools of forage fish.



D. *"FISH N' TREES"** – Pradco of Fort Smith, Arkansas, markets a product known commercially as Fish N' Trees. The product functions as a submerged upright stalk with large leaf-like units every few feet which protrude in a draping horizontal position. These large leaf-like units provide the ambush cover that attracts and hides predator fish as they await their prey. The Fish N' Trees are made up of 3-foot polypropylene modular units which, when connected with fastners, make up tall plant-like units up to 28 feet long. Upright flotation and suspension in the water column is achieved through plastic foam in the stalks with some sort of anchor device needed to maintain the units in place and at the desired depths. The plant-like units can be deployed singularly or anchored in multiples to PVC frames inserted with steel rebar for ballast. These multiple units are referred to as "Fish N' Forests." These units appear to be most effective when deployed in deeper water along known migration routes of forage fish. As a general rule, these materials are sold to private parties only for use in private waters. If the materials are to be used in public waters, it is generally required that acquisition be accomplished through an appropriate state or federal agency. More information can be obtained by contacting: Plastics Research, 3601 Jenny Lind, Ft. Smith, Arkansas, 72902, 800-422-3474.



*This does not constitute a product endorsement by the Sport Fishing Institute or the Bass Anglers Sportsman Society.



## VI. **Concluding Remarks**

Properly designed and constructed artificial reefs can be an invaluable asset to any fishery community. When planned and deployed with the assistance of knowledgeable biologists, these reefs can increase the available habitat for fish to spawn, feed, and hide from predators, thereby increasing the potential for a better fish community as well as better fishing. However, artificial reefs alone do not solve the entire problem of stock depletion. Anglers must continue to follow ethical fishing standards to ensure the conservation of their fisheries resources.

These standards include: (1) keep only the fish needed, (2) do not pollute – properly dispose of trash, (3) sharpen angling and boating skills, (4) observe angling and boating safety regulations, (5) respect the rights of other anglers and property owners, (6) pass on knowledge and angling skills, (7) support local conservation efforts, (8) never stock fish or plants into public water, and (9) promote the sport of angling.

Although the installation of artificial reef cover is a tool commonly used by fisheries management agencies, certain projects can also easily be accomplished by small, dedicated groups of volunteers. Artificial reef projects need not be expensive to have profound effects. Often, volunteer labor is readily available from local conservation groups, while local merchants may be willing to donate some of the materials needed for these projects. However, additional funds are often needed to supply extra materials and to cover additional expenses.

The FishAmerica Foundation is a fisheries conservation organization which can supply limited funds to volunteer groups who need them. FishAmerica was founded by members of the sportfishing industry who realized the need for an efficient way to help local groups enhance their fisheries resources. Since 1983, FishAmerica has provided over $1.5 million to 245 groups across North America that are dedicated to improving our waterways and fisheries. The Foundation has provided assistance to several artificial reef programs – both fresh and saltwater – and is looking for more high quality proj-

# APPENDIX F
## Training Activities in Areas Papa One and Papa Two

Received from Chris Stevenson:
March 17, 1995

Jerry -

I got the following info from Ops and Training.

| AREA | USE |
| --- | --- |
| P-1 | 144 days/year<br>240 units/year |
| P-2 | 252 days/year<br>576 units/year |
| P-3 | 180 days/year<br>408 units/year |

Desaltation doesn't occur at Pulgas Lake anymore (SSgt Thomson, pers. comm.)

Received from Chris Stevenson
March 17, 1995

BAT FIE EX 5.56,7.62 BLNK - Battalion Firing exercise, 5.56 & 7.62 mm machine guns, blank ammunition

AAV TEST - Amphibious assault vehicle test. Generally, test driving AAVs on/along beach and on rough ground between I-5 and the ocean. AAVs are tracked vehicles.

SIM CAS MISSIONS - Simulated close air support missions. They fly helicopters or jets and pretend to drop things from them. Conducted by the Low Altitude Air Defense group.

MCCRESS TRNG/3RD ANGLICO - Marine corps readiness evaluation system training / third air and naval gunfire liaison company

BN FTX/240TH SUP BN - Battalion field training exercise / 240th Support Battalion

ENGINEER RECON - Engineer reconnaissance. No heavy equipment used.

LAV MANEUVER - Light armored vehicle maneuver. LAVs are wheeled vehicles.

