EFFECTS OF VESSEL WAKE STRANDING OF JUVENILE SALMONIDS IN THE LOWER COLUMBIA RIVER, 2002 – A PILOT STUDY

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EXECUTIVE SUMMARY

We conducted day and night juvenile salmonid stranding surveys at three locations in the lower Columbia River in the summer of 2002. During the surveys we collected data on beach habitat, passing vessels, wakes generated by those vessels, and stranding of fish.

In approximately 120 survey hours we observed 35 tugs/barges and 56 deep draft vessels. Twenty-one chinook juveniles were stranded ranging in length from 48mm to 136mm. In addition, 174 fish of other species were stranded, 162 of which were vessel related. We considered possible influences of time of day, beach slope, vessel draft, tide stage, and gas saturation levels at Bonneville dam on stranding of salmonids. Other studies have correlated wake amplitude to stranding (Bauersfeld 1977). We found that wake amplitude was related to distance of vessel from shore, vessel draft and vessel length.

The results of this pilot study were used to make recommendations for a more comprehensive study in 2003.

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INTRODUCTION

Wakes from deep draft vessels traveling within the lower Columbia River navigation channel have been implicated as a cause for stranding of juvenile salmonids (*Oncorhynchus* spp.). Stranding occurs when juveniles are caught in a vessel's wake and are deposited on shore while the wake recedes or is absorbed. Stranding typically results in mortality unless another wave carries the fish back into the water. The current proposal to deepen the navigation channel in the Columbia River has heightened concern with juvenile stranding because the deeper loaded vessels that are anticipated to use the deeper channel may produce larger wakes.

Two previous studies have documented vessel wake induced stranding of juvenile salmonids in the lower Columbia. Bauersfeld (1977) observed stranding of 2,397 juvenile salmonids from 216 deep draft vessels. He estimated 145,003 chinook salmon (*O. tshawytcha*), 1,359 coho salmon (*O. kisutch*), and 4,771 chum salmon (*O. keta*) were stranded by vessels in a 33 mile reach of the Columbia River between the Willamette and Cowlitz rivers between February and July 1975. Daily estimates of stranding were as high as 117 fish per vessel. Bauersfeld (1977) found that the ability of a vessel to strand fish is a function of the size of the wave it produces. Vessel wake has been shown in laboratory tests to be related to vessel speed, channel depth, distance from shore, and vessel draft (Hay 1968, Johnson 1968).

Hinton and Emmett (1994) studied vessel wake induced stranding in the lower Columbia in 1992 and 1993. Surveys were conducted from April to September in 1992 and in March through July in 1993 at eight sites in the lower Columbia River. They collected data on vessel characteristics, habitat attributes, number of fish utilizing water adjacent to the beach, and number of fish stranded. Hinton and Emmett documented vessel wake induced stranding of only five juvenile salmonids after observing 145 vessels. They concluded that numerous factors including river-surface elevation, beach slope, vessel design and speed, the distance between the passing vessel and the beach, and numerous biological factors interact to produce stranding.

Based on these concerns, the Portland District of the United States Army Corps of Engineers (USACE) subcontracted to S.P. Cramer and Associates to conduct a pilot study of juvenile stranding at three locations on the lower Columbia River. The goal of the study was to provide information to determine what factors may influence stranding, and make recommendations in regards to what data needs to be collected in 2003 to accurately assess how different factors contribute to stranding.

METHODS

Survey Location and Timing

The three locations selected for stranding surveys were all located between the mouth of the Willamette River and the mouth of the Columbia River. The sites included Willow Bar on Sauvie Island (RM 96.5), Barlow Point (RM 61.5) and County Line Park (RM 51.5) (Figure 1). The Sauvie Island and Barlow Point sites were selected because of previous observations of stranding by National Marine Fisheries Service (NMFS) personnel. The County Line Park location was selected because it was one of the sites surveyed in the study by Hinton and Emmett (1994). These sites were selected because we expected to observe stranding, and should not be considered representative of all beaches in the lower Columbia.

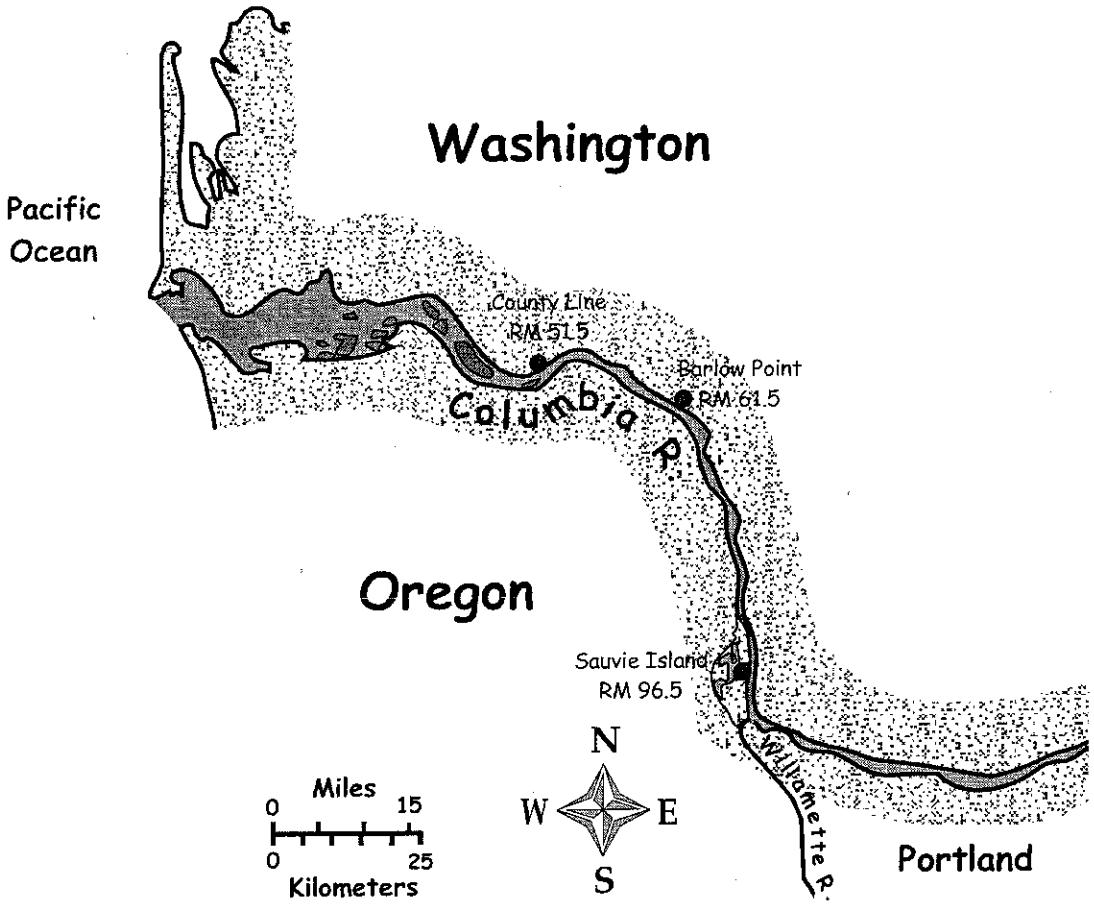


Figure 1. Map of lower Columbia River and locations of juvenile stranding survey sites.

Two surveys were done at each location. Each location was surveyed once between June 24 and July 5, and a second time between July 29 and August 3. Survey timing was based on outmigration timing of chinook subyearlings and peak timing of shipping. Outmigration of chinook subyearlings peaked in late June and early July (Figure 2). Shipping schedules were obtained from the Columbia River Pilots Association website (www.colrip.com/main/PublicView001.asp). Each survey consisted of eight to ten hours of day sampling and eight to ten hours of night sampling.

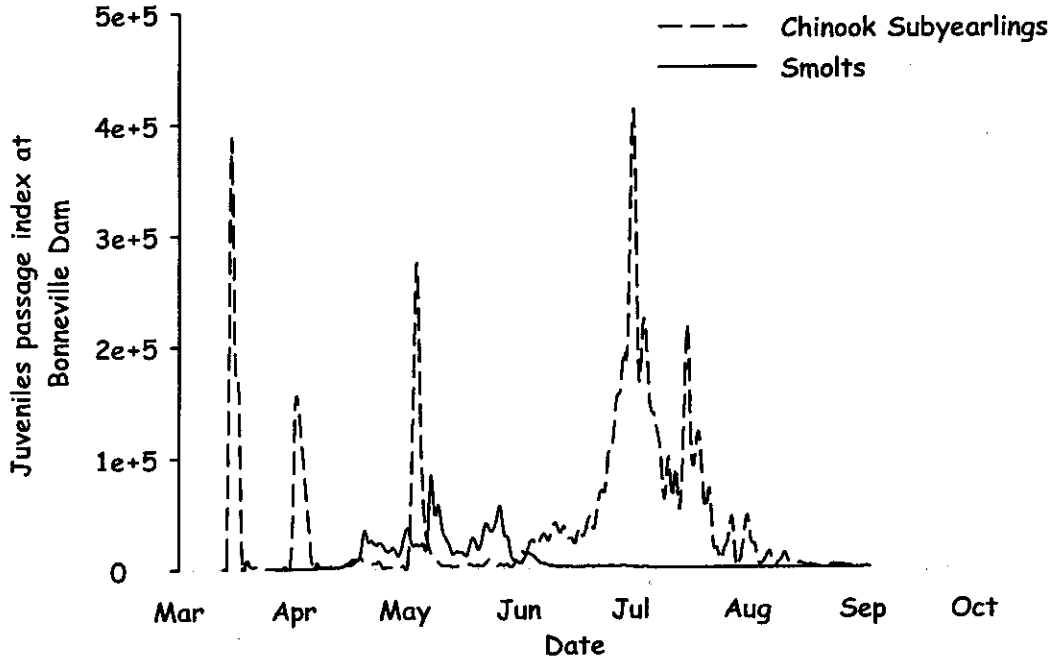


Figure 2. Passage of Chinook, coho, sockeye, and steelhead smolts and subyearling chinook over Bonneville Dam in 2002. Data obtained from the Columbia River Data Access in Real Time website (http://www.cqs.washington.edu/dart/dart.html).

Habitat Measurements

Habitat measurements were taken at low tide during the first set of surveys. Measurements were made for portions of the survey area likely to be influenced in tidal and wake actions. We established upstream and downstream boundaries of the survey and total length of beach surveyed. Then we divided the survey area into reaches based on beach slope, substrate, and vegetation. Survey and reach boundaries were marked with GPS coordinates and flagging. Lengths were measured using a hip chain. For each reach we determined the slope using a clinometer and staff gauge. We made three evenly spaced measurements for each reach and then averaged them to get the reach slope. We visually estimated the percentage composition of substrate comprised by three different size classes: fines (0-2mm), gravels (2-64mm) and

cobble/boulder (>64mm). We also visually estimated the percentage of the beach that was vegetated. Percentage vegetated was defined as the percentage of area at the beach surface composed of vegetation. Shrub or grass overstory was not considered as part of the estimate. Vegetation was composed primarily of beach grasses and small willows. The distance from the vessel to shore and channel depth was taken from maps provided by the USACE. Diagrams of each survey area including high and low tide marks, locations of slope measurements and other key features can be found in appendix A.

Gauge Placement and Data

Three staff gauges marked in 0.1m intervals were placed in the survey area to monitor tide changes and wake effects. Gauges were placed in a location that was representative of a majority of the beach. The three gauges were placed in a line perpendicular to the main channel. Three gauges were used so that the gauges could remain in the same position throughout the survey, and at least one gauge would be readable from shore at any tide stage. The gauges were calibrated to each other so that upon data entry the readings on any gauge could be truthed to a single gauge.

As a vessel passed the survey area, one surveyor using a voice recorder monitored wake effects from the vessel. As the vessel approached the survey area, the surveyor noted the exact time of day (in seconds) and began making readings with every 0.1m change in gauge level. Readings ended when wake action ceased. The voice recorded tapes were later transcribed, and each reading was correlated to the exact time of day (in seconds) that it was made. From this data we obtained wake profiles for each vessel, and were able to determine the amount of drawdown and wake heights. In addition, gauges were monitored throughout the survey to determine changes in tide level.

Columbia River stage data for the Longview, Washington gauge was obtained from the USACE online data website for the survey period (http://www.nwd-wc.usace.army.mil/cgi-bin/DataQuery).

Vessel Data

During surveys, vessel data, stranding, and wake size was recorded for all shipping vessels including deep draft vessels and tugs with and without tows.

Speed was estimated for all vessels during daytime surveys. Speed was estimated by selecting downstream and upstream transects across the river, estimating the distance between those transects using a hip chain and calculating the time it took the vessel to pass between the transects. Transects were established by standing in a fixed point in the survey area and establishing a landmark on the far shore that would be fixed and visible for the duration of the study. Since the distance between the transects was estimated, speed estimates should not be viewed as actual speed. Thus, the estimates are useful for comparing speeds between vessels within a survey site, but not useful for comparing speeds of vessels in different survey sites. Also, speed could not be estimated for vessels passing at night because we were unable to see the transect landmark on the far shore.

Other vessel data included direction (upstream/downstream) and vessel name. A picture was taken of each vessel in daytime surveys. Additional data including vessel length, vessel type, draft, and load status were obtained by calling the Columbia River Pilots Association.

We calculated river depth for each vessel because of changes in river stages between sampling periods from flow management and changes within periods from tidal influence. We began with the depth of the main channel at Columbia River Datum (CRD) for each location as derived from maps from the USACE. Then, we adjusted these depths for each survey date based on changes in mean daily river stages at Longview, Washington (USACE online data). We assumed that the lowest river stage observed during the sampling period was equal to the gauge reading at CRD. Next, we adjusted the depths for each vessel based on readings from our gauges during surveys. We assumed that our mean gauge reading was equal to the mean daily gauge reading at Longview, Washington. For each vessel, we adjusted the depth based on what the gauge reading was when the vessel passed as compared to the average gauge reading for the survey period. While this method does not provide accurate depth measurements, it is useful for comparing relative differences in depths between vessels and its effect on stranding and wake size.

To compare the magnitude of drawdown and wake action between vessels, we calculated a wake amplitude. This was considered to be the difference in gauge readings between the lowest reading during the drawdown, and the maximum wake height gauge reading.

Fish Pass Methods

A pass was conducted over the entire survey area upon arrival at the site, immediately prior to a vessel passing (when possible) and immediately following the passage of a vessel and cessation of its wake. The start and end time of each pass was noted. When a fish was found we noted which reach it was in. If it was not a salmonid we identified it. If it was live we returned it and if not we removed it from the beach so as not to be counted on subsequent surveys. If it was a salmonid we identified it and noted the presence or absence of an adipose fin. It was alive we returned it, and if it was dead we measured the fork length and preserved it in a cooler to be turned over to NMFS personnel.

Recommendations

We calculated the mean and variance of number of fish stranded per deep draft vessel, and applied methods described by Eckblad (1991) to determine how many deep draft vessels need to be observed in next year's study to obtain a mean number of fish stranded per deep draft vessel with various accuracies. Our data was not normally distributed so we applied a logarithmic transformation as described in Elliott (1977).

RESULTS

Habitat

The surveyed area of each site was approximately 200-300m long. Sauvie Island and Barlow Point were separated into two reaches, and County Line Park was separated into 3 reaches. Gradients among reaches ranged from 1.6 (Reach 2, Barlow Point) to 11.9 (Reach 3, County Line Park)(Table 1). Substrate was largely fines at all sites, and all reaches were primarily unvegetated (Table 1). Pictures of each of the sites, and GPS boundaries of each reach can be found in appendix B.

Table 1. Habitat characteristics of each of the sample sites in the lower Columbia. Habitat data was taken at low tide during the first survey.

				% Substrate				Slope (%)			
Location	Date	Reach	Length (m)	Fines	Gravel	Cob./ Bldr.	% Veg.	1	2	3	Avg.
Sauvie Island	1-Jul	1	131	100	0	0	8	7	6.5	5	6.2
		2	102.8	100	0	0	1	5.5	4.5	6	5.3
Barlow Point	5-Jul	1	111	100	0	0	10	2.2	2.8	4	3
		2	84	70	0	30	20	1.5	1.8	1.5	1.6
County Line Park	24-Jun	1	80.9	90	0	10	0	11.2	11.7	4.9	9.3
		2	121	95	0	5	0	3	3	2.8	2.9
		3	48.5	95	0	5	0	11	12.1	12.8	11.9

River stages in the lower Columbia were approximately 3 feet higher during the first survey period than the second. The average daily gauge reading in Longview for the first survey period ranged from 6.1 feet to 7.8 feet, and from 3.8 to 4.3 in the second survey period (Figure 3).

