WASHINGTON
Department of
FISHERIES

1. THE PUGET SOUND HAKE FISHERY: PAST, PRESENT, AND FUTURE

2. MIGRATION OF HERRING TAGGED OFF WEST BEACH, WHIDBEY ISLAND, WASHINGTON

3. TWO ADDITIONAL LONG-RANGE MIGRATIONS OF SABLEFISH TAGGED IN PUGET SOUND

1970 Technical Report 5

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ERRATA SHEET

Page 6, fourth paragraph, line 1 - landings should be capitalized.

Page 9, Table 4, Port Susan - 35.6 and 10,119 in W/O telemetry column 1966-1967 (May) should be in Telemetry column 1967-1968 (May). 52.8 and 4009, 118.1 and 3638 in Telemetry column 1967-1968 (May and June) should be in W/O Telemetry column 1967-1968.

Page 10, first paragraph, line 3 - 37% should be 372%.

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Page 10, fourth paragraph, line 1 - Fish should be Fishing.

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Page 19, seventh paragraph, line 5 - bear should be near.

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THE PUGET SOUND HAKE FISHERY: PAST, PRESENT, AND FUTURE

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November 1970

INTRODUCTION

Hake *(Merluccius sp.)* have been actively harvested commercially in many areas of the world since at least early in the nineteenth century. Utilized both for human consumption and industrial uses, they have been the subject of regulatory management to prevent over-exploitation in Europe, South Africa, and South America (Grinols and Tilman, 1970). Until recently, however, the abundance of hake off the west coast of the United States has been considered a nuisance. Catches were incidental to other fish and Pacific hake *(M. productus)* were rarely used for human consumption. Attempts from 1965 to 1967 to establish a large reduction fishery off the Washington coast failed despite superior extraction techniques when industry could not provide adequate profit incentive to entice fishermen from other proven, more profitable summer fisheries. The availability of Pacific hake has been demonstrated by a large Soviet trawl fleet which has taken about 150,000 tons annually since 1966.

The presence of hake in Puget Sound, Washington had been known for many years (Smith, 1936) but they were not the subject of intensive commercial harvest until the fall of 1965. Large catches of hake were taken during Bureau of Commercial Fisheries (BCF) gear experiments in 1964 and 1965 (Hipkins, 1967). The success of the then experimental "Cobb" pelagic trawl (McNeely et al., 1965) and the electronic depth telemetry system (Lusz, 1967; Johnson and High, 1970) convinced fishermen that a profitable industrial-use fishery could be established because of the abundance of hake and the close proximity of the fishing grounds to landing sites (DiDonato, 1966). Consequently what has proven to be the first economically viable United States fishery for Pacific hake commenced in Saratoga Passage (Figure 1) in November, 1965.

A program to monitor the fishery and conduct research applicable to future management of the fishery was initiated concurrent with the start of the fishery by the Bureau of Commercial Fisheries. The Washington State Department of Fisheries (WDF) assumed responsibility for the program in 1967.

This report summarizes the four year history of the Puget Sound hake fishery, evaluates the current status of the fishery, and discusses its potential for the future.

VESSELS AND EQUIPMENT

Since the Puget Sound hake fishery is seasonal, participating boats must be capable of fishing other species. All vessels participating in the fishery have been multi-purpose seine-type trawlers (Hansen, 1965) and most were equipped with