CAMMIE NET OF VEHICLES - Camouflage netting of vehicles for concealment

RAID (5.56/7.62 BLANKS, PYRO - Pre-amphibious assault raid. 100-150 Marines land from small boats and move inland. 5.56 and 7.62 blank ammunition, pyrotechnic devices (smoke, flares).

STALKING, 7.62 BLANKS - 1st Marine Regiment on foot, using blank ammunition

TEWT/BREACHING, TRENCHCLEAR - Clearing of trenches using explosives

81 MORTAR TRNG - mortar training

HRST - Helo static test. ~~Repelling~~ Rappelling from helicopters.

BN FEX - Battalion field exercise. Involves foot and vehicle travel.

DRAGON TRNG - Dragon training. Dragons are missiles.

KERNEL BLITZ - A large scale landing and inland operations exercise scheduled for March 1995. It will involve foot, vehicle, and limited aircraft activity over large areas of Camp Pendleton from the Ocean to Case Springs. Anticipate foot and vehicle traffic within the Piedre de Lumbre drainage. Vehicles will travel on the roads; Marines throughout the area.

LAND NAV/SQD TACTICS/H&S BN - Land navigation / squadron tactics / battalion

BST TRNG - Battle skills training (foot traffic, land navigation, weapons use). 1st Maintenance

RSOP - Reconnaisance, surveilance, & occupation of positions. They work with weapons systems, without using blanks or ordnance.

MECH PLT ATTKS, BLANKS, SMK - Mechanized platoon attacks, blanks, smoke

Received from Chris Stevenson
March 17, 1995

Field Training Exercises involve regiments (1200-2000 Marines) maneuvering on foot with 15-20 LAVs and 40-50 AAVs and numerous wheeled vehicles on roads and in open areas

Maneuver Training Exercises involve tactical deployment of companies (80 -100 Marines) with 14 LAVs and 2-4 HMMWVs (HumVees) in open areas and along roads.

Tactical Vehicles:

With Wheels: HMMWV (High mobility multi- wheeled vehicle)
5-Ton Trucks
LVS (Logistical vehicle system). AKA "Dragon wagon"
LAV (light armored vehicle)

With Tracks AAV (amphibious assault vehicles)
Tanks (MIAIs, M60s)

Lucas Jorgensen

Date: 23/02/95

AIRSPACE MANAGEMENT DIVISION/IMPACT AREA CONTROL CENTER
MARINE CORPS BASE
CAMP PENDLETON, CA 92055-5100

BULLETIN OF SCHEDULED TRAINING FOR AREA: PAPA 1 around Pulgas South
SORTED BY DATE AND UNIT
01/03/95 Through 31/03/95

