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GROUNDFISH ASSESSMENT: PACIFIC OCEAN PERCH (*SEBASTES ALUTUS*) AND TAGGING STUDIES

ANNUAL REPORT

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1979 PACIFIC OCEAN PERCH SURVEY

Introduction

During April 1979 the Oregon Department of Fish and Wildlife (ODFW) participated in a survey of Pacific ocean perch (*Sebastes alutus*) in cooperation with the National Marine Fisheries Service (NMFS) and Washington Department of Fisheries (WDF). The survey occurred off the coasts of Oregon and Washington from Newport, Oregon (Lat. 44° 37' N) to Cape Flattery (Lat. 48° 26' N). Planning of the overall survey was coordinated by the Northwest and Alaska Fisheries Center of the NMFS.

The overall goal was to reassess Pacific ocean perch abundance and to study survey methodology in an attempt to identify factors which may aid in increasing precision and reducing bias of biomass estimates of Pacific ocean perch. Specific objectives were:

(1) to estimate the absolute abundance of Pacific ocean perch in INPFC Columbia area and U.S. sector of INPFC Vancouver area north of Lat. 44° 37' N;

(2) to determine the percent change in precision of biomass estimates from the 1977 rockfish survey estimates caused by stratification of sampling units and allocation of tows based on commercial CPUE records, bathymetric, geographic and seasonal availability of Pacific ocean perch; and

(3) to determine whether or not the addition of optional tows based on the experience and knowledge of the fishing grounds by the vessel captain had any significant effect on the biomass estimate.

There were several concurrent sub-objectives of the survey accomplished as well. These were: (1) to determine the age and size composition of Pacific ocean perch in the INPFC Columbia area; (2) to determine the species composition of slope rockfish in the INPFC Columbia area; and (3) to estimate biomass of some of the other species of the family *Scorpeanidae* which contributed to a significant portion of the catch.

Methods

Sampling Design. A random stratified sampling scheme was used to locate stations in high and low sampling density strata within geographic areas depicted in figures 1 through 3. Initial attempts to allocate tows on the basis of the last three years of commercial CPUE data failed. The selection of geographic and/or depth strata and the allocation of tows for these strata were subsequently based on the following assumptions about distribution and abundance of Pacific ocean perch (as modified from Dark et al 1979):

(1) The shallow zone (90-174 fm) has higher Pacific ocean perch densities than the deeper zone (175-260 fms).

(2) The INPFC Vancouver and Columbia areas have about equal biomass.

(3) The Northern areas have higher densities and higher variances.

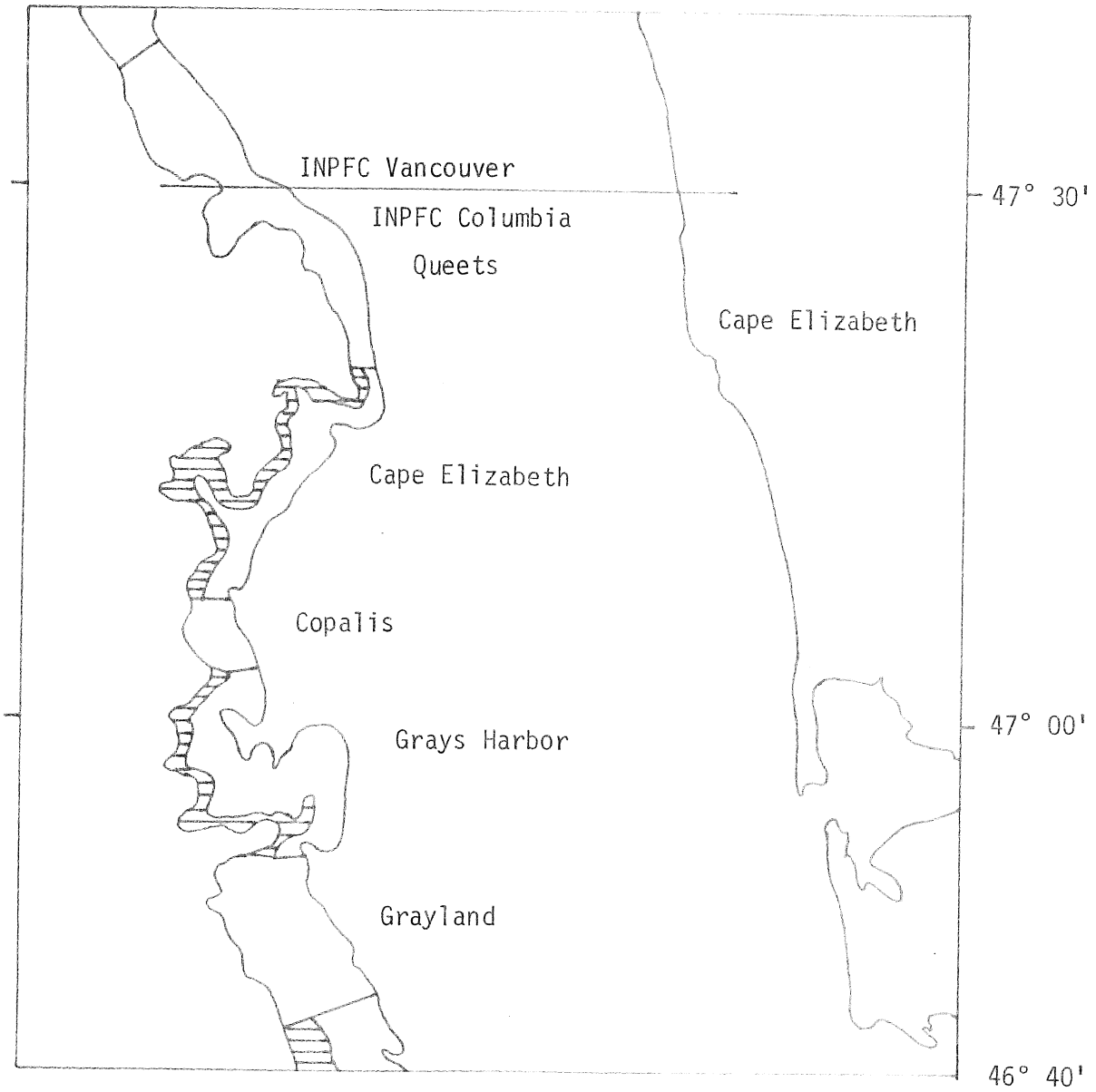

Figure 1. Sampling strata used for 1979 survey of Pacific ocean perch (*S. alutus*). Horizontal lines represent the deep zone from 175-260 fms within high density areas.

