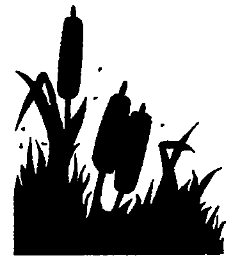
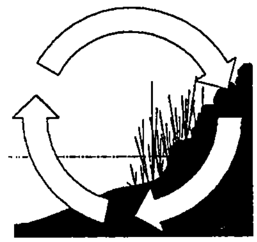
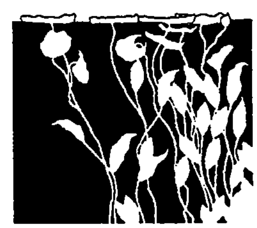


CHERRY POINT NATURAL RESOURCES STUDIES

TECHNICAL REPORTS





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EXECUTIVE SUMMARY

In 1992, Pacific International Terminals' Gateway Pacific Terminal Project (GPT) initiated several studies to acquire baseline information on natural resources in the vicinity of Cherry Point near Ferndale, Washington. The information will be used for the environmental assessment and permitting process necessary to move forward with GPT's bulk loading facility project at Cherry Point. The following is a summary of studies conducted on bald eagle, peregrine falcons, and seabirds; macroalgae and eelgrass; potential shading effects on marine vegetation; surface-water hydrology; stream habitat; and amphibians.

Bald Eagles, Peregrine Falcons, and Seabirds

Field work for the bald eagle, peregrine falcon, and seabird study began in November 1992 and continued through April 1993. Scientists from SHAPIRO conducted field observations on more than 40 different occasions. In the site vicinity, bald eagles appear to forage more frequently in December than in November. Although 80 separate sightings of bald eagles were recorded, the number of different individuals observed is much lower. On January 7, 1993, five different birds were observed. Only one peregrine falcon was observed during the study. No nests of bald eagles or peregrine falcons have been identified on the site. Forest cover at the site is relatively sparse, and trees are generally small and unsuitable as nesting sites for large raptors. Cliffs suitable for peregrine nesting do not exist on the site. Although open fields at the project site provide forage habitat for several common raptors, the overall value of the site to bald eagles and peregrine falcons is limited. The site provides perching habitat for eagles and falcons migrating through the area. Seabird densities were relatively low at the site throughout the study period, except during the herring spawning season. On April 30, several thousand scoters congregated near Cherry Point to feed on herring spawn.

Macroalgae and Eelgrass

Eelgrass and macroalgae studies began in late November 1992. The objective of these studies is to determine the abundance, by species, of marine vegetation that may be affected at the proposed GPT pier site and adjacent areas. Site investigations were conducted during extreme low tide conditions on the evening of November 23 and early in the morning of November 24, 1992. A dive survey, consistent with Washington Department of Fisheries protocols, was conducted at the proposed pier site on August 27, 1993. Composition and density of macroalgae species were recorded by depth along specific transects. The greatest cover (up to 100%) of macroalgae occurred between 0 to -12 feet mean lower low water (MLLW). *Ulva, Fucus, Sargassum, Laminaria, Gigartina, Botryglossum, Iridaea, Odonthalia, and Microcladia* were the predominant taxa. No eelgrass was found at the pier site, except for a 0.5-square-meter patch of about 60 plants located 25 feet north of the proposed pier's northern edge at the -3.1 MLLW tidal level.

Potential Shading Effects on Marine Vegetation

Shading studies began in fall 1992. The purpose of the two-phased investigation was to determine the effects of shading on nearshore intertidal and subtidal macroalgae communities near Cherry Point. The first phase involved determining the extent of shading caused by Arco's existing pier near the location of the proposed GPT pier. Photographs were taken of shadows underneath the Arco pier on September 21 and December 22, 1992, and March 26, 1993, and the shadow cast on the beach under the pier was measured. The second phase involved identification of existing vegetation under and near the Arco pier and estimation of areal coverage. This information was collected during an extreme low tide (-1.9 feet below mean sea level). *Zostera* and *Gigartina* species dominated in the vicinity of the Arco pier. The nonvegetated zone in the intertidal area under the Arco pier was 89 feet wide. It was centered under the 36-foot-wide pier (including pipes). The extent of the non-vegetated zone south of the pier corresponded to the area shaded during the late afternoon of September 21, 1992. Designing the proposed GPT trestle to allow light to pass through it or installing lights under the pier could mitigate impacts from shading.

Surface-water Hydrology

Field work for the surface-water hydrology analysis was conducted from December 1992 through May 1993. The objective was to develop a rating curve for the stream on the site of the proposed project. The stream is 1.25 miles long and drains 800 acres, 90% of which is within the site boundary. Stream flow was analyzed and compared to precipitation records for this period. Runoff generation on the site was evaluated, and a map of runoff generation zones was produced. Daily precipitation averaged 0.10 inch and ranged from 0.00 to 1.07 inch. Flows observed in the stream, however, were larger during the earlier part of the study period. Observed flows ranged from 0.76 cubic feet per second (cfs) to 14.02 cfs. The median flow was 2.62 cfs. The map of runoff generation zones indicates that approximately half of the precipitation that falls on areas with steep slopes, such as the stream ravine and coastal bluffs, immediately becomes runoff. About one-third of the precipitation becomes runoff in more level upland areas, in the form of base flow into the stream after absorption capacity of the soil has been reached.

Stream Habitat

Field work began in late spring 1993 for the stream habitat study, with the objective of characterizing habitat of the unnamed stream on the project site. Habitats were mapped along the 1.25-mile stream. Results suggest fish habitat is very limited in the stream because of intermittent flow; few high quality pools; lack of large woody debris and spawning gravels; and poor water quality attributable to sediment load, garbage in the stream, and high temperatures. Washington Department of Fisheries indicated the stream is unlikely to be used by salmon. Washington Department of Wildlife suggested the stream could be potential habitat for cutthroat and other salmonids. Only one fish species was observed, however. Schools of three-spine stickleback were seen in many pools located within the stream channel. Very few aquatic invertebrates were captured by dip net, and only one caddis fly larvae was observed.

Amphibians

The amphibian study involved two major tasks: review of existing information and on-site field investigations. Field work began in late spring 1993. Four species of amphibians were observed during timed constraint surveys at the project site: northwestern salamander, long-toed salamander, Pacific treefrog, and red-legged frog. Large numbers of frog tadpoles were observed in roadside ditches, in the estuarine marsh, and in standing water in open fields and forest habitats. Numerous treefrogs were present on the site, however, only three salamanders were observed. An important characteristic of the site is the lack of large, downed, woody debris that provide refugia for amphibians. Although the overall number of amphibians was low, up to six other species may occur in the area. The four species observed are common and widespread in western Washington.

Collected data from these natural resource baseline studies will provide necessary information to determine the effects of the proposed project on fish, wildlife, and freshwater and marine aquatic resources. Integration of this data into the environmental review process will facilitate decisions on avoidance of adverse effects and potential mitigation options.

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

INTRODUCTION

INTRODUCTION

Site Description

The Pacific International Terminals' Gateway Pacific Terminal (GPT) property consists of 1,197 acres in northwest Whatcom County, east of the City of Ferndale, Washington (within Sections 17, 18, and 19 of Township 39 North, Range 1 East, W.M.). The site is bordered to the north and west by the Arco oil refinery, to the east by Cherry Point Industrial Park and State of Washington Department of Natural Resources Trust lands, and to the south by the Strait of Georgia. Approximately 1 mile to the southeast is the Intalco aluminum processing plant and the Tosco Oil Refinery. Arco, Tosco, and Intalco have piers extending into the Strait. Land use outside of the refinery and aluminum plant is a mix of forested tracts, rural residential, and agricultural (primarily pastureland for dairy cattle and horses and smaller areas of cropland). Land in this region of the county, including the GPT property, is zoned Heavy Industrial. The site is bounded to the north by Alder Grove Road, to the east by Kickerville Road, to the south by Henry Johnson Road, and to the west by Jackson Road. Additionally, Powder Plant Road (or Gulf Road) and the Burlington Northern Railroad run north and south through the property, and Lonseth Road runs east and west (Figure 1).

The site is characterized by flat to gently rolling terrain, except for the escarpment along the Strait and a ravine in the southwest portion of the property associated with an unnamed stream (cataloged as Water Resource Inventory Area {WRIA} Stream 01.0100). The property's elevations range from sea level to approximately 220 feet above sea level, with most of the site lying between 60 and 160 foot elevation. The property contains approximately 5,460 feet of cobbly, sandy shoreline. The westernmost 2,500 feet of beach is bordered by steep escarpment slopes.

Historically, the site was logged and the land was homesteaded. Pastures were established on large tracts, while deciduous forests re-established on the remainder of the property. More recently, portions of the site have been logged for pulp or firewood; pastureland in the northwest and northeast quadrants are seasonally grazed by dairy cattle, and pastures in the southwest and southeast quadrants have been abandoned. Pastures bordering the Strait are hayed annually. Pastures, dense forests, and sparsely treed areas are interspersed with shrub-dominated or sapling-dominated plant communities. In addition, dirt roads and logging skid trails within logged areas are rapidly being colonized by deciduous tree saplings.

Project Background

GPT began investigating the feasibility of the site as a deep-water bulk loading facility in late 1990. The Cherry Point property is generally flat and contains a large expanse of shoreline with a relatively narrow offshore shelf. This property is one of only a few locations along the west coast of the United States where large transport ships could easily maneuver close to shore and where flat land adjacent to the shoreline could easily accommodate the space needed for dry bulk storage and railroad accessibility. In addition, this area is zoned for heavy industrial use.

Correspondence with Cheveron Real Estate Management Company indicated that a wetland evaluation of the property was performed by Parametrix, Inc. in 1990, which estimated approximately 65% of the site is wetland, according to delineation techniques described in the 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* (Federal Interagency Committee for Wetland Delineation, 1989). With the advent of the U.S. Army Corps of Engineers' (Corps) August 31, 1991 Special Public Notice, all projects that could involve filling or disposal of dredged material into waters of the United States, including wetlands, would need to be delineated using the 1987 *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory, 1987). Subject to the new mandate, GPT contracted Shapiro and Associates, Inc.

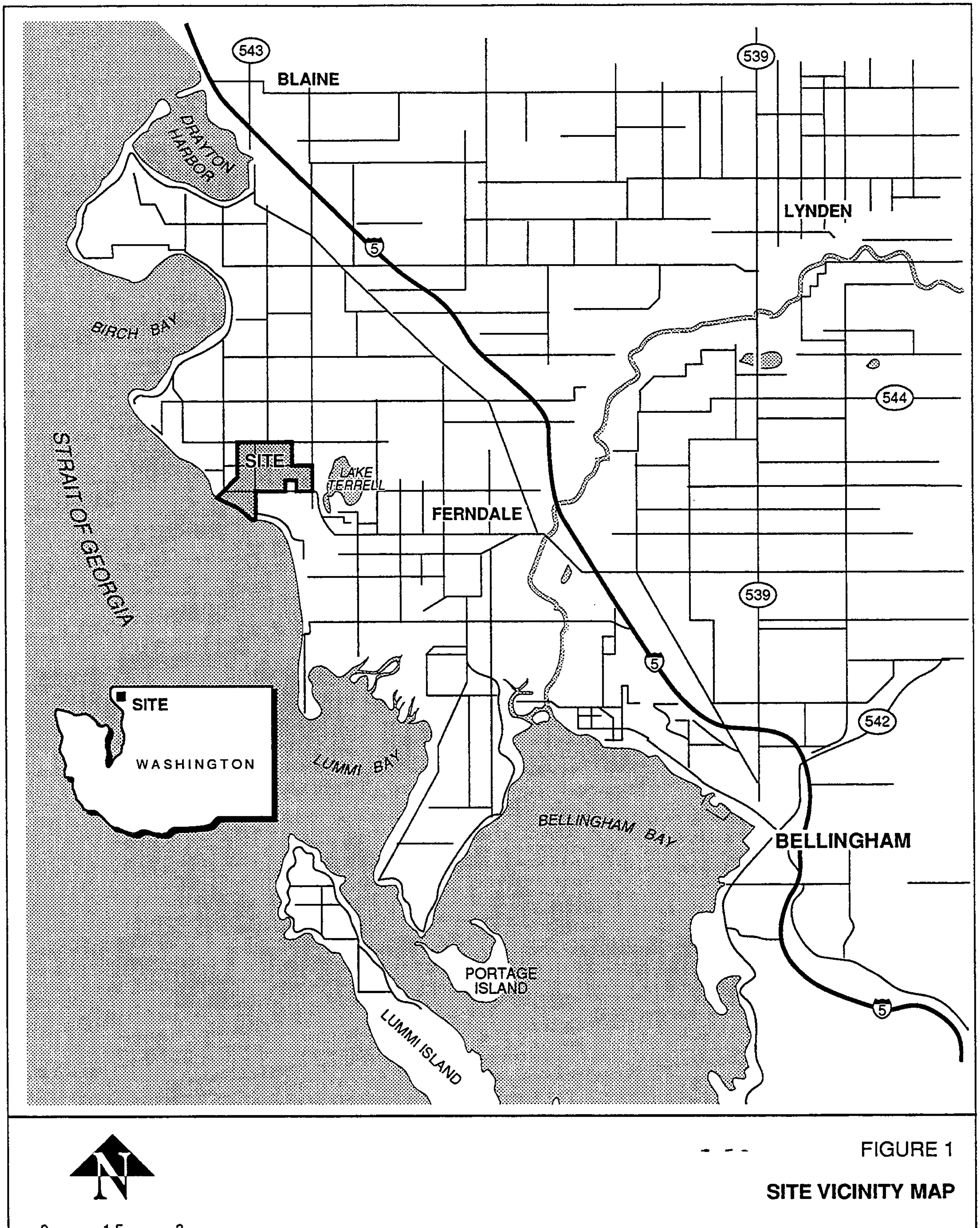

FIGURE 1

SITE VICINITY MAP

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CHERRY POINT

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(SHAPIRO) in late 1991 to re-evaluate 1,000 acres of the property for wetlands using the 1987 Manual. Under the 1987 methodology, approximately 61% of the investigated property was determined to be wetlands. This delineation was confirmed by the Corps in October 1992.

A preapplication meeting was held with the Corps on May 20, 1992, and a variety of additional studies were requested to provide detailed information that could be used as part of a National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS). These studies include a bald eagle, peregrine falcon, and seabird study; a macroalgae and eelgrass study; a study on potential shading effects of the proposed pier on marine vegetation; a surface-water hydrology study; a stream habitat study; and an amphibian survey. In addition, an evaluation of possible effects on fisheries, wetlands, and mitigation options was initiated. Wetlands information was used for preparation of the Section 404 application and public notice.

Purpose

The above-mentioned natural resource studies were performed to satisfy requests made during the preapplication meeting. Data and analyses generated from these studies are presented in this report to provide quantitative information for use in the Existing Conditions sections of NEPA and State Environmental Policy Act (SEPA) documents.

Field investigations for most of the studies began in the fall of 1992 and extended through July 1993. Most of the studies were dependent upon gathering data and making observations during specific periods in the fall, winter, and/or spring. This report includes a bald eagle, peregrine falcon, and seabird study; an assessment of macroalgae and eelgrass; a shading study of offshore floral habitat using the Acro pier as a model; a surface hydrology study of sheetflow and drainages; a stream habitat survey; and an amphibian survey of the property. Fisheries analyses and potential impacts are still being evaluated and will be discussed in a subsequent report.

The following sections present specific methodologies and findings from the six above-mentioned studies.

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

BALD EAGLE, PEREGRINE FALCON, AND SEABIRD SURVEY

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1. INTRODUCTION

Historical data obtained from the Washington Department of Wildlife (WDW) Priority Habitats and Species Program indicate that a bald eagle (*Haliaeetus leucocephalus*) territory encompasses the shoreline area of the property and extends south toward Lummi Bay (Andonaegui, 1992). The area also is designated as part of the Lummi Flats peregrine falcon (*Falco peregrinus anatum*) wintering area, which includes wintering waterfowl areas on Bellingham Bay, Lummi Bay, and Lummi Flats (Andonaegui, 1992) (Figure 1).

Because data on bald eagle and peregrine falcon activities in the project area are primarily limited to incidental sightings and records of eagles nesting near the Intalco aluminum plant, studies to evaluate abundance and behavior of these species and their potential prey resources (waterfowl, seabirds, and shorebirds) occurring in the area were conducted. Data gathered during these studies will be used to ascertain possible effects of project development on the continued use of the area by bald eagles, peregrine falcons, and other birds.

2. SPECIES DESCRIPTIONS

2.1 BALD EAGLE

2.1.1 Habitat and Distribution

The bald eagle, a federally listed and state-listed threatened species, is a common winter resident in western Washington, including inland waters of Puget Sound and the Strait of Georgia. Large numbers of eagles occur in the Skagit and Nooksack River drainages along the west slopes of the Cascade crest and in lesser numbers along other major drainage systems throughout western Washington. Winter migrations of anadromous fish up the Skagit, Nooksack, and Cascade Rivers attract some of the largest concentrations of bald eagles in the western United States (Stalmaster, 1987; Swenson, et al., 1986). Peak mid-winter counts of eagles in Skagit County have ranged between 150 and 650 individuals of resident and migrant birds. Overwintering birds in western Washington arrive from varying locales, including British Columbia, southeast Alaska, and from as far as Yellowstone National Park (Servheen and English, 1979; Swenson, et al., 1986). Many of these eagles winter along the shores of Puget Sound and along the Skagit, Sauk, Cascade, and Suiattle Rivers, which together comprise the Skagit Wild and Scenic River System (USDA Forest Service, 1983). Many additional eagles are winter and year-round residents of nearby coastal areas along the Olympic Peninsula and the Strait of Georgia.

Latest available estimates indicate that there are currently more than 400 active bald eagle nests in western Washington. Most of these occur along the Pacific Coast and along inland waters of Puget Sound (WDW, 1991). Numbers of eagles continue to increase in Washington; however, the effects of development on the success of bald eagle nesting are of concern.

Two bald eagle nests occur near the study area: one approximately 2 miles north (near Pt. White Horn Road) and the other approximately 2 miles south of the proposed project (near the Intalco plant) (Figure 1).

The shoreline area at Cherry Point consists primarily of cobbles with large quantities of driftwood. Mudflats, which are used extensively by shorebirds, do not occur in the vicinity of the proposed project and limit the number of shorebirds in the area. This, in turn, limits the available prey sources for eagles and other raptors in the area. Potential prey for bald eagles using the project vicinity are primarily fish and wintering waterfowl. Several trees along the shoreline and the unnamed creek corridor provide perch sites for eagles and other species moving through the area.

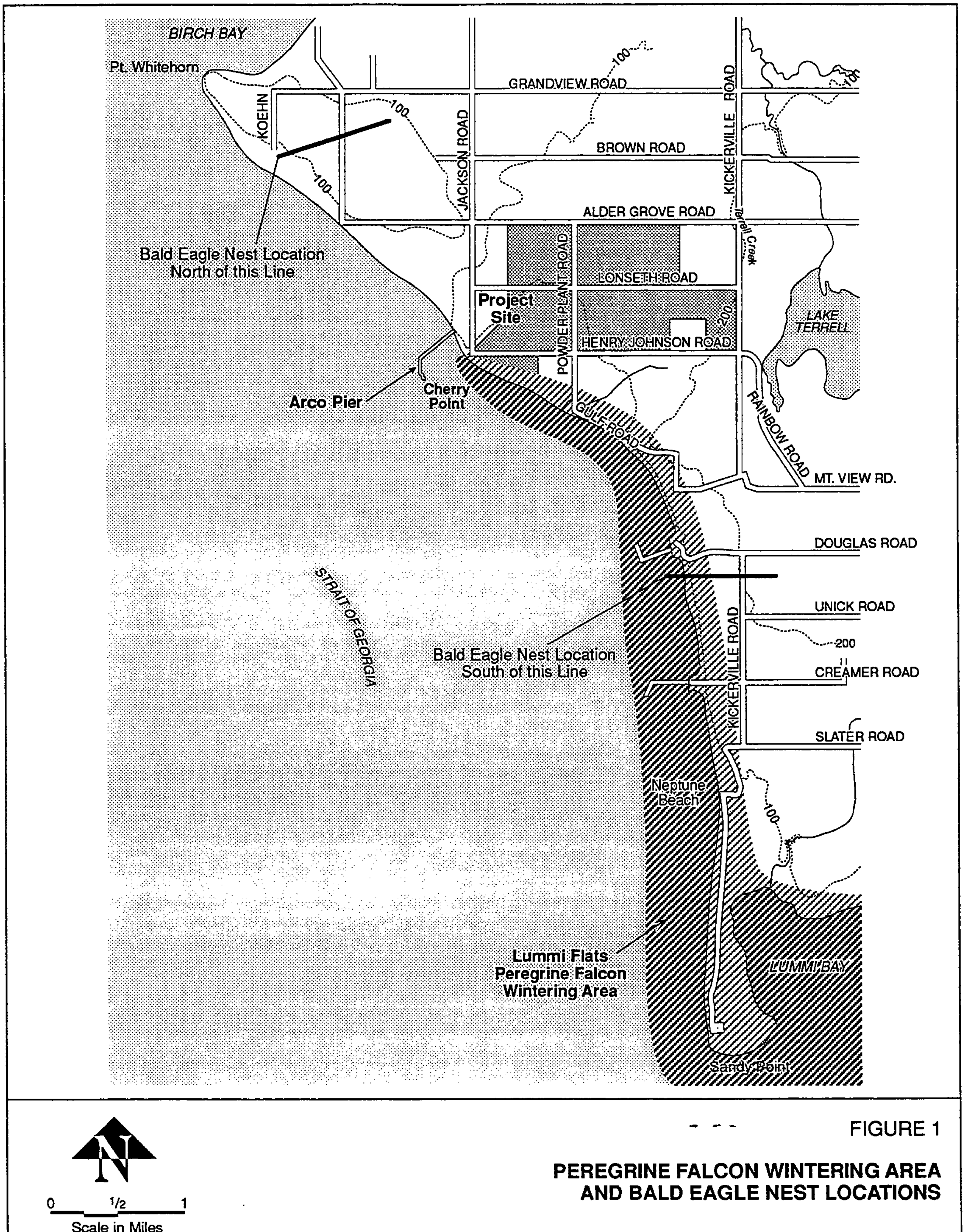

FIGURE 1

PEREGRINE FALCON WINTERING AREA AND BALD EAGLE NEST LOCATIONS

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CHERRY POINT

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The majority of the site; however, is young deciduous and mixed deciduous coniferous forest and lacks trees large enough to provide nesting platforms for eagles.

2.1.2 Foraging Ecology

Eagles can be found in western Washington throughout the year, but peak concentrations usually occur from October through March. Highest densities are reported during January and February, coinciding with peak runs of chum salmon (*Oncorhynchus keta*) in the major river systems emptying into Puget Sound (Servheen, 1975). Other salmon species also are used for food, including coho (*O. kisutch*), pink (*O. gorbuscha*), and chinook (*O. tshawytscha*) (Stalmaster, 1987). Eagles are extremely opportunistic in their food habits, but most studies indicate that eagles show a strong preference for fish (U.S. Army Corps of Engineers, 1979). In the San Juan Islands, approximately half of the year-round diet was comprised of fish, and the remaining half was attributed to mammals and birds in near equal proportions (Retfalvi, 1970). Diet often will shift in response to prey availability, however, and eagles will feed heavily on mammal carrion if readily available. Small mammals (including voles and rabbits) and carcasses of winter and/or road-killed deer and other large mammals may be eaten when alternate prey sources are in short supply (Servheen, 1975; U.S. Army Corps of Engineers, 1979). In western Washington, distribution and movements of eagles in winter depend largely on the availability of salmon carcasses deposited on gravel bars and in side channels of numerous rivers and tributaries. Eagles wintering along inland waters of Puget Sound and the Strait of Georgia also feed on populations of waterfowl, seabirds, and shorebirds inhabiting numerous bays, coves, and mudflats during winter.

2.2 AMERICAN PEREGRINE FALCON

2.2.1 Habitat and Distribution

The American peregrine falcon is a federally listed and state-listed endangered species and occurs in and along the Pacific Coast, Puget Sound, the Strait of Georgia, and the San Juan Islands. The Skagit Flats, located south of the study area, provide some of the most important wintering habitat for peregrines in North America (Anderson, et al., 1980; Wahl, et al., 1981). Grays Harbor and Willapa Bay also provide important wintering habitat for peregrines (USFWS, 1982).

Studies in 1979 revealed that 11 different peregrines used the Samish Flats (a portion of the Skagit Flats) during winter (Anderson and DeBruyn, 1979). Additionally, the northern tip of the Lummi Flats Peregrine Falcon Wintering Area that includes Bellingham Bay, Lummi Bay, and Lummi Flats (as mapped by the WDW for the Priority Habitats and Species Program) encompasses the shoreline portion of the study area (Figure 1). Southern portions of this wintering area provide mudflat habitat important to large populations of migratory shorebirds for foraging and resting, which in turn provide prey resources for peregrines, eagles, and other raptors. Recent studies by Shapiro in 1990 and 1991 found at least three individual peregrines using the Padilla Bay area. Observations of peregrines were recorded in the area from January through March 1991 (Shapiro and Associates, Inc., 1992).

Two subspecies of peregrine falcon are known to occur in the Puget Sound/Strait of Georgia region: Peale's falcon (*Falco peregrinus pealei*), most common along the coast of British Columbia, and the endangered American peregrine falcon (*F.p. anatum*) (Wahl, et al., 1981). The population of peregrine falcons continues to recover in Washington through natural recolonization and reintroduction programs. The number of known pairs in the state increased from 12 in 1989 to 17 in 1991. All but three of the 17 nest sites were in the San Juans Islands and the outer Pacific Coast (WDW, 1991).

American peregrine falcons nest predominantly on ledges of sheer cliffs 150 feet or more in height (USFWS, 1982). Many nest sites are located near water, although this may largely be a function of the high availability of coastal cliffs. Tree nesting is unknown for this species, and there are a few cases of nesting on man-made structures, particularly where peregrines have been introduced into cityscapes where they can forage on the abundant population of rock doves (WDW, 1991; USFWS, 1982). No cliffs suitable for peregrine nesting occur in the project area; however, tree perch sites occur along the shoreline.

2.2.2 Foraging Ecology

Peregrines forage almost exclusively on small- to medium-sized birds. Wintering populations of seabirds and shorebirds in bays and estuaries of Puget Sound and the Strait of Georgia provide abundant prey sources for peregrines and account, in large part, for the high number of peregrines wintering in western Washington.

Studies in the Skagit Flats area, including Padilla Bay, show that peregrines prey most often on ducks, shorebirds, and rock doves (Anderson and DeBruyn, 1979; Anderson, et al., 1980). Dunlin, which can occur in large flocks on mudflats in the Skagit and Lummi Flats areas, also are preyed upon by peregrines. Shorebirds are the predominant prey of peregrines in Grays Harbor and the Skagit Flats (USFWS, 1982). A radius of 12 to 15 miles may be used for hunting by peregrines where they forage on small birds, often captured while in flight.

Seabirds and waterfowl are present year-round in the vicinity of Cherry Point and may occasionally be preyed upon by peregrines. However, seabirds typically spend most of the day resting on the water or diving for food and spend limited time flying. They are not readily available as prey for peregrines. Additionally, the lack of mudflats in the project area severely limits the number of shorebirds using the site. Shorebirds are another significant prey source for peregrines in other areas.

2.3 SEABIRDS AND SHOREBIRDS

The study area lies within the Pacific Flyway, which is a general migratory route to and from breeding and wintering grounds for seabirds and shorebirds. Large numbers of these birds intermittently are present throughout many areas of Puget Sound and the Strait of Georgia. Wintering populations of seabirds are variable and depend to a large extent on local weather conditions and food source availability (Wahl, et al., 1981). The Cherry Point area often attracts large numbers of seabirds (primarily scoters) during the herring spawning season. However, summer, fall, and winter densities of seabirds in the Cherry Point area can be quite low in comparison to the spring period, and also when compared to other areas in the Strait of Georgia (Wahl, et al., 1981).

Seabirds are extremely mobile and pass through the Strait during north and south migrations and during daily movements between foraging and roosting/breeding areas. The Cherry Point site does not provide suitable breeding habitat for seabirds, but waters near the shoreline provide resting and possible night roost habitat. Additionally, the lack of a sheltered bay and mudflats at Cherry Point limits the number of shorebirds likely to occur in the area.

3. METHODS

3.1 BALD EAGLE AND PEREGRINE FALCON

Initial site reconnaissance and preliminary observations were conducted in early November 1992 to evaluate habitat conditions at the proposed project site and to establish viewing points for surveys (Figure 2). The data collection process is outlined below.

Surveys began in late November 1992 and were conducted approximately twice each week until mid-February 1993. Thereafter, surveys were conducted once each week through March and into mid-April 1993. Survey effort was reduced because bald eagle and peregrine falcon populations are typically lower during this period than during December, January, and early February. Each survey period was approximately six hours long. During the twice-weekly survey period, observations were conducted on consecutive days because of logistical constraints. Each survey was conducted with different time intervals to ensure observations during a variety of daylight and tidal conditions that may affect eagle or falcon behavior. One of the bi-weekly surveys was conducted from about 8:00 a.m. to 2:00 p.m. and the second from about 11:00 a.m. to 5:00 p.m. After mid-February, surveys were conducted once each week for four- to eight-hour periods.

During each survey period, areas within the field of view from each of two observation stations were scanned for the presence of bald eagles, peregrine falcons, and other raptors present in the area. Behavior observed at initial observation was placed into one of five categories: (1) hunting (feeding, catching prey, piracy, etc.); (2) flying (other than hunting flights); (3) perching; (4) agonistic interactions (intra- and inter-specific behaviors); and (5) disturbance (by humans, boats, etc.). Following initial observation, all activities and behavior of the raptor were described and mapped for reference.

All data were recorded on data sheets and transferred to computer format for analysis. Data collected include the following: age class of each eagle, as determined by feather coloration, and noted as adult (> 5 yrs.), juvenile (< 5 yrs.), or unknown (Stalmaster, 1987); eagle behavior (as described above); and observation time period. Additional variables recorded include perch type (i.e., tree species, size, etc.), and general weather conditions. Locations of all eagles observed during surveys, including perch sites, hunting locations, and flight lines, were recorded on maps (see Appendix A).

3.2 SEABIRDS AND SHOREBIRDS

Seabird and shorebird abundance were recorded by species at least once during each survey period by using spotting scopes and binoculars. During most surveys, however, three counts (once at the start, middle, and end of the survey) were conducted. Seabird counts were conducted from observation points established for the eagle and falcon surveys and covered nearshore habitats within approximately 300 to 400 meters from shore. No behavior data were collected for seabirds or shorebirds unless reactions to bald eagles or peregrine falcons were observed. Additionally, location and behavior of any marine mammals observed during the surveys were recorded on the data sheets.

4. RESULTS

4.1 BALD EAGLE

A total of 202 hours of observations for bald eagles and other raptors were conducted at the proposed project location. Seven raptors were identified near and within the project area during the course of the study, and a total of 80 separate sightings of bald eagles were recorded (Table 1).

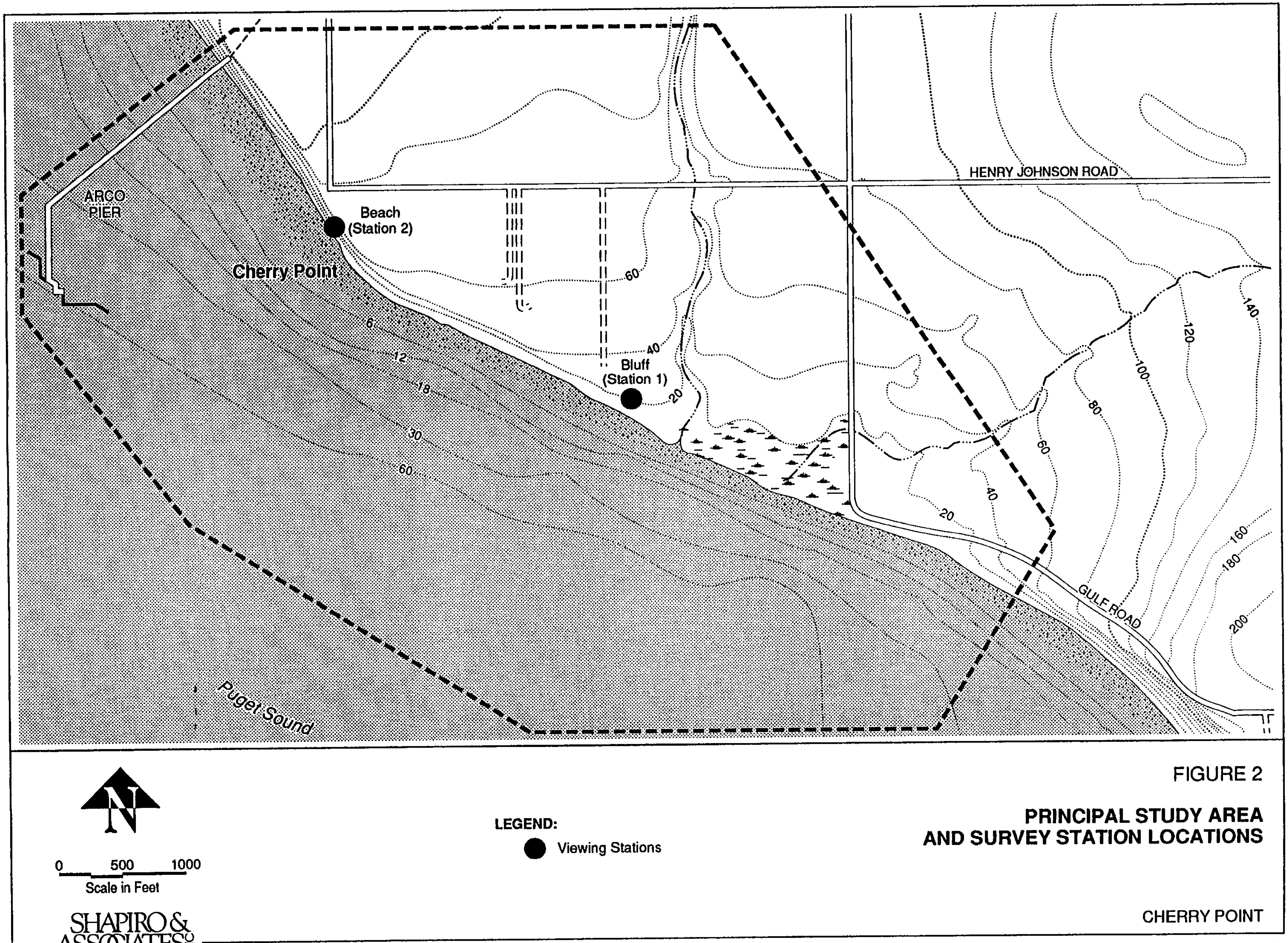

FIGURE 2

PRINCIPAL STUDY AREA AND SURVEY STATION LOCATIONS

CHERRY POINT

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Northern harriers and red-tailed hawks were relatively abundant and observed on numerous occasions, both during the timed observations and while moving through the site. Summary tables of all raptor sightings are provided in Appendix A.

Two eagle nests (one located approximately 2 miles north of the study area and the other located approximately 2 miles south) were identified during off-site investigations in the spring; these nests were first identified in March 1993. Both nests were attended to by two adult bald eagles, and on several occasions, one adult was observed sitting on the nests. It is not known whether successful fledging occurred. Periodic observations of the nests were conducted in April, May, and late June 1993; however, dense foliage obstructed clear viewing of the nests during these months. Observations on May 10, 1993, revealed the southern nest was still occupied, and one adult bald eagle was seen sitting on the nest. The last period that eagles were seen using the northern nest was April 15, 1993. Two adult eagles were observed on the nest tree (one on the nest and the other perched on large branches near the nest) at 1:25 p.m.

Most eagles observed during the study were seen flying to and from sites north and south of the project area and occasionally would perch for a few minutes to several hours on trees along the shoreline both on and adjacent to the project area. Maps indicating flight patterns and perch locations of all eagles observed during the study are provided in Appendix A.

On one occasion, an eagle was observed in pursuit of a small seabird (possibly a lesser scaup) along the shoreline. The eagle chased the bird for several hundred meters but was unsuccessful in capturing the prey. No other foraging attempts were observed, but prior to the survey on January 13, 1993, an eagle was observed flying over the unnamed creek corridor with what appeared to be a captured fish in its talons.

Table 1: LIST OF RAPTORS OBSERVED DURING SURVEYS CONDUCTED AT CHERRY POINT FROM NOVEMBER 1992 THROUGH APRIL 1993

Common Name	Scientific Name	Number of Sightings
American kestrel	*Falco sparverius*	1
bald eagle	*Haliaeetus leucocephalus*	80
northern harrier	*Circus cyaneus*	13
peregrine falcon	*Falco peregrinus*	1
red-tailed hawk	*Buteo jamaicensis*	25
rough-legged hawk	*Buteo lagopus*	1
short-eared owl	*Asio flammeus*	1

4.2 PEREGRINE FALCON

Only one peregrine falcon was observed during the study (Table 1) — on January 7, 1993. The falcon was first observed perching in a large cottonwood tree near the mouth of the unnamed creek (Appendix A). It remained perched for approximately 45 minutes and then flew southwest over the strait and continued out of sight of the observer. No attempts at foraging were observed, although several marine birds were in the nearshore vicinity of the creek mouth. No other peregrine falcon sightings were recorded at the study area.

4.3 SEABIRDS AND SHOREBIRDS

A total of 37 bird species (seabirds and shorebirds) were observed during the seabird counts from November 1992 through April 1993. An additional five categories were established during the surveys to account for species too far away to be identified, or species that could not be identified, but may account for additional species (Table 2). Marbled murrelets, a federally listed and state-listed species, were observed on several occasions during the study (a total of 32 individuals were counted) (Table 3). Additionally, harlequin ducks, a federal candidate species, were frequently observed in small numbers (Table 3). Marbled murrelets and harlequin ducks were seen approximately 150 to 1,500 feet from shore, between the Arco pier and the Intalco pier. Because the bird counts were conducted from land observation points, only individuals in the nearshore area were tallied, and additional, unidentifiable species and numbers of seabirds that occurred farther from shore were identified as rafts. The rafts ranged in number from 20 to 2,000 individuals of mixed species groups. All counts were concentrated on birds using portions of the nearshore environment within the vicinity of the proposed GPT Pier. The GPT Pier would occupy about 1% of the area approximately 1,500 feet from shore between the Arco and Intalco Piers.

Only three species of shorebirds (13 individuals) were observed during the study (dunlin, semi-palmated plover, and killdeer). This extremely low number is indicative of the lack of mudflats on the site, which minimizes the site's importance for shorebirds because of the lack of foraging opportunity. Sites located several miles south of the study area, including Lummi Flats, and Bellingham Bay provide high-quality habitat for these species, however.

Most species observed during the study occurred in small groups scattered along the nearshore area, and occasionally, large seabird rafts (up to 2,000 individuals) occurred beyond the nearshore area and north of the Arco pier (Figure 2).

The number of birds observed during each sample period remained relatively constant for the six-month study. The largest number of birds was observed in February 1993 (Figure 3). Large numbers of black scoters, white-winged scoters, Pacific loon, and western grebe were recorded during February and account for most of the high number of birds present in the study area during this period (Table 3). Great blue herons were observed frequently during the study period, both foraging in the tidal margins and presumably flying to and from the rookery located several miles north of the project area.

The spring herring spawn attracted large numbers of scoters to the Cherry Point site, and on one occasion (April 30, 1993), a flock of approximately 5,000 to 8,000 individuals was observed in the nearshore area north of the proposed pier location directly offshore from Cherry Point. This large flock of scoters was an incidental sighting, however, and therefore was not recorded during scheduled survey periods or included in statistical analysis. Gulls (western, glaucous-winged, and Bonaparte's) also were extremely abundant during this survey. The number of seabirds in the study area before and after the herring spawn were lower and were relatively similar, compared to the higher numbers observed during the herring spawn.

5. DISCUSSION

Studies at the Cherry Point project site revealed that bald eagles are common to the area and frequently fly over the site and along the shoreline traveling north and south. Although 80 separate sightings of eagles were recorded, the number of different individuals observed is considerably less. On one occasion (January 7, 1993), five different eagles (four adults and one immature) were observed flying near the site. On many occasions only one or two eagles were observed during the survey period.

Table 2: LIST OF SEABIRDS OBSERVED AT THE PROJECT SITE DURING SURVEYS CONDUCTED FROM NOVEMBER 1992 THROUGH APRIL 1993

Common Name	Scientific Name	Species Code*
Barrow's goldeneye	*Bucephala islandica*	BGOLD
belted kingfisher	*Ceryle alcyon*	KING
black scoter	*Melanitta nigra*	BKSC
Bonaparte's gull	*Larus philadelphia*	BNGULL
Brandt's cormorant	*Phalacrocorax penicillatus*	BTCOR
bufflehead	*Bucephala albeola*	BUFF
common goldeneye	*Bucephala clangula*	CGOLD
common loon	*Gavia immer*	CLOON
common murre	*Uria aalge*	CMURR
double-crested cormorant	*Phalacrocorax auritus*	DCCOR
dunlin	*Calidris alpina*	DUNLIN
eared grebe	*Podiceps nigricollis*	EGRB
great blue heron	*Ardea herodias*	GBH
greater scaup	*Aythya marila*	GSCP
glaucous-winged gull	*Larus glaucescens*	GWGULL
harlequin duck	*Histrionicus histrionicus*	HARD
herring gull	*Larus argentatus*	HGULL
horned grebe	*Podiceps auritus*	HGRB
killdeer	*Charadrius vociferus*	KILLD
lesser scaup	*Aythya affinis*	LSCP
marbled murrelet	*Brachyramphus marmoratus*	MARBM
oldsquaw	*Clangula hyemalis*	OLDSQ
pelagic cormorant	*Phalacrocorax pelagicus*	PELCOR
pied-billed grebe	*Podilymbus podiceps*	PGRB
pigeon guillemot	*Cepphus columba*	PGUILL
Pacific loon	*Gavia pacifica*	PLOON
red-breasted merganser	*Mergus serrator*	RBMER
red-necked grebe	*Podiceps grisegena*	RNGRB
red-throated loon	*Gavia stellata*	RTLOON
ring-billed gull	*Larus delawarensis*	RBGULL
semi-palmated plover	*Charadrius semipalmatus*	SPPLOV
surf scoter	*Melanitta perspicillata*	SFSC
western grebe	*Aechmophorus occidentalis*	WGRB
western gull	*Larus occidentalis*	WGULL
white-winged scoter	*Melanitta fusca*	WWSC
yellow-billed loon	*Gavia adamsii*	YBLOON
unknown cormorant		UNKCOR
unknown gull		UNKGULL
unknown scaup		UNKSCP
unknown seabird		UNKSEA
unknown shorebird		UNKSHOR

* Species code corresponding with Table 3.

Table 3: TOTAL NUMBER OF SEABIRDS OBSERVED AT THE PROJECT SITE DURING SURVEYS CONDUCTED FROM NOVEMBER 1992 THROUGH APRIL 1993. DATA REPRESENT MONTHLY TOTALS FROM EACH OBSERVATION STATION*

	Station		Nov - 92	Station		Dec - 92	Station		Jan - 93	Feb - 93	Mar - 93	Apr - 93	Grand
Species	One	Two	Summary	One	Two	Summary	One	Two	Summary	Summary	Summary	Summary	Total
BGOLD	0	0	0	3	0	3	3	0	3	0	0	0	6
BKSC	9	14	23	49	5	54	249	13	262	600	37	1	977
BNGULL	0	0	0	3	0	3	0	0	0	0	0	0	3
BTCOR	0	26	26	2	3	5	2	2	4	0	0	0	35
BUFF	4	41	45	39	92	131	44	125	169	61	37	4	447
CGOLD	49	32	81	72	137	209	44	90	134	84	23	9	540
CLOON	7	13	20	20	34	54	10	27	37	17	1	0	129
CMURR	0	0	0	0	0	0	66	0	66	20	1	0	87
DCCOR	11	0	11	1	28	29	18	24	42	59	1	1	143
DUNLIN	0	0	0	0	0	0	1	0	1	0	0	0	1
EGRB	0	0	0	0	0	0	0	9	9	35	0	0	44
GBH	0	2	2	5	3	8	2	5	7	1	0	0	18
GSCP	0	0	0	0	0	0	3	1	4	21	0	1	26
GWGULL	3	0	3	11	13	24	27	40	67	24	9	2	129
HARD	7	17	24	39	31	70	38	49	87	45	10	15	251
HGRB	10	35	45	78	134	212	57	55	112	53	27	8	457
HGULL	5	49	54	17	10	27	0	5	5	1	3	0	90
KLLD	0	0	0	0	0	0	2	0	2	1	0	0	3
KING	0	2	2	0	0	0	1	2	3	0	0	0	5
LSCP	0	118	118	115	192	307	116	146	262	21	35	4	747
MARBM	0	0	0	5	0	5	24	3	27	3	0	0	35
OLDSQ	0	4	4	8	9	17	8	8	16	4	1	0	42
PELCOR	0	0	0	4	0	4	2	1	3	42	3	0	52
PGRB	0	0	0	0	0	0	2	0	2	0	0	0	2
PGUILL	0	0	0	0	0	0	0	0	0	5	1	0	6
PLOON	100	81	181	118	140	258	650	32	682	410	53	50	1,634
RBGULL	0	0	0	2	0	2	0	0	0	2	0	0	4
RBMER	11	13	24	81	52	133	100	39	139	32	14	0	342
RNGRB	0	0	0	0	0	0	0	0	0	3	0	0	3
RTLOON	0	0	0	10	0	10	0	1	1	11	0	0	22
SFSC	31	64	95	98	502	600	92	202	294	150	27	11	1,177
SPPLOV	9	0	9	0	0	0	0	0	0	0	0	0	9
UNKCOR	110	25	135	91	120	211	42	31	73	85	51	4	559
UNKGULL	31	0	31	48	68	116	58	83	141	48	32	32	400
UNKSCP	0	0	0	11	0	11	0	0	0	5	0	0	16
UNKSEA	210	0	210	0	125	125	80	70	150	327	25	60	897
UNKSHOR	0	0	0	0	0	0	0	1	1	0	0	0	1
WGRB	18	49	67	129	15	144	150	31	181	446	97	2	937
WGULL	1	0	1	0	0	0	0	0	0	2	0	0	3
WWSC	0	1	1	203	7	210	21	231	252	289	0	0	752
YBLOON	0	0	0	0	0	0	0	0	0	1	0	0	1
Grand Total	626	586	1,212	1,262	1,720	2,982	1,912	1,326	3,238	2,908	448	204	11,032

*Station One represents the Bluff Station and Station Two represents the Beach Station

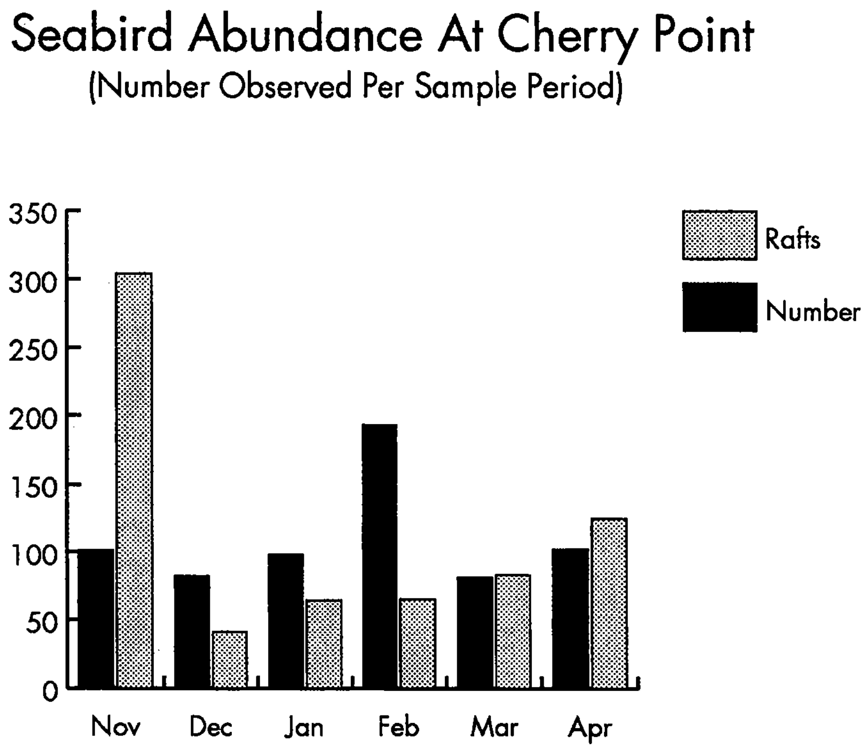


Figure 3. Monthly abundance of seabirds in the project area. Data adjusted to show number observed per sample period.

The single peregrine falcon sighted during the surveys may have been en route to the Lummi Flats wintering area or points farther south, such as the Skagit Flats. This sighting is not unusual considering the abundant wintering habitat located south of the project site.

Seabird densities were relatively low at the site throughout the study period, except during the herring spawn in May, when large numbers of scoters congregated near Cherry Point to feed. Fishing boats and large oil tankers frequently were observed but did not appear to affect seabird behavior in nearshore areas in the vicinity of the project site.

Harlequin ducks were observed in small groups during nearly every survey period. Additionally, buffleheads, horned grebe, lesser scaup, and common goldeneye were common in the study area. Large rafts of seabirds were infrequently observed, which may have been a result of conducting observations from shore where long-distance viewing is difficult.

Harbor seals (*Phoca vitulina*) also were frequently observed in the project area in the nearshore habitat. Although usually observed in pairs, on at least one occasion four different individuals were observed. None were seen to haul out in the vicinity of the project area. Northern sea lions (*Eumetopias jubatus*) also were observed offshore on two occasions.

Numerous species of songbirds were common along the shoreline during the study, including song sparrow, rufous-sided towhee, American robin, black-capped chickadee, and Bewick's wren. Upland habitats throughout the site are interspersed with large, open fields that provide high-quality foraging habitat for raptors. These fields provide resources for large numbers of voles, shrews, deer mice, and other species that are preyed upon by raptors in the project vicinity.

Although open fields at the project site provide abundant foraging habitat for red-tailed hawks, northern harriers, and other common raptors, the overall value of the site to bald eagles and peregrine falcons is limited. The project site provides perching habitat for eagles and peregrines that move through the area (particularly in winter when large populations of eagles arrive in Washington) and marginal forage resources from localized seabird concentrations. Seabirds generally congregate in small numbers in the nearshore environment in the project area, and only reach large numbers during a brief period when the herring spawn in late spring (Wahl, et al., 1981).

Forest cover at the site is relatively sparse, and stands of trees cover small areas. Trees at the site are generally small and appear to be unsuitable as nest sites for large raptors such as bald eagles. Additionally, cliffs of appropriate size and type for peregrine nesting do not occur on the site.

Based on the results of studies conducted at the project area from November 1992 through April 1993, the site provides temporary perching habitat for eagles and peregrines moving through the area during migratory periods, and only marginal forage resources for these species are available in the near vicinity.

6. LITERATURE CITED

Anderson, C.M., P.M. DeBruyn, T. Ulm, and B. Gaussoin, 1980. *Behavior and Ecology of Peregrine Falcons Wintering on the Skagit Flats, Washington.* A report on the 1980 field season, Washington Department of Wildlife.

Anderson, C.M. and P.M. DeBruyn, 1979. *Behavior and Ecology of Peregrine Falcons Wintering on the Skagit Flats, Washington.* A report of the 1979 field season. Unpub. Report. 53 pp.

Andonaegui, C., 1992. Priority Habitats and Species Data Search. Washington Department of Wildlife, Wildlife Information Systems.

Retfalvi, L., 1970. "Food of nesting bald eagles on San Juan Island, Washington." *Condor*, 72 (3): 358-361.

Servheen, C.W., 1975. *Ecology of the Wintering Bald Eagles on the Skagit River, Washington.* M.S. Thesis, Univ. of Washington, Seattle. 83 pp.

Servheen, C.W. and W. English, 1979. "Movements of rehabilitated bald eagles and proposed seasonal movements of bald eagles in the Pacific Northwest." *Raptor Research*, 13 pp. 79-88.

Shapiro and Associates, Inc., 1992. *The Effects to Bald Eagles and Peregrine Falcons from Constructing and Operating the Proposed Swinomish Marina.* Biological Assessment prepared for Swinomish Tribal Community, LaConner, Washington.

Stalmaster, 1987. *The Bald Eagle.* Universe Books, New York, N.Y. 227 pp.

Swenson, J.E., Alt, K.L. and R.L. Eng, 1986. "Ecology of bald eagles in the greater Yellowstone ecosystem." *Wildl. Monog.* No. 95. 46 pp.

U.S. Department of Agriculture, Forest Service, 1983. *Skagit Wild and Scenic Rivers System.*

U.S. Fish and Wildlife Service, 1982. *The Pacific Coast American Peregrine Falcon Recovery Plan.* Prepared by U.S. Fish and Wildlife Service in cooperation with Pacific Coast American Peregrine Falcon Recovery Team.

U.S. Army Corps of Engineers, 1979. *The Northern Bald Eagle (Haliaeetus leucocephalus alascanus): A Literature Survey.* Environmental Resources Section, Seattle District.

Wahl T.R., S.M. Speich, D.A. Manuwal, K.V. Hirsch, and C. Miller, 1981. *Marine Bird Populations of the Strait of Juan de Fuca, Strait of Georgia, and Adjacent Waters in 1978 and 1979.* DOC/EPA Interagency Energy/Environmental R & D Report No. EPA-600/7-81-156. Office of Energy, Minerals, and Industry. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

Washington Department of Wildlife, 1991. *1991 Status Report, Endangered and Threatened.* Olympia, Washington.