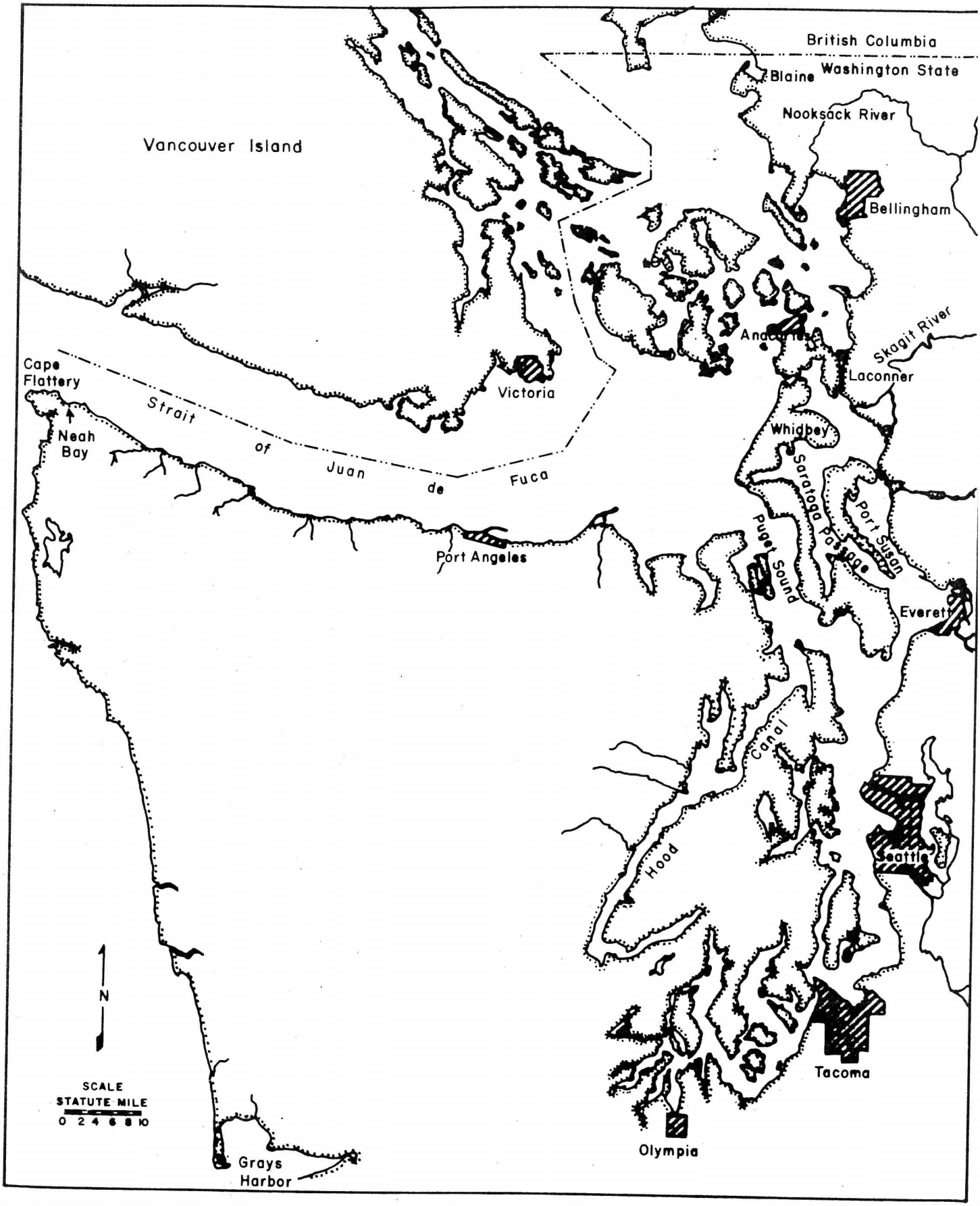

Figure 1. Location map of Puget Sound hake fishing areas and landing sites.

trawl drums (Wathne, 1959). These vessels are equipped to trawl for bottom fish, purse-seine for salmon and herring, and even charter as salmon tenders.

Generally, 5 to 7 boats fish each season but a total of 11 vessels have been involved at least one season (Table 1). Five boats have fished 3 or 4 seasons in the fishery and constitute the nucleus of the fleet. The remaining boats have entered and departed the fishery as market conditions fluctuated and alternative types of fisheries offered employment.

Table 1. List and description of all vessels which have fished in the Puget Sound hake fishery, 1965-1969.

Vessel	Length (feet)	Gross tons	Horse-power	Approx. capacity (tons)	Seasons in fishery
Baron	94	150	510	125	1 (1968-1969)
Peter E	54	43	150	35	2 (1967-1969)
Radio	55	39	150	35	3 (1966-1969)
Recruit	84	112	340	125	1 (1966-1967)
St. Janet	50	48	190	35	3 (1965-1968)
St. Michael	78	107	380	100	4 (1965-1969)
Voyager	75	96	155	100	4 (1965-1969)
Wisconsin	64	46	110	40	4 (1965-1969)
Mars	59	48	250	35	1 (1967-1968)
Lemes	66	44	110	40	1 (1965-1966)
Paradise	67	57	100	40	1 (1967-1968)

A cooperative agreement between the Bureau of Commerical Fisheries and boats interested in the Puget Sound hake fishery was implemented during the first two seasons of the fishery (Hipkins, 1967). Vessel captains agreed to keep detailed catch records and allow BCF personnel on board vessels to conduct research for the loan of 2/3 scale "Cobb" trawls and telemetry systems. This arrangement permitted the fishermen to evaluate the commercial potential of the fishery without a prohibitively large initial expenditure for gear. Conversly, the BCF was able to collect biological data and evaluate the experimental trawl equipment in a commercial operation without additional expense (ibid).

The 2/3 scale "Cobb" trawl fished with the depth telemetry system proved extremely effective for catching hake. Although less efficient, this trawl used without telemetry still provided catch rates sufficient to support a commercial venture. Vessels which attempted to utilize modified bottom trawls, however, experienced poor results and either obtained "Cobb" trawls of left the fishery.

The Bureau of Commercial Fisheries "Aid to Industry" program ceased at the end of the 1966-1967 season. Prior to the start of the 1967-1968 season, fishermen whic did not own "Cobb" trawls either bought or built them. Only one vessel, however, purchased the expensive telemetry system. The general concensus of the fishermen was that the "Cobb" trawl was essential for success but the increased catch rates due to telemetry were not sufficient to justify its purchase considering low ex-vessel prices and market instability. As a result only one vessel utilized telemetry during the 1967-1968 and 1968-1969 seasons.

Although the "Cobb" trawl is standard equipment, no preferred otterboard has emerged. Cobb pelagic otterboards, U-doors and flat plywood otterboards of different sizes have all been used. Johnson and High (1970) discuss the merits of each.

