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Effects of Flow on the Migratory Behavior and Survival of Juvenile Fall and Summer Chinook Salmon in John Day Reservoir

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ABSTRACT

Research was conducted by NMFS in 1981 to define the effects of instream flows on the passage time, survival, and migrational behavior of 0-age chinook salmon in John Day Reservoir. Fourteen groups (74,683 fish) of marked 0-age chinook salmon were wire-tagged, branded, and released into the tailrace at McNary Dam, fourteen groups (13,746 fish) were branded and released into the reservoir at River Kilometer 375, and 34 groups (14,273) were branded and released into the reservoir at various other sites. More than 55,000 0-age chinook salmon were sampled at the John Day Dam airlift facility. This sample included 623 mark recoveries. Four hundred and eight (408) additional marks were recovered from purse seine samples taken at various sites throughout the reservoir. The average passage time of marked 0-age chinook salmon released in the McNary tailrace was 22 days in 1981. There was no statistically significant evidence to indicate that instream flows affected either the rate of movement or residence time of 0-age chinook salmon in John Day Reservoir in 1981.

INTRODUCTION

Regulation of the Columbia River system for power production has had an adverse effect on salmon and steelhead runs. In response to this problem, the fisheries agencies have developed minimum instream flow recommendations and have at times requested special flows during periods of peak juvenile migration to enhance fish passage through the system. Scientific evidence supporting these actions is based for the most part on data relating to yearling spring chinook salmon and steelhead smolt migrations (Raymond 1979; Sims and Ossiander 1981). Minimum in-stream summer flow recommendations and requests for summer fish flows have been made based on the assumption that the fish passage enhancement benefits of increased flows demonstrated for yearling spring chinook salmon smolts apply equally to 0-age chinook salmon migrationg during the summer. This may or may not in fact be true.

Past research has shown that even during high-flow years, large numbers of juvenile summer and fall chinook salmon remain for considerable periods of time in John Day Reservoir (Raymond et al. 1975; Sims et al. 1976). The reason for this is not known, but it is suspected that a significant number of 0-age chinook salmon entering the reservoir are not smolting. In the past, length frequencies at McNary and John Day Dams have shown the average size of fish leaving the reservoir to be considerably larger than those entering. This indicates an extended period of reservoir rearing not representative of smolting fish. It is also possible that many of the fish that are smolting revert to parr after entering the reservoir. Zaugg et al. (1972) found that smolting steelhead reverted to parr if exposed for significant periods to water temperatures

above 54°F. Water temperatures are usually above 60°F when the 0-age chinook salmon migration begins to enter John Day Reservoir in early July. By mid-August water temperatures approach 76°F.

There is little evidence to support the assumption that delays in John Day Reservoir adversely affect the survival of 0-age chinook salmon. On the contrary, adult returns of fall and summer chinook salmon stocks in the mid-Columbia River have not declined at the rate of spring chinook salmon and steelhead stocks. It is possible that the extended periods of rearing in John Day Reservoir actually benefit 0-age chinook salmon survival.

If increased summer in-stream flows do not significantly reduce 0-age chinook salmon residence time in John Day Reservoir, or if reduced residence time in the reservoir does not result in increased survival, recommended summer in-stream flows could be reduced and special fish flows eliminated. This would provide Bonneville Power Administration (BPA) with additional water management flexibility and result in significant savings of water which could be used to augment flows during critical periods of the spring migration and provide additional power production.

Research was started by the National Marine Fisheries Service (NMFS) (under contract to BPA) in June 1981 to define the effect of flow on the migratory behavior and survival of juvenile fall and summer chinook salmon in John Day Reservoir. The objectives of this research were to: (1) define the effect of in-stream flow on the passage time of 0-age chinook salmon in John Day Reservoir, (2) define the relationship between reservoir passage time and the survival of 0-age chinook salmon in John Day Reservoir, and (3) define the effect of in-stream flow levels on the distribution and behavoir of 0-age chinook salmon in John Day Reservoir.