APPENDIX A

Field Data Summary

CHERRY POINT RAPTOR SURVEY DATABASE

SITE	DATE	TIME START	TIME STOP	TOTAL TIME	MAP ID*	SPECIES	OBS TIME	AGE	INITIAL ACTIVITY
Beach	11/23/92	11:30	16:30	5:00:00		No Raptors Seen			
Bluff	11/23/92	11:30	16:30	5:00:00	U	Red-tailed Hawk	11:30	Ad	Perching
Bluff	11/23/92				U	Red-tailed Hawk	11:38	Ad	Flying
Bluff	11/23/92				U	Northern Harrier	15:12	Ad	Flying
Beach	11/24/92	8:30	14:00	5:30:00		No Raptors Seen			
Bluff	11/24/92	8:30	14:00	5:30:00	A	Bald Eagle	10:45	Ad	Perching
Bluff	11/24/92				B	Bald Eagle	11:10	Imm	Flying
Bluff	11/24/92				U	Red-tailed Hawk	8:30	Ad	Flying
Bluff	11/24/92				U	Red-tailed Hawk	10:45	Ad	Defense
Beach	12/2/92	11:20	17:00	5:40:00		No Raptors Seen			
Bluff	12/2/92	11:20	17:00	5:40:00		No Raptors Seen			
Beach	12/3/92	8:10	14:00	5:50:00	U	Red-tailed Hawk	9:35	Ad	Flying
Bluff	12/3/92	8:10	14:00	5:50:00	U	Red-tailed Hawk	7:50	Ad	Flying
Bluff	12/3/92				U	Red-tailed Hawk (2)	13:27	Ad	Flying
Beach	12/10/92	09:20	14:00	4:40:00		No Raptors Seen			
Bluff	12/10/92	09:20	14:00	4:40:00	A	Bald Eagle	10:00	Ad	Perching
Bluff	12/16/92	11:20	17:00	5:40:00		No Raptors Seen			
Beach	12/16/92	11:20	17:00	5:40:00	U	Northern Harrier	12:08	Ad	Flying
Bluff	12/17/92	8:35	14:00	5:25:00		No Raptors Seen			
Beach	12/17/92	8:35	14:00	5:25:00	A	Bald Eagle	12:07	Ad	Flying
Beach	12/17/92				B	Bald Eagle	12:23	Ad	Flying
Beach	12/17/92				U	Red-tailed Hawk	1405	Ad	Perching
Bluff	12/22/92	9:10	14:00	4:50:00	A	Bald Eagle	9:10	Ad	Flying
Beach	12/22/92	8:00	14:00	6:00:00	A	Bald Eagle	10:14	Ad	Flying
Bluff	12/22/92				B	Bald Eagle	10:19	Imm	Flying
Beach	12/22/92				B	Bald Eagle	10:45	Ad	Flying

* Map ID—Letters correspond with eagle flight pattern maps

CHERRY POINT RAPTOR SURVEY DATABASE

SITE	DATE	TIME START	TIME STOP	TOTAL TIME	MAP ID*	SPECIES	OBS TIME	AGE	INITIAL ACTIVITY
Bluff	12/22/92	9:10	14:00	4:50:00	C	Bald Eagle	11:21	Ad	Flying
Beach	12/22/92				C	Bald Eagle	10:51	Ad	Flying
Beach	12/22/92				D	Bald Eagle	11:27	Ad	Perching
Beach	12/22/92				E	Bald Eagle	14:43	Ad	Flying
Beach	1/6/93	11:25	17:00	5:35:00	A	Bald Eagle	11:26	Ad	Flying
Bluff	1/6/93	11:00	17:00	6:00:00	A	Bald Eagle	11:40	Ad	Flying
Beach	1/6/93				B	Bald Eagle	14:12	Ad	Flying
Bluff	1/6/93				B	Bald Eagle	15:25	Ad	Flying
Beach	1/6/93				C	Bald Eagle	14:37	Ad	Perching
Bluff	1/6/93				C	Bald Eagle	15:25	Imm	Flying
Beach	1/6/93				D	Bald Eagle	14:48	Ad	Flying
Bluff	1/6/93				D	Red-tailed Hawk	11:40	Ad	Flying
Beach	1/6/93				E	Bald Eagle	15:07	Ad	Flying
Bluff	1/6/93				E	Northern Harrier	15:40	Ad	Flying
Bluff	1/6/93				F	Short-eared Owl	16:50	Ad	Flying
Road	1/6/93				U	Bald Eagle	10:55	Ad	Perching
Bluff	1/7/93	8:20	14:00	5:40:00	A	Bald Eagle	8:45	Imm	Perching
Beach	1/7/93	8:00	14:00	6:00:00	A	Bald Eagle	8:00	Ad	Perching
Bluff	1/7/93				AA	Red-tailed Hawk	9:09	Ad	Disturbance
Bluff	1/7/93				B	Peregrine Falcon	9:50	Ad	Perching
Beach	1/7/93				B	Bald Eagle	11:16	Imm	Flying
Bluff	1/7/93				C	Bald Eagle	10:55	Ad	Perching
Beach	1/7/93				C	Bald Eagle	12:05	Ad	Flying
Bluff	1/7/93				D	Bald Eagle	12:06	Ad	Hunting
Beach	1/7/93				D	Bald Eagle	12:06	Ad	Flying
Bluff	1/7/93				E	Bald Eagle	12:07	Ad	Perching

* Map ID—Letters correspond with eagle flight pattern maps

CHERRY POINT RAPTOR SURVEY DATABASE

SITE	DATE	TIME START	TIME STOP	TOTAL TIME	MAP ID*	SPECIES	OBS TIME	AGE	INITIAL ACTIVITY
Beach	1/7/93				E	Bald Eagle	12:19	Ad	Defense
Bluff	1/7/93				F	Bald Eagle	12:07	Ad	Flying
Beach	1/7/93				F	Red-tailed Hawk	12:19	Ad	Perching
Bluff	1/7/93				G	Northern Harrier	10:55	Ad	Perching
Beach	1/7/93				G	Northern Harrier	10:15	Ad	Perching
Beach	1/7/93				H	Northern Harrier	10:15	Ad	Perching
Road	1/7/93				U	Rough-legged Hawk	8:00	Ad	Foraging
Bluff	1/7/93				U	Northern Harrier	9:25	Ad	Flying
Bluff	1/13/93	11:50	17:00	5:10:00	A	Bald Eagle	12:17	Ad	Flying
Bluff	1/13/93				B	Bald Eagle	15:30	Ad	Perching
Bluff	1/13/93				C	Bald Eagle	15:33	Ad	Flying
Bluff	1/13/93				D	Bald Eagle	15:58	Ad	Flying
Bluff	1/13/93				E	Bald Eagle	16:14	Ad	Flying
Bluff	1/13/93				F	Northern Harrier	14:37	Ad	Flying
Bluff	1/13/93				U	Red-tailed Hawk	12:57	Ad	Flying
Beach	1/14/93	9:00	14:00	5:00:00		No Raptors Seen			
Road	1/14/93				U	Red-tailed Hawk	0845	Ad	Perching
Bluff	1/21/93	09:55	15:00	5:05:00	A	Bald Eagle	10:20	Ad	Flying
Beach	1/21/93	10:00	15:00	5:00:00	A	Bald Eagle	15:00	Imm	Flying
Bluff	1/21/93				B	Northern Harrier	11:13	Ad	Hunting
Bluff	1/21/93				C	Bald Eagle	11:31	Ad	Flying
Bluff	1/21/93				D	Bald Eagle	11:57	Imm	Flying
Bluff	1/21/93				U	Bald Eagle	10:25	Ad (2)	Flying
Beach	1/27/93	12:05	17:00	4:55:00	A	Northern Harrier	12:52	Ad	Perching
Bluff	1/27/93	12:05	17:00	4:55:00	A	Bald Eagle	12:15	Ad	Feeding
Beach	1/27/93				B	Bald Eagle	15:55	Ad	Perching

* Map ID—Letters correspond with eagle flight pattern maps

CHERRY POINT RAPTOR SURVEY DATABASE

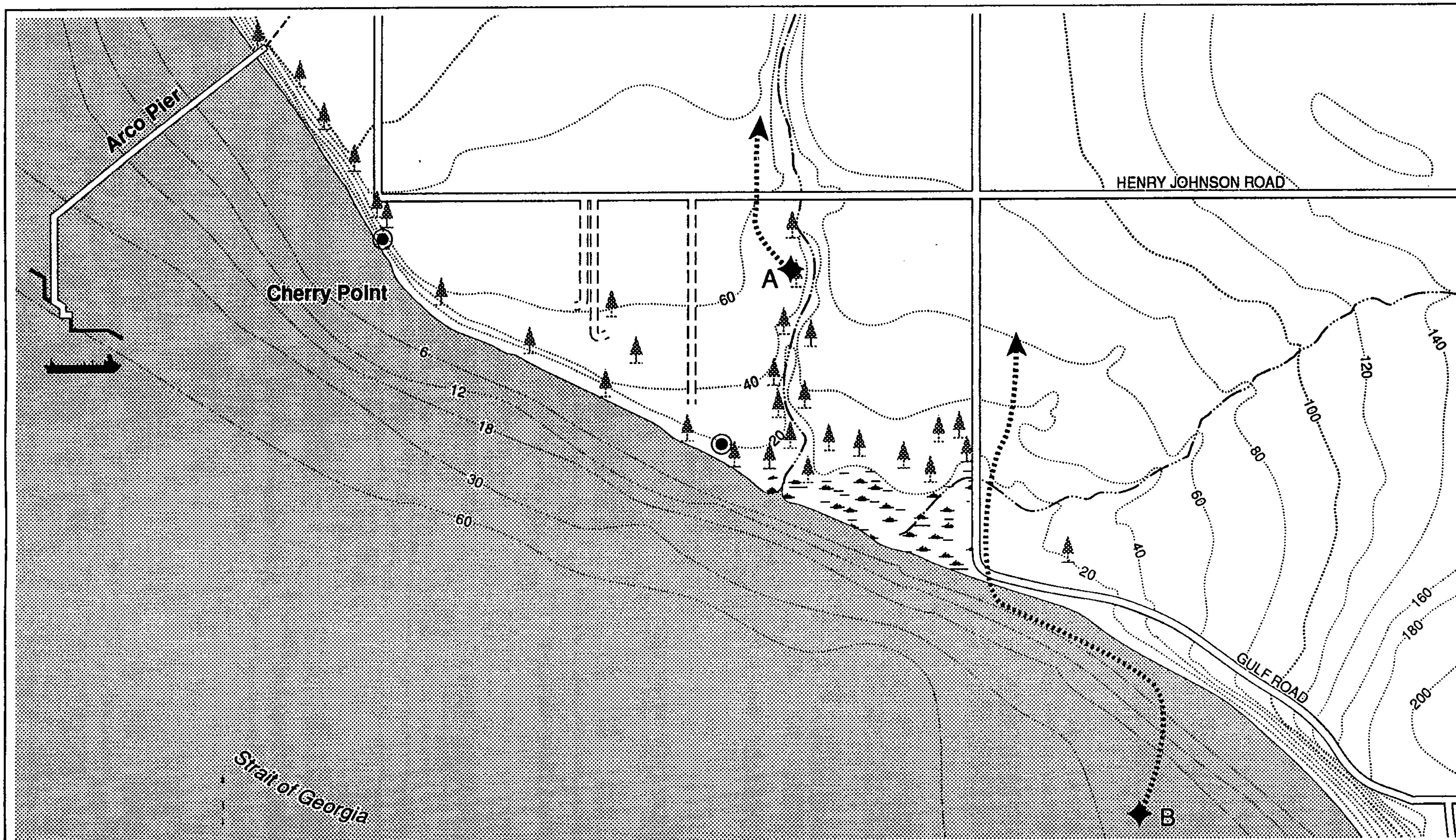
SITE	DATE	TIME START	TIME STOP	TOTAL TIME	MAP ID*	SPECIES	OBS TIME	AGE	INITIAL ACTIVITY
Bluff	1/27/93				B	Bald Eagle	16:18	Imm	Flying
Bluff	1/28/93	08:25	14:00	5:35:00	A	Bald Eagle	08:37	Ad	Flying
Beach	1/28/93	08:30	14:00	5:30:00	A	Bald Eagle	08:30	Imm	Flying
Bluff	1/28/93				B	Bald Eagle	08:37	Imm	Flying
Beach	1/28/93				B	American Kestrel	10:00	Ad	Flying
Bluff	1/28/93				C	Bald Eagle	08:53	Ad	Flying
Beach	1/28/93				C	Red-tailed Hawk	12:30	Ad	Perching
Bluff	1/28/93				D	Red-tailed Hawk	09:25	Ad	Flying
Bluff	1/28/93				E	Bald Eagle	09:29	Imm	Perching
Bluff	1/28/93				F	Red-tailed Hawk	12:19	Imm	Flying
Bluff	2/2/93	12:10	17:25	5:15:00	A	Bald Eagle	12:10	Ad	Perching
Bluff	2/2/93				B	Bald Eagle	12:20	Ad	Flying
Bluff	2/2/93				C	Bald Eagle	13:15	Ad	Flying
Bluff	2/2/93				C	Bald Eagle	13:15	Ad	Flying
Bluff	2/2/93				D	Bald Eagle	14:15	Ad	Perching
Bluff	2/2/93				E	Bald Eagle	14:24	Ad	Perching
Bluff	2/2/93				F	Bald Eagle	15:50	Ad	Perching
Bluff	2/3/93	08:00	14:00	6:00:00	A	Bald Eagle	10:12	Ad	Flying
Bluff	2/3/93				B	Bald Eagle	10:55	Ad	Flying
Bluff	2/3/93				C & D	Bald Eagle (2)	11:24	Ad & Imm	Flying
Bluff	2/3/93				E	Bald Eagle	11:24	Ad	Perching
Bluff	2/3/93				E	Bald Eagle	11:35	Ad	Perching
Bluff	2/3/93				E	Bald Eagle	11:45	Ad	Perching
Bluff	2/17/93	10:50	17:30	6:40:00	A	Northern Harrier	10:53	Ad	Flying (not on site)
Bluff	2/17/93				B	Red-tailed Hawk	11:15	Ad	Flying
Bluff	2/17/93				C	Bald Eagle	11:50	Imm	Flying

* Map ID—Letters correspond with eagle flight pattern maps

CHERRY POINT RAPTOR SURVEY DATABASE

SITE	DATE	TIME START	TIME STOP	TOTAL TIME	MAP ID*	SPECIES	OBS TIME	AGE	INITIAL ACTIVITY
Bluff	2/17/93				D	Red-tailed Hawk (2)	12:38	Ad	Flying
Bluff	2/17/93				E	Northern Harrier	13:43	Ad	Flying
Bluff	2/17/93				F	Bald Eagle	15:34	Ad	Flying
Bluff	2/17/93				G	Red-tailed Hawk	16:56	Ad	Perching
Bluff	2/19/93	10:15	16:15	6:00:00	A	Bald Eagle	10:25	Unk	Flying
Bluff	2/19/93				B	Northern Harrier	11:35	Ad	Flying
Bluff	2/19/93				C	Bald Eagle	15:55	Unk	Perching
Bluff	2/25/93	08:10	14:30	6:20:00	A	Bald Eagle	9:00	Imm	Flying
Bluff	2/25/93				B	Bald Eagle	9:45	Imm	Flying
Bluff	2/25/93				C	Bald Eagle	11:47	Ad	Flying
Bluff	2/25/93				D	Bald Eagle	12:05	Ad	Perching
Bluff	2/25/93				E	Bald Eagle (2)	13:35	Ad	Mating
Bluff	3/5/93	11:30	17:30	6:00:00	A	Red-tailed Hawk (2)	11:42	Ad	Flying
Bluff	3/5/93				B	Bald Eagle	12:37	Imm	Flying
Bluff	3/11/93	11:25	18:30	7:05:00	A	Red-tailed Hawk	11:30	Ad	Flying
Bluff	3/18/93	11:30	14:30	3:00:00	A	Bald Eagle	13:47	Ad	Flying
Bluff	3/18/93				B	Bald Eagle	13:47	Ad	Flying
Bluff	3/18/93				C	Red-tailed Hawk	13:48	Ad	Flying
Bluff	3/18/93				D	Bald Eagle	13:49	Imm	Flying
Bluff	3/18/93				E	Bald Eagle	13:56	Ad	Flying
Bluff	3/18/93				F	Bald Eagle	14:02	Ad	Flying

* Map ID—Letters correspond with eagle flight pattern maps



N

0 500 1000
Scale in Feet

SHAPIRO & ASSOCIATES INC

LEGEND

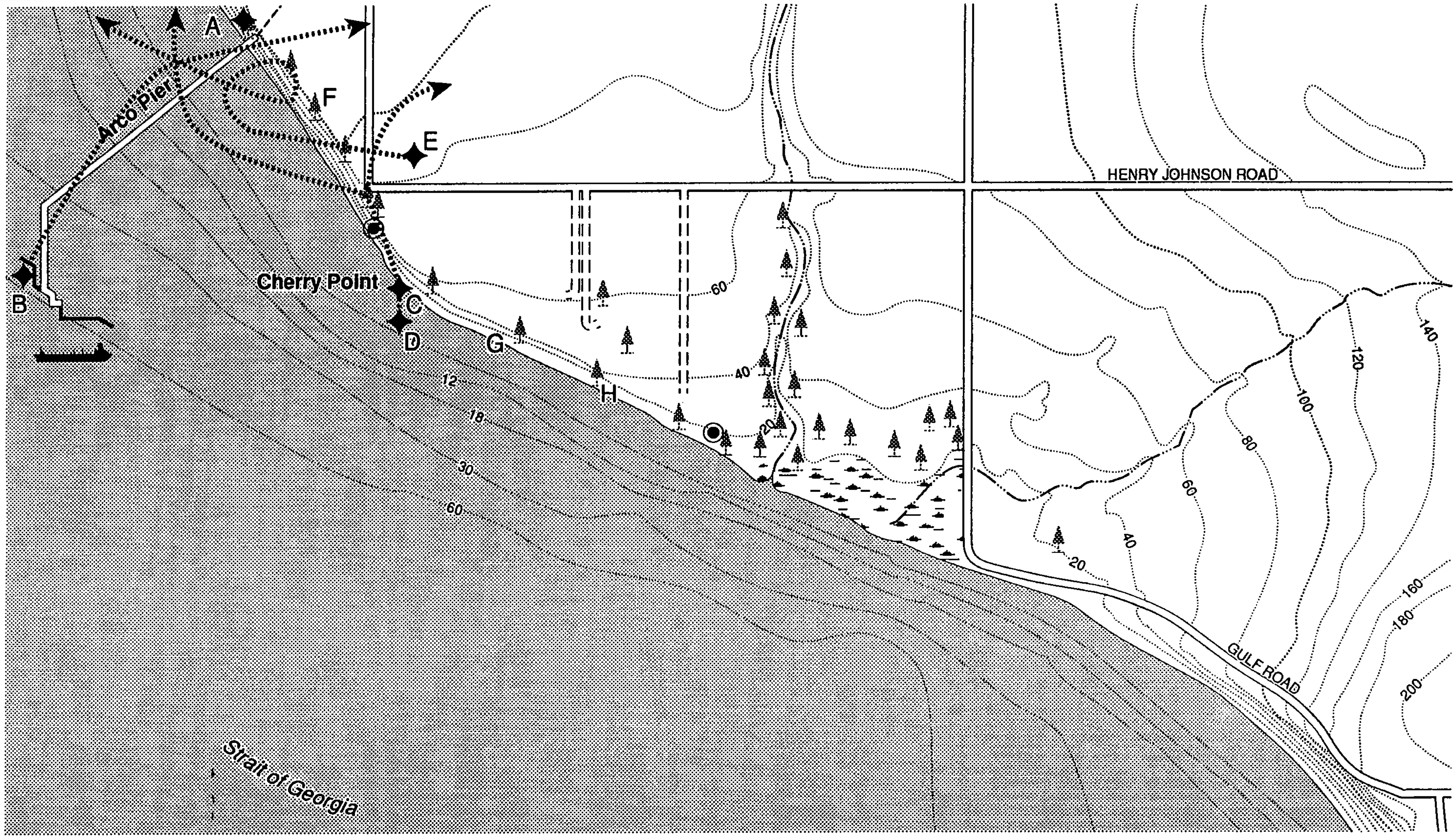
- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

November 24, 1992
Bluff Station

CHERRY POINT

9/93



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Scale in Feet

SHAPIRO & ASSOCIATES INC

LEGEND

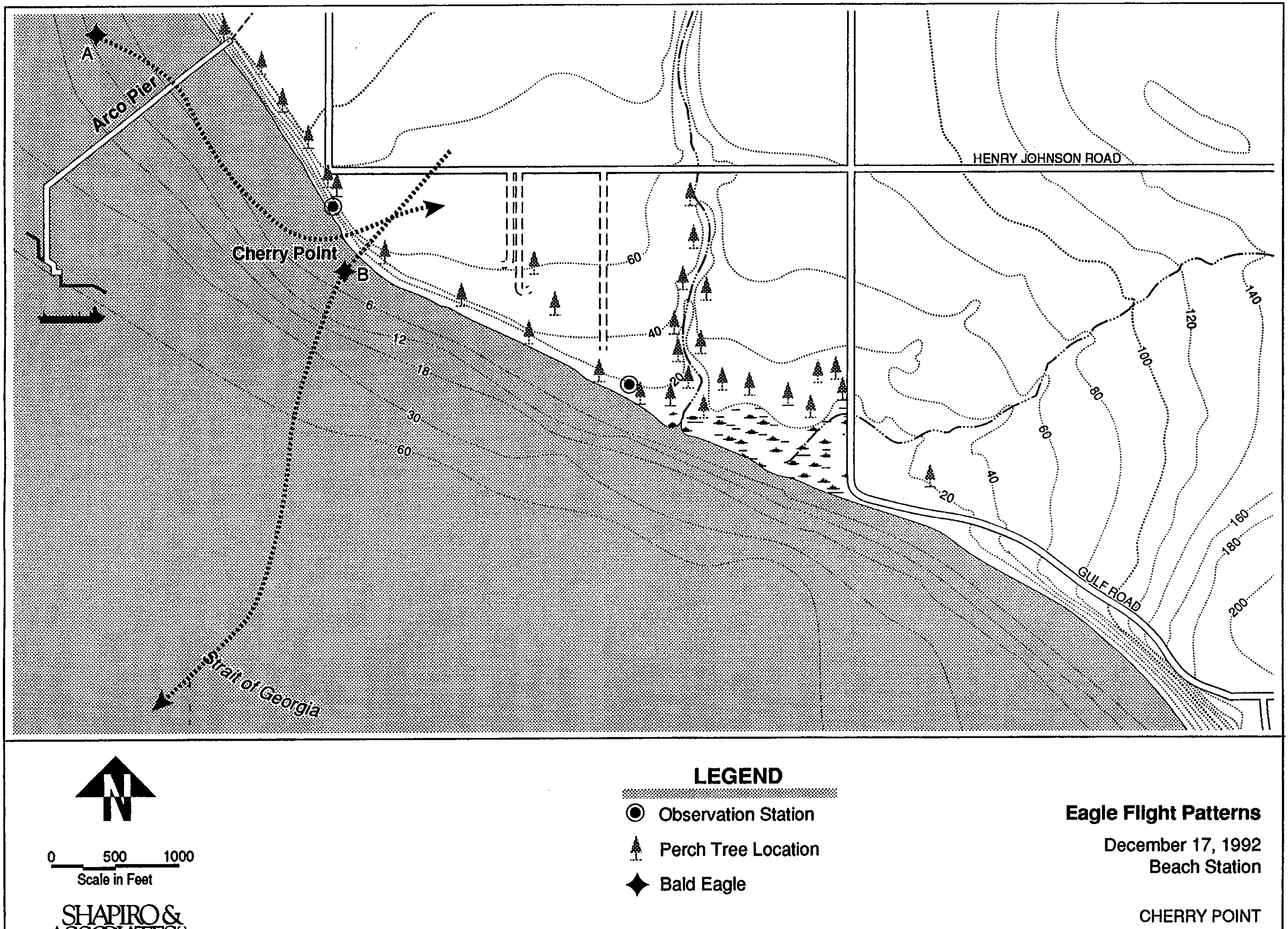
- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