FISHING METHODS

In contrast to many bottom dwelling fish which characteristically occupy specific grounds and are routinely harvested from these grounds, hake are bathypelagic and exhibit a tendency to change depth and areal distribution quickly and unpredictably. Accordingly, the standard hake fishing technique involves surveying an area with a recording echo sounder to determine precise location and depth and relative size and density of a school before the trawl is set. Tow duration is usually dependent upon school size and density but catch data suggest that mean tow duration is also vessel specific. Trawling is usually terminated when echograms show a significant decrease in fish abundance. Tows have averaged about 1 to 1.5 hours with a range of 0.4 hours to over 3 hours.

Fish handling procedures are much simpler than the normal bottom trawl operation. Minimal sorting is required since catches are consistantly over 95% hake. Pacific Dogfish *(Squalus suckleyi)* is the only other species of significance and can be sorted by placing a grating over the hatch or removed from the hold as the vessel is unloaded.

Catches are placed directly from the trawl into the cargo hold without handling. The catches are not iced or refrigerated since human food quality standards are unnecessary and fish are generally held only two to four days. Large pumps remove hake from the hold and thus eliminate fish handling by the fishermen. Under these conditions, crew size averages two to three men including the captain. During the 1968-1969 season, one fisherman singlehandedly landed over two million pounds.

Fishing generally commences in Saratoga Passage in October when hake begin to aggregate. In late December, the schools vanish from area. Late in January, large concentrations of hake form in Port Susan. The fishery is centered there from January until May when the fish disperse.

LANDINGS AND UTILIZATION

Landings

Economic factors govern the viability of the potential hake fisheries in Washington State's contiquous waters. The huge population which inhabits the coastal waters each summer remains unharvested by the Washington trawl fleet. Two large reduction plants in Aberdeen and Neah Bay have been unable to offer competitive prices to entice boats from the more lucrative alternative summer fisheries (Pererya and Richards, 1969). Conversely, the Puget Sound hake fishery provides fishermen an income during the winter when alternative fisheries are scarce. Many fishermen are willing to fish in Puget Sound for less than what was offered for coastal hake, to cover vessel depreciation, insurance, interest and other fixed costs.

Landings of hake from Puget Sound have been limited each season by insufficient market demand. During the first season, processing plants were not prepared to handle large quantities of hake. After adequate unloading and processing facilities were constructed, processors were hampered by lack of profitable outlets for their products. Subsequently, quotas were imposed on the trawlers and entry of additional vessels into the fishery was curtailed.

Landings for the fishery are presented in Table 2. The relatively small landings from Saratoga Passage reflect a distinct difference in behavior, age composition, and probably population size from the Port Susan stock. The Saratoga Passage stock is comprised of all ages of feeding hake which are sexually immature or in pre-spawning condition. Immature 2-year-old fish constitute 30 to 40% of Saratoga Passage catch.

Available data suggest maturing hake from many areas of greater Puget Sound enter Port Susan to spawn from late January to May while young immature hake remain on feeding grounds outside of Port Susan. Over 95% of the hake captured from Port Susan were at least four years old and either in advanced states of sexual maturity, ripe, or spent.

Table 2. Puget Sound hake landings, 1965-1969.

Area	Month	Pounds
	1965	
Saratoga Passage	November	287,600
	December	447,606
	1966	
Port Susan	January	46,795
	February	1,445,573
	March	1,823,683
	April	949,505
	May	1,060,400
	June	254,400
Season total		6,315,644
	1966	
Saratoga Passage	September	249,946
	October	894,200
	November	613,600
	December	264,000
	1967	
Port Susan	January	1,583,950
	February	3,182,300
	March	2,227,350
	April	1,266,700
	May	357,000
Season total		10,639,046
	1967	
Saratoga Passage	October	169,047
	November	354,453
	December	122,950
	1968	
Port Susan	January	582,294
	February	1,695,048
	March	2,392,219
	April	1,850,839
	May	565,850
	June	429,600
Season total		8,162,300
	1968	
Saratoga Passage	October	242,000
	November	1,002,150
	December	440,835
	1969	
Port Susan	January	94,000
	February	2,812,915
	March	2,969,740
	April	1,236,870
	May	536,810
Season total		9,335,320

Utilization

Utilization of Puget Sound hake is primarily for animal food and reduction to high protein fishmeal. Fish purchased for animal food are ground and frozen for eventual use as canned pet food. Fishmeal is the major ingredient in poultry food and in trout and salmon hatchery diets.

Althrough usage has changed during the short history of the fishery, landings have remained relatively constant (Table 3). For example, a decline in the animal food market in 1968-1969 was substantially offset by increased reduction landings primarily to a large new reduction plant.

Table 3. Puget Sound hake landings by utilization.

Season	Animal food	Reduction	Total	Approximate value to fishermen
1965-1966	3,909,424	2,406,220	6,315,644	$ 50,000
1966-1967	5,969,200	4,699,846	10,639,046	82,500
1967-1968	3,614,900	4,547,400	8,162,300	61,000
1968-1969	1,147,250	8,188,070	9,335,320	73,000

Processors in Everett and LaConner provided the major market but plants in Bellingham, Seattle, and Neah Bay (Figure 1) also provided limited outlets. The new reduction plant at Neah Bay opened in November 1968 but operated far below capacity during the 1968-1969 season due to processing problems.

