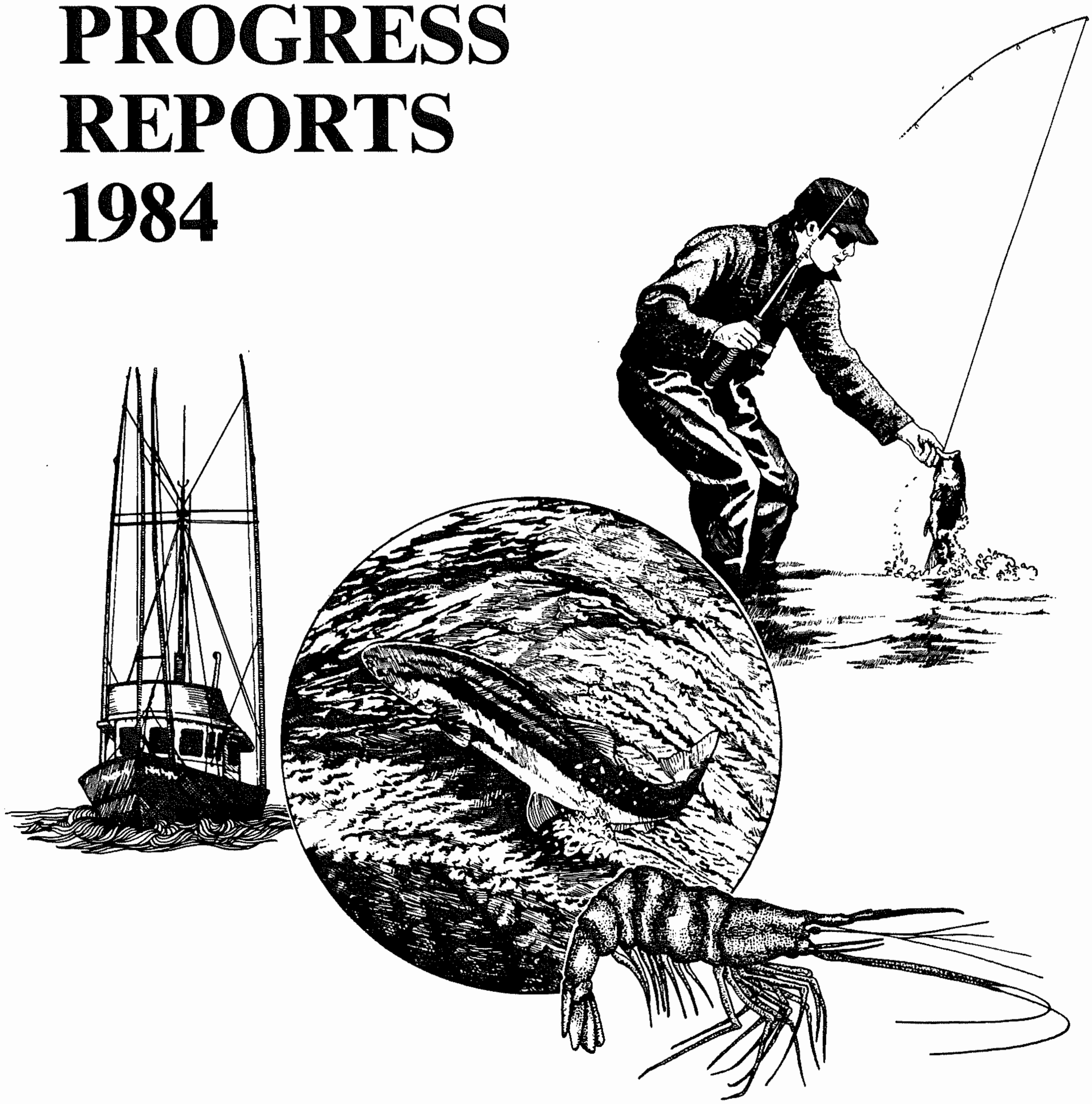
PROGRESS REPORTS 1984



FISH DIVISION

Oregon Department of Fish and Wildlife

Disposal of Seafood Waste to Enhance Recreational Fisheries on the Umpqua River Estuary

FINAL REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: Disposal of Seafood Waste to Enhance Recreational Fisheries on the Umpqua River Estuary.

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EXECUTIVE SUMMARY

Project Description

A research project was completed on the Umpqua estuary, Oregon to determine whether estuarine discharge of seafood processing wastes can be an effective method of fisheries enhancement and an ecologically viable alternative to upland or ocean disposal. The research involved the following tasks:

1. Measurement of current direction to predict the path of waste materials discharged from two locations in the Umpqua estuary.
2. Measurement of current velocities to predict potential dispersal of wastes in the Umpqua for several combinations of tidal exchange and river flow.
3. A monthly fish seining (March-September 1983) and bimonthly invertebrate sampling (March-August 1983) program to assess the effects of organic enrichment in the Umpqua estuary.

Findings

Our results showed that the present outfall location for the Inner Tidal Seafoods plant at Winchester Bay, Oregon does not provide sufficient tidal flushing to prevent excessive waste accumulation. Recommendations were made for a new outfall location. A discharge schedule was established according to ebb tide exchange and river flow conditions to ensure adequate flushing from the recommended outfall site. Recommendations were developed for site selection and for design of monitoring programs in other Oregon estuaries. Because the two seafood processing plants in the Umpqua estuary discontinued operation during this project, we were unable to evaluate biological effects of seafood waste discharge as planned. Recommendations were made for additional research needed to fully evaluate Oregon's seafood waste discharge program.

Benefits

The results of this project will benefit seafood processors along the Umpqua as well as other Oregon estuaries by providing an alternative for disposal of excess seafood waste materials. Results will help resource managers develop discharge procedures and evaluation methods for seafood waste disposal in other Oregon estuaries. A carefully managed waste disposal program should also benefit recreational and commercial fisheries through organic enrichment of Oregon estuaries. A long term evaluation will be needed to determine the volumes of seafood waste that will provide the greatest fishery benefits without risk of environmental damage from excessive accumulation of organic materials in Oregon estuaries.

INTRODUCTION

In the summer of 1981, the Department of Public Works in Douglas County, Oregon, prohibited further dumping of seafood processing wastes in the county landfill. Two Douglas county seafood processors located on the Umpqua estuary, Inner Tidal Seafoods Co. and Reedsport Seafoods, generated an estimated 3 million pounds of salmon, shrimp, crab, and groundfish wastes in 1981. There was no alternative market or nearby facility for fish meal production to use excess waste materials.

Following negotiations among the Port of Umpqua, the United States Environmental Protection Agency, the Oregon Department of Environmental Quality (DEQ), and the Oregon Department of Fish and Wildlife (ODFW), a DEQ waste discharge permit was issued to ODFW to allow disposal of unscreened seafood waste materials in Oregon estuaries. In February 1982, the Port of Umpqua Commission initiated a $50,000 emergency bond to cover costs associated with design and construction of discharge facilities at the two Umpqua processing plants. After further negotiation, ODFW and the Port of Umpqua signed an agreement specifying general discharge conditions.

In late September 1982, ODFW was awarded a grant from the National Marine Fisheries Service (NMFS) to evaluate the Umpqua discharge program. The research goal of this evaluation was to determine whether discharge of seafood processing wastes into the Umpqua River estuary could be an effective method of fisheries enhancement and an ecologically viable alternative to upland or ocean disposal. There were four primary objectives to satisfy this goal:

1. Determine the fate of material discharged by Inner Tidal and Reedsport Seafood companies.
2. Determine the impact of this material on water and sediment quality and the biological community within the estuary.

3. Determine the feasibility of using seafood wastes to directly and indirectly enhance production of commercially and recreationally important fish and shellfish species in the estuary.
4. Establish criteria for appropriate periods, locations and rates of estuarine disposal.

Because of changing market conditions and reduced plant operations, both Umpqua processing plants halted all plans to discharge seafood materials in the estuary after this study began. We continued our evaluation despite the lack of waste product. This report primarily addresses Objectives 1 and 4 above. Most of our recommendations are based on an assessment of the direction and the velocity of transport of seafood waste materials in the Umpqua.

