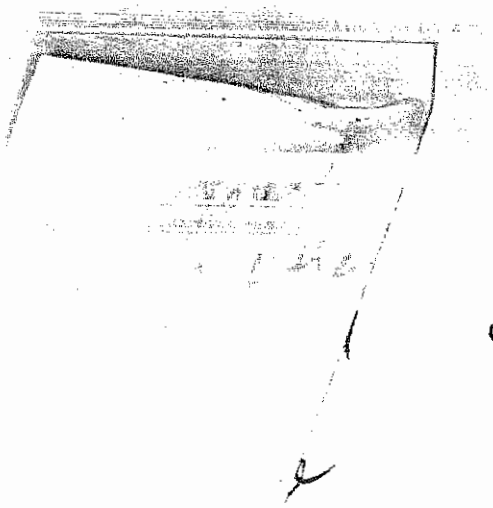
TB077

Stock Delineation Study of Black Rockfish, *Sebastes melanops*, off the Oregon Coast



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INTRODUCTION

The black rockfish, Sebastes melanops, is the most often caught recreational groundfish off the Oregon coast. This species' widespread occurrence, susceptibility to angling gear, and general acceptance by the angling public all contribute to its current importance and its continued value.

Concern for the black rockfish resource led the Oregon Department of Fish and Wildlife (ODFW) to plan a tagging study designed to better understand the movements of these fish along our coast. This study was submitted to the National Marine Fisheries Service for possible funding under the Saltonstall-Kennedy Act. Funding was approved and the project was completed. This report summarizes the field work and results of that project.

METHODS

We tagged fish in 1985 from charterboats out of Newport and Garibaldi (Figure 1). All owners of charterboats licensed to operate in Oregon were invited to bid their services for use in our program. Bids were offered for 28

boats: 13 for Garibaldi and 15 for Newport. A ranking of vessels and a selection process led to the acceptance of five boats for the Garibaldi work and four boats for Newport.

Normal angling equipment (rod and reel) was used to capture the fish. We chose to work in areas popular with both recreational anglers and commercial hook and line (jig) harvesters. However, we did restrict our efforts to areas no deeper than 60 feet; this eliminated any visible signs of decompression damage caused by bringing fish from deeper water. Only very healthy fish were tagged; all injured fish taken during our work were donated to local charity programs. Captured fish were brought aboard the boat, examined for condition suitability, measured, sexed, tagged, and returned to the water. They were then observed to determine whether they were able to quickly dive and swim away normally. Each boat was equipped with a 100-gallon tank filled with clean seawater. When fish were coming aboard rapidly, they were placed in this tank until they could be tagged and released. Every effort was made throughout the study to ensure good physical condition of released fish. This was done in an effort to reduce tagging-induced mortality and should contribute to long-term survival of the tagged fish.

Floy FD68B anchor tags were used. These were serially numbered D00001 through D08000 and carried the printed legend "RETURN ORE FISH WILD, NEWPORT".

The tagging was completed in three days (15 boat-days) out of Garibaldi, on April 29-30 and May 1. The work out of Newport required more boat-days (19) due to lower overall catch rates. The Newport tagging was done on May 6-9 and May 28-30. Approximately 350 staff days (150 at Garibaldi and 200 at Newport) were spent by people participating in the tagging operations during these 34 boat-days at sea.

The numbers of tagged fish released were 3,835 at Garibaldi and 3,914 at Newport. This total of 7,749 deviated from the target goal of 8,000 by the number of tags that were broken during the tagging operations; this is a normal occurrence.

Garibaldi fish were released at four specific sites (Figure 2). The majority (84%) were released at the most popular fishing (both recreational and jig) site, Three Arch Rocks. Fourteen percent were tagged and released near Pyramid Rock. One percent were released at Cape Lookout and one percent near the Tillamook north jetty. The sex ratio was 53% male and 47% female.

Releases of tagged fish out of Newport were more scattered than at Garibaldi (Figure 3). The overall catch rate was lower at Newport; this caused more boat movement in searching for fish, resulting in releases over much larger areas than at Garibaldi. Most of the fish (90%) were released in an area extending eight nautical miles (nm) south of Newport. Eight percent were released along a strip of coast extending 1.5 nm north of Newport. The remaining two percent were released off the town of Waldport, 12 nm south of Newport. The sex ratio was 47% male and 53% female.