January 7, 1993
Beach Station

CHERRY POINT

9/93

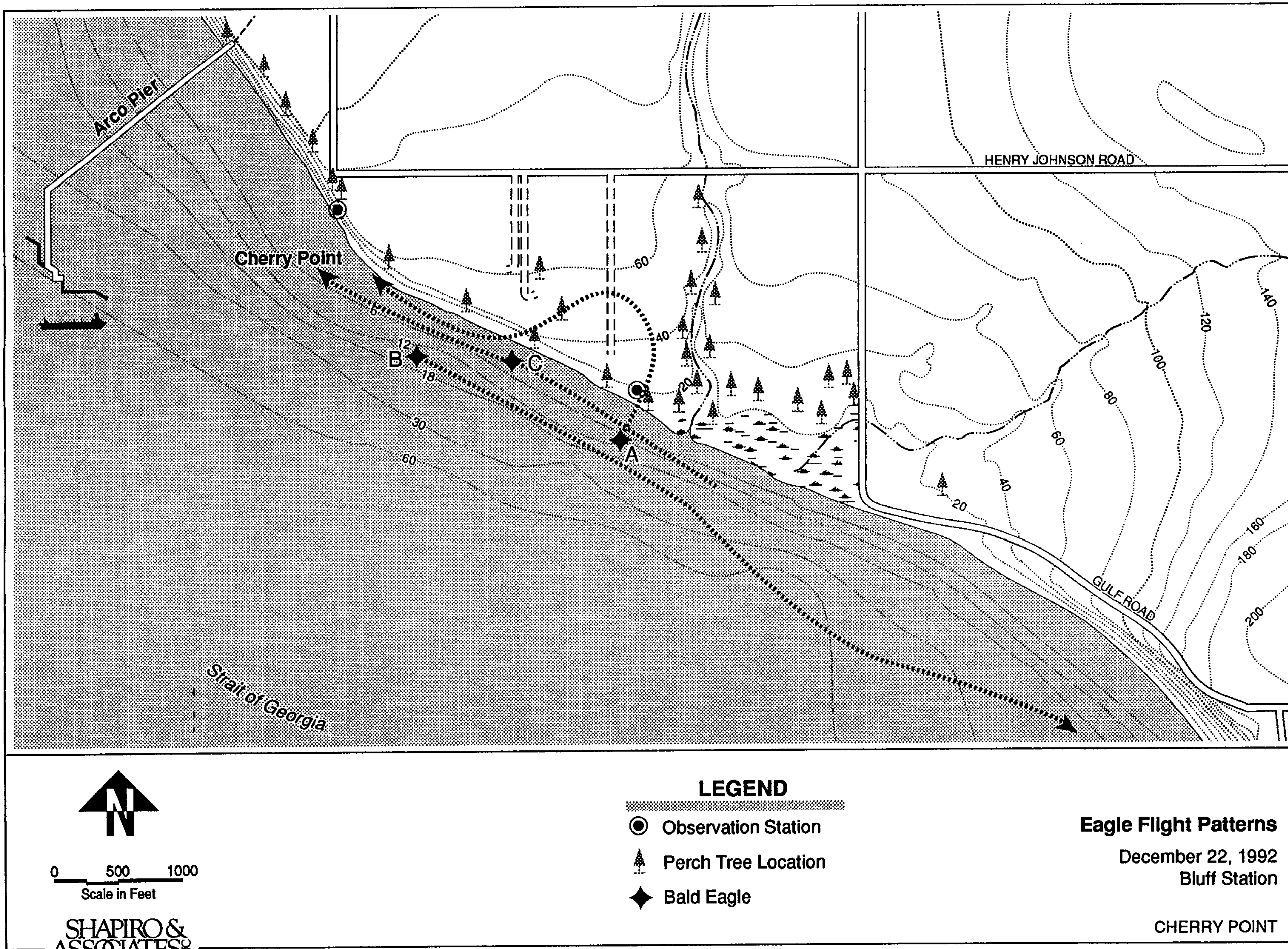


Eagle Flight Patterns

December 17, 1992
Beach Station

CHERRY POINT

9/93



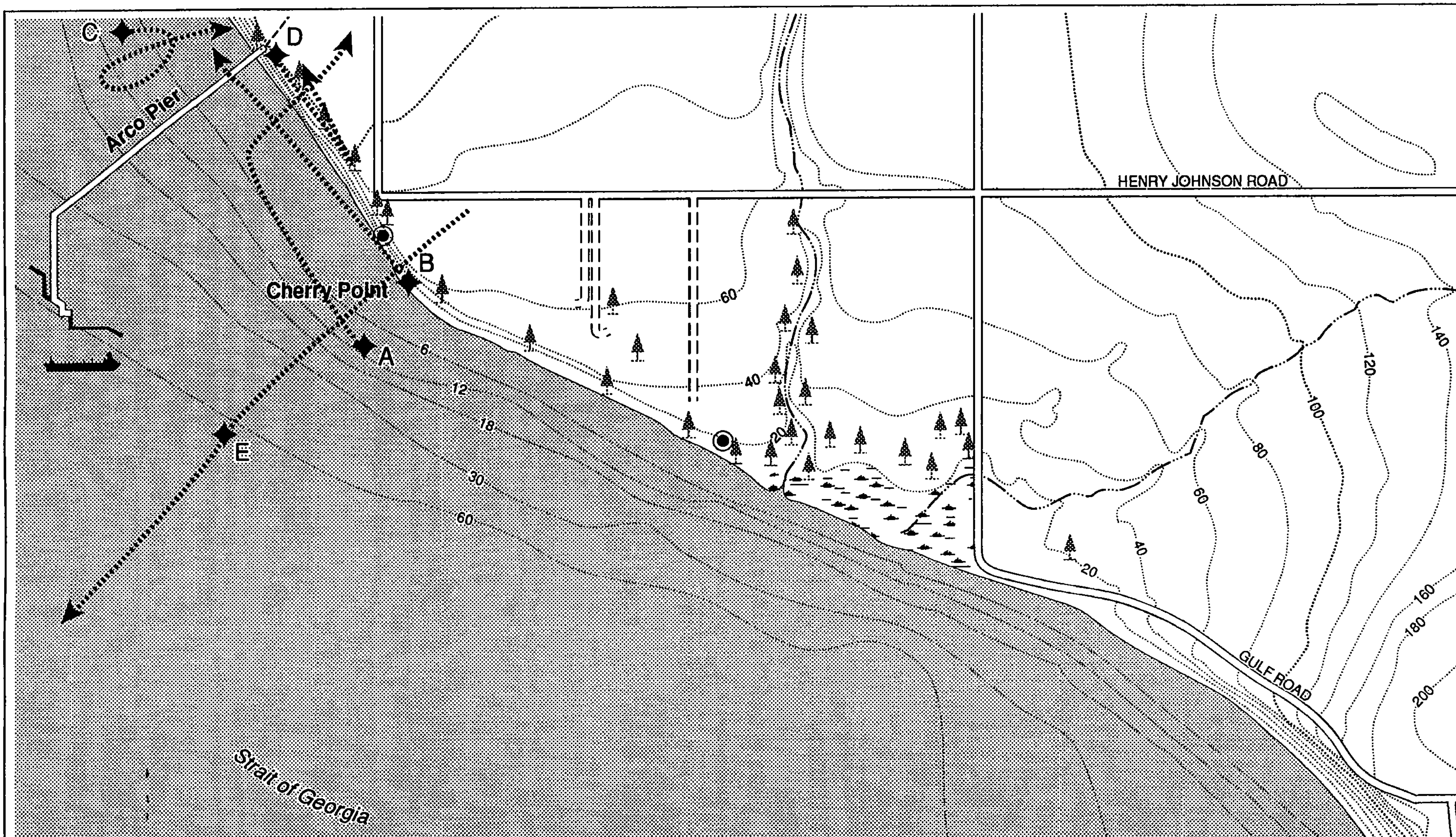
Eagle Flight Patterns

December 22, 1992
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

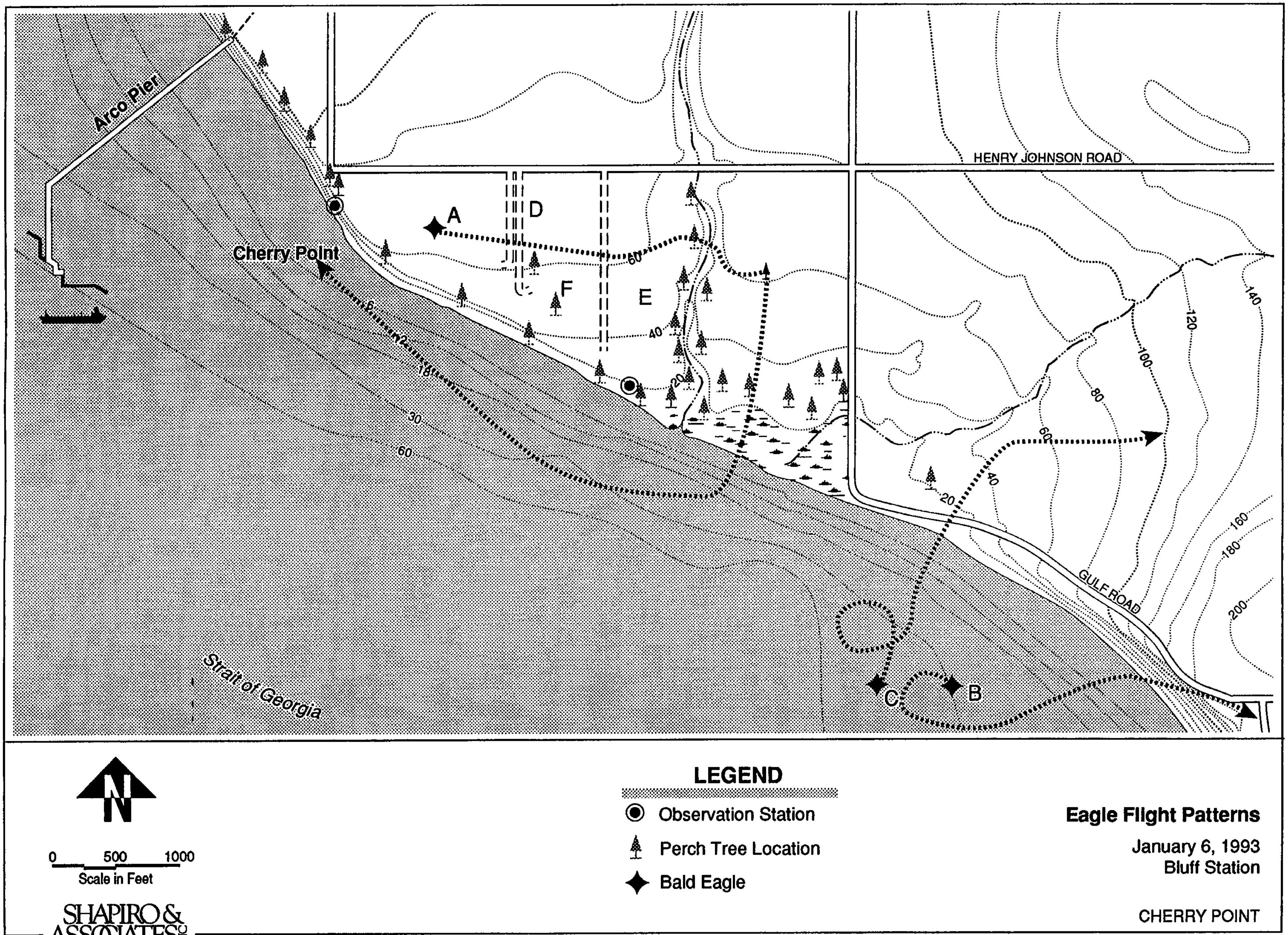
Eagle Flight Patterns

December 22, 1992
Beach Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93

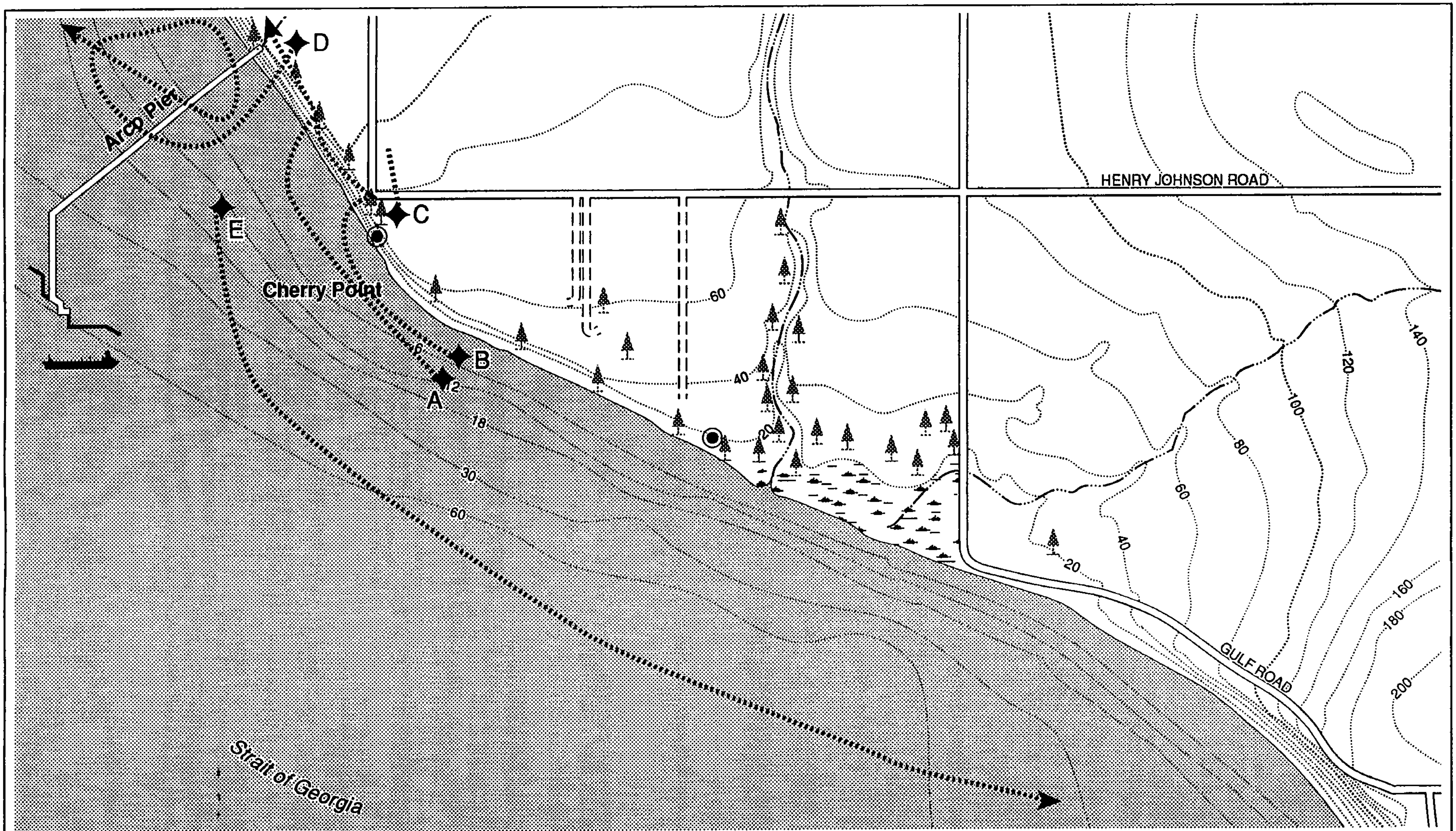


Eagle Flight Patterns

January 6, 1993
Bluff Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

0 500 1000
Scale in Feet

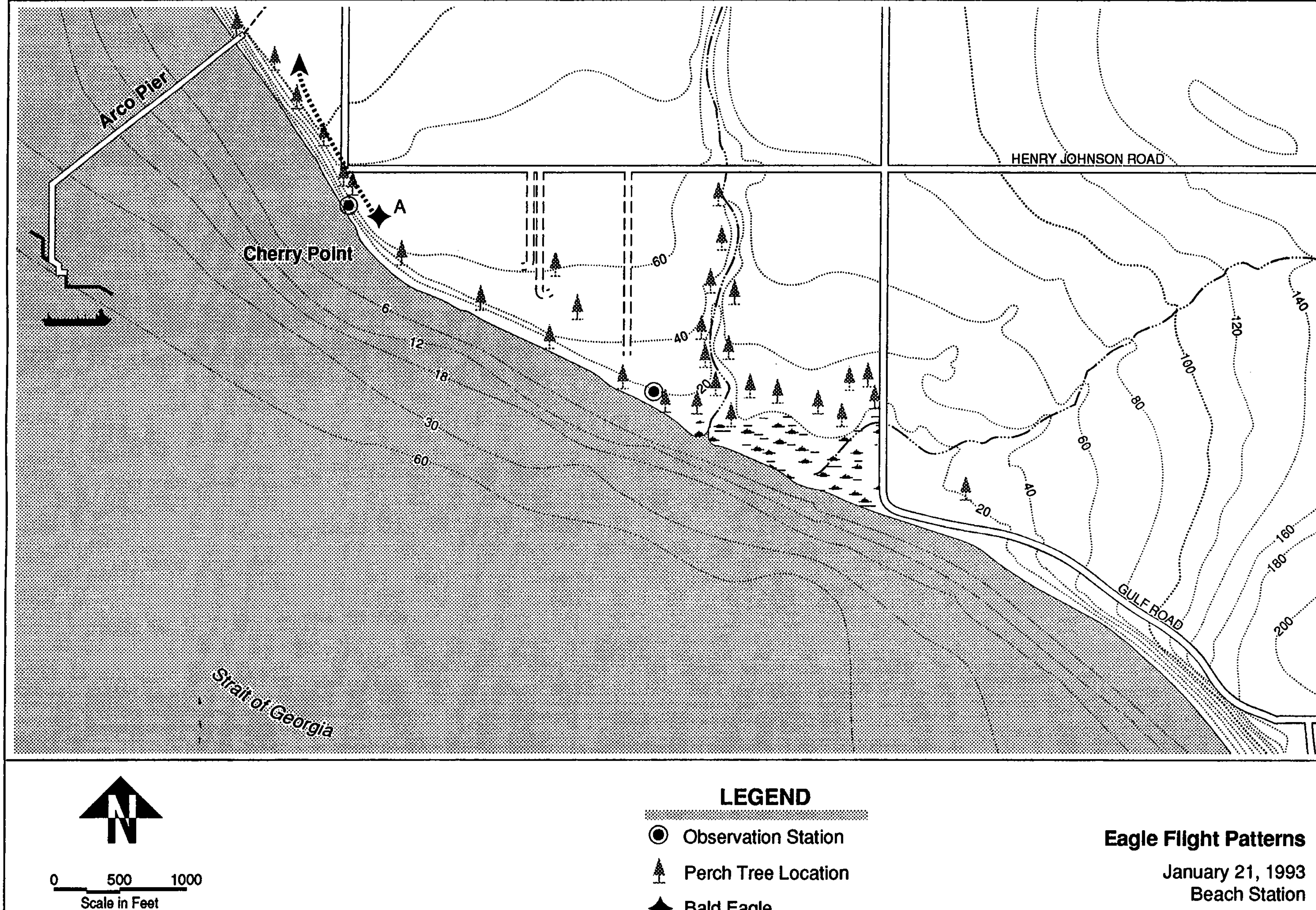
SHAPIRO & ASSOCIATES INC

Eagle Flight Patterns

January 6, 1993
Beach Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

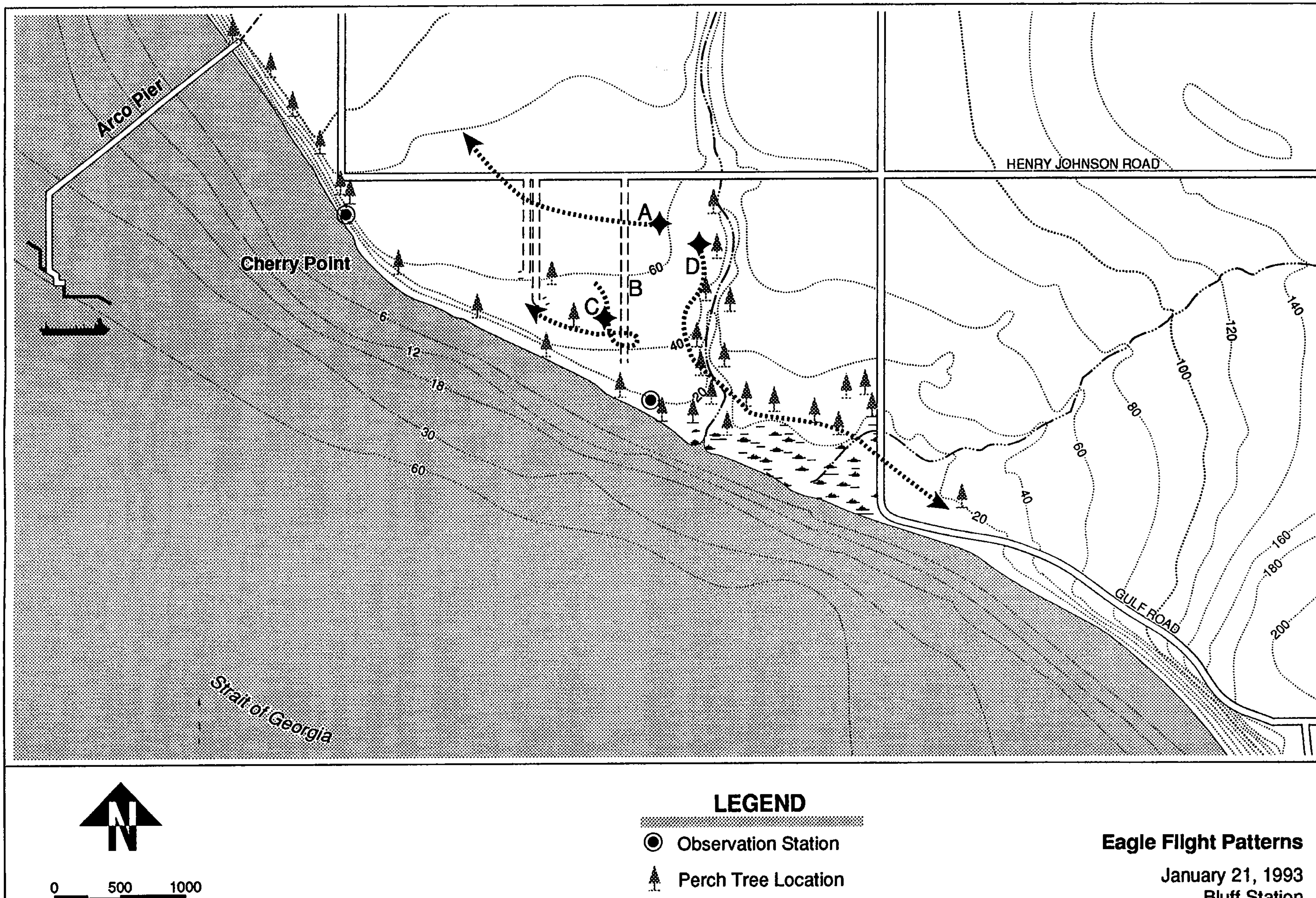
Eagle Flight Patterns

January 21, 1993
Beach Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

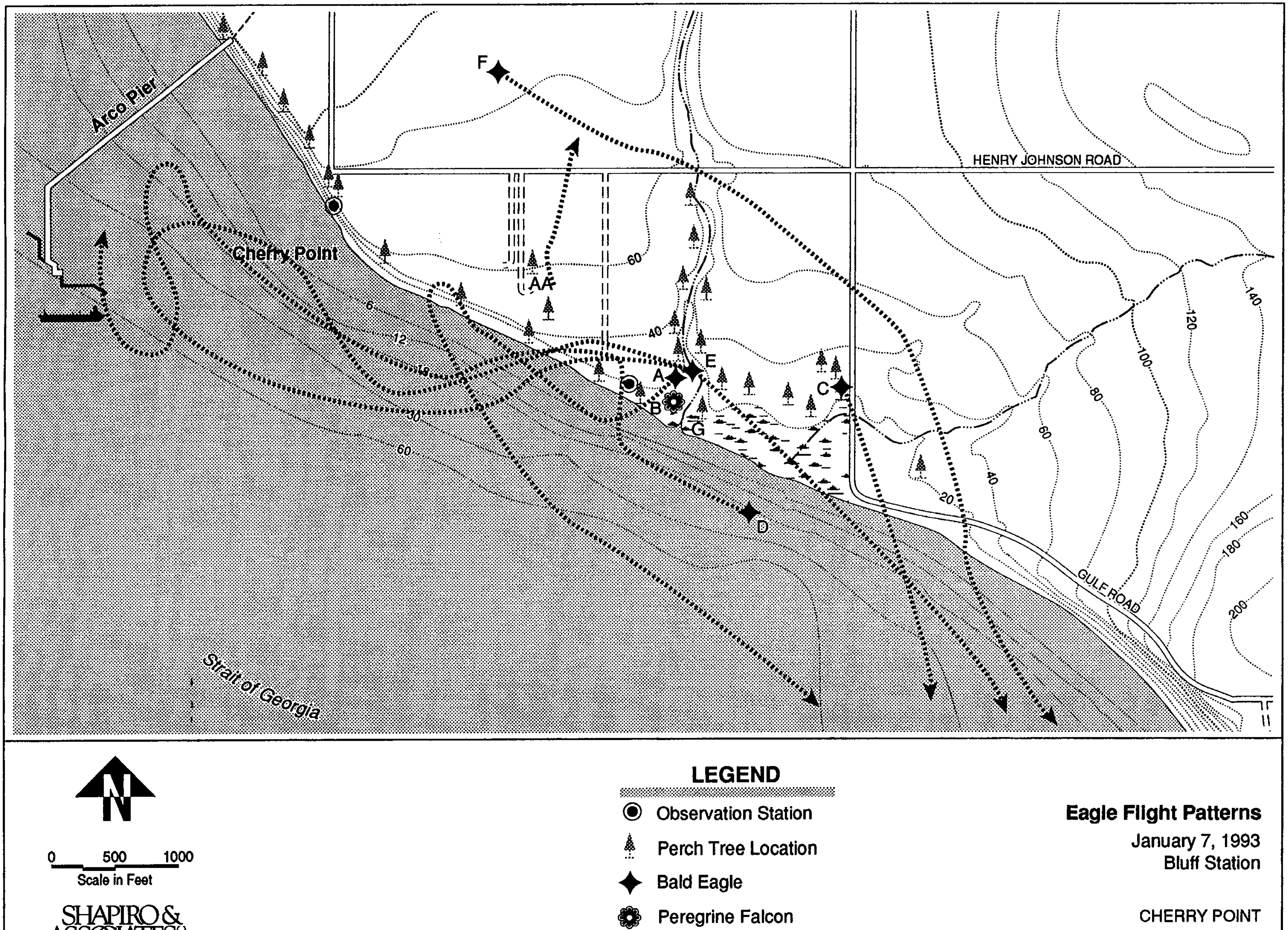
Eagle Flight Patterns

January 21, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93

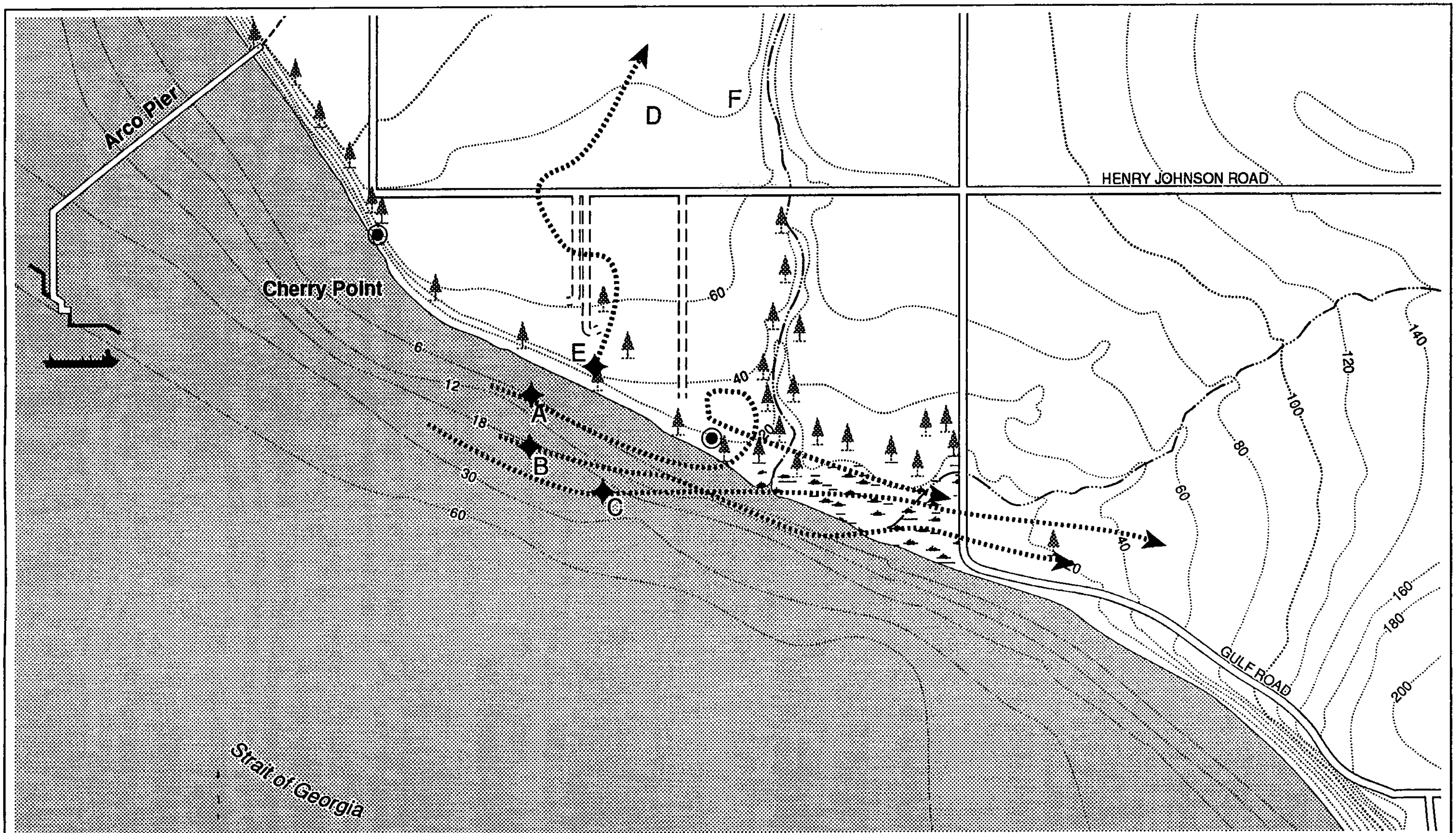


Eagle Flight Patterns

January 7, 1993
Bluff Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

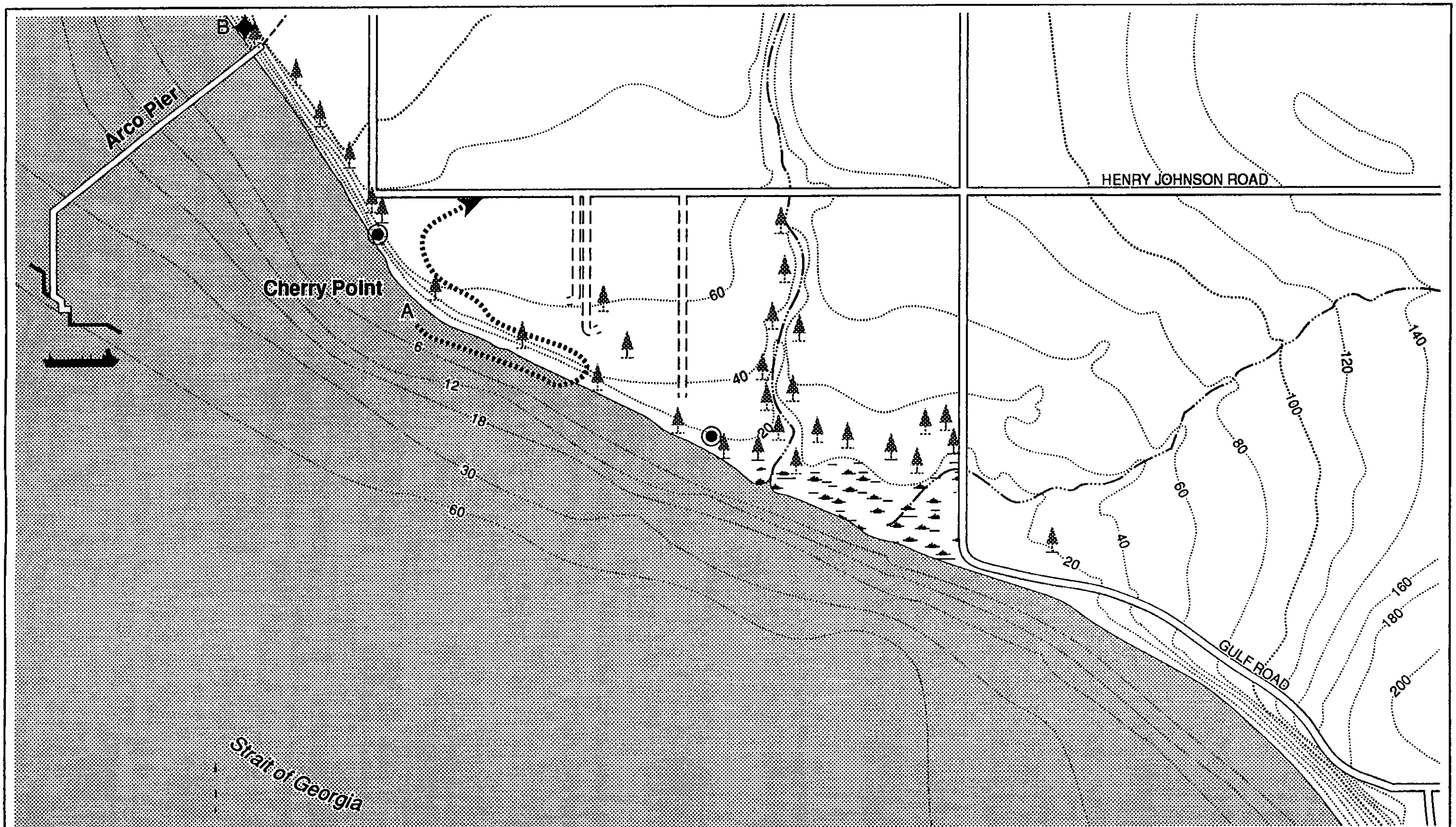
Eagle Flight Patterns

January 28, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

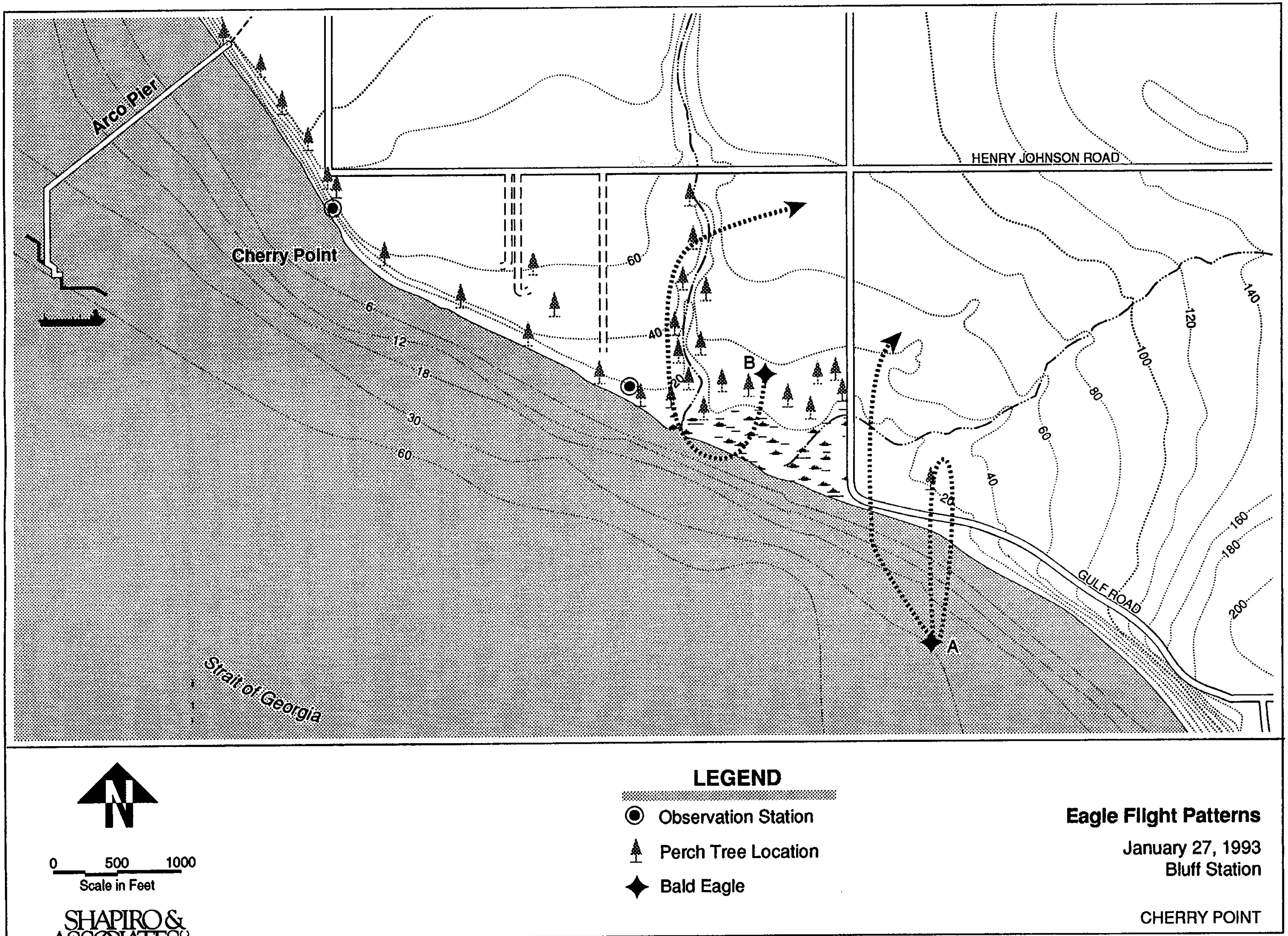
Eagle Flight Patterns

January 27, 1993
Beach Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93

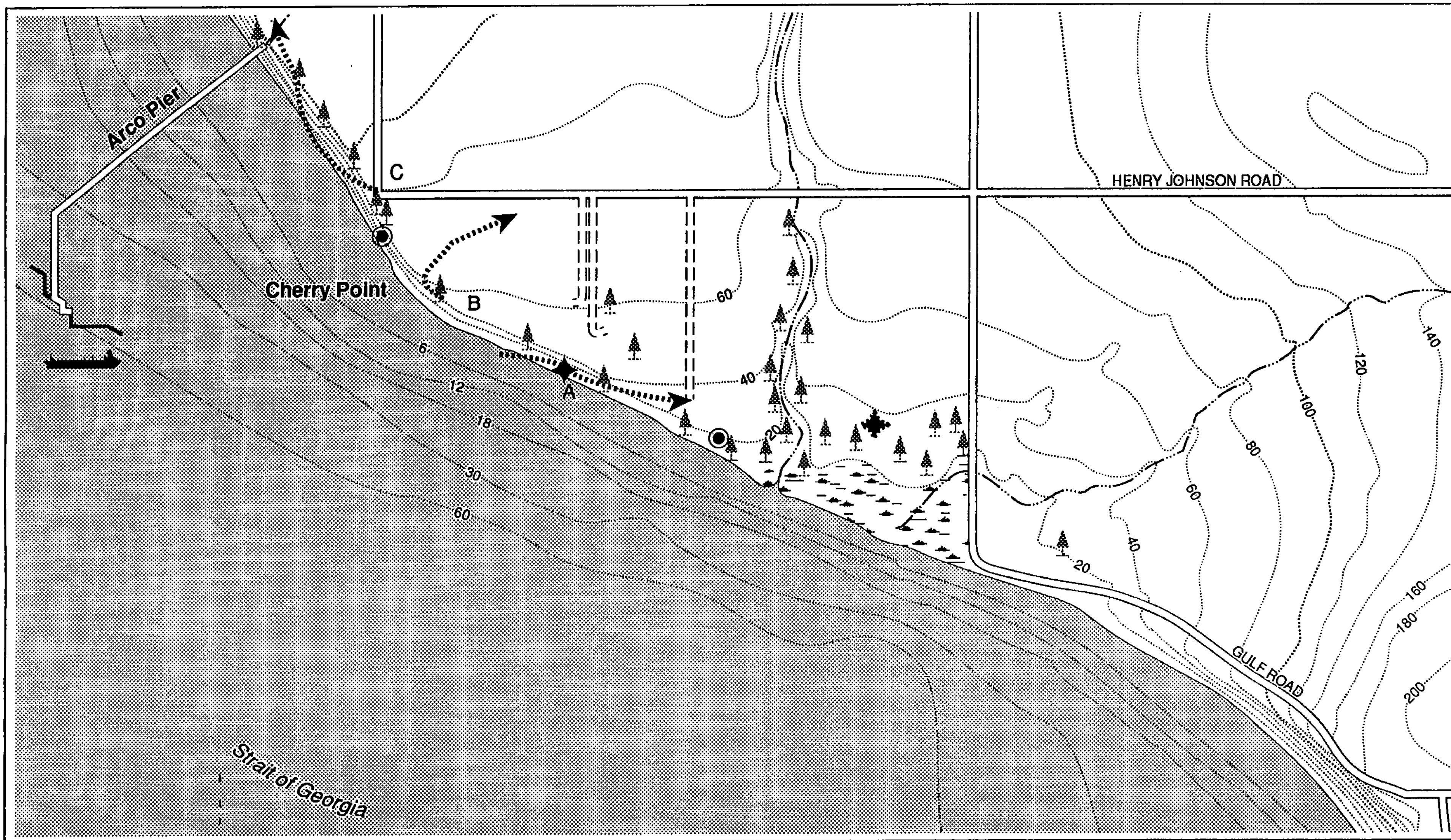


Eagle Flight Patterns

January 27, 1993
Bluff Station

CHERRY POINT

9/93



LEGEND

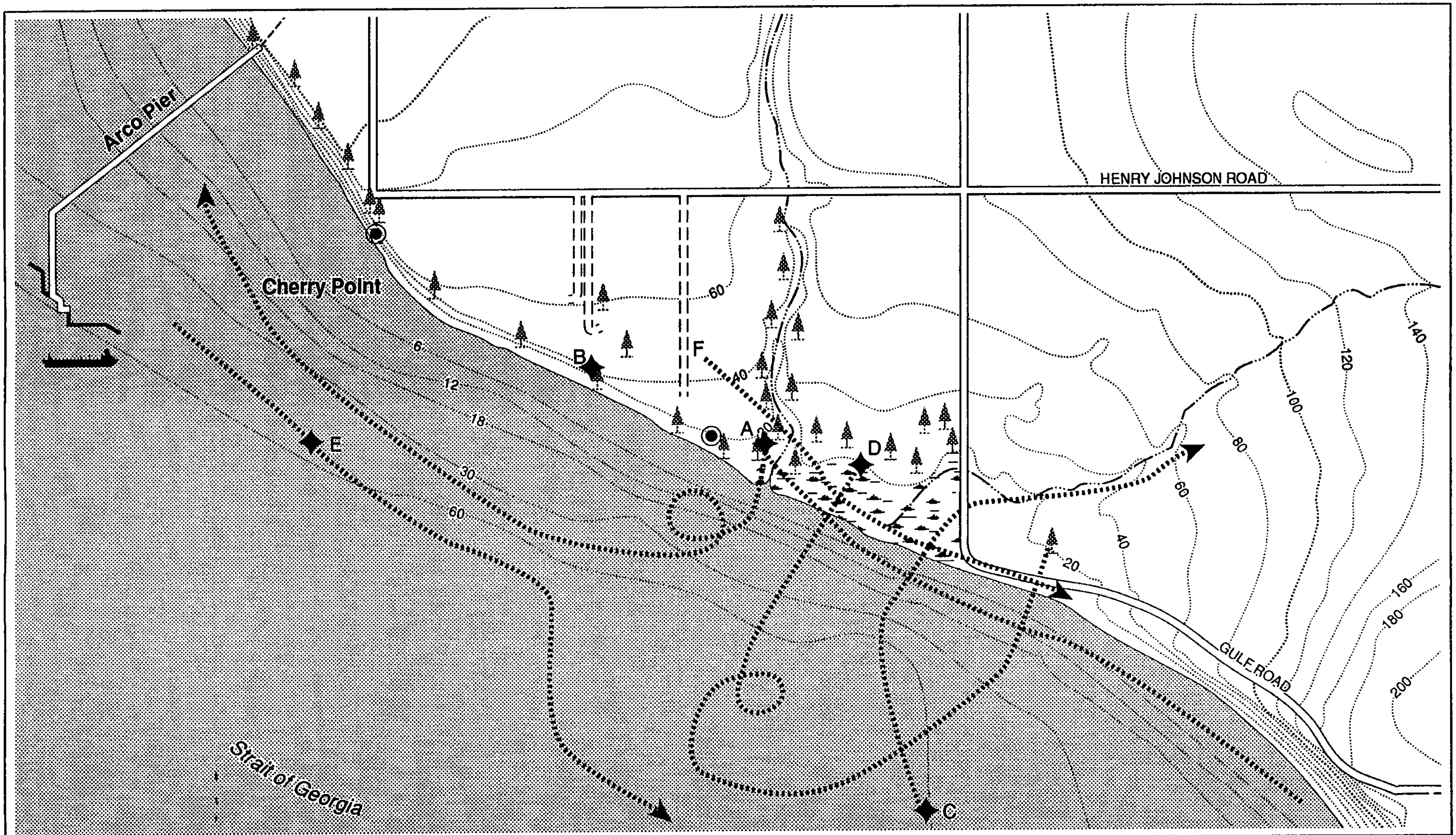
- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

January 28, 1993
Beach Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

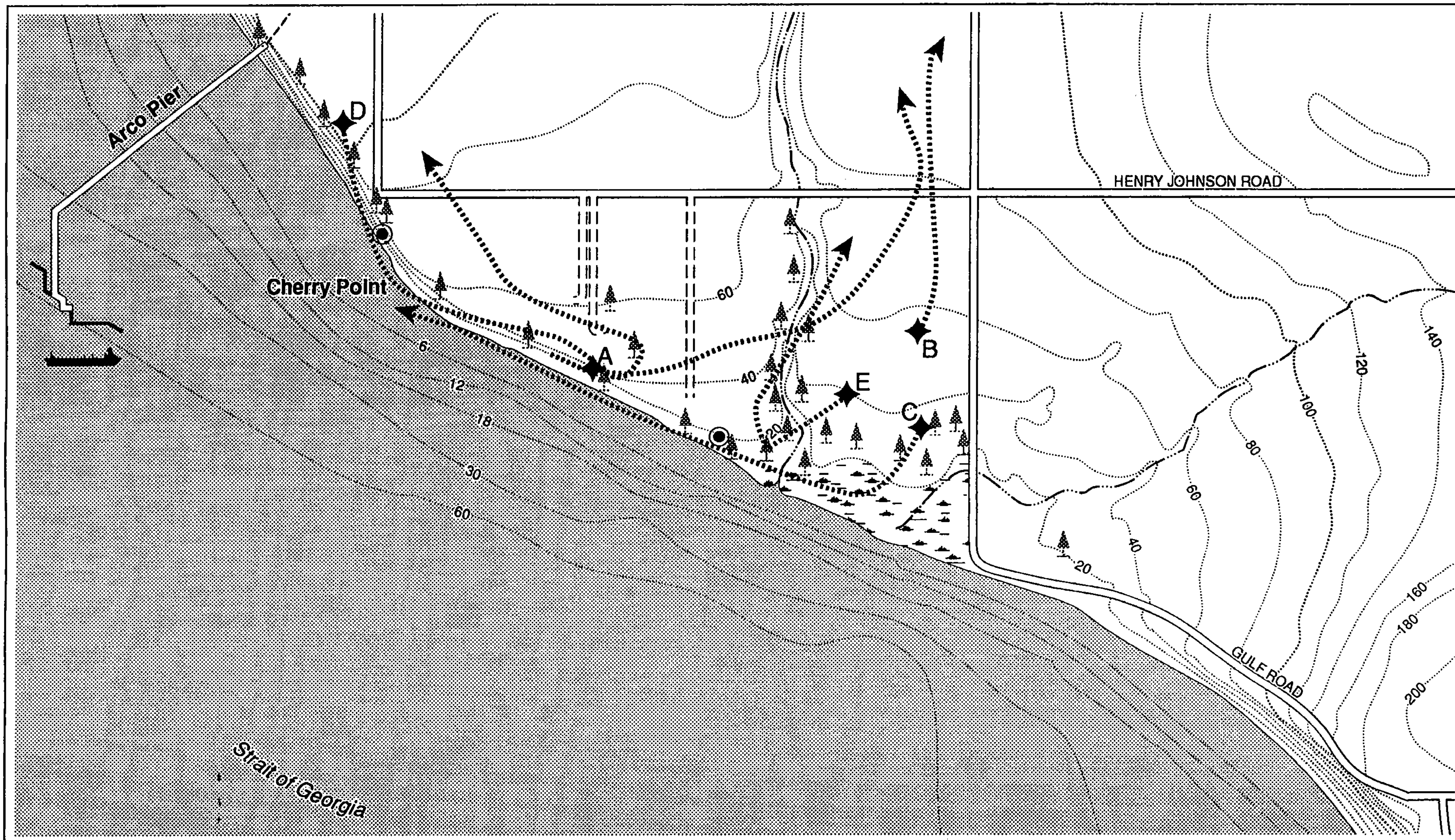
Eagle Flight Patterns

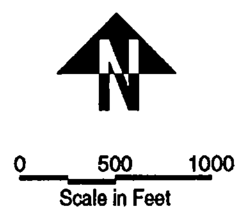
January 13, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93





SHAPIRO & ASSOCIATES INC

LEGEND

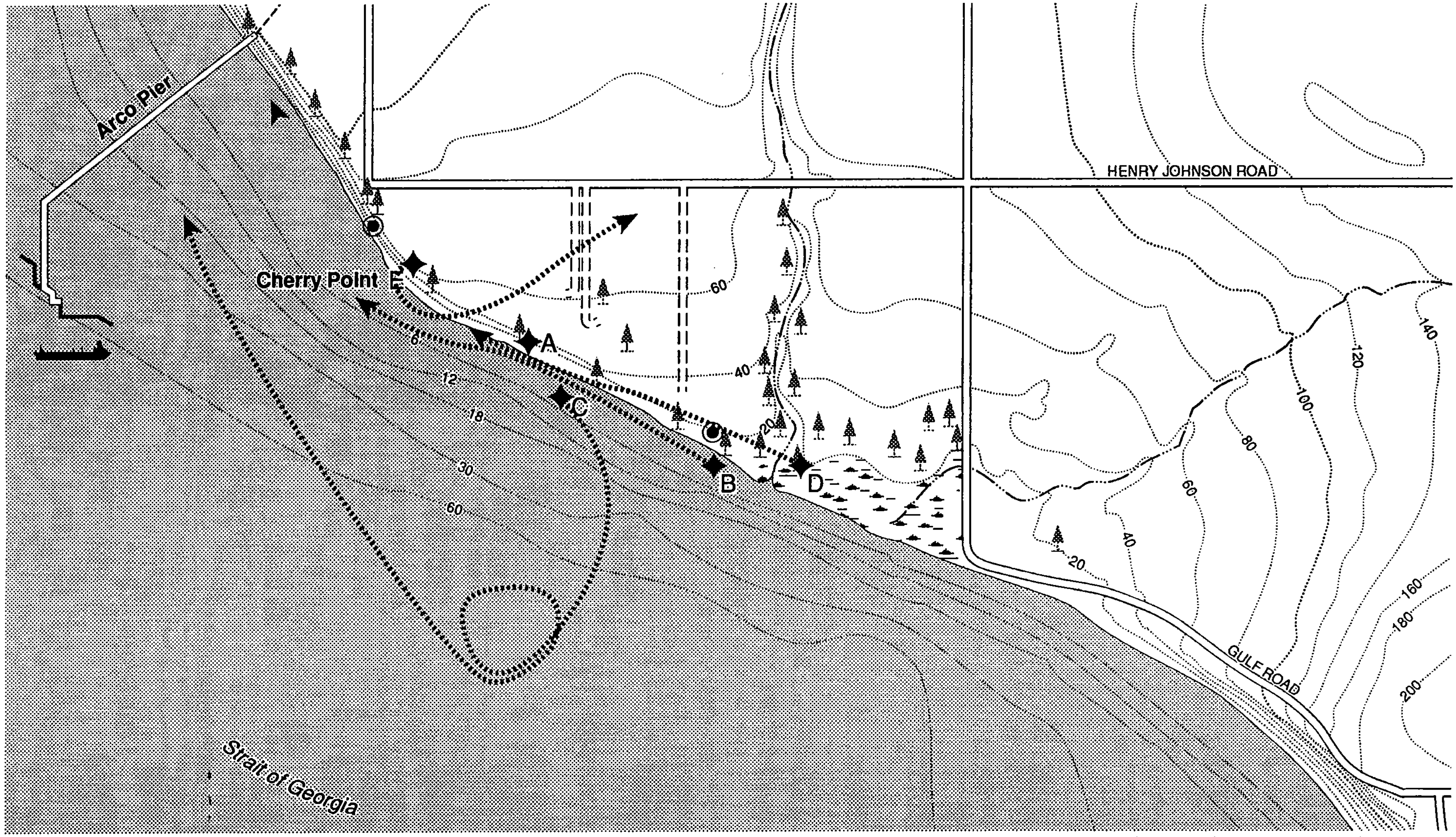
- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

February 2, 1993
Bluff Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

0 500 1000
Scale in Feet

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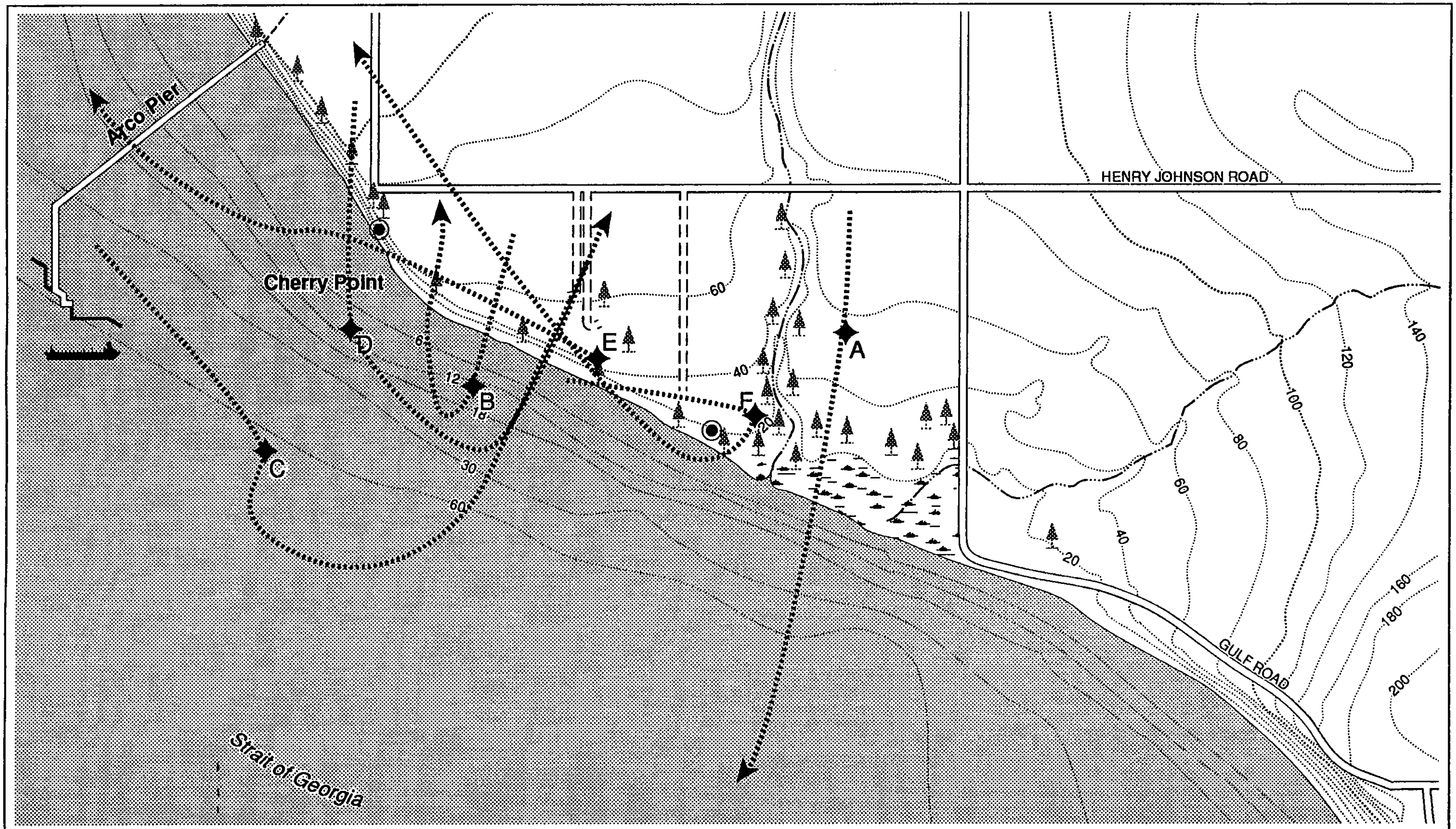
Eagle Flight Patterns

February 25, 1993
Bluff Station

CHERRY POINT

9/93



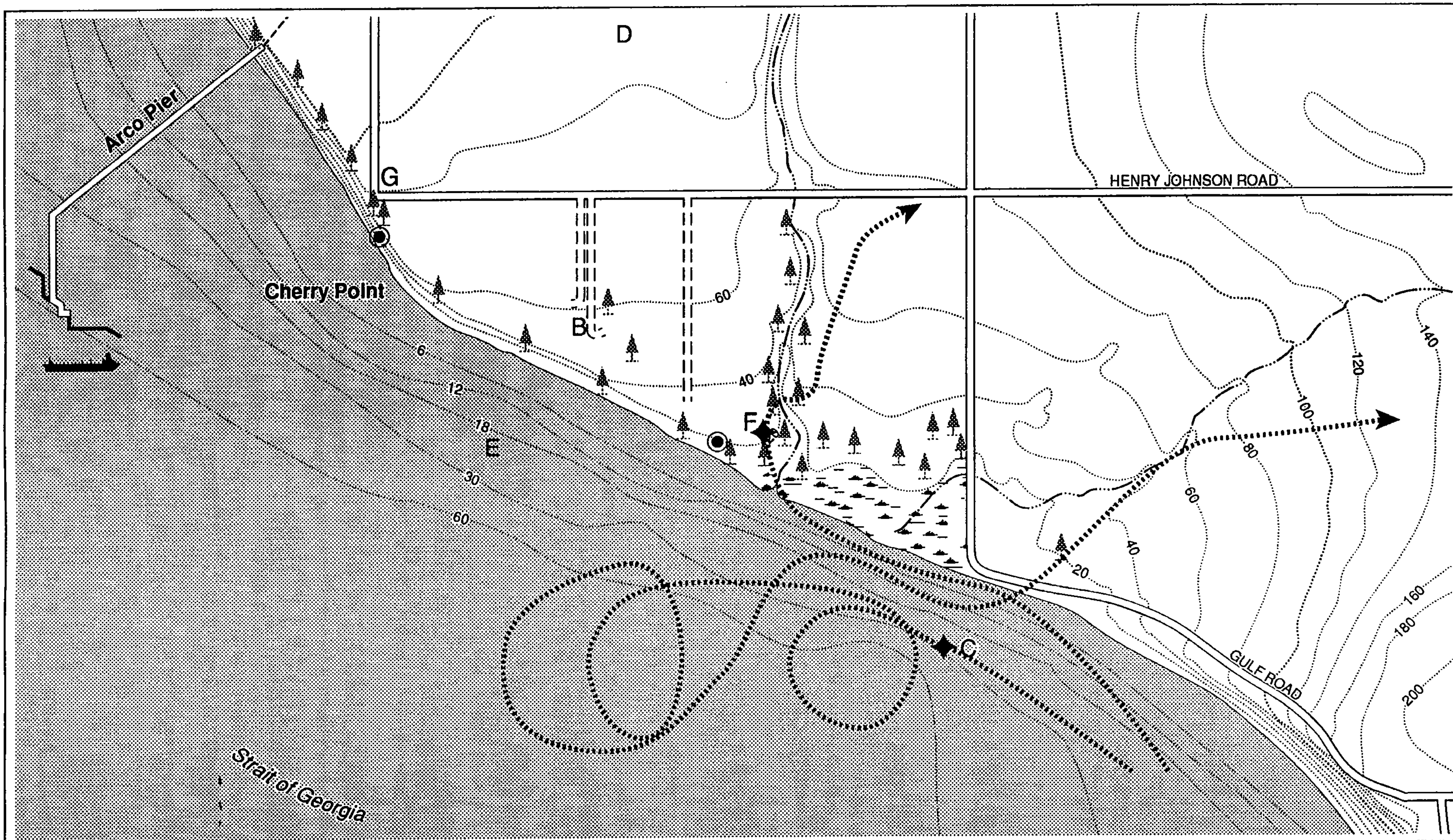
Eagle Flight Patterns

February 3, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

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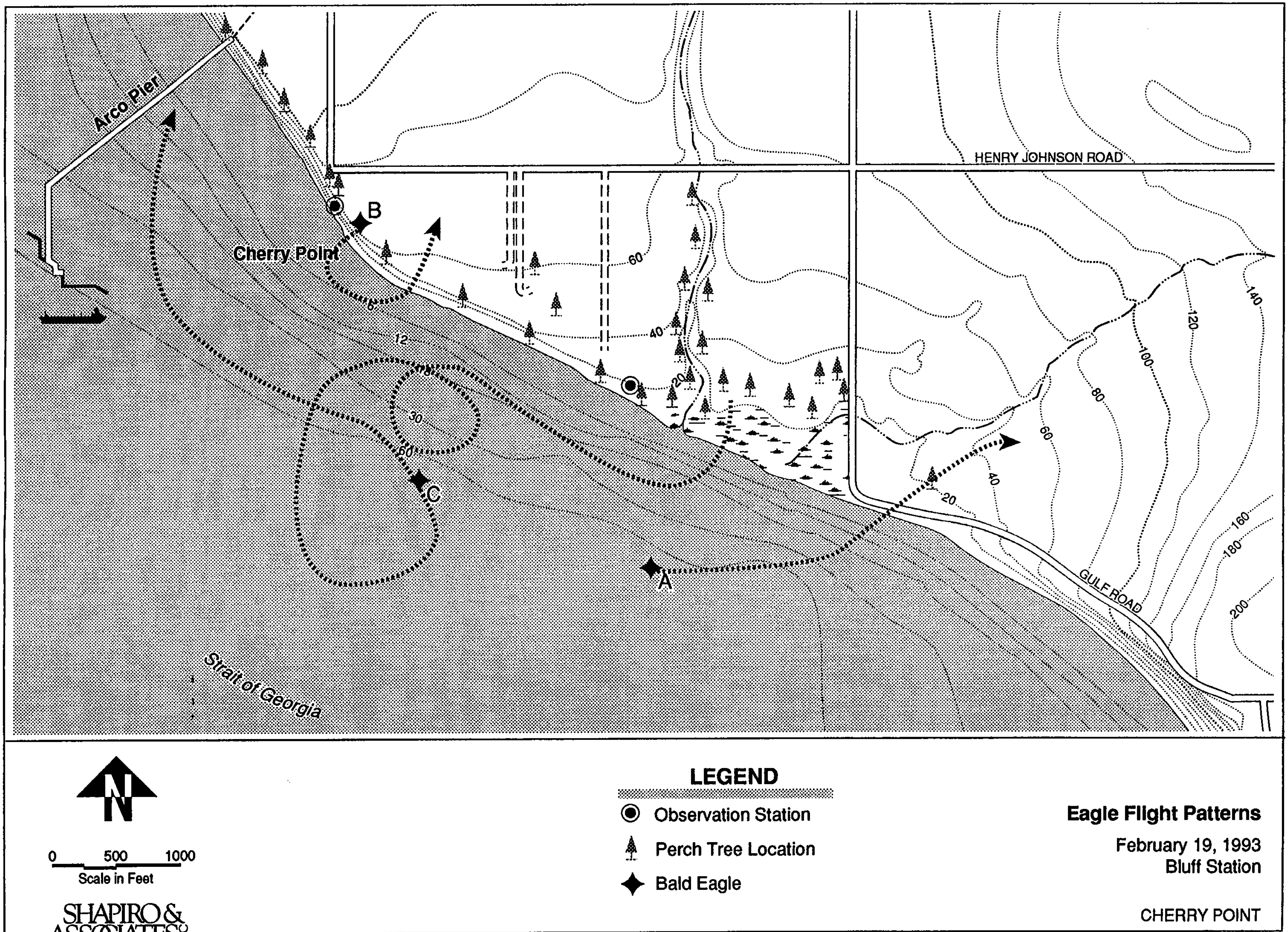
Eagle Flight Patterns

February 17, 1993
Bluff Station

CHERRY POINT

9/93

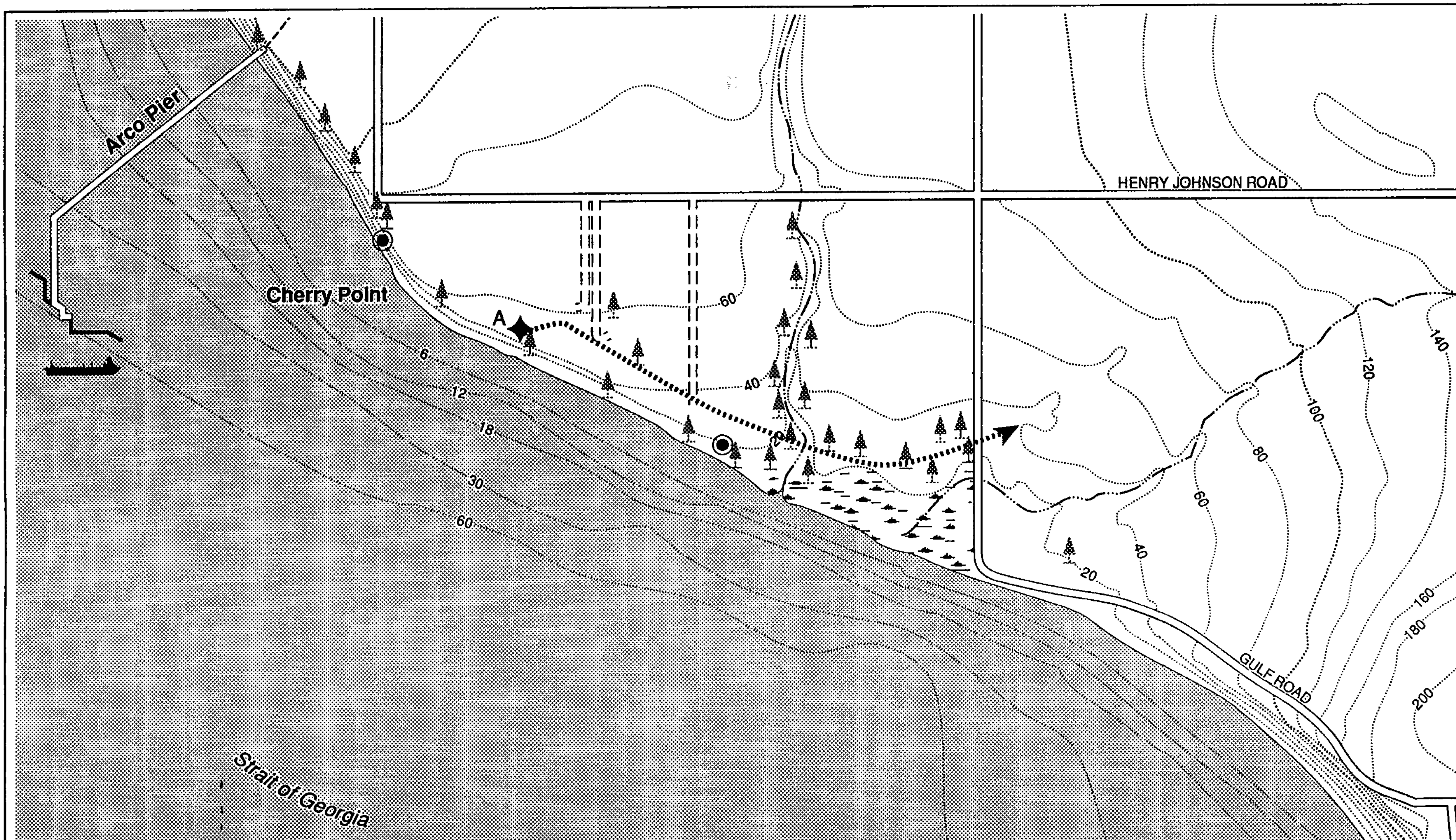


Eagle Flight Patterns

February 19, 1993
Bluff Station

CHERRY POINT

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

December 10, 1992
Bluff Station

CHERRY POINT

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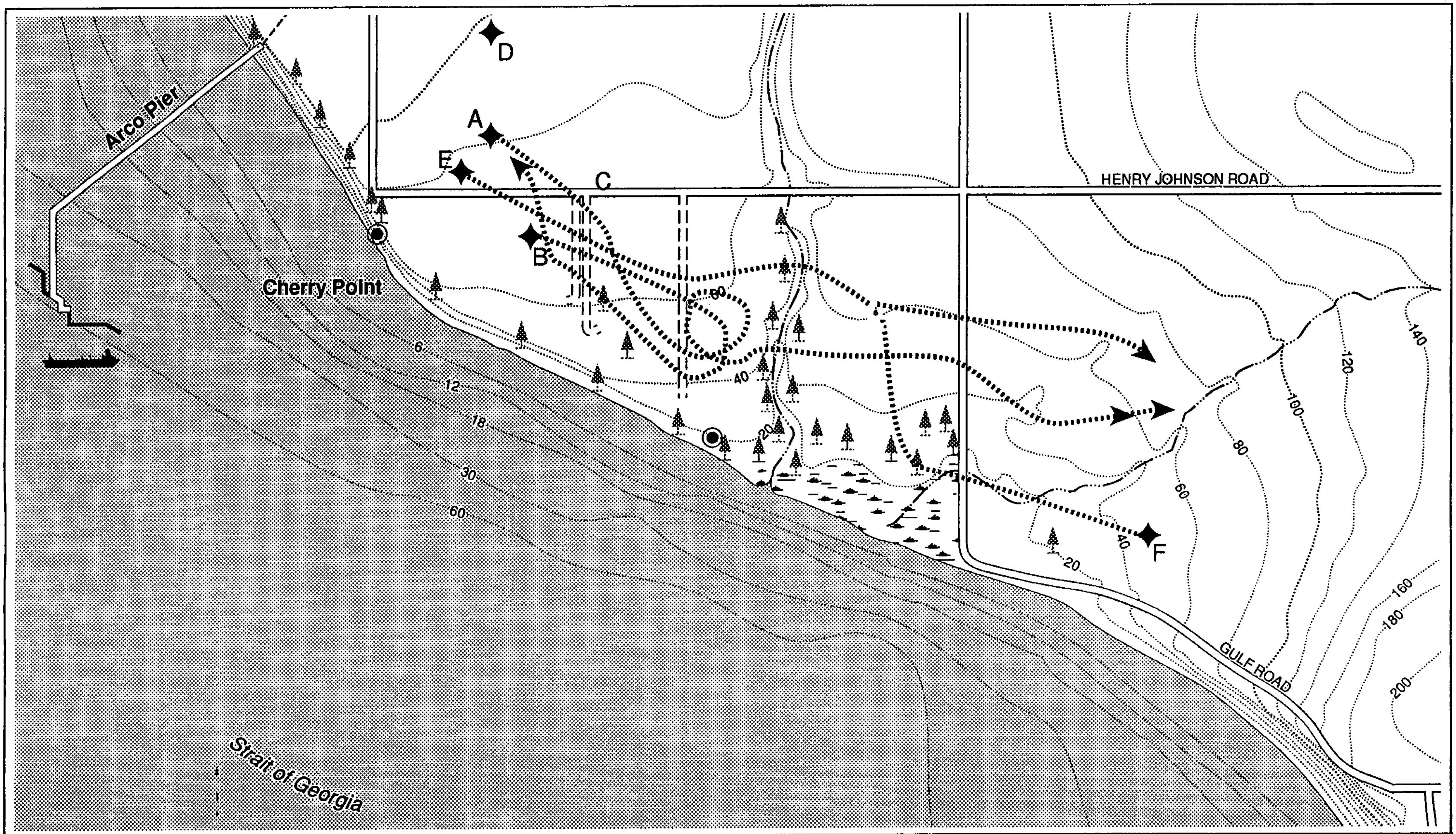
9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

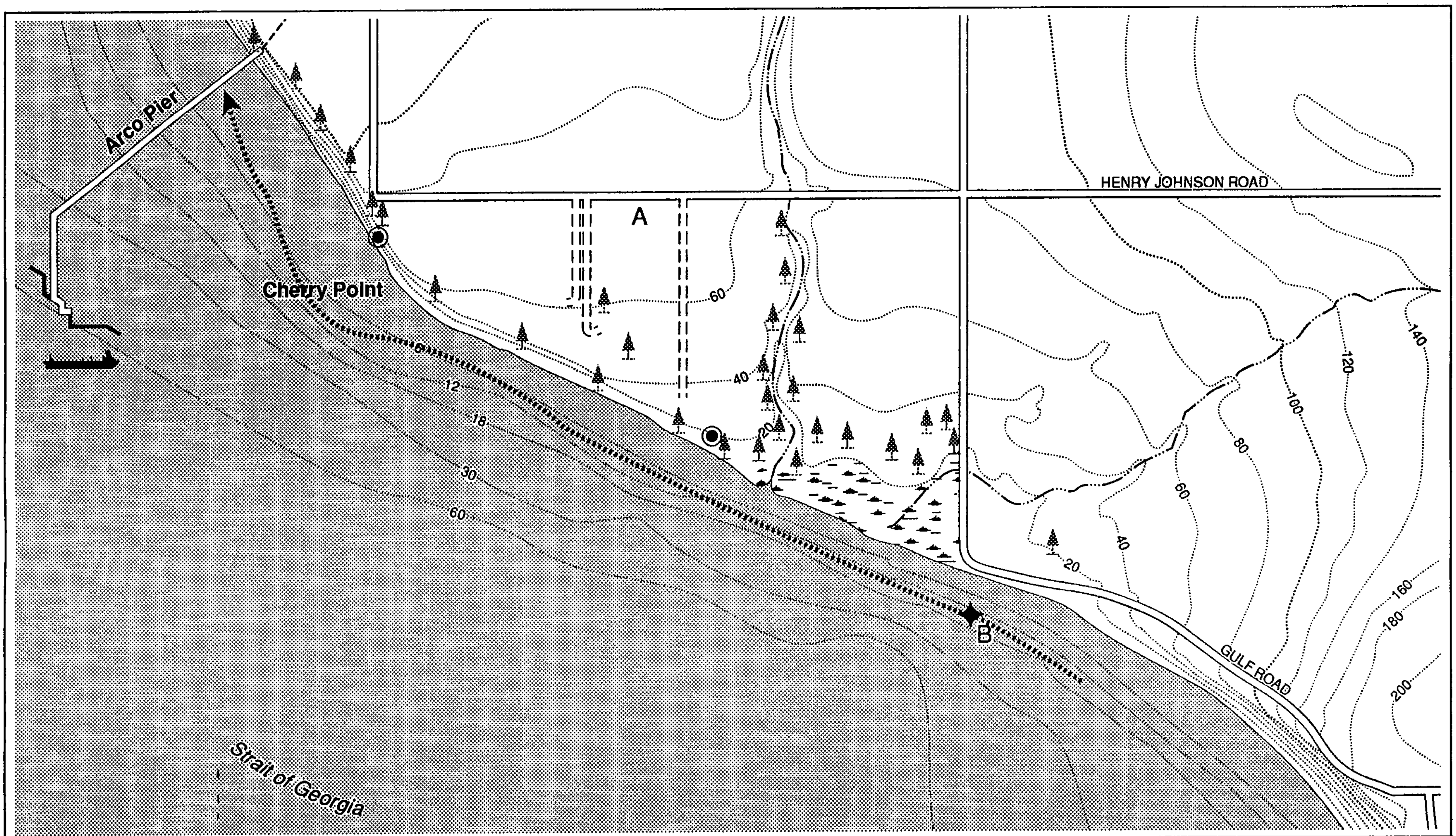
Eagle Flight Patterns

March 18, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

- Observation Station
- Perch Tree Location
- Bald Eagle

Eagle Flight Patterns

March 5, 1993
Bluff Station

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

MACROALGAE AND EELGRASS INVESTIGATION

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1. INTRODUCTION

The purpose of this study was to characterize the intertidal and subtidal macroalgae and eelgrass community in the vicinity of the proposed Pacific International Terminals Gateway Pacific Terminal (GPT) Bulk Loading Facility pier (the pier). The pier would be located approximately 2,500 feet south of Cherry Point on the Strait of Georgia (Figure 1). It would be oriented roughly perpendicular to the existing shoreline, which runs northwest to southeast, and would be 50 feet wide where it crosses the intertidal and subtidal vegetated zone (macroflora zone).

The macroalgae and eelgrass investigation was conducted in two phases. The first phase consisted of an intertidal survey of existing macroalgae and eelgrass in the project area (Figure 1). This was accomplished by identifying and estimating vegetative cover of plants encountered along transects perpendicular to the shoreline and extending seaward from the high tide line (approximately +8.8 feet Mean Lower Low Water {MLLW}) to about -4.0 feet MLLW.

The second phase of the investigation consisted of a dive survey at, and immediately north of, the proposed pier's location (Figure 1). Divers from Marine Environmental Services, Inc. (MES) identified and quantified macroalgae and eelgrass encountered along transects running perpendicular to the shoreline and extending seaward 600 feet (from approximately +5.1 feet MLLW to -20.0 MLLW). Methods used and observations made during this investigation are presented in this report.

2. METHODS

2.1 INTERTIDAL SURVEY

The intertidal macroalgae and eelgrass survey was conducted around the lower low tide (-1.9 feet MLLW), which occurred at 10:14 p.m. on November 23, 1992. The study area for this phase of the investigation extended along the shoreline from immediately north of Cherry Point south toward the Intalco Pier (Figure 2). Shapiro and Associates, Inc. (SHAPIRO) staff established nine transects perpendicular to the shore approximately 1,000 feet apart (Figure 2). Hip chains were used to measure distances. The transects extended seaward from the high tide line (approximately 8.8 feet MLLW) to a water depth of about 2 feet (approximately -4.0 feet MLLW).

Along each transect, the distance from the high tide line (as determined from the tidal debris line on the upper shore) to the first encounter with macroflora was recorded. From that point and extending seaward, species present were identified and percent cover was estimated for 1 meter quadrats located every 10 to 50 feet, to a water depth of approximately 2 feet. Representative samples of macroalgal species for which field identification was not possible were collected in plastic bags filled with seawater. These species were returned to SHAPIRO's Seattle office for identification.