FISHING SUCCESS

Catch data are collected via a fisherman interview system modified from that described by Alverson (1956). Catch data including area, time of day, tow duration, and hailed weight are kept by fishermen in a loose leaf notebook with a carbon. The carbon copy is removed by Washington Department of Fisheries personnel and the original is left for the fisherman's personal record. Catch rates by gear type for the 1965-1969 period are summarized in Table 4.

Advantages of Telemetry

The usefulness of depth telemetry for fishing hake is demonstrated in Table 4. The relative advantage of vessels with telemetry in 1965-1966, however, is not typical. The extremely poor catch rates of boats not telemetry equipped apparently resulted from the inexperience of fishermen in mid-water trawling and the use of

Table 4. Effort in hours (f) and catch rates in pounds per hour (c/f) for the Puget Sound hake fishery.

Month	1965-1966		1966-1967		1967-1968		1968-1969	
	Tele-metry	W/O tele-metry	Tele-metry	W/O tele-metry	Tele-metry	W/O tele-metry	Tele-metry	W/O tele-metry
			Saratoga Passage					
SEPT.								
f			28.8					
c/f			8664					
OCT.								
f			91.4			41.7		37.8
c/f			9788			3589		6402
NOV.								
f	20.0		77.9			93.1	14.0	172.9
c/f	14,380		7780			3807	4429	5438
DEC.								
f	43.0		54.7		7.0	32.3	26.0	59.5
c/f	10,409		4826		5831	2539	6340	4639
JAN.								
f	8.0		23.9					
c/f	5012		9550					
			Port Susan					
JAN.								
f	-		205.1		40.4	155.0		12.9
c/f	-		6610		5832	2235		7287
FEB.								
f	63.0	63.0	277.0	46.0	56.6	310.1	93.9	252.5
c/f	20,037	2368	10,364	6772	5052	4544	10,049	7399
MAR.								
f	58.0	178.0	166.0	34.0		300.4	32.1	221.5
c/f	23,906	2453	11,681	6629		7963	13,209	11,493
APRIL								
f	13.0	142.0	160.0	26.0	10.7	296.9		132.9
c/f	26,430	4264	5926	12,000	7000	5948		8105
MAY								
f	53.0	113.5	84.0	~~35.6~~	~~52.8~~	~~52.8~~ 52.8	~~35.6~~ 35.6	120.6
c/f	10,391	4512	4250	~~10,119~~	~~4009~~	~~4009~~ 14009	~~10,119~~ 10,119	4320
JUNE								
f	12.5	68.0			~~118.1~~ 118.1	118.1		
c/f	2912	3206			~~3638~~ 3638	3638		
TOTAL								
f	270.5	564.5	1168.8	106.0	150.3	1400.4	166.0	1010.6
c/f	16,091	3406	8370	8086	6625	5120	9605	7485

inefficient bottom trawls. Catch rates improved when vessels obtained mid-water trawls and developed new techniques. The relative advantage of boats with telemetry subsequently decreased from ~~37%~~ 372% to a more realistic 28 to 30% during the past two seasons. Vessels with telemetry accounted for 90% of the total fishing effort during the 1966-1967 season when most boats borrowed trawls and telemetry from the Bureau of Commercial Fisheries, but only 10 to 14% of the total fishing effort in the 1967-1969 seasons when BCF equipment was not available.

Limitations of catch per unit effort data

The basic assumption that the catch per unit effort is proportional to abundance, which is applicable to many bottom trawl fisheries, is probably not valid for the Puget Sound mid-water trawl hake fishery. There is evidence that as the population decreases in Port Susan each spring and fish emigrate from the spawning ground, the physical size of remaining aggregations diminishes while density remains relatively constant. Since all vessels locate fish acoustically, high catch rates can be maintained by fishing only the most dense aggregations and progressively decreasing tow duration. Thus catch rates and population size will ~~charge~~ change disproportionally.

Occasionally a decline in catch per unit effort may reflect an increase in effort generated by increased short term market demand rather than a change in abundance. It is possible that gear saturation in Port Susan tends to temporarily scatter schools and decrease vulnerability. Such a situation demands a detailed knowledge of the vagaries of the market before comprehensive analyses of the generated catch data are undertaken.

~~Fish~~ Fishing techniques and technology have changed each season of the fishery. Boats have fished with and without telemetry. Nets and bridles have been changed or modified. Some boats have added new electronic equipment to improve their effectiveness. The complete lack of a standard unit of effort during the four seasons of the fishery makes detailed comparison of catch per unit effort impracticable. The small fleet size (6 to 8 boats), ingress into and egress from the fishery, of vessels of varying efficiency and the fact that only four years of data are available further compound the problem. These restrictions may be overcome, however, when additional years of data are available and fishing tactics and technology have stabilized.

Catch rate trends

Despite the limitations discussed above, much useful information can be obtained from a preliminary appraisal of the catch and effort data.

The high catch rates from both Saratoga Passage and Port Susan in the 1965-1966 season (Table 4) were likely due to the initial cropping of the previously unexploited population. Lack of competition between vessels, with resultant scattering of schools, may also have contributed to the high catch rates. Not only was total effort much less than in any subsequent season but effective effort was limited to the two boats utilizing depth telemetry.