In 1981, research activities concentrated on the development of purse seine sampling techniques needed to define 0-age chinook salmon

distribution and behavior in John Day Reservior and on releasing and recapturing marked fish needed to define flow/travel time relationships. This report summarizes 1981 research activities.

METHODS

Groups of 0-age chinook salmon from early (15-29 June), middle (10 July-3 August), and late (10-26 August) segments of the 1981 migration entering John Day Reservoir were collected at McNary Dam, wire-tagged, freeze branded, and released into the tailrace below the dam. Recoveries of these marks from the airlift fish collection facility at John Day Dam (Sims et al. 1981) were used to define reservoir travel and residence time.

Travel time for each release group was computed based on the first 25% of mark recoveries. This ensured that travel time estimates for each release group were based on actively migrating fish and adjusted for the possibility that later release groups may contain larger percentages of nonsmolting fish than earlier releases. Average in-stream flows affecting each release group were calculated by averaging the daily river discharge at McNary Dam for the 10-d period following each release. Regression analysis was used to define the significance of travel time/flow relationships.

Residence time was calculated from the mean of the mark recoveries from each group. This ensured that the slower nonsmolting fish were included in the computation. The residence times calculated must be considered as minimum since they were based only on recoveries at John Day Dam through 17 December. Surviving fish still in the reservoir were not included. Subsequent recaptures, if any, at John Day Dam in the spring and summer of 1982 will increase the average residence time calculations.

An 11 m power block seiner (NMFS research vessel Columbia) was used to purse seine sample John Day Reservoir throughout the summer and fall of fall of 1981. Purse seine fishing techniques were generally as described by Johnsen and Sims (1973). Sampling extended from the forebay at John Day Dam [River Kilometer (RKm) 348] to the McNary Dam tailrace (RKm 470). Nine sampling sites were established (Table 1). These sites were grouped into three major areas of the reservoir: lower (RKm 348-380), middle (RKm 381-433), and upper (RKm 434-470). Recoveries of marked fish in the purse seine from releases in the McNary Dam tailrace, at RKm 375, and from the Columbia were used to define 0-age chinook salmon distribution and migrational behavior in John Day Reservoir.

Purse seine catches were processed aboard the Columbia. Catches at John Day Dam were processed on site. All fish were anesthetized with MS-222, counted, and examined for marks. Those fish to be marked were freeze branded. A subsample was measured for fork-length. After processing, all fish were allowed to recover from the anesthetic and released. Fish marked on the Columbia were released on site, whereas fish marked at John Day Dam were released into the reservoir at RKm 375.

RESULTS AND DISCUSSION

A total of 102,702 0-age chinook salmon were marked and released into John Day Reservoir in 1981. Fourteen groups (74,683 fish) were wire-tagged, branded, and released into the tailrace at McNary Dam (Table 2). Of the 14 groups released, four group (17,723 fish) were released during the early migration (15-29 June), five groups (45,092) during the middle migration (10 July-3 August), and five groups (11,868 fish) during the late migration (10-26 August). Additional mark releases of 13,746 fish

Table 1.--Purse seine sampling site locations, John Day Reservoir, 1981.[a/]

River Kilometer	Area
348-351	John Day Dam forebay
359-364	Goodnoe
373-378	Blalock
385-390	Arlington
406-412	Willow Creek
422-431	Crow Butte
438-447	Coyote-Blalock Islands
454-459	Irrigon
462-469	Umatilla River - McNary tailrace

[a/] See Appendix B for location detail.

Table 2.--Summary of 0-age chinook salmon wire-tagged, cold branded, and released in the McNary Dam tailrace (16 June-26 August)[a/] and recovered at John Day Dam.

