

Monitoring Human-Wildlife Interactions and  
Disturbance of Seabirds and Pinnipeds at  
Three Arch Rocks National Wildlife Refuge, 1993 - 1994



Oregon Department of Fish and Wildlife  
Wildlife Diversity Program

MONITORING HUMAN-WILDLIFE INTERACTIONS  
AND DISTURBANCE OF SEABIRDS AND PINNIPEDS  
AT THREE ARCH ROCKS NATIONAL WILDLIFE  
REFUGE, 1993 - 1994

Susan D. Riemer  
Robin F. Brown

Oregon Department of Fish and Wildlife  
Wildlife Diversity Program  
Marine Region, Newport OR.  
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## ABSTRACT

Concern for disturbance of marine birds and mammals on the National Wildlife Refuges along the Oregon coast has increased with the growing use of the nearshore ocean. In the process of developing a Territorial Sea Plan, Oregon's Ocean Policy Advisory Council directed a cooperative Oregon Department of Fish and Wildlife/U. S. Fish and Wildlife Service study to assess the level of human-wildlife interactions at Three Arch Rocks National Wildlife Refuge. From May through September of 1993 and 1994, observations of human activities and wildlife responses were recorded. Observations were made from mainland overlooks using high-powered binoculars and telescopes. Data collected included presence and activities of sport and commercial motorized and non-motorized vessels, and aircraft over-flights. Vessel activities were recorded as occurring within 500 feet of the rocks (zone 1), between 500 and 2,000 feet (zone 2), and beyond 2,000 feet (zone 3). Wildlife disturbance reactions were classified as type A - alerted (aware), type B - agitated (movement), or type C - threatened (flight). Recreational boating, fishing and diving were the most frequently observed activities in the study area. In 1993, a total of 68 and 100 observed disturbance events were related to vessel and aircraft activities, respectively. Over 98% of the disturbances caused by vessels occurred within zone 1. As a result, in 1994 a 500 foot seasonal closure (May 1 to September 15) to vessel traffic was implemented around the refuge. A variety of methods were used to inform the public of this closure, including permanent signs, posters and pamphlets. The purpose of the 1994 study was to monitor the effectiveness of the 500 foot buffer zone in preventing disturbance to wildlife. Observations conducted in 1994 were centered on weekends and holidays, when human presence in the area was known to be high (87% of all disturbance events observed in 1993 occurred on weekends and holidays). The 1994 observations indicated that most boaters did not enter the 500 foot buffer zone. Observers recorded a total of 23 disturbance events by vessels and 11 by aircraft in 1994, which represented a 39% reduction from 1993 in disturbance events observed on weekends and holidays.

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## INTRODUCTION

Tourism and sport fishing activities in Oregon's nearshore ocean waters have increased over a number of years. Three Arch Rocks National Wildlife Refuge (TAR) has become a popular area for recreational fishing and sight-seeing activities. In 1979 the first recorded disturbances at TAR were observed by U. S. Fish and Wildlife Service (USFWS) personnel. Following the increase in activity and disturbance events, the community, and the state and federal management agencies became concerned for the wildlife species that depend on the area. The importance of this site to Oregon seabirds has been well documented by the USFWS. TAR also represents one of only three breeding sites for the threatened Steller sea lion in Oregon.

Due to their breeding characteristics seabirds and pinnipeds can be negatively impacted by human disturbance. When disturbance events occur in seabird colonies the birds may flee from their nests leaving eggs and chicks unprotected from predators and adverse weather conditions. Eggs and chicks may also be accidentally knocked off the rocks or moved into another bird's territory where it may be attacked or killed (Lowe, pers. comm.; Speich et al. 1987). When disturbance events force sea lions to leave their rookeries, pups can be crushed or separated from the female (Calkins and Pitcher 1982; Lewis 1987). Additional disruption occurs due to the temporary loss and re-establishment of territories held by breeding males. Continued disturbance could result in a reduction in pup survival and/or avoidance of the site by breeding animals in the future (Brown, pers. comm.; Kenyon, 1962). The long-term effects of chronically occurring disturbance events are not well understood, but the potential for negative impacts to marine bird and mammal reproductive success does exist.

In the spring of 1993, Oregon's Ocean Policy Advisory Council (OPAC) requested that Oregon Department of Fish and Wildlife (ODFW) examine wildlife disturbance at TAR as a case study on management of human activities around Oregon's National Wildlife Refuge rocks and islands. This project was a

cooperative effort of the ODFW Nongame Program, the USFWS Nongame Program and the Department of Land Conservation and Development Ocean Resources Program. The project was conducted by ODFW and USFWS staff. The objective of this study was to characterize the nature of human activities around the refuge and to document the extent to which disturbance to marine birds and mammals was occurring.

## STUDY AREA AND METHODS

TAR is located approximately 1/2 mile offshore from the town of Oceanside in Tillamook County, Oregon. The refuge is comprised of three large rocks and six smaller rocks totaling 17 acres of land above mean high water. TAR was established as the first national wildlife refuge west of the Mississippi River on October 14, 1907. Further protection was provided when the area was given wilderness status on October 23, 1970, placing it in the Oregon Islands Wilderness Area. Management of the refuge was enhanced when the Oregon Coastal Wildlife Refuge office was established in 1985.

Various federal and state laws protect TAR and the wildlife resources utilizing the area. Refuge lands are protected under the authority of the National Wildlife Refuge Administration Act of 1966, which prohibits trespass and restricts other activities from occurring on the refuge. Seabirds and marine mammals are further protected by one or more of the following federal acts: the Migratory Bird Treaty Act, Endangered Species Act and the Marine Mammal Protection Act. All of these acts restrict the "take" of any wildlife covered by these regulations. State wildlife policy requires the State of Oregon to maintain all species of wildlife at optimum levels and prevent the serious depletion of any indigenous species. All protected, threatened or endangered wildlife are protected by Oregon Administrative Rule 635-44-130.

The refuge is used by 13 species of nesting seabirds and marine mammals (Appendix A), and is the largest seabird nesting colony in Oregon. An estimated

20,000 common murrelets nest at this site annually, making it the largest colony south of the Alaskan peninsula (Lowe and Pitkin, 1996). TAR is also used by five threatened or endangered bird species. Three species of pinnipeds are found at TAR, including the Steller sea lion. Two to three hundred Steller sea lions use this area as a haulout and breeding site, and three to six pups have been born here each year since the early 1980's (Brown, 1988; Brown and Riemer, 1992). Oregon currently has a stable population of about 3,500 Steller sea lions and the majority of pupping takes place on the southern Oregon coast. TAR is the only north coast pupping site for this species in Oregon.