Maximum fishing success occurs in March. Large numbers of hake enter Port Susan in late January but do not form extremely dense schools until March. Biological data indicate that the timing of peak catch rates coincides with the climax of the spawning season.

Success in Saratoga Passage has been consistently poorer than in Port Susan. Hake in Saratoga Passage are far less vulnerable because they remain several fathoms above bottom, do not form the compact aggregations characteristic of populations in Port Susan, and tend to change depth and areal distribution rapidly. The size composition of the Saratoga Passage population includes a high percentage of small hake which may escape through the 2 to 3-inch meshes of the trawls. There is also substantial evidence that the Saratoga Passage population is much smaller than that of Port Susan. Each of the above factors potentially contributes to fishing success.

Examinations of diurnal variation in catch rates indicates the best fishing in Port Susan occurs in early morning and early evening (Figure 2). Such a pattern is directly opposite of the observed patterns for the 1967 Washington coastal hake fishery (Nelson 1967). Echograms demonstrate a temporary downward vertical migration and concentration of schools in Port Susan in early evening which provide high catch rates (Figure 2) for the few boats which take advantage of this trend.

Although direct evidence is lacking, the early morning success may be partially attributed to a reformation of schools after maintaining a scattered pattern during nighttime hours. The fact that the aggregation had not yet been dispersed by fishing may also contribute to the success.

MANAGEMENT AND RESEARCH

The inception of the Puget Sound hake fishery presented the Bureau of Commercial Fisheries and Washington Department of Fisheries with the rare opportunity to evaluate the effects of fishing on a previously unexploited stock of fish and, if necessary, implement a rational management scheme to maximize resource utilization.

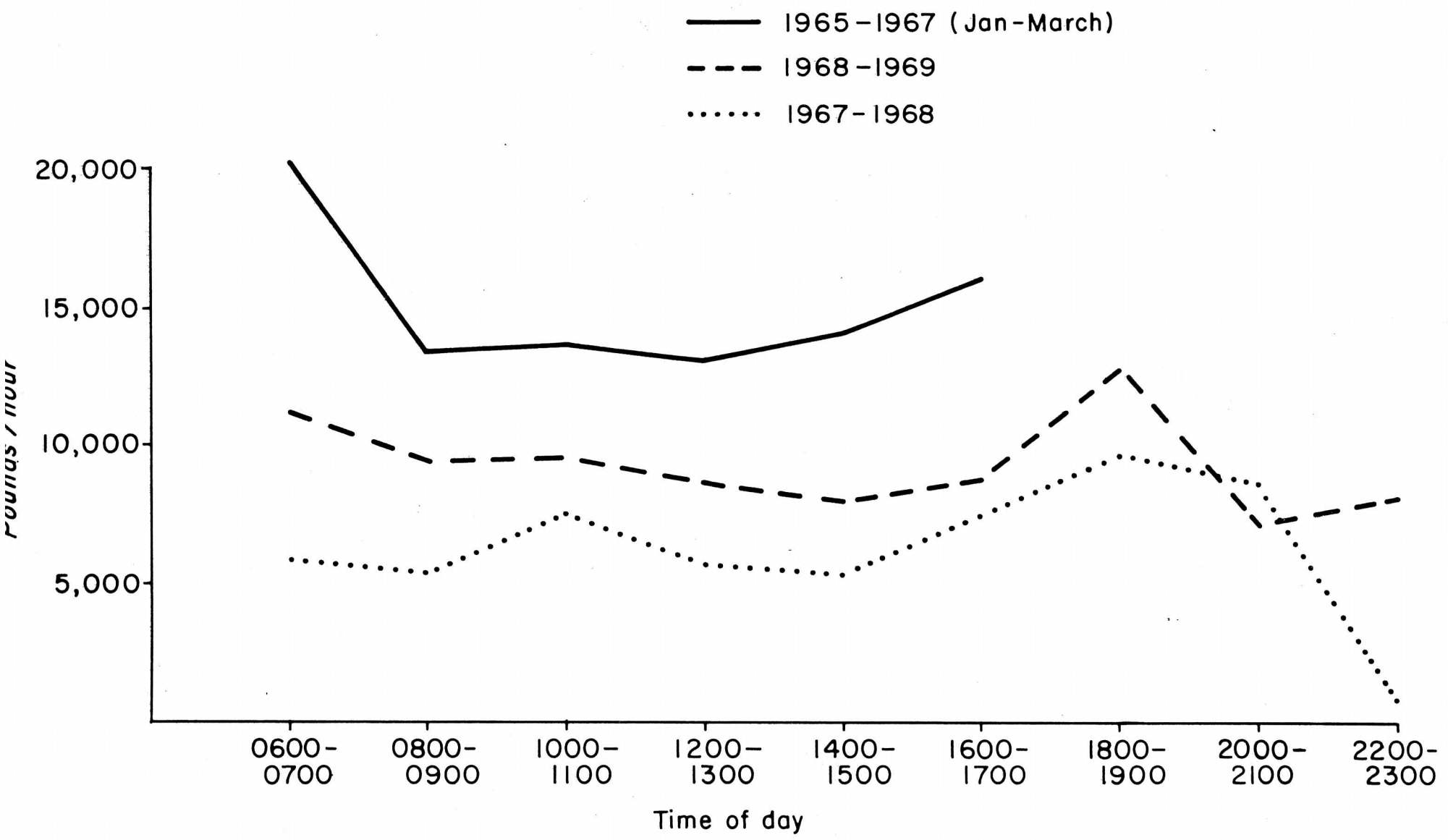

Figure 2. Port Susan hake fishery catch rates by time of day.