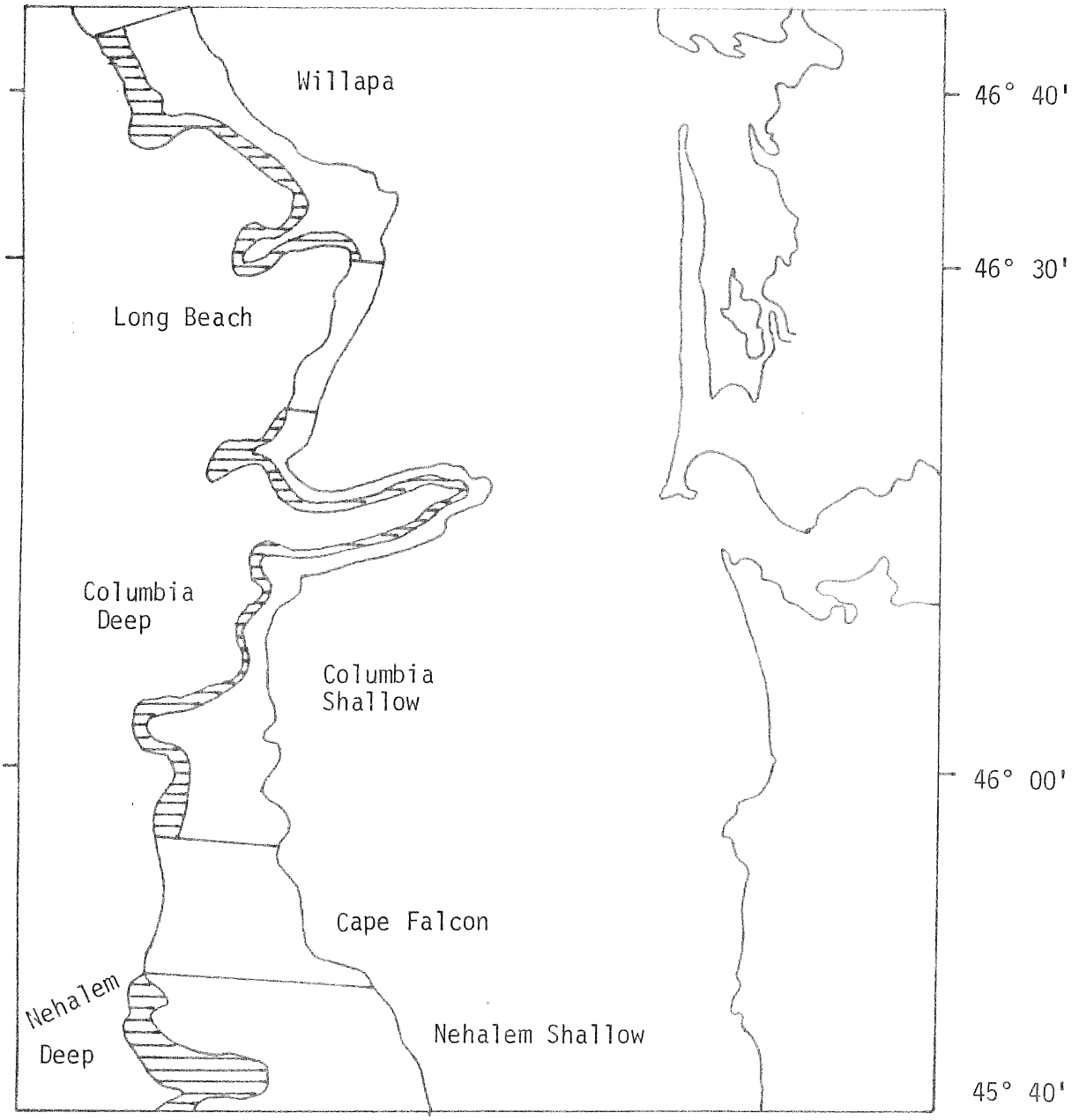

Figure 2. Sampling strata used for 1979 survey of Pacific ocean perch (*S. alutus*). Horizontal lines represent the deep zone from 175-230 fms within high density areas.