RANGE/AREA: PAPA 1

| Trng Date | Unit Name | Open-Close | Min-Max Alt | Training/Weapon System |
|---|---|---|---|---|
| 01/03/95 | 1/5 | 5:00-23:59 | 0- 0 | BAT. FIE. EX.,5.56,7.62,BLNK, |
| 01/03/95 | 1ST LAR | 0:00-23:59 | 0- 0 | INDIVIDUAL TRAINING SKILLS |
| 01/03/95 | 3/5 | 0:00-23:59 | 0- 0 | PATROLLING |
| 01/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST |
| 01/03/95 | HQBN DIV | 0:00-23:59 | 0- 0 | PATROLLING |
| 01/03/95 | HQBN DIV | 8:00-18:00 | 0- 0 | PATROLLING |
| 02/03/95 | 1/5 | 0:00-23:59 | 0- 0 | BAT. FIE. EX.,5.56,7.62,BLNK, |
| 02/03/95 | 1ST LAR | 0:00-23:59 | 0- 0 | INDIVIDUAL TRAINING SKILLS |
| 02/03/95 | 3/5 | 0:00-23:59 | 0- 0 | PATROLLING |
| 02/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST |
| 02/03/95 | HQBN DIV | 0:00-10:00 | 0- 0 | PATROLLING |
| 03/03/95 | 1/5 | 0:00-23:59 | 0- 0 | BAT. FIE. EX.,5.56,7.62,BLNK, |
| 03/03/95 | 1ST LAR | 0:00-16:00 | 0- 0 | INDIVIDUAL TRAINING SKILLS |
| 03/03/95 | 3RD LAAD | 9:00-16:00 | 0- 0 | SIM CAS MISSIONS |
| 03/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST |
| 03/03/95 | RSU | 22:00-23:59 | 0- 0 | FIELD TRNG |
| 03/03/95 | RSU | 21:00-23:59 | 0- 0 | MCCRESS TRNG/3RD ANGLICO |
| 04/03/95 | 1/5 | 0:00-17:00 | 0- 0 | BAT. FIE. EX.,5.56,7.62,BLNK, |
| 04/03/95 | 3D ANGLICO | 0:00-23:59 | 0- 0 | MCCRESS TRNG/3RD ANGLICO |
| 04/03/95 | RSU | 10:00-13:00 | 0- 0 | BN FTX/240TH SUP BN |
| 04/03/95 | RSU | 0:00-23:59 | 0- 0 | FIELD TRNG |
| 05/03/95 | 3D ANGLICO | 0:00-13:00 | 0- 0 | MCCRESS TRNG/3RD ANGLICO |
| 05/03/95 | RSU | 0:00-22:00 | 0- 0 | FIELD TRNG |
| 06/03/95 | 1ST CEB | 12:00-23:59 | 0- 1 | ENGINEER RECON |
| 06/03/95 | 1ST LAR | 8:00-24:00 | 0- 0 | LAV MANUEVER |
| 06/03/95 | 3RD LAAD | 7:30-16:00 | 0- 0 | HIKE |
| 06/03/95 | 3RD LAAD | 9:00-16:00 | 0- 0 | SIM CAS MISSIONS |
| 06/03/95 | AVTB | 6:01-23:59 | 0- 0 | AAV TEST RUN |
| 07/03/95 | 1/5 | 8:00-23:59 | 0- 1 | AAV TRNG |
| 07/03/95 | 1ST CEB | 0:00-23:59 | 0- 1 | ENGINEER RECON |
| 07/03/95 | 3/5 | 7:00-23:59 | 0- 0 | PATROLLING |
| 07/03/95 | 3RD LAAD | 9:00-23:59 | 0- 0 | SIM CAS MISSIONS |
| 07/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 07/03/95 | MSSG 15 | 6:00-18:00 | 0- 0 | CAMMIE NET OF VEHICLES |
| 08/03/95 | 1/5 | 0:00-23:59 | 0- 1 | AAV TRNG |
| 08/03/95 | 1ST CEB | 0:00-23:59 | 0- 1 | ENGINEER RECON |
| 08/03/95 | 3/5 | 0:00-23:59 | 0- 0 | PATROLLING |
| 08/03/95 | 3RD LAAD | 9:00-23:59 | 0- 0 | SIMCAS |
| 08/03/95 | 3RD LAAD | 9:00-16:00 | 0- 0 | SIM CAS MISSIONS |
| 09/03/95 | 1/5 | 0:00-16:30 | 0- 1 | AAV TRNG |
| 09/03/95 | 1ST CEB | 0:00-23:59 | 0- 1 | ENGINEER RECON |
| 09/03/95 | 1ST RETS | 8:00-23:59 | 0- 0 | RAID(5.56/7.62 BLANKS, PYRO) * |
| 09/03/95 | 3/5 | 0:00-17:00 | 0- 0 | PATROLLING |
| 09/03/95 | 3RD LAAD | 0:00-23:59 | 0- 0 | SIMCAS |
| 09/03/95 | MSSG 15 | 6:00-18:30 | 0- 0 | CAMMIE NET OF VEHICLES |
| 10/03/95 | 1ST CEB | 0:00-12:30 | 0- 1 | ENGINEER RECON |
| 10/03/95 | 1ST RETS | 8:00-12:00 | 0- 0 | RAID(5.56/7.62 BLANKS, PYRO) |