Brand[b/]	Median release date	Total released	Total recaptured	Date of 1st recapture	Mean recapture date	Date of last recapture	Minimum residence time (days)
LAID1	6/15	3,325	28	6/30	7/4	7/13	19
LAID2	6/18	4,654	44	6/25	7/8	8/8	20
LAID3	6/24	3,458	37	6/26	7/8	8/10	14
LAID4	6/29	6,286	38	7/4	7/10	8/7	11
LAIM1	7/10	10,115	79	7/14	8/5	12/17[d/]	26
LAIM3	7/16	10,143	65	7/24	8/13	11/16	28
LAIM2	7/22	10,012	50	7/27	8/9	10/23	18
LAIM4	7/29	12,310	64	7/31	8/23	11/12	25
LAUP1	8/3	2,512	11	8/8	8/14	9/8	11
LAUP3	8/10	2,663	15	8/21	9/18	12/17	39
LAUP4	8/13	2,545	12	8/21	9/20	12/17	38
LA3X1	8/17	2,547	10	8/21	9/4	9/20	18
LA3X2	8/20	2,536	22	8/25	9/19	12/17	30
LA3X3	8/26	1,577	6	8/31	9/15	9/28	19
	Total	74,683	481				

a/ Released at 2100 h.

b/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals $\overline{\text{ID}}$, 3 equals $\overline{\text{DI}}$ and 4 equals $\underline{\text{ID}}$).

c/ Difference between mean date of recovery and median release date.

d/ Last day of sampling.

were made at Blalock Canyon, RKm 375 (Table 3), and 14,273 fish from purse seine catches were marked and released at various sites in the reservoir (Table 4).

The airlift collection facility at John Day Dam captured 55,498 0-age chinook salmon between 31 May and 17 December 1981 (Table 5). Total passage of 0-age chinook salmon at John Day Dam during this period was estimated at 4.3 million fish (Sims et al. 1982). Airlift catches at John Day Dam included 481 marked fish from the McNary Dam tailrace releases, 107 marked fish from the Blalock releases, and 35 marked fish from purse seine releases. Detailed mark recovery information is included in Appendix Table A1.

Purse seine sampling began on 24 June and continued on a 3-d per week basis (when possible) through 11 November. In the 249 purse seine sets that were made, 17,437 0-age chinook salmon were taken (Table 6). Purse seine catches included 256 marks from the McNary Dam tailrace releases, 89 marks from the Blalock Canyon releases, and 63 marks from purse seine releases. Detailed purse seine mark recovery information is included in Appendix Table A2.

Incidental purse seine catches of species other than juvenile salmonids in John Day Reservoir are summarized in Table 7. Juvenile shad were by far the most abundant species taken; only small numbers of other species were taken. It is interesting to note that only 207 squawfish were caught over the entire season, and most of these were taken from the forebay area above John Day Dam.

Other types of fishing gear were used to sample shallow water areas of the reservoir where the purse seine could not be used. These included a tow net (61 x 122 cm), a mid-water trawl (6 x 6 m), and a beach seine (91 x 5 m). All proved ineffective, and no additional efforts with these types of gear appear warranted.

Table 3.--Summary of 0-age chinook salmon cold branded at John Day Dam and released into John Day Reservoir (Blalock Canyon RKm 375) 3 July-8 September 1981.

Mark[a/]	Release date	Number released
LAHE1	July 3	1,313
LASP1	July 6	721
RASP1	July 13	124
RASP2	July 14	543
RASP3	July 20	2,168
RASP4	July 21	929
RDSP1	July 22	613
RDSP2	July 27	2,370
RDSP3	Juy 28	1,424
RDSP4	July 29	952
LASP2	July 30	716
LASP3	August 8	895
LASP3	August 17	475
LDSP1	September 8	503
		13,746

[a/] Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals  , 3 equals , and 4 equals).

Table 4.--Summary of 0-age chinook salmon captured by purse seining, cold branded, and released at various locations in John Day Reservoir, 26 June-27 October 1981.