APPROACH

Water Current Studies

We conducted several current studies with 4 sq ft wooden drifting drogues to predict the path of waste material discharged from Inner Tidal Seafoods and Reedsport Seafood Company. The outfall locations and study areas near the communities of Winchester Bay and Reedsport are shown in Fig. 1. The Inner Tidal Seafoods outfall pipe at Winchester Bay was installed in August 1983 at station IS-1. It extends to the mouth of the east basin channel approximately 2,200 ft from the Inner Tidal Seafoods processing plant. A second study site (IS-2) was established approximately 550 ft beyond IS-1 to evaluate current velocities for an alternative outfall location.

The outfall at Reedsport Seafoods was in place prior to this project and extends several yards into the main river immediately downstream from their loading dock. This study location is shown in Fig. 1 as RS-1.

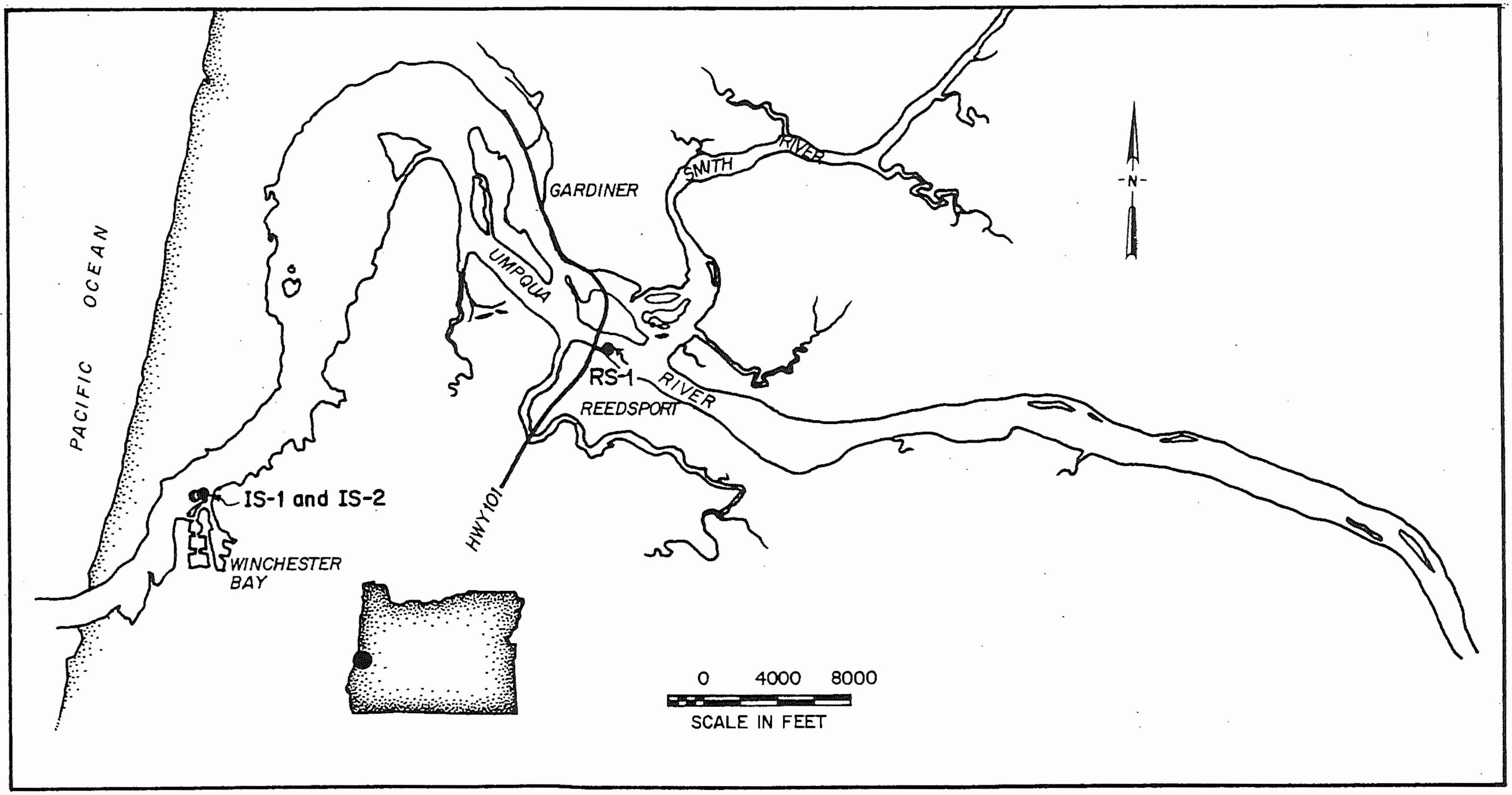

Fig. 1. Map of the lower Umpqua River estuary. Approximate locations for study sites near Inner Tidal Seafoods (IS-1 and IS-2) and Reedsport Seafood Company (RS-1) are indicated.

We also measured the rate of travel by the drogues to estimate velocities of water currents and to evaluate potential dispersion of wastes from each study location. The drogues were released at surface, middle, and bottom depths for several combinations of tide and river flow during the study. In addition, we completed a 6-hour current study on 20 September 1983 to determine ebb velocities at IS-2 throughout a tidal cycle. These data and a previous survey by Callaway (1961 a, b, c) are summarized in this report to show the most appropriate tide and river flow conditions for effective dispersion of wastes from the Inner Tidal Seafoods plant.

Biological Studies

We completed a biological baseline survey to study positive or negative effects associated with the discharge of seafood waste in the estuary. Most of our biological data were collected in the Winchester Bay area and consisted of two sampling programs: monthly fish seining from March through September 1983, and bi-monthly invertebrate collections from March through August 1983. Sampling stations for fish and invertebrates were selected to compare animal distributions within the path of the seafood waste. We also collected benthic invertebrates at the Reedsport site on 18 November 1982; however, we suspended subsequent sampling at the site when it became evident that the Reedsport Seafoods plant would not discharge waste during the remaining study period. Detailed methods and results of our baseline survey at the Winchester Bay site will be reported in a separate technical report that will be available June 1984 from the ODFW Research and Development Section, Oregon State University, 303 Extension Hall, Corvallis, Oregon 97331.

Trial Discharge

Five tests of the outfall system at Winchester Bay were conducted in August 1983 to judge performance of the grinder and pump assembly and determine the fate of organic material discharged from the outfall terminus at IS-1. Seafood wastes for these tests were trucked from Bandon Fisheries in Bandon, Oregon.

Project Management

Field studies, data analysis, and development of discharge guidelines were performed by ODFW Research and Development Section and Marine Region personnel, under a research grant from the NMFS. The project was a cooperative study with the Port of Umpqua who contributed matching funds to cover costs of design, acquisition, and installation of discharge facilities. Bandon Fisheries provided more than 30,000 pounds of seafood wastes for the trial discharge program. Inner Tidal Seafoods coordinated transport of the waste from the Bandon plant to Winchester Bay and provided assistance during test discharges of the outfall system. Costs for transport of wastes from Bandon were covered by the West Coast Fisheries Development Foundation in Portland, Oregon.

FINDINGS

Winchester Bay Site

Current direction and velocity

Information from drogues released at Winchester Bay is presented in Fig. 2 as a composite of paths taken by mid-depth and bottom drifting drogues released in mid-winter and late summer. These data represent the predicted paths from IS-1 and IS-2 of discharged material for high and low flow periods . Water from both locations converges near dolphin #2 (Fig. 2) and follows a similar course along the south shore of the Umpqua. Depths in the drift area below dolphin #2 range from 6 to 14 ft to Ork Reef, 6 to 20 ft to the entrance of the west boat basin, and 8 to 20 ft downstream of the west boat basin.