Since public cooperation in returning tags is critical, several steps were taken to publicize the project, including articles in state and local newspapers. Television crews were involved at both the Garibaldi and Newport sites; the resulting news broadcasts were carried by both Portland and Newport stations. Signs were placed in both ports where they would be seen by anglers.

RESULTS

Recoveries

There have been 149 tagged fish recovered from the Garibaldi tagging, representing a return rate of 3.9%. Two additional tags (no longer attached to the fish) were found by beachcombers at Bayocean Spit and at Netarts Bay, both

near the Three Arch Rocks - Pyramid Rock area. The principal user group to recover tags was charterboat anglers, followed by private boat anglers (Table 1). Most of the tag recoveries (76%) occurred in the tagging year, 1985. The sex ratio of fish recaptured at Garibaldi was 45% male and 55% female.

One hundred and three tagged fish have been recovered from the Newport area releases, a return rate of 2.6%. Beachcombers turned in two additional tags (again no longer attached to the fish) found near Newport. Like Garibaldi, charterboat and private boat anglers were the primary sources of tag recoveries (Table 2). Tag recoveries were distributed more evenly among years in Newport than in Garibaldi. Forty-three percent of the tagged fish that were recaptured were caught in 1985. The sex ratio of Newport recovered fish was 35% male and 65% female.

Movements

Recaptured tagged fish generally demonstrated little movement. Over 94% of the known-area recoveries from Garibaldi and 85% of those from Newport were caught within 2 nm of the release site (Table 3). Three of the Garibaldi-tagged fish had moved between Three Arch Rocks and Cape Lookout, a distance of eight nm. Tag recoveries from Newport indicated more localized movement than at Garibaldi;

nine fish were recovered three to nine nm from the release site.

Ten of the fish moved substantial distances before they were recaptured (Tables 3 & 4). All but one of these fish moved north, and eight of the ten fish were recaptured off the Washington coast. Four fish were recaptured at the "Wheatship", a sunken ship north of the Columbia River. Two fish were recaptured off Westport, Washington and two tagged fish were caught off Point Grenville (north of Pacific Beach, Washington). Females appeared to move greater distances and travel faster than males (Table 5), although the sample size is small.

Multiple tag recoveries, where more than one tagged fish was recovered on a boat trip, were observed in Garibaldi on ten occasions (Table 6). All of these fish were recaptured at the site where they had been released. In four instances, the fish that were recaptured together had been tagged on the same day and at the same location. In three cases, they had been tagged from the same boat, although not always on the same day; however, charter operators tended to position their boats at the same place from day to day during the tagging. Multiple recoveries were not related to catch size, i.e., more tags were not necessarily observed in larger catches. The sex ratio was skewed toward females (15 females and 7 males), although the

sample size was small. No multiple tag recoveries were observed in Newport.

Population Parameters

Tag recovery data were used to estimate population size and exploitation rate of black rockfish by sport fisheries at Garibaldi and Newport. Population size was obtained with the adjusted Peterson estimate, and the Poisson distribution was used for calculating confidence intervals for both population size and exploitation rate (Ricker 1975). Effects of tag loss, migration in and out of the population and mortality were minimized by using only 1985 data. Recapture data for the population estimate were restricted to July and August, since total sport catch was available for only those two months.

The population estimate for the Newport area was more than twice as high as Garibaldi, 4.2 and 1.7 million fish, respectively, (Table 7). Although 95% confidence intervals do not overlap, they are very broad. Similar results were obtained with exploitation rate estimates: Garibaldi's estimate of 0.042 was more than twice as high as Newport's, (0.019), and the 95% confidence intervals did not overlap.