flares + explosives

| Trng Date | Unit Name | Open-Close | Min-Max Alt | Training/Weapon System |
|---|---|---|---|---|
| 10/03/95 | 3RD LAAD | 0:00-16:00 | 0- 0 | SIMCAS |
| 10/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 12/03/95 | 1ST MAR | 7:00-12:00 | 0- 0 | STALKING,7.62 BLANKS |
| 13/03/95 | AVTB | 6:01-23:59 | 0- 0 | AAV TEST RUN |
| 14/03/95 | 1/1 H&S | 8:00-23:59 | 0- 0 | TEWT/ BREACHING, TRENCHCLEAR |
| 14/03/95 | 1/5 | 6:00-23:59 | 0- 1 | 81 MORTAR TRNG |
| 14/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 15/03/95 | 1/1 H&S | 8:00-17:00 | 0- 0 | TEWT/ BREACHING, TRENCHCLEAR |
| 15/03/95 | 1/5 | 0:00-23:59 | 0- 1 | 81 MORTAR TRNG |
| 15/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 16/03/95 | 1T ANGLICO | 12:00-16:00 | 0- 0 | HRST |
| 16/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 17/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 20/03/95 | 2/1 WPNS | 6:00-13:00 | 0- 0 | CONDITIONING HIKE |
| 20/03/95 | 3RD AAV | 6:00-23:59 | 0- 0 | BN FEX |
| 20/03/95 | AVTB | 6:01-23:59 | 0- 0 | AAV TEST RUN |
| 21/03/95 | 1/5 | 8:00-23:59 | 0- 0 | DRAGON TRNG |
| 21/03/95 | 3RD AAV | 0:00-23:59 | 0- 0 | BN FEX |
| 21/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 22/03/95 | 1/5 | 0:00-23:59 | 0- | |

0 DRAGON TRNG

| | | | | |
|---|---|---|---|---|
| 22/03/95 | 3RD AAV | 0:00-18:00 | 0- | 0 BN FEX |
| 22/03/95 | AVTB | 0:00-23:59 | 0- | 0 AAV TEST RUN |
| 23/03/95 | 1/5 | 0:00-22:00 | 0- | 0 DRAGON TRNG |
| 23/03/95 | 1ST RETS | 8:00-23:59 | 0- | 0 RAID(5.56/7.62 BLANKS, PYRO) |
| 23/03/95 | AVTB | 0:00-23:59 | 0- | 0 AAV TEST RUN |
| 23/03/95 | SOI | 8:00-23:59 | 0- | 0 LAV DRIVE/LAV OFF/SNCO |
| 24/03/95 | 1/5 | 6:00-23:59 | 0- | 1 81 MORTAR TRNG |
| 24/03/95 | 1ST RETS | 8:00-12:00 | 0- | 0 RAID(5.56/7.62 BLANKS, PYRO) |
| 24/03/95 | AVTB | 0:00-23:59 | 0- | 0 AAV TEST RUN |
| 24/03/95 | I MEF | 6:00-23:59 | 0- | 0 KERNEL BLITZ |
| 24/03/95 | SOI | 8:00-15:30 | 0- | 0 LAV DRIVE/LAV OFF/SNCO |
| 25/03/95 | 1/5 | 0:00-23:59 | 0- | 1 81 MORTAR TRNG |
| 25/03/95 | I MEF | 0:01-23:59 | 0- | 0 KERNEL BLITZ |
| 26/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |
| 26/03/95 | MCRD | 8:00-23:59 | 0- | 0 LAND NAV/SQD TACTICS/H&S BN |
| 27/03/95 | 1ST MAINT | 6:00-23:59 | 0- | 0 BST TRNG |
| 27/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |
| 27/03/95 | MCRD | 0:00-23:59 | 0- | 0 LAND NAV/SQD TACTICS/H&S BN |
| 28/03/95 | 1ST MAINT | 0:00-23:59 | 0- | 0 BST TRNG |
| 28/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |
| 28/03/95 | MCRD | 0:00-23:59 | 0- | 0 LAND NAV/SQD TACTICS/H&S BN |
| 28/03/95 | SOI | 8:00-15:30 | 0- | 0 LAV DRIVE/LAV CO |
| 29/03/95 | 1ST MAINT | 0:00-23:59 | 0- | 0 BST TRNG |
| 29/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |
| 29/03/95 | MCRD | 0:00-23:59 | 0- | 0 LAND NAV/SQD TACTICS/H&S BN |
| 29/03/95 | SOI | 9:00-15:00 | 0- | 0 LAV CO |
| 30/03/95 | 1ST MAINT | 0:00-23:59 | 0- | 0 BST TRNG |
| 30/03/95 | 1T ANGLICO | 6:00-23:59 | 0- | 0 PATROLLING |
| 30/03/95 | 9TH COMM | 6:00-23:59 | 0- | 0 MOTOR VEHICLE TRNG (SVC) |
| 30/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |
| 30/03/95 | MCRD | 0:01- 3:00 | 0- | 0 COND HIKE |
| 31/03/95 | 1ST MAINT | 0:00-23:59 | 0- | 0 BST TRNG |
| 31/03/95 | 1T ANGLICO | 6:00-16:30 | 0- | 0 PATROLLING |
| 31/03/95 | 9TH COMM | 0:00-16:30 | 0- | 0 MOTOR VEHICLE TRNG (SVC) |
| 31/03/95 | I MEF | 0:00-23:59 | 0- | 0 KERNEL BLITZ |