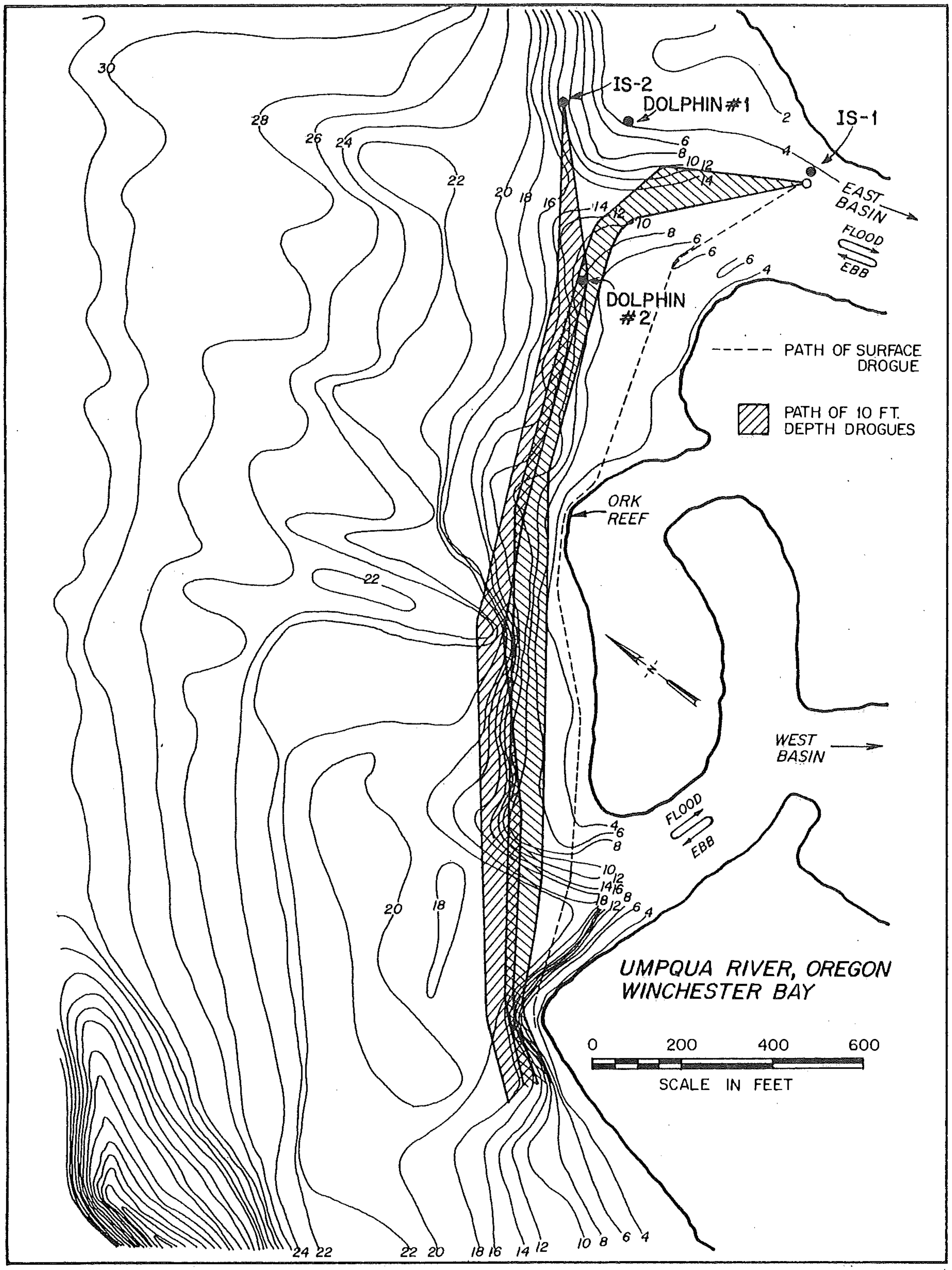

Fig. 2. Bathymetry of lower Umpqua estuary and drift area of 10 ft depth and surface drogues released at two sites (IS-1, IS-2) in Winchester Bay.

Surface drogues released near the present outfall site typically travelled between dolphin #2 and the south shore over shallow, eelgrass flats less than 6 ft deep (Fig. 2). These data suggest that seafood material discharged at IS-1 and caught in surface waters could settle and accumulate in the shallow flats.

Table 1 shows current velocities recorded for drogues released at Winchester Bay during ebb tide. A large tidal exchange (9.5 ft from high to low tide) was chosen for the December drogue study and relatively low tidal exchanges (3.6 to 4.0 ft) were chosen for the late summer studies to determine the range of ebb velocities expected inside the east basin channel. The maximum velocity we measured inside the east basin channel was 0.7 ft/sec at 3.7 hours after the predicted high slack tide during winter high flows. During low flow conditions the highest velocity recorded near IS-1 was 0.3 ft/sec at 2.5 hours after predicted high slack. Velocities at the outfall in August during test discharges were less than 0.1 ft/sec.

Table 1. Ebb current velocities (ft/sec) at 10 ft depth at two locations in Winchester Bay.

Salmon Harbor Channel (0-100 ft North of IS-1)		
Hours after predicted high slack	Winter 12/18/82 [a]	Summer 08/09/82 [b]
1.0	0.1(flood)	--
1.3	-	<0.1
1.5	0.2	--
2.4	0.3	0.1
2.5	--	0.3
3.7	0.7	--

Station IS-2			
Hours after predicted high slack	Winter 12/18/82 [a]	Summer 08/09/82 [b]	Summer 09/20/83 [c]
1.0	--	--	0.6
1.5	--	--	1.1
2.0	--	1.0	1.3
3.0	--	1.0	2.2
4.0			2.8
4.5	2.1		2.2

[a] *9.5 ft ebb exchange at 12,900 cfs*
[b] *3.6 ft ebb exchange at 1,200 cfs*
[c] *4.0 ft ebb exchange at 1,320 cfs*

Table 2 shows amounts of material and discharge dates for several tests of the outfall system at Winchester Bay. Tests were made using rockfish, sole, and blackcod carcasses ground to approximately 1 inch chunks. The low ebb tide velocities at the outfall were not sufficient to transport waste from the site. Waste accumulated in a 1,600 sq ft area and as much as 2 ft deep during test discharges and persisted several days after the last discharge. Velocities were clearly insufficient to disperse waste material from the outfall during low river flow conditions and moderate tidal exchanges (4 to 8 ft).

Smaller batches of waste were released to determine ebb velocities and fate of material at other potential outfall sites. Buckets containing approximately 40 pounds of ground waste were manually released at a depth of 10 ft, approximately half the distance between IS-1 and IS-2. Ebb velocities between 0.1 and 0.2 ft/sec at this site were not sufficient to transport waste. Ebb velocities measured at IS-2 were 1.0 ft/sec or greater and ground waste released at this site was quickly dispersed by current velocities of 1.0 ft/sec. The range of ebb velocities measured at IS-2 during low flow conditions is shown in Table 1.

Table 2. Amounts of material discharged during tests of waste outfall at Winchester Bay. [a]

Date	Amount
8 August 1983	500 lbs
9 August 1983	11,000 lbs
10 August 1983	5,000 lbs
12 August 1983	7,000 lbs
27 August 1983	11,000 lbs

[a] *All materials ground to approximately 1 inch size.*

Waste dispersion and discharge conditions

To provide maximum benefit to marine life and minimum risk from excessive waste buildup, outfall location and times of discharge should be selected so that material is dispersed over a broad area. Our results show that discharge depth, delay after high slack, duration, and minimum ebb tide exchange influence waste dispersion:

Depth: Duration and velocity of the ebb tide influence the transport of waste from an estuarine outfall; these factors in turn vary with outfall depth and location. Data collected by Callaway (1961c) in the Umpqua River main channel (one half mile above Winchester Bay) show that duration and velocity of the ebb tide decrease with depth (Figs. 3 and 4). An outfall should therefore be relatively shallow to maximize horizontal dispersion of waste, but it should be sufficiently deep to provide vertical dispersion and minimize nuisance conditions from materials floating to the water surface. In this evaluation, a depth of 10 feet was chosen as a practical compromise between horizontal and vertical dispersion. Other discharge criteria in this report are evaluated for a 10 foot depth.