May through September was chosen as the study period during both 1993 and 1994 to cover the nesting and breeding season when animals are most sensitive to disturbance. This period was also expected to coincide with the highest levels of human activity in the area. Observers were scheduled in 1993 to monitor and record human activities and wildlife reactions during daylight hours on weekends, holidays and 3 - 4 weekdays (observations were delayed or limited on days when weather conditions restricted visibility). After reviewing the 1993 study results, it was decided that 1994 observations would take place on weekends and holidays in order to provide the best coverage of expected peak vessel and aircraft activities (in 1993, 87% of all vessel disturbances occurred on a weekend or holiday).

The 1993 TAR study also concluded that Steller sea lions and seabirds using this refuge as a breeding site were sensitive to disturbance by vessels occurring within 500 feet of the principle rocks and from aircraft flying at low altitudes over the area (less than 1000 feet Above Ground Level). After reviewing the 1993 study results, OPAC recommended the establishment of a 500 foot seasonal vessel restriction (buffer zone) from May 1 to September 15. This closure was implemented by the Oregon State Marine Board and its effectiveness was monitored during the follow-up study in 1994. Information regarding the closure was distributed by various means prior to the 1994 field season. The objectives of the 1994 TAR study were to educate boaters and aircraft operators about wildlife disturbance problems and to determine the effectiveness of the buffer zone.

Equipment used during observations included a Questar fieldscope with a 32 mm eye piece, binoculars, video recorder and 35 mm camera with telephoto lens. Observations were made from Maxwell Point above Oceanside (approximately 1 mile east of TAR) and from the House on the Hill Motel (approximately 1 mile south east of TAR). Three activity/observation zones were identified to describe the general location of vessels occurring within the study area (Figure 1). Boats observed within 500 feet of the refuge rocks were recorded as having occurred in zone 1; the area outside of 500 feet but within 2,000 feet of the rocks was identified as zone 2; and all other vessels present in the study area beyond 2,000 feet from the rocks were recorded as having occurred in zone 3. To reduce observer variability when estimating distances of boats from the rocks, a photographic catalogue of pictures of a U.S. Coast Guard vessel located at various points around the rocks was developed in 1993. A laser measuring survey device was used to position the Coast Guard vessel at exactly 500 feet from the rocks at each of ten locations around the refuge. These photographs were taken from the two field observation points (House on the Hill Motel and Maxwell Point) using 35 mm cameras with normal and telephoto lenses. The photographs were then used by observers to more consistently estimate if a vessel was in zone 1 or zone 2.

Data collected by observers included: type of vessel (commercial, charter, private), location of vessel (zone), weather and sea conditions, visibility, aircraft type, aircraft lateral distance from the refuge, altitude and direction of flight, and disturbance events (natural and human caused). Disturbance events were categorized by the level of wildlife response. A type A disturbance resulted in wildlife becoming alerted and aware of human presence or activity. A type B disturbance resulted in animals becoming agitated, vocalizing, and/or moving short distances. Type C disturbance events were those that resulted in birds or mammals fleeing from the refuge rocks to the air or water. An field data record sheet is included here as Appendix B.

Aerial photographic surveys were conducted by ODFW to record Steller sea lion numbers at TAR. These sea lion surveys were flown in conjunction with other

statewide pinniped surveys. The USFWS documented seabird use of the study area during annual statewide aerial surveys.

## 1993 STUDY RESULTS

### General Activity Description

Observations of human activities and wildlife disturbances at TAR in 1993 were made from May 1 through September 9. Observations occurred an average of 7.5 hours per day and 5.5 days per week, totaling 782 hours over 104 days (Table 1).

Observed vessel activities were classified as fishing, diving (SCUBA), sightseeing and running (transiting through the area). These observations demonstrated that a variety of recreational activities take place at TAR, the most common being sport fishing. Some commercial crabbing was observed, but most commercial vessels observed were transiting the area. Private and charter SCUBA diving was also a common activity in the area. Large numbers of aircraft were observed to pass over or near TAR. Commercial, private and government fixed-wing aircraft and helicopters were all observed during the study period.

### Fishing

Fishing (sport and commercial in all zones) was the most commonly observed activity in the study area, representing 96.0% of all hours of observed activities. Fishing occurred from commercial vessels, charter boats, private sport boats, dive boats using SCUBA gear, and occasionally from kayaks (kayak activities, including fishing, are considered below under the heading of sightseeing). The majority (90.2% of total hours) of all fishing activity of all types occurred within zone 2. Most of these vessels originated from the Port of Garibaldi in Tillamook Bay, however small numbers of vessels (including kayaks and jet-skis) entered the ocean from Netarts Bay or were launched from the beach at Oceanside.

Recreational (sport) boats applies only to privately owned, relatively small fishing boats and excludes SCUBA and charter fishing activities. Fishing from small

sport vessels represented 67.4% of all observed fishing hours of all types in all zones. The majority of this type of fishing (91.6%) occurred in zone 2. Only 6.8% of sport fishing activities took place in zone 1 (Figure 2).

Charter boat activities consisted of larger fishing vessels carrying sport anglers as a commercial enterprise. When fishing, the majority of the charter boats stayed to the west and south of Shag Rock, located at the southwest corner of the refuge (zone 2). The majority of observed charter boat fishing activity (96.8%) occurred in zone 2 (Figure 2).

Commercial shrimping, groundfish (beach draggers), crabbing and salmon boats were all observed in the study area. The vast majority of the commercial boats observed were transiting through the area. Fishing effort for commercial boats was split between zones 2 and 3, with the majority (61.3%) occurring in zone 2 (Figure 2). Only one commercial boat was recorded in zone 1 during the study period.

Both sport and charter dive (SCUBA) trips were observed at TAR. Of all hours of observed diving activity, 91.9% of the total hours occurred in zone 1 (Figure 2). No diving activity was recorded in zone 3. While within zone 1 these boats tended to operate much closer to the rocks than most other vessels. Activity levels on dive boats was also elevated by people getting into and out of the boats while the boats were anchored close to the rocks.

### Sightseeing Activities

Most vessel types observed including charter, recreational, SCUBA, kayak, and jet ski, engaged in sightseeing activities to some extent. Sightseeing however, made up only 0.5% of the total hours of observed activities at TAR. The majority of this activity occurred within zone 1 (66.5%). Sightseeing boats tended to approach the rocks at slow speeds, but would in many cases, continue to move closer until animals would leave the rocks. Vessel types in this category also included kayaks and jet-skis. One group of three jet-skis were observed on only one observation day, transiting through all three observation zones. Kayaks were observed near TAR on 16 occasions on eight different days during the study period. Kayaks engaged in

sightseeing and fishing activities, and tended to spend the majority of their time in zone 1.