Management

Management of the fishery throughout its brief history has been nonrestrictive. The hake fishery has been exempt from many regulations controlling the groundfish fishery and season and area restrictions were relaxed to encourage its expansion. There are yet no data which suggests that restrictive measures are necessary.

Research

Both genetic and non-genetic evidence suggest the Puget Sound hake population is distinct from the population which inhabits coastal waters of Oregon and Washington each summer. Utter (1969) presents evidence of genetic isolation of the two stocks and WDF and BCF biological data demonstrate that the oceanic hake are considerably larger at the same age. Consequently, the oceanic population can be disregarded when establishing investigative and management objectives for the Puget Sound hake fishery.

During the first two seasons of the fishery, the BCF assumed all research responsiblity. A biological sampling program was initiated by the BCF Biological Laboratory to monitor basic biological parameters of the population and investigate specific aspects of the life history of Puget Sound hake.

In 1967, the BCF completed its Puget Sound hake investigations and concentrated on the coastal hake fishery. The WDF assumed research and management studies under the "Commercial Fisheries Research and Development Act" (PL 88-309) on a 50-50 matching funds contract. A sampling program was implemented which expanded and intensified the BCF program, but care was taken to insure that continuous and comparable data were available for all seasons.

Exploratory cruises were conducted in greater Puget Sound in 1968 to supplement BCF explorations. All exploratory data indicate that hake do not concentrate in other areas in large dense schools for sufficient duration to support a profitable fishery.

Perhaps the most promising research undertaken was an acoustical census of the Port Susan spawning population. An electronic echo-integrator recently developed by the University of Washington (Thorne 1969) was used to derive a standing stock estimate in February, March, and April 1969. An estimated 47 million pounds of hake inhabited Port Susan in March 1969 with 23 million and 11 million pounds present in February and April respectively. No precise estimates of annual maximum-sustainable yield have been calculated.

FUTURE OF THE FISHERY

Long term growth of the fishery is inevitable if only as a reflection of increased demand resulting from population growth. Short term expansion, however, is less predictable. Crutchfield and MacFarland, (1968) suggest that there will be an increased demand over the next five years for fish to be processed for fishmeal and Fish Protein Concentrate (F.P.C.).

Demand for hake from the Puget Sound hake fishery for reduction has increased somewhat but F.P.C. production from Puget Sound hake on a commercial basis has not been proposed.

New products are slow in developing. Ideas are routinely researched and rejected as uneconomical. One recent development, a food for captivated marine mammals shows promise and has a large potential market. Other realistic new uses for hake have not been proposed.

Presently development of an industrial use fishery is dependent upon world trends in fish prices (Broadhead 1969). Low prices historically favor nations with large industrial fisheries and inexpensive labor. If demand for fishmeal exceeds the supply from these countries, prices will rise and marginal industrial-use fisheries in the United States, such as the Puget Sound hake fishery, will expand.

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MIGRATION OF HERRING TAGGED OFF WEST BEACH, WHIDBEY ISLAND, WASHINGTON

Nick Pasquale
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November 1970

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INTRODUCTION

For several consecutive years, fishermen actively engaged in salmon fishing in Puget Sound at West Beach reported the presence of a large concentration of herring *Clupea pallasii* Valenciennes. Echograms verified the reports and showed commercial quantities of herring in an area extending from Deception Pass south to Pt. Partridge along the west shore of Whidbey Island (Figure 1). Fishermen requested a herring season in this area by purse seine gear for all-purpose use, including reduction. At the time, this area had a fishing season for herring restricted to use as bait or human consumption. The lack of information regarding this stock of herring prompted a tagging study to obtain knowledge of the migration and distribution pattern of these fish.

METHODS AND MATERIALS

Fishing and tagging operations were conducted from the herring seiner M/V "Radio". Herring were captured in a 1-1/2-inch mesh purse seine nearly the maximum lawful length of 1,650 feet. The net, including the leadline, was approximately 25 fathoms deep, and capable of capturing fish to depths of 15 to 16 fathoms. Power for hauling the net was supplied by a Puretic power block.

Fish for tagging were held in the bunt of the seine along side the boat. Galvanized metal pans 27-inches long by 16-inches wide by 7-inches deep capable of holding 3 to 4 dozen herring in sea water were positioned on deck to permit two taggers to work conveniently from each pan. A total of seven taggers worked throughout the operation with one crewman supplying the taggers with herring. All herring were tagged with internal tags made from .062 inch steel material, 5/32 inch wide by 3/4 inch long, nickel plated, and with ends and edges rounded. The tags were manufactured by Puget Sound Stamp Works, Seattle, Washington.