Discharge delay: A period of time between the predicted high slack and the start of waste discharge is necessary to allow the ebb current to reach a velocity sufficient to transport waste. Discharge of materials during low current velocities may result in accumulation of waste at the outfall. Dispersion of a significant waste accumulation may not be possible even after current velocities have increased.

The curves in Fig. 5 represent current velocities measured at 10 ft depth during a range of tidal exchanges. Our test releases of waste at Winchester Bay showed that velocities near 1.0 ft/sec are necessary to transport ground seafood

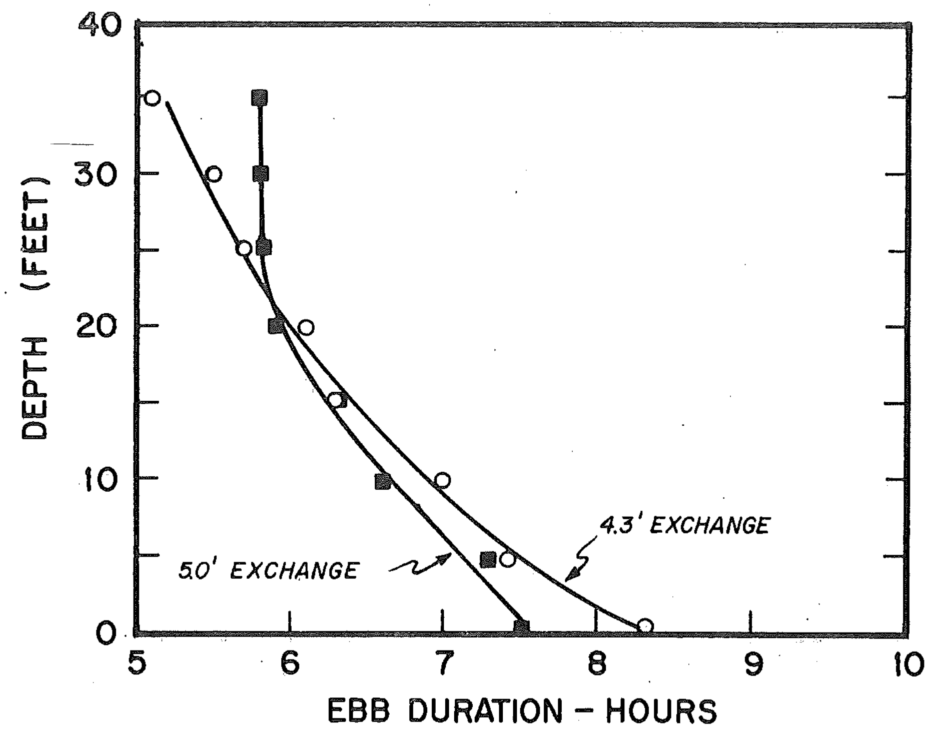

Fig. 3. Relationship of ebb duration to depth, Umpqua River, RM 2.7, 6 April 1961, 5,400 cfs. Data replotted from Callaway (1961c).

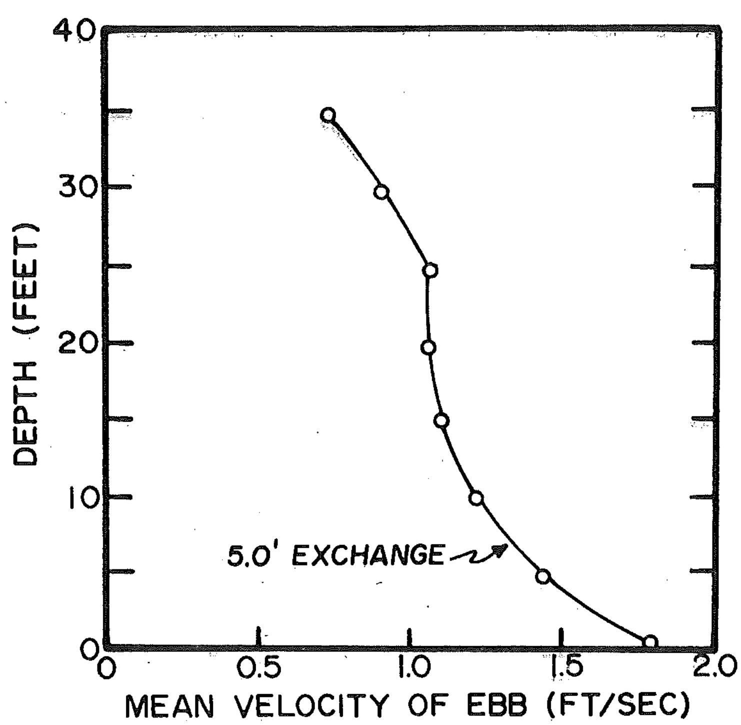

Fig. 4. Relationship of ebb velocity to depth, Umpqua River, Rm 2.7, 26 April 1961, 5,400 cfs. Data replotted from by Callaway (1961c).

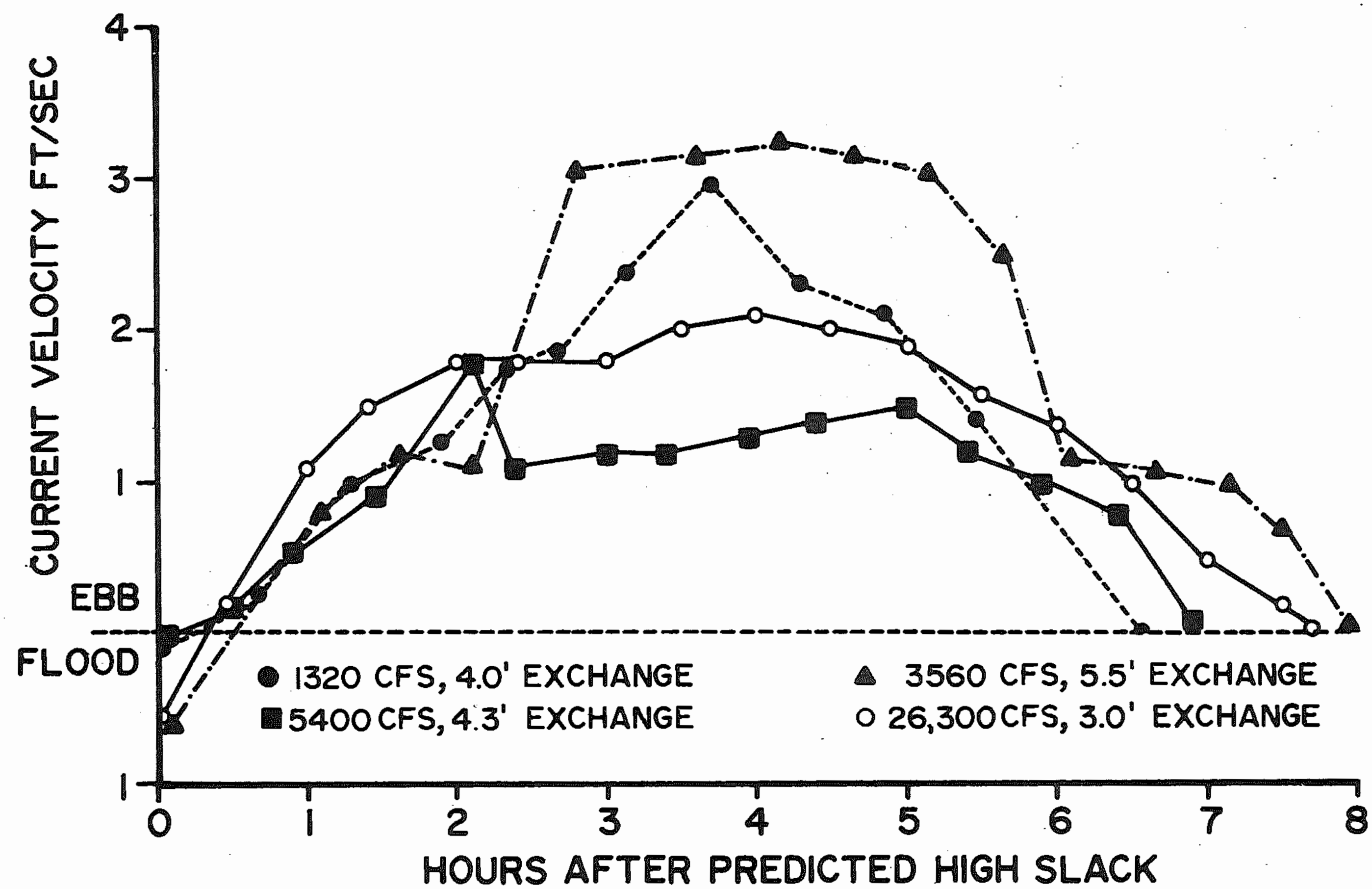

Fig. 5. Ebb tide velocity curves for four combinations of tidal exchange and river flow at 10 ft depth in Umpqua River at Winchester Bay [a].