2.2 DIVE SURVEY

Washington Department of Fisheries was consulted to establish the protocol for the dive survey. The survey was conducted on August 27, 1993. It consisted of identifying and enumerating macroalgae and eelgrass along seven transects in the vicinity of the proposed GPT pier (Figure 3). MES and SHAPIRO staff surveyed and installed two reference stakes for each transect line. The transects began at approximately 5.0 feet MLLW and extended seaward approximately perpendicular to the shore, through the vegetated zone. Six transects were situated at 10-foot intervals beginning at the centerline of the proposed pier and extending north. The seventh transect was located at the southern edge of the proposed pier. Lead lines were used to establish the subtidal transects. The seaward end of each lead line was attached to an anchor with a float

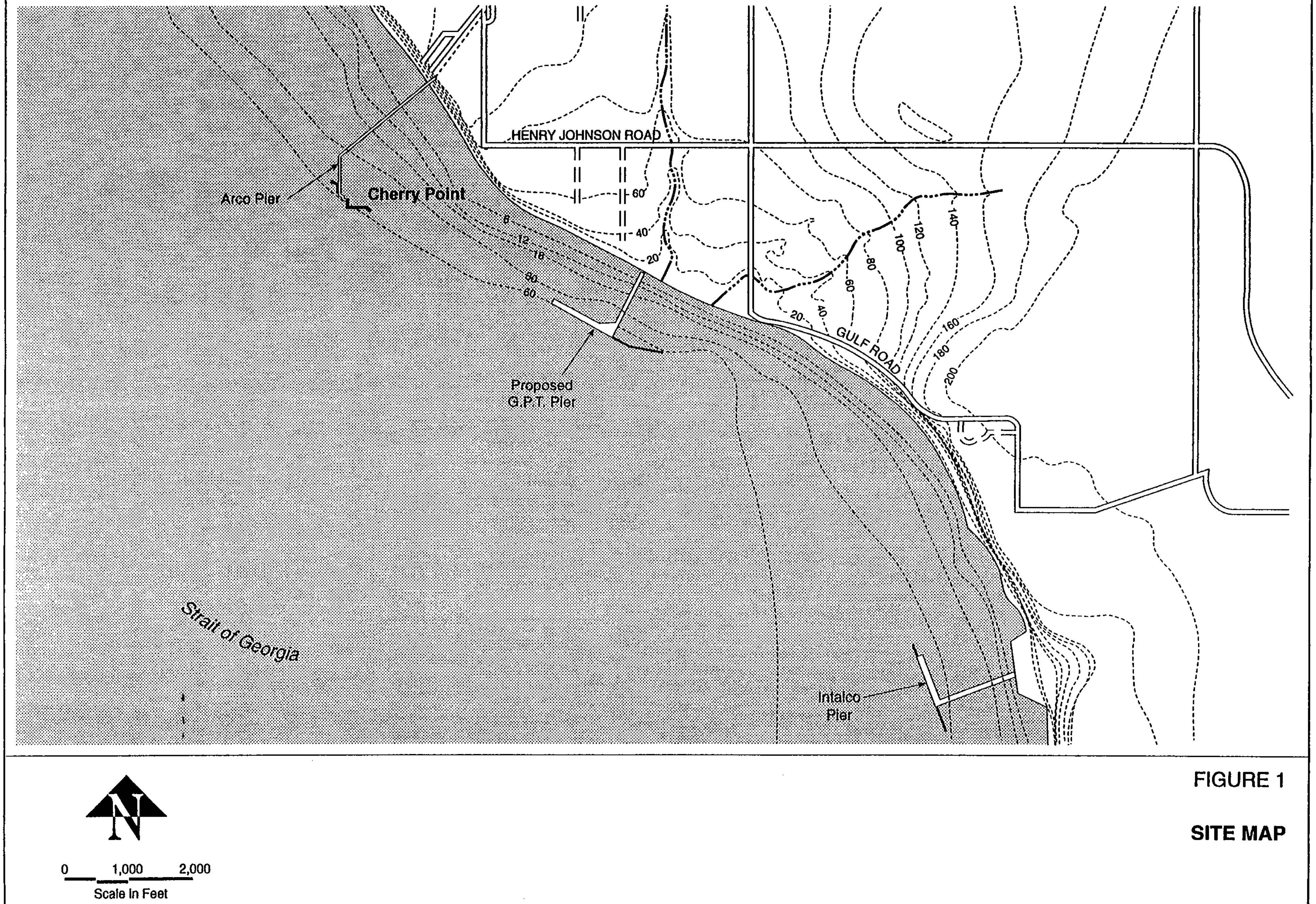

FIGURE 1

SITE MAP

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CHERRY POINT

7/94

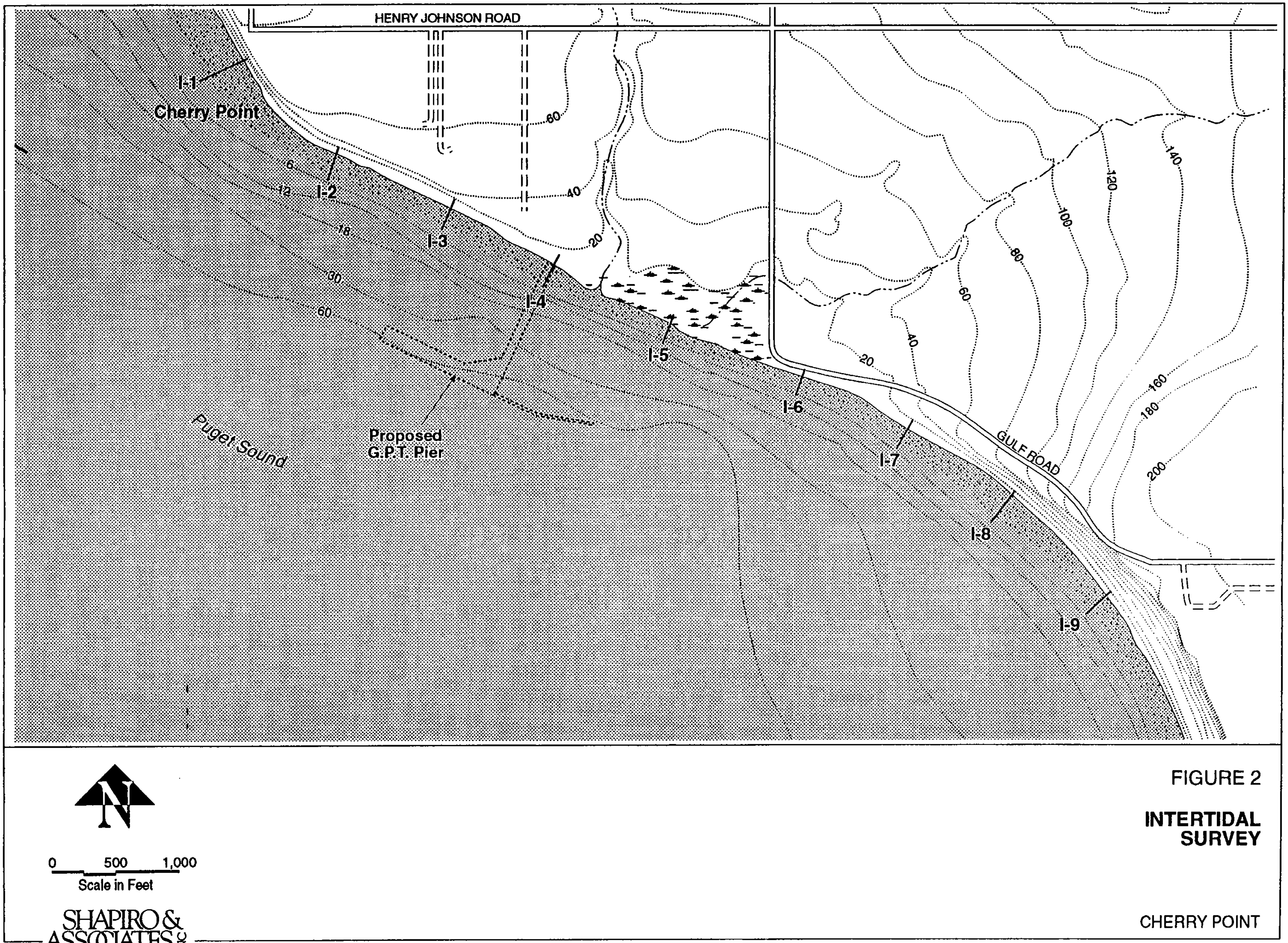
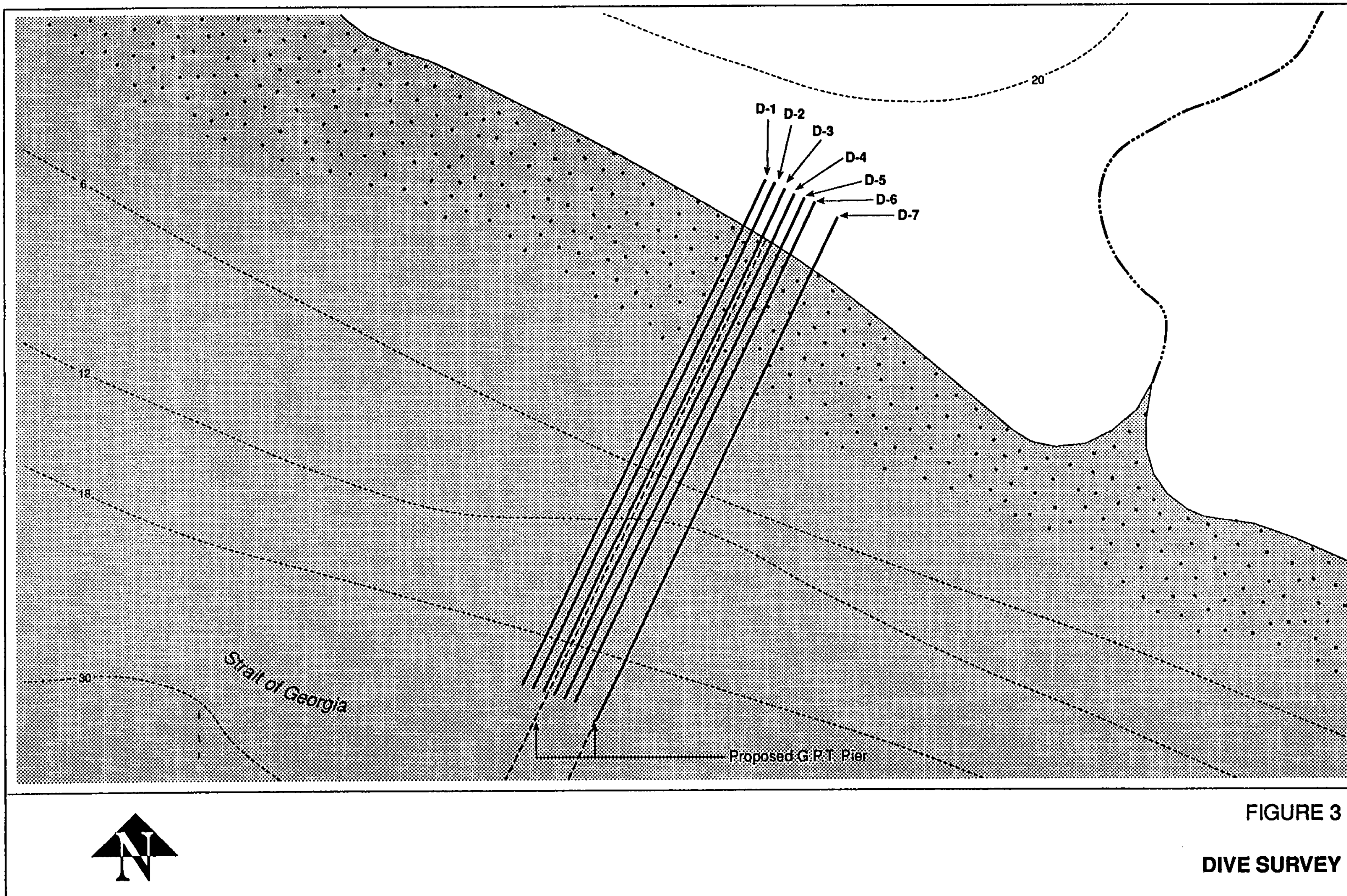


FIGURE 2

INTERTIDAL SURVEY

CHERRY POINT

12/93



SHAPIRO & ASSOCIATES INC

FIGURE 3

DIVE SURVEY

CHERRY POINT

marking its location at the water surface. Figure 3 shows the dive survey area, transect locations, and the proposed pier location as it traverses the intertidal and subtidal vegetated zone.

SCUBA divers from MES recorded data along each transect. Plant species were identified to genus, and total vegetative cover and numbers of individuals of each species encountered were determined in square meter quadrats centered at 40-foot intervals. Also recorded for each quadrat were the elevation (recorded depth adjusted to MLLW) at the center of the quadrat and a description of the substrate. In addition, any eelgrass beds observed in the survey area were identified as to location, size, and plant density. Plant density was determined by counting eelgrass turions within the square meter quadrat. Observations were recorded to depths where macroalgae were no longer apparent and the substrate became consistently sand or mud.

3. RESULTS

3.1 INTERTIDAL SURVEY

The macroflora zone began between 50 and 100 feet seaward of the high tide line and generally extended to the limit of the transect during the November 23-24, 1992 intertidal survey. Common species observed included *Ulva/Monostroma, Gracilaria pacifica, Gigartina exasperata, Fucus distichus,* and *Iridaea splendens*. Rooted eelgrass (*Zostera marina*) was observed at two locations during this survey: a few turions were found in Transect I-1, and a small patch was found along Transect I-9 (Figure 2). No eelgrass was observed at the site of the proposed GPT trestle. Species observed, locations relative to the high tide line, estimates of percent cover for each species, and other observations made during the intertidal macroalgae and eelgrass survey are presented in Table 1. Substrate observed in the survey area was predominantly cobble with scattered patches of sand.

3.2 DIVE SURVEY

Divers observed macroalgae at all quadrat stations except those located at +5.1 MLLW. The greatest cover of macroalgae occurred between 0 and -12 feet MLLW. *Ulva*, *Fucus*, *Sargassum*, *Laminaria*, *Gigartina*, *Botryglossum*, *Iridaea*, *Odonthalia*, and *Microcladia* were the predominant taxa, with some *Nereocystis* present. Six *Nereocystis* plants were observed in the transects. This species represented 0.004% of the 1,440 plants recorded in survey transects. Eelgrass (*Zostera marina*) was observed at one location only. A 0.5-square-meter patch of eelgrass with approximately 60 plants was observed on Transect D-1, 240 feet from shore, at a depth of -3.1 feet MLLW.

The beach along the site consists of cobbles. Cobble size increases seaward from the shoreline, and some boulders are present (Table 2). About 200 to 280 feet from shore (approximately -5 feet MLLW), the substrate changes to sand; farther seaward, at depths below approximately -13 feet MLLW, the substrate changes to mud and silt/sand.

A summary of observations made by the divers is provided in Table 2.

Table 1: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-1			
50 feet	*Ulva/Monostroma*	35	Tops of large boulders
	Gigartina exasperata	5+	Sides of boulders
100	*Gigartina exasperata*	30	Tops of large rocks; sandy below
	Ulva/Monostroma	5	
			Fragments of broken & shredded Gigartina & Iridaea on sand
150+	*Fucus distichus*	< 1	
	Plocamium cartilagineum	< 1	
	Rhodomela larix	< 1	
	Ulva/Monostroma	< 1	
	Zostera marina	< 1	

Start Time: 0010

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-2			
100	*Ulva/Monostroma*	< 1	3 colonies, φ1 cm
	Iridaea splendens	<1	12 individuals, φ2 cm
	Fucus distichus	<1	2 clumps, φ8 cm
	Gigartina exasperata	<1	10 clumps, φ10 cm
150	*Ulva/Monostroma*	<1	5 clumps, φ6 cm
	Gigartina exasperata	<1	3 clumps
	Ahnfeltia sp.	<1	2 clumps
	Iridaea splendens	< 1	
	Rhodomela larix	< 1	
200	*Ulva/Monostroma*	< 1	Top & sides of boulders
	Gigartina exasperata	< 1	Mid-level sides of boulders
	Iridaea splendens	< 1	Lower sides of boulders & in water
	Petrocelis	< 1	Abundant on tops of large rocks & cobbles
250	*Laminaria*	1	
	Gigartina	1	
	Iridaea	1	
300	*Gigartina*	1	
	Iridaea	1	
350	*Iridaea splendens*	1	Dominant

Start Time: 2350

Table 1 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-3			
100	*Gigartina exasperata*	<1	5 individuals, φ15 cm
	Gracilaria pacifica	<1	3 individuals
150	*Fucus distichus*	1	1 group, φ12 cm
	Rhodomela larix	40	
	Iridaea splendens	1	12 individuals
	Petrocelis	6	
	Ulva/Monostroma	4	9 colonies
160	*Sargassum muticum*	< 1	Tidepool
	Iridaea splendens	< 1	
	Ulva/Monostroma	< 1	
200	*Rhodomela larix*	30	
	Gracilaria pacifica	2	
	Gigartina exasperata	30	
	Iridaea splendens	15	
	Fucus distichus	3	
	Plocamium cartilagineum	1	
	Bangia sp.	1	
	Ulva/Monostroma	3	
	Sargassum muticum	< 1	
	Laminaria saccharina	< 1	
250	*Iridaea*	10	
	Gigartina	20	
	Laminaria	1	
300	*Nereocystis luetkeana*	<1	

Start Time: 2300

Table 1 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-4			
100	*Ulva/Monostroma*	<1	4 colonies, φ1 cm
	Gigartina exasperata	<1	2 individuals
150	*Gigartina exasperata*	15	
	Iridaea splendens	2	
	Plocamium cartilagineum	<1	
	Rhodomela larix	1	3 patches
	Petrocelis	10	
184	*Costaria costata*	10	2 individuals, 0.7-1 m
	Rhodomela larix	25	
	Iridaea splendens	10	
	Ulva/Monostroma	2	
	Bangia sp.	1	
	Sargassum muticum	< 1	
	Plocamium cartilagineum	< 1	
	Desmarestia ligulata	< 1	
200	*Iridaea splendens*	< 1	
	Bossiela/Callarthion	< 1	
	Plocamium cartilagineum	< 1	
	Gracilaria pacifica	< 1	
220	*Plocamium cartilagineum*	<1	
	Ulva/Monostroma	<1	
	Rhodomela larix	<1	
	Gracilaria pacifica	<1	
	Iridaea splendens	<1	

Start Time: 2200

Table 1 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-5			
0	*Zostera marina*	0	Washed up on tide line
	Iridaea splendens	0	
	Plocamium cartilagineum	0	
80	*Iridaea splendens*	< 1	
	Corallina/Calliarthon	< 1	
	Gigartina exasperata	< 1	
	Ulva/Monostroma	< 1	
	Rhodomela larix	< 1	
100	*Ulva/Monostroma*	1	
	Gigartina exasperata	1	
110	*Gracilaria pacifica*	<1	Fragment
	Gigartina exasperata	<1	ca. 8 individuals
	Ulva/Monostroma	<1	8-10 colonies; φ2 cm
145	*Fucus distichus*	< 1	
	Gracilaria pacifica	< 1	
	Iridaea splendens	< 1	
	Bangia sp.	< 1	
160	*Fucus distichus*	< 1	
	Iridaea splendens	< 1	
	Laminaria saccharina	< 1	
	Ulva/Monostroma	< 1	
170	*Gigartina exasperata*	20	
	Iridaea splendens	12	
	Gracilaria pacifica	<1	8 colonies
	Ulva/Monostroma	<1	10 colonies
	Fucus distichus	< 1	
195	*Nereocystis luetkeana*	<1	Holdfast, ca. 20 ft. beyond

Start Time: 2100

Table 1 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-6			
0-90	none	0	
94	*Fucus distichus*	<1	
100	*Fucus distichus*	<1	
	Plocamium cartilagineum	10	
120	*Plocamium cartilagineum*	20	
140	*Plocamium cartilagineum*	20	
	Gigartina exasperata	<1	2 plants/m2
	Nereocystis luetkeana	<1	1 plant
160	*Plocamium cartilagineum*	20	
	Ulva/Monostroma	<1	2 plants/m2
	Iridaea splendens	<1	2 plants/m2
180	*Rhodomela larix*	15	
190	*None*	0	sand & cobble
200	*Gigartina exasperata*	20	sand & rocks
	Iridaea splendens	5	3/m2
	Plocamium cartilagineum	2	2/m2
	Ulva/Monostroma	<1	1/m2
250	*Gigartina exasperata*	15	
	Odenthalia sp.	5	
	Iridaea splendens	5	8 plants/m2
270			2' deep but too murky

Start Time: 21:54

Table 1 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-7			
0-72	none	0	
73	*Fucus distichus*	2	4 plants, 4 cm
	Petrocelis sp.	< 1	4
	Bangia sp.	< 1	3
100	*Rhodomela larix*	20	
	Odenthalia sp.	20	
	Gigartina exasperata	1	4 plants/m2
	Ulva/Monostroma	<1	1 small plant/m2
	Sargassum muticum	<1	1 small bunch
120	*Rhodomela larix*	15	
	Odenthalia sp.	10	
	Gigartina exasperata	<1	2/m2
	Fucus distichus	<1	1/ m2
140	*Rhodomela larix*	10	
	Laminaria saccharina	<1	1/m2
	Ulva/Monostroma	<1	2/m2
150	*Laminaria saccharina*	5	10/m2
	Ulva/Monostroma	2	6/m2
200	*Ulva*	10	
	Laminaria saccharina	10	
224	*Iridaea splendens*	15	water depth 2 ft.
	Laminaria saccharina	10	battered plants
	Ulva/Monostroma	<1	2/m2
	Rhodomela larix	<1	2/m2
	Nereocystis luetkeana	<1	2/m2

Start Time: 22:46

Table 1 cont.: **Cherry Pt. Macroalgae and Eelgrass Investigation Intertidal Survey**

Distance from High Tide Line	Taxon	Percent cover	Comments
Transect I-8			
0-76	none	0	
77	*Sargassum muticum*		1 isolated plant
88	*Ulva/Monostroma* *Odenthalia sp.* *Fucus distichus*	<1 10 < 1	6/m2 (Start of vegetative zone) 2/m2
100	*Plocamium cartilagineum*	10	
226	*Laminaria saccharina* *Ulva/Monostroma* *Iridaea splendens* *Gigartina exasperata* *Plocamium cartilagineum*	10 < 1 < 1 5 < 1	2 ft. deep 3/m2 2/m2 5/m2

Start Time: 23:23

Transect I-9			
0-93	none	0	Sandy beach, no cobble
94	*Ulva/Monostroma* *Iridaea splendens*	3 < 1	(Water's edge 23:50) 5/m2 2/m2
103	*Ulva/Monostroma*	50	
112	*Zostera marina*	<1	Sandy, 3-10 turions/m2
113-176		0	2 ft. deep, bare sand

Start Time: 23:49

Table 2: Cherry Pt. Macroalgae and Eelgrass Investigation Dive Survey

Station	Distance (feet)	Time	Depth (feet MLLW)	Substrate	Genus	Number of Individuals	% Cover	Comments
Transect D-1								
0	0	12:30	5.1	large & small cobble			0	
1	40	12:35	2.5	large & small cobble	*Ulva*	15	10	
					Botryglossum	2		
					Porphyra	2		
2	80	12:45	-0.3	sand & small cobble	*Ulva*	25	50	
					Fucus	2		
					Gigartina	5		
					Sargassum	1		
					Odonthalia	5		
3	120	12:49	-1.3	small cobble & 1 boulder	*Ulva*	15	40	
					Fucus	1		
					Botryglossum	1		
					Sargassum	20		
					Odonthalia	1		
4	160	12:54	-1.2	medium & large cobble	*Sargassum*	15	90	
					Laminaria	1		
					Botryglossum	1		
					Gigartina	1		
					Iridaea	1		
					Odonthalia	1		
5	200	12:57	-2.1	sand & large cobble	*Sargassum*	5	80	Station 5 + 3 feet; substrate changes to sand to Station 6.
					Laminaria	5		
					Botryglossum	2		
					Gigartina	2		
					Microcladia	1		
6	240	13:01	-3.1	sand & cobble	*Ulva*	5	90	
					Botryglossum	10		
					Iridaea	1		
Station 6 + 7 meters; Zostera marina 0.5 m2, ~60 turions, or 120 turions/m2.								
7	280	13:07	-3	sand & cobble	*Iridaea*	8	50	
					Botryglossum	4		
					Gracilaria	1		
8	320	13:10	-2.9	sand & cobble	*Ulva*	10	60	
					Botryglossum	20		
					Iridaea	1		
					Gigartina	2		
					Odonthalia	1		
9	360	13:13	-4.8	sand & cobble	*Ulva*	5	90	Station 9 - 3 feet; 100% cover Laminaria
					Botryglossum	20		
					Iridaea	3		
					Laminaria	1		
					Odonthalia	1		
10	400	13:16	-6.8	large cobble	*Ulva*	3	90	
					Botryglossum	20		
					Iridaea	15		
					Microcladia	3		
11	440	13:18	-9.8	sand, shell, & boulder	*Laminaria*	5	80	
12	480	13:21	-10.7	sand & gravel	*Laminaria*	5	60	
					Gracilaria	3		
					Botryglossum	2		
					Microcladia	1		
13	520	13:23	-12.7	sand & shell	*Laminaria*	2	10	Occasional Nereocystis
					Gracilaria	10		
14	560	13:24	-14.7	silt & shell	*Laminaria*	1	5	
					Gracilaria	10		
15	600	13:26	-17.6	mud, silt, & shell	*Gracilaria*	5	1	
Transect D-2								
0	0	12:38	5.1	large & small cobble				
1	40	12:41	2.6	large & small cobble	*Ulva*	11	10	
2	80	12:45	-0.3	sand & small cobble	*Ulva*	4,5,1	40	
					Sargassum			
					Gracilaria			

Table 2 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Dive Survey

Station	Distance (feet)	Time	Depth (feet MLLW)	Substrate	Genus	No.	% Cover	Comments
				Transect D-2				
3	120	12:50	-1.2	boulder, cobble, & sand	*Ulva*	8	70	
					Sargassum	6		
					Gracilaria	2		
					Botryglossum	2		
					Nereocystis	1		
4	160	12:55	-1.2	boulder, cobble, & gravel	*Ulva*	3	70	
					Sargassum	4		
					Gracilaria	2		
					Botryglossum	3		
					Laminaria	3		
5	200	12:59	-1.1	sand, shell, & gravel	*Ulva*	3	50	
					Sargassum	4		
					Gracilaria	5		
					Botryglossum	6		
6	240	13:02	-2.1	sand & mud	*Ulva*	2	40	
					Gracilaria	9		
					Porphyra	6		
7	280	13:05	-3	sand & mud	*Ulva*	3	100	
					Sargassum	4		
					Fucus	3		
					Botryglossum	20		
					Porphyra	5		
8	320	13:09	-2.9	sand & cobble	*Ulva*	4	90	
					Fucus	7		
					Laminaria	3		
9	360	1311	-5.9	sand & gravel	*Ulva*	4	100	
					Sargassum	1		
					Laminaria	2		
					Botryglossum	12		
10	400	1313	-7.8	sand & gravel	*Ulva*	1	70	
					Sargassum	2		
					Gigartina	6		
					Botryglossum	5		
					Laminaria	3		
11	440	1316	-9.8	sand & gravel	*Ulva*	2	80	Station 10 to Station 12; thick Laminaria bed
					Laminaria	4		
					Fucus	3		
					Gigartina	4		
12	480	1318	-10.8	sand & large cobble	*Laminaria*	2	75	
					Nereocystis	1		
13	520	1320	-13.7	sand & silt	*Gracilaria*	1	<5	
14	560	1322	-16.7	sand & silt	*Gracilaria*	7	<1	
15	600	1324	-18.7	sand & silt	*Gracilaria*	4	<1	
				Transect D-3				
0	0	1235	5.1	large & small cobble				
1	40	1239	0.6	large & small cobble	*Ulva*		30	
2	80	1243	-3.4	large & small cobble	*Ulva*	10	75	
					Sargassum	1		
					Iridaea	1		
					Gigartina	1		
3	120	1248	-4.3	sand & small cobble	*Ulva*	3	60	
					Nereocystis	1		
					Gigartina	5		
4	160	1254	-4.2	sand & boulder	*Ulva*	1	85	
					Sargassum	1		
					Iridaea	1		
					Gigartina	1		
					Fucus	1		
5	200	1259	-5.1	sand & large gravel	*Sargassum*	3	90	
					Laminaria	3		
					Nereocystis	1		
6	240	1300	-6.1	sand	*Gigartina*	1	5	
					Botryglossum	1		
7	280	1302	-6	boulder & large cobble	*Laminaria*	2	95	
					Fucus	10		
					Porphyra	2		

Table 2 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Dive Survey

Station	Distance (feet)	Time	Depth (feet MLLW)	Substrate	Genus	No.	% Cover	Comments
					Transect D-3			
8	320	1306	-6	sand, cobble, & boulder	*Laminaria*	2	80	
					Ulva	1		
					Porphyra	3		
9	360	1311	-8.9	sand, cobble, & boulder	*Laminaria*	3	75	Transect crosses Transect 4
					Ulva	5		
					Fucus	1		
					Gigartina	3		
10	400	1317	-12.8	sand, cobble, & boulder	*Laminaria*	3	65	
					Ulva	2		
					Botryglossum	3		
					Sargassum	1		
					Odonthalia	4		
11	440	1323	-14.7	sand & boulder	*Laminaria*	4	70	
					Fucus	1		
					Gracilaria	1		
12	480	1324	-14.7	sand	*Gracilaria*	4	5	
13	520	1326	-17.6	sand	*Gracilaria*	5	5	
14	560	1329	-17.6	sand & mud	*Gracilaria*	4	5	
15	600	1330	-17.6	sand & mud	*Gracilaria*	5	5	
					Transect D-4			
0	0	1358	5.1	cobble				
1	40	1402	1	cobble	*Ulva*	20	20	Seastar, Anthopleura
2	80	1404	-1	sand, gravel, & cobble	*Ulva*	20	60	
					Fucus	1		
					Botryglossum	10		
					Gracilaria	5		
					Odonthalia	3		
					Microcladia	2		
3	120	1406	-1.9	sand, cobble, & 2 boulders	*Ulva*	3	30	
					Sargassum	5		
					Botryglossum	5		
					Gracilaria	5		
					Odonthalia	3		
4	160	1409	-1.9	sand & cobble	*Sargassum*	5	50	Kelp crab
					Botryglossum	5		
					Laminaria	2		
					Odonthalia	3		
5	200	1411	-2.9	sand & cobble	*Sargassum*	5	90	
					Botryglossum	8		
					Laminaria	1		
6	240	1414	-3.8	sand	*Iridaea*	2	0	Anthopleura
7	280	1416	-3.8	cobble	*Ulva*	15	95	
					Botryglossum	30		
					Laminaria	1		
					Iridaea	10		
					Microcladia	5		
8	320	1419	-5.7	sand & cobble	*Ulva*	10	80	
					Botryglossum	20		
					Laminaria	2		
					Iridaea	5		
					Microcladia	3		
9	360	1421	-7.7	sand & cobble	*Ulva*	10	80	Rockfish
					Botryglossum	10		
					Iridaea	5		
					Microcladia	3		
10	400	1424	-9.6	sand & cobble	*Nereocystis*	1	60	Transect crosses Transect 3
					Botryglossum	5		
					Laminaria	5		
					Iridaea	3		
					Microcladia	4		
11	440	1427	-11.6	sand & cobble	*Sargassum*	2	80	Station 11 + 16 feet; boulders and Nereocystis
					Botryglossum	5		
					Laminaria	3		
					Iridaea	3		
12	480	1430	-14.5	sand & silt	*Gracilaria*	15	1	
					Gigartina	1		
					Ulva	1		

Table 2 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Dive Survey

Station	Distance (feet)	Time	Depth (feet MLLW)	Substrate	Genus	No.	% Cover	Comments
Transect D-4								
13	520	1431	-16.5	silt & shell	*Gracilaria*	15	1	Juvenile sole
14	560	1433	-18.5	silt & shell	*Gracilaria*	10	1	2 rockfish
15	600	1435	-18.5	silt & mud	*Gracilaria*	1	<1	
Transect D-5								
0	0	1407	5.1	cobble				
1	40	1410	1.1	cobble & gravel	*Ulva*	5	20	
2	80	1414	-0.8	sand & cobble	*Ulva*	14	40	
					Fucus	1		
					Odonthalia	7		
					Gracilaria	4		
3	120	1417	-1.8	sand, gravel, & boulder	*Ulva*	4	70	
					Fucus	2		
					Sargassum	4		
					Laminaria	1		
					Odonthalia	3		
					Gigartina	1		
					Botryglossum	3		
4	160	1420	-2.7	sand & small cobble	*Sargassum*	10	100	Station 4 to Station 5; 100% cover of Sargassum and Laminaria.
					Laminaria	1		
					Ulva	1		
5	200	1423	-2.7	sand & gravel	*Sargassum*	6	60	
					Laminaria	1		
					Ulva	2		
					Botryglossum	12		
6	240	1425	-3.6	sand & gravel	*Ulva*	2	<5	Station 6 + 10 feet; 100% cover of Laminaria and Botryglossum
					Botryglossum	1		
7	280	1427	-3.6	sand & large cobble	*Sargassum*	1	10	
					Laminaria	1		
					Fucus	2		
					Ulva	1		
					Botryglossum	1		
8	320	1431	-5.5	sand & cobble	*Ulva*	1	100	
					Laminaria	2		
					Botryglossum	15		
9	360	1433	-7.5	sand & cobble	*Ulva*	5	90	
					Laminaria	3		
					Botryglossum	10		
10	400	1435	-9.5	sand & shell	*Ulva*	3	30	
					Laminaria	1		
					Botryglossum	4		
					Gracilaria	6		
11	440	1439	-11.4	sand & cobble	*Laminaria*	6	80	
12	480	1441	-13.4	sand & shell	*Gracilaria*	7	15	
					Ulva	2		
13	520	1443	-15.3	sand & shell	*Gracilaria*	6	1	
14	560	1445	-18.3	sand & shell	*Gracilaria*	3	1	
15	600	1447	-20.3	sand & shell	*Gracilaria*	2	1	
Transect D-6								
0	0	1415	5.1	cobble				
1	40	1417	3.2	cobble & boulder	*Ulva*	15	45	
2	80	1419	-2.7	cobble, boulder, & gravel	*Ulva*	10	50	
					Botryglossum	15		
3	120	1422	-3.7	gravel & boulder	*Ulva*	5	70	
					Fucus	2		
					Botryglossum	20		
					Gracilaria	2		
					Odonthalia	2		
4	160	1426	-3.6	gravel & boulder	*Ulva*	3	65	
					Sargassum	2		
					Laminaria	2		
					Gracilaria	1		
5	200	1428	-4.6	sand & large cobble	*Sargassum*	1	80	
					Gracilaria	2		
					Gigartina	2		
6	240	1431	-4.5	sand	*Odonthalia*	5	0	Snail

Table 2 cont.: Cherry Pt. Macroalgae and Eelgrass Investigation Dive Survey

Station	Distance (feet)	Time	Depth (feet MLLW)	Substrate	Genus	No.	% Cover	Comments
Transect D-6								
7	280	1433	-5.5	sand & boulder	*Ulva*	4	100	
					Botryglossum	5		
					Gigartina	1		
8	320	1435	-6.5	sand & boulder	*Laminaria*	2	85	
					Botryglossum	13		
					Gracilaria	2		
9	360	1438	-11.4	sand & boulder	*Ulva*	4	85	
					Laminaria	2		
					Gigartina	2		
					Gracilaria	3		
10	400	1440	-12.4	sand & boulder	*Laminaria*	3	80	
					Gigartina	1		
					Gracilaria	3		
11	440	1442	-13.3	sand & boulder	*Laminaria*	3	85	
					Gracilaria	3		
12	480	1444	-15.3	sand	*Gracilaria*	5	1	
13	520	1445	-16.3	sand	*Gracilaria*	4	1	
14	560	1447	-17.3	sand	*Gracilaria*	4	1	
15	600	1449	-17.2	sand	*Gracilaria*	2	1	
Transect D-7								
0	0	1523	5.1	cobble				
1	40	1525	2.4	cobble	*Ulva*	9	25	
2	80	1528	-0.6	cobble	*Ulva*	8	45	
					Fucus	3		
					Gigartina	2		
					Odonthalia	3		
3	120	1530	-0.5	sand & cobble	*Ulva*	2	35	
					Fucus	6		
					Botryglossum	2		
					Odonthalia	4		
4	160	1532	-1.5	sand, gravel, & cobble	*Ulva*	4	80	
					Laminaria	2		
					Sargassum	5		
					Botryglossum	1		
5	200	1535	-1.4	sand, shell, & large cobble	*Laminaria,*	3	100	
					Sargassum	5		
6	240	1537	-2.4	sand			0	
7	280	1538	-4.4	sand & cobble	*Ulva*	20	100	
					Laminaria	2		
					Botryglossum	20		
8	320	1536	-5.4	sand & cobble	*Laminaria*	8	90	
					Porphyra	3		
					Botryglossum	10		
					Microcladia	5		
9	360	1534	-8.5	sand, gravel, & cobble	*Laminaria*	2	60	
					Sargassum	1		
					Botryglossum	10		
					Gracilaria	3		
10	400	1532	-10.5	sand & large cobble	*Laminaria*	5	60	
					Sargassum	1		
					Botryglossum	5		
					Gracilaria	2		
					Nereocystis	1		
					Microcladia	3		
11	440	1530	-12.5	sand & 12 large cobbles	*Laminaria*	3	60	
					Botryglossum	5		
					Gracilaria	5		
12	480	1528	-14.6	silt & mud	*Gracilaria*	6	1	Transect crosses Transect 6
13	520	1527	-16.6	silt & mud	*Gracilaria*	3	<1	3 rock crab
14	560	1526	-18.6	silt & mud	*Gracilaria*	2	<1	seastar, juvenile sole
15	600	1524	-21.6	silt & mud	*Gracilaria*	2	<1	

4. DISCUSSION

The shoreline in the vicinity of Cherry Point, located on the eastern shore of the Strait of Georgia, supports a rich and diverse macroalgal community. Several studies have been conducted in the area and have characterized marine vegetation and substrate types. The intertidal zone of Cherry Point has been surveyed for biological characteristics since 1954. Schneider and Dube (1969, 1972) and Broad and Dube (1974) inventoried flora of the intertidal zone between Sandy Point and Birch Bay.

A description of marine vegetation and substrate of the Sandy Point-Point Whitehorn vicinity is given in Campbell and Geiger (1978). Presence of stable substrate (to allow plant attachment) and strong currents (to retard siltation) in addition to light, appear to be factors that may regulate the depth of plant growth. The lowest depth of marine vegetation growth varied from -30 feet MLLW near Sandy Point and Point Whitehorn, to -10 feet east of the Tosco Pier (formerly BP). For all transects recorded during this study, vertical zonation of vegetation was also observed. Green algae (*Ulva* and *Enteromorpha* species) occurred in the lower intertidal, integrating into a zone of brown algae (*Fucus* sp.) and red algae (*Gigartina* sp.) at greater depths.

Smith and Webber (1978) identified 60 species of algae near the abandoned gravel pier off Gulf Road. Green algae, brown algae, and red algae comprised 13, 6, and 33 of these species, respectively. *Gigartina* species were the most abundant species of red algae, and *Polysiphonia* sp., *Rhodomela* sp., *Ahnfeltia* sp., *Microcladia* sp., and *Odonthalia* sp. were also common.

Nyblade (1979) described intertidal benthos in the Cherry Point vicinity in the summer of 1978. The sampling station was approximately 330 feet northwest of Gulf Road. A vertical zonation of algae was also observed in this study. No algae was found at +5.0 feet MLLW. At +2.0 feet MLLW, nine species of red algae, dominated by *Gigartina* sp., and two species of green algae, *Ulva* sp. and *Enteromorpha* sp., where found. The species assemblage at -1.0 foot MLLW consisted of 26 species of red algae, dominated by *Gigartina* sp., and three species of brown algae, dominated by *Fucus* sp. At -1.0 MLLW tidal level, the algae biomass was estimated to be 532 grams per square meter.

Results of field investigations of substrate and marine vegetation were described by Whatcom County (1981, 1984) for the Sandy Point - Point Whitehorn vicinity during the spring of 1980. It was estimated that 52% of the intertidal area between 0.0 and -6.0 feet MLLW was vegetated, and that algae made up 95%.

A study conducted in August 1992 (Whatcom County, 1992) at the site of a proposed pier for the proposed Cherry Point Industrial Park, indicated the greatest algal cover occurred between -3.0 and -10.0 feet MLLW. *Laminaria* sp. predominated, with *Nereocystis, Ulva, Gigartina, Iridia* , *Microcladia*, and *Plocamium* sp. also present. Percent cover varied from 0 to 85%.

In the study by Campbell and Geiger (1979) conducted for Mobil Oil, differences in the presence and areal cover of algae appeared to depend upon the availability of stable substrate. During storm events between 1977 and mid-1979, substrate changes may have occurred. The study results suggested that differences in species composition and coverage among years are primarily attributable to natural variables rather than human causes.

Occurrences of eelgrass (*Zostra marina*) have been observed in sandy substrate in the Sandy Point-Point Whitehorn vicinity. Depths observed ranged from 0 to -3 feet MLLW (Anvil, 1983) and -2 to -13 feet MLLW (Campbell and Geiger, 1978). Eelgrass was found at -8 and -13.5 feet MLLW in quadrats sampled during August 1992 (Whatcom County, 1992) and was also found rarely in narrow bands between sampled quadrats. That sampling corresponded with sampling done at Transect I-7 (Figure 2) of the present study. Between the Arco Pier and the Intalco Pier, eelgrass tends to be relatively more abundant in the broad, lower grade subtidal areas. Much eelgrass was observed around the Arco Pier (Shapiro and Associates, Inc., 1994) and was observed along Transect I-9 (Figure 2). No eelgrass was observed in the footprint of the proposed GPT Pier and it appears to be very scarce in the immediate vicinity.

In the present study, at the site of the proposed GPT pier, there was a difference in density and composition of the species of macroalgae between that observed during the late November 1992 intertidal survey (Transect I-4) and the late August 1993 dive survey. Observations in depths shallower than the -2.0 MLLW were compared. *Sargassum muticum, Gigartina exasperata, Iridaea splendens, Gracilaria pacifica,* and *Ulva* sp. were present in both surveys. *Plocamium cartilagineum, Rhodomela larix, Petrocelis* sp., *Costaria costata, Bangia* sp., *Desmarestia ligulata, and Bossiela* sp. were observed only during the former survey, and *Laminaria, Botryglossum, Odonthalia, Microcladia, Fucus, Porphyra,* and *Nereocystis* were only observed during the latter survey. The percent cover in the fall survey was generally light with a maximum of 50% in one quadrat and about 1% in three of the four other quadrats sampled. During the summer dive survey, percent cover was generally greater, ranging from 20% to 100% in the quadrats sampled.

Based on previous studies and the present study, it appears that at any specific site, variability in species composition and density will occur at different times of the year and among years. While some of the variability observed in past studies is due to different sampling techniques, the substrate upon which macroalgae grow is dynamic. Stability of the macroalgae community is likely linked to the frequency and magnitude of storms and currents which could affect the substrate.

Potential adverse effects on the macroalgal and eelgrass community would primarily result from shading caused by the proposed pier. The proposed GPT pier trestle would be located to avoid shading of any eelgrass. The trestle could be constructed at a higher elevation should this be a factor in reducing potential impacts on macroalgae due to shading. Some displacement of individual macroalgae plants would be expected during construction, but in the absence of any shading and assuming little disturbance of the existing substrate, most of the disturbed area probably would be recolonized by marine macroalgae. Shading, however, has been implicated in causing reduced marine plant densities (Penttila and Doty, 1990; Shapiro and Associates, Inc., 1994). Marine macroflora is mostly absent in the intertidal area 41 feet to the north and 48 feet to the south of the Arco pier, located about 4,400 feet north of the location of the proposed GPT pier. This absence of vegetation may be due, at least in part, to shading caused by the pier.

The marine vegetation community supports marine animals such as herring, crab, juvenile salmonids, marine fish, and invertebrates upon which they feed. These marine animals are an important component of the local economy. The policies of Washington Departments of Fisheries and Natural Resources are to incur no net loss of habitat. Loss of macroalgae in the marine environment near Cherry Point could reduce the ability of this area to support important marine fisheries. While it would be difficult to measure a net loss of marine algae with statistical precision (due to the natural variability discussed above), a net loss may be assumed if marine vegetation present in the predicted shadow zone of a proposed pier trestle disappears after the trestle is constructed. Protocols to determine if a net loss of habitat occurs would be negotiated with state agencies. Mitigation measures, such as artificial daytime lighting, grating in the trestle deck, or establishment of marine vegetation in areas currently not vegetated, would be established in collaboration with agencies.

This investigation was conducted to provide baseline information that will be used to assess possible impacts on the local marine ecosystem from construction and operation of the proposed GPT pier. Calculation of areal coverage of macroalgae and eelgrass in the study area and estimates of potential adverse effects have been completed and are documented in the report titled "Potential Shading Effects on Macroalgae," by Shapiro and Associates, Inc. (1994).

5. LITERATURE CITED

Anvil Corporation, 1983. Eelgrass Transect Survey. Cherry Point Facility. Kiewit Construction Company.

Broad, A.C. and M.A. Dube, 1974. *1973 Survey of the Intertidal Zone from Sandy Point to Birch Bay, Whatcom County, Washington.* Prepared for the Atlantic Richfield Company and Mobil Oil Corporation. Western Washington State College. Bellingham, Washington.

Campbell, K. and N. Geiger, 1978. *Assessment of the Effects of a Proposed Marine Construction Facility at Cherry Point on the Pacific Herring (Clupea harengus pallasi) of the Gulf of Georgia.* Beak Consultants, Inc. Manuscript Report.

Geiger, N. and K. Campbell, 1979. *The 1979 Survey of the Intertidal Zone from Sandy Point to Birch Bay, Whatcom County, Washington.* Prepared for Mobil Oil Company. Bellingham, Washington.

Penttila, D. and D. Doty, 1990. *Results of 1989 Eelgrass Shading Studies in Puget Sound.* Washington Department of Fisheries, Marine Fish Habitat Investigations Division. August 1990.

Schneider, D.E. and M. A. Dube, 1969. *1969 Survey of the Intertidal Zone from Sandy Point to Birch Park Marina, Whatcom County, Washington.* Prepared for the Mobil Oil Company and the Atlantic Richfield Oil Company. Western Washington State College. Bellingham, Washington.

Schneider, D.E. and M.A. Dube, 1972. *1971 Survey of the Intertidal Zone from Sandy Point to Birch Park Marina, Whatcom County, Washington.* Prepared for the Mobil Oil Company and the Atlantic Richfield Oil Company. Western Washington State College. Bellingham, Washington.

Shapiro and Associates, Inc., 1994. *Cherry Point Natural Resources Baseline Studies Potenital Shading Effects on Macroalgae.* January 1994.

Smith, G.F. and H.H. Webber, 1978. *A Biological Sampling Program of Intertidal Habitats of Northern Puget Sound.* Washington Department of Ecology North Puget Sound Baseline Study. 1977-1977. Appendix K.

Whatcom County, 1981. *Final Environmental Impact Statement. Cherry Point Marine Facility Chicago Bridge and Iron Co./Snelson-Anvil, Inc.* Whatcom County Planning Department. Bellingham, Washington.

Whatcom County, 1984. *Kiewit Marine Facility. Draft Environmental Impact Statement.* Whatcom County Planning Department. Bellingham, Washington.

Whatcom County, 1992. *Draft Environmental Impact Statement. Cherry Point Industrial Park (CPIP).* Whatcom County Department of Public Works. Bellingham, Washington.

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

POTENTIAL SHADING EFFECTS ON MACROALGAE

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1. INTRODUCTION

The purpose of this study was to estimate the extent of shading that could be caused by installation of a pier as part of the proposed Pacific International Terminals' Gateway Pacific Terminal (GPT) Bulk Loading Facility Project and to discuss potential effects on the macrofloral community. The vicinity of the Arco pier at Cherry Point was chosen for examination because of its proximity to the proposed structure's location, although it has a more east-west orientation. The base Arco pier is approximately 0.84 mile northwest of the proposed GPT trestle. The Arco pier is oriented northeast-southwest over the shallow subtidal area, a zone known to support macroalgae and eelgrass (Figure 1). The Arco pier's structure, which includes a concrete pier for vehicular traffic and five oil pipelines, is approximately 36 feet wide. The proposed GPT pier would be 50 feet wide. The Arco pier is about 20 feet above mean lower low water (MLLW); the proposed GPT trestle is currently proposed to be 22 feet above MLLW. The GPT trestle could be constructed at a higher elevation should this be a factor in reducing potential impacts to marine vegetation.

A two-phased investigation was undertaken to determine potential effects of shading on the nearshore intertidal and subtidal plant community near Cherry Point. The first phase involved determining the extent of shading caused by the Arco pier. This was accomplished by collecting photographic evidence of shading at the Arco pier and by measuring the shadow cast on the beach under the pier.

The second phase of this investigation involved identifying existing vegetation in the vicinity of the Arco pier and estimating areal coverage. This was done by visiting the site during an extreme low tide (-1.9 MLLW). Methods used and observations made during this investigation are presented in this report.

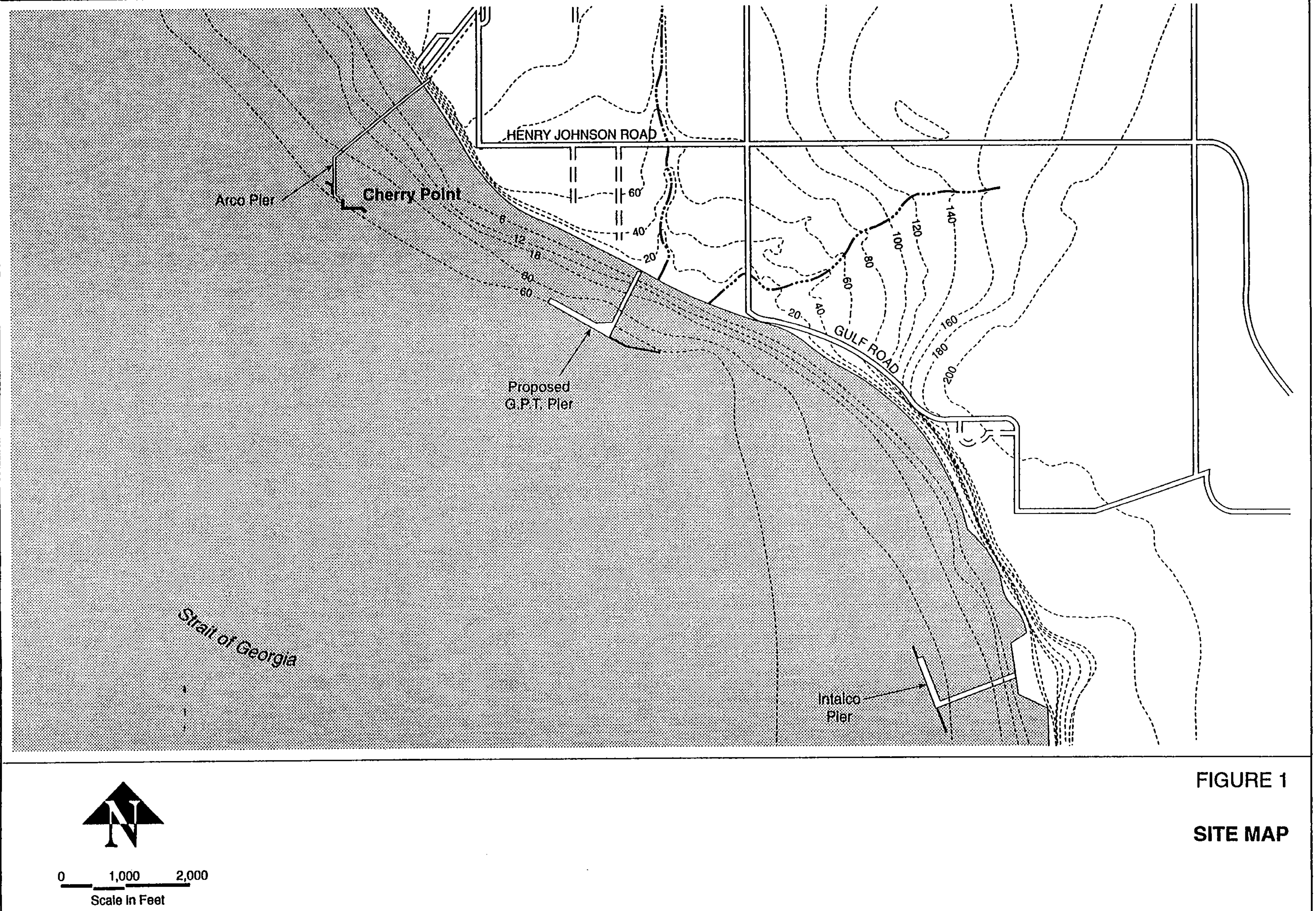
2. METHODS

2.1 PHASE 1

A Shapiro and Associates, Inc. (SHAPIRO) staff member visited the shoreline area in the vicinity of the Arco pier on September 21, 1992 (one day before the autumnal equinox), on December 22, 1992 (one day after the winter solstice), and on March 26, 1993 (six days after the vernal equinox) for the purpose of determining the extent of the shadow cast by the pier. The target dates for the site visits were the equinox and the winter solstice. These dates were chosen to compare their amount of daylight relative to other days of the year and associated angle of the sun relative to the Arco pier. Actual dates of the site visits were determined by logistical considerations and favorable weather conditions. Phase 1 of the study was conducted to aid in estimating the extent of shadow that would be cast by the proposed GPT pier.

During the first visit, two locations were chosen from which time-series photographs could be taken: one south of the Arco pier (approximately 104 feet from the center of the structure) and one north of the Arco pier (approximately 120 feet north of the structure). These locations were established prior to the sun becoming visible through the fog during the morning of September 21, 1992. Pictures were taken every hour from each of the two locations. The pictures were collected to visually document the extent of shade cast by the Arco pier throughout the day. The pictures are on file at SHAPIRO.

After the fog burned off, it became evident that the shadow cast by the pier would not be visible from either of the chosen locations and therefore a third location was added. In addition to collecting photographic records of the shadow, the width of the shaded zone was estimated. This was done along the beach, parallel to the shoreline, approximately 6 feet west of the most shoreward pier supports. Although narrower than the most seaward portion of the pier, the



SHAPIRO & ASSOCIATES INC

FIGURE 1

SITE MAP

CHERRY POINT

7/94

portion of the pier along the shore was the most accessible and provided a distinct shadow for width estimates.

Three additional photo locations were established for the second visit (December 22, 1992): one directly under the concrete pier, one immediately north of the most shoreward pier support structure, and one immediately south of the most shoreward pier support structure. Photos were taken every 30 minutes during the second visit. Figure 2 shows the photo locations.

The primary purpose of the third site visit was to collect early morning shading data to supplement the data collected during the September site visit. The morning fog and clouds present on September 21, 1992, had prevented the observation of shade from the pier until 11:00 a.m. March 26, 1993, was chosen for the third site visit because it was the first day after the vernal equinox that had a favorable weather forecast. Weather conditions prior to and immediately after the equinox were rainy and overcast.

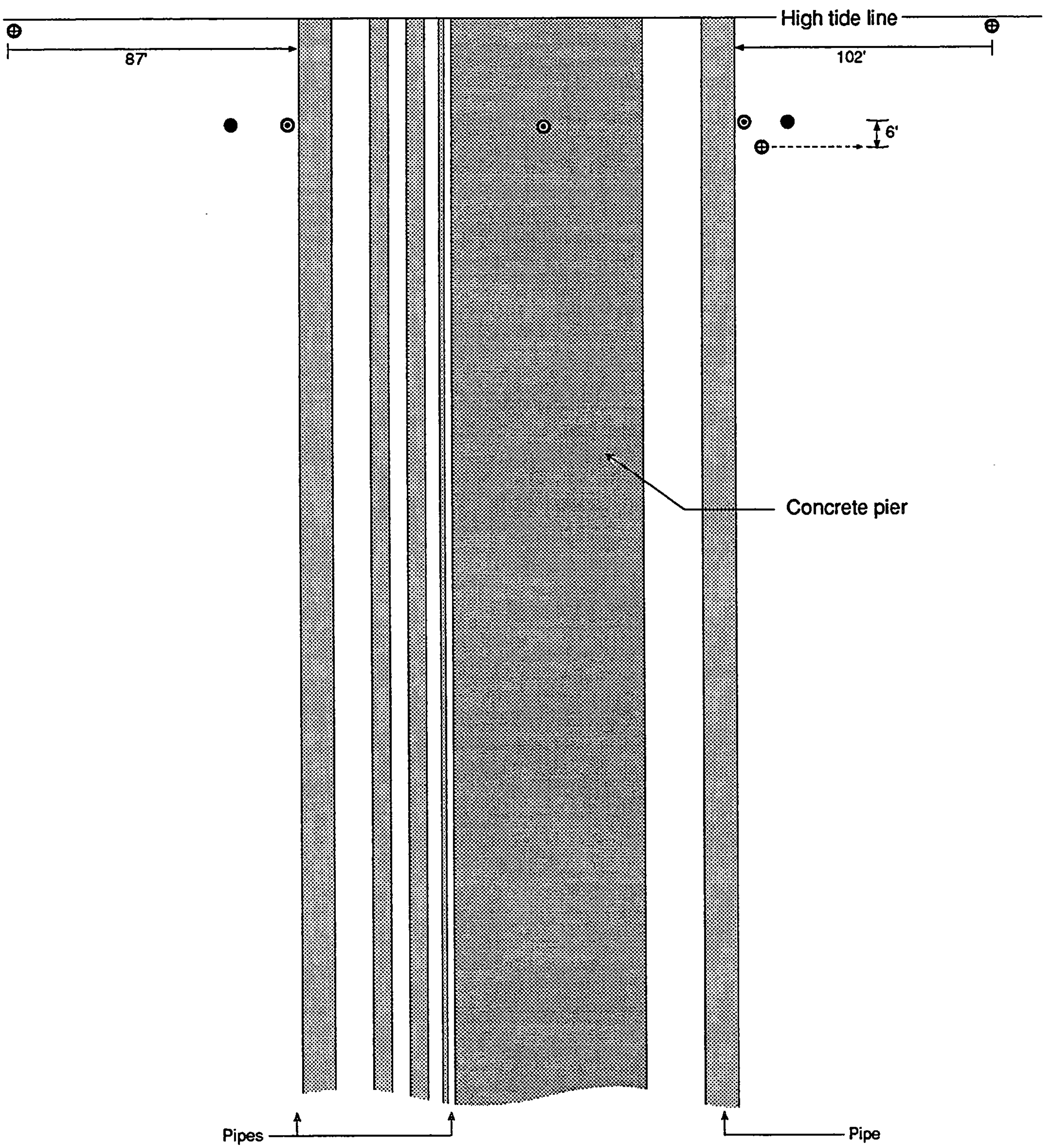
After the first series of photos were taken on the third site visit, pictures were no longer taken from the extreme north and south photo locations (sites established during the first site visit). These locations were too far from the pier to observe the shade or differentiate the shade from the reflection of the pier on the water. Additional photos were taken within 35 feet of the center of the pier structure where the shading would be obvious in the pictures.