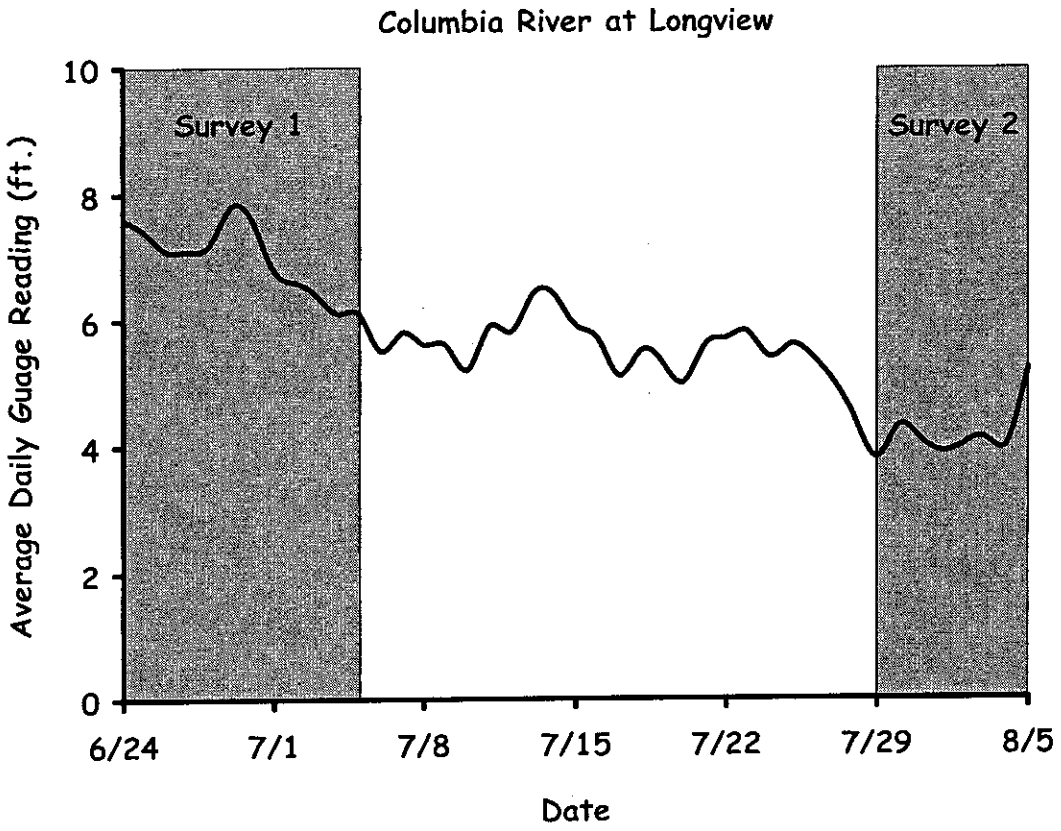


Figure 3. Average daily gauge reading at Longview, Washington from July 24, 2002 to August 5, 2002. Data obtained from USACE online data website (http://www.nwd-wc.usace.army.mil/cgi-bin/DataQuery).

Tidal changes caused a 1.6m change in gauge levels at County Line Park and as little as a 0.2m change in levels at Sauvie Island during the first survey (Figure 4, Figure 5). Tidal influences were greater at Barlow Point and Sauvie Island during the second survey, but were greater at County Line Park during the first survey. There doesn't appear to be any relation between timing of vessel passage with tidal stage or time of day (Figure 4, Figure 5).

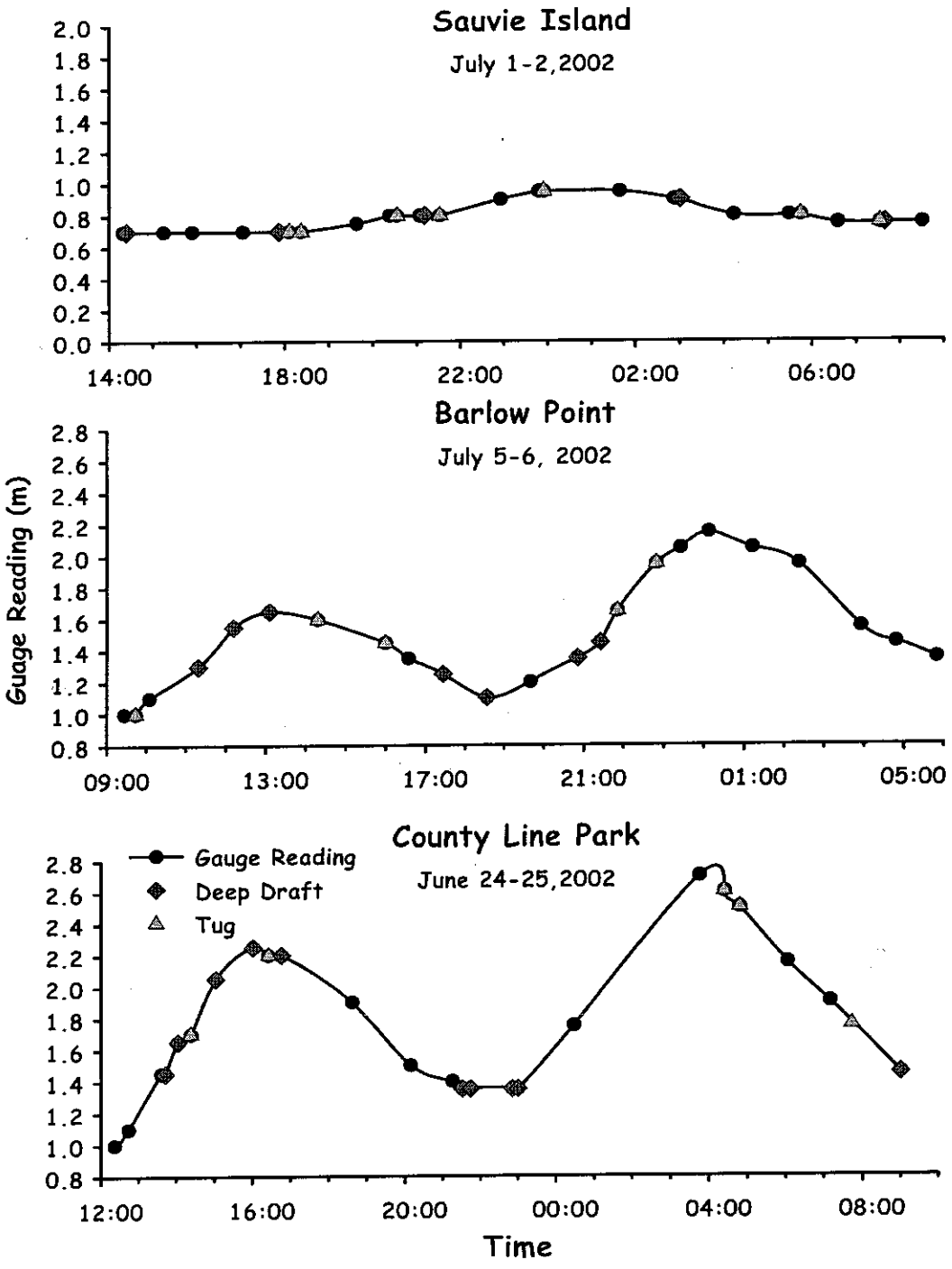


Figure 4. Baseline gauge readings at each of the three survey sites during the first survey period. Diamonds and triangles demote the time and tide stage of vessel passings.

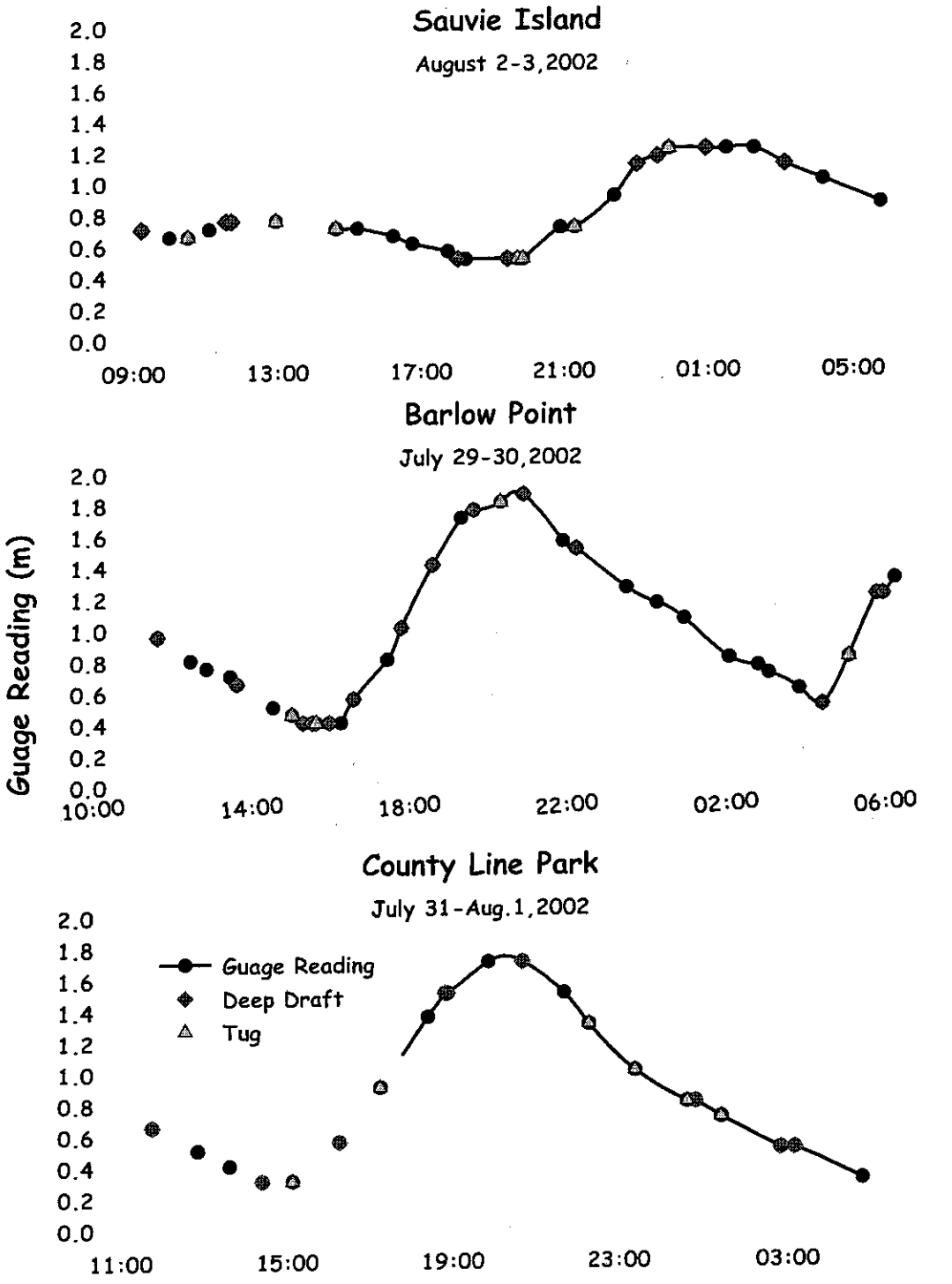


Figure 5. Baseline gauge readings at each of the three survey sites during the second survey period.

Vessels

A total of 91 vessels were observed during surveys including 35 tugs and 56 deep draft vessels (Table 2). Thirty-eight vessels were observed during the first round of surveys compared to 51 in the second (Table 2). A majority of vessels (63 of 91) were observed during day surveys (Figure 6).

Table 2. Number of deep draft vessels and tugs observed at each survey site during each survey period.

	Deep Draft			Tugs			
Location	Survey 1	Survey 2	Sub-total	Survey 1	Survey 2	Sub-total	Total
Sauvie Island	5	9	14	6	7	13	**27**
Barlow Point	7	14	21	5	4	9	**30**
County Line Park	10	11	21	7	6	13	**34**
Total	**22**	**34**	**56**	**18**	**17**	**35**	**91**

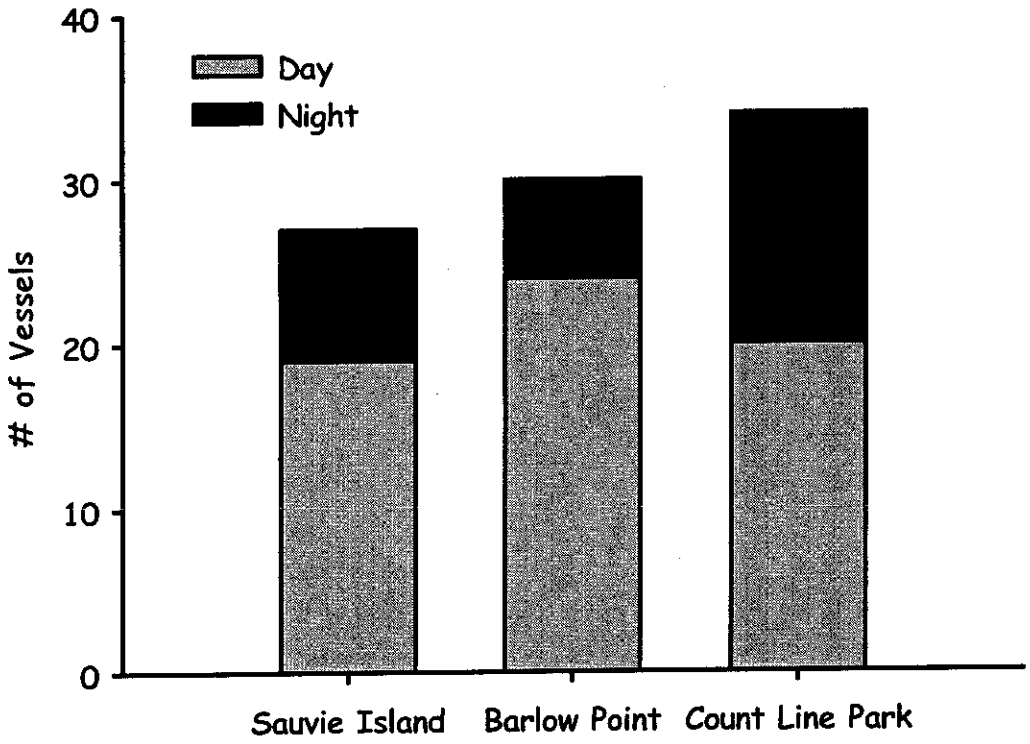


Figure 6. Number of vessels observed at each survey during day and night surveys.

Six different types of vessels were observed. Tugs were the dominant vessel type at 39% of observations. Among deep draft vessels, bulk carriers comprised another 35% of total observations, and the remainder were car ships, oil tankers, container ships, and general cargo carriers (Figure 7). Pictures of each of the vessel types can be seen in figures 8 through 10 except general cargo carrier. Photos were not available because these vessels only passed at night.

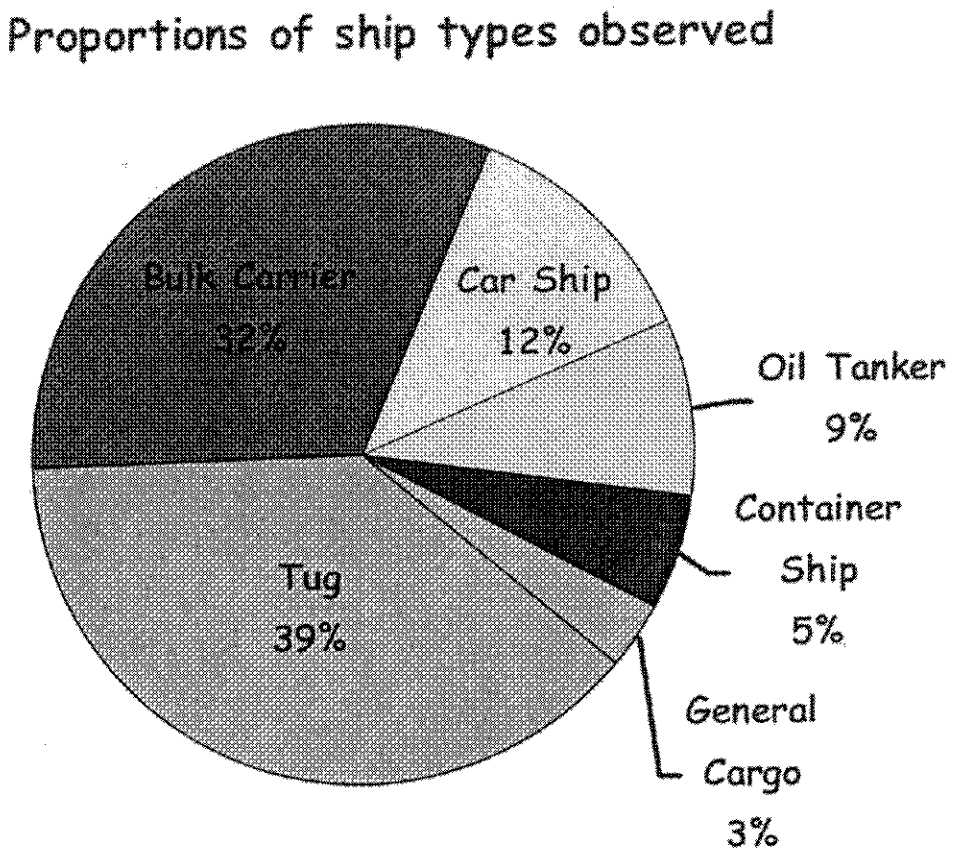
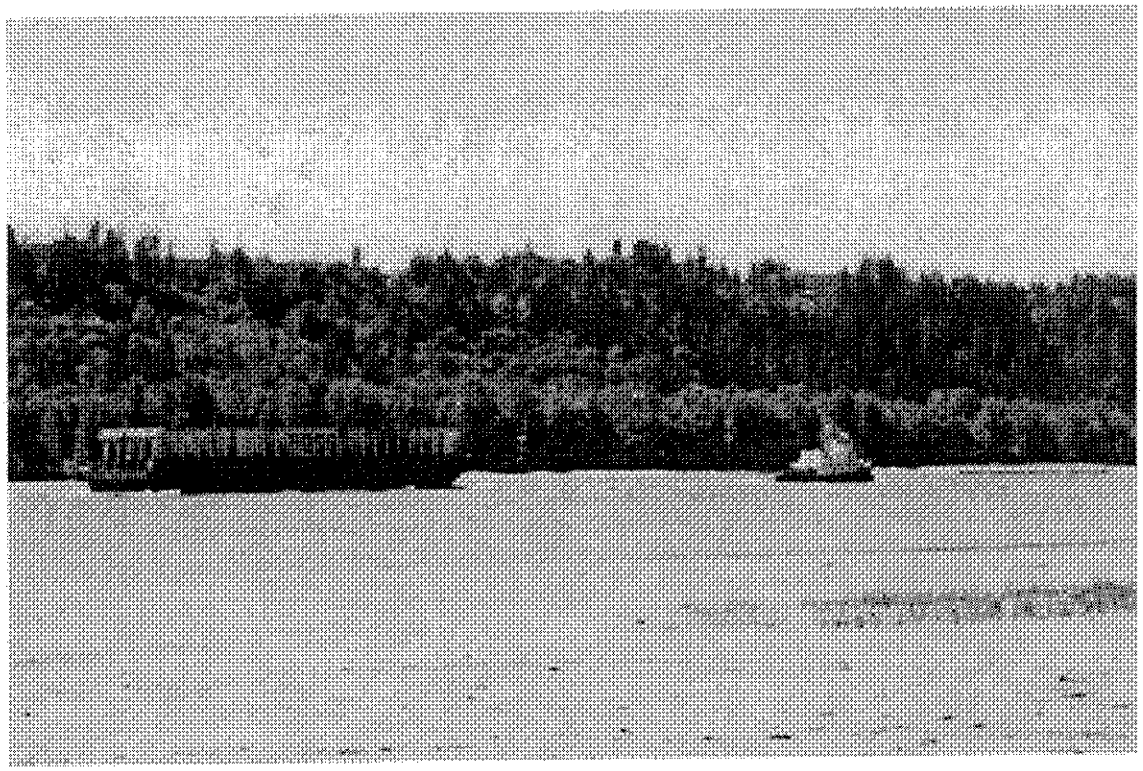


Figure 7. Percentage composition of total observations of each vessel type.