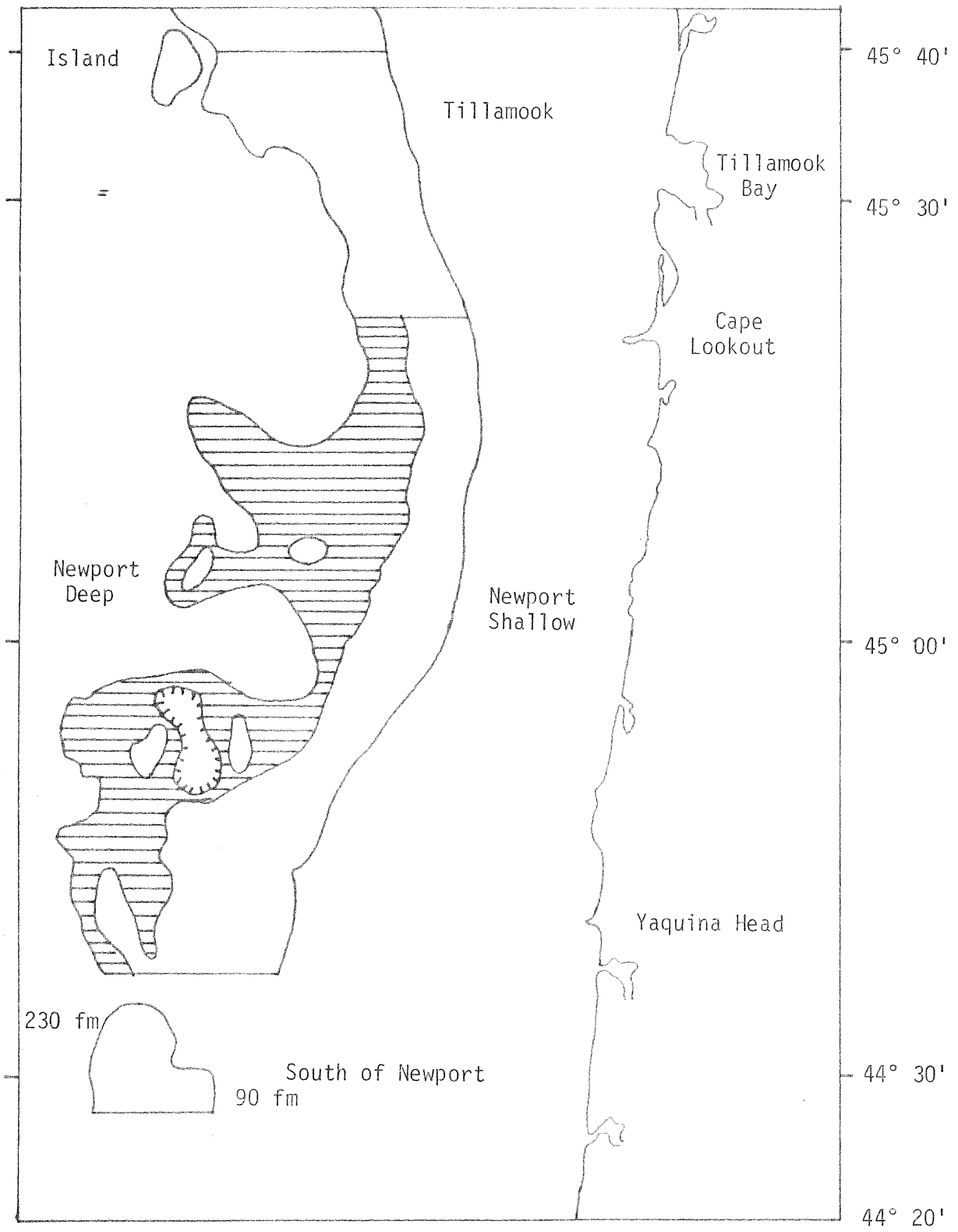

Figure 3. Sampling strata used for 1979 survey of Pacific ocean perch (*S. alutus*). Horizontal lines represent the deep zone from 175-230 fms within high density areas.

These assumptions were based on conclusions drawn from commercial CPUE data, results of the 1977 rockfish survey and earlier work done by Gunderson (1971).

The following guidelines were used in allocating tows:

1. High density area allocation:

	Number of tows/nm^2	
	Shallow	Deep
a. U.S. border through Cape Elizabeth	1/3	1/4
b. Grays Harbor through Columbia River	1/4	1/5
c. Nehalem and Newport	1/9	1/12

   d. Above allowed only if there was a minimum of 3/4 tows in each stratum.

2. Low density area allocation:

   a. Ten percent of the total available tows distributed according to square miles of area plus any tows remaining after high density allocation. Each area must have at least three stations.

Sampling allocations as finally determined for the INPFC Columbia area are shown in Table 1. Adjustments were made in the placement of tows and the designation of high and low density sampling areas after consultation with captains of the chartered vessels.

Sampling areas south of the Astoria canyon were confined to a maximum depth of 230 fms due to the broader character of the slope of this portion of the survey. The northern portion was much steeper in terrain and constituted a smaller geographic area per degree of latitude and survey limits were from 90 to 260 fms. In order to maintain sampling densities (tows/nm^2) at a high level it was necessary to truncate the depths in the southern portion.

Gear. Four different vessels and three different trawls were used to conduct the survey.

The vessels R/V Oregon and M/V California Horizon used Nor'eastern trawls with 44 ft horizontal by 30 ft vertical openings. Their area of operation was north of the Astoria Canyon (see Figure 1). The M/V Washington used a 400-Eastern trawl with 45 ft horizontal by 12-14 ft vertical opening and operated from the Astoria Canyon south through the Tillamook Stratum (Figure 2). The M/V New Life used a Mystic trawl with a 28 ft horizontal and 20-22 ft vertical opening. The M/V New Life operated in the area to the south of the Tillamook Stratum (Figure 3). The latter two vessels used the gear mentioned at the request of the vessel captains. The gear has withstood the trials of service on grounds traditionally fished by the captains of both vessels and were particularly suited to hard bottom and irregular terrain.

Sampling Procedure. Sampling at each regular survey station was done by making a set of approximately 30 minutes duration. Every attempt was made to sample on station or within a 1.5 nm radius of the station. Catches were weighed and counted by species. For large catches, the vessel captain's hail (estimate) was taken as the total weight to which the sampled portion was extrapolated (to), to obtain total

weight and numbers by species. Length, sex, maturity and age samples were taken on selected rockfish, sablefish (*Anoplopoma fimbria*), and arrowtooth flounder (*Atheresthes stomias*).

Table 1. Area in nm^2, approximate boundaries and tow allocation for the INPFC Columbia area 1979 Pacific ocean perch survey. Tows used in making the biomass estimate and optional tows are also listed.

Stratum	Density type	Area	Allocated Tows	No. of Tows/nm^2	Good Tows	Optional Tows
Cape Elizabeth Shallow*	High	26.9	9		8	-
Cape Elizabeth Deep*	High	18.1	5		2	-
Grays Harbor Shallow*	High	37.1	9		6	-
Grays Harbor Deep*	High	10.8	4		1	-
Willapa Shallow*	High	40.4	10		8	-
Willapa Deep*	High	23.7	5		5	-
Copalis and Grayland*	Low	93.9	6		6	-
Columbia Shallow	High	99.6	19	1/5	18	6
Columbia Deep	High	42.3	7	1/6	4	-
Cape Falcon	Low	59.9	4	1/15	4	-
Nehalem Shallow	High	82.6	10	1/8	10	2
Nehalem Deep	High	9.7	3	1/3	3	-
Island	N.A.	6.5	-	-	-	-
Tillamook	Low	175.5	10	1/18	10	1
Newport Shallow	High	281.8	31	1/9	31	4
Newport Deep	High	275.9	25	1/11	20	1

* Areas surveyed by National Marine Fisheries Service and Washington Department of Fisheries.

Optional tows were selected at the discretion of the vessel captain and the biological party chief. These tows were chosen on the basis of the captain's past experience and knowledge of the terrain associated with concentrations of Pacific ocean perch. Catches were handled in the same manner as catches from regular survey tows.

Analysis. Biomass estimates and associated variances were determined using the area-swept method (Gunderson and Sample, 1978). Catch data from optional tows which occurred within the boundaries of pre-established sampling strata were lumped with catch data from regular survey tows prior to calculating biomass. Optional tows which occurred in special areas outside of the normal survey boundaries were treated separately and a separate biomass estimate utilizing the area associated with those tows was made.

Length frequencies for Pacific ocean perch were obtained from NMFS. Age composition data were available for the portion of the survey conducted by ODFW (vessels M/V New Life and Washington) and were summarized by numbers caught per hour by age group. Species composition, based on pounds per tow, was determined for each sampling strata south of the Astoria Canyon.