### Vessel Disturbances

Vessel disturbances were characterized by boats moving close to the rocks (i.e. entering zone 1); by boats moving at high speeds; by noise and activity on and around the vessels; and by combinations of these activities. A total of 68 disturbance events caused by vessel activity were recorded during the 1993 study period. Nearly all (67) of these disturbance events were caused by vessels occurring in zone 1. One disturbance event was caused by a vessel in zone 2, and no disturbance was caused by vessels beyond 2,000 feet from the refuge rocks. Thirty-four of the disturbances involved birds, ten involved both birds and sea lions, 24 involved sea lions only. Fifty-seven of the 67 observed disturbances in zone 1 were caused by sport or dive boats. Sport fishing boats caused 13 type A, 5 type B and 21 type C disturbances during the study. Dive boats were responsible for 4 type A, 2 type B and 13 type C disturbances (Figure 3). Dive boats and sport fishing boats caused 88% of the most severe (type C) vessel disturbances observed during the study. Five of the 12 charter boats observed in zone 1 during the study caused disturbances of types A, B and C. Four disturbances were recorded for kayaks, one type A and 3 type B. One type B disturbance was caused by jet-skis. Forty-one percent of the disturbance events occurred in July. No disturbance by commercial boats was observed.

Vessels passing through the arches in the rocks at TAR have been frequently observed in the past and was highlighted as an issue of concern by the USFWS Coastal Refuges staff. During the 1993 study period, 17 vessels were observed passing through one of the rock arches a total of 20 times on nine days. Individual vessels observed passing through the arches included charter (1), jet-skiis (3), private sport boats (5), and inflatable dive boats (6).

## Aircraft

Four hundred and seventy-eight aircraft (commercial, military, U.S. Coast Guard, and private) were recorded passing the study area. Of the 410 private aircraft observed, 37% passed at an altitude of less than 1,000 feet. Of twenty-one U.S. Coast Guard (USCG) aircraft observed 16 were flying under 1000 feet. Seventeen military aircraft (large transport aircraft) were observed passing near TAR during the study period. Aircraft that were detected by sound, but were not seen, were categorized as "other" aircraft. The "other" category of aircraft included 13 planes (probably large commercial aircraft) that passed the study area at high altitudes.

## Aircraft Disturbances

The majority of the aircraft disturbance events resulted from private aircraft activity (Figure 4). Private aircraft observed in the study area caused 52 type A, 6 type B, and 5 type C disturbances. Private aircraft flying under 1,000 feet over the study area caused 49 of these disturbance events, while similar aircraft flying over 1,000 feet caused 14 disturbances. USCG aircraft observed over TAR caused eight type A, and 5 type B disturbances. Military aircraft caused, 6 type A, 4 type B and 4 type C disturbances as they passed over the area. Fourteen of the seventeen military aircraft that flew over the area caused some type of disturbance. The 13 aircraft in the "other" category caused 6 type A disturbances. Twenty-two commercial aircraft were observed during the study. These aircraft caused 2 type A and 2 type B disturbances.

## 1994 STUDY RESULTS

### General Activity Description

Observation of human activities and wildlife disturbances at TAR in 1994 were made on weekends and holidays from May 14 through September 11. Observations occurred on an average of 6.6 hours per day and 2.4 days per week, totaling 271 hours over 41 days (Table 1). In order to fairly compare and contrast the

study results of 1993 and 1994, only data collected on weekends and holidays in 1993 were used to examine differences between years.

Observations indicated that the majority of the vessel activity in 1994 took place in zones 2 and 3 (Figure 5) and that few boaters entered the 500 foot buffer zone (zone 1). Activities of the various types of boaters (charter, sport, sightseeing etc.) were similar to those observed in 1993 with the exception of the reduced activity in zone 1 (Figure 6) and the reduced number of disturbances observed.

The number of boats observed in 1994 was down from the 1993 study. A comparison of data collected on weekends and holidays for the two years shows a reduced number of commercial, charter and sport boats in 1994 (Table 2, Figures 6 and 7). The restricted commercial and sport salmon seasons and a general public perception that there was little or no salmon fishing on the coast probably accounted for much of this reduction in effort. There was a 28.6% reduction in combined observed vessel activity in 1994 when compared to 1993. Observations of commercial vessels had the greatest decline in effort at 41.2%. Activity in zone 1 was greatly reduced in 1994, with fifty boats of all types spending 35 hours and 11 minutes; compared to 142 boats spending 240 hours and 16 minutes in zone 1 in 1993 (Figure 6). A total of 675 boats were observed in all zones combined in 1994 compared to 946 in 1993 (Table 2).

### Vessel Disturbances

During the 1994 study there were 23 vessel disturbance events observed, and all but one occurred in zone 1 (Table 3). These boats in zone 1 had entered the closed area for a variety of activities but most were fishing or sightseeing. Disturbances varied from boats moving too close to the rocks, to boats running at high speed through the area and the arches. Twenty-one of the 22 observed disturbances in zone 1 were caused by private sport boats (Table 4). Sport boats caused 8 type A, 6 type B and 7 type C disturbances observed during the 1994 study. One charter boat sightseeing in zone 1 during the study caused one type A disturbance. One type B disturbance was recorded for a commercial boat in zone 2.

Sixteen boats were responsible for all 23 disturbances observed in all zones. Five boats caused multiple disturbances while in zone 1. Disturbances occurred on 13 separate days the first on May 28 and the last on August 14, twelve of the 23 occurred in July. The reduction in vessel activity in zone 1 resulted in fewer weekend and holiday disturbance events; 22 in 1994 compared with 59 in 1993 (Table 4, Figure 8). Since 22 of the 23 disturbance events were caused by boats illegally entering the closed area (zone 1), disturbances would have been almost completely eliminated if all boaters had observed the closure.

#### Aircraft Activities and Disturbances

Three hundred and twenty aircraft (commercial, military, U.S. Coast Guard, and private) were recorded in the study area in 1994. Thirteen disturbance events were caused by aircraft flying over TAR (Table 5). Eleven of these 13 aircraft were recorded as flying at or below 1000 feet. Nine disturbances were caused by private aircraft, two by military aircraft and two by commercial aircraft. No disturbances by USCG aircraft were observed in 1994.

### DISCUSSION

It was the opinion of the field observers that most of the disturbances seen in 1994 were caused by boaters that were unfamiliar with the closure and the issues of wildlife disturbance. When approached by enforcement officials, ignorance of the buffer zone was the defense used by nearly all boaters. Determining the actual location of the outside boundary of the buffer zone was difficult for some boaters that were interested in fishing as close to the refuge as possible. No floats or buoys were placed to mark the edge of the buffer zone and boaters were required to estimate the 500 foot distance from the rocks. Some self-enforcement by informed boaters appeared to have taken place at TAR. In some cases observations were made of vessels within the closed zone being approached by boaters from outside the zone, it appeared that these boaters were being informed of the closure by others.

The increase in public awareness regarding wildlife disturbances at TAR and the establishment of the buffer zone helped to reduce the number of disturbance events observed at TAR in 1994. More emphasis should also be placed on educating boaters from outside the local area.