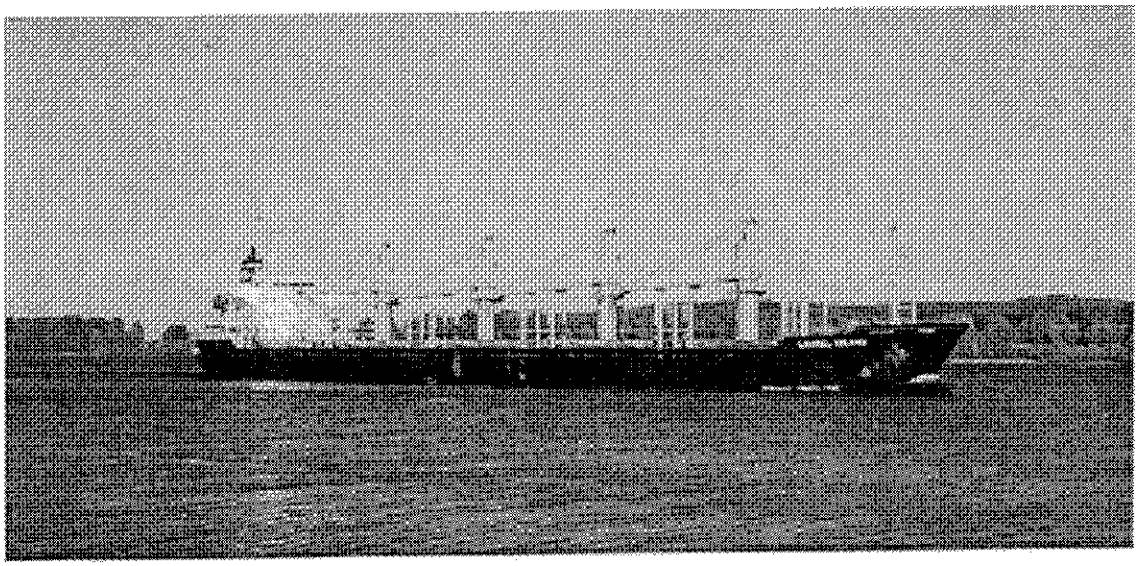


Figure 8. Top: Picture of tug at Barlow Point. Bottom: Picture of the Laurel Island, a bulk carrier at Sauvie Island.

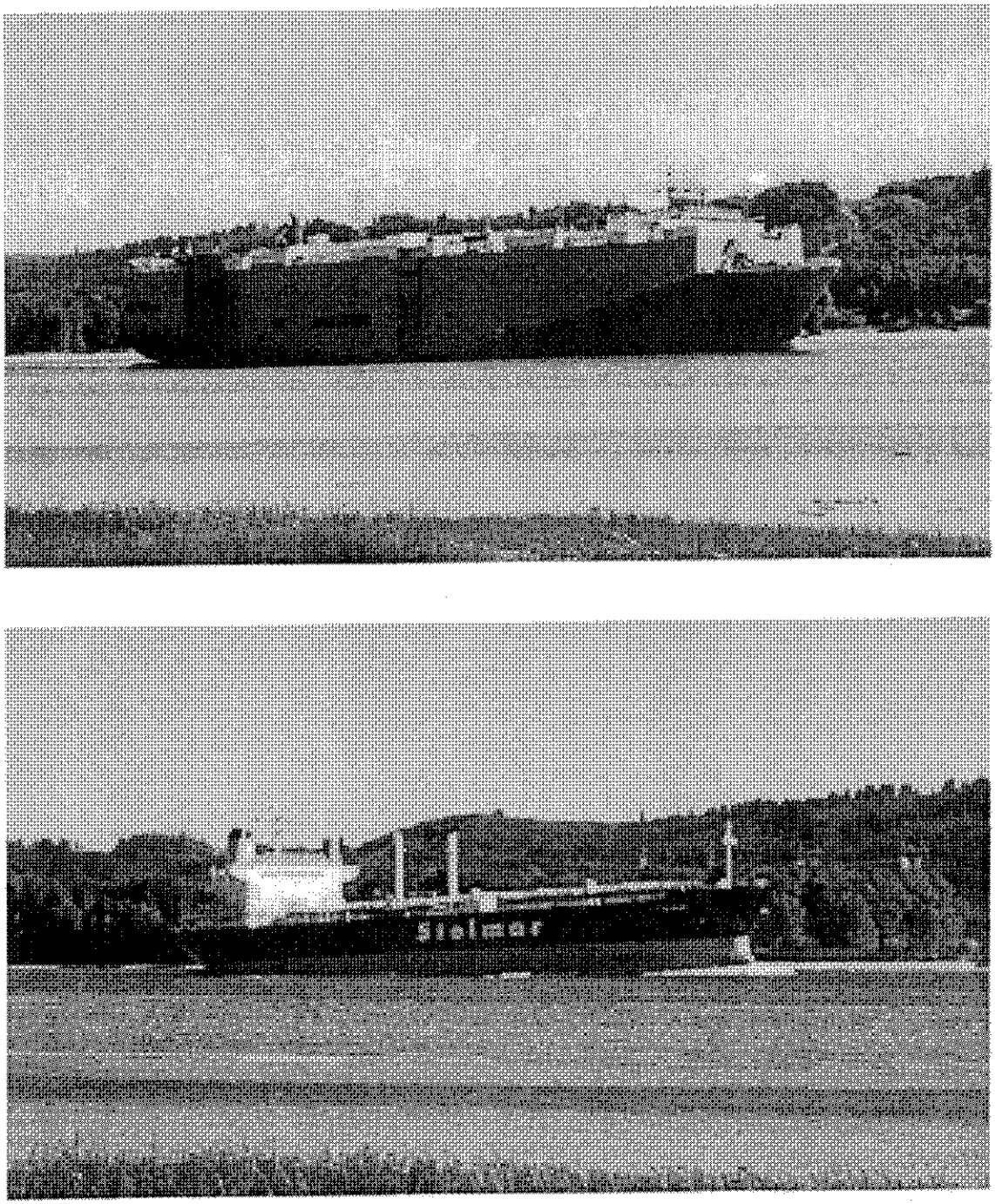


Figure 9. Top: Picture of the Century Highway #1, a car ship at Barlow Point. Bottom: Picture of the Fulmar, an oil tanker at Barlow Point.

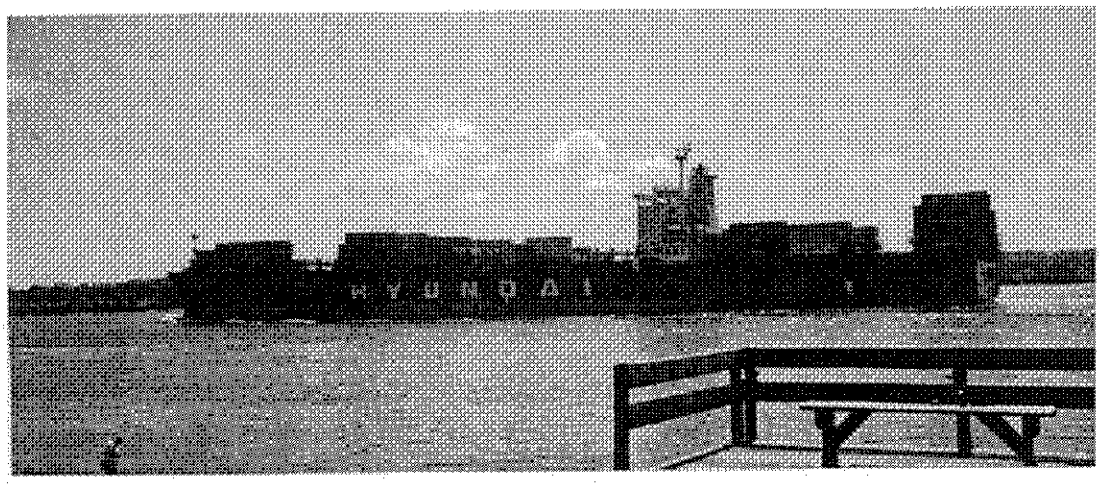


Figure 10. Picture of the Hyundai Admiral, a container ship at County Line Park.

We found that vessels produced wake profiles of similar shape, but of varying magnitude. In general, wake profiles of deep draft vessels show a drawdown as the vessel began to pass the survey area, followed by an intial surge, and subsequent wake action. Tugs showed no evidence of a drawdown, and much less wake action than the deep draft vessels (Figure 11). This is not surprising since the tugs are much smaller, draft less water and move slower than the deep draft vessels. The average speed of tugs was 7.5 knots compared to 10.5 knots for deep draft vessels. The wake amplitude for deep draft vessels averaged 0.52m as compared to 0.16m for tugs.

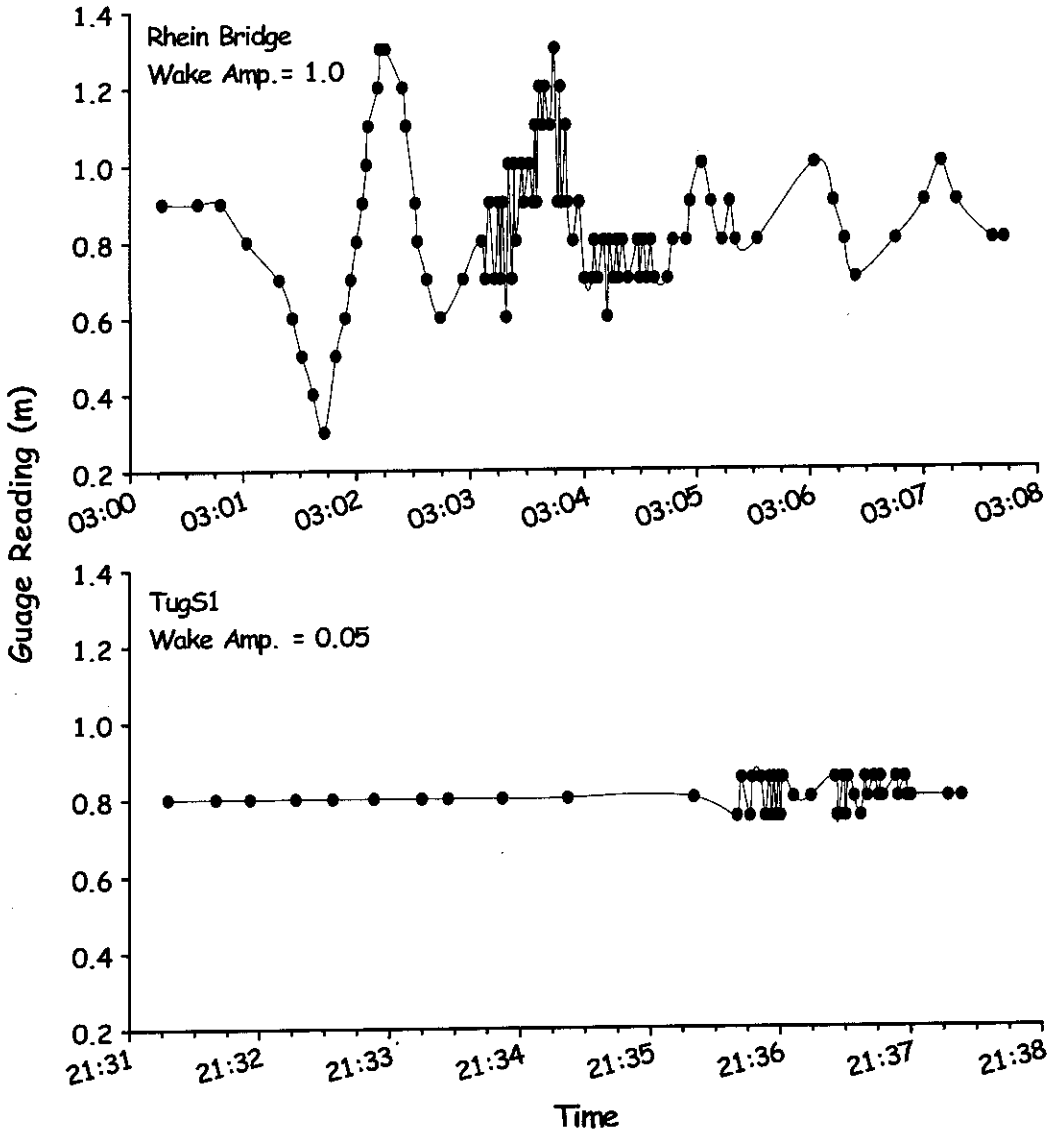


Figure 11. Wake profile of a deep draft vessel (top) and tug (bottom) at Sauvie Island, July 1 and 2, 2002.

The average wake amplitude from deep draft vessels was the largest at County Line Park of the three sites (Table 3). The vessels drafting the most were observed at Barlow Point. All vessel data for each vessel can be found in appendix C.

Table 3. Characteristics of deep draft vessels and their wakes at each of the three survey sites.

Location	Direction	# Vessels	Distance from shore (m)	Avg. Est. Depth (m)	Est. Speed (knots)	Avg. Draft (m)	Avg. Drawdown (m)	Avg. Wake Amplitude
Sauvie Island	US	6	331	14.9	7.5	8.1	0.35	0.63
	DS	8	442	14.3	8.6	8.4	0.25	0.58
Barlow Point	US	14	497	14.0	11.1	8.7	0.14	0.33
	DS	7	387	13.7	13.7	9.4	0.26	0.43
County Line	US	11	331	14.5	9.4	7.9	0.29	0.55
Park	DS	10	238	15.0	10.4	8.5	0.37	0.75

A stepwise regression using our data showed that vessel length, draft and distance from shore were significantly related to wake amplitude ($P<0.05$). Distance to shore was the variable most highly correlated to wake amplitude ($r^2 = 0.29$). Field observations confirmed this. The main channel at Barlow Point was further from shore than at the other two sites, and we noticed during surveys that wake amplitude was smaller given similar sized vessels and speeds.

Stranded Fish

We observed stranding of 21 juvenile chinook salmon during surveys. (Table 4) All of the stranding was observed during the second survey period from July 29 to August 3, 2002. Twelve chinook were stranded at Barlow Point, 9 at County Line Park, and none at Sauvie Island. At Barlow Point, 10 chinook were stranded by one vessel (Table 4). All of the stranding observed occurred during night surveys. Twenty of the stranded chinook were unclipped, and one could not be identified as to the presence of an adipose fin (Table 4). That fish appeared to have been wounded by a bird, leaving a wound where the adipose fin would have been. The wound likely played a role in the fish being stranded since it was much larger (136mm) than the other fish stranded (48-90mm) (Table 5).

Table 4. Summary of observations of juvenile chinook stranding. Included are the location, reach, date, time and vessel characteristics.

							Chinook		
Date	Time	Vessel	Location	Reach	Draft (m)	Wake Amplitude (m)	Clipped	Unclipped	Unknown
29-Jul	21:34	K & A	Barlow	2	8.2	0.3	0	1	0
30-Jul	3:44	Fairy Queen	Barlow	2	12.1	0.2	0	10	0
30-Jul	4:24	Tug	Barlow	2	--	0	0	1	0
31-Jul	20:59	Cielo de Vancouver	County Line	2	9.8	1.05	0	1	0
1-Aug	1:10	Hanjin Osaka	County Line	1	9.3	1	0	1	0
1-Aug	1:10	Hanjin Osaka	County Line	2	9.3	1	0	2	1
1-Aug	2:45	Serena	County Line	2	7.7	0.7	0	4	0

Table 5. Lengths of stranded juvenile chinook. * Denotes the fish with the injury.

Location	Date	Vessel	Reach	Fork Length (mm)
Barlow Point	29-Jul	K & A	2	90
Barlow Point	30-Jul	Fairy Queen	2	63
Barlow Point	30-Jul	Tug	2	72
County Line Park	31-Jul	Cielo de Vancouver	2	53
County Line Park	1-Aug	Hanjin Osaka	1	78
County Line Park	1-Aug	Hanjin Osaka	2	79
County Line Park	1-Aug	Hanjin Osaka	2	48
County Line Park	1-Aug	Hanjin Osaka	2	136*
County Line Park	1-Aug	Serena	2	62
County Line Park	1-Aug	Serena	2	64
County Line Park	1-Aug	Serena	2	55
County Line Park	1-Aug	Serena	2	77

Seventeen of the 21 salmonids were stranded at Barlow Point reach 2 and County Line Park reach 2. These two reaches had the lowest slopes of all reaches at 1.6% and 2.9% respectively indicating lower sloped beaches are more conducive to stranding than higher sloped beaches.