Results

Increasing the sampling intensity was not given a high priority in the INPFC Columbia area because of the predicted low gains in precision with respect to increasing the number of tows/nm^2. The precision of biomass estimates of *S. alutus* in 1979 was improved in the INPFC Vancouver area over 1977 rockfish survey results by increasing sampling intensity. The 1977 biomass estimate and 90% confidence interval was 7,730 mt ± 112% compared to the 1979 estimate of 5,711 mt ± 77%. The slight increase in sampling intensity and the stratification scheme used in the 1979 survey produced a biomass estimate in the Columbia area with precision equal to that of the 1977 rockfish survey (e.g. ± approximately 40%). Although the overall estimate for 1979 was 11,276 mt ± 4,616 mt as opposed to the 1977 estimate of 6,546 mt $\tilde{\pm}$ 40% (1977 INPFC Columbia north of 44° 37') the 90% CI of the estimates overlap. Gear, seasonal and sampling design differences confound comparisons between years however, and it would be risky to state that this comparison has any statistical validity.

Table 2 contains the biomass estimates by strata based on regular survey tows plus optional tows. Stepwise addition of tows was made based on the following options: Option 1, no optional tows; option 2, include regular plus tows that were placed in areas of potential *S. alutus* abundance based on vessel captains' experience and knowledge of the fishing grounds; option 3, same as option 2 above except that electronic surveillance was used to position the trawl to avoid hang-ups. In the last option, fish were observed incidentally to positioning of trawl. Tow number 61 of the M/V New Life was eliminated from the analysis because it was the tow made on a school detected during transit between stations.

Table 2. Biomass estimates of *S. alutus* by sampling strata for INPFC Columbia area derived from 1979 regular survey tows and optional tows. Strata north of the Columbia river were lumped. Numbers in parentheses represent no change in biomass but are additive within options 2 and 3.

Strata	Depth, fms	Area, nm^2	Option 1 regular tows		Option 2		Option 3	
			Tows	Biomass, mt	Tows	Biomass, mt	Tows	Biomass, mt
INPFC Columbia north of 46° 16' N	90-260	250.9	36	2,180[1]/	-	(2,180)	-	(2,180)
Columbia Shallow	90-174	99.6	18	1,406	24	2,524	-	2,524
Columbia Deep	175-230	42.3	4	2	-	(2)	-	(2)
Cape Falcon	90-230	59.9	4	29	5	52	-	(52)
Nehalem Shallow	90-174	82.6	10	165	12	218	-	(218)
Nehalem Deep	175-230	9.7	3	14	-	(14)	-	(14)
Island	175-230	6.5	-	-	2	23	-	(23)
Tillamook	90-230	175.5	10	264	11	284	-	(284)
Newport Shallow	90-174	281.8	31	2,738	33	3,357	35	9,778
Newport Deep	175-230	275.9	20	4,480	21	5,042	-	(5,042)
Total				11,278		13,696		20,117
South of Newport	90-230	22.9	-	-	2	1,592	-	-

[1]/ Estimate from NMFS

Large differences in biomass estimates of *S. alutus* were seen between the different modes of analysis outlined above; however, none were statistically significant at the 80% confidence level. Ranked means and confidence intervals for the INPFC Columbia area estimates appear in Table 3 for the different options. The 20,116 mt estimate based on regular survey tows plus the optional tows (option 3) was significantly greater than the 11,276 mt estimate based on regular survey tows only at the 60% confidence level. Option 3 includes 8.2 nm^2 of additional area added to the total survey area and reflects the extension of grounds covered by some of the optional tows. The area south of Newport yielded a biomass estimate of 1,592 mt but was excluded from the comparisons as there were no regular survey tows placed south of Lat 44° 37' N. Pacific ocean perch occur in quantities that diminish with respect to other members of the perch-complex from north to south. Cost considerations prevented sampling the southern portion of the INPFC Columbia area from Lat 44° 37' to Lat 43° 00 N. However, the 1977 survey estimate was 558 mt of *S. alutus* south of Lat 44° 37' N.

Table 3. Biomass estimates ($\hat{B}$) of Pacific ocean perch from Lat 44° 30' to 47° 20' N of the INPFC Columbia area based on: regular survey tows (option 1); regular tows plus optional tows selected by vessel captain and biological party chief without electronic positioning of net (option 2); option 2 plus tows that assisted with electronics (option 3). Confidence intervals are expressed for 50% through 90% probability levels.

Options	Probability			
	$P \geq 0.90$	$P \geq 0.80$	$P \geq 0.60$	$P \geq 0.50$
Option 1:				
$\hat{B}$ = 11,276				
UL[1]/	15,921	14,975	13,640	13,168
LL[2]/	6,632	7,578	8,913	9,386
Option 2:				
$\hat{B}$ = 13,696				
UL	19,241	18,012	16,518	15,954
LL	8,151	9,380	10,874	11,438
Option 3:				
$\hat{B}$ = 20,116				
UL	32,230	29,546	26,282	25,049
LL	8,002	10,686	13,950	15,184

[1]/ Upper limit
[2]/ Lower limit

Species composition of *S. alutus* with respect to other rockfish reflected changes latitudinally similar to those observed in 1977 (Demory et al, 1979). Table 4 lists the species composition (percent by weight) by strata from Lat 44° 37' N to Lat 46° 21' N sampled by ODFW and based on regular survey tows. Off Newport *S. alutus* was 40.6% to 43.9% of the catch of rockfish in the shallow and deep strata respectively, increasing to 78.4% and 70.8% for the Columbia shallow and deep sampling strata.

Table 4. Species composition of rockfish by sampling strata from 1979 survey catches off Oregon. Estimates based on regular tows only.

	Columbia Shallow	Columbia Deep	Cape Falcon	Nehalem Shallow	Nehalem Deep	Tillamook	Newport Shallow	Newport Deep
Sebastes alutus	78.4	70.8	72.0	29.0	47.2	15.1	40.6	43.9
S. crameri	16.9		2.2	3.4	2.2	34.5	12.0	13.8
S. diploproa	0.3		9.2	3.7	10.6	33.3	16.3	16.3
S. proriger				0.3		0.1	0.1	
S. reedi	1.1			0.3			1.1	
S. saxicola	<0.1			2.2		0.4	1.7	
S. zacentrus	<0.1			45.8		0.4	8.0	<0.1
S. aleutianus	1.4				1.9	3.9	0.1	3.4
S. aurora			3.8			0.1	<0.1	0.8
S. babcocki	0.1		4.1	8.7		1.9	0.6	1.4
S. borealis							0.3	
S. brevispinis	0.1			0.6				
S. elongatus	<0.1			1.1		0.6	4.6	
S. entomelas	1.3			0.3		0.1	1.0	
S. flavidus	0.2					0.2	0.5	
S. helvomaculatus				0.6	0.2	0.2	0.3	<0.1
S. jordani				0.1			<0.1	
S. paucispinis							0.1	
S. pinniger						0.2	1.2	
S. ruberrimus							0.1	1.3
S. rubrivinctis							<0.1	
Sebastelobus alascanus	0.1	29.2	8.6	3.8	29.0	9.0	11.5	19.1
Lbs sampled	6662.5	7.2	78.0	1865.7	264.6	2546.5	9613.0	6197.5
Tows	18	4	4	10	3	10	31	20