Herring selected for tagging were held head down in the hand with the ventral edge against the fingers. The fish was contained in the hand with the tail section held between the index and second finger which restrained movement of the fish and arched the body to expose the left side of the body wall to receive the incision for tag insertion.

The incision was made at a midpoint between the lateral line and the ventral edge of the body, and at an approximately midpoint between the pelvic fin and the anus. The incision was made by first dislodging several scales at the point of desired tag insertion with the cutting instrument. A small, shallow incision not greater than the width of the tag was then made in the body wall of the fish with the cutting edge of the instrument. The tag was inserted through the incision into

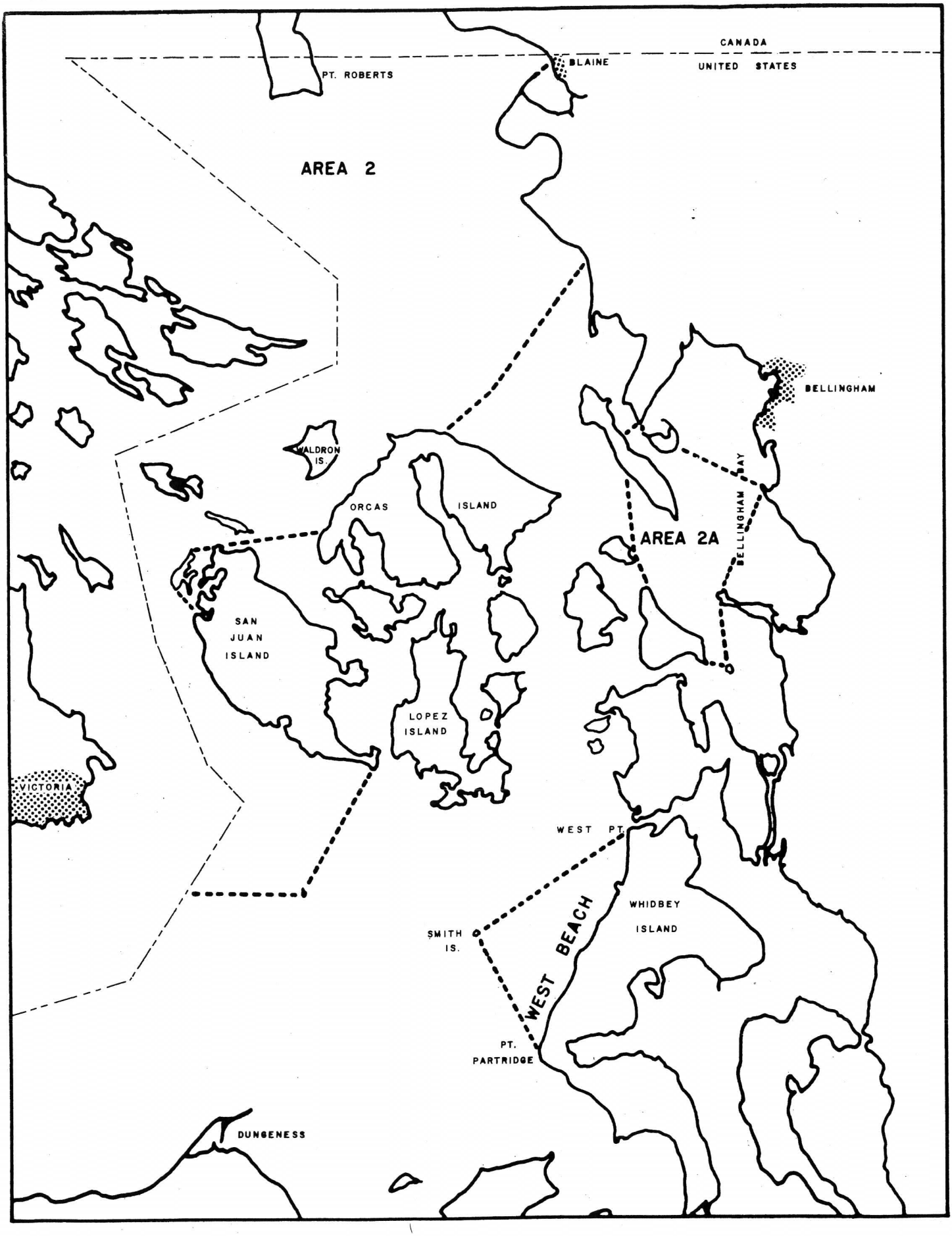

Figure 1. Fishing areas for herring for all purpose use.

the body cavity. Complete insertion of the tag was determined by passing the thumb gently back and forth over the tag insertion area before the fish was released.

Instruments for cutting into the body wall of the herring were fashioned from sections of small scissors which had the points modified to form a cutting edge.

RESULTS AND DISCUSSION

The established commercial herring fishing season for any purpose use in herring fishing Area 2 (Waldron Island and adjacent waters northward) and Area @A (Bellingham Bay) opened on September 15 (Figure 1).

On October 1, 1965, a total of 6,219 herring was tagged and released off West Beach in the experimental area (Figure 1). Good weather and sea conditions made it possible to tag and release extremely vigorous herring. One set provided sufficient fish for tagging.