Mark[a/]	Release date	Number released	Release site(RKm)
LA01	June 26	177	351
LAX1	June 30	140	422
LAX2	July 1	565	388
LDX1	July 2	389	375
LAWV1	July 8	157	430
LAWV2	July 14	264	373
LAWV3	July 15	117	361
LAWV4	July 16	654	351
LDWV1	July 23	366	359
LDWV2	July 24	570	351
LDWV3	July 30	328	359
LDWV4	July 31	614	351
LPWV1	August 4	1,110	373
LPWV2	August 5	1,070	359
LPWV3	August 6	1,238	351
LPWV4	August 13	332	425
LAAR1	August 18	472	375
LAAR2	August 19	206	359
LDAR1	August 26	512	409
LDAR2	August 27	623	390
LPAR1	September 2	246	377
LPAR2	September 3	795	359

a/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals  , 3 equals  , and 4 equals ).

Table 4.--Continued

Mark [a]	Release date	Number released	Release site(RKm)
LAD1	September 10	522	425
LAD2	September 11	596	388
LAD3	September 15	268	377
LAD4	September 16	64	259
LDD1	September 23	327	425
LDD2	September 24	213	410
LDD3	September 25	212	390
LDD4	September 29	217	377
LPD1	October 15	135	377
LPD2	October 21	301	425
LPD3	October 22	297	390
LPD4	October 27	176	377
		14,273	

Table 5.--Weekly summary of sample catch and estimated passage of 0-age chinook salmon at John Day Dam, 31 May-19 December 1981.

Date	Catch	Estimated passage
5/31-6/06	429	70,849
6/07-6/14	1,250	193,636
6/14-6/20	1,181	185,154
6/21-6/27	553	89,066
6/28-7/04	6,274	642,423
7/05-7/11	2,220	258,993
7/12-7/18	5,377	472,928
7/19-7/25	5,625	356,107
7/26-8/01	11,906	822,755
8/02-8/08	7,006	569,097
8/09-8/15	3,624	185,688
8/16-8/22	3,012	165,564
8/23-8/29	566	29,031
8/30-9/05	997	40,979
9/06-9/12	1,007	36,824
9/13-9/19	712	23,411
9/20-9/26	619	23,038
9/27-10/03	511	20,280
10/04-10/10	293	12,014
10/11-10/17	194	8,098
10/18-10/24	108	4,546
10/25-10/31	160	6,639
11/01-11/07	196	7,254
11/08-11/14	138	6,349
11/15-11/21	345	15,500
11/22-11/28	200	8,333
11/29-12/05	336	14,545
12/06-12/12	185	10,278
12/13-12/17	474	27,558
Total	55,498	4,306,937

Table 6.--Summary of purse seine catches of 0-age chinook salmon in John Day Reservoir, June through November 1981.

Date	Area	No. sets	Total catch	Catch/set
June	Lower (RKm 348-380)	6	354	59
	Middle (RKm 381-434)	3	150	50
	Upper (RKm 435-476)	2	0	0
July	Lower	38	3,359	88
	Middle	20	1,171	59
	Upper	16	130	8
August	Lower	26	4,775	184
	Middle	20	2,043	102
	Upper	9	67	7
September	Lower	33	1,974	60
	Middle	18	1,992	111
	Upper	7	44	6
October	Lower	21	439	21
	Middle	11	631	57
	Upper	-	-	-
November	Lower	10	158	16
	Middle	9	150	17
	Upper	-	-	-
	Totals	249	17,437	70

Table 7.--Catch summary of salmonid and nonsalmonid fish captured by purse seine in John Day Reservoir, June to November 1981.

	June	July	August	Sept.	Oct.	Nov.	Total
Adult chinook		2		15	6		23
Jack chinook		1		5	13	3	22
Adult sockeye		8					8
Adult steelhead		20	22	10	4	5	61
Carp			8				8
Peamouth chub		4	2	1			7
Chiselmouth chub	1	16	5			1	23
Adult shad		30	9				39
Juvenile shad			1,200	81,000	24,000	500	106,700
Squawfish	3	77	115	12			207
Sucker		1					1
Adult walleye		1					1
Juvenile walleye		1		1			2
Whitefish	1	3					4

Radio-tracking of 0-age chinook salmon was attempted in the McNary Dam tailrace area in August and September. No successful tracks were completed. High water temperatures during this period resulted in almost 100% tagging mortality. No additional radio tagging will be attempted.