[a] *Curves representing flows of 3,560 (Callaway 1961a), 5,400 (Callaway 1961c), and 26,300 cfs (Callaway 1961b) from RM 2.7. Curves representing 1,320 cfs from present study at IS-2 (RM 2.0).*

waste. The curves in Fig. 5 show that for low to moderate ebb tide exchanges (3.0 to 5.5 ft) and river flow (1300 to 5400 cfs), a velocity of 1.0 ft/sec is reached approximately 1.5 hours after predicted high slack. Even at a high flow of 26,300 cfs, a 1 hour delay was needed to assure sufficient tidal velocities to transport waste from an outfall at IS-2.

Discharge duration: The total period of time ebb currents equal or exceed a threshold velocity necessary to transport seafood waste materials will vary with river discharge and daily tidal prism (volume of water exchanged from high to low tide). In Fig. 6 we have estimated the duration of two current velocities (0.5 and 1.0 ft/sec) over the range of tide and river flow conditions plotted in Fig. 5. For moderate river discharge conditions (between 1,000 and 5,400 cfs) ebb duration (hours) increases linearly with "ebb discharge", an index we have defined as the product of river flow (cfs) and feet of tidal exchange (high to low tide). For example, at low river flows and tidal exchanges, ebb velocities (at 10 ft depth) will equal or exceed a 1.0 ft/sec threshold for approximately 3 hours. At higher river flows, the threshold velocity is maintained for up to 5 hours. At very high flows (e.g. 26,000 cfs) the duration of the 1 ft/sec threshold velocity was 30 to 60 minutes longer than predicted for lower discharges in Fig. 6. Figure 7 shows the corresponding tidal exchanges and river flows for the ebb discharge values used in Fig. 6.

Minimum ebb tide exchange: At tide exchanges less than 2 ft during flow conditions found in August and September, current velocities will reach or exceed 1.0 ft/sec for less than 3 hours. Acceptable periods for discharge during very low ebb exchanges may be too brief to be of practical value to a processor. The risk from discharge during insufficient dispersal velocities will increase as tidal exchanges decrease to less than 3 feet.

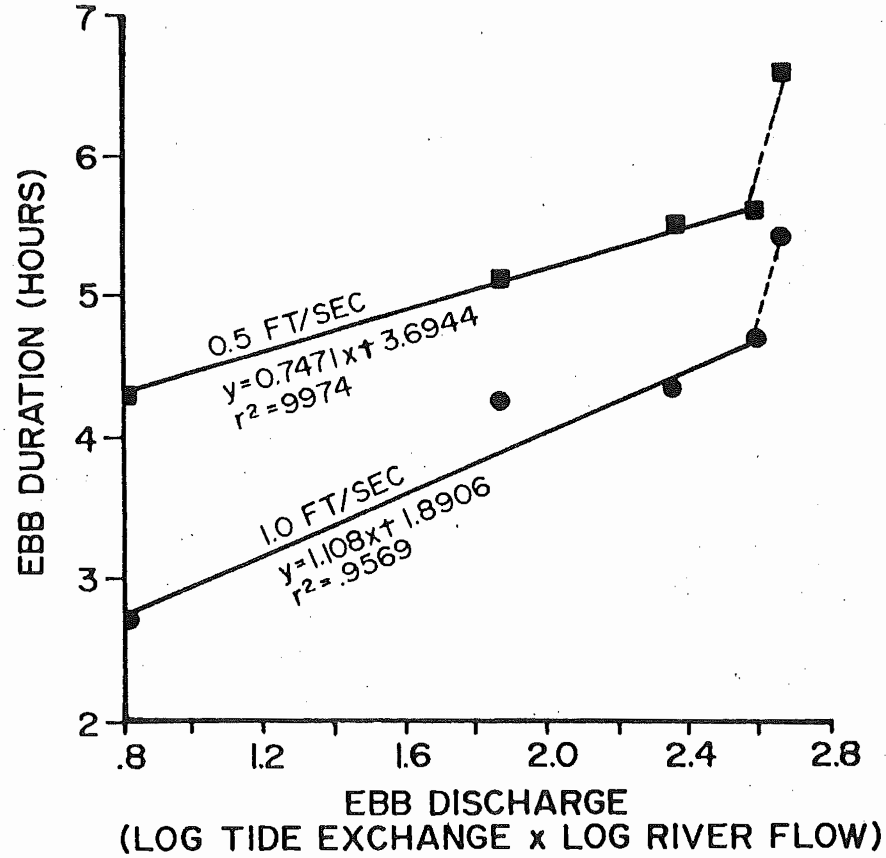

Fig. 6. Relationship of ebb duration to ebb discharge at 10 ft depth, Umpqua River at Winchester Bay. [a]

[a] *Points connected by dotted lines represent values during very high flows (26,000 cfs).*

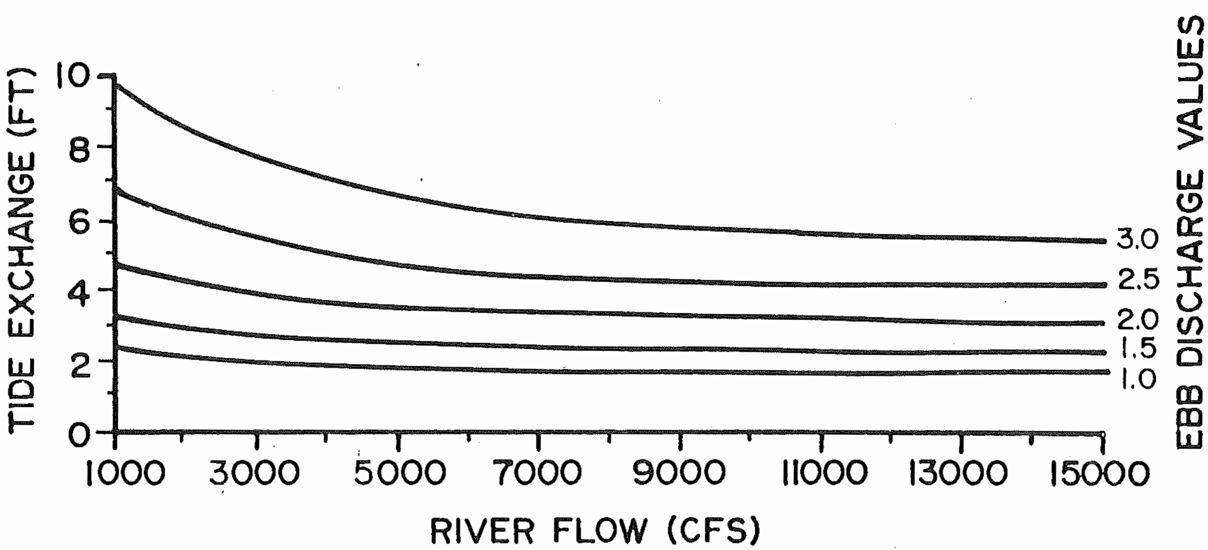

Fig. 7. Representative river flows and tide exchanges (high to low tide) corresponding to the "ebb discharge" values given in Fig. 6.