There was some indication that tide stage may influence stranding. The Fairy Queen which stranded 10 chinook, passed Barlow Point at low tide. In addition, the Serena which stranded 4 chinook passed County Line Park as the river was approaching low tide. However, the Serena was soon followed by the Seven Seas and Pactrader, neither of which stranded salmonids. At low tide, more beach is exposed allowing for a greater chance of stranding. At high tide at reach 2 at Barlow Point and reach 3 at County Line Park, no beach was left available for stranding because the water had come up to the rip-rap at the high end of the beach.

We observed stranding of 174 non-salmonids. These included three-spined stickleback (*Gasterosteus aculeatus*), eastern banded killfish (*Fundulus diaphanous*), common carp (*Cyprinus carpio*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), peamouth (*Mylocheilus caurinus*), and sculpin (*Cottus spp.*). Stranding of 162 of the 174 fish were vessel related. Of these, 129 were stranded at Barlow Point (Table 6). Of the 12 non-vessel related strandings, eight were stranded by the outgoing tide, and 4 were found during initial passes upon site arrival. Lengths of the stranded non-salmonids were not taken, but all were estimated to be less than 100mm in length.

Table 6. Summary of non-salmonids stranded by vessels at each of the survey sites.

Location	Reach	Stickleback	E. Killfish	C. Carp	Y. Perch	L Bass	S Bass	Sculpin	Peamouth
Sauvie Island	1	0	3	2	9	5	0	0	9
	2	0	0	0	0	0	0	0	0
Subtotal		**0**	**3**	**2**	**9**	**5**	**0**	**0**	**9**
Barlow Point	1	15	0	5	3	0	5	1	2
	2	81	7	4	0	0	3	3	0
Subtotal		**96**	**7**	**9**	**3**	**0**	**8**	**4**	**2**
County Line	1	1	0	0	0	0	0	0	1
Park	2	2	0	0	0	0	1	0	0
	3	0	0	0	0	0	0	0	0
Subtotal		**3**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
Total		**99**	**10**	**11**	**12**	**5**	**9**	**4**	**12**

Effects of Sample Size on Accuracy

Our observations indicated a non-normal distribution of salmonids stranded per deep draft vessel, and a high degree of variance (Figure 12). Based on this data after it was transformed using the natural log and methods of Eckblad (1991), we estimate that to achieve a mean accuracy of +/- 20% from actual values, 1300 vessels would need to be observed using a completely random design (Figure 13). A stratified sampling design would substantially reduce the necessary sample sizes. This analysis is included as an example for further refinement in future study plans rather than a definitive assessment of sample needs.

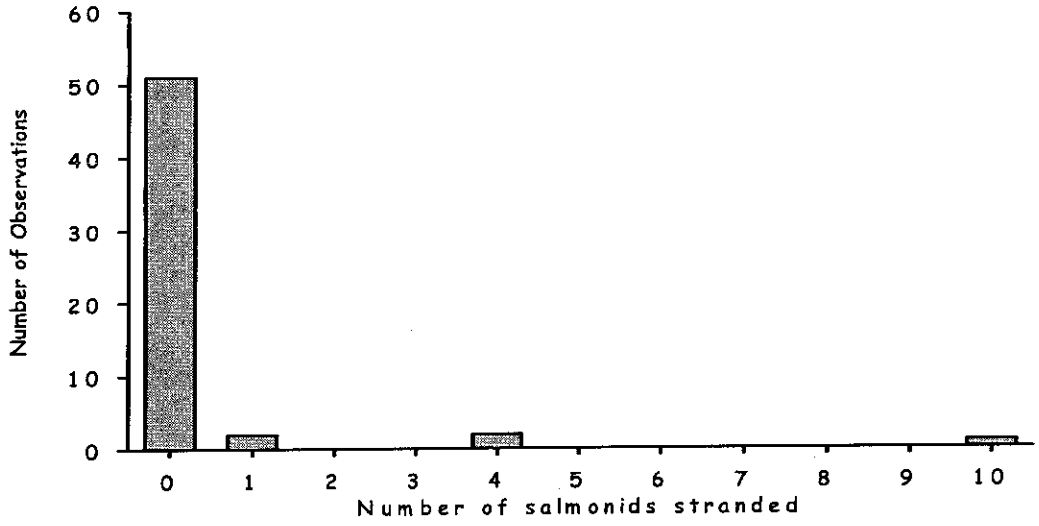


Figure 12. Frequency distribution of observations of number of salmonids stranded.

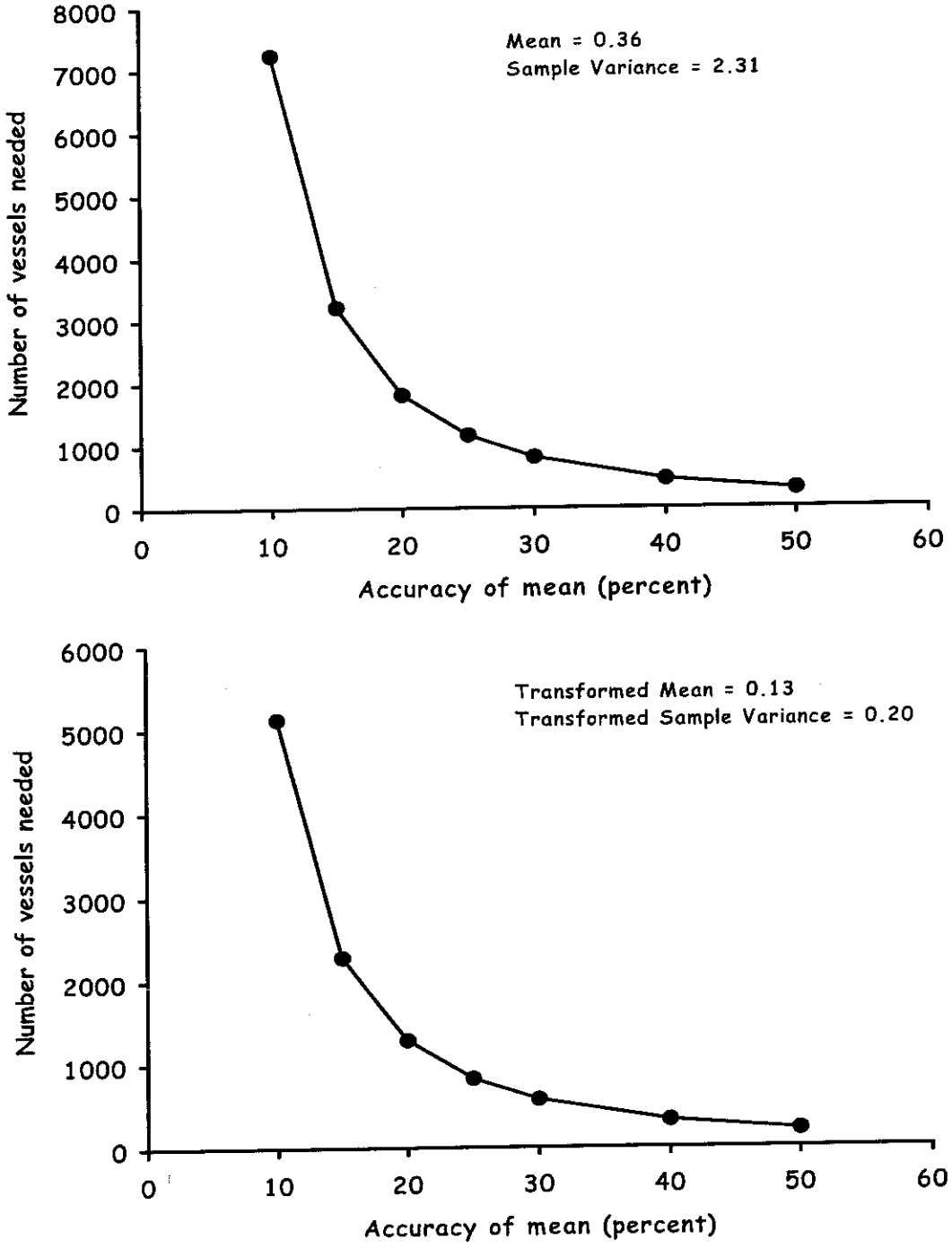


Figure 13. Number of vessels needed to estimate fish stranded per vessel with a given accuracy, expressed as +/- x percent of the mean. Top graph is base on untransformed data, and bottom graph is based on logarithmically transformed data. Transformed using the natural log.

DISCUSSION

The intent of this project was to test a sample design for a more comprehensive study. In our pilot study, we examined numerous factors that may influence stranding of juvenile salmonids including beach habitat characteristics, channel characteristics, tides, effects from the time of day and time of year, and vessel characteristics.

Stranding results from a combination of factors working together with different degrees of influence. Bauersfeld (1977) found that beach slope, time of day, and vessel draft contribute to stranding. Hinton and Emmett (1994) theorized that increased dissolved gas levels resulting in reduced swimming efficiency correlate to increased stranding. We identified tide stage as a potential confounding factor.

Bauersfeld (1977) suggested that stranding occurs only on low sloped beaches and recommended that beaches created by dredgings be contoured to a slope of 9% or more. We found that stranding only occurred on our lowest sloped beaches.

Bauersfeld (1977) found the time of day to be important in stranding. From mid-June through July, he only observed stranding at night. Our surveys took place between June 24, and August 3, and we only observed stranding at night as well.

Bauersfeld (1977) found that vessel draft was related to stranding. He found that stranding rates of 31 vessels with a draft of 7.6m or greater was 19 fish per vessel. Also, he observed stranding of 2,397 salmonids, and none were stranded by tugs. Vessels drafting less than 7.6m only stranded three fish per vessel. All the juvenile chinook we observed stranded were from vessels drafting 7.7m or greater with the exception of the chinook stranded by the tug at Barlow Point.

Bauersfeld (1977) concluded that wake size was one of the primary factors related to stranding. We found that wake amplitude was related to distance from the vessel to shore, vessel draft and vessel length.

Hinton and Emmett (1994) cited dissolved gas levels as a potential factor contributing to stranding. Reduced swimming efficiency and buoyancy regulation resulting from increased levels of dissolved gases at Bonneville dam might increase stranding.

Dissolved gas levels greater than 106% have been shown to decrease swimming performance of juvenile chinook (Schiewe 1974). In 1974 and 1975 when Bauersfeld (1977) observed significant stranding, dissolved gas saturation at Bonneville dam was typically above 110% (Hinton and Emmett 1994). In 1992 and 1993 when Hinton and Emmett (1994) observed only 6 stranded salmonids for 145 vessels, dissolved gas saturation levels were typically at or below 106% (Figure 14). During our study gas saturation levels at Bonneville dam were greater than 106% (Figure 14).

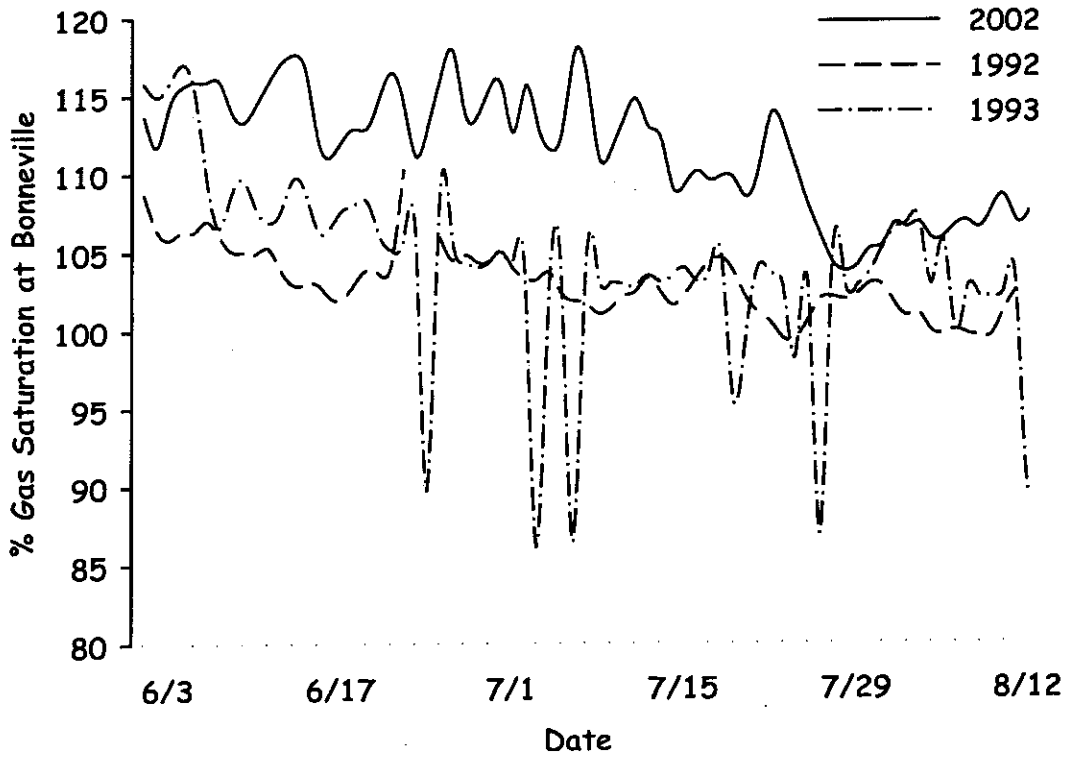


Figure 14. Average daily dissolved gas readings (%saturation) at Bonneville dam from June 1 – August 12 for 1992, 1993 and 2002. Data obtained from the Columbia River Data Access in Real Time website (http://www.cqs.washington.edu/dart/dart.html).

Hinton and Emmett (1994) beach seined at survey locations during their study of juvenile salmonids. In July, 1994 they found chinook lengths ranged from 60mm to 120mm with most chinook being 90mm. All of the dead chinook we observed stranded (with the exception of the injured fish) were in the lower end of this size range. This may indicate that only the smaller fish of the age class are being stranded.

Our survey did not specifically evaluate early season stranding when smaller fish are present. Early in the season (March and April) fry are present throughout the lower Columbia, and are highly susceptible to stranding. Observations by NMFS personnel and people we talked to while performing surveys suggest that significant vessel induced stranding may occur in early spring. In addition, Bauersfeld (1977) showed that the size class with the most stranding mortalities in 1974 and 1975 were juveniles in the 35-40mm range indicating a majority of stranding occurs early in the year.

The discrepancy in results between the studies by Bauersfeld (1977) and Hinton and Emmett (1994), high variance in observations in this study, and potential roles of multiple factors contributing to stranding indicate a substantial

number of surveys and a carefully stratified sample design will be needed to accurately assess the causes and magnitude of vessel wake induced stranding of juvenile salmonids in the lower Columbia.

RECOMMENDATIONS

Because of experiences and results gained from this pilot study, we suggest that the following recommendations be considered in planning a more comprehensive study in 2003.

1. Use methods from this pilot study to collect habitat, vessel, wake, and stranding data.

We believe that the data we collected in this study was sufficient to determine what effects habitat, tidal and vessel characteristics have on juvenile stranding given the benefits of a larger sample size, and beach seining data. However, we suggest that at least three people be used during stranding surveys. For the purposes of the pilot study, two people was sufficient because we saw relatively little stranding. If more fish were stranded which will likely be the case earlier in the year, it will be necessary to have three surveyors per crew. A method for estimating vessel speed at night should be used. It is likely that speed is a contributing factor to stranding, and if stranding occurs primarily at night, it will be helpful to have estimated speeds for vessels passing at night. Radar guns may be a possibility.

2. Conduct surveys throughout the period of smolt and subyearling outmigration.

Bauersfeld (1977) observed significant levels of vessel induced stranding from February through July. We recommend that surveys encompass this time frame with the potential for going into August depending on hatchery release schedules of subyearling chinook. Beginning in February will allow for the observation of the magnitude of stranding of swim-up fry, and continuing through August will allow for observation of the magnitude of stranding of smolts and subyearling chinook.

3. Surveys should be conducted at numerous sites with various slopes throughout the lower Columbia.

Surveys should be conducted on at least as many sites as would be needed to accurately statistically estimate the extent of stranding in the lower Columbia River between the Willamette River and Astoria. Beaches of varying slopes should be monitored to better understand the importance of beach slope in stranding.

4. Conduct a general inventory of beaches with the potential for stranding in the lower Columbia.

A survey of the amount of beach where stranding could potentially occur would aid in estimating the total amount of stranding that occurs in the lower Columbia. This inventory would allow for sample sites chosen to be a representative sample of the population of beaches.

5. Base sample effort and sample sites on desired accuracy of stranding estimates.

High variance in results from this study, and differences in results between Bauersfeld (1977) and Hinton and Emmett (1994) indicate substantial sampling will be needed to accurately estimate the magnitude of stranding in the lower Columbia. A stratified sampling design will minimize sampling effort while maximizing sampling efficiency for a given budget.

6. Conduct beach seining to evaluate presence, abundance, size distribution and origin of juveniles subject to potential stranding.

Evaluating factors that contribute to stranding is difficult if it is unknown as to whether juveniles are present at the site when vessels pass. Without presence/absence data, it is impossible to determine if fish were not stranded because they weren't there, or because the environmental factors and vessel characteristics weren't conducive to stranding.

Abundance of juveniles at a beach prior to stranding is important because it can be used in conjunction with stranding data to estimate what proportion of fish present are being stranded.

Using seining to sample size distribution of juveniles is important for determining differences in length, weight and condition factor between fish stranded, and those present offshore of the beach. Making this comparison will help clarify differences in condition between fish stranded and those in the population.

Through seining, it will be possible to estimate the wild to hatchery ratio of the population subject to stranding, and compare this to the ratio of wild to hatchery among stranded fish.

7. Evaluate physiological condition of stranded salmonids.

An important question when evaluating the impacts of vessel wake induced stranding and mortality of salmonids, is whether mortality incurred is compensatory or additive. A physiological evaluation of stranded juveniles may give an indication of the health of the fish prior to stranding, and provide understanding of the impacts of the mortalities incurred on the population.