DISCUSSION

Recoveries

There is a large difference in tag returns between the two ports (151 from Garibaldi and 105 from Newport). This cannot be explained by differences either in angling effort or total black rockfish catch between the two ports, since Newport leads Garibaldi in both of these statistics (Table 8) but trails in tag returns. For example, in July and August of 1985, the estimated catches of black rockfish out of Garibaldi and Newport were 18,422 and 23,702, respectively. Total effort for ocean boat anglers for the same period was estimated to be 31,757 angler trips out of Garibaldi and 49,534 angler-trips out of Newport. Directed trips for bottomfish at Garibaldi and at Newport were about the same ratio as total trips. Since the proportion of recoveries was reversed from ratios of effort and catch at the two ports, while tags out were essentially the same, it seems unlikely that the tag return differences can be attributed to differences in either effort or total catch.

There are at least two possible reasons for the difference in tag return rates between ports. The first is that the total black rockfish population near Garibaldi may be smaller than the population out of Newport. A Garibaldi

population that equaled 70% of the Newport population could result in approximately the observed tag return pattern. The estimated population size of black rockfish in the Garibaldi area is only 40% of the Newport population estimate and could account for some of the difference in tag returns. However, the difference in estimated population sizes does not fully explain the disparity in tag returns between the two ports.

We believe that "tagging density" is responsible for the observed difference in tag returns. As discussed above, the Garibaldi tags were released in a much smaller area than those released out of Newport. The angling effort out of Garibaldi is likewise concentrated in a smaller area , than out of Newport. Garibaldi anglers tend to concentrate mainly around Three Arch Rocks and to a lesser extent at Pyramid Rock, while Newport anglers typically scatter over a much larger area. Catch rates during the actual tagging work support this hypothesis, since they were 25% higher in Garibaldi than in Newport. Concentration of effort at release sites and higher catch rates would result in more tag recoveries at Garibaldi than at Newport.

Movements

Most tagged fish showed very little movement; over 95% of the tag recoveries occurred within 10 nm of the release

sites (Table 3). Most of the tag returns occurred during summer months; the distribution of tagged fish may have differed during the winter. If black rockfish moved out of the reef areas in question during the winter, they seemed to return to release sites prior to spring and summer fisheries.

The multiple recaptures observed at Garibaldi further support the hypothesis that most black rockfish in that area were residential. Multiple recaptures imply an affinity for reefs as well as particular schools of fish. Many of the multiple recaptures were fish that had been tagged from the same school on the same date, and some were recovered together as much as two years later from the tagging site.

Some short term movements of Garibaldi-tagged fish were documented. One fish moved 8 nm north (from Cape Lookout to Three Arch Rocks) before it was caught 21 days after release. Three fish moved two miles each, between Pyramid Rock and Three Arch Rocks. Subsequent tag returns showed substantial exchange between Three Arch Rocks and Pyramid Rock and they are now regarded as one reef complex. No short-term movements were documented for fish tagged out of Newport.

Although most tag recoveries indicated little movement, others showed that black rockfish are capable of moving substantial distances (Table 4). All but one of the recaptures that had moved sizable distances had moved north; the reason for this is unknown. Sport fisheries for bottomfish exist in major ports south of Garibaldi and Newport, so sufficient effort exists to recapture south-moving tagged fish.

It is tempting to hypothesize that the fish showing greater movements were juveniles seeking out good habitat before becoming residential. However, the tagged fish that had moved more than 10 nm were probably adults. The average lengths at tagging of males and females that moved long distances were 41 cm and 43 cm, respectively (Table 5). Data collected dockside at Garibaldi indicate that a 41-cm male black rockfish is probably nine years old, and age maturity relationships indicate 96% of nine-year-old males are adults. A 43-cm female is probably also nine years old, and 89% of nine-year-old females have spawned at least once. It is not likely that fish which moved considerable distances before recapture were juveniles.

The possibility for overfishing important reefs where fisheries on black rockfish occur is an important management consideration. Results of this study indicate that black

rockfish stocks in the Newport and Garibaldi areas are relatively discrete. However, tag returns demonstrate that some substantial movements occur, so the potential exists for recolonizing over-harvested areas.

Population Parameters

A number of conditions must be met for population estimates from mark-recapture experiments to be valid. These conditions include:

- The tagging operation does not adversely affect a fish or change its probability of recapture,
- The population is closed to immigration or emigration for an appropriate length of time,
- No (or minimal) tag loss, and
- All recovered tags are reported.