2.2 PHASE 2

A survey of the intertidal area near the Arco pier was conducted November 23-24, 1992, from 21:15 to 00:15 (9:15 p.m. to 12:15 a.m.). The survey was conducted to determine species composition and relative abundance of the plant community in the intertidal area near the pier and to determine the effects that the pier has on surrounding vegetation.

SHAPIRO staff established nine transects, four to the north, four to the south, and one directly under the center of the concrete pier. The transects were 50 feet apart. Survey plots were established at 50-foot intervals along each transect from the high tide line (as delineated by the drift line directly under the pier, approximately 8.8 feet MLLW) to a tidal depth of approximately -4.0 feet MLLW. The initial intent was to begin sampling plots where vegetation was first encountered and establish plots seaward every 50 feet along each transect. The point directly under the pier determined to be the high tide line is referred to as 0 feet west for the remainder of this report. Figure 3 shows a diagram of the sample grid layout. Survey plot locations along a transect are referred to as the distance west of the high tide line directly under the center of the pier. Each survey plot had a radius of 1 meter. Dominant plant species present at each survey plot were identified, either in the field or from samples collected and placed in sample bags at the time of the survey for later identification. Macrofloral percent cover was estimated during the survey, and dominant species were noted. The distance from the pier (north and south) before vegetation was first encountered also was noted.

Deviations from the methods listed in the previous paragraph occurred for the transect directly underneath the concrete pier and for the first transect north of the centerline of the concrete pier. For the transect directly under the pier, vegetation was not encountered at any of the survey plot locations but was encountered on a large rock (4 feet in diameter) at 313 feet west along this transect. Water depth along the transect under the pier beyond 313 feet west was too deep to proceed seaward. For the first transect north of the pier, survey plots were established at 330 feet and 360 feet west along this transect. Eelgrass was first encountered at 330 feet. Water depth west of 360 feet along the first transect north of the pier was too deep to proceed seaward, so 360 feet west was established as the secondary survey plot of the transect.



LEGEND

- ⊕ Established 1st site visit
- ⊙ Established 2nd site visit
- ● Established 3rd site visit
- ----→ Location moved south with shade

Not to scale

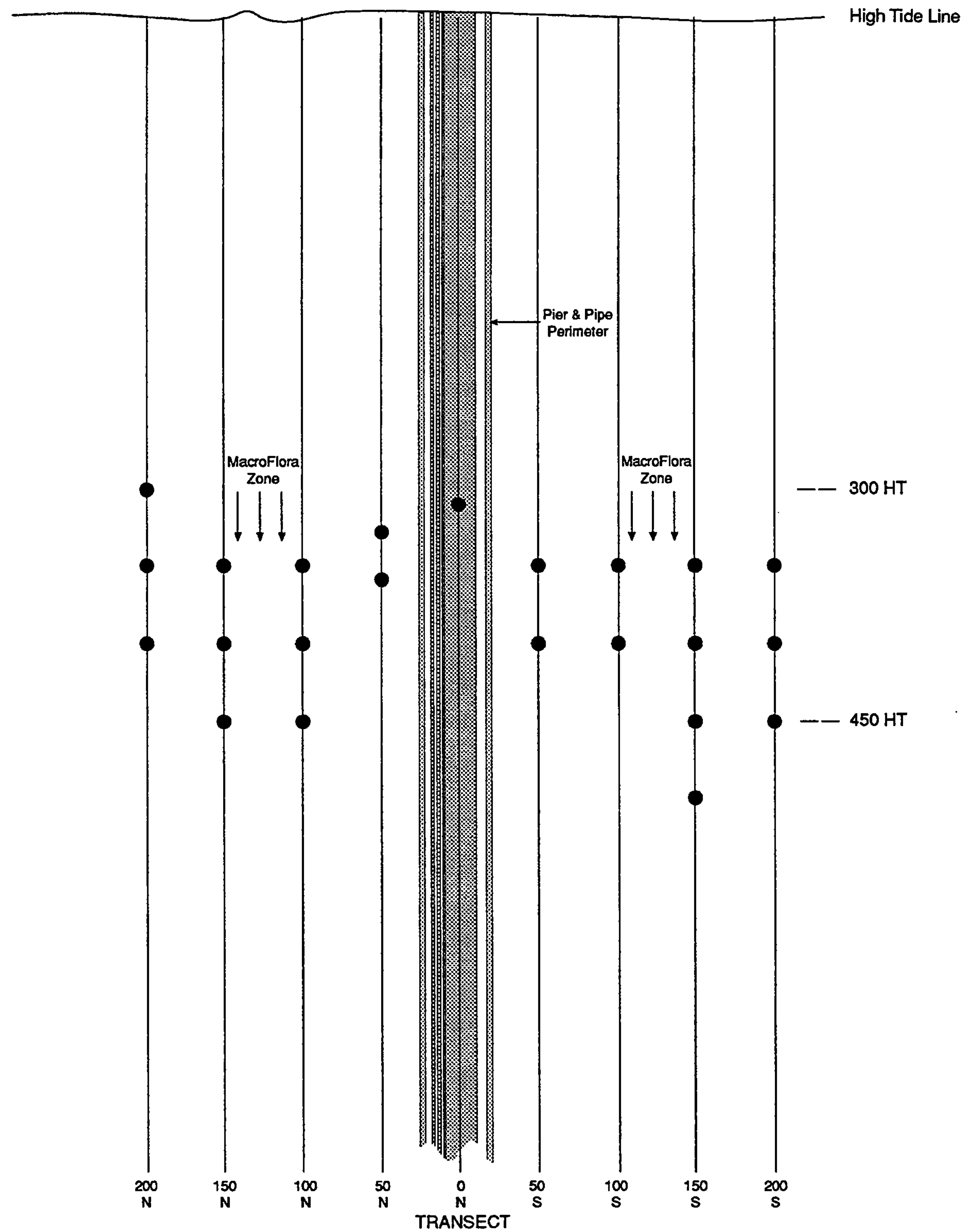
FIGURE 2

ARCO PIER
PHOTO LOCATIONS

CHERRY POINT

SHAPIRO & ASSOCIATES INC

9/93



LEGEND

● Station Location

FIGURE 3

SHADE MAP

Not to scale

SHAPIRO & ASSOCIATES INC

CHERRY POINT

9/93

3. RESULTS

3.1 PHASE 1

As mentioned above, photographic evidence of shading collected from both the distant north and south vantage points did not provide an adequate means for determining the extent of the shadow cast by the pier. Measurement of the extent of the shadow cast immediately under the Arco pier, however, provided usable data. Table 1 presents shadow width, orientation, and time of measurement for Phase 1 observations.

The sun was obscured by fog and cloud cover during the morning of September 21, 1992. The first measure of shade cast by the pier was made at 11:00 (a.m.). The sun became visible through the fog and cloud cover only a short time before this measurement was made. The remainder of the day was sunny with clear skies until sunset.

The sky was overcast most of the day on December 22, 1992. The sun broke through the cloud cover and cast a shadow on only two occasions during the second site visit. The first was at 12:30 (p.m.). By 12:57 (p.m.) the sun was again obscured and no shadow was visible. The second sun break occurred at 13:37 (1:37 p.m.). By 14:00 (2 p.m.) the clouds were beginning to obscure the sun. A faint shadow was still visible on the beach north of the pier. The sun did not reappear that day.

The area on the beach shaded by the Arco pier varied in width from a minimum of approximately 30 feet to a maximum of approximately 54 feet. The minimum observed width occurred at 15:00 (3 p.m.) September 21, 1992. The shaded area was almost directly under the pier at this time. The maximum observed width occurred at 18:20 (6:20 p.m.) September 21, 1992. The shaded area was almost entirely south of the pier at this time. Prior to 15:00 (3 p.m.), the shadow was cast to the north of the pier.

3.2 PHASE 2

The dominant plant species encountered during this survey in the vicinity of the pier was eelgrass (*Zostera marina*). Where present, eelgrass plant cover ranged from a trace to a maximum of about 40% substrate cover (Table 2). Within areas where eelgrass was abundant, few other plants were observed. This could be due to the substrate in the area being composed almost entirely of sand, which does not provide sufficient attaching structures for most macroalgae. Some large rocks and boulders were encountered in the survey area. Observed macroalgae were attached to the rock substrate.

With the exception of the algae (*Gracilaria pacifica, Laminaria saccharina, Gigartina exasperata*, and *Ulra*), attached to the large rock located at about -4 feet MLLW underneath the pier, no vegetation was observed in the immediate vicinity of the pier from 0' west to a tidal height of -4 feet, and about 41 feet north and 48 feet south (a total of approximately 89 feet) of center line of the pier. Based on these observations, shading from the pier appears to limit the growth of marine vegetation.

Table 1: ARCO PIER SHADING MEASUREMENTS

TIME	SHADOW WIDTH	ORIENTATION
September 21, 1992		
11:00	36 feet	Starting near middle of concrete portion of the pier and extending north.
12:00	36 feet	Starting roughly 1.5 feet south of 11:00 measurement near middle of concrete portion of the pier and extending north.
13:00	36 feet	Starting roughly 1.5 feet south of 12:00 measurement and extending north.
14:00	33 feet	Starting roughly 2 feet south of 13:00 measurement and extending north.
15:00	30 feet	Starting roughly 2 feet south of 14:00 measurement and almost entirely under pier.
16:00	35 feet	Shadow directly under pier and extending from the southern to northern edges.
17:00	36 feet	Starting roughly 2 feet south of the southern edge of the pier and extending to roughly 1 foot from the northern edge of the pier.
18:00	39 feet	Starting at southern edge of pier and extending south.
18:20	54 feet	Starting roughly 2 feet south of southern edge of pier and extending south.
December 22, 1992		
09:30	–	No shadow due to overcast conditions.
10:00	–	No shadow due to overcast conditions.
10:30	–	No shadow due to overcast conditions.
11:00	–	No shadow due to overcast conditions.
11:30	–	No shadow due to overcast conditions.
12:00	–	No shadow due to overcast conditions.
12:30	36 feet	Starting at northern edge of pier and extending north.
13:00	–	No shadow due to overcast conditions.
13:30	–	No shadow due to overcast conditions.
14:00	33 feet	Shadow very faint. Starting at approximately middle of pier and extending north.
14:30	–	No shadow due to overcast conditions.
15:00	–	No shadow due to overcast conditions.
15:30	–	No shadow due to overcast conditions.
March 26, 1993		
08:20	45 feet	Shadow starting at roughly mid-point under pier and extending north to within 2 feet of ramp to north.
09:20	36 feet	North end of shadow now 4 feet south of 08:20 location.
09:50	36 feet	North end of shadow now 2.5 feet south of 09:20 location.
10:20	35 feet	North end of shadow now 2 feet south of 09:50 location.
10:50	36 feet	North end of shadow now roughly 2 feet south of 10:20 location.
11:20	36 feet	North end of shadow now roughly 2 feet south of 10:50 location.
11:50	36 feet	North end of shadow now roughly 2 feet south of 11:20 location.
12:20	36 feet	North end of shadow now roughly 2 feet south of 11:50 location.
12:50	36 feet	North end of shadow now roughly 2 feet south of 12:20 location.
13:20	36 feet	North end of shadow now roughly 2 feet south of 12:50 location. Shadow mostly under pier.
13:50	35 feet	North end of shadow now roughly 2 feet south of 13:20 location. Shadow mostly under pier.

Table 2: INTERTIDAL MARCOFLORAL SURVEY OF THE ARCO PIER VICINITY

STATION LOCATION	PERCENT MACROFLORAL COVERAGE	DOMINANT SPECIES
0 feet N-S, 0 to 313 feet W	0%	No vegetation observed
0 feet N-S, 313 feet W	20%	*Gracilaria pacifica, Laminaria saccharina, Ulva/Monostroma* sp., *Gigartina exasperata*
50 feet N, 0 to 330 feet W	0%	No vegetation observed
50 feet N, 330 feet W	20%	*Zostera marina*
50 feet N, 360 feet W	15%	*Zostera marina, Nereocystis luetkeana*
100 feet N, 0 to 328 feet W	0%	No vegetation observed
100 feet N, 350 feet W	30%	*Zostera marina* with trace *Ulva/Monostroma* sp., *Iridaea* sp., *Gracilaria pacifica, Plocomium* sp.
100 feet N, 400 feet W	15%	*Zostera marina*
100 feet N, 450 feet W	10%	*Zostera marina*
150 feet N, 0 to 330 feet W	0%	No vegetation observed
150 feet N, 350 feet W	40%	*Zostera marina*
150 feet N, 400 feet W	15%	*Zostera marina, Iridaea* sp.
150 feet N, 450 feet W	20%	*Zostera marina*
200 feet N, 0 to 300 feet W	0%	No vegetation observed
200 feet N, 300 feet W	10%	*Ulva/Monostroma* sp., *Gracilaria pacifica, Iridaea* sp., *Zostera marina*
200 feet N, 350 feet W	1%	*Zostera marina, Nereocystis luetkeana, Gigartina exasperata, Ulva/Monostroma* sp.
200 feet N, 400 feet W	5%	*Gigartina exasperata, Iridaea* sp., *Desmarestia ligulata*
50 feet S, 0 to 400 feet W	0%	No vegetation observed
50 feet S, 400 feet W	15%	*Zostera marina*
100 feet S, 0 to 350 feet W	0%	No vegetation observed
100 feet S, 350 feet W	5%	Unidentifiable brown algae[1], *Nereocystis luetkeana, Zostera marina*
100 feet S, 400 feet W	trace	*Nereocystis luetkeana*
150 feet S, 0 to 350 feet W	0%	No vegetation observed
150 feet S, 350 feet W	30%	*Gigartina exasperata*
150 feet S, 400 feet W	30%	Unidentifiable brown algae[1]
150 feet S, 450 feet W	45%	*Gigartina exasperata*, unidentifiable brown algae[1]
150 feet S, 500 feet W	30%	*Gigartina exasperata*, unidentifiable brown algae[1], *Zostera marina, Ulva/Monostroma* sp.
200 feet S, 0 to 450 feet W	0%	No vegetation observed
200 feet S, 450 feet W	1%	*Zostera marina*

[1] - Condition of algae found was not adequate to make macroscopic identification.

4. DISCUSSION

Based on observations made during the first visit to the Arco pier, it appears that during days with no cloud cover the shaded zone extends to the north in the morning and to the south in the afternoon. The width of shading observed on the beach in the vicinity of the pier in the morning during an equinox was approximately 45 feet. The width of shading observed on the beach near the pier in the evening was approximately 54 feet. The sun is obscured by the bluff immediately east of the beach in the morning and becomes visible from this vantage at about 8:30 a.m. during the equinox, provided no cloud cover is present.

Shading may affect eelgrass and macroalgae plant densities (Whatcom County, 1992). The intertidal and subtidal vegetated zone extends from about 0 feet MLLW to about -25 feet MLLW in the Cherry Point area (Whatcom County, 1992). Vegetation begins about 300 feet seaward of 8.8 feet MLLW, or at roughly 0 feet MLLW near the Arco pier. Based on map interpretation (USGS 7.5 minute quadrangle Lummi Bay, Wash.), -25 feet MLLW occurs approximately 1,400 feet offshore at the Arco pier. The nonvegetated zone observed in the intertidal area near the Arco pier was about 89 feet wide. If the nonvegetated zone near the pier extends westward at roughly the same width, the intertidal and subtidal area devoid of macroflora is approximately 98,000 square feet or 2.2 acres. The extent of the nonvegetated zone in the nearshore intertidal area south of the pier corresponds somewhat to the area shaded during the late afternoon of September 21, 1992. It is not unreasonable to assume that the nonvegetated zone south and north of the pier could be, at least in part, a result of shading effects.

These observations of shading effects correspond to observations made by Washington Department of Fisheries staff during a 1989 study assessing the effects of shading on eelgrass at the Shell Oil Pier at March Point near Anacortes, Washington (Penttila and Doty, 1990). This pier is oriented south to north, as opposed to the Arco pier's mostly east-to-west orientation. These researchers observed an absence of eelgrass directly underneath the pier and diminished plant densities "outward in both directions some distance from the edge of the directly shaded transect beneath [the pier]." The areal extent of the absence of vegetation in the vicinity of the Shell Oil Pier was not mentioned. Vegetation was observed at 45 feet east and west of the pier. No observations were documented between the centerline under the pier and the sampling points 45 feet in either direction. The diminished plant densities were attributed to "partial shading of adjacent areas during mornings and afternoons" (Penttila and Doty, 1990).

The effects on marine vegetation of a new pier in the Cherry Point area could be similar to those observed at the Arco pier, but would depend on a number of factors. These factors include the height of the trestle and its orientation, bathymetry of the site, as well as the type and stability of substrate under the trestle.

Based on the dive survey results from the report entitled "Cherry Point Natural Resources Baseline Studies Macroalgae and Eelgrass Investigation" (Shapiro and Associates, 1994), the total observed vegetative zone occurred between +3.2 and -21.6 feet MLLW. The dive survey covered an area 85 feet wide (as recommended by WDF) by 600 feet in length. The average percent cover for each transect ranged from 38.8% to 50.3%. The total area average cover was 44.9%, or 22,899 square feet. The foot print of the proposed trestle covering the total vegetative zone is approximately 500 feet by 50 feet, and Transects D-4 to D-7 were surveyed within this area. The average cover observed for these transects combined was 41.8%. This would represent an area of 10,450 square feet of vegetative cover, or 0.24 acre.

The marine macrovegetation and epibenthic communities supports marine animals such as herring, crab, juvenile salmonids, marine fish, and invertebrates upon which they feed. These marine animals are an important component of the local economy. Loss of macroalgae in the marine environment near Cherry Point could reduce the ability of this area to support important marine fisheries. The policies of Washington Departments of Fisheries and Natural Resources are to incur no net loss of habitat. To mitigate any loss, current policy would require an applicant to replace in the vicinity (within the Point Whitehorn to Sandy Point area) in kind vegetation upon which it has been demonstrated that herring would spawn within the range of pre-project levels. Mitigation measures could include establishment of marine vegetation in areas currently not vegetated, use artificial daytime lighting, and use of grating in the trestle.

While it would be difficult to measure a net loss of marine algae with statistical precision (due to the natural variability discussed above), a net loss may be assumed if marine vegetation present in the predicted shadow zone of a proposed pier trestle disappears after the trestle is constructed. Protocols to determine if a net loss of habitat occurs, as well as practical time frames for standards of success would need to be developed in collaboration with state agencies

5. LITERATURE CITED

Penttila, D. and D. Doty, 1990. *Results of 1989 Eelgrass Shading Studies in Puget Sound.* Washington Department of Fisheries, Marine Fish Habitat Investigations Division. August 1990.

Shapiro and Associates, Inc., 1994. *Cherry Point Natural Resources Baseline Studies Macroalgae and Eelgrass Investigation.* January 1994.

Whatcom County, 1992. *Draft Environmental Impact Statement Cherry Point Industrial Park.* Whatcom County Department of Public Works. November 1992.

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

SURFACE WATER HYDROLOGY STUDY

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1. INTRODUCTION

A surface hydrology assessment was conducted as part of the baseline studies for the proposed Pacific International Terminals' Gateway Pacific Terminal Project (GPT) bulk loading facility at Cherry Point. The main components of the assessment included a precipitation analysis and a stream flow monitoring program conducted during the winter and spring of 1992-93. A runoff generation map for the site was also produced. The following includes a description of research methods used for this assessment and a discussion of the study results.

2. SITE HYDROLOGY

Most of the 1,197-acre site is located on fairly flat coastal terrace ranging in elevation from 100 to 220 feet above sea level. Thirty-foot-high bluffs are found along the coast in the southwest corner of the site. Ravines with side slopes of up to 40% have been formed by two streams as they cut through the terrace near the coast.

The site contains four subbasins, which are shown in Figure 1. Subbasin 1, located in the northwest corner of the site, drains to the northwest. Subbasin 2, which encompasses the southwest portion of the site, drains south and west to the Strait of Georgia. Subbasin 3, which includes the southern and easternmost portions of the site, drains to a stream that flows southwestward to the Strait of Georgia. Because this stream has no tributaries, it is considered a first-order stream. This stream is unnamed but is cataloged in *A Catalog of Washington Streams and Salmon Utilization* (Williams, et al., 1975) as Washington Resource Inventory Area (WRIA) Stream 01.0101. Except for its lowermost reach, Stream 01.0101 lies outside the project boundary.

Sixty-two percent of the site lies within Subbasin 4, which drains to a first-order stream that flows southward into the strait. This stream is unnamed but is cataloged as WRIA Stream 01.0100 (Williams, et al., 1975). The surface hydrology assessment focused on surface flows within this stream.

Stream 01.0100 is about 1.25 miles long and drains an estimated 800 acres. About 90% of the stream basin lies within the site boundary. The stream originates on the relatively flat terrace in the northeast portion of the site and flows westward for a short distance. After turning southward, the stream flows through a fairly steep-sided ravine down to the Strait of Georgia. The stream enters the strait about 5.5 miles north of Lummi Bay and about 3.75 miles south of Birch Bay (Figure 1).

3. PRECIPITATION ANALYSIS

Precipitation data were obtained from the National Climatic Data Center for climatological observation stations at Bellingham and Blaine, Washington. The Bellingham station is located at Bellingham International Airport, approximately 11 miles southeast of the site. The observation station at Blaine is located about 9 miles north of the site.

Daily precipitation data from these two stations were obtained for the period from December 1992 to May 1993. Because the site is located roughly between the two stations, it was assumed that precipitation at the site would be represented best by the mean of the daily-precipitation values from the two stations. For the rare instances when snowfall was recorded, snowfall depth was converted to rainfall depth by using the assumption that 1 inch of snow is equivalent to 0.10 inch of rain. A plot of the mean daily precipitation values for the study period is shown in Figure 2.

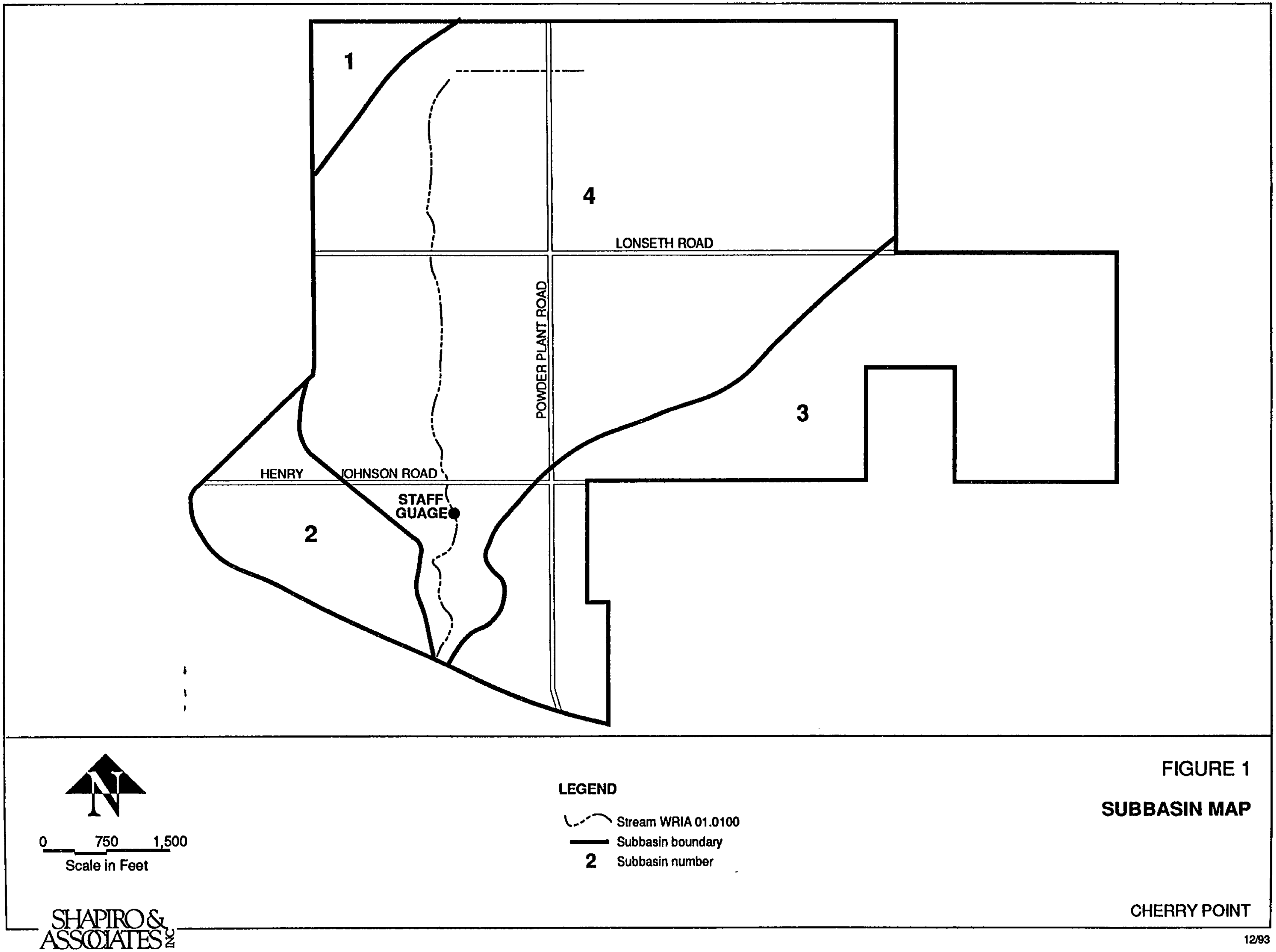

FIGURE 1

SUBBASIN MAP

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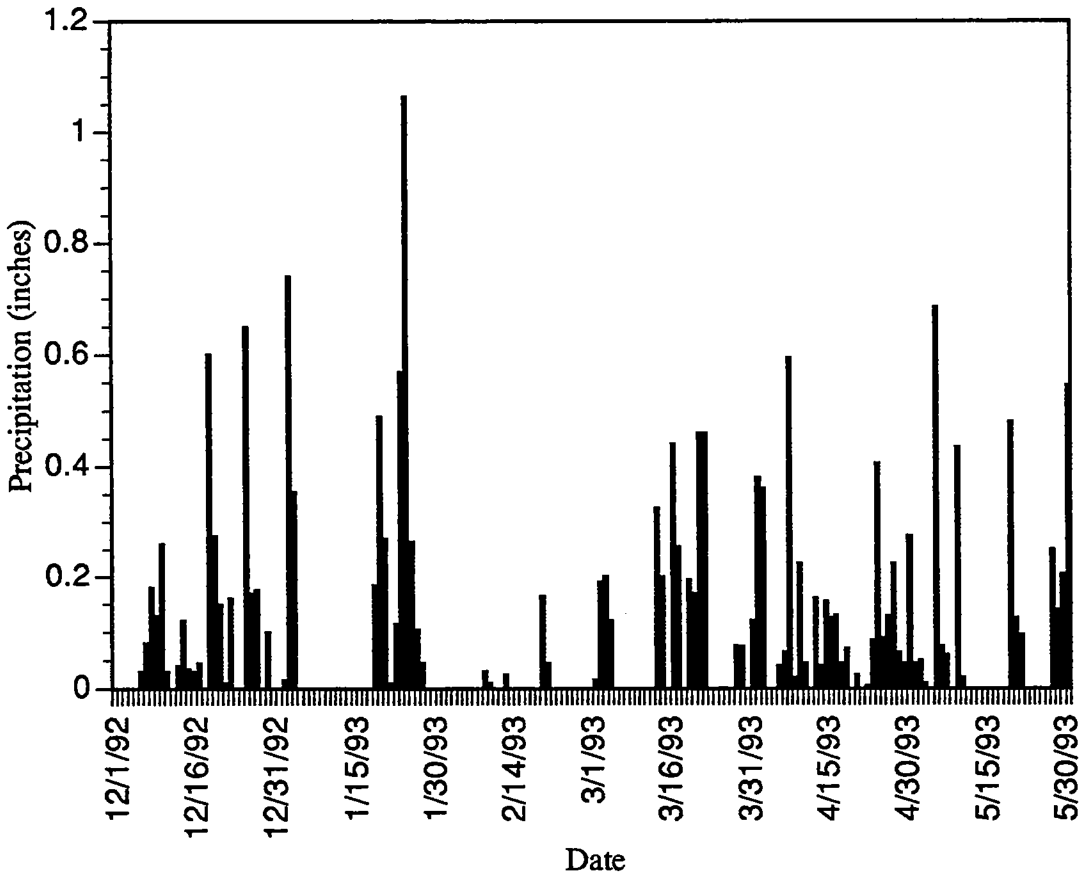

FIGURE 2

DAILY PRECIPITATION IN THE PROJECT VICINITY

CHERRY POINT

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8/93

Average daily precipitation was 0.10 inch during the study period. Based on 43 years of rainfall data from the Bellingham and Blaine stations, average daily precipitation for December through May is typically 0.12 inch (Hydrosphere, Inc., 1992). A total of 18.10 inches of precipitation fell during the study period. The average precipitation total for December through May is 22.57 inches, according to the 43-year rainfall record (Hydrosphere, Inc., 1992). Precipitation was evenly distributed over this period. From December through February, daily precipitation averaged 0.09 inch. From March through May, the average daily precipitation was 0.11 inch. The largest rainfall event was 1.07 inch on January 25, 1993.

Measurable amounts of rain fell on 93 out of 184 days during the period reviewed. For the most part, intervals of both dry and wet days were relatively short. Forty-five percent of the wet periods were two to three days long, while 62 percent of the dry periods lasted only one to two days. The longest dry period was in mid-January and lasted 14 days. The longest rainy period, which occurred at the end of April and beginning of May, was 12 days long. An analysis of the precipitation record with respect to observed flows in Stream 01.0100 is presented in Section 4.2, Results of Stream Discharge Study.

4. STREAM DISCHARGE STUDY

Surface flows in Stream 01.0100 were monitored from December 1992 to May 1993. Measurements of water surface elevation (stage) and stream flow were used to develop a stage-discharge relationship (rating curve) for the stream. The rating curve is used to estimate stream discharge by using measurements of stream stage. The following section includes a description of the procedures used to collect field data and develop the rating curve. Results of the stream flow monitoring program are discussed in relation to the precipitation record for the site vicinity.

4.1 METHODOLOGY

A staff gauge was installed in Stream 01.0100 on December 10, 1992, near mid-channel at a location 1,800 feet upstream from the stream mouth and 450 feet downstream from the Henry Johnson Road crossing (Figure 1). The staff gauge was placed at this point along the stream for several reasons. The section of stream immediately upstream and downstream from the gauge is straight and has a generally uniform slope. Because the gauging site is located close to the mouth of the stream, flow measurements taken there include discharges from most of the stream's basin. Lastly, access to the control section is easy because of its proximity to Henry Johnson Road.

The only limitation to using this stream section as a gauging site is the unstable nature of the streambed, which consists of sand and small gravel. Over time, the geometry of the section may change because of scouring or deposition. When and if this occurs, the rating curve must be adjusted to account for changes in the stage-discharge relationship. Because substrate conditions are similar along most of the lower portion of the stream, this site was determined to be a suitable gauging site. Photos of the gauging site are located in Appendix A.

The staff gauge was attached to a metal fence post, which was driven several feet into the streambed near mid-stream. The "0.00" mark on the gauge was aligned with the surface of the streambed.

Staff gauge readings were taken regularly from December 10, 1992, to May 30, 1993. In all, 23 measurements were taken over this period. On two occasions, readings were taken when the stream was partially frozen. Data collected on these days were not used in this analysis.

Sediment deposition occurred at the gauging site in mid-February. By February 17, 0.3 foot of sand and small gravel had built up at the staff gauge. The sediment remained stable throughout the remainder of the study period. Because deposition appeared to be uniform across the gauging site, staff gauge readings taken after February 3 were adjusted simply by subtracting 0.3 foot from the water surface level observed at the gauge.

In order to gather data on stream discharge, a transect was established on March 11, 1993, across the stream channel immediately upstream from the staff gauge. Measurements of water velocity and water depth taken along this transect were used to establish a stage-discharge relationship for the stream. Two rebar stakes were driven into the ground to serve as head pin and tail pin for the transect. The stakes were placed on the side slopes of the channel above the ordinary high water mark for the stream. The head pin was placed on the left side of the channel and the tail pin on the right side. In this report, the designations "left side" and "right side" of a stream channel are made while looking downstream.

A cord was stretched between the two pins and leveled by using a bubble level suspended on the cord. This cord served as a datum from which water surface and streambed elevations were measured. The location of the cord was marked on the pins so that the cord could be placed at the same position each time elevation measurements were taken. A tape measure was extended from the head pin to the tail pin directly above the transect cord. The distance from the cord to the ground surface was measured with a leveling rod. Measurements were taken along the transect at 1-foot intervals outside the stream and at 0.5-foot intervals inside the stream. A cross sectional profile of the transect is shown in Figure 3. The length of the transect is 72.5 feet. The bankfull depth of the stream is 2.19 feet at the deepest point along the transect.

Water velocity and water surface and streambed elevation measurements were taken along the transect on six occasions between March 11 and April 28, 1993. On each occasion, the cord and tape measure were placed in the same position, stretched between the head pin and tail pin. The position of the left and right edges of the stream were recorded, as was the distance from the cord to water surface at these points. The distance from the cord to the streambed was measured at 0.5-foot intervals between the left and right edges of the stream beginning at the half-foot increment on the measuring tape nearest the left edge of the stream. These data were used to calculate the cross sectional area of the stream at the transect. Cross sectional profiles of the stream are presented in Appendix B for each sampling date.

Water velocity was measured along the transect at the same points that streambed elevation measurements were taken. Water velocity was measured by using a Swoffer Instruments Model 2100-14 current velocity meter. At each measurement station the meter was positioned above the streambed at a distance of six-tenths the depth of the stream at that point. The meter readout was set to display the average velocity measured over a 90-second interval.

To calculate discharge at the transect, the stream cross section was partitioned into two-dimensional cells, one for each measurement station within the stream. Cell widths corresponded to the transect sections, extending from a given station to a point half the distance to the two adjacent stations. For the stations adjacent to each edge of the stream, the cell widths extended to the water's edge. Cell depths were assumed to be equal to the depth of water at the station. The area of each cell was calculated as the product of the cell width and depth. Discharge for each cell was calculated by multiplying the cell area by the water velocity at the station. The total stream discharge across the transect was determined by summing the discharges for the individual cells.

4.2 RESULTS OF STREAM DISCHARGE STUDY

Stream stage measurements are shown in Table 1. As discussed previously, the readings taken after February 3 have been adjusted to account for deposition at the staff gauge. Stream stage measurements ranged from 0.14 foot to 1.58 foot. The median stage was 0.68 foot. In general,

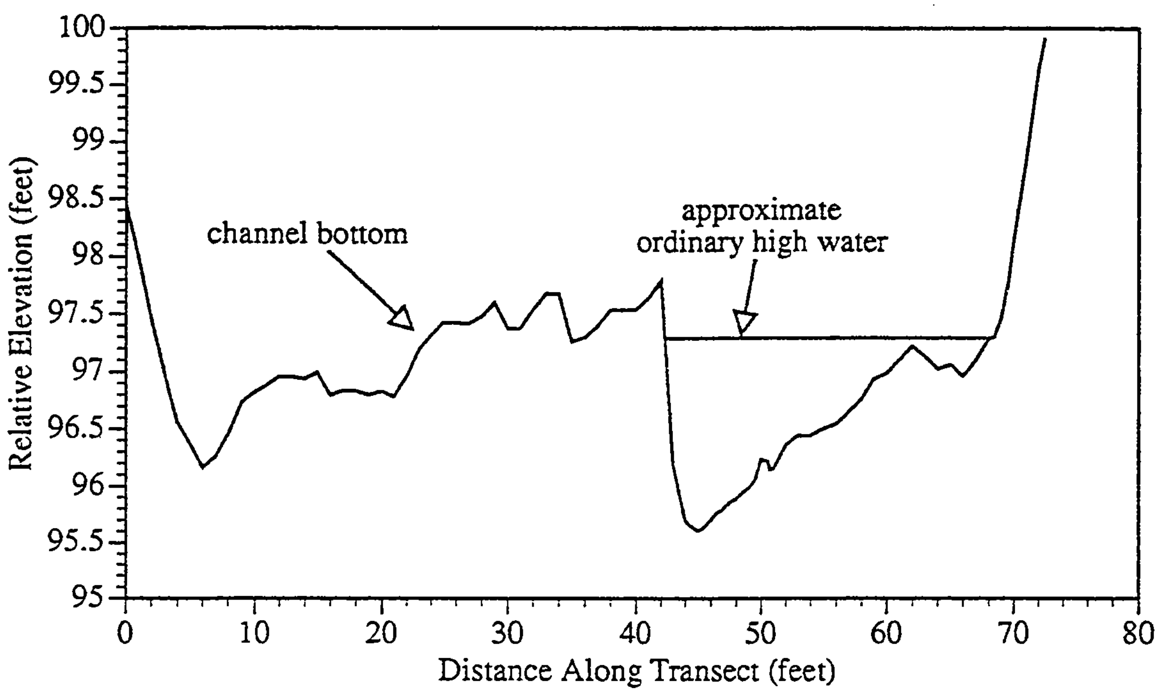

FIGURE 3

CHERRY POINT STREAM NO. WRIA 01.0100
CHANNEL CROSS SECTION

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higher stages were observed during December and January. The stage mean for these months was 1.43 foot. For the period from February to May, the stage mean was 0.43 foot.

Discharge measurement results are presented in Table 1 and in Appendix C. Discharges from 0.76 cubic feet per second (cfs) to 14.02 cfs were observed. The median discharge was 2.62 cfs. Stream stages corresponding to the measured discharges ranged from 0.24 foot to 1.38 foot. This range constitutes 80% of the range of stages observed during the study period.

Table 1: RESULTS OF STAGE AND DISCHARGE MONITORING AND ESTIMATED DISCHARGES FOR STREAM 01.0100

Date	Stage (feet)	Measured Discharge (cfs)	Estimated Discharge (cfs)
12/10/92	0.90		7.88
12/16/92	0.77		6.37
12/17/92	0.90		7.88
12/22/92	1.50		15.79
1/6/93	0.78		6.48
1/21/93	1.58		16.95
1/27/93	1.55		16.52
1/28/93	1.39		14.24
2/2/93	0.48		3.35
2/3/93	0.75		6.15
2/17/93	0.18		0.88
2/19/93	0.14		0.63
3/5/93	0.60		4.54
3/11/93	0.24	0.76	1.30
3/16/93	0.29	2.45	1.69
3/23/93	1.38	14.02	14.10
3/26/93	0.35		2.18
4/2/93	0.26	1.71	1.45
4/16/93	0.68	4.71	5.38
4/28/93	0.38	2.80	2.44
5/30/93	0.24		1.30

The measured discharges and corresponding stage data were used to develop a rating curve for the stream. A rating equation was produced by performing a linear regression using the base 10 logarithms of the stage and discharge values. The resulting regression equation has a coefficient of variation (r^2) of 0.90. The rating curve is presented in Figure 4 as a log-log plot of discharge versus stage. The rating curve has been extrapolated to include the entire range of stages observed in the study. Extension of the rating curve is within limits suggested by Hammer and MacKichan (1981).

Using the rating curve, discharges were estimated for all stages observed during the study period. Discharge estimates are presented in Table 1 and are shown graphically in Figure 5. Values ranged from a low of 0.63 cfs for February 19 to a high of 16.95 cfs for January 21. The median estimated discharge was 2.44 cfs.

A comparison of the plots of daily precipitation data (Figure 2) and discharge estimates for Stream 01.0100 (Figure 6) shows the highest flow events, measured in December and January,

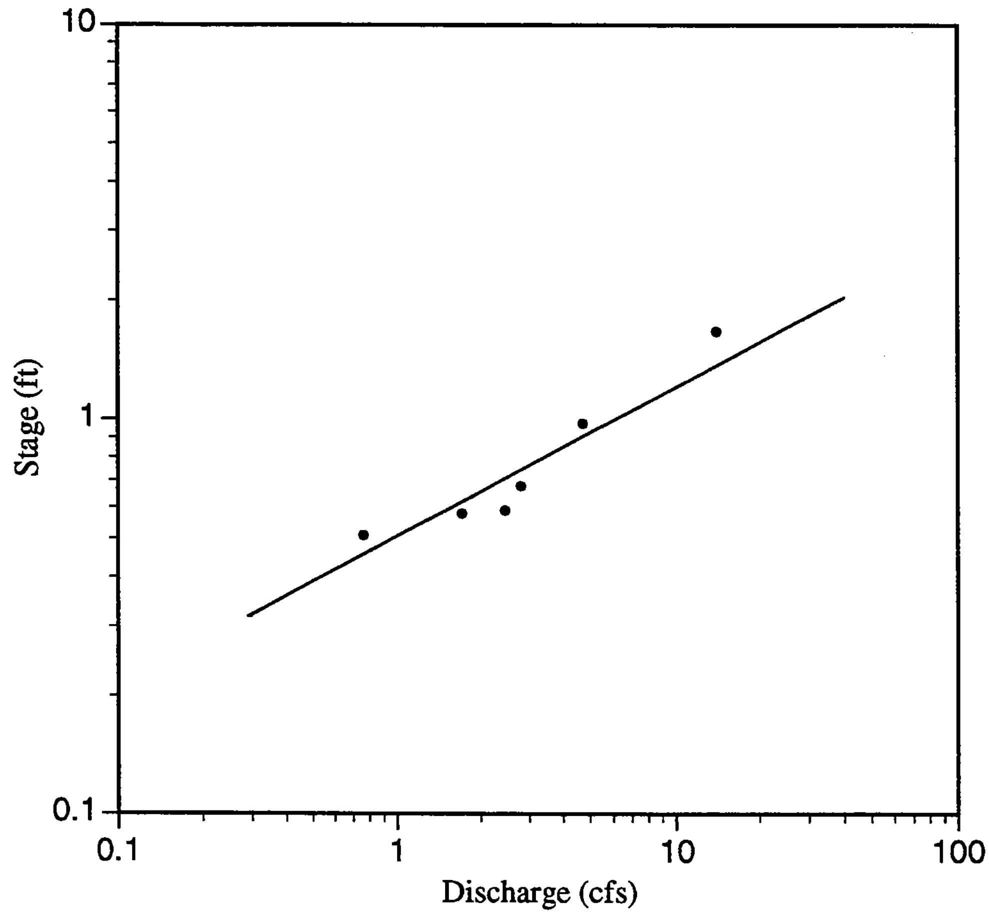

FIGURE 4

RATING CURVE FOR STREAM NO. WRIA 01.0100

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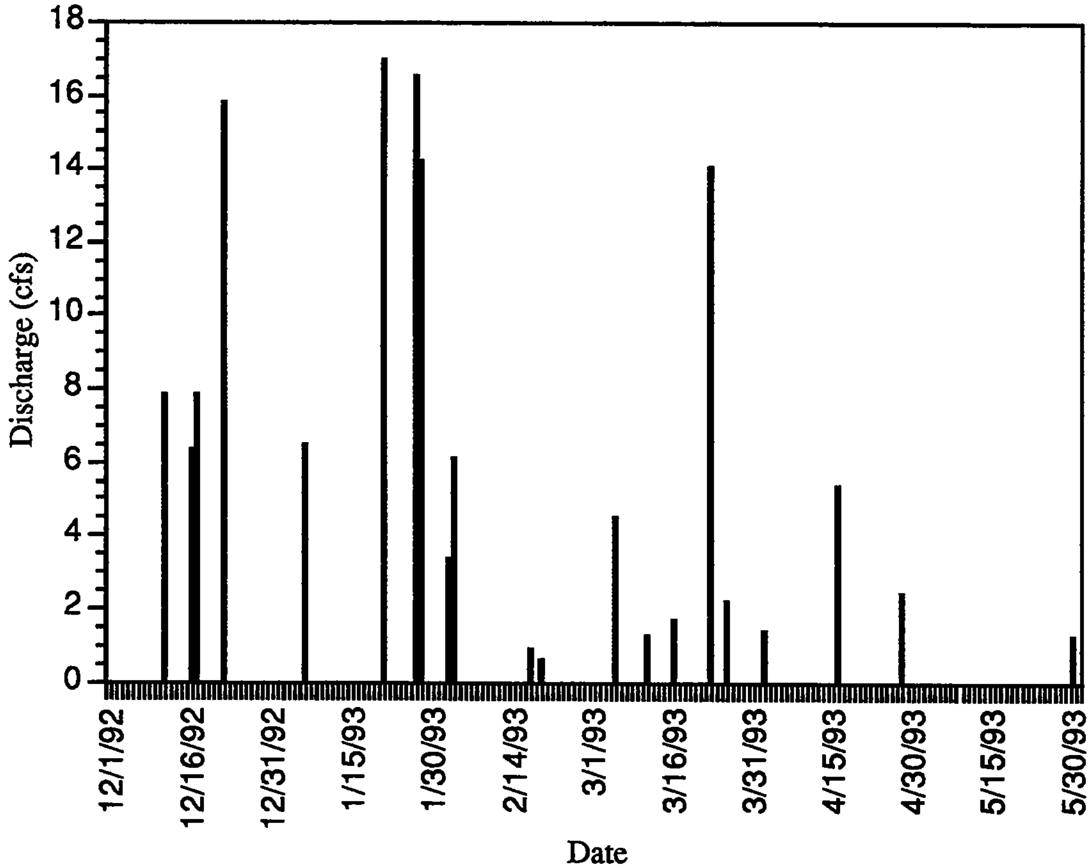

FIGURE 5

STREAM NO. WRIA 01.0100
DISCHARGE

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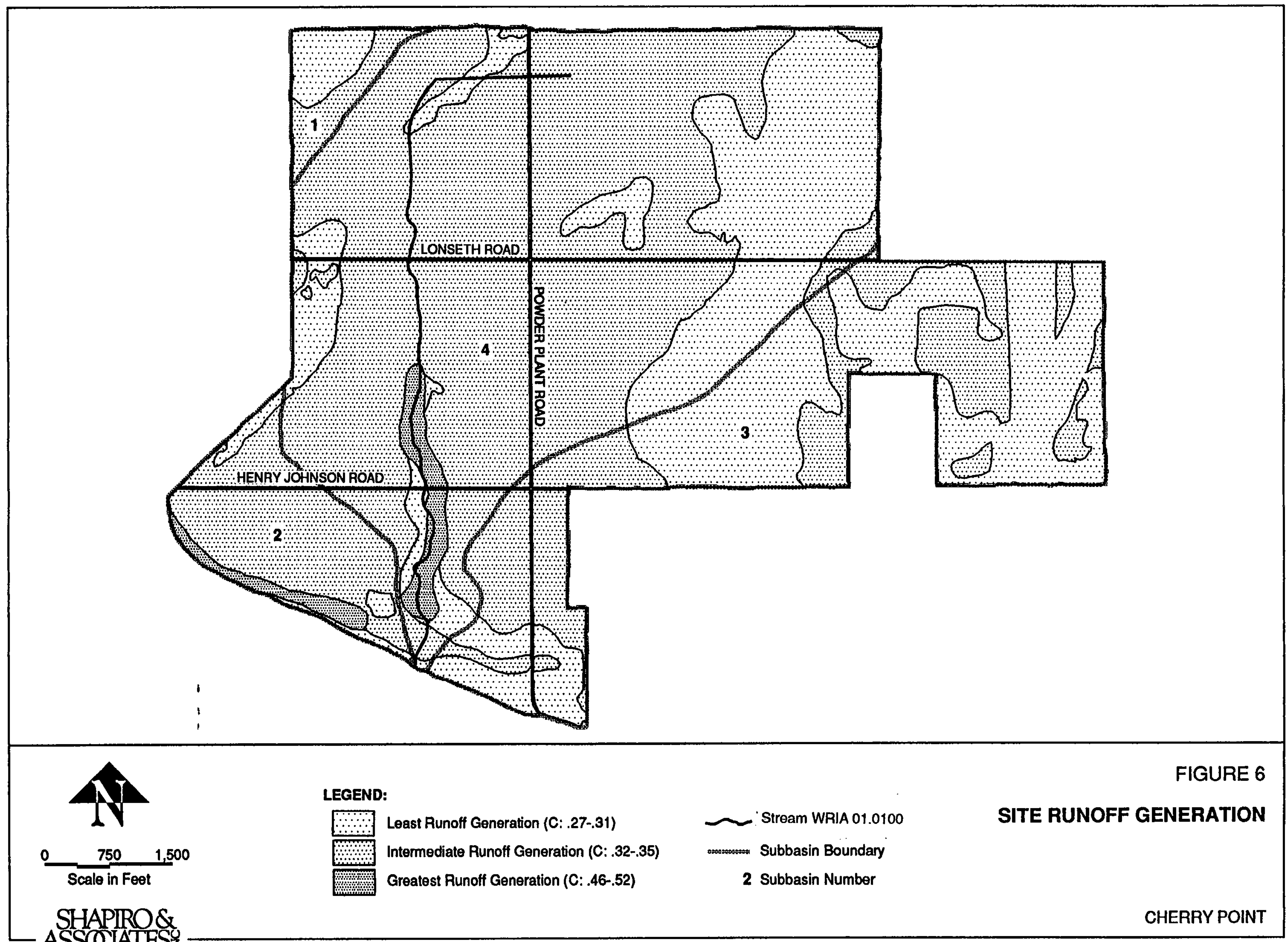

FIGURE 6

SITE RUNOFF GENERATION

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correspond to periods of relatively high precipitation. The lowest recorded flows, which occurred in mid-February, correspond with a period when little precipitation was recorded. Stream flows measured in the last half of the study period are somewhat lower than in earlier months, even though precipitation was fairly constant over the study period. This pattern is most likely the result of increased plant growth during the late winter and spring. As plants "leaf out," rainfall interception, retention, and evapotranspiration by vegetation increase substantially, resulting in relatively lower amounts of runoff reaching the stream.

Mean annual discharge for Stream 01.0100 was estimated using data from isoplethic maps of mean annual runoff presented in the *Columbia-North Pacific Region Comprehensive Framework Study* (Pacific Northwest River Basins Commission, 1971). The runoff map that covers the project site indicates that mean annual runoff in this area is 16 inches. Mean annual discharge for Stream 01.0100 was calculated by applying this mean annual runoff value over the 800-acre stream basin. Based on 16 inches of average annual runoff, the mean annual discharge for Stream 01.0100 is 1.2 cfs.

5. RUNOFF GENERATION MAP

A runoff generation map was developed by evaluating specific characteristics of the site, including slope, vegetative cover, soil type, and drainage conditions. Data sources included aerial photographs, soil surveys, topographic maps, wetland survey results, and observations by field personnel. The *Erosion and Sediment Control Handbook* (Amimoto 1981) presents a method for calculating the runoff coefficient "C" based on the characteristics listed above. The runoff coefficient, a number between 0 and 1, represents the portion of precipitation that immediately becomes surface runoff. The runoff coefficient is a useful means of comparing runoff generation among different portions of a site. For instance a level, heavily vegetated area with well drained soils or marshes and ponds would be assigned a low "C" value (0.25 - 0.31) because much of the rain falling on this area would be taken up by plants, absorbed by the soil, or detained in ponds or marshes. On the other hand, an area that contains many impervious surfaces such as roads, roofs, and sidewalks would receive a high "C" value (0.85-0.90) because much of the rain falling onto these surfaces would quickly be converted to runoff.

Runoff coefficients were assigned to discrete areas across the site. Runoff coefficient values were then grouped to form three categories to represent the degree of runoff generation from undeveloped portions of the site. Impervious road surfaces were included as a separate mapping category. The resulting runoff generation map is shown in Figure 6. Most of the western two-thirds of the site is contained in the "least runoff generation" category. Areas with "intermediate runoff generation" are located primarily in the eastern portion of the site and in isolated pockets elsewhere. The coastal bluffs and steep-sided ravine of Stream 01.0100 are included in the "greatest runoff generation" category.

6. SUMMARY

This study was conducted to assess surface hydrology on the site of the proposed GPT facility at Cherry Point and, in particular, to collect flow data for Stream 01.0100. Flow in Stream 01.0100 was monitored periodically from December 1992 through May 1993. Observations of stream flow were analyzed and compared to the precipitation record for this period. Runoff generation on the site was evaluated, and a map of runoff generation zones was produced.

Daily precipitation averaged 0.10 inch and ranged from 0.00 inch to 1.07 inch. Precipitation was evenly distributed over the study period. Flows observed in Stream 01.0100, however, were somewhat larger during the earlier part of the study period. Observed flows ranged from 0.76

cubic feet per second (cfs) to 14.02 cfs. The median flow was 2.62 cfs. Mean annual discharge for Stream 01.0100 is estimated to be 1.2 cfs. The map of runoff generation zones indicates that approximately half of the precipitation that falls on areas with steep slopes, such as the stream ravine and coastal bluffs, becomes runoff. About one-third of the precipitation becomes runoff in more level upland areas.

7. LITERATURE CITED

Amimoto, Perry, Y. 1981. *Erosion and Sediment Control Handbook.* California Department of Conservation, Division of Mines and Geology. Sacramento, California.

Hammer, Mark J., and Kenneth A. MacKichan, 1981. *Hydrology and Quality of Water Resources.* John Wiley and Sons, New York.