Additional

RSOP

MECH PLT ATTKS, BLANKS, SMK

Date: 23/02/95

AIRSPACE MANAGEMENT DIVISION/IMPACT AREA CONTROL CENTER
MARINE CORPS BASE
CAMP PENDLETON, CA 92055-5100

BULLETIN OF SCHEDULED TRAINING FOR AREA: PAPA 3 East of Pulgas
SORTED BY DATE AND UNIT
01/03/95 Through 31/03/95

RANGE/AREA: PAPA 3

| Trng Date | Unit Name | Open-Close | Min-Max Alt | | Training/Weapon System |
|---|---|---|---|---|---|
| 01/03/95 | 1/5 | 5:00-23:59 | 0- | 0 | BAT. FIE.EX,5.56,7.62 SMOK,SMO |
| 01/03/95 | 1ST LAR | 0:00-23:59 | 0- | 0 | INDIVIDUAL SKILLS TRAINING |
| 01/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 01/03/95 | HQBN DIV | 8:00-18:00 | 0- | 0 | PATROLLING |
| 02/03/95 | 1/5 | 0:00-23:59 | 0- | 0 | BAT. FIE.EX,5.56,7.62 SMOK,SMO |
| 02/03/95 | 1ST LAR | 0:00-23:59 | 0- | 0 | INDIVIDUAL SKILLS TRAINING |
| 02/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 03/03/95 | 1/5 | 0:00-23:59 | 0- | 0 | BAT. FIE.EX,5.56,7.62 SMOK,SMO |
| 03/03/95 | 1ST LAR | 0:00-16:00 | 0- | 0 | INDIVIDUAL SKILLS TRAINING |
| 03/03/95 | 3RD LAAD | 9:00-15:00 | 0- | 0 | COND HIKE |
| 03/03/95 | 3RD LAAD | 9:00-16:00 | 0- | 0 | SIMCAS |
| 03/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 03/03/95 | RSU | 22:00-23:59 | 0- | 0 | FIELD TRNG 4TH LAI |
| 04/03/95 | 1/5 | 0:00-17:00 | 0- | 0 | BAT. FIE.EX,5.56,7.62 SMOK,SMO |
| 04/03/95 | RSU | 0:00-23:59 | 0- | 0 | FIELD TRNG 4TH LAI |
| 05/03/95 | RSU | 0:00-15:00 | 0- | 0 | FIELD TRNG 4TH LAI |
| 06/03/95 | 1ST LAR | 8:00-24:00 | 0- | 0 | LAV MANUEVER |
| 06/03/95 | 3RD LAAD | 9:00-23:59 | 0- | 0 | SIM CAS MISSIONS |
| 06/03/95 | AVTB | 6:00-23:59 | 0- | 0 | AAV TEST RUN |
| 07/03/95 | 1/5 | 8:00-23:59 | 0- | 0 | AAV TRNG |
| 07/03/95 | 1/5 | 8:00-23:59 | 0- | 0 | MECH PLT ATTKS,BLANKS,SMK |
| 07/03/95 | 1/5 | 8:00-23:59 | 0- | 0 | PLATOON ATTACK |
| 07/03/95 | 1ST DIV | 6:00-23:59 | 0- | | CO I DEFENSE/TRK CO |
| 07/03/95 | 3RD LAAD | 0:00-23:59 | 0- | 0 | SIM CAS MISSIONS |
| 07/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 08/03/95 | 1/5 | 0:00-23:59 | 0- | 0 | AAV TRNG |
| 08/03/95 | 1/5 | 0:00-23:59 | 0- | 0 | MECH PLT ATTKS,BLANKS,SMK |
| 08/03/95 | 1/5 | 0:00-23:59 | 0- | 0 | PLATOON ATTACK |
| 08/03/95 | 1ST DIV | 6:00-23:59 | 0- | 0 | TACTICAT CONVOYS |
| 08/03/95 | 3RD LAAD | 9:00-23:59 | 0- | 0 | SIMCAS |
| 08/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 09/03/95 | 1/5 | 0:00-14:00 | 0- | 0 | MECH PLT ATTKS,BLANKS,SMK |
| 09/03/95 | 1/5 | 0:00-16:30 | 0- | 0 | AAV TRNG |
| 09/03/95 | 1/5 | 0:00-14:00 | 0- | 0 | PLATOON ATTACK |
| 09/03/95 | 1ST DIV | 13:00-23:59 | 0- | 0 | PATROLLING/TRK CO |
| 09/03/95 | 3RD LAAD | 0:00-23:59 | 0- | 0 | SIMCAS |
| 09/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 10/03/95 | 3RD LAAD | 0:00-16:00 | 0- | 0 | SIMCAS |
| 10/03/95 | AVTB | 0:00-23:59 | 0- | 0 | AAV TEST RUN |
| 13/03/95 | 1ST MEDBN | 0:01-23:59 | 0- | 0 | PATROLING/LAND NAV |
| 13/03/95 | 3/5 | 7:00-23:59 | 0- | 0 | BLANKS,PATROLS/ KCO |
| 13/03/95 | AVTB | 6:01-23:59 | 0- | 0 | AAV TEST RUN |
| 14/03/95 | 1/1 C | 7:30-17:00 | 0- | 0 | PATROLLING |
| 14/03/95 | 1/5 | 6:00-23:59 | 0- | 0 | RSOP |
| 14/03/95 | 1/5 | 6:00-23:59 | 0- | 0 | 81MM MORTAR TRAIN.,ORD N/A |
| 14/03/95 | 1ST MEDBN | 0:00-23:59 | 0- | 0 | PATROLING/LAND NAV |
| 14/03/95 | 3/5 | 0:00-23:59 | 0- | 0 | BLANKS,PATROLS/ KCO |