For similar latitudes in 1977, *S. alutus* comprised approximately 26% of the catch off Newport (Lat 45° 00' N) and 48% of the catch off the Columbia River (Lat 46° 15' N). The lower percentages reflect the fact that a much shallower area (50-90 fms) was included in the 1977 rockfish survey. The special tows reflected changes in the species composition also (Table 5). A higher proportion of *S. alutus* was caught in the Columbia and Newport shallow strata. Other sampling strata reflected increases or decreases in the proportion of *S. alutus* caught but had small sample sizes and may not be indicative of any trend.

Other species comprising a significant proportion of the catch were *Sebastes crameri, S. diploproa and Sebastolobus alascanus.*

Age composition expressed as No./hr was estimated on the basis of regular survey tows and combined for the strata sampled by ODFW (Figure 4). In the INPFC Columbia area the age composition reflects the presence of a strong 1970 year class now

Table 5. Species composition of rockfish by sampling strata from 1979 survey catches off Oregon. Estimates based on optional tows only.

	Columbia Shallow	Columbia Deep	Cape Falcon	Nehalem Shallow	Nehalem Deep	Tillamook	Newport Shallow	Newport Deep
Sebastes alutus	92.0		11.4	16.2		28.5	71.4	39.7
S. crameri	7.1		0.2			52.8	0.3	0.7
S. diploproa	0.1		5.7			3.6	6.3	4.2
S. proriger			2.2	0.1				
S. reedi			22.2	13.2			4.9	8.8
S. saxicola			2.7	0.1		0.2		
S. zacentrus	0.2		40.0	61.2		4.0	14.2	1.1
S. aleutianus	<0.1							37.4
S. aurora								<0.1
S. babcocki	0.3			<0.1		2.0	<0.1	0.8
S. brevispinis			4.0	8.1			0.1	
S. elongatus			1.5	0.1		1.1		
S. entomelas	<0.1		0.6			2.5		
S. flavidus	0.2							
S. helvomaculatus			3.4	0.2		0.7	0.1	0.3
S. paucispinis			1.5					
S. pinniger	<0.1		4.4					
S. ruberrimus				0.7				0.7
Sebastelobes alascanus	<0.1		0.2	0.1		7.1	0.3	6.2
Lbs. sampled	3489.3		596.0	1939.9		323.8	15784.2	1821.4
Tows	6		2	2		2	4	2

NO SAMPLES

recruited to the fishery and the potential for a strong 1974 or 1975 year class still not fully recruited. The 1970 year class was dominant in the age composition in the INPFC Columbia area in 1977 (Golden et al, 1979).

Discussion

Accurate estimates of the absolute abundance of highly aggregating fishes such as the rockfishes would be useful in setting acceptable limits of harvest and monitoring long term trends in the population, but are, in general, difficult to obtain.

Schooling behavior of rockfish results in non-normal and highly skewed catch per unit effort (CPUE) which leads to large variances and relatively imprecise estimates of biomass when calculated by the area-swept method. Attempts to reduce the variance by increasing the sampling intensity work, but the relative gains in precision are not usually cost effective (Grosslein, 1971). For example, four times as many tows as were made in the 1977 rockfish survey would be necessary to reduce

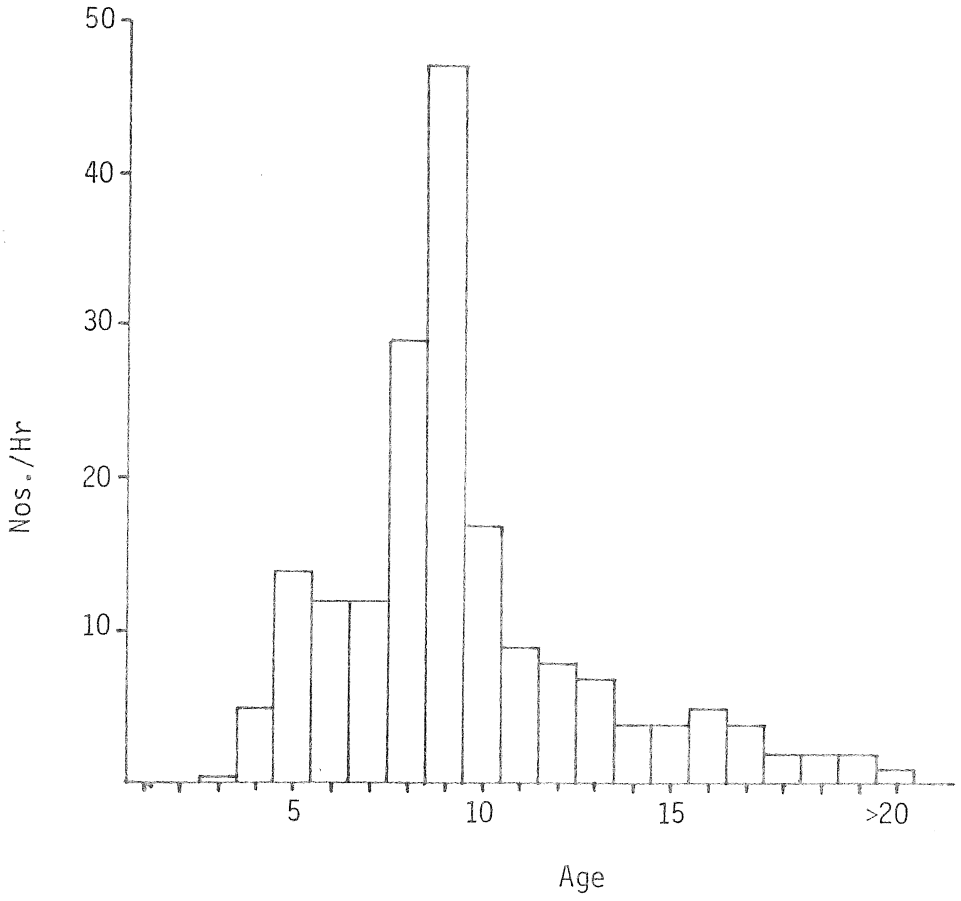

Figure 4. Age composition of Pacific ocean perch (Nos./hr) in the INPFC Columbia area from the 1979 survey. Age composition based on regular survey tows only.

the confidence limits by a factor of two (Fraidenburg, unpublished manuscript).