Hydrosphere, Inc., 1992. CD-ROM data base: "Climatedata CD-ROM Advanced with Flags." Boulder, Colorado.

Pacific Northwest River Basins Commission, 1971. *Columbia-North Pacific Region Comprehensive Framework Study, Appendix V.* Vancouver, Washington.

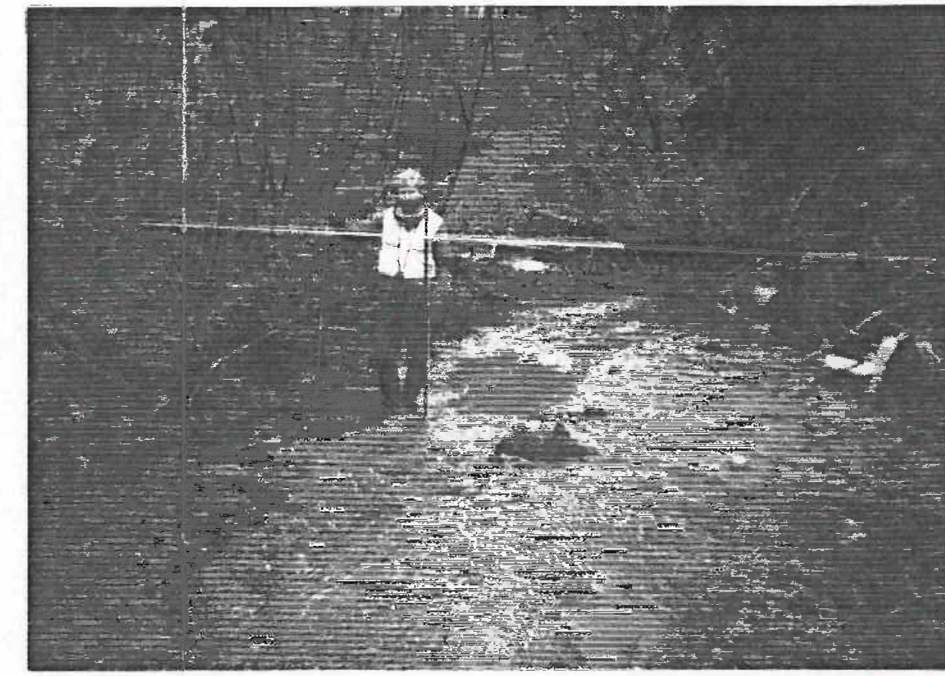
Williams, Walter R., Richard M. Laramie, and James J. Ames, 1975. *A Catalog of Washington Streams and Salmon Utilization, Volume 1 - Puget Sound Region.* Washington Department of Fisheries. Olympia, Washington.

APPENDIX A

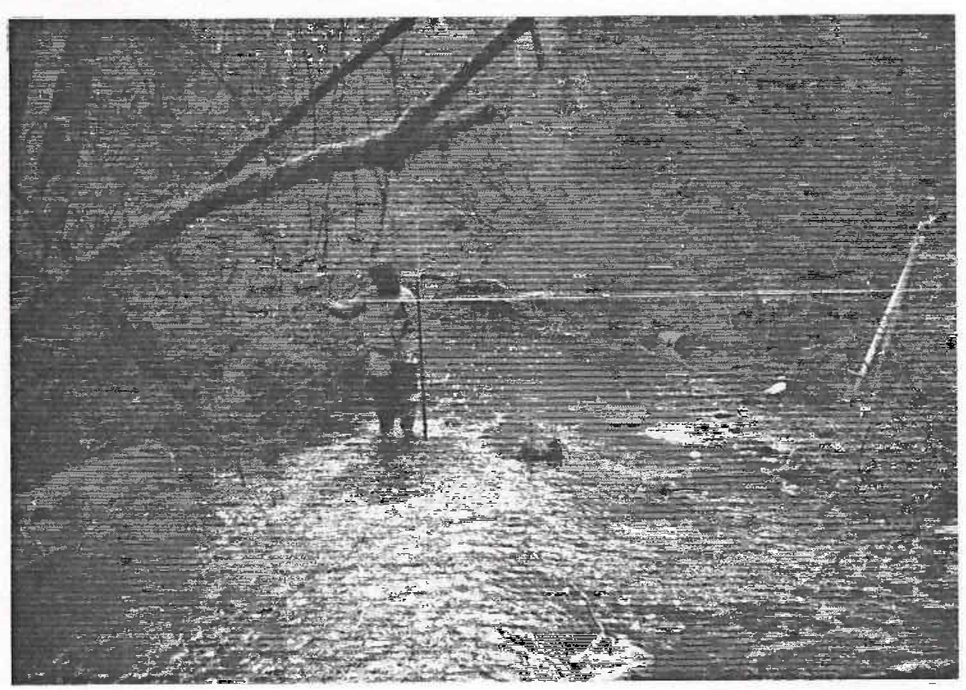
Site Photos

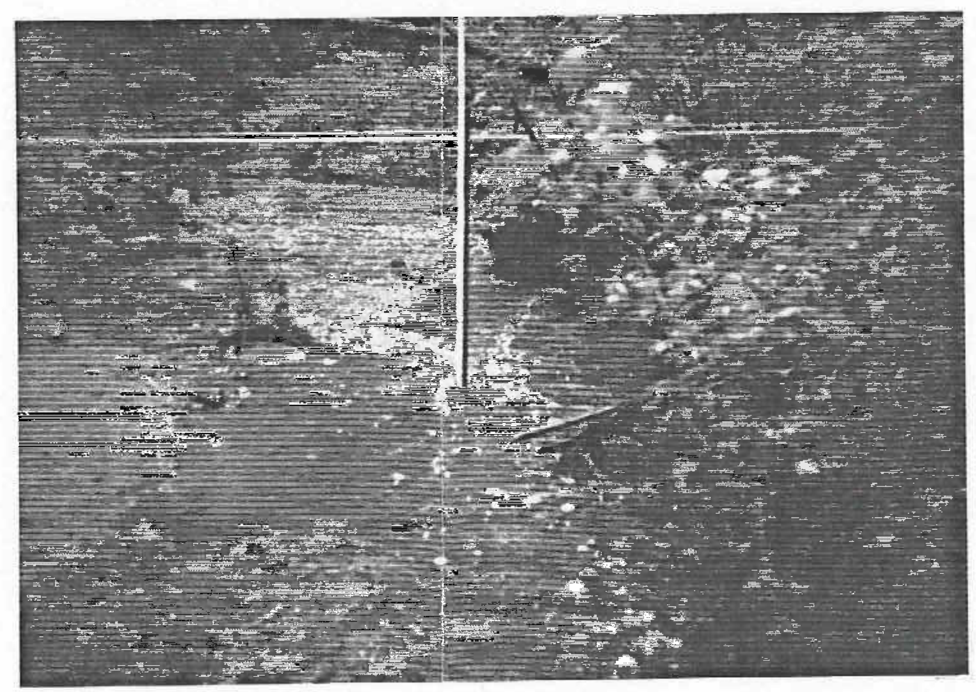

December 10, 1992

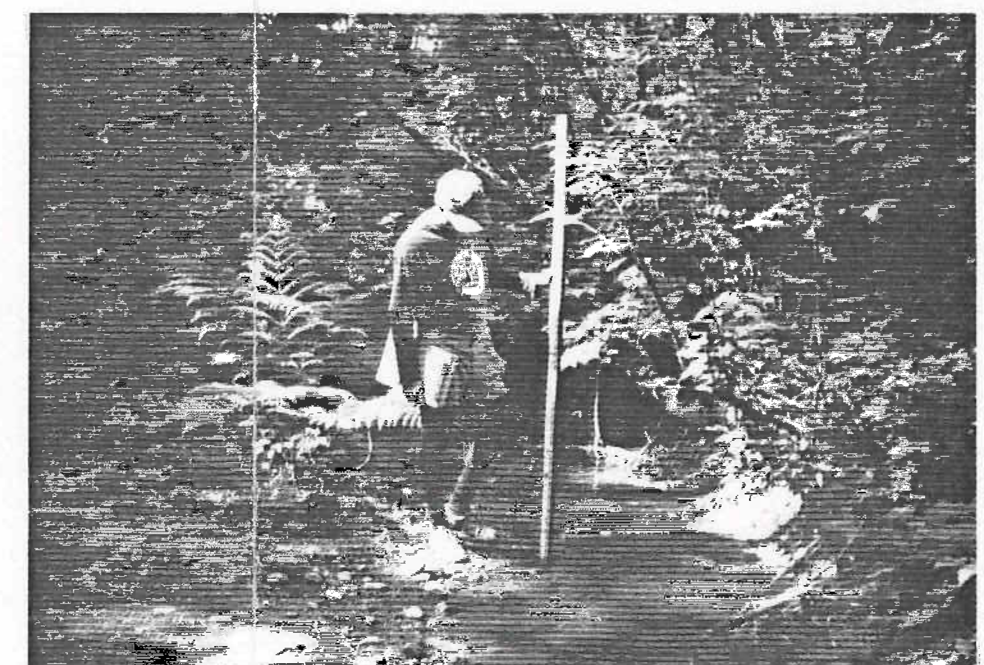

March 23, 1993


April 2, 1993

Stream 01.0100 Gauging Site


April 16, 1993

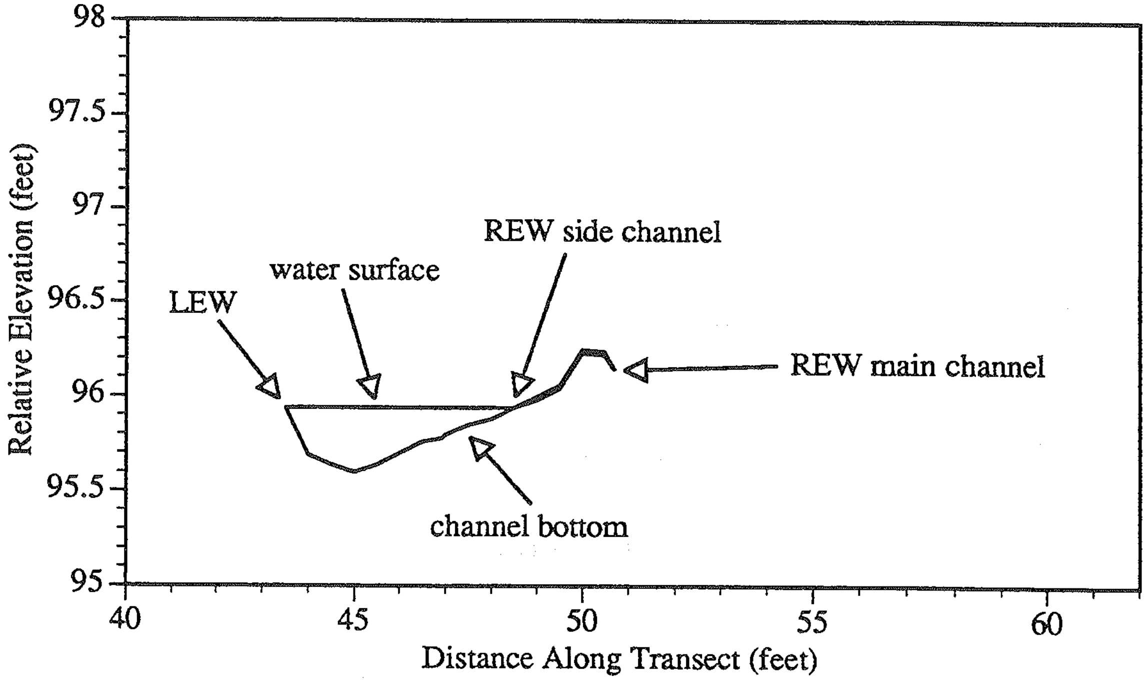

April 28, 1993


May 28, 1993

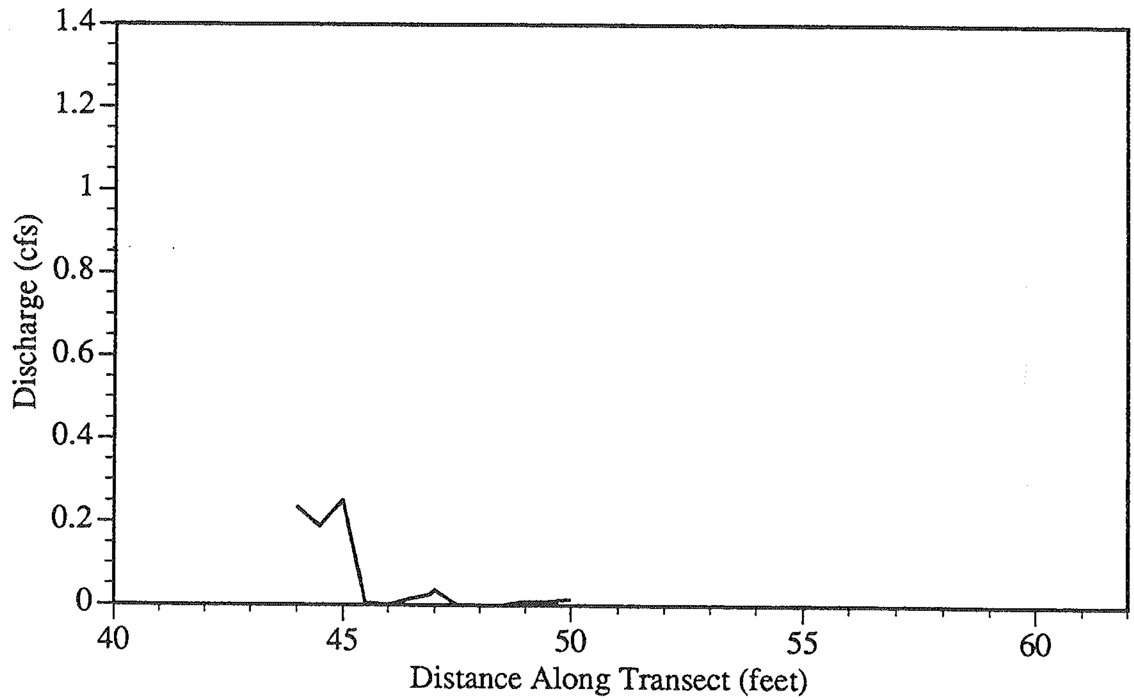
APPENDIX B

Cross Sectional Profiles Of Stream 01.0100 Along Study Transect

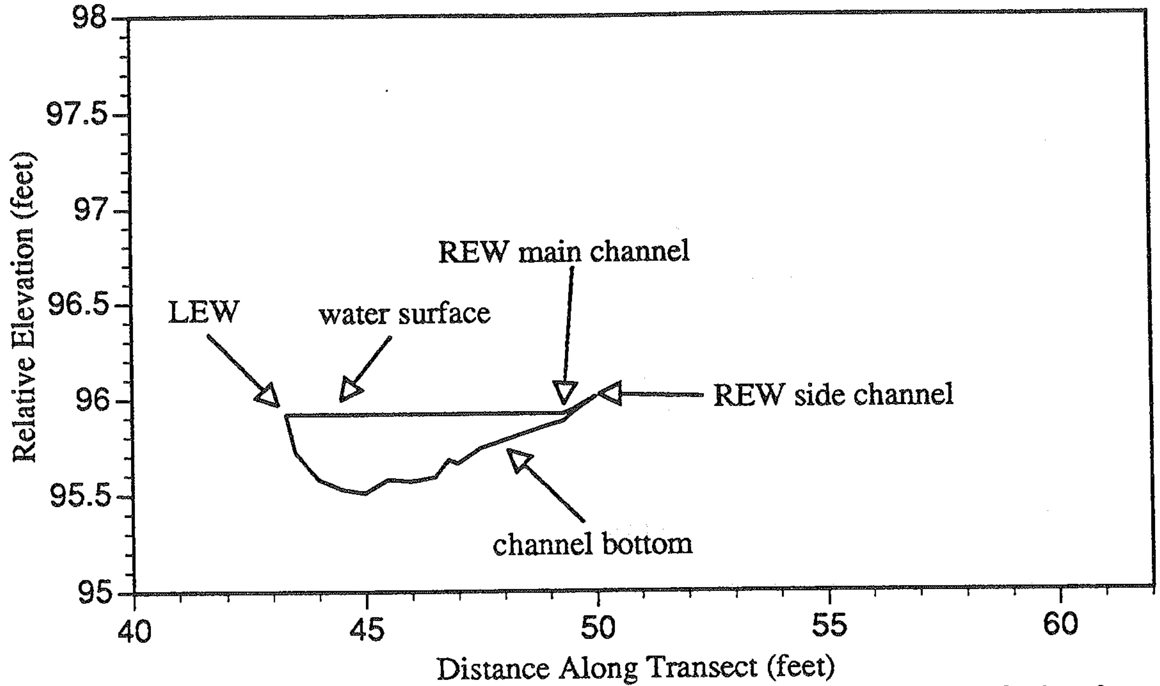
STREAM NO. WRIA 01.0100
DISCHARGE MONITORING DATA
FOR MARCH 11, 1993



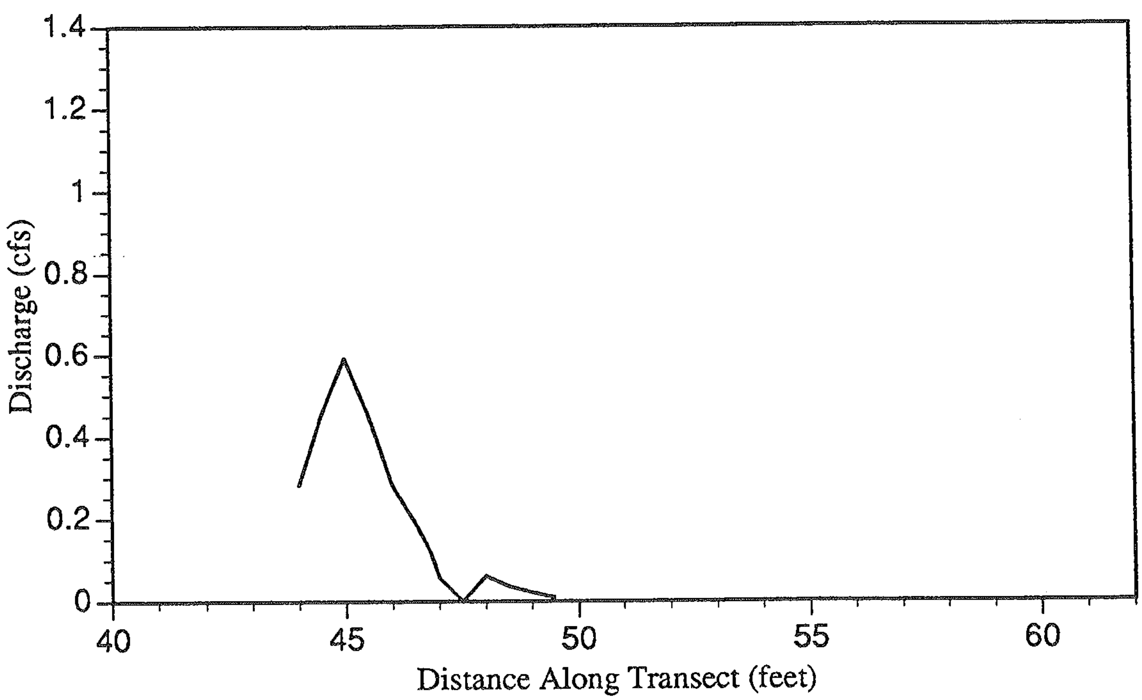
LEW: left edge of water
REW: right edge of water



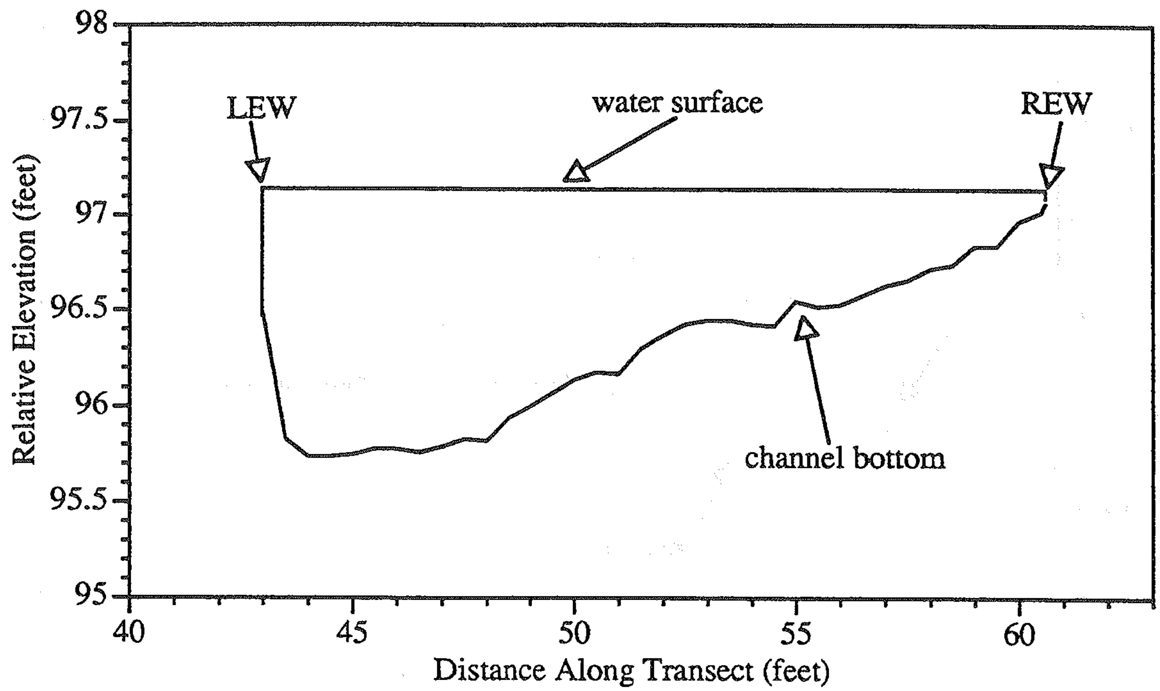
STREAM NO. WRIA 01.0100
DISCHARGE MONITORING DATA
FOR MARCH 16, 1993



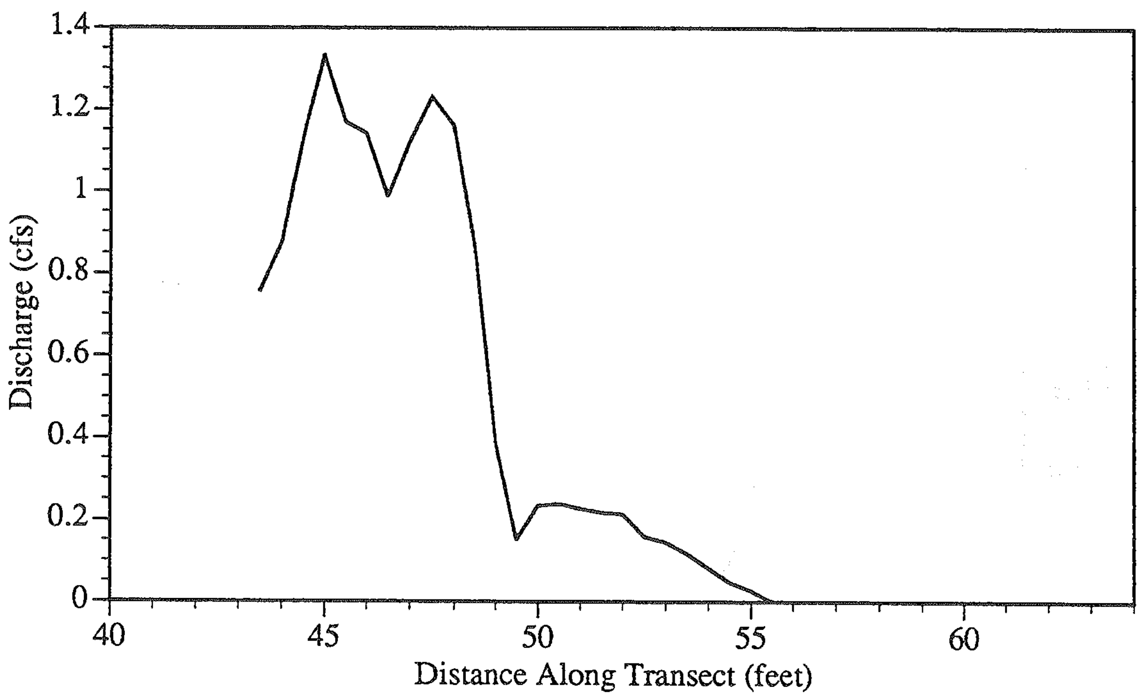
LEW: left edge of water
REW: right edge of water



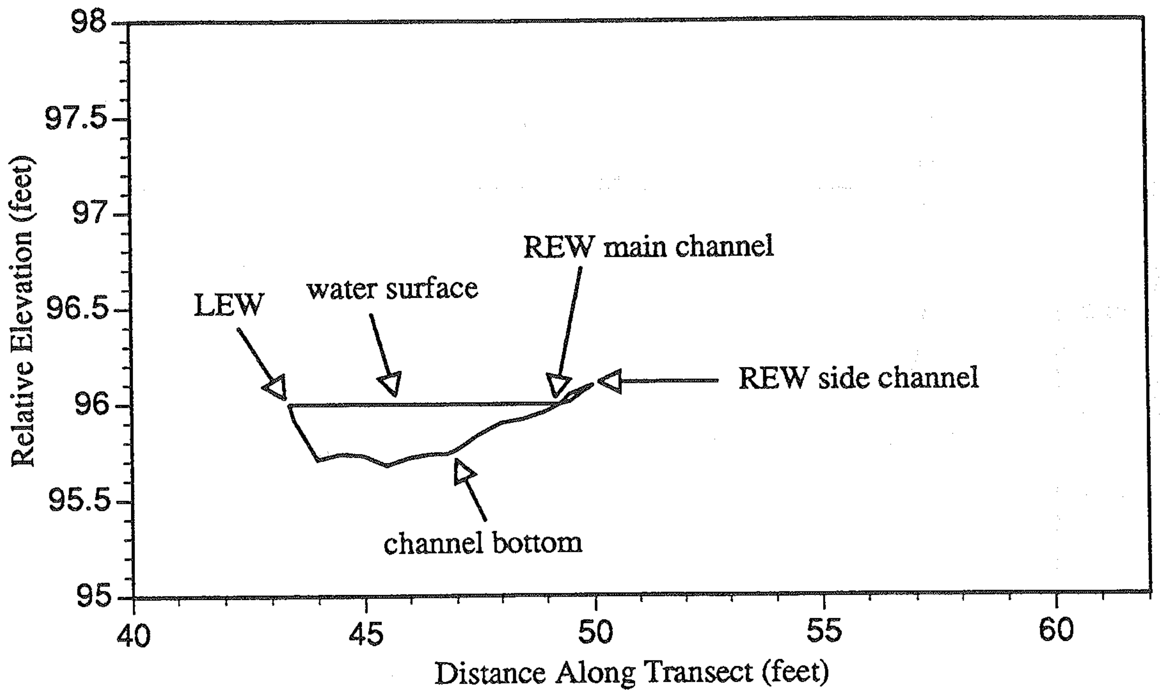
STREAM NO. WRIA 01.0100
DISCHARGE MONITORING DATA
FOR MARCH 23, 1993



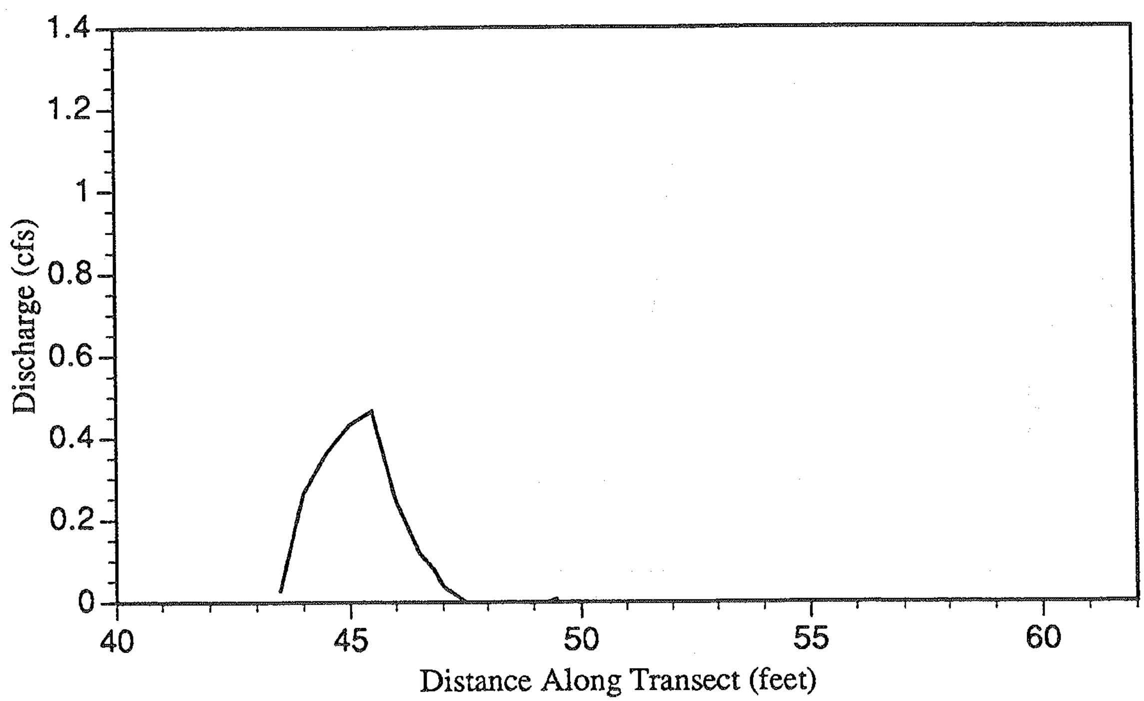
LEW: left edge of water
REW: right edge of water



STREAM NO. WRIA 01.0100
DISCHARGE MONITORING DATA
FOR APRIL 2, 1993



LEW: left edge of water
REW: right edge of water



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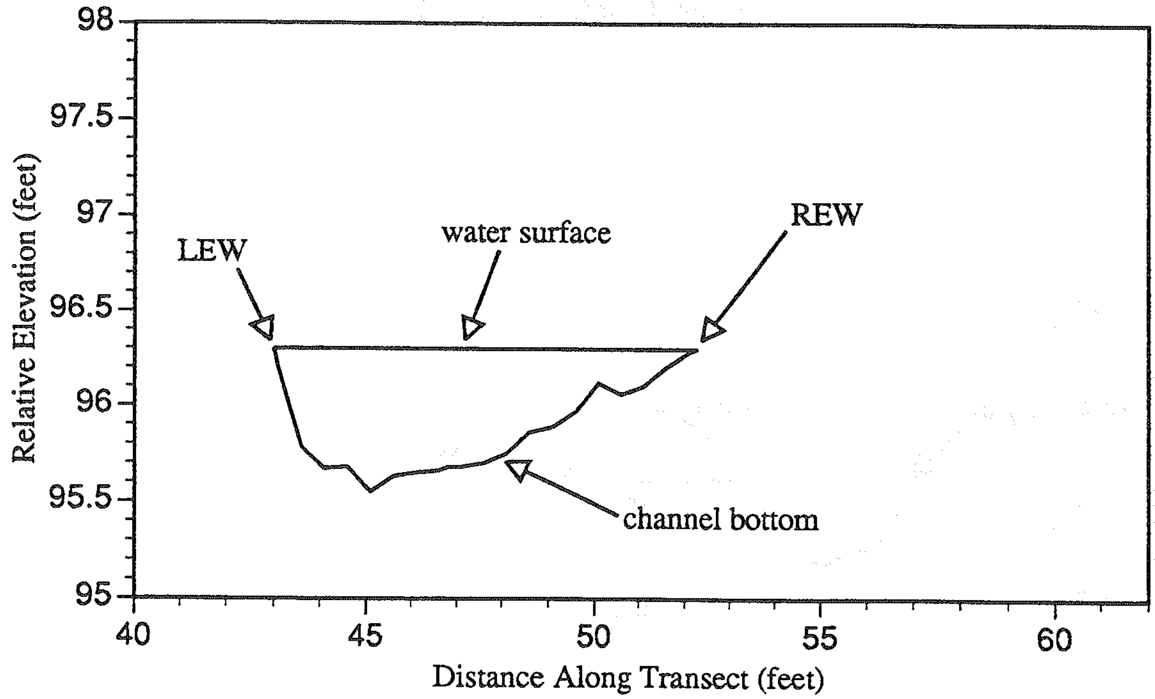
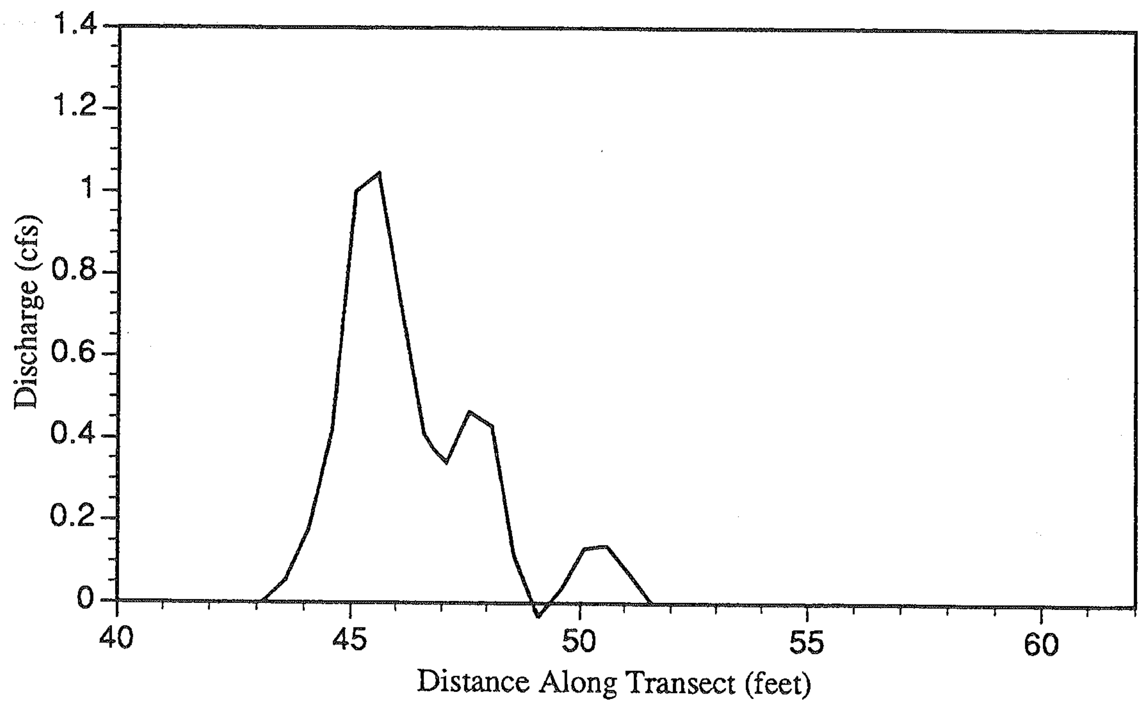
DISCHARGE MONITORING DATA
FOR APRIL 16, 1993

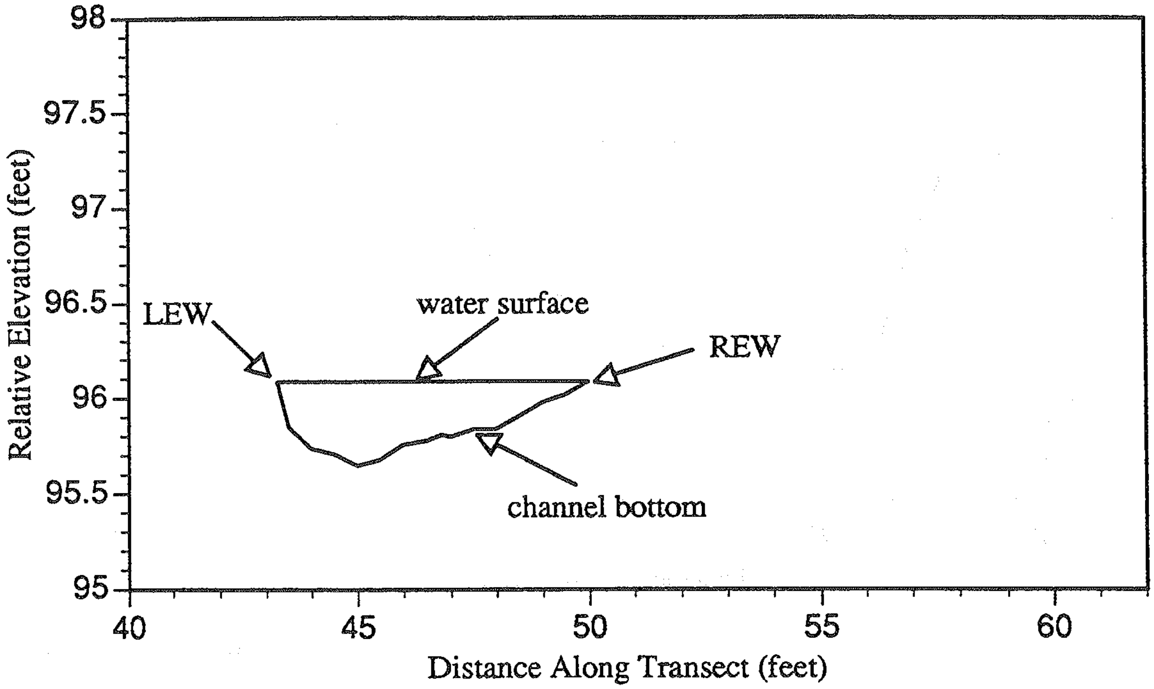


LEW: left edge of water
REW: right edge of water

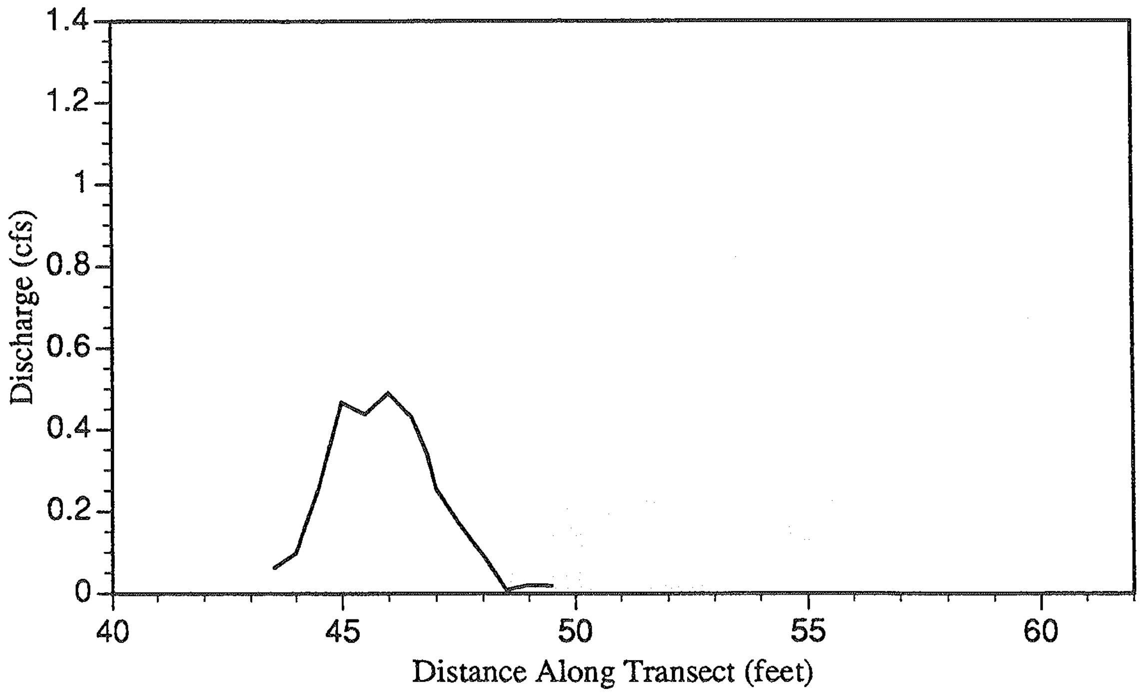


note: negative discharge values represent flow in the upstream directon within an eddy

STREAM NO. WRIA 01.0100
DISCHARGE MONITORING DATA
FOR APRIL 28, 1993



LEW: left edge of water
REW: right edge of water



APPENDIX C

Stream Discharge Data
and Spreadsheet Calculations

Stream Survey Results from March 11, 1993

Note	Station	Transect String to Channel Bottom Distance (feet)	Transect String to Water Surface Distance (feet)	* Relative Channel Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
head pin	0.0	1.54		98.46							
	1.0	2.02		97.98							
	2.0	2.54		97.46							
	3.0	3.02		96.98							
	4.0	3.44		96.56							
	5.0	3.62		96.38							
	6.0	3.84		96.16							
	7.0	3.74		96.26							
	8.0	3.54		96.46							
	9.0	3.27		96.73							
	10.0	3.18		96.82							
	11.0	3.12		96.88							
	12.0	3.04		96.96							
	13.0	3.04		96.96							
	14.0	3.06		96.94							
	15.0	3.00		97.00							
	16.0	3.20		96.80							
	17.0	3.16		96.84							
	18.0	3.16		96.84							
	19.0	3.20		96.80							
	20.0	3.17		96.83							
	21.0	3.22		96.78							
	22.0	3.04		96.96							
	23.0	2.80		97.20							
	24.0	2.68		97.32							
	25.0	2.57		97.43							
	26.0	2.57		97.43							
	27.0	2.58		97.42							
	28.0	2.52		97.48							
	29.0	2.40		97.60							
	30.0	2.62		97.38							
	31.0	2.62		97.38							
	32.0	2.46		97.54							
	33.0	2.32		97.68							
	34.0	2.32		97.68							
	35.0	2.74		97.26							
	36.0	2.70		97.30							
	37.0	2.60		97.40							
	38.0	2.46		97.54							
	39.0	2.46		97.54							
	40.0	2.46		97.54							
	41.0	2.36		97.64							

top of active channel bank	42.0	2.21		97.79							
	43.0	3.80		96.20							
LEW	43.5	4.06	4.06	95.94	95.94	0.00					
(used velocity from stn. 44.5)	44.0	4.31	4.06	95.69	95.94	0.25	0.8	0.19	1.26	0	0.24
	44.5	4.36	4.06	95.64	95.94	0.30	0.5	0.15	1.26	0	0.19
	45.0	4.40	4.06	95.60	95.94	0.34	0.5	0.17	1.49	0	0.25
	45.5	4.36	4.06	95.64	95.94	0.30	0.5	0.15	0.03	0	0.00
	46.0	4.30	4.06	95.70	95.94	0.24	0.5	0.12	0.00	0	0.00
	46.5	4.24	4.06	95.76	95.94	0.18	0.5	0.09	0.17	0	0.02
staff gage	46.9	4.22	4.06	95.78	95.94	0.16	-------------	-------------	-------------	-------------	0.00
	47.0	4.20	4.06	95.80	95.94	0.14	0.5	0.07	0.58	30	0.04
	47.5	4.15	4.06	95.85	95.94	0.09	0.5	0.05	0.00	30	0.00
	48.0	4.12	4.06	95.88	95.94	0.06	0.5	0.03	0.00	30	0.00
REW main channel	48.5	4.06	4.06	95.94	95.94	0.02	0.5	0.01	0.00	30	0.00
velocity estimated visually	49.0	4.02		95.98		0.02	0.5	0.01	1.00	30	0.01
velocity estimated visually	49.5	3.96		96.04		0.02	0.5	0.01	1.00	30	0.01
velocity estimated visually	50.0	3.77		96.23		0.02	0.8	0.02	1.00	30	0.01
velocity estimated visually	50.5	3.78		96.22		0.00					
REW side channel	50.7	3.86		96.14							
	51.0	3.85		96.15							
	52.0	3.64		96.36							
	53.0	3.56		96.44							
	54.0	3.56		96.44							
	55.0	3.50		96.50							
	56.0	3.46		96.54							
	57.0	3.35		96.65							
	58.0	3.24		96.76							
	59.0	3.07		96.93							
	60.0	3.02		96.98							
	61.0	2.90		97.10							
	62.0	2.78		97.22							
	63.0	2.86		97.14							
	64.0	2.98		97.02							
	65.0	2.94		97.06							
	66.0	3.04		96.96							
	67.0	2.90		97.10							
	68.0	2.71		97.29							
break in slope	68.5	2.70		97.30							
	69.0	2.54		97.46							
location of bank full flow	69.6	2.21		97.79							
	70.0	1.86		98.14							
	71.0	1.15		98.85							
	72.0	0.38		99.62							
tail pin	72.5	0.09		99.91							
	TOTALS										0.76

* calculated using a baseline elevation o of 100 feet for the transect string

Stream Survey Results from March 16, 1993

Note	Station	Transect String to Channel Bottom Distance (feet)	Transect String to Water Surface Distance (feet)	* Relative Channel Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
LEW	43.3	4.08	4.08	95.92	95.92	0.00					
flow velocity from stn. 44.0	43.5	4.28	4.08	95.72	95.92	0.20	0.4	0.09	1.65	0	
	44.0	4.42	4.08	95.58	95.92	0.34	0.5	0.17	1.65	0	0.28
	44.5	4.47	4.08	95.53	95.92	0.39	0.5	0.19	2.34	0	0.46
	45.0	4.49	4.08	95.51	95.92	0.41	0.5	0.20	2.89	0	0.59
	45.5	4.42	4.08	95.58	95.92	0.34	0.5	0.17	2.67	0	0.45
	46.0	4.43	4.08	95.57	95.92	0.35	0.5	0.17	1.62	0	0.28
	46.5	4.41	4.08	95.59	95.92	0.33	0.5	0.17	1.14	0	0.19
	46.8	4.32	4.08	95.68	95.92	0.24	--------------	--------------	--------------	--------------	0.00
	47.0	4.34	4.08	95.66	95.92	0.26	0.5	0.13	0.49	30	0.06
	47.5	4.26	4.08	95.74	95.92	0.18	0.5	0.09	0.00	0	0.00
	48.0	4.22	4.08	95.78	95.92	0.14	0.5	0.07	1.00	30	0.06
	48.5	4.18	4.08	95.82	95.92	0.10	0.5	0.05	1.00	45	0.04
	49.0	4.14	4.08	95.86	95.92	0.06	0.5	0.03	1.00	45	0.02
REW main channel	49.3	4.12	4.08	95.88	95.92	0.04	0.5	0.02	1.00	45	0.01
	49.5	4.08		95.92		0.02	0.6	0.01	1.00	45	0.01
REW side channel	50.0	3.99		96.01		0.02					
	50.5	3.90		96.10							
	51.0	3.95		96.05							
TOTALS											2.45

* calculated using a baseline elevation of 100 feet for the transect string.

Stream Survey Results from March 23, 1993

Note	Station	Transect String to Channel Botttom Distance (feet)	Transect String to Water Surface Distance (feet)	* Relative Channel Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
LEW	43.0	3.52	2.86	96.48	97.14	0.66			0.00		
	43.5	4.17	2.86	95.83	97.14	1.31	0.8	0.98	0.77		0.76
	44.0	4.26	2.86	95.74	97.14	1.40	0.5	0.70	1.25		0.88
	44.5	4.26	2.86	95.74	97.14	1.40	0.5	0.70	1.61		1.13
	45.0	4.25	2.86	95.75	97.14	1.39	0.5	0.69	1.92		1.33
	45.5	4.22	2.86	95.78	97.14	1.36	0.5	0.68	1.72		1.17
	46.0	4.22	2.86	95.78	97.14	1.36	0.5	0.68	1.68		1.14
	46.5	4.24	2.86	95.76	97.14	1.38	0.5	0.69	1.43		0.99
staff gage	46.8	4.20	2.86	95.80	97.14	1.34	----------	----------	----------	----------	0.00
	47.0	4.21	2.86	95.79	97.14	1.35	0.5	0.67	1.66		1.12
	47.5	4.17	2.86	95.83	97.14	1.31	0.5	0.65	1.88		1.23
	48.0	4.18	2.86	95.82	97.14	1.32	0.5	0.66	1.76		1.16
rock	48.5	4.06	2.86	95.94	97.14	1.20	0.5	0.60	1.44		0.86
	49.0	4.00	2.86	96.00	97.14	1.14	0.5	0.57	0.68		0.39
	49.5	3.93	2.86	96.07	97.14	1.07	0.5	0.53	0.28		0.15
rock	50.0	3.86	2.86	96.14	97.14	1.00	0.5	0.50	0.47		0.24
	50.5	3.82	2.86	96.18	97.14	0.96	0.5	0.48	0.50		0.24
	51.0	3.83	2.86	96.17	97.14	0.97	0.5	0.49	0.47		0.23
	51.5	3.70	2.86	96.30	97.14	0.84	0.5	0.42	0.52		0.22
	52.0	3.63	2.86	96.37	97.14	0.77	0.5	0.38	0.56		0.22
	52.5	3.57	2.86	96.43	97.14	0.71	0.5	0.35	0.45		0.16
	53.0	3.55	2.86	96.45	97.14	0.69	0.5	0.35	0.42		0.14
	53.5	3.55	2.86	96.45	97.14	0.69	0.5	0.35	0.34		0.12
	54.0	3.57	2.86	96.43	97.14	0.71	0.5	0.35	0.23		0.08
	54.5	3.58	2.86	96.42	97.14	0.72	0.5	0.36	0.13		0.05
rock	55.0	3.45	2.86	96.55	97.14	0.59	0.5	0.29	0.09		0.03
	55.5	3.48	2.86	96.52	97.14	0.62	0.5	0.31	0.00		0.00
	56.0	3.47	2.86	96.53	97.14	0.61	0.5	0.31	0.00		0.00
	56.5	3.42	2.86	96.58	97.14	0.56	0.5	0.28	0.00		0.00
	57.0	3.37	2.86	96.63	97.14	0.51	0.5	0.26	0.00		0.00
	57.5	3.34	2.86	96.66	97.14	0.48	0.5	0.24	0.00		0.00
	58.0	3.28	2.86	96.72	97.14	0.42	0.5	0.21	0.00		0.00
vegetation in stream	58.5	3.26	2.86	96.74	97.14	0.40	0.5	0.20	0.00		0.00
vegetation in stream	59.0	3.16	2.86	96.84	97.14	0.30	0.5	0.15	0.00		0.00
vegetation in stream	59.5	3.16	2.86	96.84	97.14	0.30	0.5	0.15	0.00		0.00
vegetation in stream	60.0	3.03	2.86	96.97	97.14	0.17	0.5	0.08	0.00		0.00
vegetation in stream	60.5	2.98	2.86	97.02	97.14	0.12	0.4	0.04	0.00		0.00
REW	60.6	2.93	2.86	97.07	97.14	0.07					
TOTALS											14.02

* calculated using a baseline elevation of 100 feet for the transect string.