We believe that these conditions were met acceptably well during this study. The tags did not seem to affect behavior; on several occasions, a school of black rockfish was observed swimming along with one or more tagged individuals. Also, a tagged fish was recaptured by the tagging crew twice during the work. We do not believe that tagging-induced mortality was a problem; as discussed above,

a major effort was made to tag only very healthy fish. Also, recaptured fish that were examined during this time did not show serious tag wounds. We do not know if the condition requiring a closed population was met. The rate or seasonality with which black rockfish recruit to reefs is unknown. The tag return and total catch data from July and August, 1985 were used; therefore, this portion of the study extended from approximately 1 May through 31 August. We assumed that no significant exchange of fish occurred. Tag loss was also considered negligible during this four-month period. As mentioned, we saw no evidence that tag wounds formed during this period. Tag reporting rates were believed high, since the project was well publicized and tag reward hats were given for the return of a tag.

We used catch data from areas that coincided well with tagging sites in Newport; however, catch data represented a larger area than the tagging area in Garibaldi. In Newport, anglers principally fished the area from a few miles north of Newport to the Seal Rock area. In Garibaldi, the sport fleet operated from Cannon Beach on the north (approximately 20 miles from the Tillamook bay entrance) to Pacific City on the south (about 19 miles from Tillamook Bay and 5 miles south of the Cape Lookout tagging site). Garibaldi catch data include catches from at least three reefs not included in the tagging study, but it was not possible to sort out those catches.

This study represents the first attempt to estimate the population size of black rockfish at Garibaldi and Newport; these data provide valuable information but must be used with caution.

Exploitation rate estimates differ from relative total catch and effort data trends for Garibaldi and Newport. The Garibaldi exploitation rate estimate is higher than Newport's, but higher catch and effort levels were reported for Newport. The estimates seem more appropriate when tagging and fishing patterns are considered. Since the bulk of the fish tagged and tag returns from Garibaldi came from Three Arch Rocks, the estimate is somewhat specific for that site. These data may indicate relatively high exploitation at Three Arch Rocks, since it is a small, easily-identified reef close to Garibaldi. Nearly all of the private boat effort and a substantial portion of the charterboat effort out of Garibaldi was concentrated at Three Arch Rocks. At Newport, tags, effort and catch were dispersed over a much broader area than at Garibaldi. It is not surprising that catches over this larger expanse would be greater while overall exploitation rate would be lower than at the smaller, more discrete site at Three Arch Rocks.

Disparities in sex ratios of tagged and recaptured fish and exploitation rate estimates infer differential mortality of male and female black rockfish. Proportionally more females than males were recaptured, leading to higher sex-specific estimates of exploitation rate for females than for males (Table 9). This is in accord with mortality rates estimated with catch curves from Garibaldi biological sampling, although the portion of total mortality attributable to fishing is unknown.

These estimates of exploitation rate for Garibaldi and Newport are within an acceptable level. Both estimates are well below the natural mortality rate for a species like black rockfish, approximately 0.18 (PFMC 1982). This conclusion is supported by age data collected at Garibaldi, where mean age of black rockfish remained essentially unchanged from 1979 to 1988.

Black rockfish are important to recreational bottomfish fisheries in Oregon. Results of this study indicate that, although black rockfish are largely residential, they can and do move among reefs. If localized depletions occurred, fish from other areas could move in and recolonize reefs. Exploitation rates are low, indicating minimal biological stress to Garibaldi and Newport stocks at this time. These

results agree with data collected at Garibaldi independently of this tagging project. Population size remains essentially unknown, but indexes of stock condition are positive.

ACKNOWLEDGEMENTS

We wish to thank the many boat operators, fish cleaning people, and anglers who made this study possible by reporting tagged fish.