Although aircraft caused 100 disturbance events during the 1993 TAR study (74% were type A) no further restrictions were placed on aircraft near the refuge. Observations in 1993 showed that higher altitudes and lateral distances of at least 1/2 mile from the rocks were beneficial in preventing disturbance to wildlife. During type C disturbances (when animals left the rocks) altitude may or may not have been a factor depending on the type of plane (animals occasionally responded to the sound of high altitude, large commercial aircraft). Before the 1994 field season, OPAC contacted the Federal Aviation Administration to request information on flight restrictions. OPAC was informed that there was in place a request that pilots not fly below 2000 feet over National Wildlife Refuges. This request is printed on all aeronautic sectional charts. Actual flight restrictions, however, are typically implemented for military purposes only, so the request by OPAC to establish a 2000 foot minimum altitude requirement over TAR was not accepted. The USCG was contacted by OPAC and flight crews were notified about the sensitivity of the refuge areas. USCG pilots were asked to fly around or over the refuge, at altitudes above 2000 feet. This cooperation eliminated disturbance by USCG aircraft in 1994. Local pilots from the Tillamook County area were also contacted and informed of the flight request and the sensitivity of the wildlife at TAR. Since these pilots were mainly conducting scenic flights and TAR is a location they highlighted, they were cooperative and adjusted their flight behavior to reduce disturbances. This type of communication should be made periodically to ensure continued cooperation from pilots flying over these sensitive areas. Limited attempts to reduce disturbances by military aircraft over TAR proved unsuccessful.

In 1993 and 1994 four aerial surveys were flown over TAR during the Steller sea lion breeding season by ODFW personnel. Breeding activity and pup numbers observed during these surveys appeared normal in both years. After an

unproductive year in 1993, large numbers of common murres were observed by USFWS personnel on aerial surveys of the area in 1994. Breeding behavior of seabirds at TAR in 1994 appeared normal although chick numbers were down. Again as in 1993, the low survival rate of chicks was most likely due to limited amounts of food available resulting from continuing El Nino conditions (Lowe, pers. comm.).

Education was a main component of the proposal adopted by OPAC to reduce disturbance at TAR. ODFW developed permanent signs and a brochure to help educate boaters and aircraft operators. Temporary signs were placed at the main boat launches at Garibaldi, Netarts and Oceanside early in the season and were replaced by permanent signs in July, 1994. Signs were left in place over the winter to continue the education of boaters year-round. A pamphlet was developed to provide information on wildlife disturbance, the buffer zone at TAR and other wildlife protective measures along the coast. Brochures were distributed locally to law enforcement personnel, charter boat offices, Chambers of Commerce and other locations.

## SUMMARY

This study demonstrated that when motor-powered boats and other water vessels approached to within 500 feet of TAR, disturbance to wildlife on the refuge was likely to occur. Most of the more severe (type C) disturbance events were caused by small sport fishing and SCUBA dive boats while within the 500 foot zone (zone 1). Sport fishing boats in zone 1 commonly caused disturbances of all types, but less than 7% of their total activity in the study area occurred within 500 feet of the rocks. Conversely, over 90% of the SCUBA vessel activity occurred within zone 1 and this activity commonly resulted in wildlife disturbance. One commercial fishing vessel caused a type B disturbance from zone 2 during the two years of the study. Holidays and weekends tended to have more disturbance events (87% of the disturbances observed in 1993 took place on a weekend or holiday). The increase in

boating and other activities that occurred on weekends and holidays was most likely the reason for this increase in disturbances. Animals became wary with greater numbers of vessels in zone 1, even when boats were drifting or moving at slow speeds. Allen (1984) noted while studying the disturbance of harbor seals at Bolinas Lagoon, California that boats advancing toward the seals or lingering nearby caused the animals to flee more often than a boat moving past the haulout. Animals at TAR seemed to be more tolerant of single vessels which approached at slow speeds rather than groups of boats or boats moving at high speeds. However, as boats continued to move closer to the haulout, regardless of speed, the sea lions would eventually abandon the haulout. The noise level of boat motors, activity onboard boats, and the location of the boats all seemed to have a various affects on animals, as did the combination of weather conditions, aircraft presence and boat activity.

Low-flying aircraft frequently caused disturbance to wildlife. The most commonly observed aircraft type at TAR were private planes. Although not common in the study area, military aircraft (17 in 1993 and 14 in 1994) caused frequent disturbance events. These multi-engine aircraft were loud and while observed at various altitudes, they tended to fly directly over TAR. Educating pilots on the issues of wildlife disturbance is necessary when attempting to reduce disturbance from aircraft, since altitude restrictions may be difficult to implement.

The closure to vessel traffic within 500 feet of the rocks resulted in a significant decrease in disturbance to wildlife. Difficulty in enforcing the buffer zone and the problems boaters experienced determining the location of the closed area (without marked buoys) increased the need for good education efforts. The buffer zone did reduce the amount of boat traffic near the refuge and through the arches, which in itself decreased the number of disturbance events.

Natural disturbance events such as predation by crows, ravens, bald eagles and peregrine falcons did occur at TAR. Variable ocean conditions, such as El Nino can have an impact on chick survival by influencing food availability. Compounding these natural factors with human-caused disturbances could result in reduced breeding effort, changes in the timing of nesting, and/or reduced

survival of young. Controlling natural disturbance events is not possible or necessarily desirable, however controlling human-caused disturbances can be achieved and can produce favorable results.

Table 1. Observation statistics for the 1993 and 1994 studies at Three Arch Rocks National Wildlife Refuge (observations in 1994 were made on weekends and holidays only).

	<u>1993</u>	<u>1994</u>
Study Date	May 1 - Sept. 9	May 14 - Sept. 11
Days of Observation	104	41
Total Hours of Observation	782	271
Average Days Observed per Week	5.5	2.4
Average Hours Observed per Day	7.5	6.6

Table 2. Vessel activity by zone at Three Arch Rocks National Wildlife Refuge, during the 1993 and 1994 study periods (weekends and holidays only).

<u>ZONE 1</u>			<u>ZONES 2/3</u>		
<u>User Type</u>	<u># Boats</u>		<u>User Type</u>	<u># Boats</u>	
	<u>1993</u>	<u>1994</u>		<u>1993</u>	<u>1994</u>
Commercial	1	0	Commercial	96	57
Charter	9	4	Charter	152	96
Sport	116	44	Sport	524	452
USCG	0	0	USCG	4	3
Other (inc Kayak)	16	2	Other (inc Kayak)	28	17
<b>TOTAL</b>	<b>142</b>	<b>50</b>	<b>TOTAL</b>	<b>804</b>	<b>625</b>

Table 3. Vessel disturbances by zone, during the 1993 and 1994 study periods (weekends and holidays only) at Three Arch Rocks National Wildlife Refuge.