Fish and shellfish community

Little attraction of fish or crabs occurred during the first four tests of discharge (8, 9, 10, and 12 August) at the outfall system at Winchester Bay, but waste material for those tests had been decomposing for several days before being discharged. Test discharges on August 27 using fresh waste attracted approximately 100 Dungeness crabs and several hundred shiner perch to the outfall site. After 3 days the decomposing accumulation of waste was bubbling, and few crabs and fish were noted.

The small area of waste dispersion and the brief time period of test discharge during this study were not sufficient to establish persistent fish populations or to document significant attraction or enhancement from organic enrichment. However our baseline studies provided information on the species that may most directly benefit from future discharge in the lower estuary.

Table 3 summarizes the relative abundance of fish species seined at 4 stations in the estuary between Cornwall Point, just above IS-1, and the entrance to the west boat basin (Fig. 2). The larger surfperches, starry flounder and crabs were plentiful near the discharge area and may benefit directly from waste disposal. Other species may benefit indirectly through increased production of prey organisms. Significant enrichment of marine communities was shown in a recent study of a tuna waste outfall in California (Soule and Oguri 1979).

Table 3. Mean catch per seine haul (CPUE) of fish species caught at four stations between Cornwall Point and Salmon Harbor west basin entrance, Winchester Bay, Oregon, April through September 1983.

Species (adults and juveniles combined)	CPUE
Shiner perch	205.0
Striped surfperch	8.1
Pile perch	6.5
White surfperch	4.2
Starry flounder	4.0
Staghorn sculpin	2.8
Juvenile chinook	2.7
Walleye surfperch	2.5
English sole	2.1
Surf smelt	2.0
Yearling coho	1.7
Speckled sanddab	1.4
Bay pipefish	1.4
Pacific herring	1.3
Jack smelt	1.0
Juvenile Cabezon	0.8
Juvenile rockfish	0.7
Saddleback gunnel	0.7
Topsmelt	0.6
Silver surfperch	0.5
Cutthroat trout	0.5
American shad	0.1
Northern anchovy	<0.1

Reedsport Site

The predicted path of material discharged at Reedsport Seafoods in Reedsport is shown in Fig. 8. Drogue studies were conducted in December at an average winter streamflow (12,900 cfs) with a relatively large tidal exchange (10.0 ft). These data represent the drift area expected during high flow conditions.

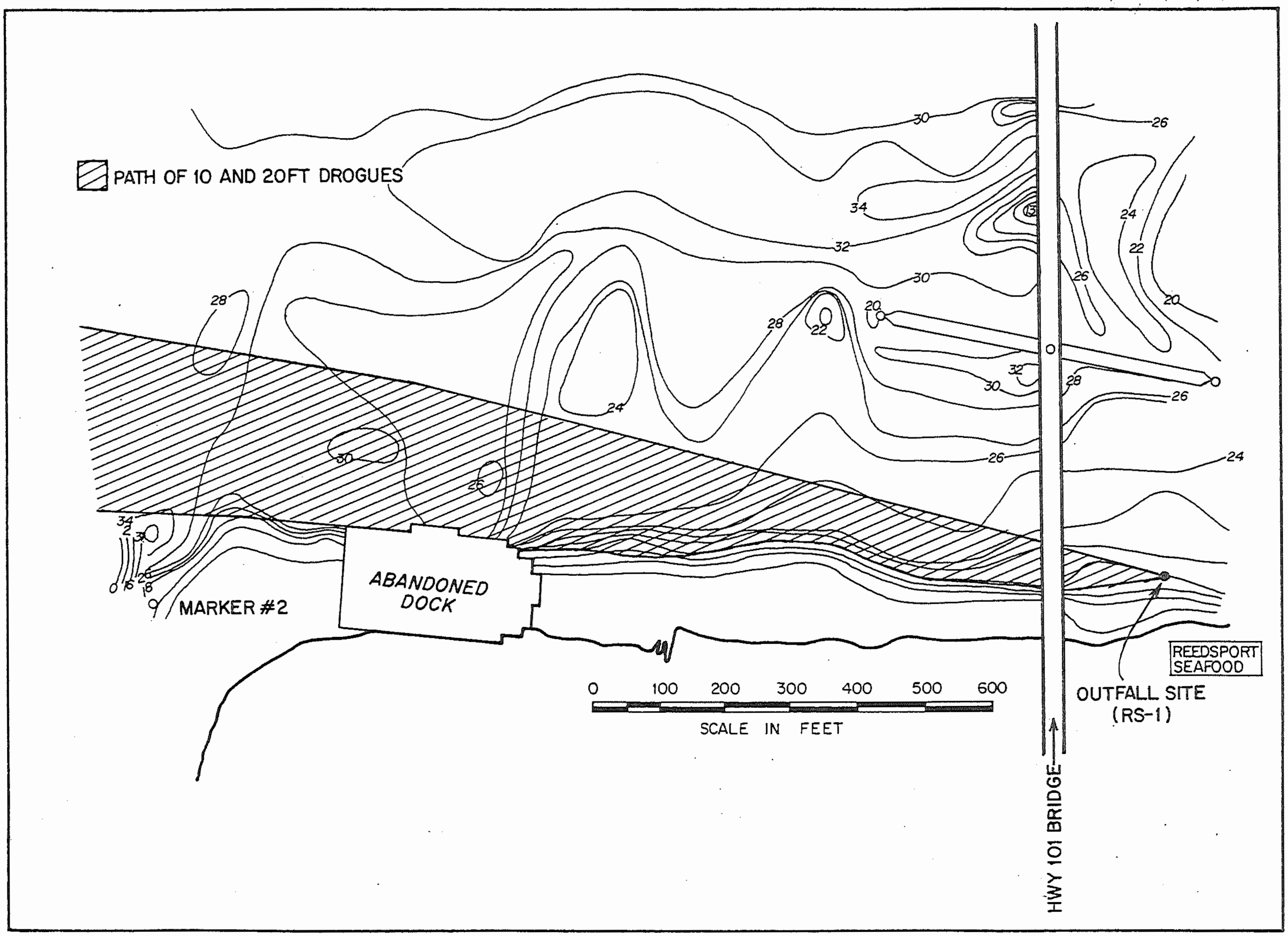

Fig. 8. Bathymetry of Reedsport reach, Umpqua River and drift area of 10 ft and 20 ft depth drogues released at Reedsport Seafoods outfall site, December 30, 1982.

Ebb velocities recorded in December are shown in Table 4. During the period from 1.0 to 2.3 hours after predicted high slack, mid-depth and bottom velocities ranged from 1.3 to 2.8 ft/sec in the area below the outfall site. Velocities generally increased below Scholfield Creek, approximately 1500 ft below the outfall. No drogues were released at this site during low flow periods.

Table 4. Mean ebb velocities (ft/sec) in two areas below Reedsport Seafoods, 30 December 1983, 12,900 cfs, 10.0 ft tide exchange.

Hours after predicted slack	RS-1 to Scholfield River		Below Scholfield River to navigation marker #8	
	10' depth	20' depth	10' depth	20' depth
1.0	1.3	2.2	2.4	1.9
2.3	2.0	2.2	2.8	2.5

CONCLUSIONS AND RECOMMENDATIONS

Termination of processing at the two Umpqua seafood plants prevented a long-term evaluation of the effects of discharge on biological communities in the estuary. However, we were able to collect sufficient physical data to provide specific recommendations for outfall location and timing of future discharge. Until further information on long term effects can be collected, these recommendations should minimize the risk of excessive accumulation of waste and should increase the potential for positive benefits to marine life and to recreational fisheries in the estuary. Application of these guidelines to other Oregon estuaries and further research needs are also presented.

Winchester Bay Site

Outfall location

During low flow periods, mid-depth and bottom ebb velocities measured at the present outfall site (IS-1) and several hundred feet north of this site are insufficient to transport waste or prevent accumulation. The recommended outfall terminus is at IS-2 at the 10 ft depth contour (below mean low water). This site is approximately 150 ft north of dolphin #1, or approximately 550 ft from the present outfall site (Fig. 2). This location provides minimum ebb velocities of 1.0 ft/sec of sufficient duration to allow discharge and dispersion of waste for all but very low tidal exchanges.