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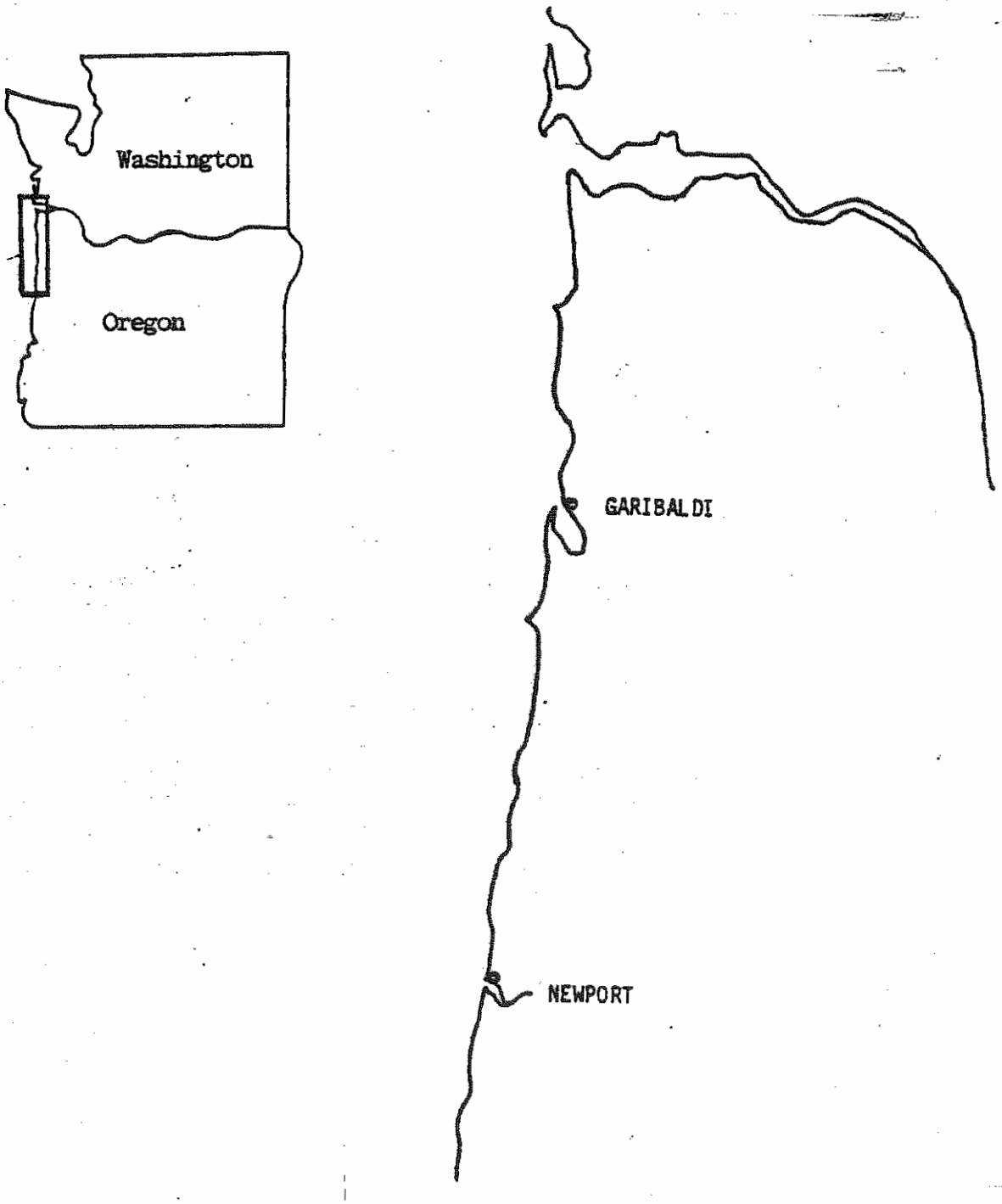

Figure 1. Location of ports adjacent to reefs used in 1985 black rockfish tagging project.