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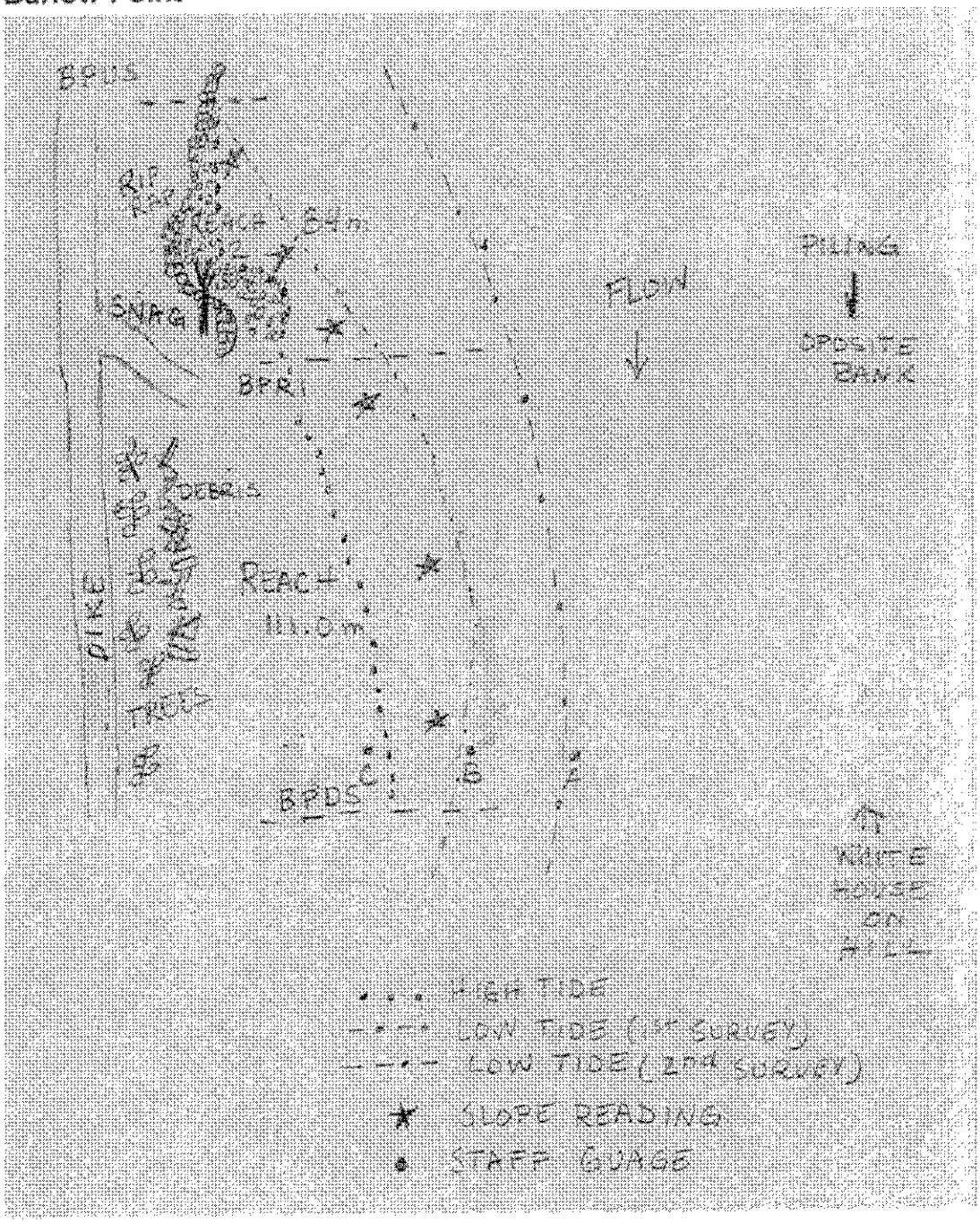
APPENDICIES

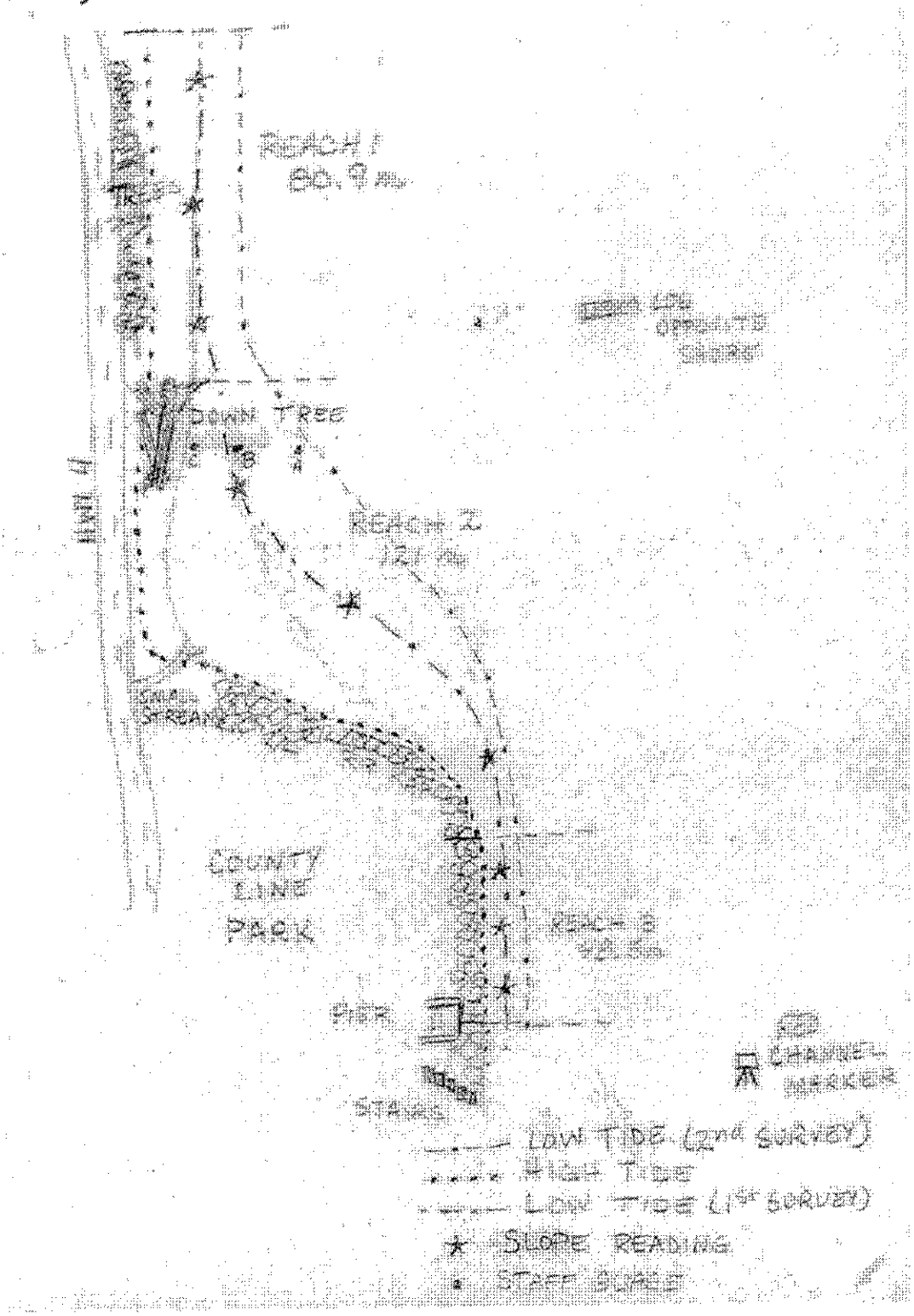
Appendix A: Survey site diagrams

Barlow Point



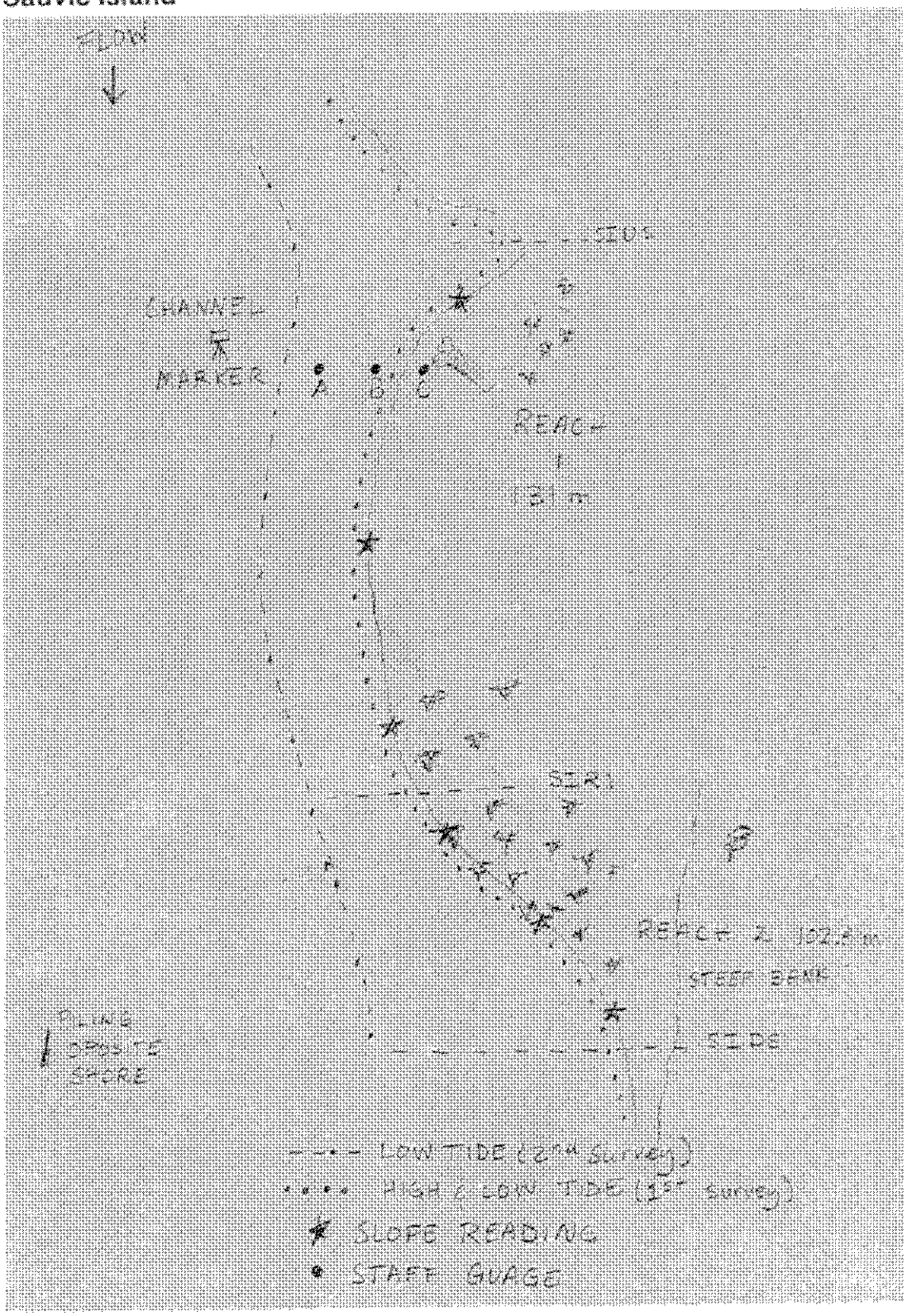
Appendix Figure 1. Drawing of Barlow Point survey area

County Line Park



Appendix Figure 2. Drawing of County Live Park survey area

Sauvie Island

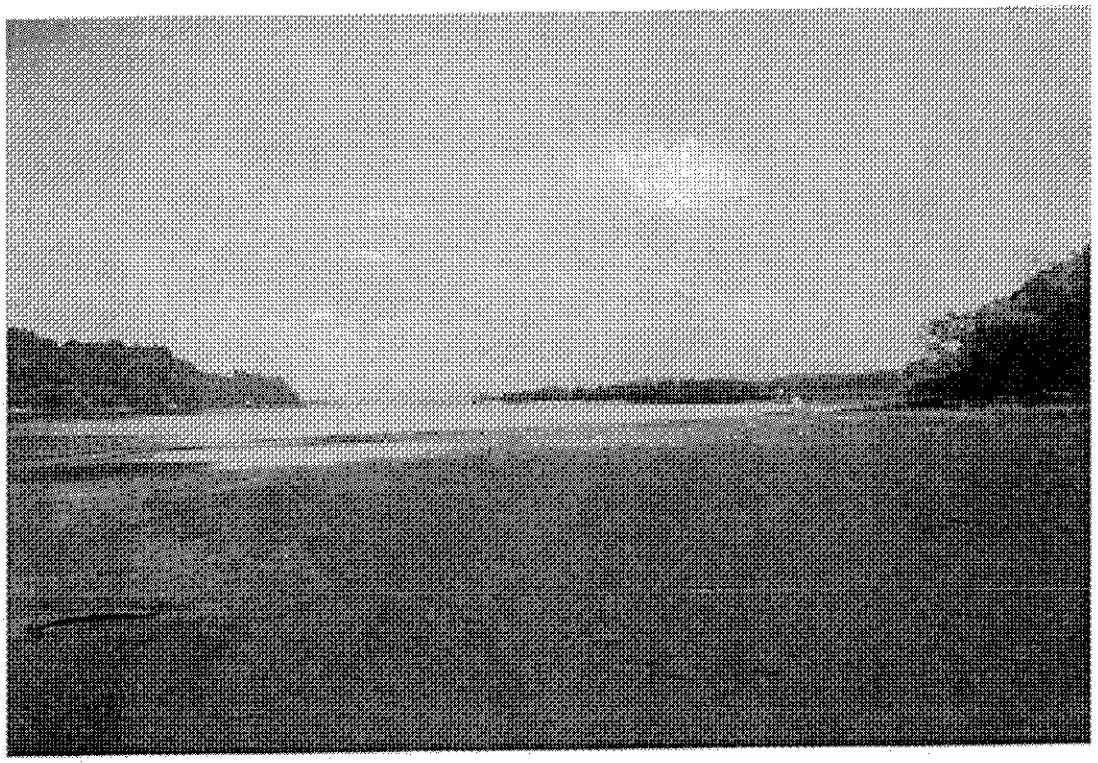


Appendix Figure 3. Drawing of Sauvie Island survey area.

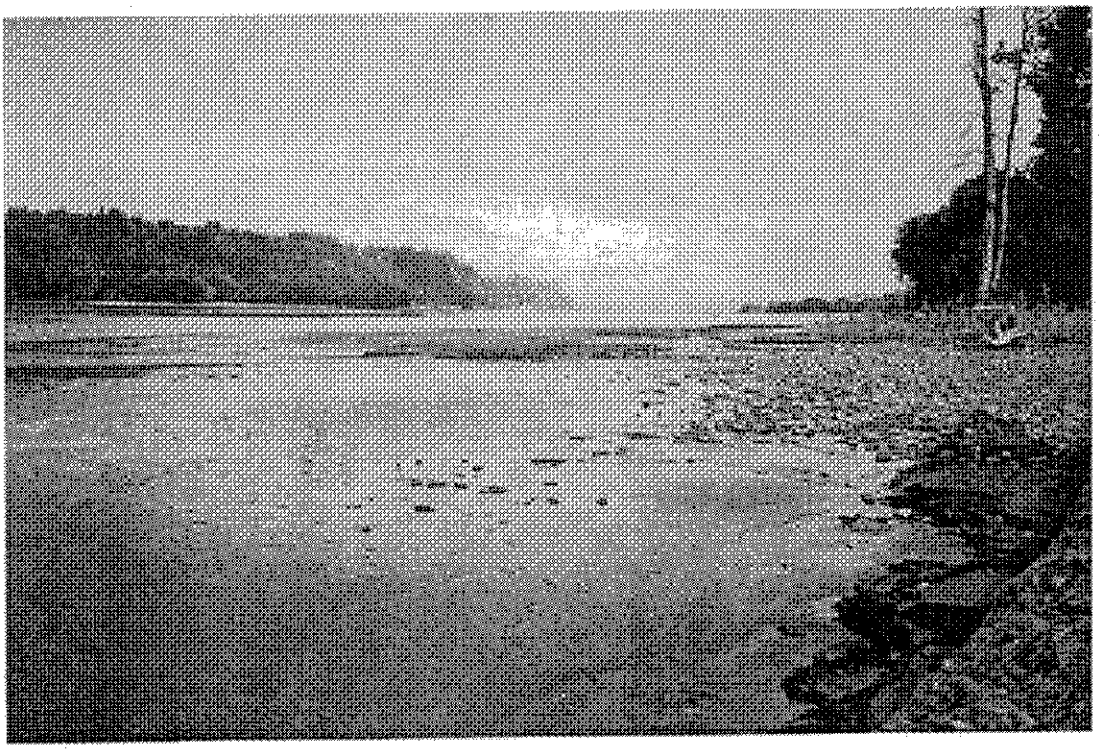
Appendix B: Survey site pictures and GPS locations

Appendix Table 1. GPS locations of reach breaks for each survey area.