Stratification can be advantageous in increasing precision and decreasing bias by concentrating sampling effort on target species in areas of abundance. Considerable bias may be removed by including hard bottom areas or areas of unique terrain type that may be difficult to fish but may contain high concentrations of fish. In the 1979 survey the stepwise addition of optional tows from such areas increased the biomass estimate substantially indicating a potential for biased estimate based on regular survey tows alone. This potential bias could lead to an underestimate of the abundance of *S. alutus* based on the random stratified scheme used in this survey. The bias, if it exists however, appears to be obscured by the lack of precision in the estimates. Only at the 60% probability level was any significant difference detected between biomass estimates based on the regular survey and biomass estimates based on option 3.

A stratification scheme that identifies terrain type (e.g. hilltops, gullies and steep slopes) associated with Pacific ocean perch and the development of survey trawl gear efficient enough to operate in these marginal but highly productive areas, may make it possible to determine if a significant bias exists. If true bias can be determined, more accurate estimates of absolute abundance would be developed.

Survey designs, and results, need to be scientifically valid as well as credible to the recipients of management decisions. A design which accounts for other factors associated with perch abundance, not accounted for in past surveys, may help bridge the gap between scientists and commercial fishermen who sample the same population with different motives, techniques and criteria.

TAGGING STUDIES

English sole (*P. vetulus*) and lingcod (*O. elongatus*) are important components in the Oregon trawl fishery. Lingcod are also prized marine sport fish. Conflict between user groups for lingcod is a growing problem, and there are possible localized areas of stock depletion off Oregon for this species.

Prior to these tagging studies distribution of English sole and lingcod stocks inhabiting waters off central Oregon (between Cape Blanco and Cascade Head) was unknown. This area has been a gap in the extensive English sole tagging projects which have been carried out by west coast fishery agencies.

The purpose of these studies was to increase our knowledge of life histories and fisheries for English sole and lingcod. Specific objectives were:

1. To determine stock definition of English sole off the South-Central Oregon coast (PMFC Areas 2B and 2C).

2. To determine fishing rates on English sole in the above area.

3. To determine movement and the relationships between nearshore reef and offshore reef populations of lingcod.

Tagging procedures are described in detail in an earlier report[1]/.

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[1]/ Annual report, October 1, 1977-September 30, 1978. Ore. Dept. Fish and Wildl. Processed Rept. Project No. 1-132-R; Grant No. 820840 RAC

English sole

Of the 4,188 English sole tagged in December 1977 and March 1978, 314 or 7.5% have been recovered and documented by October 1979. There are an unknown number of tags that have been recovered but not documented by Oregon Department of Fish and Wildlife.

Since there appears to be a difference in the extent of northward distribution of tagged fish between the December and March tagging effort, results will be described by tagging period first. No allowance has been made for dispersal of tagged fish and fish recaptured within the first month following tagging were included in the following discussion. Also, tag recoveries were summarized by calendar year quarter.

December 1977 tagging

As would be expected tag returns from the area of tagging during the first quarter 1978 were substantial because there was an intense fishery at the time and fish had not had time to disperse; however one tagged fish was recaptured in area 3B within a month after being tagged. Overall, about 7% of tag recoveries during the first quarter occurred north of the tagging area (Table 6). Movement south of the tagging was quite limited, amounting to 1% of all recoveries.

Table 6. Recoveries of tagged English sole by international statistical area from December 1977 tagging.

	Number recovered, 1978				
Area of Recovery	First Qtr.	Second Qtr.	Third Qtr.	Fourth Qtr.	
5A	0	0	1	0	
4B	0	2	1	0	
3C	0	2	1	0	
3B	7	3	3	0	
3A	6	8	21	11	
2C-2B	34[1]/	7	11	30	
2A	0	0	1	1	
1C	2	5	2	3	
Unknown	1	5	4	2	3[2]/

Total tags recovered = 177

	Number recovered, 1979				
	First Qtr.	Second Qtr.	Third Qtr.	Fourth Qtr.[3]/	
5A	0	1	0	-	
3C	1	0	1	-	
3B	1	1	2	-	
3A	3	0	4	5	
2C-2B	18	2	2	-	
1C	0	1	1	-	
Unknown	0	0	1	-	3[2]/

Total tags recovered = 47

1/ Includes 5 recoveries between Dec. 30, 1977 and Jan. 1, 1978.
2/ Time and area unknown
3/ Only recoveries at time of this report

By the second quarter 1978 tagged fish were caught in inland waters of British Columbia in Area 4B and off the west coast of Vancouver Island in Area 3C. Overall, tags recovered north of the tagging area in the second quarter amounted to 8%. There was also a substantial decline in the number of tags recovered from the tagging area--4% as opposed to 19% in the first quarter. Again there was limited movement south of the tagging area (3%).

Third quarter 1978 returns showed that tagged fish had extended as far north as Area 5A off northern Vancouver Island. The number recovered north of the tagging area amounted to about 15% with most recoveries occurring in Area 3A. The number of tags recovered in the area of tagging amounted to 6%. Movement to the south of the tagging area was limited.

During the fourth quarter 1978 there were no fish recaptured north of Area 3A but a large number (17%) were recaptured in the tagging area. The number of tags recovered from Area 3A was about one-half the number recovered during the third quarter suggesting a southerly movement back to the tagging area. Fourth quarter returns coupled with first quarter 1979 returns certainly suggests a collection of tagged fish in the tagging area.

Returns from 1979 show much the same pattern as was evident in 1978; however, fourth quarter 1979 returns are incomplete.

Considering only tag returns from north of Cape Blanco, recoveries from the December 1977 tagging strongly suggest a general movement to the north during the late winter and spring with most fish remaining in Area 3A during the summer months. In the fall the pattern is reversed with tagged fish returning south to the tagging area.

March 1978 tagging

Fish tagged during the March 1978 tagging were recovered to a much lesser extent northward than tagged fish from the December tagging; however, a similar pattern of distribution prevails. An apparent northward movement to Area 3A occurred during the second and third quarters 1978 with an attendant decline of tagged fish recaptured in the area of tagging (Table 7). Fourth quarter 1978 returns occurred only in the tagging area and these returns combined with first quarter 1979 returns clearly indicate a return of tagged fish to the tagging area.