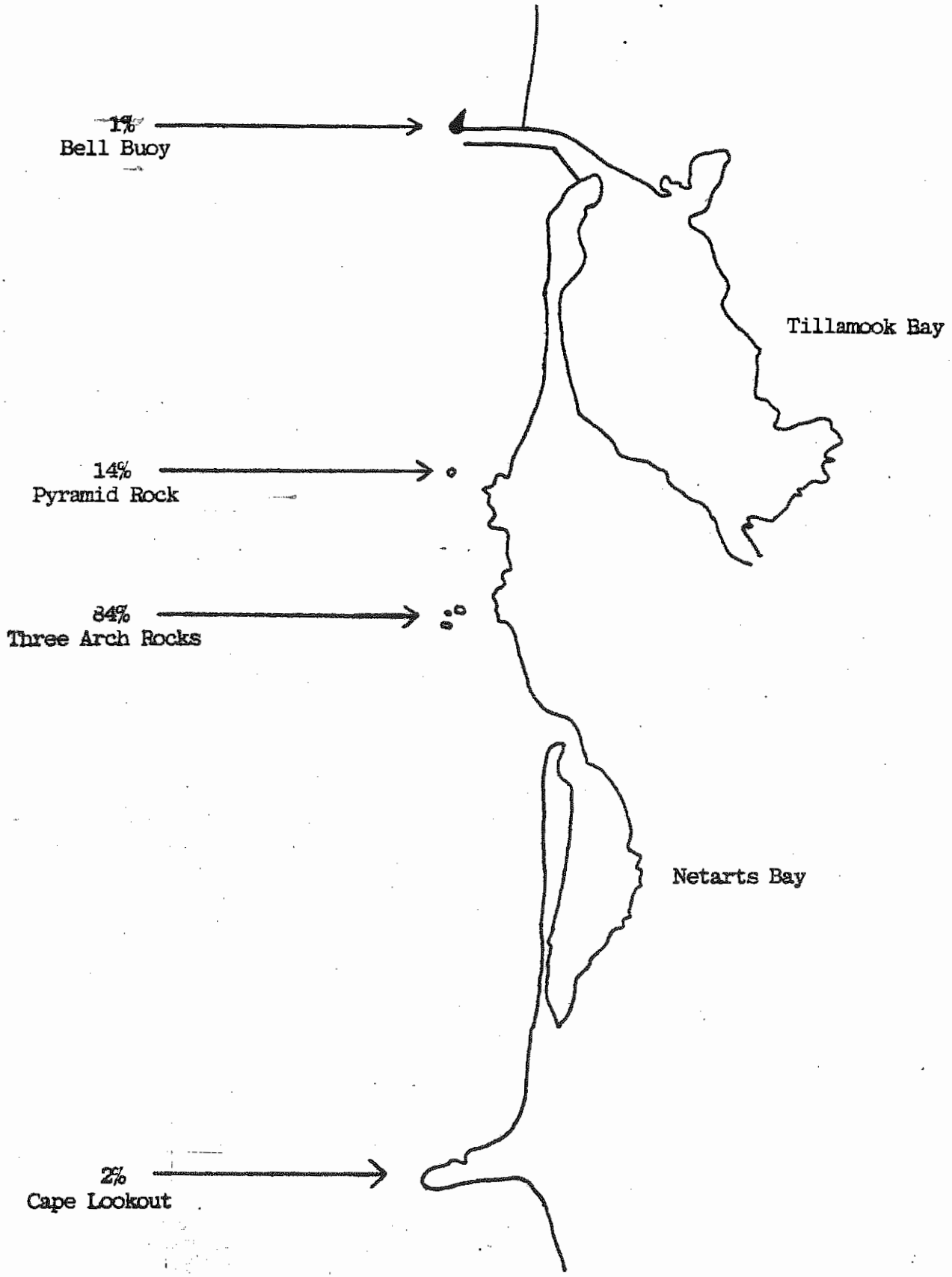

Figure 2. Tagging area out of Garibaldi. The 3,835 tagged fish were released proportionally in the subareas shown.