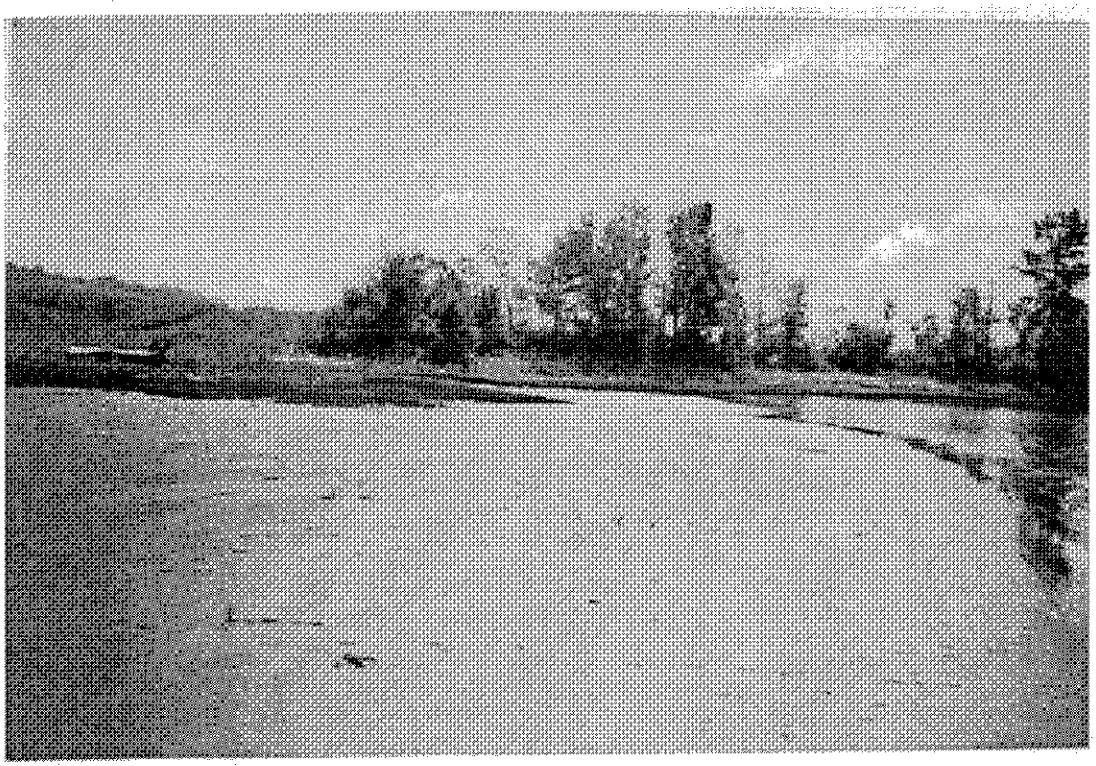
GPS Description	10T	UTM	N	W
County Line Park boundary of reach 2/3	0483172	5113423	46.10.451	123.13.081
County Line Park downstream boundary	0483126	5113402	46.10.439	123.13.116
County Line Park boundary of reach 1/2	0483255	5113492	46.10.488	123.13.017
County Line Park upstream boundary	0483337	5113524	46.10.506	123.12.953
Sauvie Island upstream boundary	0517975	5063434	45.43.454	122.46.141
Sauvie Island boundary of reach 1/2	0518048	5063549	45.43.516	122.46.083
Sauvie Island downstream boundary	0518025	5063650	45.43.570	122.46.102
Barlow Point downstream boundary	0497325	5110580	46.08.928	123.02.078
Barlow Point reach 1/2 boundary	0497404	5110500	46.08.884	123.02.017
Barlow Point upstream boundary	0497474	5110470	46.08.868	123.01.962



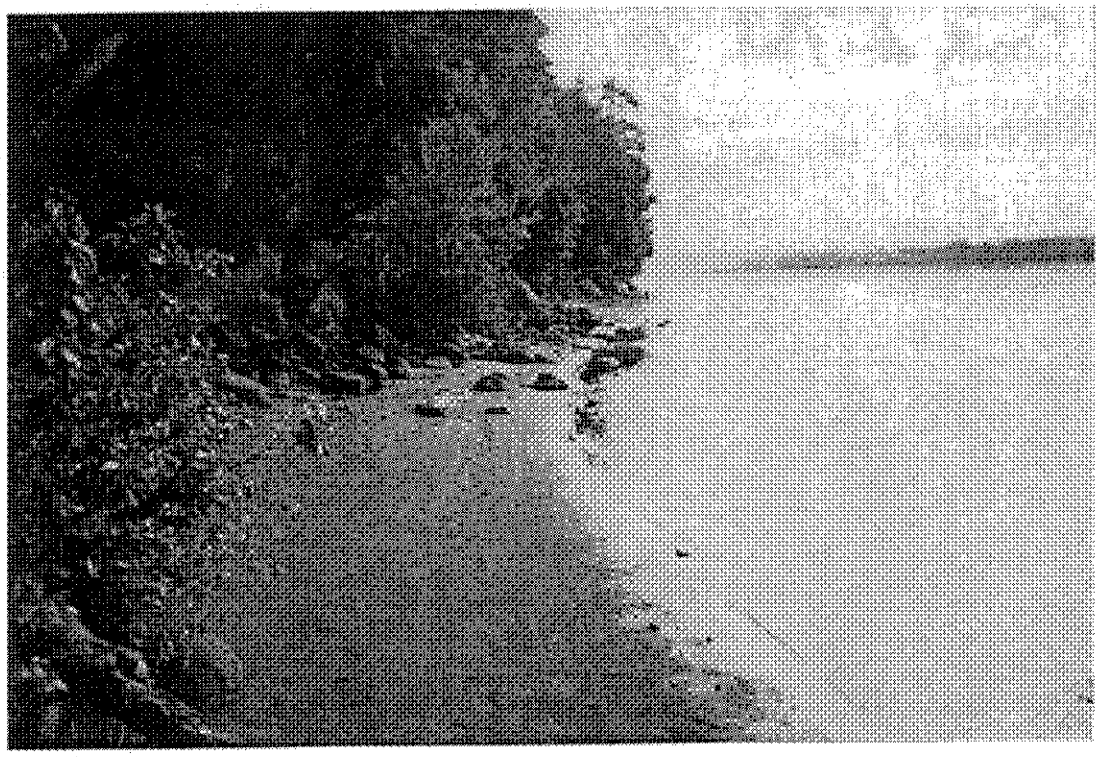
Appendix Figure 4. Photo of Barlow Point Reach 1 looking downstream.



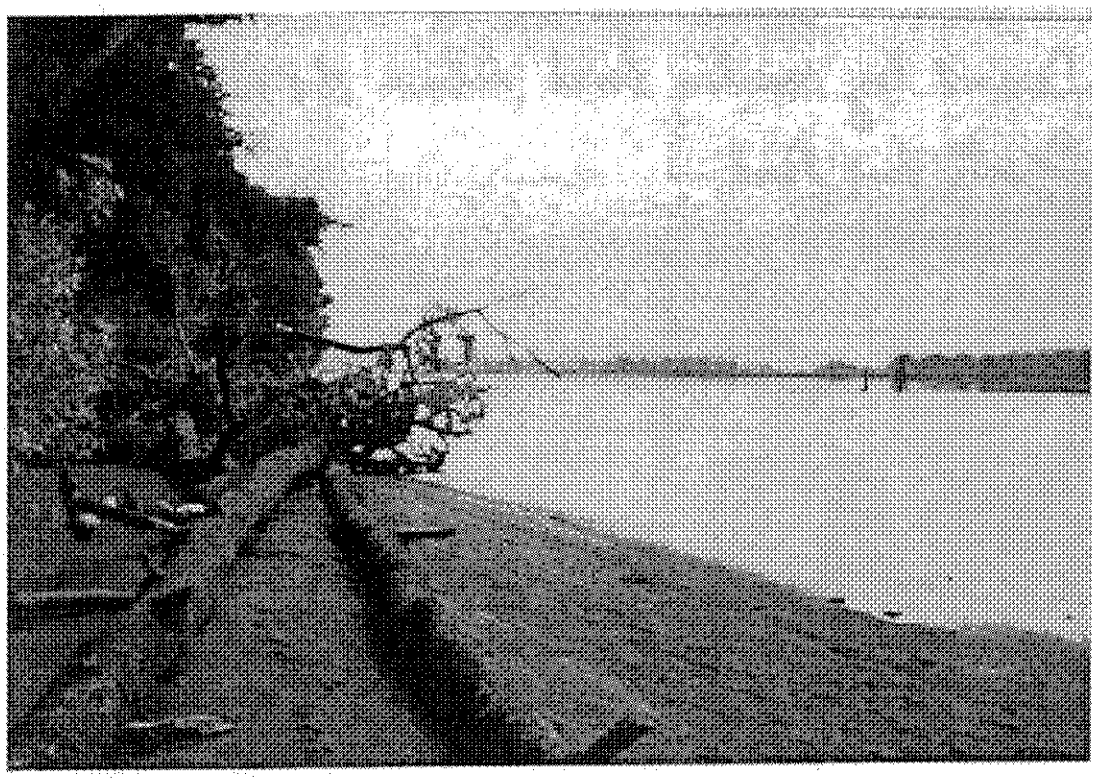
Appendix Figure 5. Barlow Point Reach 2 looking downstream.



Appendix Figure 6. Barlow Point Reach 2 looking upstream.

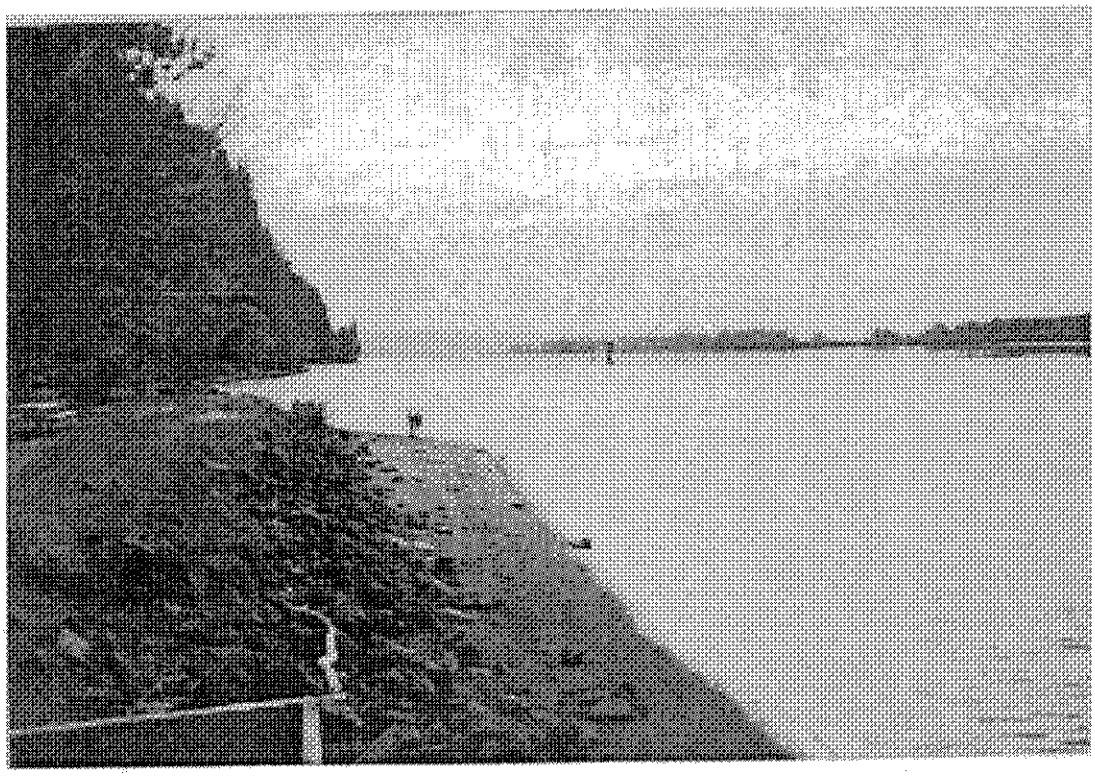


Appendix Figure 7. County Line Park Reach 1 looking upstream



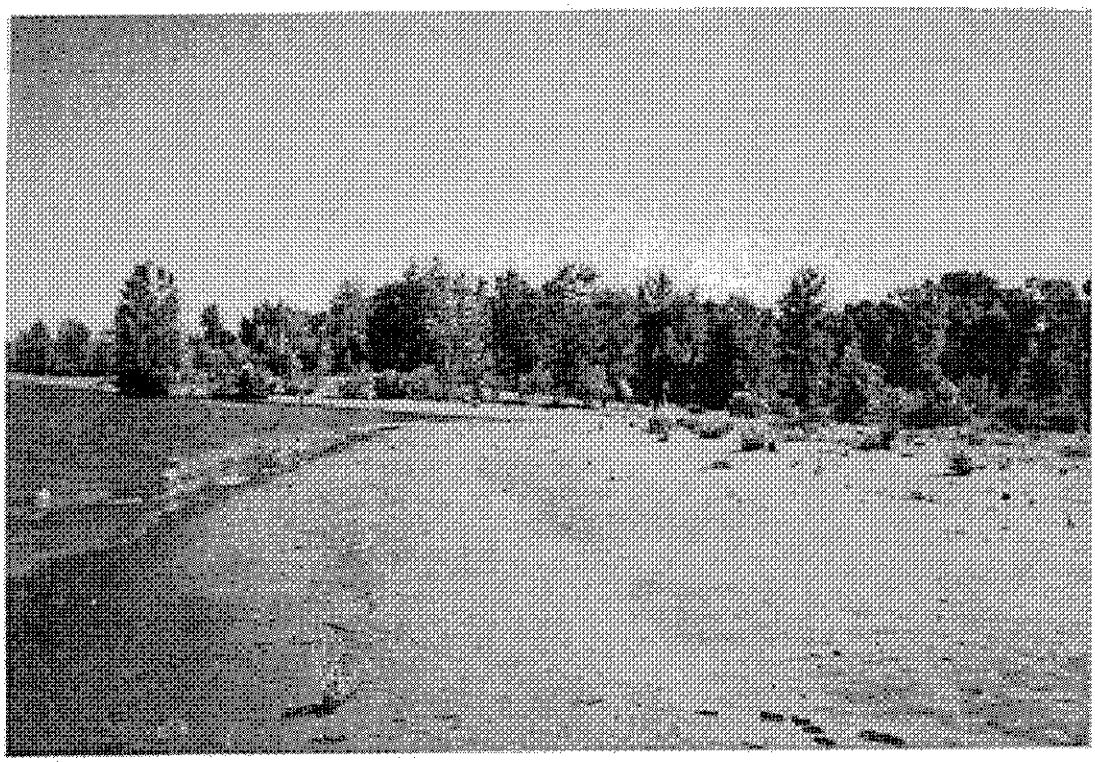
Appendix Figure 8. County Line Park reach break between Reach 1 and Reach 2 (upstream)

Appendix Figure 9. County Line Park Reach 2 looking upstream.

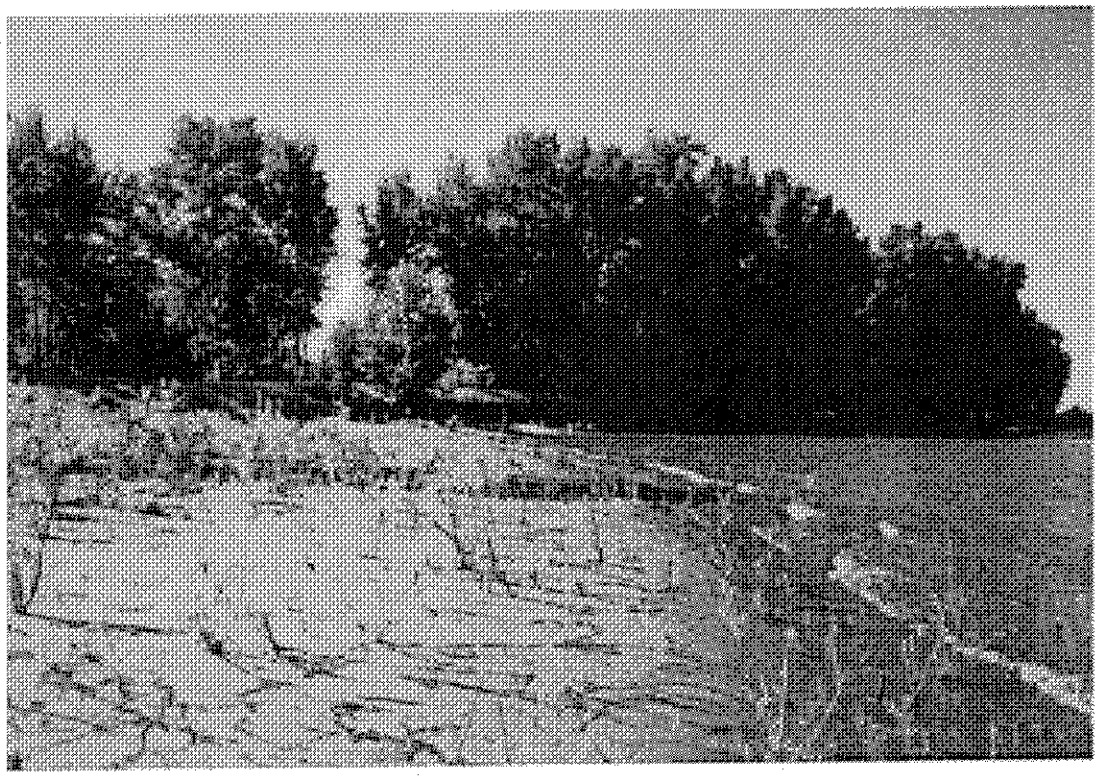


Appendix Figure 10. County Line Park Reach 3 looking upstream.

Appendix Figure 11. Sauvie Island Reach 1 looking downstream.



Appendix Figure 12. Sauvie Island Reach 1 looking upstream.



Appendix Figure 13. Sauvie Island Reach 2 looking downstream.