| Trng Date | Unit Name | Open-Close | Min-Max Alt | Training/Weapon System |
|---|---|---|---|---|
| 14/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 15/03/95 | 1/5 | 0:00-23:59 | 0- 0 | 81MM MORTAR TRAIN.,ORD N/A |
| 15/03/95 | 1/5 | 0:00-23:59 | 0- 0 | RSOP |
| 15/03/95 | 3/5 | 0:00-23:59 | 0- 0 | BLANKS,PATROLS/ KCO |
| 15/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 16/03/95 | 1/1 B | 3:00-23:59 | 0- 0 | FIELD TRNG |
| 16/03/95 | 3/5 | 0:00-23:00 | 0- 0 | BLANKS,PATROLS/ KCO |
| 16/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 17/03/95 | 1/1 | 8:00-11:00 | 0- 0 | RAPPELLING FR/(2)CH-46 |
| 17/03/95 | 1/1 B | 0:00-16:30 | 0- 0 | FIELD TRNG |
| 17/03/95 | 1/1 B | 7:00-22:00 | 0- 0 | SQD TACTICS(5.56,7.62 BLANK) |
| 17/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 20/03/95 | 2/1 WPNS | 6:00-10:00 | 0- 0 | CONDITIONING HIKE |
| 20/03/95 | 3RD AAV | 6:00-23:59 | 0- 0 | BN FEX |
| 20/03/95 | AVTB | 6:01-23:59 | 0- 0 | AAV TEST RUN |
| 21/03/95 | 1ST LAR | 7:00-23:59 | 0- 0 | PATROLLING |
| 21/03/95 | 3RD AAV | 0:00-23:59 | 0- 0 | BN FEX |
| 21/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 22/03/95 | 1/5 | 9:00-23:59 | 0- 0 | FORTIFIED POSITIONS |
| 22/03/95 | 1ST LAR | 0:00-23:59 | 0- 0 | PATROLLING |
| 22/03/95 | 3/5 | 7:00-23:59 | 0- 0 | PATROLLING KILO CO |
| 22/03/95 | 3RD AAV | 0:00-18:00 | 0- 0 | BN FEX |
| 22/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 23/03/95 | 1/5 | 9:00-18:00 | 0- 0 | FORTIFIED POSITIONS |
| 23/03/95 | 1ST LAR | 0:00-16:30 | 0- 0 | PATROLLING |
| 23/03/95 | 3/5 | 7:00-16:30 | 0- 0 | PATROLLING KILO CO |
| 23/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 24/03/95 | AVTB | 0:00-23:59 | 0- 0 | AAV TEST RUN |
| 24/03/95 | I MEF | 6:00-23:59 | 0- 0 | KERNEL BLITZ |
| 25/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 26/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 26/03/95 | MCRD | 8:00-23:59 | 0- 0 | LANDNAV,SQDTAC, X1974 |
| 27/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 27/03/95 | MCRD | 0:00-23:59 | 0- 0 | LANDNAV,SQDTAC, X1974 |
| 27/03/95 | MSSG 15 | 6:00-23:59 | 0- 0 | CONVOY TRNG; BLANKS |
| 27/03/95 | SNCOA | 0:01-23:59 | 0- 1 | MK19 M203 M249 |
| 28/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 28/03/95 | MCRD | 0:00-23:59 | 0- 0 | LANDNAV,SQDTAC, X1974 |
| 28/03/95 | MSSG 15 | 0:00-23:59 | 0- 0 | CONVOY TRNG; BLANKS |
| 28/03/95 | SNCOA | 0:00-23:59 | 0- 1 | MK19 M203 M249 |
| 29/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 29/03/95 | MCRD | 0:00-23:59 | 0- 0 | LANDNAV,SQDTAC, X1974 |
| 29/03/95 | MSSG 15 | 0:00-23:59 | 0- 0 | CONVOY TRNG; BLANKS |
| 29/03/95 | SNCOA | 0:00-23:59 | 0- 1 | MK19 M203 M249 |
| 30/03/95 | 1T ANGLICO | 6:00-23:59 | 0- 0 | PATROLLING |
| 30/03/95 | 9TH COMM | 6:00-23:59 | 0- 0 | MOTOR VEHICLE TRNG (SVC) |
| 30/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 30/03/95 | MSSG 15 | 0:00-23:59 | 0- 0 | CONVOY TRNG; BLANKS |
| 30/03/95 | SNCOA | 0:00-23:59 | 0- 1 | MK19 M203 M249 |
| 31/03/95 | 1T ANGLICO | 6:00-16:30 | 0- 0 | PATROLLING |
| 31/03/95 | 9TH COMM | 0:00-16:30 | 0- 0 | MOTOR VEHICLE TRNG (SVC) |
| 31/03/95 | I MEF | 0:00-23:59 | 0- 0 | KERNEL BLITZ |
| 31/03/95 | MSSG 15 | 0:00-23:59 | 0- 0 | CONVOY TRNG; BLANKS |
| 31/03/95 | SNCOA | 0:00-23:59 | 0- 1 | MK19 M203 M249 |