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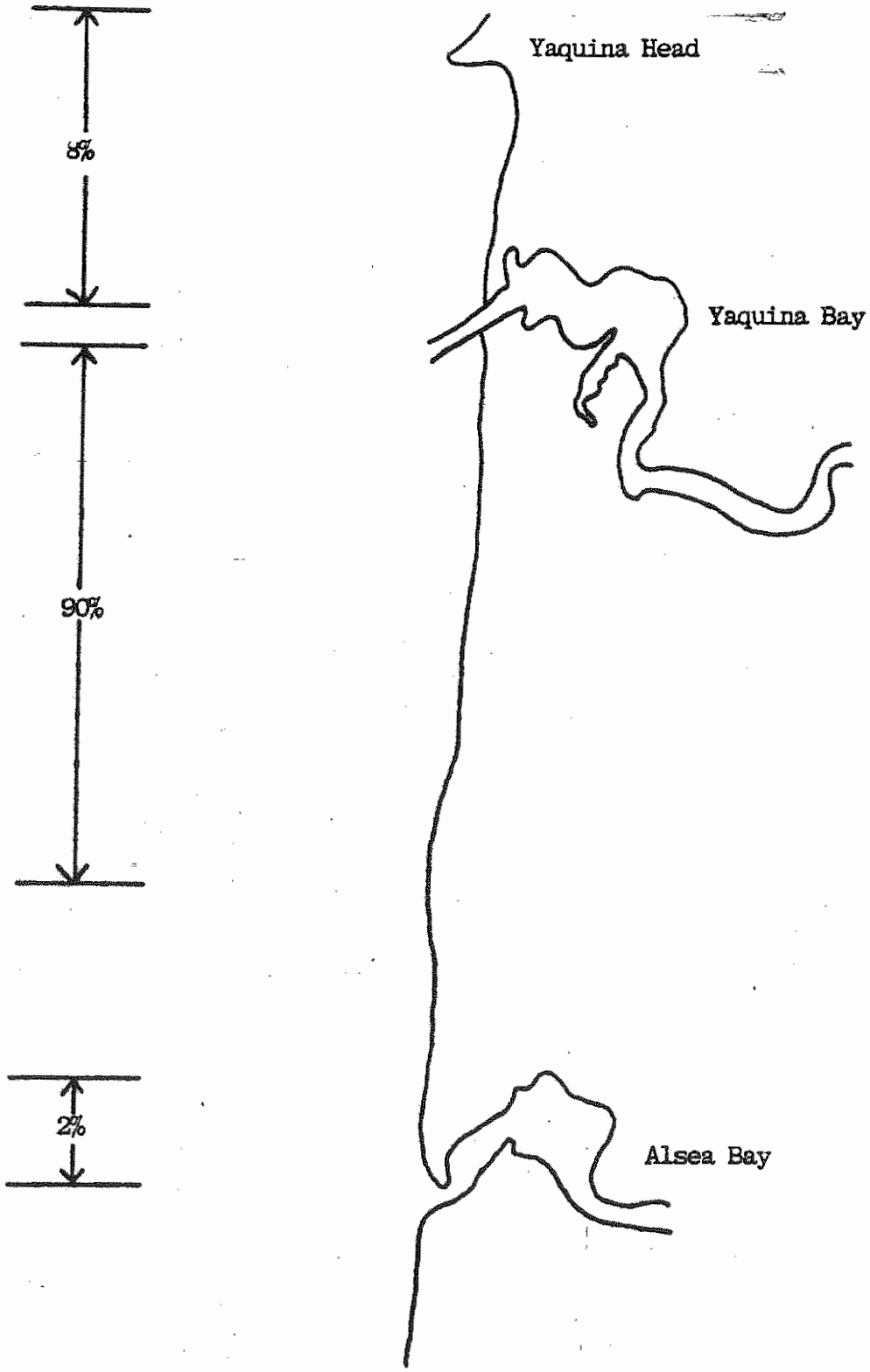

Figure 3. Tagging area out of Newport. The 3,914 tagged fish were released proportionally in the subareas shown.

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Table 1. Tag returns at Garibaldi by year and user group.

	1985	1986	1987	1988	1989	Total	%
Charter boat	61	11	6	2		80	53
Private boat	30	3	3		1	37	25
Unknown sport	13		1	1		15	10
Commercial jig	9	3	2			14	9
Trawl				1		1	1
Unknown	2					2	1
Beachcombers			2			2	1
Total	115	17	14	4	1	151	100

Table 2. Tag returns at Newport by year and user group.