Migrational Behavior

The 1981 migration of 0-age chinook salmon began to enter John Day Reservoir in mid-May, peaked about the first week in July, and continued through mid-September. The migratory behavior exhibited by 0-age chinook salmon within the reservoir was markedly different from spring run yearling chinook salmon. The average reservoir residence time of branded 0-age chinook salmon released into the McNary Dam tailrace was 22 d (range 3 to 160+ d). This compared to 6 d (range 3 to 20 d) for branded yearling chinook salmon released in the same area in the spring of 1981 (Sims et al. 1982) (Table 8). The minimum residence time for both 0-age and yearling chinook salmon from the McNary Dam tailrace to John Day Dam was the same (3 d), however, the maximum residence time for yearling fish was only 20 d compared to 160 d plus for 0-age fish. This indicates that a large portion of the 0-age chinook salmon that entered John Day Reservoir were not actively smolting. Average residence time increased from 16 d for the early run to 30 d for the late run. This indicates that either the percentage of nonsmolting fish increased as the run progressed, or the residence time increased with decreased flows.

Purse seine recoveries of marked fish released at various locations within the reservoir (excluding McNary Dam tailrace releases) also indicated the presence of significant numbers of nonsmolting 0-age chinook salmon in John Day Reservoir. Nearly 50% of all such recoveries (71 out of

Table 8.--Residence time of marked yearling and 0-age chinook salmon in John Day Reservoir based on mean date of recovery at John Day Dam, 1981.

Species	Residence time (days)	
	Mean	Range
Yearling chinook salmon	6	3-20
0-age chinook salmon	22	3-160+[a]
Early run (15-29 June)	16	3-50
Mid-run (10 July-3 August)	24	3-160+[a]
Late run (10-26 August)	30	3-130+[a]

a/ Marked fish still in reservoir on last day of sampling, 17 December 1981.

146) were upstream from the original release site (Appendix Table A2). For example, one fish released at RKm 351 was recaptured at RKm 430, 79 km upstream, 6 d later. Such behavior is certainly not representative of smolting fish.

Flow/Survival Relationships

Samples of the three segments of the 0-age chinook salmon migration (early, middle, and late) entering John Day Reservoir in 1981 were wire-tagged and released into the tailrace at McNary Dam (Table 9). Adult returns from these releases will be used to determine relative survival of each segment. By plotting the survival estimates against the appropriate river flows, a regression line will be developed to determine if a significant flow/survival relationship existed.

Flow/Travel Time Relationships

Travel time from McNary Dam to John Day Dam was calculated for the 14 groups of marked fish released into the McNary tailrace in 1981 (Table 9). Average river flow for the 10-d period following each release ranged from 126 to 345 kcfs. As can be seen, average travel time ranged from 5 to 17 d. Considerable variance in travel time occurred regardless of river flow. Overall, average travel time for the early, middle, and late groups were nearly the same even though river flows declined from an average of 298 kcfs for the early group to 145 kcfs for the late group. A regression line was constructed by plotting the travel time of each release group against the appropriate river flow (Figure 1). The regression coefficient b (slope) of the line $y = 7.48 + 0.02X$ can be tested for significance by testing the hypothesis that the population regression coefficient is equal

Table 9.--Recoveries of 0-age chinook salmon (wire-tagged, cold branded, and released in McNary Dam tailrace, 16 June to 26 August 1981 at John Day Dam.