<u>Disturbance</u>	<u>Zone 1</u>		<u>Zone 2</u>		<u>Zone 3</u>	
	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>
Type A	16	9	1	0	0	0
Type B	7	6	0	1	0	0
Type C	35	7	0	0	0	0
TOTAL	58	22	1	1	0	0

Table 4. Vessel disturbances by type in zone 1, during the 1993 and 1994 study periods (weekends and holidays only) at Three Arch Rocks National Wildlife Refuge.

<u>Vessel Type</u>	<u>Disturbance Type A</u>		<u>Disturbance Type B</u>		<u>Disturbance Type C</u>	
	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>
Commercial	0	0	0	0	0	0
Charter	1	1	0	0	4	0
Sport	15	8	4	6	30	7
Other	1	0	3	0	1	0
TOTAL	17	9	7	6	35	7

Table 5. Aircraft disturbances by type, during the 1993 and 1994 study periods (weekends and holidays only) at Three Arch Rocks National Wildlife Refuge.

<u>Aircraft Type</u>	<u>Disturbance Type A</u>		<u>Disturbance Type B</u>		<u>Disturbance Type C</u>	
	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>	<u>1993</u>	<u>1994</u>
Commercial	1	2	0	0	0	0
Private	31	6	5	2	4	1
USCG	4	0	3	0	0	0
Military	2	2	2	0	2	0
Other	4	0	0	0	0	0
TOTAL	42	10	10	2	6	1

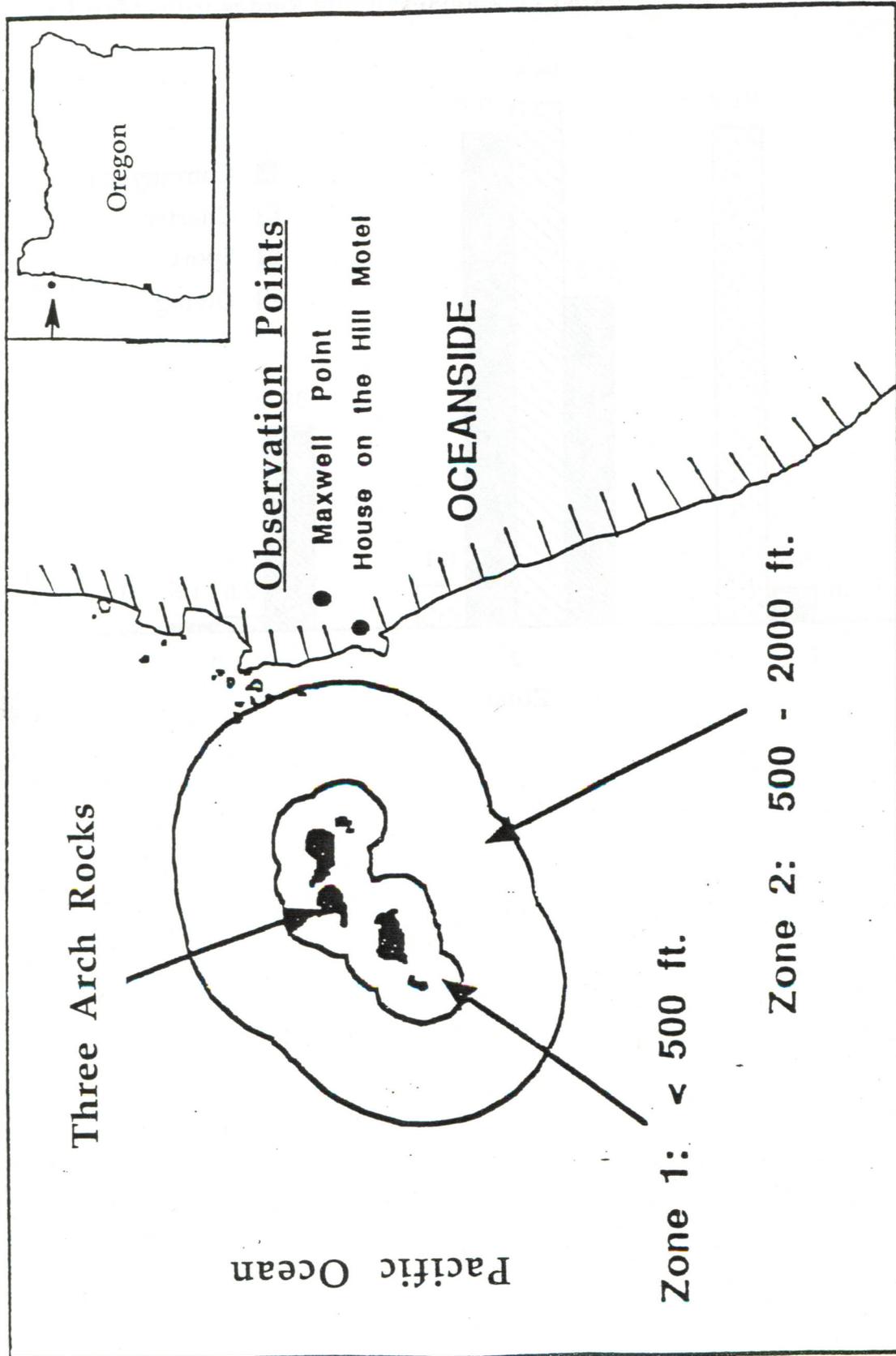


Figure 1. Three Arch Rocks National Wildlife Refuge study site, Tillamook County, Oregon.

Figure 2. Percent of time that each vessel type was observed fishing or diving in each zone of the study area at Three Arch Rocks National Wildlife Refuge from May 1 to September 9, 1993.