**Table 3-1. Description, Duration, Frequency, and Personnel of Military Training Activities by Type Presently Occurring aboard Marine Corps Base, Camp Pendleton, September 1994.**

| TRAINING TYPE | ACTIVITY | NUMBER TROOPS | FREQ | LENGTH |
|---|---|---|---|---|
| Infantry Operations | Battle skills training conducted on foot. Mobile, offensive tactics and static, defensive tactics. Skills developed include patrolling, land navigation, communications, and fire and maneuver. | 4-12<br>50-100 | Daily<br>Daily | 1-3 days<br>1-3 days |
| Communication Exercises | Establish temporary bivouacs, set up communications antennae and associated equipment. Establish mobile communications nodes on HMMWVs which operate on roads and in open areas. | 25-100 | 2/mo. | 1-4 days |
| MCCRES | Marine Corps Combat Readiness Evaluation System. Tactical maneuvering, convoy operations. HMMWVs moving on roads and across open areas. Helicopter operations in Landing Zones (LZs). | 600-700 | 2/yr. | 5 days |
| RETS Raids | Regimental Enhanced Training Section. Pre-amphibious assault training in use of ~~rubber~~ small boats, direction of follow-on forces movement inland. | 100-150 | 1/mo. | 3 days |
| CPX | Command Post Exercises. Establishment of tent camps, communications centers, security patrolling, defensive perimeters. | 100-120 | 1/mo. | 2-5 days |
| MOUT | Military Operations in Urban Terrain. Conducted in the Combat Towns, which simulate an urban environment. | 20-100 | 3/wk. | 1 day |
| Engineer CAPEX | Capabilities Exercise for Engineers using fork lifts, small cranes, and wheeled vehicles to move material. Graders and bulldozers move sand to set up logistics points. | 12-20 | 2/yr. | 3 days |
| Medical Support | Occurs in conjunction with major training exercises. Establishment of a tent camp with field showers, electrical generators, and medical and dental facilities for medical support of Marines and sailors. | 70-100 | 2-4/yr. | 3-10 days |