Stream Survey Results from April 2, 1993

Note	Station	Transect String to Channel Bottom Distance (feet)	Transect String to Water Surface Distance (feet)	* Relative Channel Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
LEW	43.4	4.00	4.00	96.00	96.00	0.00					
	43.5	4.08	4.00	95.92	96.00	0.08	0.6	0.05	0.51	0	0.02
	44.0	4.29	4.00	95.71	96.00	0.29	0.5	0.15	0.91	0	0.13
	44.5	4.26	4.00	95.74	96.00	0.26	0.5	0.13	1.87	0	0.24
	45.0	4.27	4.00	95.73	96.00	0.27	0.5	0.14	3.20	0	0.43
	45.5	4.32	4.00	95.68	96.00	0.32	0.5	0.16	2.92	0	0.47
	46.0	4.28	4.00	95.72	96.00	0.28	0.5	0.14	1.77	0	0.25
	46.5	4.26	4.00	95.74	96.00	0.26	0.5	0.13	0.91	0	0.12
staff gage	46.8	4.26	4.00	95.74	96.00	0.26	------------	------------	------------	------------	0.00
	47.0	4.24	4.00	95.76	96.00	0.24	0.5	0.12	0.33	15	0.04
	47.5	4.16	4.00	95.84	96.00	0.16	0.5	0.08	0.00	45	0.00
	48.0	4.10	4.00	95.90	96.00	0.10	0.5	0.05	0.00	60	0.00
	48.5	4.08	4.00	95.92	96.00	0.08	0.5	0.04	0.00	60	0.00
	49.0	4.04	4.00	95.96	96.00	0.04	0.5	0.02	0.00	60	0.00
REW main channel	49.3	4.00	4.00	96.00	96.00	0.00	0.5	0.00	0.50	60	0.00
	49.5	3.99	3.95	96.01	96.05	0.04	0.8	0.03	0.50	60	0.01
REW side channel	50.0	3.90	3.86	96.10	96.14	0.04			0.50	60	
TOTALS											1.71

Stream Survey Results from April 16, 1993

Note	Adjusted *Station	Transect String to Channel Bottom Distance (feet)	Transect String to Water Surface Distance (feet)	Relative Channel **Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
LEW	43.0	3.70	3.70	96.30	96.30	0.00					
	43.1	3.81	3.70	96.19	96.30	0.11	0.4	0.04	0.00	0	0.00
	43.6	4.22	3.70	95.78	96.30	0.52	0.5	0.26	0.21	0	0.05
	44.1	4.33	3.70	95.67	96.30	0.63	0.5	0.32	0.57	0	0.18
	44.6	4.32	3.70	95.68	96.30	0.62	0.5	0.31	0.90	0	0.28
	45.1	4.45	3.70	95.55	96.30	0.75	0.5	0.38	1.78	0	0.67
	45.6	4.37	3.70	95.63	96.30	0.67	0.5	0.34	2.08	0	0.70
	46.1	4.35	3.70	95.65	96.30	0.65	0.5	0.33	2.24	0	0.73
	46.6	4.34	3.70	95.66	96.30	0.64	0.5	0.32	1.29	0	0.41
staff gage	46.8	4.32	3.70	95.68	96.30	0.62	----------	----------	----------	----------	0.00
	47.1	4.32	3.70	95.68	96.30	0.62	0.5	0.31	1.10	0	0.34
	47.6	4.30	3.70	95.70	96.30	0.60	0.5	0.30	1.55	0	0.47
	48.1	4.25	3.70	95.75	96.30	0.55	0.5	0.28	1.56	0	0.43
	48.6	4.14	3.70	95.86	96.30	0.44	0.5	0.22	0.51	0	0.11
reverse flow	49.1	4.11	3.70	95.89	96.30	0.41	0.5	0.21	-0.17	0	-0.03
	49.6	4.03	3.70	95.97	96.30	0.33	0.5	0.17	0.31	45	0.04
rock	50.1	3.88	3.70	96.12	96.30	0.18	0.5	0.09	1.48	0	0.13
	50.6	3.94	3.70	96.06	96.30	0.24	0.5	0.12	1.17	0	0.14
	51.1	3.90	3.70	96.10	96.30	0.20	0.5	0.10	0.75	15	0.07
	51.6	3.80	3.70	96.20	96.30	0.10	0.5	0.05	0.00	0	0.00
	52.1	3.72	3.70	96.28	96.30	0.02	0.5	0.01	0.00	0	0.00
REW	52.3	3.70	3.70	96.30	96.30	0.00					4.71
TOTALS											

*adjusted to match measurements on original tape measure

** calculated using a baseline elevation of 100 feet for the transect string.

Stream Survey Results from April 28, 1993

Note	Station	Transect String to Channel Bottom Distance (feet)	Transect String to Water Surface Distance (feet)	Relative Channel *Elevation (feet)	* Relative Water Surface Elevation (feet)	Stream Depth (feet)	Cell Width (feet)	Cell Area (square feet)	Water Velocity (feet/second)	Flow Angle (degrees)	Discharge through cell (cfs)
LEW	43.3	3.91	3.91	96.09	96.09	0.00					
	43.5	4.15	3.91	95.85	96.09	0.24	0.5	0.12	0.50	0	0.06
	44.0	4.26	3.91	95.74	96.09	0.35	0.5	0.17	0.56	0	0.10
	44.5	4.29	3.91	95.71	96.09	0.38	0.5	0.19	1.36	0	0.26
	45.0	4.35	3.91	95.65	96.09	0.44	0.5	0.22	2.12	0	0.47
	45.5	4.32	3.91	95.68	96.09	0.41	0.5	0.20	2.13	0	0.44
	46.0	4.24	3.91	95.76	96.09	0.33	0.5	0.16	2.97	0	0.49
	46.5	4.22	3.91	95.78	96.09	0.31	0.5	0.15	2.77	0	0.43
staff gage	46.8	4.19	3.91	95.81	96.09	0.28	-------------	-------------	-------------	-------------	0.00
	47.0	4.20	3.91	95.80	96.09	0.29	0.5	0.14	1.75	0	0.25
	47.5	4.16	3.91	95.84	96.09	0.25	0.5	0.13	1.35	0	0.17
	48.0	4.16	3.91	95.84	96.09	0.25	0.5	0.13	0.74	0	0.09
	48.5	4.09	3.91	95.91	96.09	0.18	0.5	0.09	0.10	15	0.01
	49.0	4.02	3.91	95.98	96.09	0.11	0.5	0.06	0.50	45	0.02
	49.5	3.98	3.91	96.02	96.09	0.07	0.8	0.05	0.50	45	0.02
REW	50.0	3.91	3.91	96.09	96.09	0.00					
TOTALS											2.80

*calculated using a baseline elevation of 100 feet for the transect string.

CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

STREAM HABITAT SURVEY

TABLE OF CONTENTS

List of Figures

1. INTRODUCTION

A habitat survey was conducted of the stream that flows through the proposed Gateway Pacific Terminal (GPT) bulk loading facility project at Cherry Point. The survey was done primarily to characterize stream habitat conditions and general stream channel stability. Fish use of the stream also was assessed, based on existing information and visual observation. The following report presents general information on stream configuration, classification, and riparian corridor condition, in addition to the findings of the stream habitat survey.

2. GENERAL BASIN DESCRIPTION AND RIPARIAN CORRIDOR LAND USE

The stream located on the project site is one of a number of small, independent drainages that flow into the Strait of Georgia along the northwest shore of Whatcom County. Its mouth is located about 5.5 miles north of Lummi Bay and about 3.75 miles south of Birch Bay (see Figure 1). The stream is unnamed but is cataloged in *A Catalog of Washington Streams and Salmon Utilization* (Williams, et al., 1975) as Washington Resource Inventory Area (WRIA) Stream 01.0100. Other principal independent drainages include Terrell Creek, which drains much of the area immediately east and north of Stream 01.0100, and Dakota and California Creeks, both of which drain areas north of Terrell Creek.

Stream 01.0100 is about 1.25 miles long and drains an estimated 800 acres. The stream originates on a relatively flat terrace above the Strait of Georgia. Terrace elevations range from about 100 to 160 feet above sea level. From the terrace, the stream flows south through a steep-sided ravine down to the Strait of Georgia. Stream 01.0100 does not have any significant tributaries.

Whatcom County rates Stream 01.0100 as a Type 4 Water below Henry Johnson Road and Type 5 above Henry Johnson Road (Fox, 1993). The County uses the water typing system that is set forth in Washington Administrative Code (WAC) 222-16-030. Type 4 Water may be intermittent, and Type 5 Water is intermittent. Appendix A gives a description of water types. Stream 01.0100 flows much of the year, but during late summer, flows become intermittent.

Land use within the drainage area of Stream 01.0100 generally is rural in character. An exception is the Arco oil refinery located less than one-quarter-mile north of the stream's headwaters. Pastures, hayfields, and woodlots make up much of the existing land use within the drainage area.

A riparian corridor consisting of forested or scrub-shrub communities is present along the stream, except along the upper portion where vegetation consists of pasture grasses. The riparian corridor provides a buffer from adjacent land uses, except where roads cross the stream and along the upper thousand feet of the stream where it is bordered by pasture. Pasture along the upper portion of the stream is used for livestock grazing, and livestock have access to the stream.

Three roads cross the stream: from upstream to the mouth, they are Powder Plant Road, Lonseth Road, and Henry Johnson Road (see Figure 2). The crossing at Henry Johnson Road is used as an illegal dump. Dumped refuse ranges from furniture and appliances to animal carcasses. Refuse is dumped primarily along the south side of the road, down the slope that is formed by the road fill. Some refuse was found in the stream. Roadside ditches, which carry runoff from the surrounding pasturelands and from road surfaces, enter the stream at road crossings.

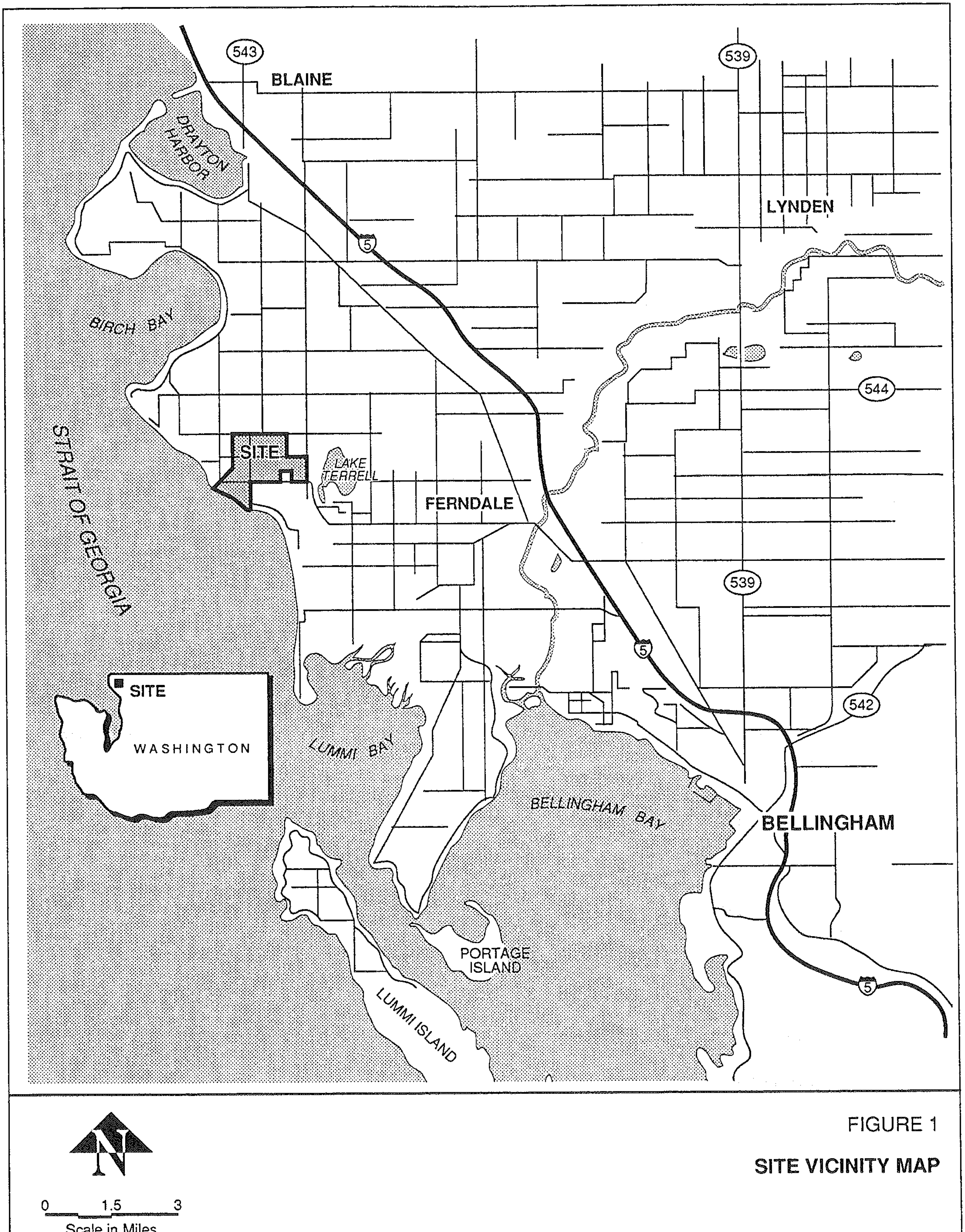


FIGURE 1

SITE VICINITY MAP

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10/92

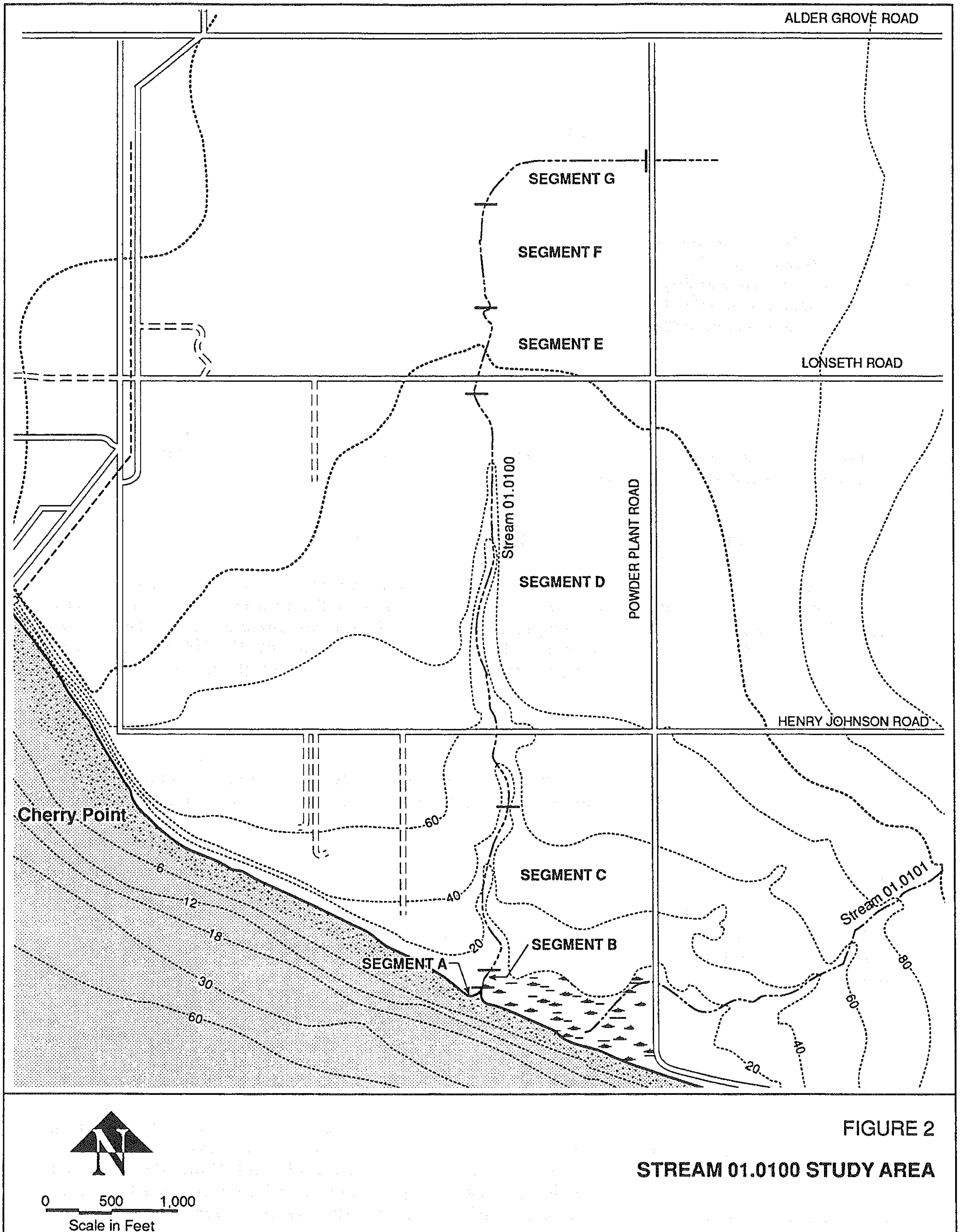

FIGURE 2

STREAM 01.0100 STUDY AREA

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3. STREAM HABITAT SURVEY METHODS

A survey of stream habitat, beginning at the mouth of Stream 01.0100 and proceeding upstream to Powder Plant Road, was conducted on May 10 and May 28, 1993. During the survey, the following features were characterized:

- dominant habitat types
- significant habitat features
- dominant substrate type
- general bank stability
- presence of woody debris
- riparian vegetation species

Survey methods consisted of an upstream walk of the stream channel during which visual observations of the above features were noted in field notebooks. Only quantitative data were collected. The purpose of the survey was to provide a narrative description of the physical habitat features of the stream and adjoining vegetative communities, and to provide information on the possible use of the stream by fish. Photographs taken during the survey to document habitat conditions are included as Appendix B.

4. STREAM HABITAT SURVEY RESULTS

The following paragraphs describe the findings of the habitat survey. It should be noted that on May 10, water levels were visually observed to be at or near the ordinary high water mark (OHWM). When the survey was completed on May 28, the stream exhibited lower flow conditions. On May 10 the survey extended from the mouth of Stream 01.0100 to just below Lonseth Road, and on May 28 the survey continued to Powder Plant Road, the upper extent of the survey.

For descriptive purposes the stream has been divided into seven segments, labeled A through G, which are shown in Figure 2. The following paragraphs provide an overview of each segment, beginning with the segment at the mouth of Stream 01.0100 and continuing upstream. Lists of common and scientific names of plants and wildlife discussed in the text are presented in Appendix C.

Segment A

Segment A consists of the short portion of the stream that flows over beach cobble deposits and into the Strait of Georgia (see Photo 1). This segment is highly variable in character because it is greatly affected by tides and wave action. At the time of the survey, the width of the wetted channel averaged about 9 feet and depth averaged 0.5 foot.

Segment B

Segment B is a 150-foot-long segment of stream that flows under a large accumulation of driftwood (see Photos 2 and 3). The stream channel varies in width and averaged about 16 feet from bank to bank. Depth on the day of the survey was about 1 foot. It does not appear that driftwood, which both bridges and floats within the stream, would block fish passage, but during lower flows it is possible some blockage could occur. On the day of the survey, no fish were observed within this portion of the stream. Numerous small pools and abundant cover are provided by the driftwood, much of which consists of logs greater than 1 foot in diameter and 10 feet in length. Substrate within Segment B consists of some sand, but is comprised primarily of fine silt and mud.

An estuarine marsh wetland borders the stream east of Segment B. Several small channels meander through the marsh and may drain toward Stream 01.0100 during high water events. The estuarine marsh, which is described in *Jurisdictional Wetland Determination for Cherry Point Project* (Shapiro and Associates, Inc., 1992), receives runoff from another small, independent drainage that has been identified as Stream 01.0101 in *A Catalog of Washington Streams and Salmon Utilization* (Williams, et al., 1975).

Segment C

Upstream of the driftwood accumulation for a distance of nearly 1,500 feet, stream habitat in Segment C is dominated by glides. Width of the stream averaged about 6 to 8 feet, and depths averaged 1.5 feet on the day of the survey. Pools occur infrequently and are formed primarily as a result of either backwater effects behind small woody debris, as areas of slower water along undercut banks, or as a result of midchannel scour. Pools may be more evident during times of lower stream flow, as higher flows may drown out pools. Photos 4, 5, 6, and 7 show habitat typical of this segment.

Habitat-forming large woody debris is scarce in this segment, although small woody debris is fairly abundant. Small woody debris plays an important role in forming habitat, but is less stable within the channel and therefore less likely to form long-lasting habitat features.

In short reaches of Segment C, the channel is incised, with steep-sided banks that are several feet high. Both the banks and channel bottom along most of the segment consist of fine, organic-rich silt. Sand dominates the substrate in some sections. Several vegetated islands that vary in length from approximately 25 to 75 feet are located within the channel in Segment C. On the day of the survey, water flowed in channels on both sides of most islands, but during lower flows, one channel may be dominant.

In the lower 500 feet of Segment C, the channel is unconfined so that during high flow events, the stream may overtop its banks and enter the floodplain. In the upper portion of Segment C, the stream is constrained between the steep sides of the ravine. Channel gradient along Segment C averages about 0.3% in the lower, unconstrained portion and about 0.8% in the upper, constrained portion.

Water clarity along the entire stream was poor, but within Segment C, stream flow appeared particularly murky and carried a high load of fine suspended material on the day of the survey.

Riparian vegetation along Segment C consists primarily of deciduous and mixed deciduous/ coniferous forested communities. Dominant species include salmonberry, Indian plum, Pacific blackberry, red elderberry, and Pacific ninebark in the understory. Red alder, black cottonwood, big-leaf maple, and an occasional Douglas fir, western red cedar, and grand fir comprise the overstory. Large cedar stumps are infrequently interspersed throughout the riparian corridor; they are a legacy of the forests that once grew along the stream. Vegetation overhangs the stream channel along much of this segment, providing overhead cover, moderating temperatures, and a nutrient source to the stream.

Segment D

Segment D begins where the stream gradient increases to greater than 2% and continues upstream about 2,800 feet almost to Lonseth Road (see Figure 2). It is characterized by run/riffle/pool habitat. Photos 8 through 20 show habitat characteristic of this segment.

Stream wetted width varied considerably on the day of the survey but averaged about 6 to 8 feet in areas of run and 10 to 16 feet in areas of riffle. Depth ranged from about 0.5 to 1 foot. Riffle habitat was limited to short reaches generally less than 100 feet long, with runs being much longer. Pools were present, but make up about 5% to 10% of the stream area. Pools tend to be small, with their length being less than the average channel width, and are primarily formed by small woody debris, tree roots, or channel flow patterns (i.e., pools formed along the outside of meander bends). The largest pool within Segment D is the plunge pool formed below the culvert at Henry Johnson Road (see Photo 9). On the day of the survey, this pool measured approximately 20 feet wide by 20 feet long and had a maximum depth exceeding 3 feet.

Almost the entire stretch of Segment D is relatively confined between the slopes of the steep-sided ravine. Only at the upstream end of the segment, near the edge of the terrace, is the stream not confined within the ravine. Channel substrate within this segment is predominantly gravel, although sand is abundant in some reaches. Channel banks are steep-sided and overhanging in short reaches, but bank stability does not appear to be a problem.

Woody debris is present throughout the segment, although large, stable pieces are not common. Some reaches contain an abundance of small woody debris, possibly a result of windstorm blowdown.

In the first 500 to 600 feet of Segment D, in the reach immediately downstream of Henry Johnson Road, the stream contains refuse that has washed down from the illegal dump site along the road (see Photos 9 and 10). Water seeps down the slope through the refuse; it is likely that water quality is adversely affected. At the Henry Johnson Road crossing, runoff enters the stream from roadside ditches that flow along the north and south sides of the road. The ditches contain runoff from roadways and agricultural fields.

A reach about 200 feet in length, which is located about 400 to 500 feet upstream of the Henry Johnson Road, is distinct in that there are only a few scattered large trees and snags within the riparian corridor and cottonwood saplings are abundant (see Photo 13). As a result, this reach of Segment D has a more open canopy, and overhead cover is sparse.

Immediately upstream of this reach, the stream contains an abundance of woody debris (see Photos 14 and 15). The large amount of woody debris may be the result of blowdown during a windstorm. A significant portion of the woody debris bridges the stream (see Photo 16) and therefore is not interacting with flow to create instream habitat. Wood that does lie within the stream is creating habitat (Photo 17), although most pools within this reach, as well as the rest of Segment D, are small (i.e., shorter in length than the average channel width).

Riparian vegetation along most of Segment D consists of deciduous and some mixed deciduous coniferous forest, as well as some scrub-shrub communities. Overhanging vegetation is abundant along most of the segment and is sparse only within the open reach. The forested community downstream of Henry Johnson Road is more mature and contains larger trees, while upstream of Henry Johnson Road there are fewer large red alder, cottonwood, and coniferous trees. Cottonwood saplings, red-osier dogwood, and vine maple are more common tree species upstream of Henry Johnson Road.

<u>Segment E</u>

Segment E begins immediately below Lonseth Road, near the top of the terrace where the stream gradient decreases to less than 1%, and continues upstream approximately 500 to 700 feet. In this segment, habitat is dominated by glides and mid-channel pools. Roadside ditches along Lonseth Road drain into the stream within this segment. It should be noted that Segments E, F, and G were surveyed on May 28, during lower flow conditions. The greater abundance of pools observed in this segment compared to downstream segments is partly a reflection of the lower flow conditions. During higher flow conditions, many of the mid-channel pools observed would be drowned out. Photos 21 through 29 show habitat typical of this segment.

Stream width of the wetted channel through this reach was relatively narrow, averaging only a few feet, and stream depth was generally less than 0.5 foot. A number of large pools occur within this segment, however, and stream widths and depths are greater at these locations. Substrate in Segment E consists primarily of fine, organic-rich silt, although some sand is present. Small woody debris is present throughout the segment, although large, stable woody debris is much less common, as it is in all segments. Riparian vegetation within Segment E is a mixture of scrub-shrub and forested communities.

In the reach upstream of Lonseth Road, thick overhanging scrub-shrub vegetation is predominantly Pacific ninebark, as well as sapling black cottonwood, willow, and red-osier dogwood. This riparian vegetation completely shades much of the stream (see Photos 25 and 27). This reach extends several hundred feet upstream of Lonseth Road.

The next reach within Segment E, which is several hundred feet in length, is characterized by an interconnected series of relatively large pools (see Photos 28 and 29) with very slow moving water. These pools are about 20 feet wide and 1 foot or more in depth. They contained emergent vegetation, including Pacific water-parsley and American speedwell. Because they are wide and the surrounding vegetation is scrub-shrub of low stature, these pools have little overhead cover.

Segment F

The division between Segments E and F occurs at the transition from where the stream flows in one main stream channel to where it flows in several smaller meandering channels. The smaller channels were 1 to 2 feet in width on the day of the survey, and observed depths were less than 0.5 foot. A large wetland consisting of palustrine scrub-shrub and sapling-shrub regrowth communities surrounds the stream along this segment. Dominant species include willow, black cottonwood saplings, salmonberry, Indian plum, red-osier dogwood, and red alder saplings. The thick vegetation produces a closed canopy over the stream, as flow meanders through the organic-rich substrate. This segment is about 300 to 500 feet in length. Photo 30 is a view of the vegetation through which Segment F flows.

Segment G

Segment G begins where the stream flows in a shallow ditch through a wet pasture consisting almost exclusively of reed canarygrass, and extends upstream about 1,000 feet to Powder Plant Road. On the day of the survey, the stream was about 6 feet in width and less than 1 foot in depth. The substrate, which is not very firm, consists of fine, organic-rich silts. Photos 31 through 35 are of this segment.

Because the stream is surrounded by pasture in this segment, there is little overhead vegetation to provide cover. The most significant habitat feature within Segment G is a stand of willows that provides some cover over the channel (see Photo 33).

The stream habitat survey ended at Powder Plant Road where the stream pools on the downstream side of the road (see Photo 35). Upstream of Powder Plant Road, Stream 01.0100 originates in numerous, small, ephemeral channels.

5. STREAM HABITAT, UTILIZATION, AND POTENTIAL HABITAT ENHANCEMENT

Fish use of Stream 01.0100 was determined from existing information sources and from personal communication with biologists from the Washington Department of Fisheries (WDF) and Washington Department of Wildlife (WDW). No electroshocking or other instream method of collecting data on fish use, other than visual observations, was conducted for this study.

5.1 FISH SPECIES

Little is known about anadromous salmonid occurrence within Stream 01.0100 or any of the other small independent drainages flowing into the Strait of Georgia, according to *A Catalog of Washington Stream and Salmon Utilization* (Williams, et al., 1975). Williams, et al. note that it is possible some chum salmon use occurs, as well as some coho use in streams that are not intermittent. Cutthroat trout may occur in the stream, according to Jim Johnston of WDW.

Resident fishes include three-spine stickleback and sculpin and may include largescale sucker, long-nosed dace, and western brook lamprey. During the stream survey for amphibians (see below), three-spine stickleback were the only fish species captured or observed.

5.2 OTHER VERTEBRATE AQUATIC SPECIES

Sampling for amphibian species within the stream and over other portions the site was conducted as part of a separate study. During this study the only amphibian species found in the stream was red-legged frog. For a more detailed description of amphibian species at the site and their use of the site, consult the Cherry Point Amphibian Survey Report, which is included in this document.

5.3 FISH HABITAT

Production and survival of resident and juvenile anadromous fish in Stream 01.0100 would be directly related to the quality and quantity of instream habitat. Juvenile coho salmon and cutthroat trout reside in a stream ecosystem for about a year before migrating to saltwater, and therefore are highly influenced by factors affecting instream habitat quality and quantity.

Juvenile salmonid rearing habitat within Stream 01.0100 appears to be limited by several factors, including intermittent flow characteristics and limited amount of high-quality pool habitat. According to Jim Johnston of WDW, the intermittent nature of the stream does not preclude its use by anadromous cutthroat trout, as long as pools persist between flow events. Pool habitat is somewhat limited, even when the stream is flowing. Based on calculations from two sample reaches, pool area makes up from 5% to 10% of stream area in the portion of the stream below Henry Johnson Road. Pools tend to be small and relatively shallow. Although overhead vegetative cover is generally abundant, cover elements within pools are less common. In addition, although small woody debris is abundant, the general scarcity of large woody debris may be a factor affecting the limited amount of high-quality pool habitat.

Another factor limiting quality of habitat within Stream 01.0100 is water quality. Although no water quality data were collected, visual appearance and bad odor of the water, especially immediately below Henry Johnson Road, indicate that water quality is generally poor. Further indication that water quality is poor comes from a random sampling for benthic macroinvertebrates. During the stream survey, a number of riffles were sampled for presence of benthic macroinvertebrates. Sampling consisted of randomly selecting five cobble-sized rocks within a riffle and visually searching for macroinvertebrates. No benthic macroinvertebrates were observed. Benthic macroinvertebrates are common inhabitants of healthy stream ecosystems; their scarcity in Stream 01.0100 may be an indication of poor water quality.

The quality of spawning habitat within Stream 01.0100 also is limited. Much of the stream substrate consists of fine silt and organics not suitable for spawning. The higher-gradient portion of the stream in Segment D contains gravel substrate, some of which appears suitable for spawning. Most of this segment lies above Henry Johnson Road; therefore, anadromous fish must be able to pass through the culvert to gain access to a large portion of the spawning gravels. The culvert likely is passable during high flows; however, on the day of the survey when flow levels were visually estimated to be at or near ordinary high water, the drop from the culvert invert to the pool was about 1.5 feet. As this drop increased with lower flows, fish passage could become difficult. In addition to the overall small amount of gravel substrate, spawning habitat quality also appears to be limited by the occurrence of sand that has become imbedded in spawning-sized gravels.

5.4 HABITAT UTILIZATION

As mentioned above, no fish were observed in Stream 01.0100 during the two days of the habitat survey. The only fish species observed during other field visits to the site was three-spine stickleback. Stickleback were observed in pools and near the mouth of the stream.

Biologists from both WDF and WDW were contacted for information on fish use within the stream. Brian Williams of WDF visited the mouth of the stream and suggested it would be unlikely that salmon would use this stream. This was due to the intermittent flow, the mouth clogged with logs, and presence of a berm that would restrict adult movement except at high tide. Mark Schuller with WDF has seen only the upper reaches of Stream 01.0100 and did not believe any anadromous fish used the stream. He has electroshocked the stream in Segment G within the wet pasture area; no fish were found, however. Mr. Schuller was not aware the stream flowed into the Strait of Georgia; he understood that a berm had been constructed near the lower end of the stream that prevented surface flow from reaching the Strait. Upon hearing that the stream does flow into the Strait, he stated that the next time he visited the area, he would electroshock within the lower portion of the stream. At the time of this writing, Mr. Schuller had not revisited the stream.

Jim Johnston with WDW was contacted concerning cutthroat use of the stream. He stated that he did not have any specific knowledge of Stream 01.0100, but that unless there was conclusive evidence that cutthroat were not using the stream, he would assume there was some use. Mr. Johnston stated that cutthroat would use an intermittent stream as long as pools persisted between flow events. Pools have been observed within the stream during times of intermittent flow.

Based on the fact that the stream experiences intermittent flows and that water quality appears generally to be poor, anadromous fish use of the stream, other than some possible use by cutthroat, is not currently expected.

5.5 POTENTIAL HABITAT ENHANCEMENT

Several measures could be considered for enhancement of Stream 01.0100. These include: cleaning up the illegal dump near the crossing at Henry Johnson Road; replacing the existing culvert at Henry Johnson Road with a bottomless culvert; introducing large woody debris to increase formation of additional high quality pools and provide cover for fish; planting trees near existing pools that lack overstory to provide shade; creating backwater areas to provide refugia for overwintering juvenile salmonids during high flow events; cleaning existing gravel areas that may have sand or silt embedded in them; improving treatment of surface-water runoff from roads and agricultural areas to improve water quality; and preventing livestock from grazing near the headwaters of the stream to reduce siltation and possible undesirable enrichment from manure.

flow. Detention/retention ponds and associated biofiltration swales would need to be designed so as to achieve state and local water quality standards for release into the stream.

6. RIPARIAN HABITAT UTILIZATION

Riparian forest communities provide an important connection between stream and terrestrial ecosystems. Such communities are important for wildlife, are especially productive for many species, and provide critical habitat for some species (Raedeke, 1988). The riparian zone along Stream 01.0100 provides important forested habitat for wildlife, particularly because much of the upland habitat outside the riparian corridor consists of pasturelands.

The only mammal species observed in the riparian zone was mink, while sign (tracks) of black-tailed deer and raccoon also was observed. Bird species observed within the riparian zone include red-tailed hawk, black-capped chickadee, song sparrow, western flycatcher, downy woodpecker, rufous-sided towhee, Swainson's thrush, cedar waxwing, and white-crowned sparrow. Other species expected to occur within the riparian corridor include shrews, voles, deer mice, weasel, skunk, and amphibians such as ensatina, western red-back salamander, and red-legged frog. Additional bird species may include American robin, bushtit, golden and ruby crowned kinglets, hairy woodpecker, willow flycatcher, red-eyed vireo, and evening grosbeak. (Also, see the Cherry Point Amphibian Survey Report included in this document.)

7. LITERATURE CITED

Fox, Steve, June 1993. Whatcom County Planning Department. Personal communication.

Johnson, Jim, June 1993. Washington State Department of Wildlife. Personal communication.

Raedeke, Kenneth, 1988. *Streamside Management: Riparian Wildlife and Forestry Interactions.* College of Forest Resources, University of Washington.

Schuller, Mark, June/July 1993. Washington Department of Fisheries. Personal communications.

Shapiro and Associates, Inc., 1992. *Jurisdictional Wetland Determination for Cherry Point Project.* Report to Pacific International Terminals.

Williams, Brian, May 1992. Washington Department of Fisheries, Personal Communication.

Williams, R.W., R.M. Laramie, and J.J. Ames, 1975. *A Catalog of Washington Streams and Salmon Utilization. Volume I.* Washington Department of Fisheries. Olympia, Washington.

Wydoski, R.S., and Richard R. Whitney, 1979. *Inland Fishes of Washington.* University of Washington Press. Seattle, Washington.

APPENDIX A

Water Categories

WATER CATEGORIES

The following types of water are used in these regulations, the system for typing the waters is as set forth in WAC 222-16-030 water typing system.

3.01 "**Type 1 Water**" shall mean all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW, but not including those waters' associated wetlands.

3.02 "**Type 2 Water**" shall mean segments of natural waters which are not classified as Type 1 water and have a high use and are important from a water quality standpoint. Classification shall be applied to segments of natural waters which:

.021 Are diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 100 persons, where such diversion is determined by the department to be a valid appropriation of water and the only practical water source for such users. Such waters shall be considered to be Type 2 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50%m whichever is less;

.022 Are within a federal, state, local, or private campground having more than 30 camping units: provided, That the water shall not be considered to enter a campground until it reaches the boundary of the park lands available for public use and comes within 100 feet of a camping unit, trail, or other park improvement;

.023 Are used by substantial numbers of anadromous or resident game fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have highly significant fish populations:

(a) River or stream segments having a defined channel of 20 feet or greater in width between the ordinary high-water marks and having a gradient of less than 4%.

(b) Impoundments having a surface area of 1 acre or greater at seasonal low water.

3.03 "**Type 3 Water**" shall mean segments of natural waters which re not classified as Type 1 or 2 water and have a moderate to slight use and are moderately important from a water quality standpoint. Classifications shall be applied to segments of natural water which:

.031 Are diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons, where such diversion is determined to be a valid appropriation of water and the only practical water source for such users.

(a) Such waters shall be considered to be Type 3 Water upstream from the point of such diversion for 1,500 feet or until the drainage area is reduced by 50%, whichever is less;

.032 Are used by significant numbers of anadromous fish for spawning, rearing or migration. Waters having the following characteristics are presumed to have significant anadromous fish use:

(a) River or stream segments having a defined channel of 5 feet or greater in width between the ordinary high-water marks; and having a gradient of less than 12% and not upstream of a falls of more than 10 vertical feet.

(b) Impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to an anadromous fish stream or river.

.033 Are used by significant numbers of resident game fish. Waters with the following characteristics are presumed to have significant resident game fish use:

(a) River or stream segments having a defined channel of 10 feet or greater in width between the ordinary high-water marks; and a summer low flow greater than 0.3 cubic feet per second; and a gradient of less than 12%.

(b) Impoundments having a surface area greater than 0.5 acre at seasonal low water.

.034 Are highly significant for protection of downstream water quality. Tributaries which contribute greater than 20% of the flow to a Type 1 or 2 Water are presumed to be significant for 1,500 feet from their confluence with the Type 1 or 2 Water or until their drainage area is less than 50% of their drainage area at the point of confluence, whichever is less.

3.04 "**Type 4 Water**" classification shall be applied to segments of natural waters which are not classified as Type 1, 2, or 3, and for the purpose of protecting water quality downstream are classified as Type 4 Water upstream until the channel width becomes less than 2 feet in width between the ordinary high-water marks. These may be perennial or intermittent.

3.05 "**Type 5 Water**" classification shall be applied to all natural waters not classified as Type 1, 2, 3, or 4; areas of perennial or intermittent seepage, ponds, natural sinks, and drainage ways having short periods of spring or storm runoff.

APPENDIX B

Photograph Log

PHOTOGRAPH LOG
Stream 01.0100

Photo No.	Description
1	View looking downstream showing flow into the Strait of Georgia (Segment A). Photo taken 5/10/93.
2	View looking generally upstream showing accumulation of driftwood; stream flows beneath driftwood (Segment B). Photo taken 5/10/93.
3	View looking downstream showing driftwood accumulation; stream flows beneath (Segment B). Photo taken 5/10/93.
4	View looking downstream showing glide habitat in Segment C; note large woody debris bridging stream. Photo taken 5/10/93.
5	View looking upstream showing glide habitat; note overhanging vegetation (Segment C). Photo taken 5/10/93.
6	View looking downstream showing glide habitat with small woody debris (Segment C). Photo taken 5/10/93.
7	View of streamside vegetation within glide habitat (Segment C). Photo taken 5/10/93.
8	View looking downstream showing run habitat in Segment D. Photo taken 4/16/93.
9	View of plunge pool below culvert at Henry Johnson Road (Segment D); note refuse on road fill slope. Photo taken 4/28/93.
10	View showing refuse along road fill at Henry Johnson Road (Segment D). Photo taken 4/28/93.
11	View looking downstream in reach just upstream of Henry Johnson Road (Segment D). Photo taken 5/10/93.
12	View looking downstream showing dammed pool created behind small woody debris jam (Segment D). Photo taken 5/10/93.
13	View looking upstream showing run habitat within the more open area where there are numerous cottonwood saplings (Segment D). Photo taken 5/10/93.
14	View looking upstream in area of stream where there is abundant woody debris (Segment D). Photo taken 5/10/93.
15	View generally downstream in same area as that shown in Photo 14 (Segment D). Photo taken 5/10/93.
16	View looking downstream showing run habitat in area of Segment D where there is abundant wood; note wood bridging stream. Photo taken 5/10/93.

17 View looking downstream showing run habitat within Segment D; note abundant overhead cover and woody debris in stream. Photo taken 5/10/93.

18 View looking upstream within Segment D showing abundant overhead cover and small woody debris. Photo taken 5/10/93.

19 View looking upstream within Segment D in area of stream where the ravine banks constrain the stream. Photo taken 5/10/93.

20 View of dammed pool formed by woody debris within Segment D. Photo taken 5/10/93.

21 View looking upstream showing a mid-channel pool within Segment E. Photo taken 5/28/93.

22 View of small pool formed by small woody debris; note overhanging roots (Segment E). Photo taken 5/28/93.

23 View of plunge pool below culvert at Lonseth Road (Segment E). Photo taken 5/28/93.

24 View looking upstream from the culvert at Lonseth Road; note vegetation completely shading stream (Segment E). Photo taken 5/28/93.

25 View of the stream from a point upstream of Lonseth Road; note the dense vegetation (Segment E). Photo taken 5/28/93.

26 View of stream channel within Segment E; note small woody debris. Photo taken 5/28/93.

27 View of a small, shallow pool within Segment E; note dense vegetation. Photo taken 5/28/93.

28 View of a portion of a large pool in Segment E where several large interconnected pools occur; note aquatic vegetation. Photo taken 5/28/93.

29 View of portion of a large pool in Segment E. Photo taken 5/28/93.

30 View of dense vegetation in which Segment F flows. Photo taken 5/28/93.

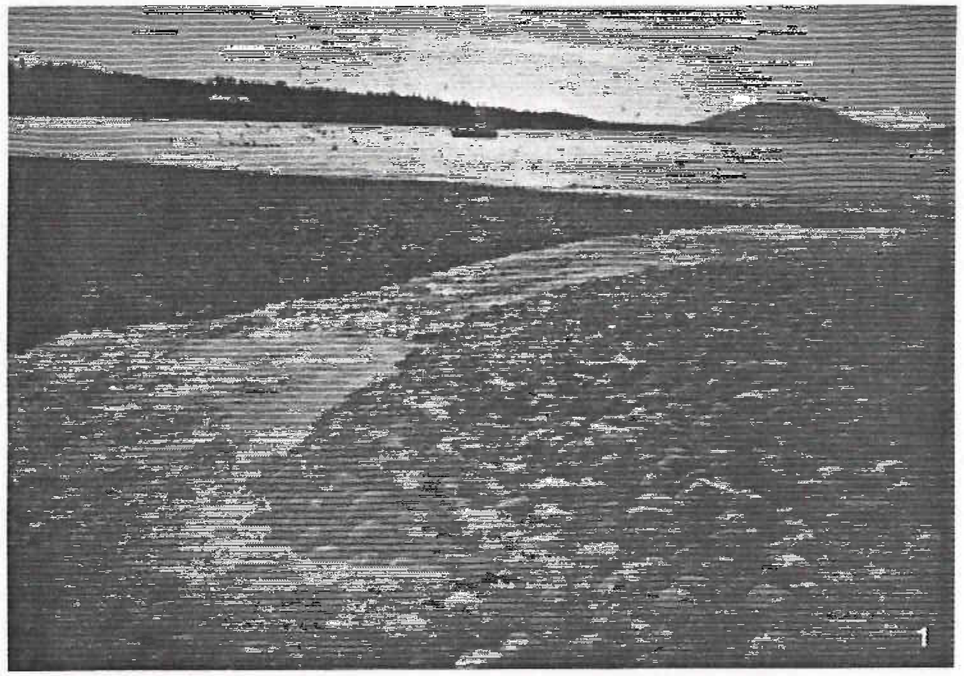
31 View looking downstream where stream flows from the pasture area of Segment G into the forested area of Segment F. Photo taken 5/28/93.

32 View looking upstream as stream flows through pasture area in Segment G. Photo taken 5/28/93.

33 View looking upstream within Segment G; willows provide overhead cover. Photo taken 5/28/93.

34 View looking upstream of end of Segment G and upstream end of habitat survey. Photo taken 5/28/93.

35 View looking downstream at Segment G from Powder Plant Road. Photo taken 5/28/93.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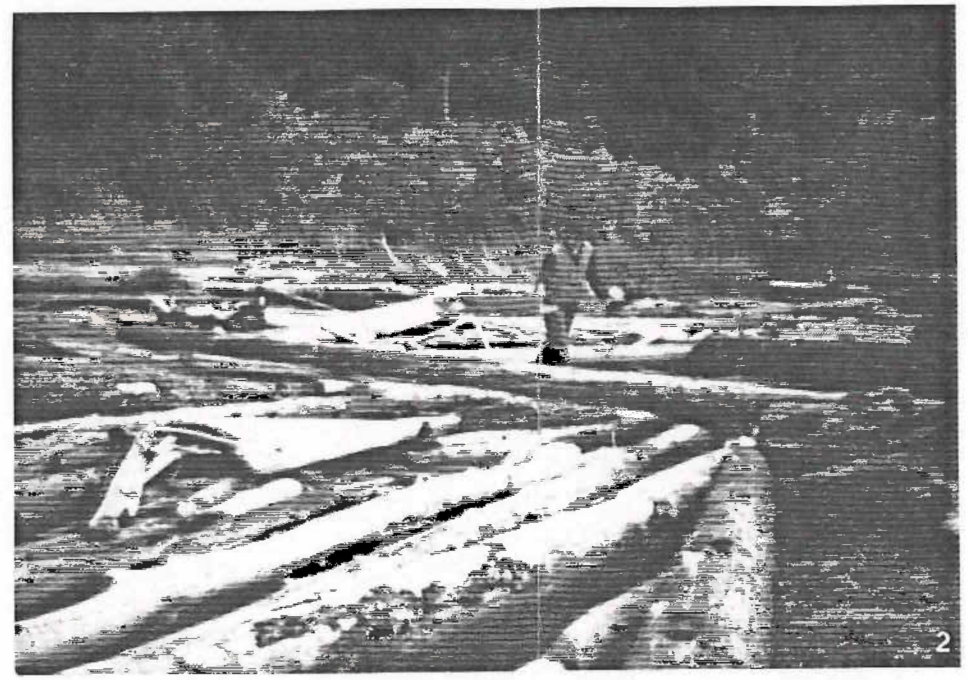
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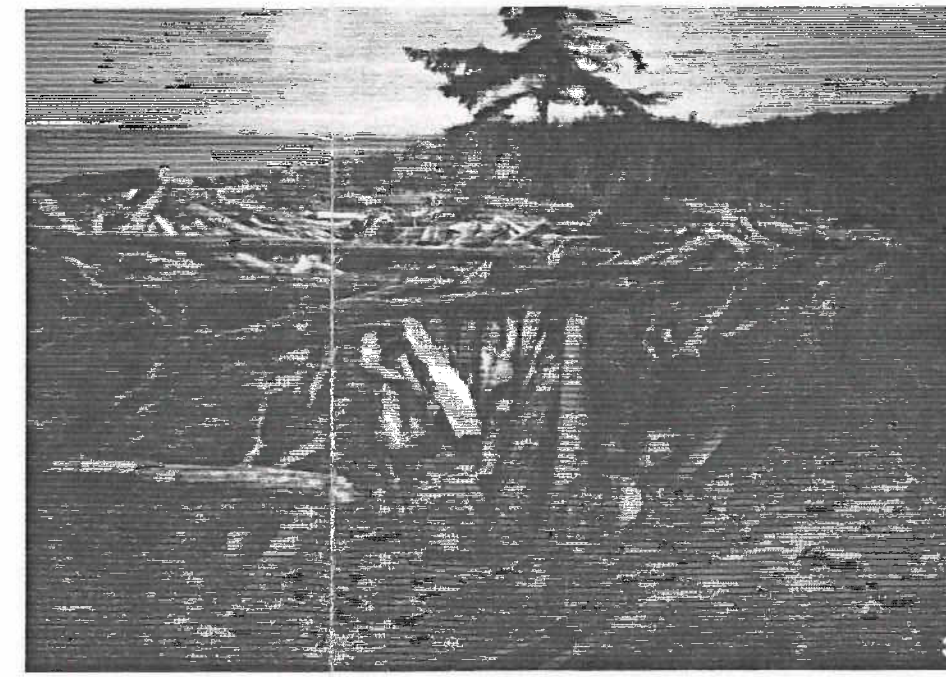
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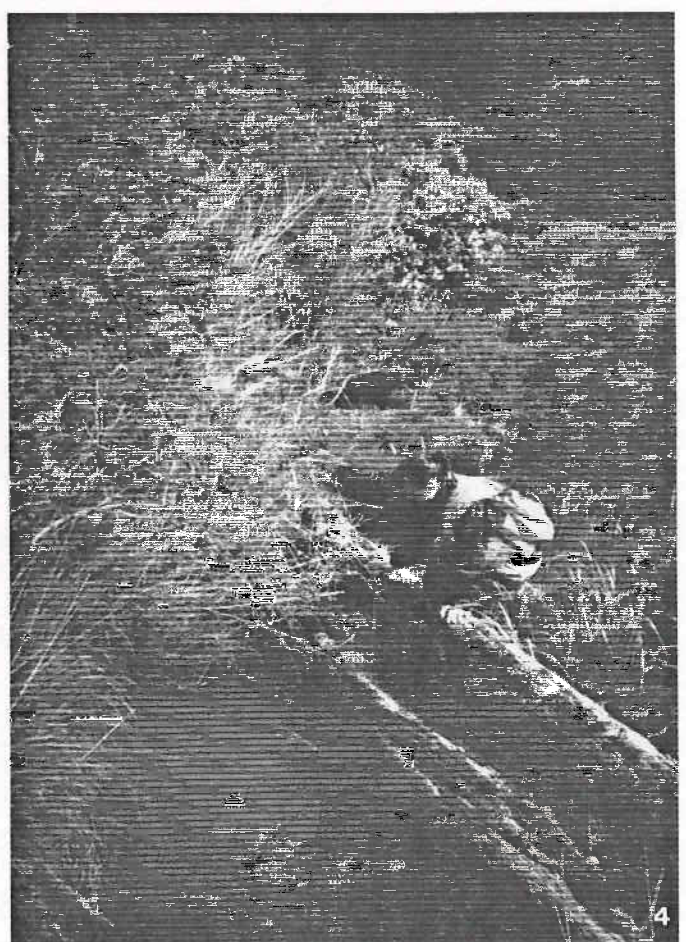
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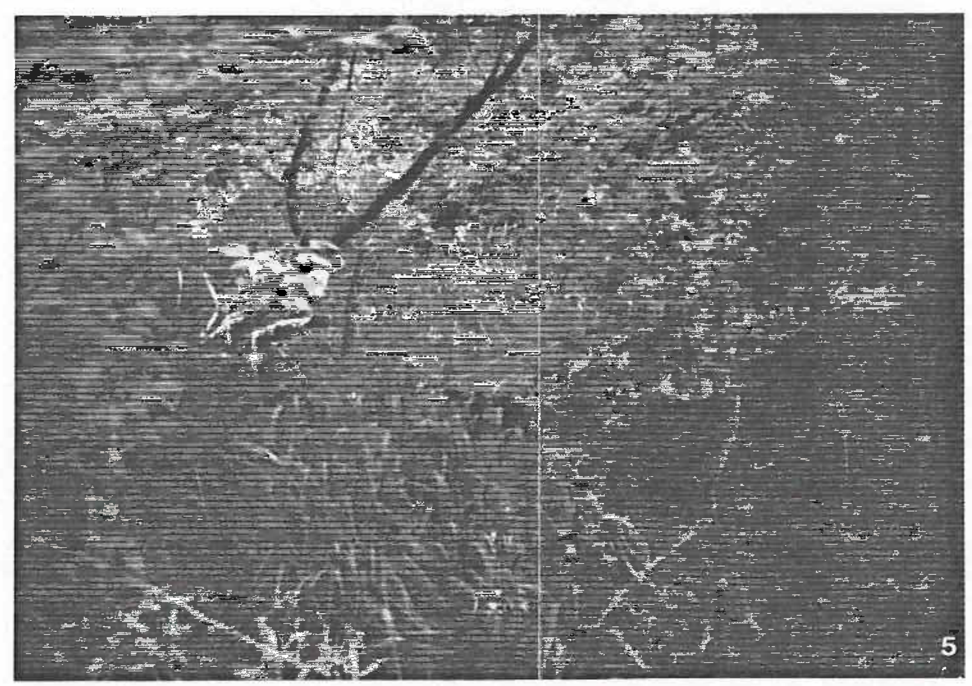
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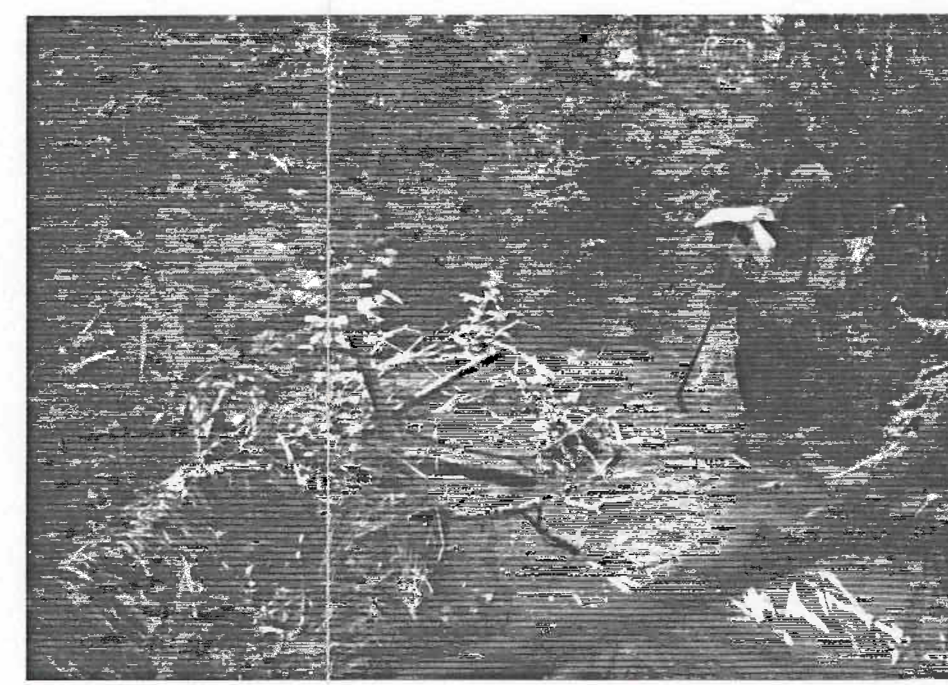
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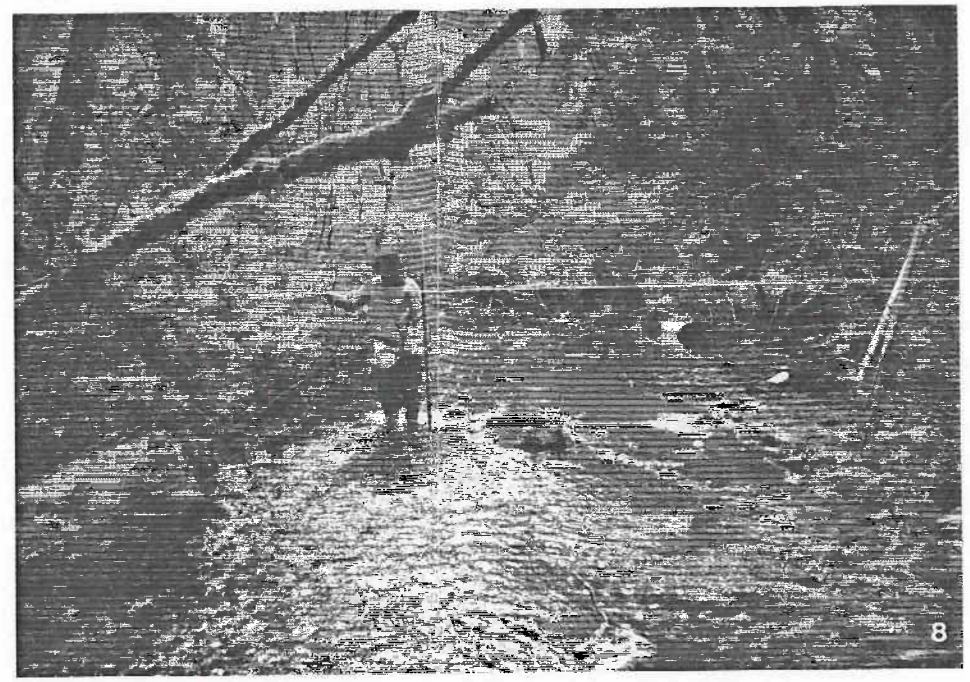
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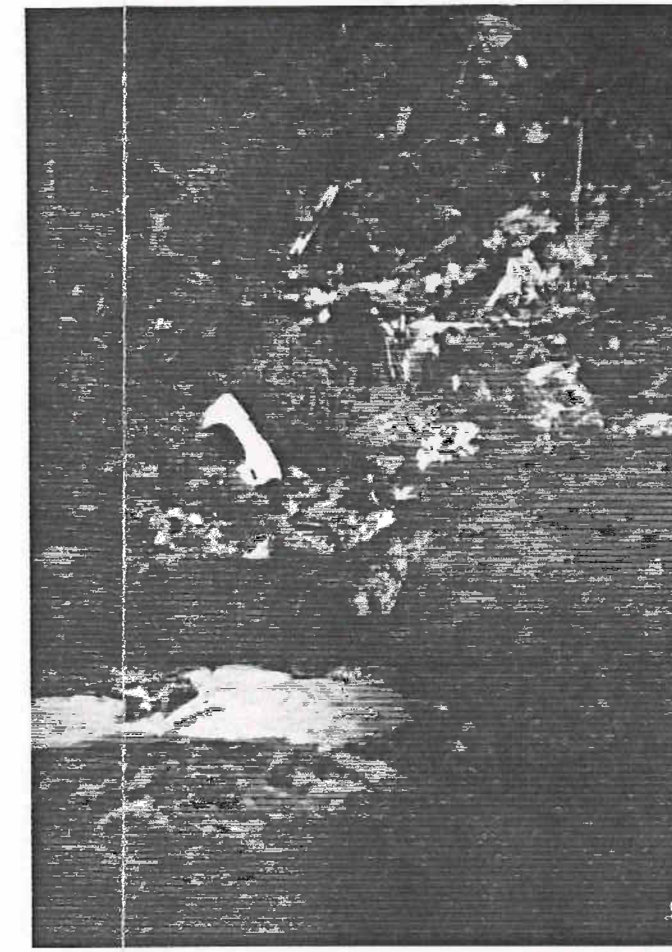
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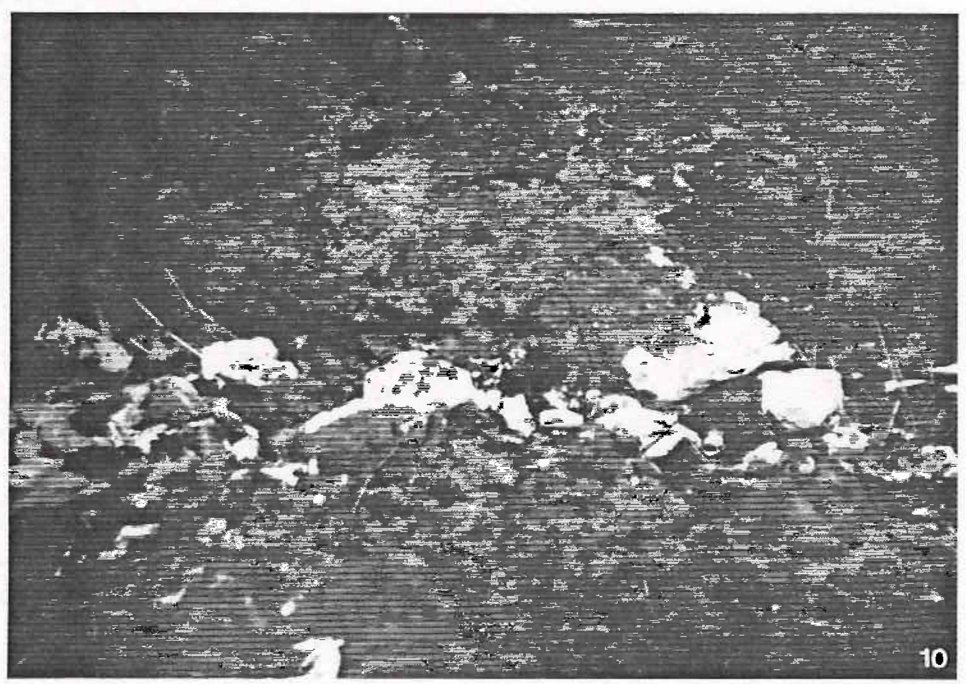
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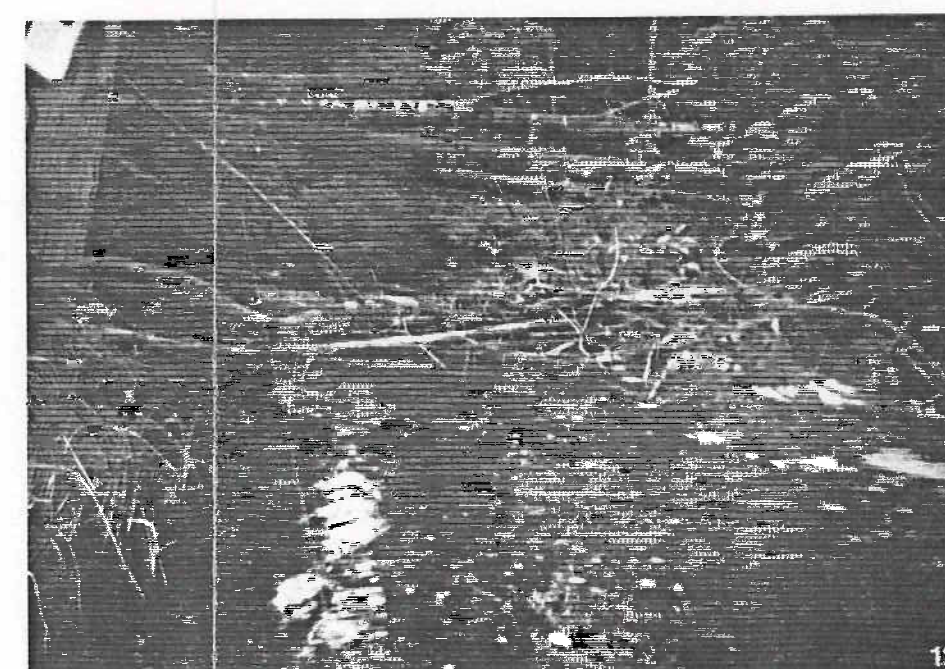
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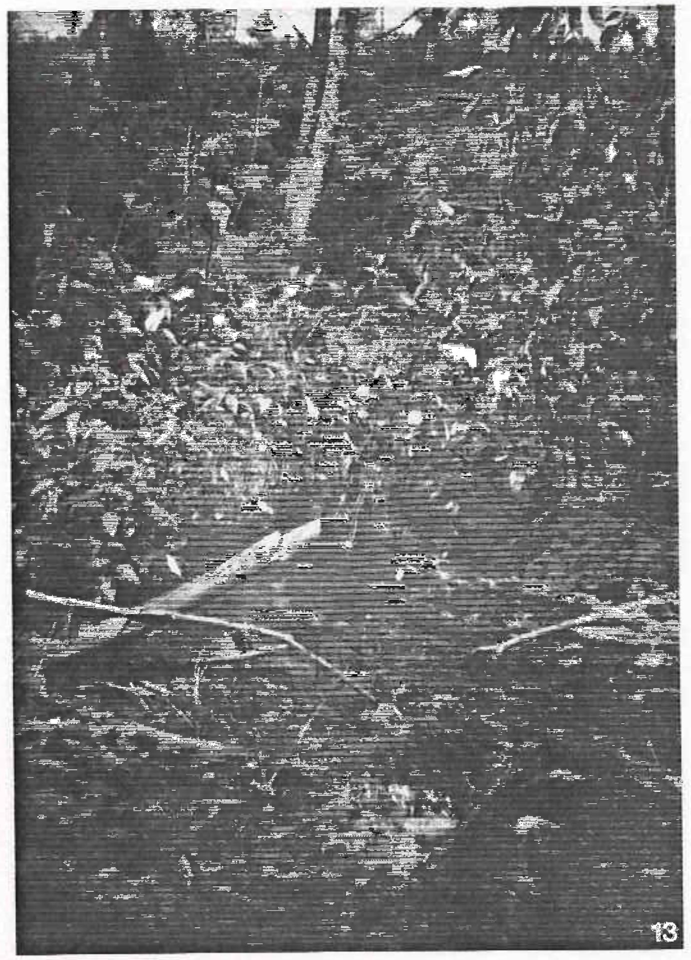