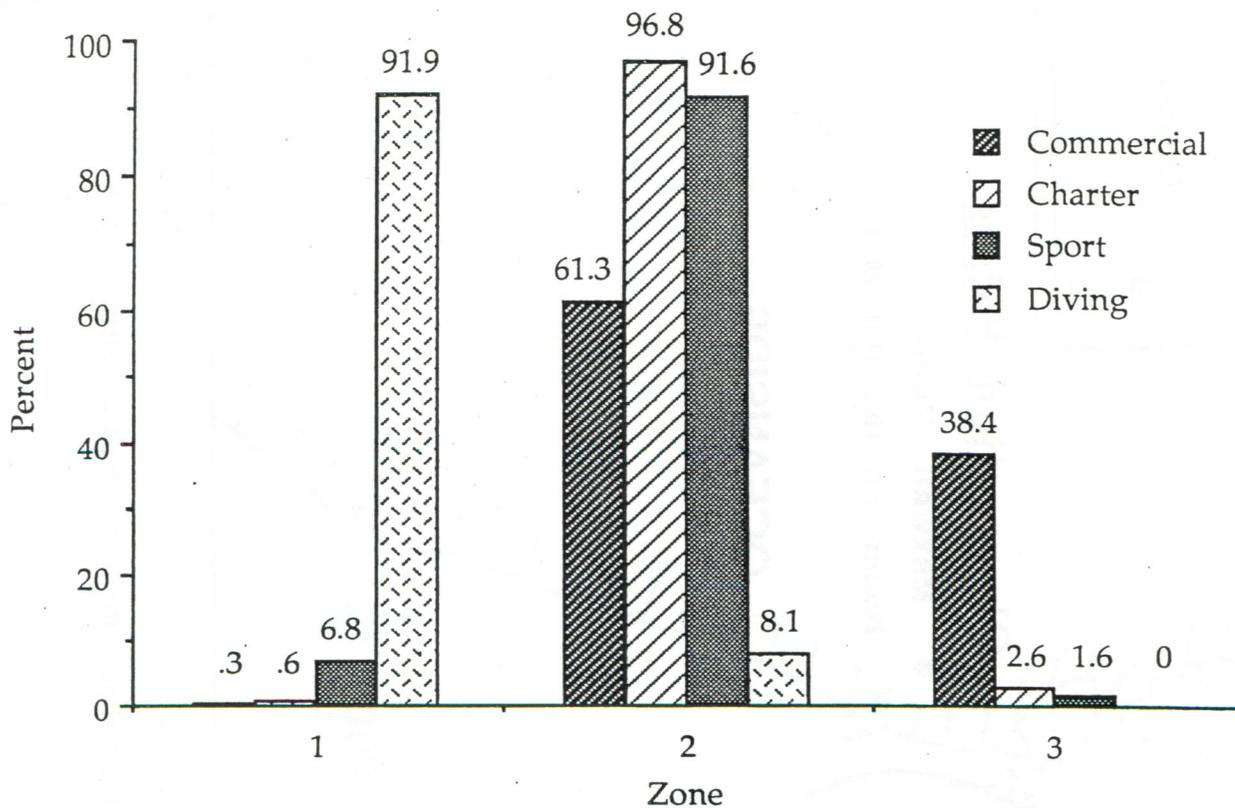


Figure 3. Disturbances caused by boats, by boat type and disturbance type in all zones at Three Arch Rocks, National Wildlife Refuge from May 1 to September 9, 1993. (type A - aware, type B - movement, type C - flight)

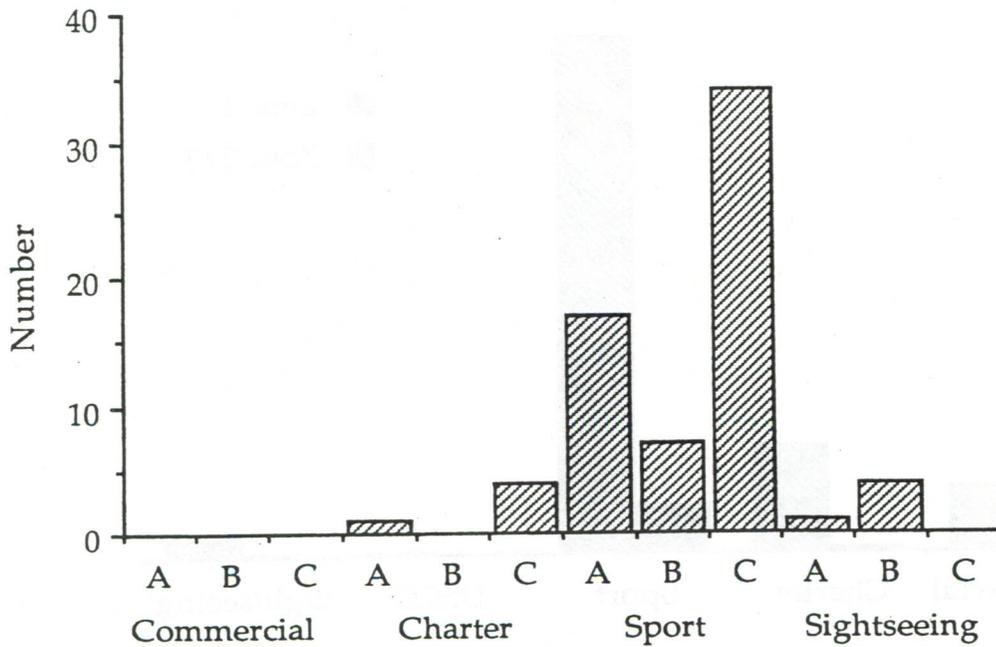


Figure 4. Disturbances caused by aircraft, by aircraft type and disturbance type, at Three Arch Rocks, National Wildlife Refuge from May 1 to September 9, 1993. (type A - aware, type B - movement, type C - flight)

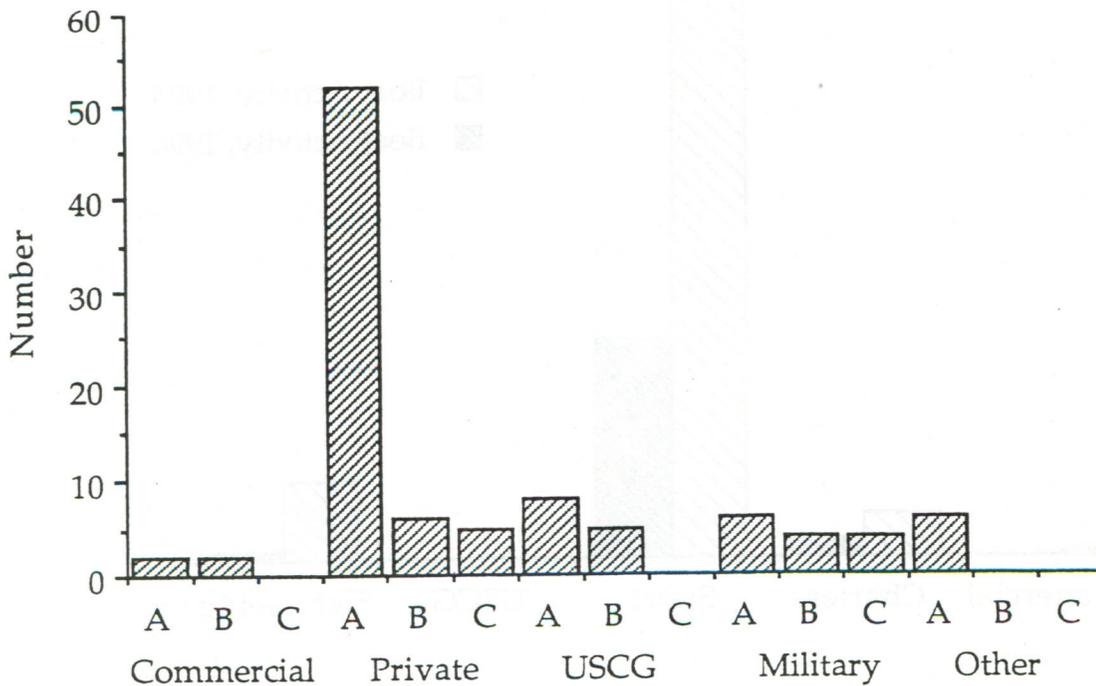


Figure 5. Number of boats, by boat type and by zone at Three Arch Rocks, National Wildlife Refuge from May 14 to September 11, 1994 (weekends and holidays).