An experimental season was opened October 11 at West Beach in that portion of Puget Sound herring fishing Area 1 easterly of a line drawn from Partridge Point to the Smith Island Light to West Point on Whidbey Island (Figure 1). A weekly closed period was in effect from 12:00 noon Saturday to 12:00 noon Sunday of each week.

The experimental fishery at West Beach was virtually nonexistent by the first part of November because the main body of fish apparently had migrated from the area. The catch for the season was only 116 tons.

Twenty-six tagged herring were recovered by electromagnets at a reduction plant in Anacortes, all during the 1965-1966 herring season. Only one confirmed recovery was made in the West Beach area. Six tags could not be designated as to recovery area because of mixed landings at the reduction plant. Area 2 produced a total of 13 tag recoveries, including 6 from ~~bear~~ near Waldron Island, and 5 from near Pt. Roberts. Area 2A (Bellingham Bay) produced 6 tag recoveries (Table 1).

The tag recoveries indicated that the population of herring present at West Beach during the summer and early fall left early in October, and migrated northerly into established herring fishing areas of northern Puget Sound. Migration into these areas has also been shown by herring tagged off the west coast of Vancouver Island (Taylor, personal communication)[1/]. Six Canadian tags were recovered in Puget Sound herring fishing Areas 2 and 2A between October 14, 1965 and February 20, 1966. They were among nearly 12,000 released off the west coast of Vancouver Island in August and September 1965.

[1/] F. A. C. Taylor, Fisheries Research Board of Canada, Nanaimo, B.C.

Table 1. Recoveries of herring tagged on October 1, 1965 off West Beach, Whidbey Island.

Tag number	Recovery date	Recovery area
WSF AC7	10/-/65	Waldron Island (Area 2)
WSF 8G8	10/-/65	Waldron Island (Area 2)
WSF 5Q5	10/-/65	Waldron Island (Area 2)
WSF AD2	10/14/65	Area 2A or Area 2 or West Beach
WSF AD2	10/14/65	Area 2A or Area 2 or West Beach
WSF AD2	10/14/65	Area 2A or Area 2 or West Beach
WSF AC3	10/24/65	West Beach
WSF AB7	10/26/65	West Beach or Waldron Island
WSF AD1	10/27/65	Waldron Island (Area 2)
WSF AC2	10/27/65	Waldron Island (Area 2)
WSF AC3	10/28/65	Waldron Island (Area 2)
WSF AD2	11/3/65	Pt. Roberts (Area 2)
WSF AD1	11/6/65	Bellingham Bay (Area 2A)
WSF 8G8	11/16/65	Pt. Roberts (Area 2)
WSF AB7	11/16/65	Pt. Roberts (Area 2)
WSF AB7	11/16/65	Pt. Roberts (Area 2)
WSF AC3	11/16/65	Pt. Roberts (Area 2)
WSF AC3	11/17/65	Waldron Island or Pt. Roberts (Area 2)
WSF 8G8	11/17/65	Waldron Island or Pt. Roberts (Area 2)
WSF AD2	11/24/65	Area 2 or Area 2A
WSF 8G8	12/1/65	Bellingham Bay (Area 2A)
WSF AB7	12/1/65	Bellingham Bay (Area 2A)
WSF AD1	12/1/65	Bellingham Bay (Area 2A)
WSF AB7	12/2/65	Area 2 or Area 2A
WSF AC3	2/10/66	Bellingham Bay (Area 2A)
WSF AB7	2/20/66	Bellingham Bay (Area 2A)

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TWO ADDITIONAL LONG-RANGE MIGRATIONS OF SABLEFISH TAGGED IN PUGET SOUND

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Scientific Aid

November 1970

TWO ADDITIONAL LONG-RANGE MIGRATIONS OF SABLEFISH TAGGED IN PUGET SOUND

by Brad Pattie

Three long-ranged migrations of sablefish *Anoplopoma fimbria* Pallas tagged in Puget Sound were documented by Pasquale (1964). These fish had been tagged at Holmes Harbor, Whidbey Island during 1955 and 1956, and recovered by Japanese fishing vessels in the Bering Sea in 1962.

Two additional recoveries of sablefish tagged in Holmes Harbor were made by Japanese vessels in the Bering Sea during May and June of 1962. Spaghetti tag F-471 was recovered from a 55-cm male sablefish caught on longline gear on June 17, 1962 at lat. 56° 21'N, long. ~~17~~ 171° 30'W. This fish had been tagged and released in Holmes Harbor on May 9, 1958. It had grown 19-cm in length and had traveled roughly 2,000 nautical miles in 4 years 6 weeks. Distance was determined using a route along the continental shelf.

Dart tag B-408 was recovered from a sablefish captured with trawl gear on May 28, 1962 at lat. 54° 30'N, long. 166° 00'W. This fish had been tagged and released in Holmes Harbor on May 10, 1960, and traveled roughly 1,900 nautical miles in 2 years 3 weeks.

Recovery information for these five sablefish was reported by the International North Pacific Fisheries Commission[1/]. All were recaptured along the continental shelf of the Bering Sea from a point 35 nautical miles west of Unimak Island, Alaska, to a point 35 nautical miles off the Siberian coast between M. Navarin and M. Olyutorskiy.

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1/ International North Pacific Fisheries Commission, October 1963. Document 645: 3p.

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