As stated earlier the tagging effort was considered as two distinct tagging studies; however, the major difference between the two tagging experiments seems to be the greater northward movement of fish tagged in December 1977. Because of the similarity between the two experiments it was decided to combine the two experiments into one, because even though the northward migration of tagged fish was apparently impacted by time of tagging, the return of tagged fish to the tagging area should not have been.

The same general movement is apparent with the two taggings combined, i.e., a shift northward during the second and third quarters with a return of tagged fish to the tagging area during the fourth quarter (Figure 5).

The number of recovered tags alone is not necessarily a measure of movement unless directed fishing effort is somewhat constant between tag recovery areas. This is

Table 7. Recoveries of tagged English sole by international statistical area from March 1978 tagging.

Area of Recovery	Number recovered, 1978				
	First Qtr.	Second Qtr.	Third Qtr.	Fourth Qtr.	
3A	0	1	5	0	
2C-2B	18	12	6	20	
1C	0	0	2	0	
Unknown	0	0	3	2	1[1]/
Total tags recovered = 70					

	Number recovered, 1979				
	First Qtr.	Second Qtr.	Third Qtr.	Fourth Qtr.	
3A	0	1	0	-	
2C-2B	16	1	0	-	
1C	0	0	0	-	
Unknown	0	0	1	-	1[1]/
Total tags recovered = 20					

[1]/ Time and area unknown

not the case because fishing effort varies widely between areas and it was necessary to evaluate tag returns relative to the amount of directed fishing effort required to obtain them.

Effort data required for such an analysis is available only for 1978 for Areas 2B-3A inclusive. Fishing effort is shown in Table 8 along with the number of tags recovered by area. Recovery (incidence) is expressed as tags returned per 100 hours of trawling.

The generalized picture of movement is a northerly migration northward in the early winter and spring, a general occupation of northern areas during the summer and a return to the tagging area in the late fall and early winter. Because of data limitations it is not possible at this time to determine whether or not there will be a decline in the incidence of tagged fish in Area 3A during the fourth quarter 1979 but it is highly probable since first quarter 1979 returns from Area 3A were quite low.

Lingcod

In July 1978, 3,818 lingcod were tagged adjacent to Stonewall Bank in PMFC Area 2C. Females comprised 89% of fish tagged. In addition to lingcod tagged offshore, lingcod were also tagged nearshore beginning in November 1977 and continuing through March 1978. These fish were captured by hook and line from a reef area adjacent to Yaquina Bay. There were 294 lingcod tagged of which 83% were males. A third tagging effort on lingcod occurred during the English sole tagging and fish tagged were caught incidentally to the English sole fishing. There were 39 lingcod tagged from this effort of which 62% were males.

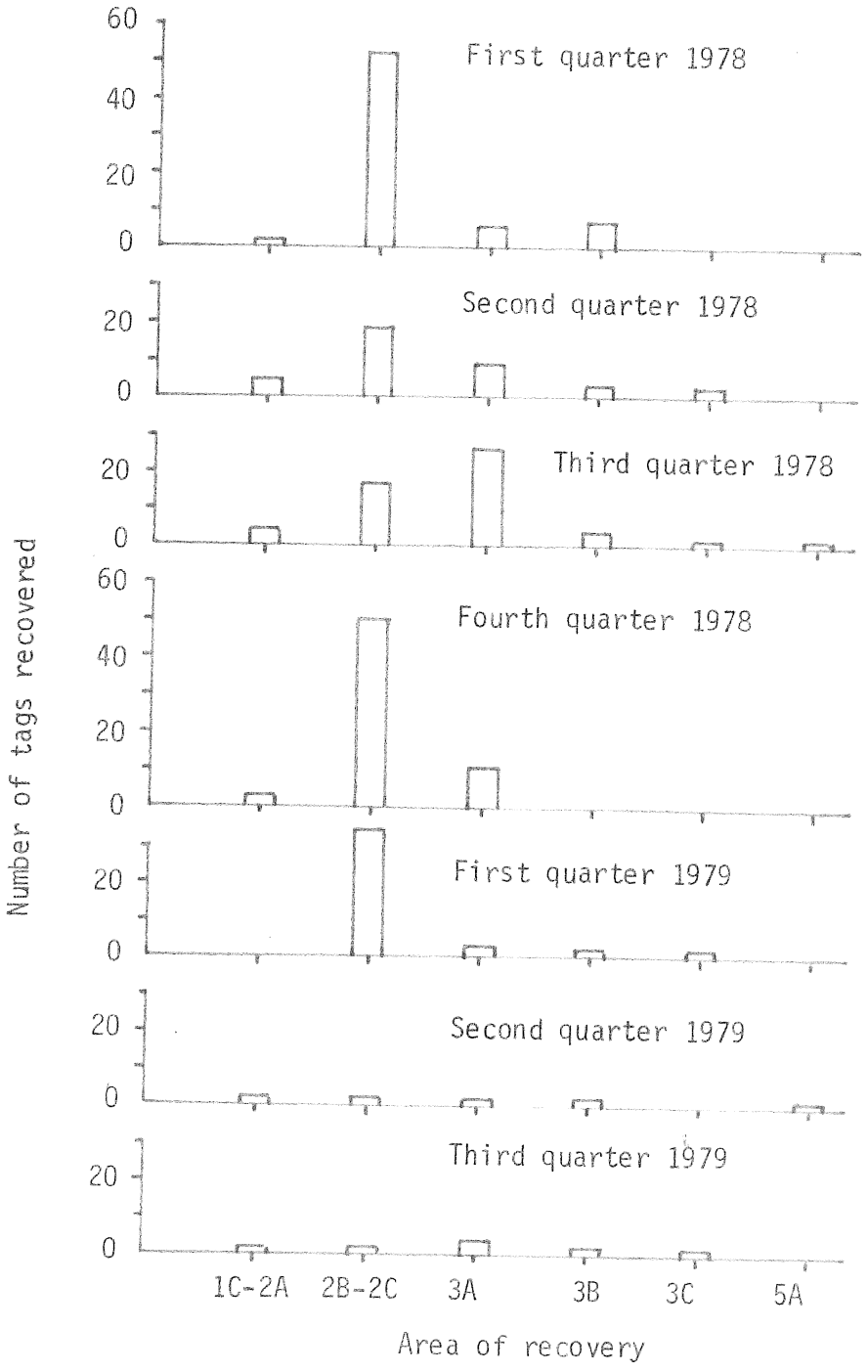

Figure 5. Number of tagged English sole recovered by international statistical area. Tag returns from December 1977 and March 1978 tagging experiments are combined.