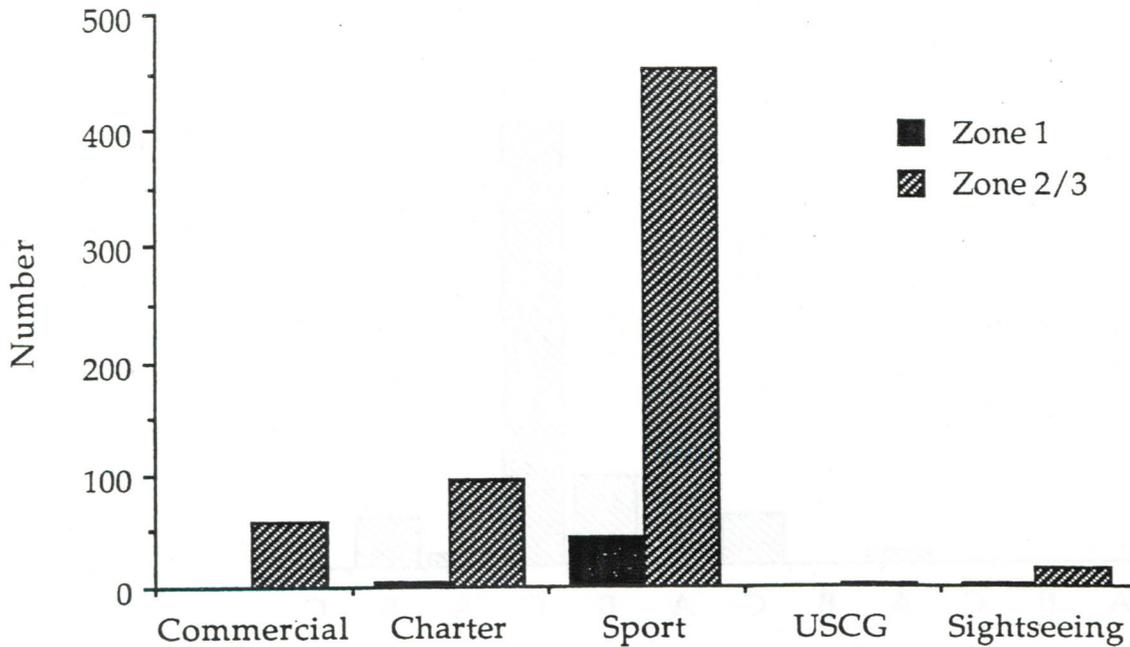


Figure 6. Number of boats, by boat type, in zone 1 at Three Arch Rocks, National Wildlife Refuge, during the 1993 and 1994 study periods (weekends and holidays).

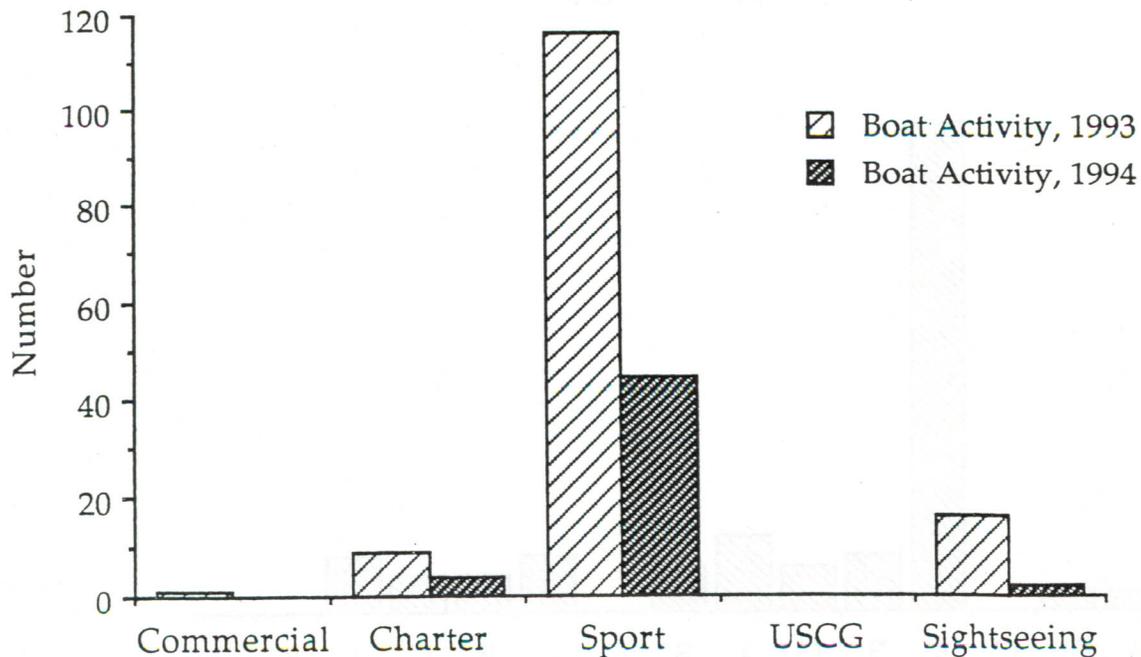


Figure 7. Number of boats, by boat type, in zones 2 and 3 at Three Arch Rocks, National Wildlife Refuge, during the 1993 and 1994 study periods (weekends and holidays).