Appendix C: Vessel data

Appendix Table 2. Vessel data

Location	Date	Vessel Name	Pass #	Est. Speed (knots)	Direction	Drawdown (m)	Max Wake (m)	Amplitude (m)	Ship Length (m)	Draft (m)	Type	Est. Depth	Dist to Shore (m)	Comment
County Line	24-Jun	Skaugran	3	--	US	0.5	0.4	0.9	183	8.7	CAR	15.1	331	No picture taken, missed upstream speed gate time
County Line	24-Jun	Bright State	4	10.476	US	0.1	0.2	0.3	138	--	GC	15.3	331	River pilots did not have draft on this ship
County Line	24-Jun	TugCL1	5	7.128	US	0	0.2	0.2	--	--	TUG	15.3	331	Tug pulling a container barge
County Line	24-Jun	Joint Spirit	7	9.396	DS	0.3	0.1	0.4	152	10.4	BC	15.7	238	
County Line	24-Jun	BargeCL1	9	4.536	US	0.7	0.5	1.2	--	--	TUG	15.9	331	Tug pushing a container barge, crossed paths with Westwood Marianne in survey area
County Line	24-Jun	Westwood Marianne	9	11.178	DS	0.7	0.5	1.2	200	9.0	BC	15.9	238	Crossed paths with Barge 1 in survey area
County Line	24-Jun	TugCL2	10	--	DS	0	0.3	0.3	--	--	TUG	15.8	238	Tug named Ernst Campbell, towing barge named Energizer, no speed obtained
County Line	24-Jun	Chevron Colorado	11	10.476	DS	0.4	0.4	0.8	198	7.9	OT	15.8	238	
County Line	24-Jun	General Villa	13	7.722	US	0.1	0.3	0.4	175	7.6	BC	15.0	331	Too dark for picture
County Line	24-Jun	Kapitan Afanasyev	14	--	US	0.3	0.3	0.6	184	8.5	CS	15.0	331	Too dark for speed or picture
County Line	24-Jun	TugCL3	15	--	DS	--	--	--	--	--	TUG	15.0	238	Too dark for picture, speed, or load status. Ship snuck up on us, no wake measurements
County Line	24-Jun	Maersk Sun	16	--	DS	0.3	0.5	0.8	157	7.6	CAR	15.0	238	Too dark for speed or picture
County Line	24-Jun	Ken Shin	17	--	US	0.3	0.2	0.5	172	6.7	BC	15.0	331	Too dark for speed or picture
County Line	25-Jun	TugCL4	18	--	DS	0	0.2	0.2	--	--	TUG	16.1	238	Too dark for speed or picture
County Line	25-Jun	TugCL5	19	7.83	DS	0	0.1	0.1	--	--	TUG	16.0	238	Too dark for picture
County Line	25-Jun	BargeCL2	21	7.02	DS	0	0	0	--	--	TUG	15.5	238	Barge named Miki Hana
County Line	25-Jun	Ocean Duke	22	--	US	0	0.1	0.1	175	6.7	BC	15.0	331	No speed recorded
Sauvie Island	1-Jul	Hyundai # 108	2	9.342	DS	0.15	0.5	0.65	174	8.2	CAR	14.7	442	
Sauvie Island	1-Jul	Liberty Spirit	4	9.18	DS	0.4	0.4	0.8	225	10.7	BC	14.7	442	
Sauvie Island	1-Jul	BargeS1	5	6.426	DS	0	0.1	0.1	--	--	TUG	14.7	442	Carrying grain or sawdust
Sauvie Island	1-Jul	BargeS2	6	5.184	US	0	0.05	0.05	--	--	TUG	15.4	331	Barge named the Nancy Ann
Sauvie Island	1-Jul	BargeS3	8	3.618	US	0	0	0	--	--	TUG	15.5	331	Barge named Lissy Too
Sauvie Island	1-Jul	Star Kim	10	6.912	US	0.15	0.2	0.35	174	6.7	BC	15.5	331	
Sauvie Island	1-Jul	TugS1	11	5.832	DS	0	0.05	0.05	--	--	TUG	14.8	442	Tug named Pacific Sassanda. Too dark for picture
Sauvie Island	2-Jul	BargeS4	12	--	US	0	0.15	0.15	--	--	TUG	15.6	331	Too dark for speed or picture
Sauvie Island	2-Jul	Rhein Bridge	13	--	DS	0.6	0.4	1	276	11.1	CS	14.8	442	Too dark for speed or picture

Location	Date	Vessel Name	Pass #	Est. Speed (knots)	Direction	Drawdown (m)	Max Wake (m)	Amplitude (m)	Ship Length (m)	Draft (m)	Type	Est. Depth	Dist to Shore (m)	Comment
Sauvie Island	2-Jul	BargeS5	15	6.966	US	0	0.15	0.15	--	--	TUG	15.5	331	
Sauvie Island	2-Jul	Rubin Dragon	17	8.802	DS	0.1	0.4	0.5	169	6.1	BC	14.7	442	
Barlow Point	5-Jul	BargeBP1	2	14.85	DS	0	0.3	0.3	--	--	TUG	14.1	387	
Barlow Point	5-Jul	Green Lake	4	12.69	US	0.15	0.1	0.25	200	8.2	CAR	14.1	497	
Barlow Point	5-Jul	New Spirit	6	10.152	US	0.1	0.1	0.2	189	11.0	BC	14.3	497	
Barlow Point	5-Jul	Christoforo Columbo	8	11.124	US	0.3	0.2	0.5	207	10.4	CS	14.5	497	
Barlow Point	5-Jul	BargeBP2	10	4.212	US	--	--	--	--	--	TUG	14.4	497	No wake height because 3 yachts passed during vessel passage creating large wakes. Likely no wake would have been created because of slow speed. Barge named Sea Hawk and Pacific.
Barlow Point	5-Jul	BargeBP3	12	6.966	US	0	0.1	0.1	--	--	TUG	14.3	497	Barge labeled James River
Barlow Point	5-Jul	Twinkle	14	11.124	US	0.1	0.25	0.35	153	7.3	BC	14.1	497	
Barlow Point	5-Jul	Eternal Clipper	16	9.126	US	0.05	0.1	0.15	164	8.5	CAR	13.9	497	
Barlow Point	5-Jul	Petersfield	18	10.152	US	0.05	0.25	0.3	187	7.0	GC	14.2	497	Too dark for picture
Barlow Point	5-Jul	Perseverance	19	10.8	US	0	0.2	0.2	187	10.7	OT	14.2	497	Too dark for picture
Barlow Point	5-Jul	TugBP1	20	4.482	US	0	0	0	--	--	TUG	14.4	497	Too dark for picture
Barlow Point	5-Jul	TugBP2	22	--	US	0	0.2	0.2	--	--	TUG	14.7	497	Too dark for speed or picture
Barlow Point	29-Jul	Galena Bay	2	--	US	0.15	0.25	0.4	201	7.9	OT	13.6	497	No speed recorded
Barlow Point	29-Jul	Maple Ace II	4	13.176	US	0.25	0.15	0.4	188	8.2	CAR	13.3	497	
Barlow Point	29-Jul	TugBP3	5	--	DS	0	0.1	0.1	--	--	TUG	13.4	387	No speed recorded
Barlow Point	29-Jul	Ace Century	6	16.146	DS	0.1	0.1	0.2	177	9.8	BC	13.3	387	
Barlow Point	29-Jul	Sunny Success	7	16.146	DS	0.1	0	0.1	180	11.6	BC	13.3	387	Pass the same as for BargeBP4 because ships were so close together
Barlow Point	29-Jul	BargeBP4	7	18.738	DS	0	0.1	0.1	--	--	TUG	13.3	387	Pass the same as Sunny Success because the ships were so close together
Barlow Point	29-Jul	Ocean Duke	8	11.88	US	0.1	0.1	0.2	175	7.3	BC	13.0	497	
Barlow Point	29-Jul	Century Hwy No. 1	9	9.612	DS	0.3	0.2	0.5	186	7.9	CAR	13.5	387	
Barlow Point	29-Jul	Fulmar	10	16.956	DS	0.3	0.15	0.45	182	7.3	OT	13.7	387	
Barlow Point	29-Jul	Nena F	11	9.882	DS	0.3	0.3	0.6	182	7.0	BC	13.9	387	
Barlow Point	29-Jul	Chevron Colorado	13	11.502	US	0.1	0.25	0.35	198	10.4	OT	14.0	497	
Barlow Point	29-Jul	BargeBP5	15	8.91	US	0	0	0	--	--	TUG	14.3	497	
Barlow Point	29-Jul	Pactrader	17	10.8	US	0.1	0.35	0.45	169	7.9	BC	14.4	497	
Barlow Point	29-Jul	K + A	19	--	US	0.1	0.3	0.4	177	8.2	BC	14.2	497	Too dark for speed or picture

Location	Date	Vessel Name	Pass #	Est. Speed (knots)	Direction	Drawdown (m)	Max Wake (m)	Amplitude (m)	Ship Length (m)	Draft (m)	Type	Est. Depth	Dist to Shore (m)	Comment
Barlow Point	30-Jul	Fairy Queen	20	--	DS	0.4	0.2	0.6	190	12.1	BC	13.6	387	Too dark for speed or picture
Barlow Point	30-Jul	BargeBP6	21	--	US	0	0	0	--	--	TUG	13.6	497	Too dark for speed or picture
Barlow Point	30-Jul	New York Hwy.	23	--	US	0.35	0.05	0.4	--	8.5	CAR	14.0	497	Not enough time before Ansaz & Serity to do pass. Too dark for speed or picture
Barlow Point	30-Jul	Ansax & Serity	23	--	DS	0.35	0.2	0.55	--	10.1	BC	14.3	387	Not enough time in after New York Hwy to do pass. Too dark for speed or picture
Sauvie Island	2-Aug	Blue Ridge	1	--	US	0.5	0.3	0.8	201	8.5	OT	14.5	331	Ship passed just as we arrived on site, no time for speed or picture.
Sauvie Island	2-Aug	BargeS6	3	11.124	DS	0	0.15	0.15	--	--	TUG	13.8	442	
Sauvie Island	2-Aug	Ankora	5	7.776	DS	0.25	0.15	0.4	169	10.3	BC	13.8	442	
Sauvie Island	2-Aug	Green Lake	6	8.046	US	0.5	0.55	1.05	200	8.8	CAR	14.6	331	
Sauvie Island	2-Aug	BargeS7	8	7.02	US	0	0.15	0.15	--	--	TUG	14.6	331	
Sauvie Island	2-Aug	BargeS8	10	5.508	DS	0	0.1	0.1	--	--	TUG	13.8	442	
Sauvie Island	2-Aug	Lantau Queen	12	8.64	DS	0.15	0.4	0.55	186	6.7	BC	13.7	442	
Sauvie Island	2-Aug	Ocean Rose	14	8.046	DS	0.1	0.3	0.4	157	6.4	BC	13.7	442	
Sauvie Island	2-Aug	BargeS9	15	8.424	US	0	0.2	0.2	--	--	TUG	14.4	331	
Sauvie Island	2-Aug	BargeS10	16	5.454	DS	0	0.2	0.2	--	--	TUG	13.7	442	
Sauvie Island	2-Aug	TugS2	18	--	DS	0	0.3	0.3	--	--	TUG	13.9	442	Too dark for speed or picture
Sauvie Island	2-Aug	Serifopoulo	19	--	DS	0.25	0.1	0.35	183	7.3	OT	14.0	442	Too dark for speed or picture
Sauvie Island	3-Aug	Pan Hope	20	--	US	0.05	0.15	0.2	164	6.9	BC	15.0	331	Too dark for speed or picture
Sauvie Island	3-Aug	BargeS11	21	--	US	0	0.15	0.15	--	--	TUG	15.0	331	Too dark for speed or picture
Sauvie Island	3-Aug	Moldanger	22	--	US	0.5	0.3	0.8	180	11.2	OT	15.0	331	Too dark for speed or picture
Sauvie Island	3-Aug	Anangel Progress	23	--	US	0.4	0.2	0.6	225	6.4	BC	15.0	331	Too dark for speed or picture
County Line	31-Jul	Hyundai Admiral	2	8.532	US	0.45	0.45	0.9	275	11.2	CS	14.1	331	
County Line	31-Jul	Hyundai # 103	4	10.908	US	0.3	0.2	0.5	184	8.5	CAR	13.7	331	
County Line	31-Jul	TugCL6	6	8.91	DS	0	0.2	0.2	--	--	TUG	13.7	238	
County Line	31-Jul	Maersk Sun	8	12.204	DS	0.25	0.45	0.7	158	7.0	CAR	13.9	238	
County Line	31-Jul	BargeCL3	10	4.968	US	0	0.2	0.2	--	--	TUG	14.3	331	
County Line	31-Jul	Laurel Island	12	9.342	DS	0.35	0.15	0.5	169	9.8	BC	14.7	238	Pactrader so close behind that it may have influenced the max wake measurement for this ship.
County Line	31-Jul	Pactrader	12	10.098	DS	0.2	0.4	0.6	169	5.7	BC	14.9	238	Not enough time between this and Laurel Island to do separate passes.

Location	Date	Vessel Name	Pass #	Est. Speed (knots)	Direction	Drawdown (m)	Max Wake (m)	Amplitude (m)	Ship Length (m)	Draft (m)	Type	Est. Depth	Dist to Shore (m)	Comment
County Line	31-Jul	Pacific Ace	13	--	DS	--	--	--	150	10.4	BC	15.0	238	Too dark to read guage with naked eye, not dark enough to get reflection from flashlight, too dark for speed or picture. Visual observation indicated little change in guage levels from pass of vessel.
County Line	31-Jul	Cielo de Vancouver	13	--	DS	0.45	0.6	1.05	185	9.8	BC	15.1	238	Too dark for speed or picture. Too close to Pacific Ace to do pass between.
County Line	31-Jul	BargeCL4	15	--	DS	0	0.05	0.05	--	--	TUG	14.9	238	Too dark for speed or picture, or to tell load status.
County Line	31-Jul	TugCL7	17	--	DS	0	0.2	0.2	--	--	TUG	14.3	238	Too dark for speed or picture, or to tell load status.
County Line	1-Aug	BargeCL5	19	--	US	0	0	0	--	--	TUG	14.1	331	Too dark for speed or picture.
County Line	1-Aug	Hanjin Osaka	20	--	US	0.6	0.4	1	290	9.3	CS	14.1	331	Too dark for speed or picute.
County Line	1-Aug	TugCL8	21	--	DS	0	0.2	0.2	--	--	TUG	14.0	238	Too dark for speed or picute.
County Line	1-Aug	Serena	22	--	DS	0.4	0.3	0.7	200	7.7	GC	13.8	238	Too dark for speed or picute. Technical difficulties, no wake profile.
County Line	1-Aug	Seven Seas	23	--	US	0.2	0.2	0.4	157	5.8	BC	13.8	331	Too dark for speed or picute.
County Line	1-Aug	Pactrader	24	--	US	0.3	0.2	0.5	169	5.7	BC	13.8	331	Too dark for speed or picute.