Table 8. Number of tags recovered in 1978 weighted to fishing effort for English sole tagged in December 1977 and March 1978.

	Area of Recovery			
	5A-3B	3A	2C-2B	2A-1C
First Quarter				
Effort, hrs.	1/	2,644	2,812	1/
Tags recovered	7	6	52	2
Incidence 2/	-	0.23	1.85	-
Second Quarter				
Effort, hrs.	1/	2,710	1,989	1/
Tags recovered	7	9	19	5
Incidence 2/	-	0.33	0.96	-
Third Quarter				
Effort, hrs.	1/	5,488	2,280	1/
Tags recovered	6	26	17	4
Incidence 2/	-	0.47	0.75	-
Fourth Quarter				
Effort, hrs.	1/	2,286	3,159	1/
Tags recovered	0	11	50	3
Incidence 2/	-	0.48	1.58	-

1/ Effort statistics incomplete or not available.

2/ Number of tags recovered per 100 hrs. of trawling (No. of tags ÷ hours x 100).

As of August 21, 1979, 347 (9.1%) tagged lingcod from the offshore tagging have been recovered. Females comprised 89% of the recoveries, identical to the proportion tagged. Movement was detected for only 18 fish as shown in Figure 6. The preponderance of recoveries from and near the area of tagging suggests very little movement. Of the 18 fish showing movement, 11 traveled north while only 2 moved south. The greatest movement north was off Cascade Head or possibly Cape Lookout while the greatest movement south was to the "mudhole" off Heceta Head. Nine of the 11 fish caught north moved into deeper water (85-188 fathoms) while 5 moved into shallower water (22-30 fathoms). All fish recovered outside the tagging area were females. Most tag recoveries came from trawlers but some returns came from sport charter boats fishing on Stonewall Bank or from trollers fishing near the bank. Of the 19 fish recovered from the inshore tagging, 17 (89%) were males and all fish were captured from the reef where they were tagged. Only two lingcod have been recovered from the fish tagged during the English sole tagging experiments and both fish were caught near the area of tagging. The female moved offshore but into shallower water on Heceta Bank while the male moved south into deeper water.

Apparent differences among stocks from different tagging areas could be due to seasonal differences or actual differences in stocks. The winter tagging in the "mudhole" area and the nearshore reef produced mostly males but the summer tagging on Stonewall Bank produced mostly females. Movement has been limited almost entirely to females and no movement has been observed between the nearshore reefs and the offshore areas.

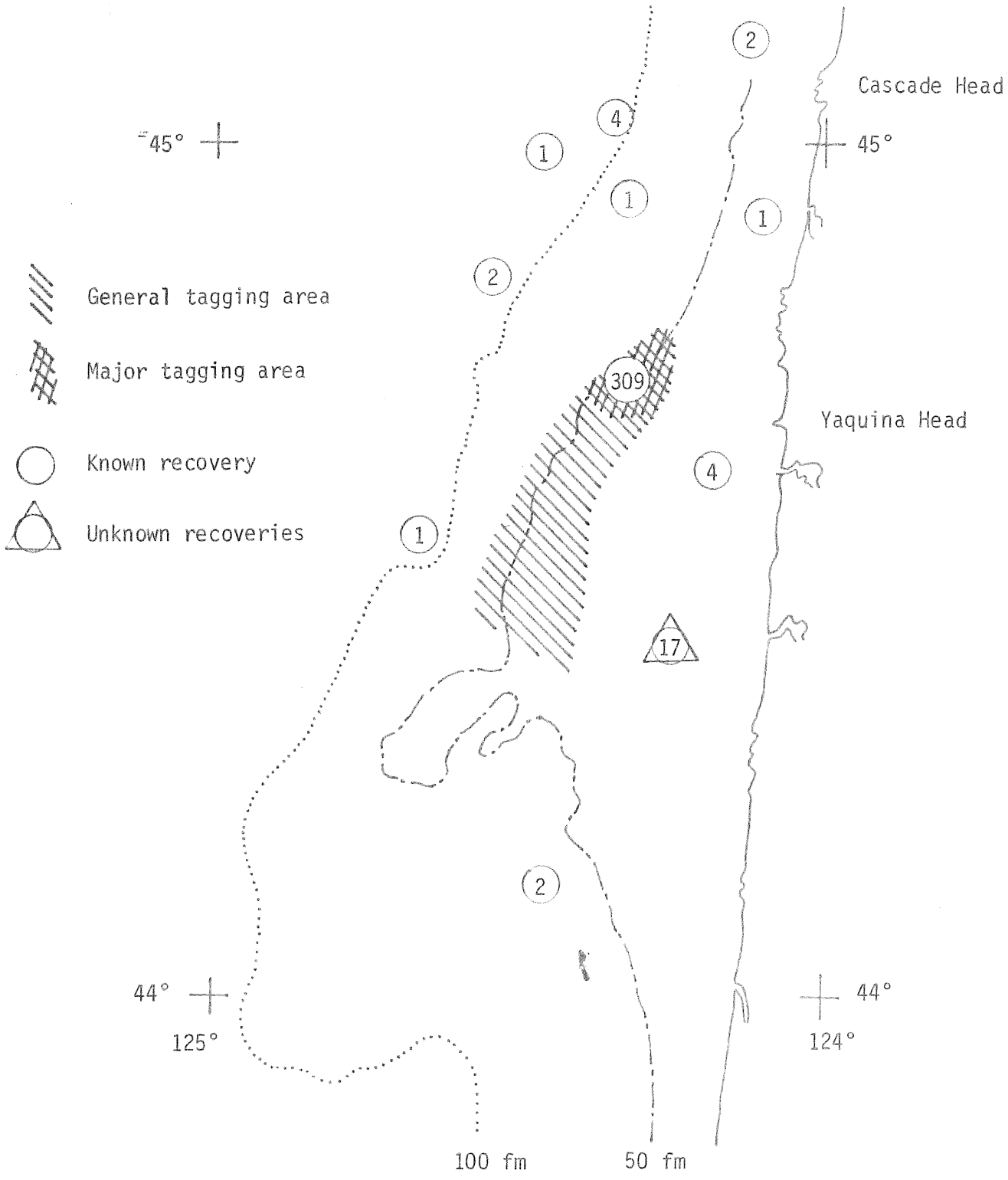

Figure 6. Lingcod tag recoveries from lingcod tagged on Stonewall Bank, July 1978. Except for tags of unknown recovery area, enclosed numbers represent approximate location of tag recoveries.

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