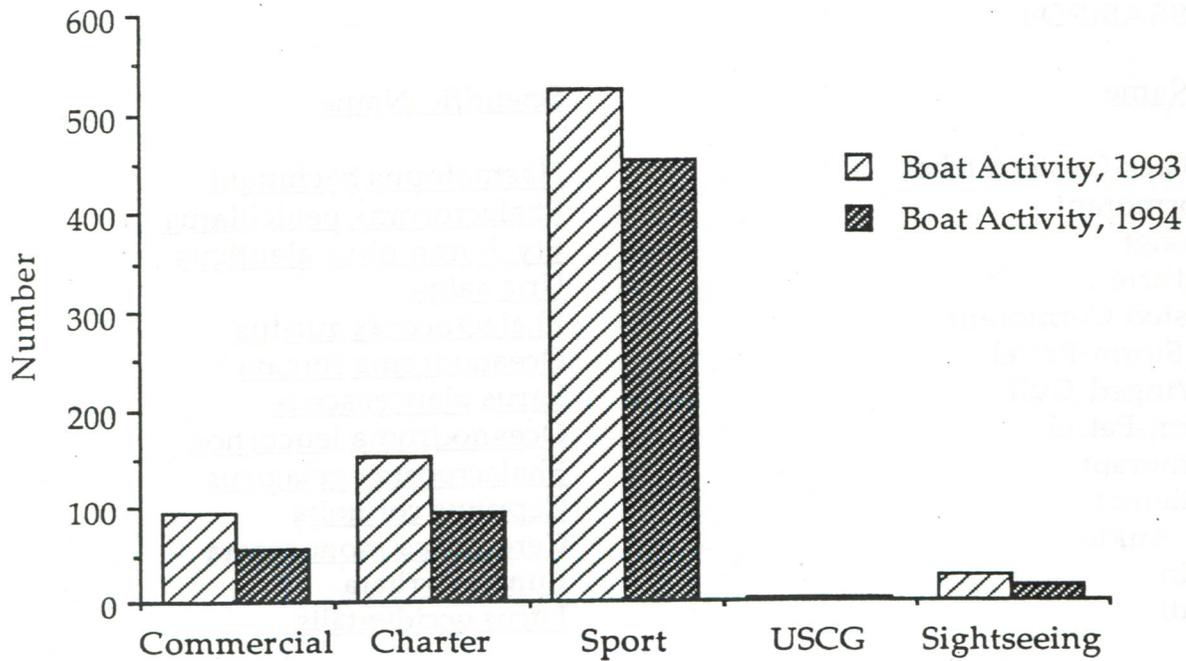
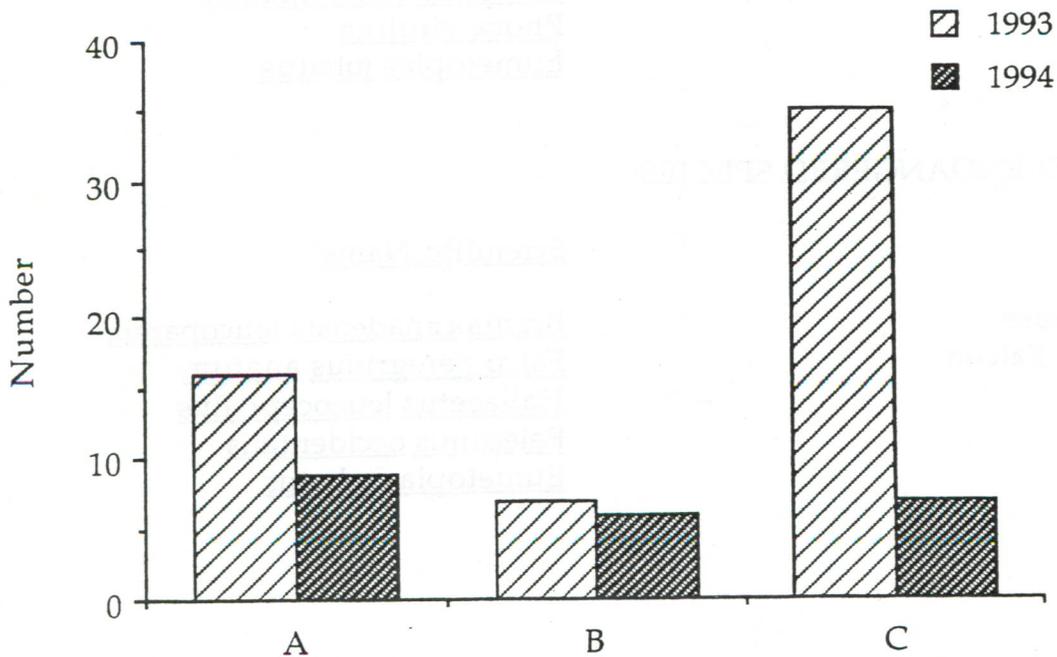


Figure 8. Boat disturbances, types A, B and C, observed in zone 1 on weekends and holidays during the 1993 and 1994 study periods. (type A - aware, type B - movement, type C - flight)



Appendix A. Seabirds and marine mammals utilizing Three Arch Rocks, National Wildlife Refuge.

NESTING SEABIRDS:

<u>Common Name</u>	<u>Scientific Name</u>
American Black Oystercatcher	<u>Haematopus bachmani</u>
Brandt's Cormorant	<u>Phalacrocorax penicillatus</u>
Cassin's Auklet	<u>Ptychoramphus aleuticus</u>
Common Murre	<u>Uria aalge</u>
Double-Crested Cormorant	<u>Phalacrocorax auritus</u>
Fork-tailed Storm-Petrel	<u>Oceanodroma furcata</u>
Glaucous-Winged Gull	<u>Larus glaucenscens</u>
Leach's Storm-Petrel	<u>Oceanodroma leucorhoa</u>
Pelagic Cormorant	<u>Phalacrocorax pelagicus</u>
Pigeon Guillemot	<u>Cepphus columba</u>
Rhinoceros Auklet	<u>Cerorhinca monocerata</u>
Tufted Puffin	<u>Lunda cirrhata</u>
Western Gull	<u>Larus occidentalis</u>

PINNIPEDS:

<u>Common Name</u>	<u>Scientific Name</u>
California Sea lion	<u>Zalophus californianus</u>
Harbor Seal	<u>Phoca vitulina</u>
Steller Sea lion	<u>Eumetopias jubatus</u>

THREATENED AND ENDANGERED SPECIES:

<u>Common Name</u>	<u>Scientific Name</u>
Aleutian Canada Goose	<u>Branta canadensis leucopareia</u>
American Peregrine Falcon	<u>Falco peregrinus anatum</u>
Bald Eagle	<u>Haliaeetus leucocephalus</u>
Brown Pelican	<u>Pelecanus occidentalis</u>
Steller Sea lion	<u>Eumetopias jubatus</u>



No	Start Time	End Time	Type V	Activity	Zone	Disturb V	Vessel ID	R	Type A	Alt	Lat Dist	Direct	Disturb A	Comments
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
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17														
18														
19														
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21														
22														
23														
24														
25														
26														
27														
28														

- Vessel Type:**  
 1 - Commercial  
 2 - Charter  
 3 - Sport  
 4 - USCG  
 5 - Kayak  
 6 - Other
- Activity**  
 F - Fishing  
 R - Running  
 D - Diving  
 A - Anchored  
 S - Sighting  
 U - Unknown
- Zone**  
 1 - <= 500 ft  
 2 - 500 ft - 2000 ft  
 3 - >2000 ft

- Disturbance**  
 A - Alert State  
 B - Agitated State  
 C - Threatened State  
 N - No Disturbance
- Aircraft Type:**  
 1 - Commercial  
 2 - Private  
 3 - USCG  
 4 - Military  
 5 - Unknown
- A - Airplane**  
 J - Jet  
 H - Helicopter
- S - Single Engine**  
 T - Twin Engine  
 H - High Wing  
 L - Low Wing

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