| TRAINING TYPE | ACTIVITY | NUMBER TROOPS | FREQ | LENGTH |
|---|---|---|---|---|
| Field Training Exercises | Tactical deployment of Regiments maneuvering on foot and with 15-20 LAVs, 40-50 AAVs, and numerous wheeled vehicles on roads and in open areas. | 1200-2000 | 2/yr. | 5 days |
| Maneuver Training | Tactical deployment of Companies with 14 LAVs and 2-4 HMMWVs in open areas and along roads. | 80-100 | 2/mo. | 3 days |
| Mechanized Operations | Tactical deployment of Platoons or Companies with 12-22 AAVs in open areas and along established routes.<br>Battalions use 50 AAVs. | 30-100<br>500 | 4/wk.<br>3/yr. | 3-4 days |
| TOW Training | TOW Missile Systems are wire guided anti-armor weapons. Tow Platoons, with 26 HMMWVs, fire missiles at targets moving across rough terrain. | 50 | 4/yr. | 4 days |
| LAV Drivers Training | Road and rough terrain driving during day or night. | 20 | 1/mo. | 1 day |
| Amphibious Operations | Various sized units [LCACs] land at beaches and move inland using AAVs and other assault craft and supported by helicopters and engineering equipment. Trucks haul troops and supplies. | 30-70<br>1200-2000 | 1/mo.<br>1/ 2 yr | 2 days<br>14 days |
| Artillery Field Exercises | Various sized units establish command and control, firing, and logistical support positions and fire howitzers into established impact areas. Trucks haul troops, weapons, and supplies (9 5-Tons/2 HMMWVs/6 howitzers per Battery; 35-40 5-Tons/18 HMMWVs/18 howitzers per Battalion). | 150<br>600 | 10/mo.<br>1/mo. | 2-4 days<br>3-5 days |
| Regimental Fire Support Exercises | Regimental-sized artillery exercises similar to those discussed above, but consisting of less artillery firing and increased command, control, and communications. | 1200-2000 | 4/yr. | 2 days |
| Motorized Movement Exercises | Movement of Troops, weapons, and supplies from point to point along established routes. | 100 | 4/mo. | 3 days |

| TRAINING TYPE | ACTIVITY | NUMBER TROOPS | FREQ | LENGTH |
|---|---|---|---|---|
| Helicopter Training | Helicopters are based at the Marine Corps Air Station (MCAS). Routine operations consist of take-offs and landings to transport troops and equipment at the MCAS and at established LZs, seven of which are in riparian areas. | 2-15 per aircraft | 12,000 per mo. | 1-2 hrs. |
| Helicopter Medivac Training | Helicopters simulate medical evacuation of Troops. | 100 | 4/yr. | 3 days |
| Sensor Emplacement | Reconnaissance sensors are set up and retrieved, both by hand and dropped from helicopters. | 10 | 1/wk. | 1-2 hrs. |
| Parachute Operations | Marines drop into established Drop Zones (DZs), conduct patrols and other infantry operations, and often are extracted by helicopter. | 100 | 1/mo. | 4-6 hrs. |
| Post Maintenance Service Testing | Following maintenance of tactical equipment, including LAVs, AAVs, and trucks, road and rough terrain driving is done to ensure operability and safety. | 1-20 | daily | 1 hr. |
| Exercise Maintenance Support | This logistical support is conducted during field exercises using AAVs, 5-Ton trucks, HMMWVs, and fork lifts. | 20-100 | 6/mo. | 3-5 days |
| NBC Defense Maneuver Training | | | | |
| EOD Activities | | | | |

The following discussions address specific military training actions occurring in or adjacent to riparian areas and the biological effects associated with each activity.

Table 3-2 summarizes the riparian habitat and endangered species present in each of the Base's military training areas. Figure 3-1 denotes areas, ranges and beaches used for training activities.

Alternative Analysis: There are no alternatives to the ongoing military training aboard the Base. The national security mission of the installation requires military training be accomplished year-round in a wide variety of conditions. Military training has been occurring on Camp Pendleton since 1942.