Locations between IS-1 and IS-2 are not recommended because current velocities remain very low for sites within or near the east basin channel. Increased velocities occur outside dolphins #1 and #2 because of the influence of currents from the main river. Locations in less than 10 ft depth are not recommended because of the visual effects of seafood material in surface waters. In addition, surface transport of materials in shallow waters between dolphin #2 and Ork Reef could accumulate in productive eelgrass habitats (Fig. 2).

Discharge guidelines

1. Waste discharge should occur only on ebb tide flows, which would result in a net movement of material toward the bay mouth. Peak velocities and flow duration are greater during ebb flows than during flood. Upstream transport of wastes further increases the risk of trapping excessive amounts of organic material in the estuary.

2. Delay waste discharge 1.5 hours after predicted high slack tide. This delay is necessary to reach an ebb velocity of 1.0 ft/sec at 10 ft depth for most combinations of ebb tide exchange and river flow. A 2-hour delay is specified in conditions of the present seafood waste discharge permit for the Umpqua estuary.

3. Discharge duration should be limited to 3 hours during low tidal exchanges and river flows (minimum 2.5 ft and 1,000 cfs) and to 5 hours at higher exchanges and flows. Figure 9 shows recommended periods of waste discharge. Discharge duration represents the number of hours tidal velocities should reach or exceed 1.0 ft/sec beginning 1.5 hours after high slack tide.

   Tests of the outfall system at Winchester Bay showed a discharge rate capacity of 30,000 pounds per hour. A period of 3 to 5 hours should be more than sufficient to pump wastes generated each day; however, holding capacity to contain ground wastes prior to discharge will be required.

4. Waste discharge should be conducted only during ebb tide exchanges greater than 2.5 ft. Because recommended periods of discharge decrease with tidal exchange (Figure 9), a minimum ebb tide exchange of 2.5 ft is recommended to provide sufficient time to pump waste and reduce the risk of waste accumulation following discharge. The present seafood waste disposal permit for the Umpqua estuary allows discharge only on exchanges above 5.0 ft. Reducing this minimum to 2.5 ft will increase the number of ebb tides when discharge is permitted at a cost of reduced discharge duration during low flow periods.

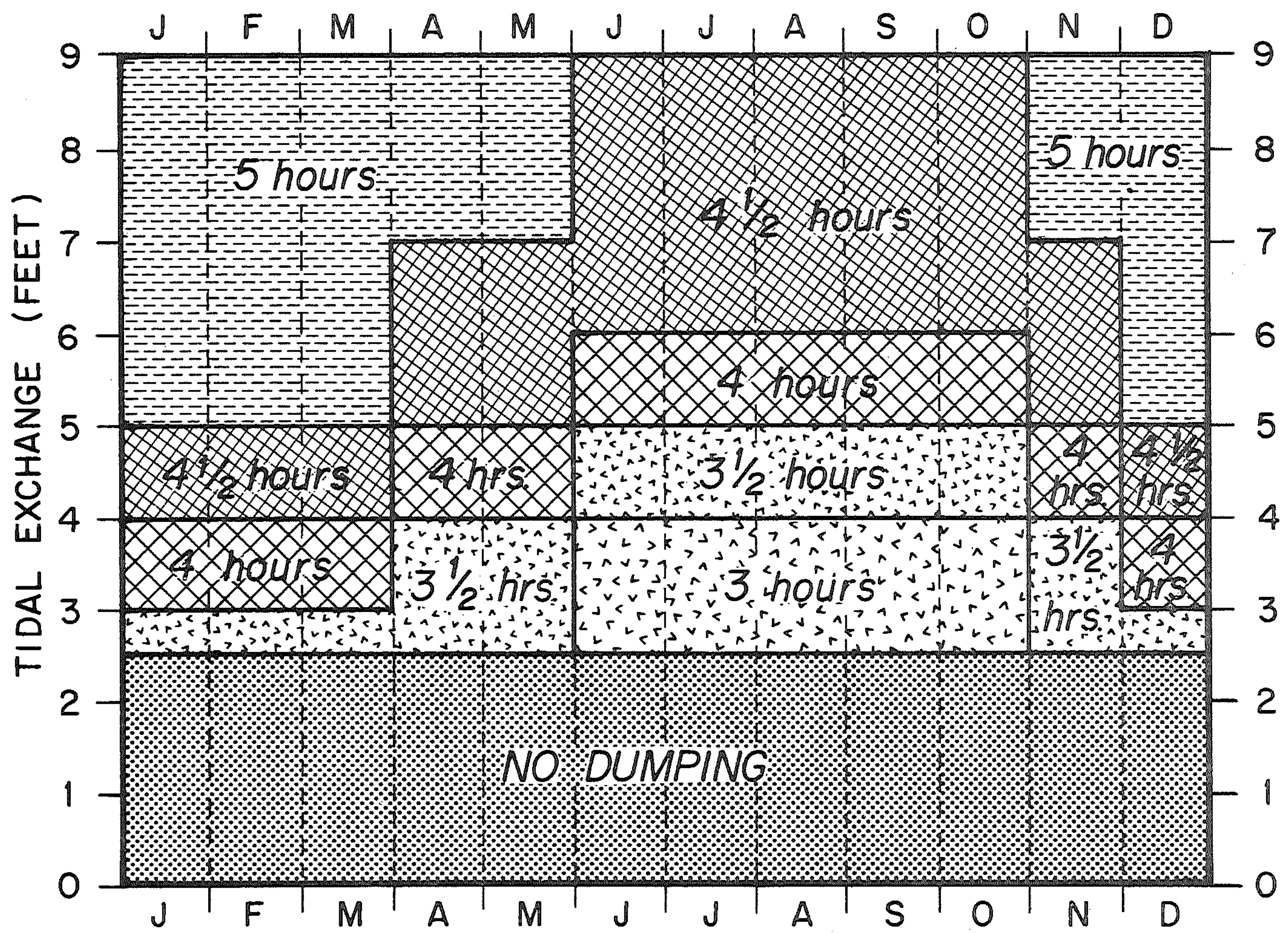

Fig. 9. Recommended periods of waste discharge by feet of tidal exchange (high to low tide) and month. [a]

[a] *Discharge periods refer to total hours of discharge beginning 1.5 hours after predicted high slack tide.*

5. Even though the present permit allows discharge of up to 50,000 pounds per day, we found that waste accumulation resulted from test discharges of 5,000 to 11,000 pounds at the present outfall site (IS-1). Our guidelines for outfall location and discharge periods should prevent these problems; however, daily discharges of 15,000 pounds per day or greater should be closely monitored to determine whether these guidelines are sufficient to prevent excessive waste accumulation.

Reedsport Site

Outfall location

The end of the outfall pipe at Reedsport Seafoods should be at least 15 ft deep at mean low water. This depth is necessary to move the discharged material far enough offshore to avoid deposition on the shallow mudflats extending downstream to Scholfield Creek.

Discharge guidelines

Data relating current velocity to tide stage at Reedsport are not available; however, these relationships should be similar to those found downstream near Winchester Bay. The discharge guidelines established for Winchester Bay are recommended for Reedsport Seafoods until further information can be collected. When processing resumes at this site, the outfall system and potential areas of impact should be inspected during low flow to determine whether these guidelines are sufficient.

Site Selection in Other Oregon Estuaries

The information collected in the Umpqua will be helpful to consider future discharge proposals in other Oregon estuaries. However, many decisions regarding the placement or operation of an outfall must be made on a site specific basis. We recommend the following guidelines for site selection and evaluation of discharge proposals in other estuaries:

1. Limit discharge of unscreened seafood waste to areas where a sustained ebb velocity of 1.0 ft/sec is maintained for at least several hours during low river flows and moderate tidal exchanges in the estuary.
2. Underwater inspection may be sufficient to evaluate a proposed discharge site, if channels are obviously scoured to rubble or bedrock by fast tidal currents. Over sand or mud habitats, however, releases of drogues or other measurements of current may be necessary to evaluate water velocities, particularly during periods of low flow.
3. Avoid discharge into enclosed embayments or boat basins, over shallow intertidal flats, in estuaries with minimal flushing, or inside very small estuaries with little assimilative capacity. Risk of harmful effects from waste discharge is less for outfalls in main river channels and in larger Oregon estuaries, particularly near the mouth.
4. Depth of discharge should be sufficient to disperse waste that may float, thereby minimizing visual effects. Maximum depth of discharge will depend on current velocities at a specific location.
5. Optimum timing and duration of discharge at an acceptable outfall site will also vary for each location. Conservative criteria may be inferred from the results of this study until more detailed data can be collected at a specific site. Interim criteria should be to discharge only during tide exchanges (high to low tide) of 4 ft or greater, beginning 2 hours after predicted high slack tide.
6. Restrictions on discharge schedules should be commensurate with risk for a specific outfall location or discharge volume. Risk will increase as the number of outfalls and the volume of waste discharged in an estuary increases; and as the distance of an outfall from the estuary mouth increases.