Appendix D: Fish stranding data

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
County Line Park	24-Jun	1	INITIAL	--	12:25	12:40	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	1	INITIAL	--	12:25	12:40	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	1	INITIAL	--	12:25	12:40	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	2	PRE	--	13:34	13:36	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	2	PRE	--	13:34	13:36	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	2	PRE	--	13:34	13:36	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	3	VESSEL	Skaugran	13:46	13:52	1	0	0	0	0	0	0	0	0	0	1
County Line Park	24-Jun	3	VESSEL	Skaugran	13:46	13:52	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	3	VESSEL	Skaugran	13:46	13:52	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	4	VESSEL	Bright State	14:10	14:16	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	4	VESSEL	Bright State	14:10	14:16	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	4	VESSEL	Bright State	14:10	14:16	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	5	VESSEL	TugCL1	14:30	14:38	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	5	VESSEL	TugCL1	14:30	14:38	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	5	VESSEL	TugCL1	14:30	14:38	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	6	PRE	--	14:58	15:00	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	6	PRE	--	14:58	15:00	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	6	PRE	--	14:58	15:00	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	7	VESSEL	Joint Spirit	15:08	15:18	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	7	VESSEL	Joint Spirit	15:08	15:18	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	7	VESSEL	Joint Spirit	15:08	15:18	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	8	PRE	--	15:50	15:57	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	8	PRE	--	15:50	15:57	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	8	PRE	--	15:50	15:57	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	9	VESSEL	BargeCL1 & Westwood Marianne	16:10	16:14	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	9	VESSEL	BargeCL1 & Westwood Marianne	16:10	16:14	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	9	VESSEL	BargeCL1 & Westwood Marianne	16:10	16:14	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	10	VESSEL	TugCL2	16:30	16:40	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	10	VESSEL	TugCL2	16:30	16:40	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killfish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
County Line Park	24-Jun	10	VESSEL	TugCL2	16:30	16:40	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	11	VESSEL	Chevron Colorado	16:50	16:55	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	11	VESSEL	Chevron Colorado	16:50	16:55	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	11	VESSEL	Chevron Colorado	16:50	16:55	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	12	PRE	--	21:21	21:26	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	12	PRE	--	21:21	21:26	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	12	PRE	--	21:21	21:26	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	13	VESSEL	General Villa	21:37	21:43	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	13	VESSEL	General Villa	21:37	21:43	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	13	VESSEL	General Villa	21:37	21:43	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	14	VESSEL	Kapitan Afansayev	21:50	22:04	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	14	VESSEL	Kapitan Afansayev	21:50	22:04	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	14	VESSEL	Kapitan Afansayev	21:50	22:04	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	15	VESSEL	TugCL3	22:20	22:34	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	15	VESSEL	TugCL3	22:20	22:34	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	15	VESSEL	TugCL3	22:20	22:34	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	16	VESSEL	Maersk Sun	22:57	22:58	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	16	VESSEL	Maersk Sun	22:57	22:58	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	16	VESSEL	Maersk Sun	22:57	22:58	3	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	17	VESSEL	Ken Shin	23:05	23:13	1	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	17	VESSEL	Ken Shin	23:05	23:13	2	0	0	0	0	0	0	0	0	0	0
County Line Park	24-Jun	17	VESSEL	Ken Shin	23:05	23:13	3	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	18	VESSEL	TugCL4	4:29	4:32	1	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	18	VESSEL	TugCL4	4:29	4:32	2	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	18	VESSEL	TugCL4	4:29	4:32	3	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	19	VESSEL	TugCL5	4:52	4:32	1	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	19	VESSEL	TugCL5	4:52	4:32	2	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	19	VESSEL	TugCL5	4:52	4:32	3	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	20	PRE	--	7:27	7:33	1	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	20	PRE	--	7:27	7:33	2	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	20	PRE	--	7:27	7:33	3	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	21	VESSEL	BargeCL2	7:47	7:52	1	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	21	VESSEL	BargeCL2	7:47	7:52	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
County Line Park	25-Jun	21	VESSEL	BargeCL2	7:47	7:52	3	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	22	VESSEL	Ocean Duke	9:06	9:13	1	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	22	VESSEL	Ocean Duke	9:06	9:13	2	0	0	0	0	0	0	0	0	0	0
County Line Park	25-Jun	22	VESSEL	Ocean Duke	9:06	9:13	3	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	1	INITIAL	--	14:13	14:19	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	1	INITIAL	--	14:13	14:19	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	2	VESSEL	Hundai # 108	14:29	14:34	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	2	VESSEL	Hundai # 108	14:29	14:34	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	3	PRE	--	17:40	17:44	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	3	PRE	--	17:40	17:44	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	4	VESSEL	Liberty Spirit	17:58	18:05	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	4	VESSEL	Liberty Spirit	17:58	18:05	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	5	VESSEL	BargeS1	18:12	18:17	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	5	VESSEL	BargeS1	18:12	18:17	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	6	VESSEL	BargeS2	18:27	18:32	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	6	VESSEL	BargeS2	18:27	18:32	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	7	PRE	--	20:24	20:27	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	7	PRE	--	20:24	20:27	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	8	VESSEL	BargeS3	20:36	20:41	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	8	VESSEL	BargeS3	20:36	20:41	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	9	PRE	--	21:06	21:08	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	9	PRE	--	21:06	21:08	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	10	VESSEL	Star Kim	21:17	21:21	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	10	VESSEL	Star Kim	21:17	21:21	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	11	VESSEL	TugS1	21:37	21:42	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	1-Jul	11	VESSEL	TugS1	21:37	21:42	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	12	VESSEL	BargeS4	0:01	0:09	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	12	VESSEL	BargeS4	0:01	0:09	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	13	VESSEL	Rhein Bridge	3:08	3:25	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	13	VESSEL	Rhein Bridge	3:08	3:25	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	14	PRE	--	5:38	5:40	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	14	PRE	--	5:38	5:40	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	15	VESSEL	BargeS5	5:48	5:52	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	15	VESSEL	BargeS5	5:48	5:52	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
Sauvie Island	2-Jul	16	PRE	--	7:26	7:29	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	16	PRE	--	7:26	7:29	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	17	VESSEL	Rubin Dragon	7:45	7:49	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Jul	17	VESSEL	Rubin Dragon	7:45	7:49	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	1	INITIAL	--	9:24	9:28	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	1	INITIAL	--	9:24	9:28	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	2	VESSEL	BargeBP1	9:50	9:55	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	2	VESSEL	BargeBP1	9:50	9:55	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	3	PRE	--	11:04	11:06	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	3	PRE	--	11:04	11:06	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	4	VESSEL	Green Lake	11:26	11:32	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	4	VESSEL	Green Lake	11:26	11:32	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	5	PRE	--	12:04	12:07	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	5	PRE	--	12:04	12:07	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	6	VESSEL	New Spirit	12:20	12:28	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	6	VESSEL	New Spirit	12:20	12:28	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	7	PRE	--	12:44	12:51	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	7	PRE	--	12:44	12:51	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	8	VESSEL	Christoforo Columbo	13:13	13:20	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	8	VESSEL	Christoforo Columbo	13:13	13:20	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	9	PRE	--	14:10	14:13	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	9	PRE	--	14:10	14:13	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	10	VESSEL	BargeBP2	14:23	14:28	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	10	VESSEL	BargeBP2	14:23	14:28	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	11	PRE	--	15:55	15:57	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	11	PRE	--	15:55	15:57	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	12	VESSEL	BargeBP3	16:06	16:10	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	12	VESSEL	BargeBP3	16:06	16:10	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	13	PRE	--	17:19	17:22	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	13	PRE	--	17:19	17:22	2	0	0	0	0	0	0	0	0	2	0
Barlow Point	5-Jul	14	VESSEL	Twinkle	17:34	17:39	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	14	VESSEL	Twinkle	17:34	17:39	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	15	PRE	--	18:27	18:31	1	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
Barlow Point	5-Jul	15	PRE	--	18:27	18:31	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	16	VESSEL	Eternal Clipper	18:41	18:45	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	16	VESSEL	Eternal Clipper	18:41	18:45	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	17	PRE	--	20:41	20:47	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	17	PRE	--	20:41	20:47	2	0	0	1	0	0	0	0	0	0	0
Barlow Point	5-Jul	18	VESSEL	Petersfield	20:59	21:03	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	18	VESSEL	Petersfield	20:59	21:03	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	19	VESSEL	Perseverance	21:32	21:39	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	19	VESSEL	Perseverance	21:32	21:39	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	20	VESSEL	TugBP1	21:56	22:01	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	20	VESSEL	TugBP1	21:56	22:01	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	21	PRE	--	22:44	22:46	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	21	PRE	--	22:44	22:46	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	22	VESSEL	TugBP2	22:55	22:59	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	5-Jul	22	VESSEL	TugBP2	22:55	22:59	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	1	INITIAL	--	10:43	10:48	1	0	0	0	0	0	0	0	1	0	0
Barlow Point	29-Jul	1	INITIAL	--	10:43	10:48	2	0	0	3	0	0	0	0	0	0	0
Barlow Point	29-Jul	2	VESSEL	Galena Bay	10:59	11:08	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	2	VESSEL	Galena Bay	10:59	11:08	2	0	0	9	0	0	0	0	1	0	0
Barlow Point	29-Jul	3	PRE	--	12:42	12:49	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	3	PRE	--	12:42	12:49	2	0	0	2	0	0	0	0	0	0	0
Barlow Point	29-Jul	4	VESSEL	Mapel Ace II	12:57	13:10	1	0	0	2	0	0	0	0	0	0	0
Barlow Point	29-Jul	4	VESSEL	Mapel Ace II	12:57	13:10	2	0	0	3	0	0	0	0	0	0	0
Barlow Point	29-Jul	5	VESSEL	TugBP3	14:20	14:25	1	0	0	2	0	0	0	0	0	0	0
Barlow Point	29-Jul	5	VESSEL	TugBP3	14:20	14:25	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	6	VESSEL	Ace Century	14:38	14:42	1	0	0	2	0	0	0	0	0	0	0
Barlow Point	29-Jul	6	VESSEL	Ace Century	14:38	14:42	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	7	VESSEL	Sunny Success & BargeBP4	14:53	15:00	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	7	VESSEL	Sunny Success & BargeBP4	14:53	15:00	2	0	0	1	0	0	0	0	0	0	0
Barlow Point	29-Jul	8	VESSEL	Ocean Duke	15:19	15:25	1	0	0	1	0	0	0	0	0	0	0
Barlow Point	29-Jul	8	VESSEL	Ocean Duke	15:19	15:25	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
Barlow Point	29-Jul	9	VESSEL	Century Hwy. #1	15:53	16:13	1	0	0	5	0	5	3	0	4	0	2
Barlow Point	29-Jul	9	VESSEL	Century Hwy. #1	15:53	16:13	2	0	0	0	0	2	0	0	1	0	0
Barlow Point	29-Jul	10	VESSEL	Fulmar	17:07	17:17	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	10	VESSEL	Fulmar	17:07	17:17	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	11	VESSEL	Nena F	17:56	18:02	1	0	0	3	0	0	0	0	0	0	0
Barlow Point	29-Jul	11	VESSEL	Nena F	17:56	18:02	2	0	0	9	0	0	0	0	0	0	0
Barlow Point	29-Jul	12	PRE	--	18:39	18:43	1	0	0	1	0	0	0	0	0	0	0
Barlow Point	29-Jul	12	PRE	--	18:39	18:43	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	13	VESSEL	Chevron Colorado	18:56	19:02	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	13	VESSEL	Chevron Colorado	18:56	19:02	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	14	PRE	--	19:25	19:29	1	0	0	1	0	0	0	0	0	0	0
Barlow Point	29-Jul	14	PRE	--	19:25	19:29	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	15	VESSEL	BargeBP5	19:36	19:40	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	15	VESSEL	BargeBP5	19:36	19:40	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	16	PRE	--	20:03	20:05	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	16	PRE	--	20:03	20:05	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	17	VESSEL	Pactrader	20:13	20:18	1	0	0	0	0	0	0	0	1	0	0
Barlow Point	29-Jul	17	VESSEL	Pactrader	20:13	20:18	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	18	PRE	--	21:21	21:26	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	18	PRE	--	21:21	21:26	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	19	VESSEL	K + A	21:34	21:45	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	29-Jul	19	VESSEL	K + A	21:34	21:45	2	1	0	1	1	0	0	0	0	0	0
Barlow Point	30-Jul	20	VESSEL	Fairy Queen	3:44	4:10	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	30-Jul	20	VESSEL	Fairy Queen	3:44	4:10	2	10	0	50	3	2	0	0	0	3	0
Barlow Point	30-Jul	21	VESSEL	BargeBP6	4:24	4:34	1	0	0	0	0	0	0	0	0	1	0
Barlow Point	30-Jul	21	VESSEL	BargeBP6	4:24	4:34	2	1	0	0	0	0	0	0	0	0	0
Barlow Point	30-Jul	22	PRE	--	4:56	5:04	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	30-Jul	22	PRE	--	4:56	5:04	2	0	0	0	0	0	0	0	0	0	0
Barlow Point	30-Jul	23	VESSEL	New York Hwy. + Ansax & Serity	5:18	5:24	1	0	0	0	0	0	0	0	0	0	0
Barlow Point	30-Jul	23	VESSEL	New York Hwy. + Ansax & Serity	5:18	5:24	2	0	0	8	3	0	0	0	1	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
Sauvie Island	2-Aug	1	VESSEL	Blue Ridge	9:34	9:39	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	1	VESSEL	Blue Ridge	9:34	9:39	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	2	PRE	--	10:41	10:45	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	2	PRE	--	10:41	10:45	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	3	VESSEL	BargeS6	10:51	10:55	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	3	VESSEL	BargeS6	10:51	10:55	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	4	PRE	--	11:46	11:49	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	4	PRE	--	11:46	11:49	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	5	VESSEL	Ankora	11:54	11:56	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	5	VESSEL	Ankora	11:54	11:56	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	6	VESSEL	Green Lake	12:04	12:16	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	6	VESSEL	Green Lake	12:04	12:16	2	0	0	0	3	2	9	5	0	0	9
Sauvie Island	2-Aug	7	PRE	--	13:10	13:12	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	7	PRE	--	13:10	13:12	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	8	VESSEL	BargeS7	13:17	13:21	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	8	VESSEL	BargeS7	13:17	13:21	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	9	PRE	--	14:51	14:53	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	9	PRE	--	14:51	14:53	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	10	VESSEL	BargeS8	15:00	15:05	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	10	VESSEL	BargeS8	15:00	15:05	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	11	PRE	--	18:14	18:17	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	11	PRE	--	18:14	18:17	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	12	VESSEL	Lantau Queen	18:23	18:27	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	12	VESSEL	Lantau Queen	18:23	18:27	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	13	PRE	--	19:37	19:40	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	13	PRE	--	19:37	19:40	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	14	VESSEL	Ocean Rose	19:48	19:51	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	14	VESSEL	Ocean Rose	19:48	19:51	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	15	VESSEL	BargeS9	20:00	20:04	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	15	VESSEL	BargeS9	20:00	20:04	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	16	VESSEL	BargeS10	20:13	20:17	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	16	VESSEL	BargeS10	20:13	20:17	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	17	PRE	--	21:30	21:33	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	17	PRE	--	21:30	21:33	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
Sauvie Island	2-Aug	18	VESSEL	TugS2	21:37	21:40	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	18	VESSEL	TugS2	21:37	21:40	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	19	VESSEL	Serifopoulo	23:22	23:26	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	2-Aug	19	VESSEL	Serifopoulo	23:22	23:26	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	20	VESSEL	Pan Hope	0:01	0:06	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	20	VESSEL	Pan Hope	0:01	0:06	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	21	VESSEL	BargeS11	0:15	0:21	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	21	VESSEL	BargeS11	0:15	0:21	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	22	VESSEL	Moldanger	1:20	1:27	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	22	VESSEL	Moldanger	1:20	1:27	2	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	23	VESSEL	Anangel Progress	3:29	3:38	1	0	0	0	0	0	0	0	0	0	0
Sauvie Island	3-Aug	23	VESSEL	Anangel Progress	3:29	3:38	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	1	INITIAL	--	11:50	11:54	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	1	INITIAL	--	11:50	11:54	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	1	INITIAL	--	11:50	11:54	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	2	VESSEL	Hyundai Admiral	12:06	12:13	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	2	VESSEL	Hyundai Admiral	12:06	12:13	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	2	VESSEL	Hyundai Admiral	12:06	12:13	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	3	PRE	--	14:31	14:35	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	3	PRE	--	14:31	14:35	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	3	PRE	--	14:31	14:35	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	4	VESSEL	Hyundai #103	14:44	14:50	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	4	VESSEL	Hyundai #103	14:44	14:50	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	4	VESSEL	Hyundai #103	14:44	14:50	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	5	PRE	--	15:14	15:20	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	5	PRE	--	15:14	15:20	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	5	PRE	--	15:14	15:20	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	6	VESSEL	TugCL6	15:27	15:30	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	6	VESSEL	TugCL6	15:27	15:30	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	6	VESSEL	TugCL6	15:27	15:30	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	7	PRE	--	16:20	16:24	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	7	PRE	--	16:20	16:24	2	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killifish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
County Line Park	31-Jul	7	PRE	--	16:20	16:24	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	8	VESSEL	Maersk Sun	16:33	16:41	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	8	VESSEL	Maersk Sun	16:33	16:41	2	0	0	0	0	0	0	0	1	0	0
County Line Park	31-Jul	8	VESSEL	Maersk Sun	16:33	16:41	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	9	PRE	--	17:22	17:26	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	9	PRE	--	17:22	17:26	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	9	PRE	--	17:22	17:26	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	10	VESSEL	BargeCL3	17:35	17:38	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	10	VESSEL	BargeCL3	17:35	17:38	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	10	VESSEL	BargeCL3	17:35	17:38	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	11	PRE	--	18:53	18:57	1	0	0	1	0	0	0	0	0	0	0
County Line Park	31-Jul	11	PRE	--	18:53	18:57	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	11	PRE	--	18:53	18:57	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	12	VESSEL	Laurel Island & Pactrader	19:09	19:16	1	0	0	1	0	0	0	0	0	0	0
County Line Park	31-Jul	12	VESSEL	Laurel Island & Pactrader	19:09	19:16	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	12	VESSEL	Laurel Island & Pactrader	19:09	19:16	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	13	VESSEL	Pacific Ace & Cielo de Vancouver	20:59	21:08	1	1	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	13	VESSEL	Pacific Ace & Cielo de Vancouver	20:59	21:08	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	13	VESSEL	Pacific Ace & Cielo de Vancouver	20:59	21:08	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	14	PRE	--	22:19	22:19	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	14	PRE	--	22:19	22:19	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	14	PRE	--	22:19	22:19	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	15	VESSEL	BargeCL4	22:36	22:46	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	15	VESSEL	BargeCL4	22:36	22:46	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	15	VESSEL	BargeCL4	22:36	22:46	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	16	PRE	--	23:30	23:34	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	16	PRE	--	23:30	23:34	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	16	PRE	--	23:30	23:34	3	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	17	VESSEL	TugCL7	23:42	23:48	1	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	17	VESSEL	TugCL7	23:42	23:48	2	0	0	0	0	0	0	0	0	0	0
County Line Park	31-Jul	17	VESSEL	TugCL7	23:42	23:48	3	0	0	0	0	0	0	0	0	0	0

Location	Date	Pass #	Pass Reason	Vessel	Start Time	End Time	Reach	Unclipped Chinook	Unknown Chinook	3-Spined Stickleback	Eastern Killfish	Common Carp	Yellow Perch	LM Bass	SM Bass	Sculpin	Peamouth
County Line Park	1-Aug	18	PRE	--	0:45	0:49	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	18	PRE	--	0:45	0:49	2	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	18	PRE	--	0:45	0:49	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	19	VESSEL	BargeCL5	0:56	0:58	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	19	VESSEL	BargeCL5	0:56	0:58	2	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	19	VESSEL	BargeCL5	0:56	0:58	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	20	VESSEL	Hanjin Osaka	1:10	1:35	1	1	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	20	VESSEL	Hanjin Osaka	1:10	1:35	2	2	1	2	0	0	0	0	0	0	0
County Line Park	1-Aug	20	VESSEL	Hanjin Osaka	1:10	1:35	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	21	VESSEL	TugCL8	1:46	1:50	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	21	VESSEL	TugCL8	1:46	1:50	2	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	21	VESSEL	TugCL8	1:46	1:50	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	22	VESSEL	Serena	2:45	3:00	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	22	VESSEL	Serena	2:45	3:00	2	4	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	22	VESSEL	Serena	2:45	3:00	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	23	VESSEL	Seven Seas	3:05	3:10	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	23	VESSEL	Seven Seas	3:05	3:10	2	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	23	VESSEL	Seven Seas	3:05	3:10	3	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	24	VESSEL	Pactrader	3:30	3:36	1	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	24	VESSEL	Pactrader	3:30	3:36	2	0	0	0	0	0	0	0	0	0	0
County Line Park	1-Aug	24	VESSEL	Pactrader	3:30	3:36	3	0	0	0	0	0	0	0	0	0	0