	1985	1986	1987	1988	Total	%
Charter boat	25	14	17	10	66	63
Private boat	12	3	1	2	18	17
Unknown sport	4	1			5	5
Commercial jig		3	1	1	5	5
Trawl	1	3	1		5	5
Bank angler				1	1	1
Unknown	2			1	3	3
Beachcombers	2				2	2
Total	46	24	20	15	105	101

Table 3. Distance moved by fish from Garibaldi and Newport.

Distance moved (nm)	Garibaldi No.	Garibaldi Pct.	Newport No.	Newport Pct.	Total No.	Total Pct.
<2	136	94.5	77	84.5	214	91
3-10	3	2	9	10	12	5
>10	5	3.5	5	5.5	10	4
Total	144	100	91	100	236	100

Table 4. Distance and direction of movement for fish recovered more than 10nm from release area.

	Distance (nm)	Direction	Sex	Tagging Site	Recovery
Garibaldi	41	S	F	Three Arch	Rocky Cr
	52	N	M	Three Arch	Wheatship
	85	N	M	North jetty	Westport
	95	N	F	Three Arch	Westport
	102	N	F	Three Arch	Pt.Grenville
Newport	32	N	M	Moolack	Pacific City
	100	N	F	Moolack	Wheatship
	115	N	F	Theil Cr.	Wheatship
	115	N	F	Theil Cr.	Wheatship
	159	N	F	Theil Cr.	Pt.Grenville

Table 5. Selected characteristics of fish moving more than 10nm.

	Females	Males	Both
Number	7	3	10
Average fork length (cm)	43	41	42
Average distance (nm)	104	56	90
Average days at liberty	523*	921	656
Average nm per day	.21*	.06	.16
Maximum distance (nm)	159	85	—
Minimum distance (nm)	41	32	—

*Sample size is 6 fish because an exact date of recapture was not available for one fish.

Table 6. Data on multiple recoveries.

Date	No. Tags	Recap. Fishery	Recap. Location	Days Out	Sex	Total Catch (no.fish)
6/85	3	Private	Three Arch	~38	1F,2M	30A
7/85	2	Charter	Three Arch	71	2F	110B
7/85	2	Private	Three Arch	66	2F	12B
8/85	3	Private	Three Arch	~10	3F	37B
9/85	3	Charter	Three Arch	~15	1F,2M	61B
9/85	2	Charter	Three Arch	132	2M	30B
10/85	2	Private	Three Arch	~160	1F,1M	UNKNOWN
10/85	2	Charter	Three Arch	~170	2F	UNKNOWN
8/86	2	Charter	Bell Bouy	466	2F	<100A
6/87	2	Comm jig	Three Arch	788	1F,1M	150lb.B

A unknown species
B black rockfish

Table 7. Estimates of population size and exploitation rate for black rockfish out of Garibaldi (GAR) and Newport (NPT), July and August, 1985.

	Population size (millions of fish)		Exploitation rate (annual)	
Criteria	GAR	NPT	GAR	NPT
Estimate	1.7	4.2	.042	.019
95% CI[a]	1.2-2.3	2.8-6.6	.034-.050	.014-.025

[a] 95% confidence interval

Table 8. Catch of black rockfish in thousands of fish and angler effort in thousands of angler trips out of Garibaldi (GAR) and Newport (NPT), July and August, 1985-88.

	Catch		Effort			
			Total		Bottomfish-directed	
Year	GAR	NPT	GAR	NPT	GAR	NPT
1985	18.4	23.7	31.8	49.5	3.7	5.0
1986	18.7	27.4	18.1	40.4	4.6	9.8
1987	19.9	16.8	23.6	49.2	4.2	7.5
1988	22.1	26.2	24.3	51.7	4.1	4.9

Table 9. Sex-specific population parameters for black rockfish at Garibaldi and Newport.

	Garibaldi		Newport	
	males	females	males	females
Sex ratio at tagging	53	47	47	53
Recapture sex ratio	45	55	35	65
Annual exploitation rate	.049	.070	.035	.055
Annual mortality rate (Z)	.202	.405	N/A	N/A