Monitoring Programs

Following installation and tests of an outfall system in any estuary, a program of site inspection should be established to monitor compliance with DEQ water quality requirements and to determine whether discharge guidelines specified on individual permits are sufficient for long term compliance with those standards. A basic program should include the following:

1. An outfall should be inspected during the first disposal period to identify any problems with the discharge system.
2. Underwater surveys of the outfall site and any areas of potential accumulation should be scheduled for a range of seasonal flow and tidal conditions. These should also include inspection of adjacent intertidal areas for deposition of floating material that results from discharge.
3. If accumulation is a problem, more comprehensive water quality measurements may be needed. Temperature, salinity, and dissolved oxygen should be monitored along a gradient extending from the problem area. Drogue or current studies may be necessary to determine causes and develop solutions to problems identified.
4. Frequency of monitoring will depend on the character of individual sites, but emphasis should be placed on periods of increased waste loads or low flows.

APPLICATION OF PROJECT RESULTS

The results of this research will be directly applied to the management of waste discharge programs in the Umpqua and other Oregon estuaries as outlined in our Conclusions and Recommendations. The estuarine seafood waste discharge program is managed by ODFW through a waste discharge permit issued by the DEQ. Discharge of seafood wastes in other Oregon estuaries requires a written letter of application to ODFW. A preliminary survey must be made of each proposed discharge site before ODFW will approve any permit. Upon approval a written letter of authorization is prepared specifying the conditions for estuarine discharge of seafood waste materials. Requests for further information or applications for an estuarine discharge permit should be sent to Robert E. Loeffel, Marine Region Supervisor, Oregon Department of Fish and Wildlife, Marine Science Drive, Bldg. 3, Newport, Oregon 97365.

PROJECT EVALUATION

Benefits to Douglas County

A long-term solution to disposal of seafood wastes is critical to the continued operation of processors at Winchester Bay and Reedsport. The lack of an alternative market or nearby facility for fish meal production to use wastes has left estuarine disposal as the preferred alternative. Disposal of processing wastes in the Douglas County landfill has been prohibited since 1981. This project has developed guidelines for waste discharge into the Umpqua estuary that should provide an alternative to upland disposal.

Oregon's estuarine resources face increasing demands from commercial and recreational users. In addition to meeting these resource demands, Oregon's estuaries serve as nursery grounds for large numbers of fish and shellfish. Umpqua estuary, for example, is a rearing area for juvenile and larval forms of flatfish, herring, surfsmelt, shiner perch, chinook salmon, shad, and striped bass. During a 1971 survey (Gaumer et al. 1971), these and other species (including Dungeness crab and softshell clam) provided 142,100 hours of recreational effort for Umpqua sportsman and 337,376 pounds of fish and shellfish for commercial fisherman. A carefully managed program of estuarine waste disposal offers potential benefits to commercial and recreational fisheries in this and other Oregon estuaries.

Benefits to Seafood Processing Industry

An estimated 42,300 tons of seafood processing wastes are generated in Oregon annually (WCFDF 1983). New facilities may be necessary to develop alternative economic uses for wastes generated by Oregon fish processors. Production of fish oil and solubles probably offers the most promising economic use for seafood wastes (WCFDF 1983). In many areas of Oregon, however, a combined commitment by local or regional processors would be necessary to provide sufficient volumes of waste material to justify costs for development of fish meal production. The WCFDF (1983) noted that installation and operation of a fish meal facility with a capacity less than 50 tons/day is not justified economically unless the facility is subsidized by the local community.

Disposal of excess fish wastes is likely to be the preferred alternative for many seafood processing plants, at least for the near future. For small, remote processing plants, there may be few options for future economic uses of excess seafood wastes. Disposal of processing wastes in sanitary landfills has been prohibited in many areas because of insufficient capacity and nuisance conditions caused by decomposing fish wastes. The criteria for discharge and site evaluation prepared for the Umpqua estuary will help to develop acceptable estuarine waste disposal programs for other suitable locations in Oregon.

Potential Negative Effects and Other Research Needs

Despite the possible benefits, we cannot discount the potential for negative effects from discharge of seafood waste in a confined estuary. The indiscriminant disposal of sewage, pulp effluents, food wastes, and other organic materials into estuaries has deteriorated water quality, destroyed habitat, and caused losses of commercially important species of fish and shellfish along both coasts of the United States (Weiss and Wilkes 1974; Tsai 1975). For example seafood waste has a very high biological oxygen demand (BOD). During periods of peak processing, we estimate a potential BOD of 13,500-18,000 pounds per day from the two Umpqua seafood processors. Maximum discharge volumes will probably occur between May and October when (1) flows are low to moderate (United States Army Corps of Engineers 1975), (2) the estuary is partially or well mixed (Mullen 1973) and (3) the potential for considerable upriver transport is high (Burt and Marriage 1957; Gladwell and Tinney 1962). The highest waste loads may occur when estuary flushing is minimal.

Tests of offshore dumping of crab processing waste in Tangier Sound, Maryland (Krantz, et al. 1983) have shown reduced water quality (low dissolved oxygen and accumulation of waste) and high coliform bacteria counts at the dump site. Studies of tuna waste in Los Angeles Harbor, in addition to enrichment, showed a "mortality" zone within 200 feet of the outfalls, where biological productivity was depressed (Emerson 1976; Reish and Ware 1976; Soule and Oguri 1976). Results of bioassays suggested there may have been a toxicity factor in the effluent other than merely low dissolved oxygen (McConaugha 1976). A zone of undesirable effects beyond an outfall could be a serious problem in a narrow confined estuary, where juvenile and larval fishes or anadromous species require passage.

The positive or negative effects of organic waste discharge are largely a matter of the quantity of material and its rate of flushing from an estuary (Heald and Odum 1974). The termination of processing activities during this project prevented evaluation of biological effects of continuous organic enrichment in the Umpqua estuary. Additional research will be required to determine (1) long-term enhancement benefits or effects from estuarine discharge of unscreened seafood processing wastes, and (2) acceptable waste volumes for discharge within an estuary.

ODFW has received applications for seafood discharge permits for several other Oregon estuaries. The biological response to various levels of organic enrichment is a key concern that should be addressed before we commit large sums of money and manpower to extensive discharge programs throughout Oregon estuaries.

Discharge tests in Oregon have been made only with groundfish species, but most seafood plants also process shrimp and crab. Careful testing of shrimp and crab wastes may be necessary to establish specific discharge criteria that will minimize accumulation of wastes or visual effects.

Currents at the Inner Tidal Seafoods outfall (IS-1) were never sufficient to determine velocities necessary to disperse the waste. The 1 ft/sec threshold velocity recommended in this study was based solely on batches of ground waste released by divers near the estuary bottom. Additional tests should be conducted at other outfall sites to better define transport velocities. Discharges should be made from an outfall pipe over a range of tidal conditions to measure threshold velocities for waste dispersal. Crab and shrimp as well as groundfish wastes should be tested.

Although there is considerable freshwater and tidal current velocity in the main channel of the Umpqua River estuary, local conditions in the immediate vicinity of the outfall (IS-1) were inadequate to transport ground seafood waste. These results emphasize the importance of sufficient water velocities at an outfall terminus to prevent negative effects from excessive waste accumulation.

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