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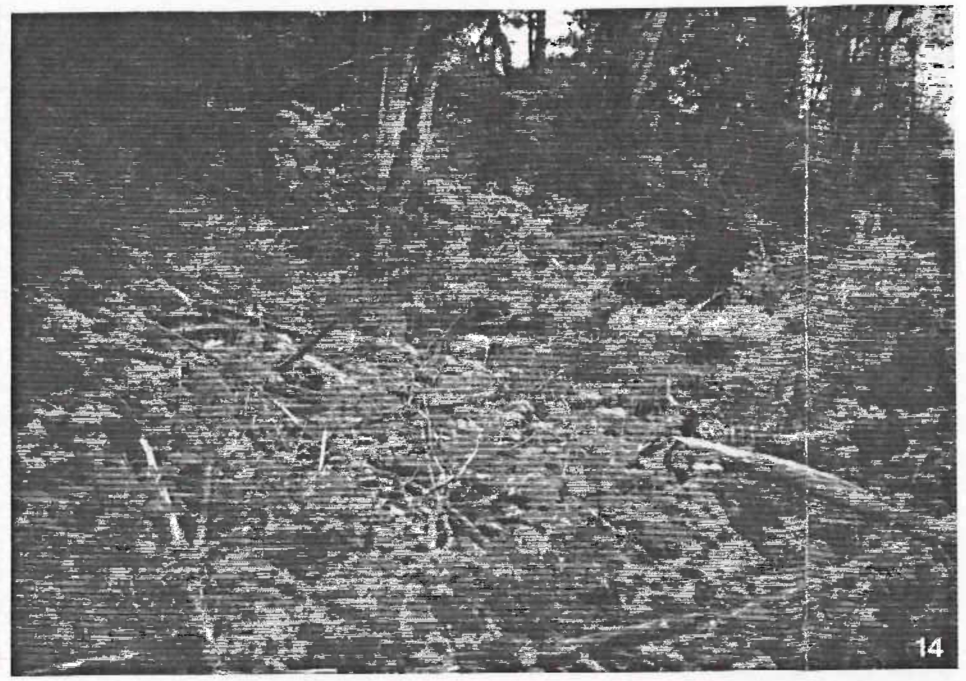

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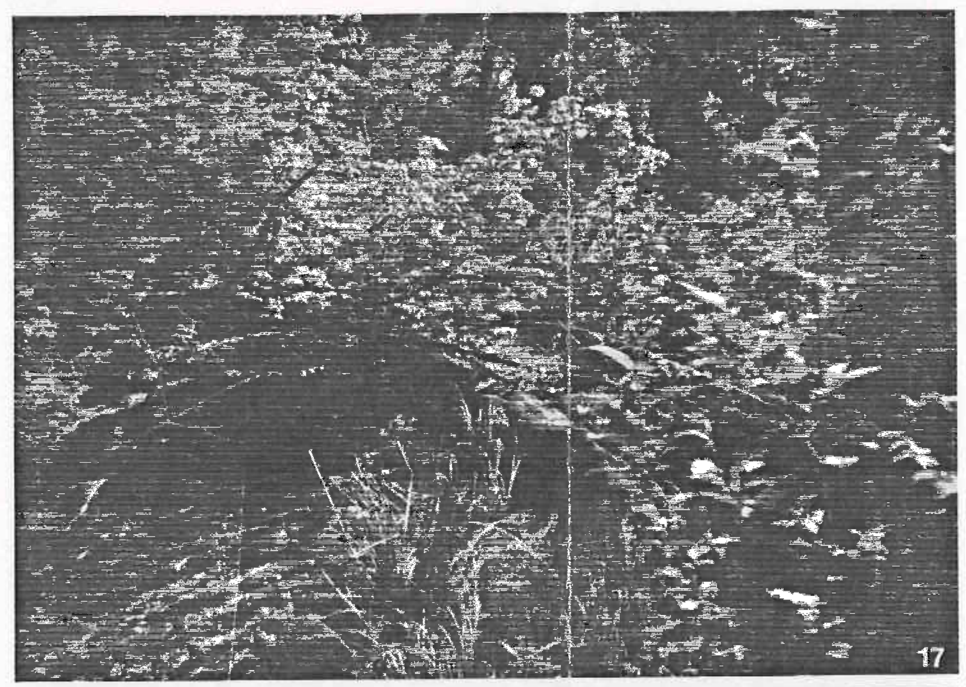

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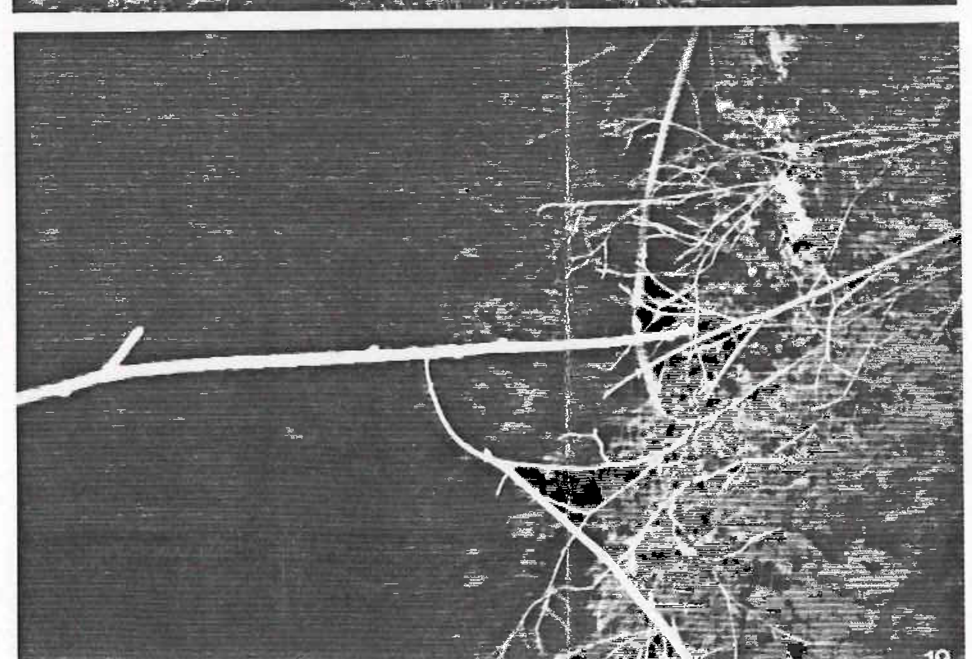

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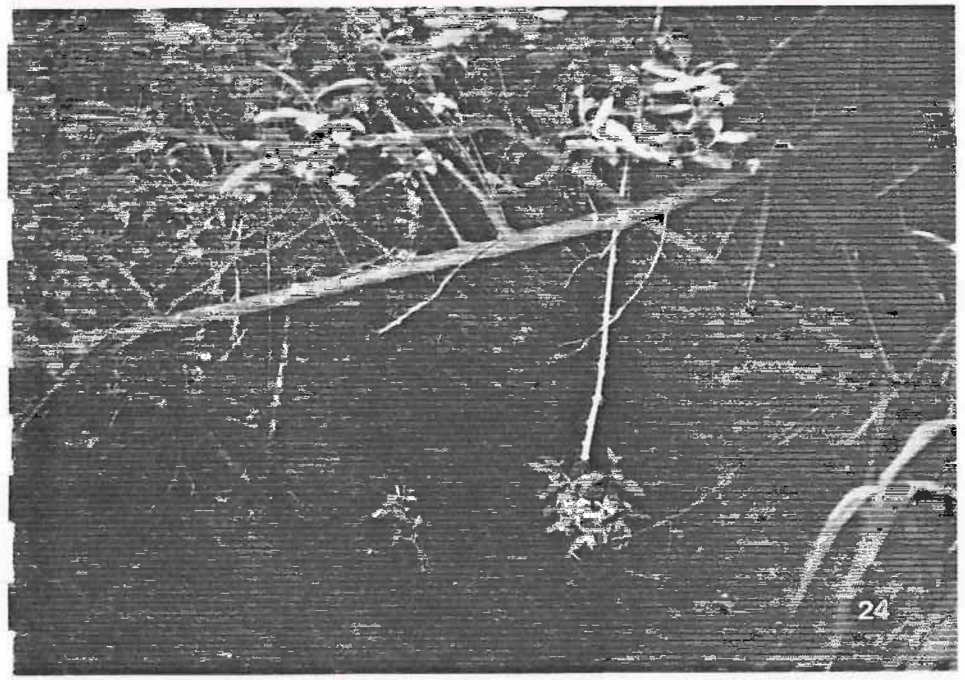
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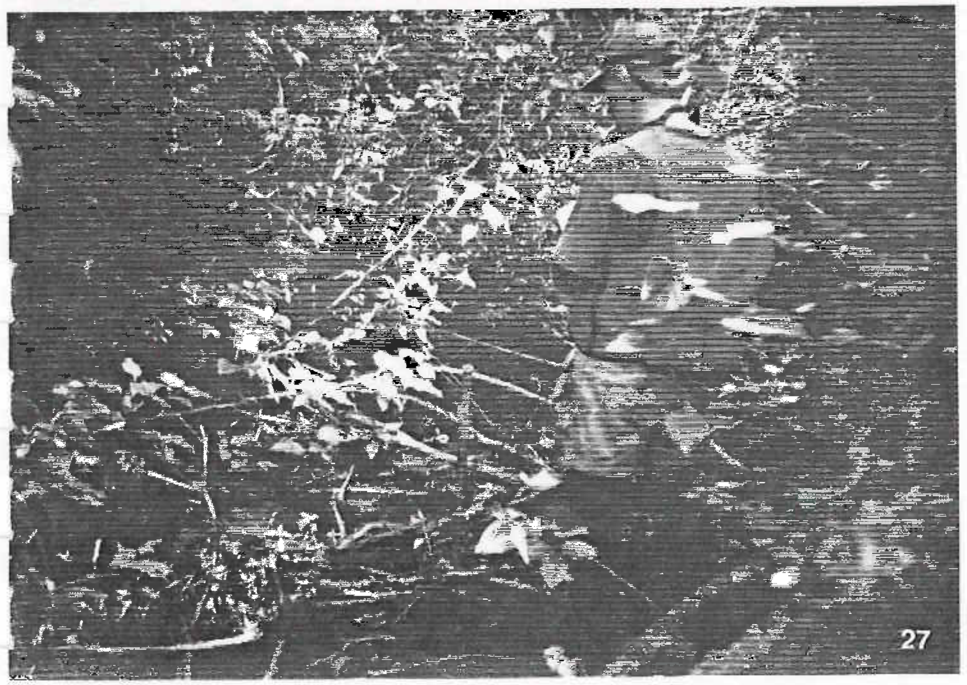
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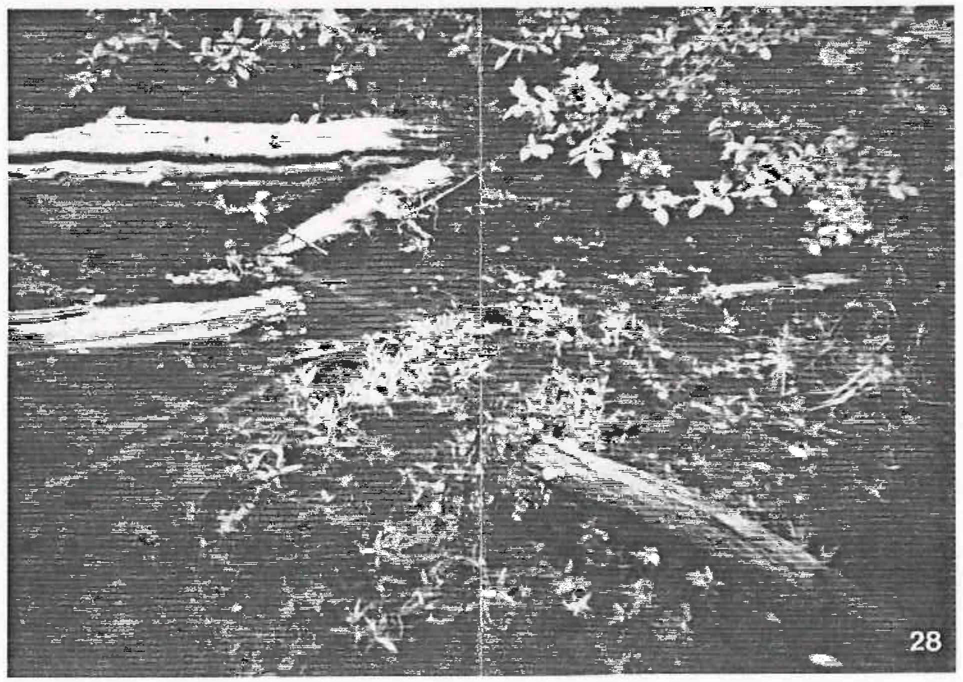
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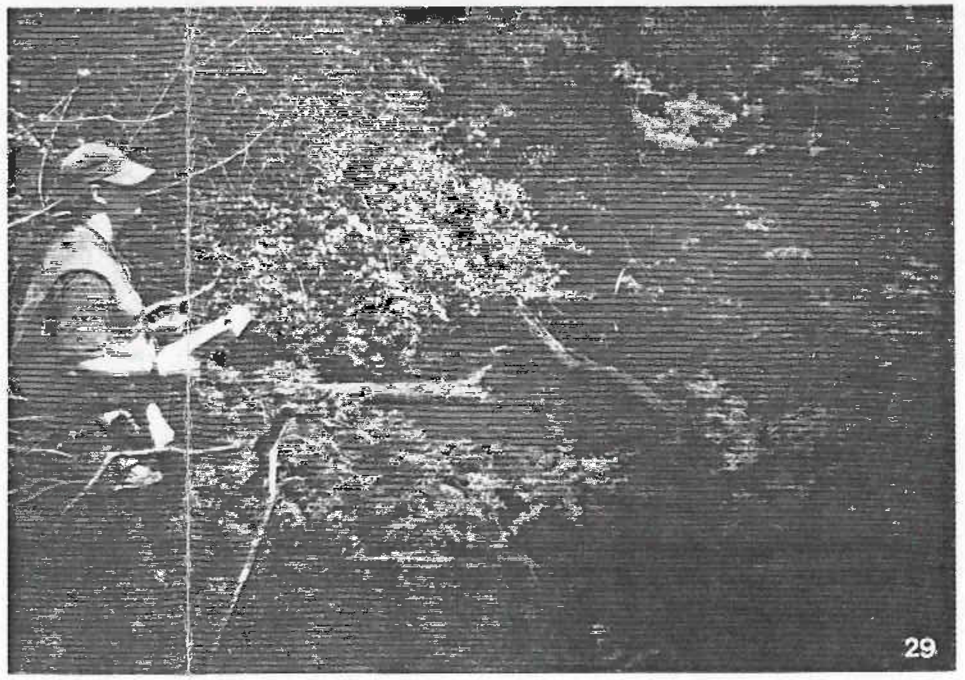
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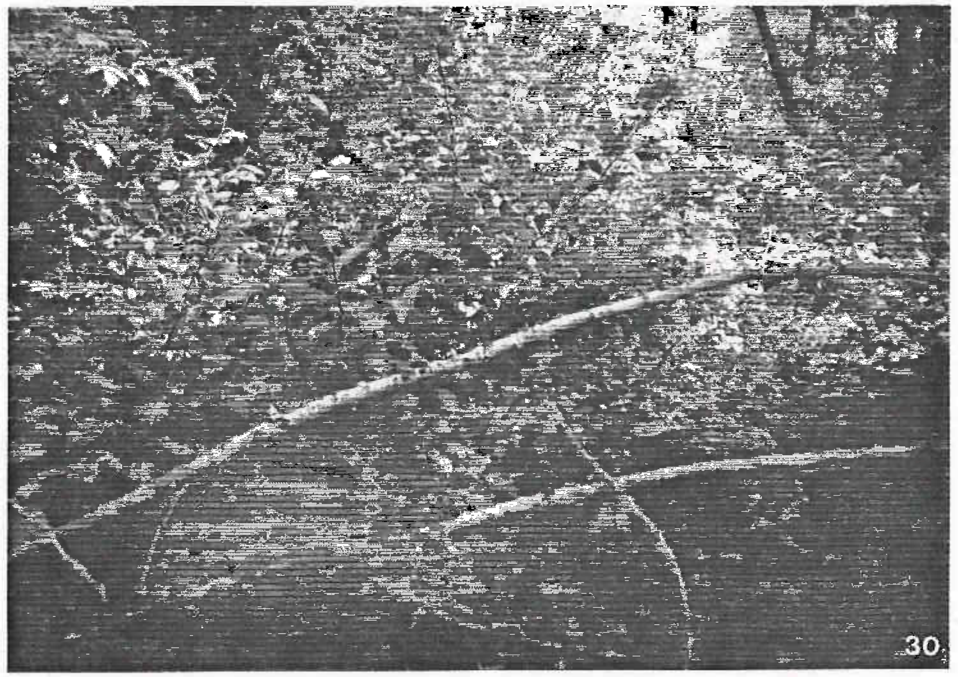
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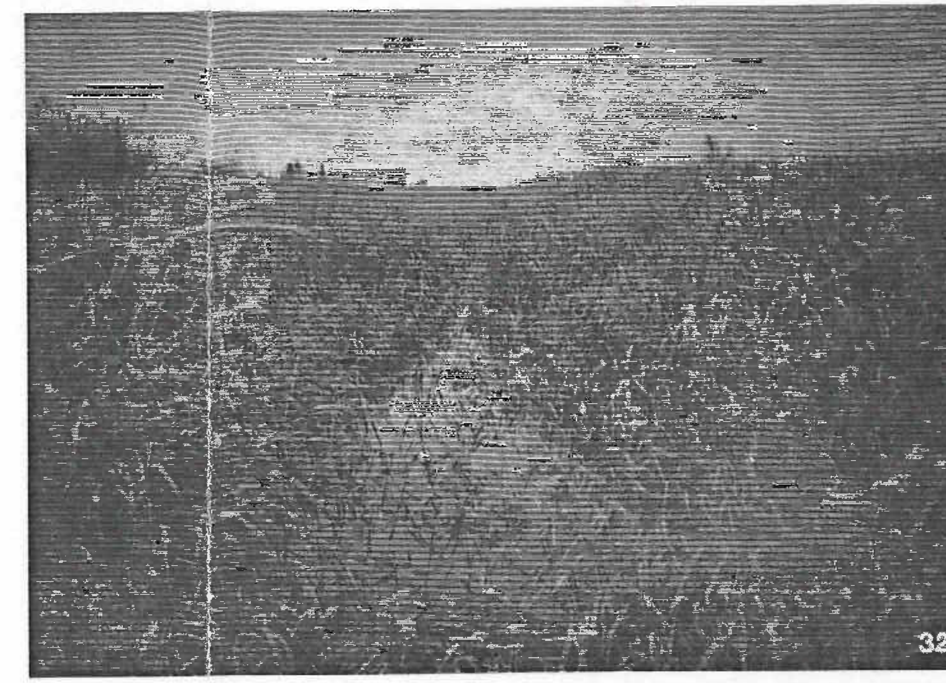
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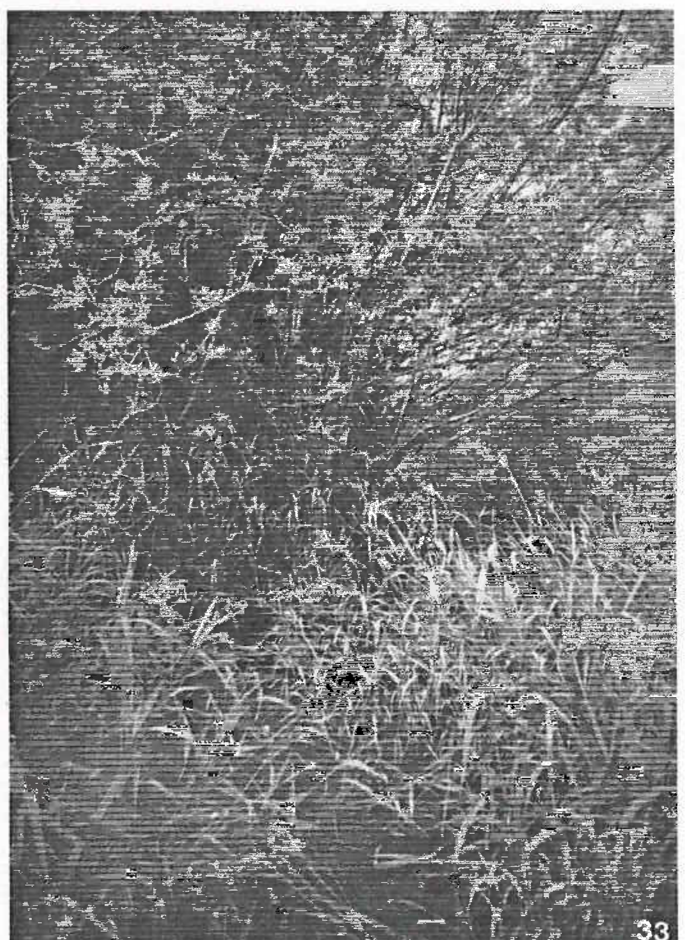
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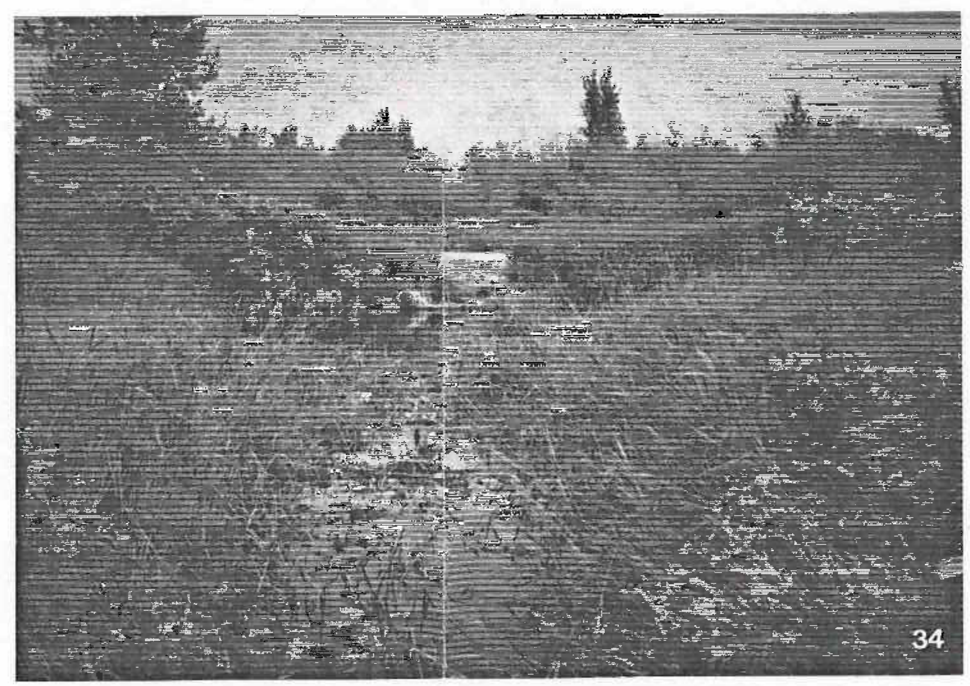
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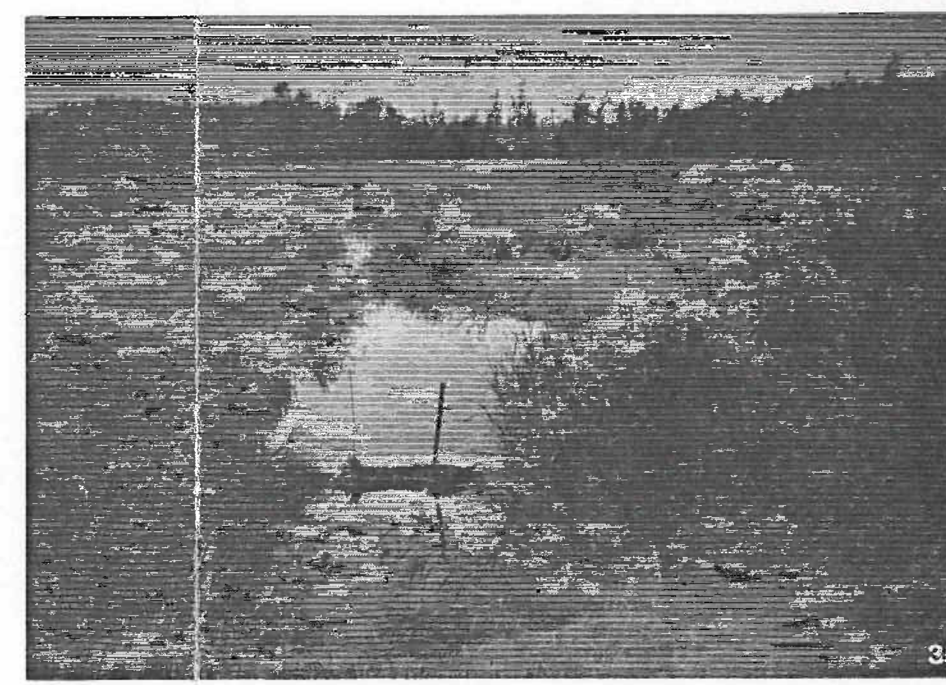
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CHERRY POINT NATURAL RESOURCES BASELINE STUDIES

AMPHIBIAN SURVEY

APPENDIX C

List of Common and Scientific Names for Plants and Wildife

Table C-1: LIST OF COMMON AND SCIENTIFIC NAMES FOR WILDLIFE

Common Name	Scientific Name
Fish	
chum salmon	*Oncorhynchus keta*
coho salmon	*Oncorhynchus kisutch*
cutthroat trout	*O. clarki*
three-spine stickleback	*Gasterosteus aculeatus*
sculpin	*Cottus* sp.
largescale sucker	*Catostomus macrocheilus*
long-nosed dace	*Rhinicthys cataractae*
western brook lamprey	*Lamptera richardsoni*
Mammals	
mink	*Mustela vison*
black-tailed deer	*Odocoileus hemionus columbianus*
raccoon	*Procyon lotor*
shrew	*Sorex* spp.
vole	*Microtus* spp.
deer mouse	*Perpmyscus maniculatus*
weasel	*Mustela* spp.
skunk	*Mephitis hudsonica*
Amphibians	
ensatina	*Ensatina eschscholtzii oregonensis*
western red-back salamander	*Plethodon vehiculum*
red-legged frog	*Rana aurora*
Birds	
red-tailed hawk	*Buteo jamaicensis*
black-capped chickadee	*Parus atricapillus*
song sparrow	*Melospiza melodia*
western flycatcher	*Empidonax difficilis*
downy woodpecker	*Picoides pubexscens*
rufous-sided towhee	*Pipilo erythrophthalmus*
Swainson's thrush	*Catharus ustulatus*
cedar waxwing	*Bombycilla cedrorum*
white-crowned sparrow	*Zonotrichia leucophrys*
American robin	*Turdis migratorius*
bushtit	*Psaltriparus minimus*
golden crowned kinglet	*Regulus satrapa*
ruby crowned kinglet	*Regulus calendula*
hairy woodpecker	*Picoides villosus*
willow flycatcher	*Empidonax traillii*
red-eyed vireo	*Vireo olivaceus*
evening grosbeak	*Hesperiphona vespertina*

Table C-2: LIST OF COMMON AND SCIENTIFIC NAMES FOR PLANTS

Common Name	Scientific Name
salmonberry	*Rubus spectabilis*
Indian plum	*Oemleria cerasiformis*
Pacific blackberry	*Rubus ursinus*
red elderberry	*Sambucus racemosa*
Pacific ninebark	*Physocarpus capitatus*
red alder	*Alnus rubra*
black cottonwood	*Populus trichocarpa*
big-leaf maple	*Acer macrophyllum*
Douglas fir	*Pseudotsuga menziesii*
western red cedar	*Thuja plicata*
grand fir	*Abies grandis*
red-osier dogwood	*Cornus stolonifera*
vine maple	*Acer circinatum*
willow	*Salix* sp.
Pacific water-parsley	*Oenanthe sarmentosa*
American speedwell	*Veronica americana*
reed canarygrass	*Phalaris arundinacea*

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1. INTRODUCTION

Pacific International Terminals proposes construction and operation of the Gateway Pacific Terminal (GPT), a bulk loading facility at Cherry Point in Whatcom County, Washington. The proposed terminal would be located between the Arco and Intalco piers. Development of the site would include construction of roads and storage areas on the upland portion of GPT's site. Several surveys have been conducted to assess potential impacts of the project on environmental resources. This report describes a survey for amphibians (salamanders and frogs) conducted in May 1993.

The frequent rain and mild climate of the Pacific Northwest create conditions favorable to amphibians. Five families of salamander (*Plethodontidae, Ambystomatidae, Dicamptodontidae, Rhyacotritonidae, and Salamandridae*) occur in Washington and Oregon. Up to 11 species of salamander occur at some locations (Leonard, et al., 1993). Five families of frog also occur in the Northwest; however, representatives from only three of these families – *Bufonidae, Hylidae, and Ranidae* – may occur in the project vicinity (Leonard, et al., 1993).

Based on range and distribution maps, 10 species of amphibians could occur in the vicinity of the proposed project at Cherry Point (Nussbaum, et al., 1983; Leonard, et al., 1993). Many of these species are associated with mature and old growth coniferous forests that provide large volumes of downed logs and other debris for abundant hiding cover (Nussbaum, et al., 1983). The absence of old growth forests in the project area reduces the number of species that may occur on the GPT site. Most of the site is dominated by young deciduous forest and open fields. These areas have very little large woody debris on the ground and do not contain high-quality amphibian refugia, such as large slabs of bark and large, rotten, downed logs. Wetland areas throughout the site provide abundant breeding and rearing habitat for pond-breeding amphibians, such as the northwestern salamander (*Ambystoma gracile*) and Pacific treefrog (*Pseudacris regilla*), however.

The survey was conducted at the request of resource agencies and the project proponent to assess existing habitat conditions and amphibian distribution on the Cherry Point site.

2. METHODS

2.1 SITE RECONNAISSANCE

Aerial photographs and habitat information gathered during wetland studies at the site were used to identify target survey areas (streams and habitats to be sampled with Timed Constraint Surveys). Survey areas were distributed throughout the site to sample habitats most representative of the project area.

2.2 LITERATURE REVIEW

Prior to initiation of field surveys, applicable literature was reviewed, including *Amphibians and Reptiles of the Pacific Northwest* (Nussbaum, et al., 1983), *A Field Guide to Western Amphibians and Reptiles* (Stebbins, 1985), "Aquatic amphibian communities in Washington and Oregon" (Bury, et al., 1991a), and "Regional patterns of terrestrial amphibian communities in Oregon and Washington" (Bury, et al., 1991b). In addition, the Washington Department of Wildlife and the U.S. Fish and Wildlife Service were contacted for information about amphibians (and other threatened or endangered species) in the project area. A recent publication titled *Amphibians of Washington and Oregon* (Leonard, et al., 1993) also was reviewed for pertinent background and distributional information.

2.3 FIELD SAMPLING METHODS

Field sampling methods are based on techniques described in Corn and Bury (1990) and Bury and Corn (1991). All species identifications are based on Nussbaum, et al. (1983) and Leonard, et al. (1993).

2.3.1 Timed Constraint Surveys

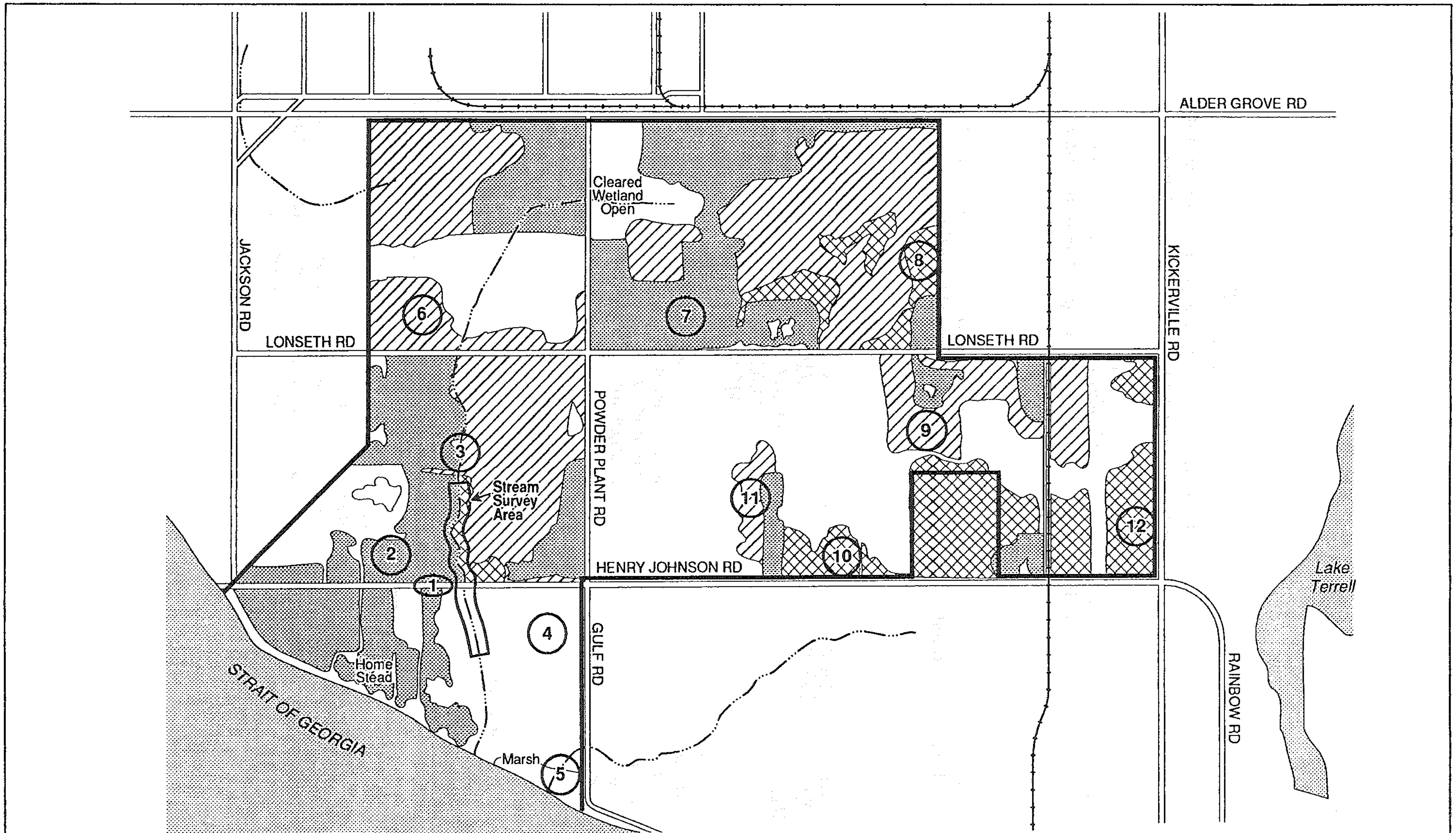
Prior to initiating field surveys, each habitat type at the Cherry Point site was delineated on maps to minimize time used for sample site selection. Timed constraint surveys were conducted in each major habitat type following field reconnaissance to verify habitat conditions and suitability for the surveys.

Sites (plots) were selected for the survey to provide an assessment of inter- and intra-site variability in amphibian populations. Several habitat types were selected for the survey with sample plot distribution as follows: Young Forest - plots 9 and 11; Forest - plots 4, 6, 8, 10, and 12; Open Field - plots 2 and 7; Estuarine Marsh - plot 5; Roadside Ditch - two 100-foot lengths at plot 1; and Riparian - plot 3 (sampled intensively during the stream survey - see below) (Figure 1).

Each survey plot consisted of an approximately 100-foot-radius circle at least 200 feet from habitat edges. The plots were divided into two equal portions or sub-plots. Forty-five minute timed searches were conducted by two scientists at each of the designated sample plots (a total of 22 sub-plots) equaling approximately 15 hours of timed constraint searches (approximately 75 minutes per plot). Methods of searching followed those described in Corn and Bury (1990). When possible, amphibians and reptiles found during the surveys were captured, by hand or net. Data recorded included species, weight, snout-vent length, total length, tail length, age, and general condition. Additional variables recorded included microhabitat features of capture location, weather, and general site characteristics.

2.3.2 Stream Survey

The unnamed creek located on the site was searched for aquatic amphibians generally following collection methods described in *Sampling Methods for Amphibians in Streams in the Pacific Northwest* (Bury and Corn, 1991). Representative sections of the creek were identified and used as sample areas (Figure 1). The creek sample areas were searched by turning over large objects (such as rocks and large woody debris) and searching through gravel (where present) with a potato rake. All objects moved during the searches were replaced in their original position before moving on. A second person held a dip net downstream to collect any amphibians (or other aquatic species) carried by the flow. Additionally, portions of the riparian-vegetated stream border were searched by turning over bark, logs, and other debris, and by raking through leaf litter with a hand rake. Species, snout-vent length, total length, weight, tail length, and general condition were recorded for each captured animal.



LEGEND:

- Pasture
- Young Deciduous Forest
- Mature Deciduous Forest
- Recently Cleared/Logged (Unless Otherwise Noted)
- Stream Survey Area
- 4 Survey Plot Area

0 600 1200
Scale in Feet

SHAPIRO & ASSOCIATES INC

FIGURE 1

HABITAT TYPES AND SURVEY PLOT LOCATION MAP

CHERRY POINT

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3. RESULTS

3.1 TIMED CONSTRAINT SURVEYS

Four species of amphibian and one species of reptile were observed during the timed constraint surveys at the Cherry Point site (Table 1) on May 11, 1993. Additionally, large numbers of *Ranid* and *Pseudacris* tadpoles were collected and observed in several locations at the site, particularly in roadside ditches, in the estuarine marsh, in open fields, and in forest habitats. No amphibians were observed at sites located within young forest habitat (Table 1). Large numbers of three-spined stickleback (*Gasterosteus aculeatus*) fish also were observed in the estuarine marsh.

The northwestern salamander was found under a large slab of bark from a remnant of fallen oldgrowth western red cedar (*Thuja plicata*). One long-toed salamander was found under moss on a large, downed log, and the other was found at the edge of a small pond within a forested wetland.

Table 1: AMPHIBIANS AND REPTILES OBSERVED AT THE CHERRY POINT PROJECT SITE DURING TIMED CONSTRAINT SURVEYS*

Roadside Ditch	Open Field	Riparian	Young Forest	Forest	Estuarine Marsh
RAsp	THOR	AMGR	-	PSRE	RAsp
THOR	PSRE			AMMA (2)	
				RAAU	
				THOR	

* Species listed in table by code as follows:

AMGR	*Ambystoma gracile*	northwestern salamander
AMMA	*Ambystoma macrodactylum*	long-toed salamander
PSRE	*Pseudacris regilla*	Pacific treefrog
RAAU	*Rana aurora*	red-legged frog
RAsp	*Rana* species	
THOR	*Thamnophis ordinoides*	western terrestrial garter snake

3.2 STREAM SURVEY

Only one species of amphibian (red-legged frog) was observed during the stream survey. A total of five frogs were seen, and four of these were captured. All were located adjacent to the creek, either under overhanging vegetation or resting on the mud banks. Very few aquatic invertebrates were captured with the dip net, and only one caddis fly (*Trichoptera*) larvae was found. Water striders (*Gyridae*) were extremely common, and several water beetles (*Dytiscidae*) also were observed. Throughout the survey and in most areas of the creek corridor and channel, slugs, earthworms, and snails (aquatic and terrestrial) were abundant. Many pools located within the creek channel contained three-spined stickleback fish. No other species of fish were either captured or observed.

4. DISCUSSION

Although overall numbers of amphibians captured or observed at the Cherry Point site were low, it is expected that additional species could occur in the area. Up to 10 species of amphibian could occur on the project area, based on range and distribution accounts in Leonard, et al. (1993) and Nussbaum, et al. (1983).

An important characteristic of the Cherry Point site is the scarcity of large, downed, woody debris that typically provides refugia for amphibians (particularly salamanders) during warm and cold weather. Most of the timed constraint searches involved sifting through layers of leaf litter, which provides only marginal habitat for amphibians. The timed-constraint surveys were conducted in May, when ground conditions were relatively wet and generally favorable to amphibian populations (Nussbaum, et al., 1983).

Ranid and *Pseudacris* tadpoles were found in many locations throughout the project area where stagnant water pools had formed, and in the estuarine marsh adjacent to Gulf Road (Figure 1). In addition to the tadpole populations, the high number of treefrog vocalizations heard on several occasions during site visits to the area indicate that a relatively large adult frog population likely exists at the site. The low number of salamanders observed during both the timed constraint and stream surveys, however, may be indicative of poor-quality habitat, even though large areas of wetland area are present.

The two species of salamander observed at the project site are widespread in western Washington and occur from sea level to over 6,000 feet in elevation (Leonard, et al., 1993). Both the northwestern salamander and long-toed salamander are pond breeders that attach their eggs to sticks or submerged vegetation in either temporary or year-round ponds. They commonly use subterranean refugia, such as rodent burrows, during summer and cold winter periods (Leonard, et al., 1993). Long-toed salamanders are infrequently seen because of their subterranean habits, however, they can be found in a variety of habitats, including lowland forests, disturbed pastures, high elevation lakes and ponds, and residential greenbelts. Northwestern salamanders often can be encountered aboveground during rainy periods in winter and early spring, but retreat to moist crevices, rodent burrows, and rotting logs during dry seasons (Leonard, et al., 1993). Habitats at the project site are suitable for these salamanders (particularly the long-toed salamander), where the predominant vegetation cover is disturbed pasture, recently logged areas, and young deciduous forests (Figure 1).

Similarly, the two species of frog observed at the site are common and widespread in western Washington and occur in a variety of habitat types. Red-legged frogs are primarily terrestrial in habit, while the Pacific treefrog uses a wide range of habitats and can be found in ponds, woodlands, pastures, and meadows (Leonard, et al., 1993). These habitat types are common throughout the project site (Figure 1). Both the red-legged frog and the Pacific treefrog commonly breed in seasonal and/or year-round wetlands where eggs are attached to submerged emergent vegetation.

Six additional amphibian species are indicated on distributional maps as possibly occurring in the vicinity of the project area. Most of these species, however, are not likely to be common to the area. Two species, the Pacific giant salamander (*Dicamptodon tenebrosus*) and western redback salamander (*Plethodon vehiculum*), are most commonly found in coniferous forest habitat, which does not occur on the project site. The bullfrog (*Rana catesbeiana*), an introduced exotic species, is highly aquatic. If it occurs on the site, it would likely be limited to the estuarine marsh area because no other suitable areas exist on the site. The ensatina (*Ensatina eschscholtzii*) most commonly occurs under bark or other woody debris generally found in mature forest habitats, of which there is relatively little at the site. This may be a factor in the absence of this species during the surveys (Figure 1). The remaining species, the western toad

(*Bufo boreas*), may possibly occur on the site because it is commonly found near marshes and small lakes, but it also can be found in terrestrial habitats (Leonard, et al., 1993; Nussbaum, et al., 1983). The rough-skinned newt (*Taricha granulosa*) may also occur at the site, as they are commonly found in forest habitats far from water. Their eggs are usually laid in shallow water habitats and are attached to submerged vegetation. No newts were observed during the surveys, however. It is possible that they occur on the site and may inhabit areas adjacent to the large estuarine marsh adjacent to Gulf Road (Figure 1).

None of the amphibians observed during the survey (or those possibly occurring on the project site) are listed as sensitive, threatened, or endangered by the Washington Department of Wildlife or the U.S. Fish and Wildlife Service. Habitats at the project site are limited in their suitability to many amphibian species because of the lack of mature forested cover, scarce large logs and woody debris, abundant pasture and disturbed areas, and few temporary or seasonal pools for breeding and egg-laying (Nussbaum, et al., 1983; Leonard, et al., 1993).

5. LITERATURE CITED

Bury, R.B., P.S. Corn, and K.B. Aubry (and others), 1991a. "Aquatic amphibian communities in Washington and Oregon." In: Ruggiero, L.F., K.B. Aubry, A.B. Carey, M.H. Huff, tech. coords. *Wildlife and Vegetation of Unmanaged Douglas-fir Forests*. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 353:362.

Bury, R.B., P.S. Corn, and K.B. Aubry, 1991b. "Regional patterns of terrestrial amphibian communities in Oregon and Washington." In: Ruggiero, L.F., K.B. Aubry, A.B. Carey, M.H. Huff, tech. coords. *Wildlife and Vegetation of Unmanaged Douglas-fir Forests*. Gen. Tech. Rep. PNW-GTR-285. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 353:362.

Bury, R.B., and P.S. Corn, 1991. *Sampling Methods for Amphibians in Streams in the Pacific Northwest.* General Technical Report PNW-GTR-275. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. 29 pp.

Corn, P.S., and R.B. Bury, 1990. *Sampling Methods for Terrestrial Amphibians and Reptiles.* General Technical Report PNW-GTR-256. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. 34 pp.

Leonard, W.P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm, 1993. *Amphibians of Washington and Oregon.* Seattle Audubon Society. Seattle, Washington. 168 pp.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm, 1983. *Amphibians and Reptiles of the Pacific Northwest.* University Press of Idaho, Moscow, Idaho. 332 pp.

Stebbins, R.C., 1985. *A Field Guide to Western Reptiles and Amphibians*. Boston: Houghton Mifflin Company. 336 pp.