Wire tag code	Brand[a]	Release date	Average river flow(kcfs)[b]	Recovery date[c]	Travel time
031731	LAID1	6/15	345	7/2	17
031731	LAID2	6/18	327	7/3	15
031731	LAID3	6/24	265	7/2	8
031731	LAID4	6/29	253	7/4	5
Averge			298		11
031732	LAIM1	7/10	225	7/27	17
031732	LAIM3	7/16	210	8/2	17
031732	LAIM2	7/22	200	7/29	7
031732	LAIM4	7/29	192	8/6	8
031732	LAUP1	8/3	179	8/9	6
Average			201		11
031733	LAUP3	8/10	165	8/22	12
031733	LAUP4	8/13	153	8/21	8
031733	PA3X1	8/17	146	8/25	8
031733	LA3X2	8/20	137	9/4	15
031733	LA3X3	8/26	126	9/8	13
Average			145		11

a/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals ID, 3 equals DI, and 4 equals DI).

b/ For the 10-d period following each release date. Daily average river discharges at McNary Dam from 10 June to 24 September are shown in Appendix A.

c/ 25 percentile recovery.

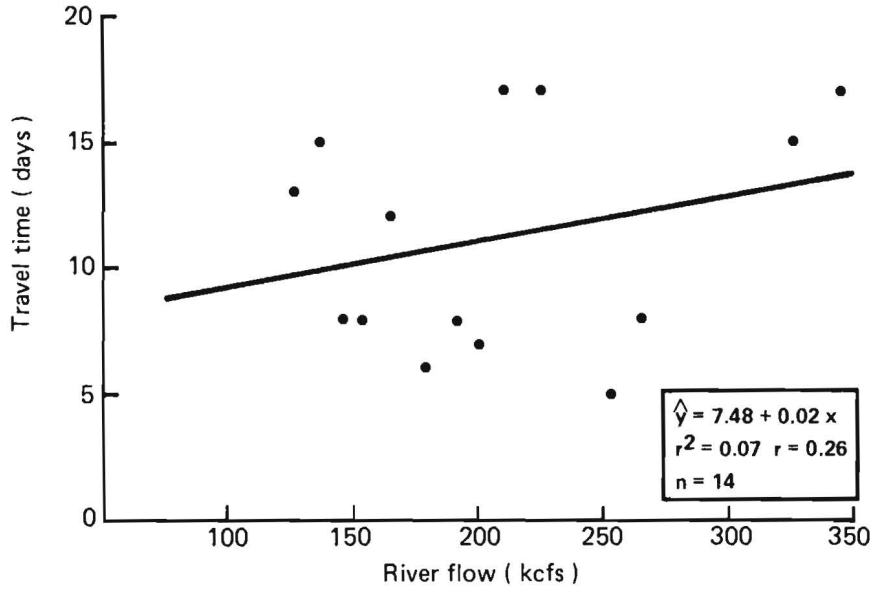

Figure 1.--Relationship of river flow and 0-age chinook salmon travel time (McNary Dam tailrace to John Day Dam) in John Day Reservoir, 1981.

to zero (H_o: = 0). This has been done by applying a sample t test according to the formula:

$$t = \frac{b-0}{\sqrt{\frac{2}{Syx}\ \frac{2}{(X-X)}}} \quad \text{where b = slope}$$

x = flow, y = travel time, and $\overset{2}{Syx}$ = pool variance of x and y, or in this case, t = 1.104. Since $t_{0.05}$ with 12 degrees of freedom = 2.179, H_o: = 0 is accepted, and we conclude that the slope (b) of the line is not statistically significantly different from zero.

Based on the 14 data points developed in 1981, there was no statistical evidence to indicate that river flows were affecting the rate of migration or residence time of 0-age chinook salmon in John Day Reservoir. It should be remembered, however, that this analysis was based on only 1 year's data and represents a limited number of data points. Results could change significantly as additional data points are added in 1982 and 1983.

SUMMARY AND CONCLUSIONS

Research was initiated by NMFS in 1981 to define the effects of instream flows on the passage time, survival, and migrational behavior of 0-age chinook salmon in John Day Reservoir. This report summarizes 1981 research activities.

1. Fourteen (14) groups of 0-age chinook salmon (74,683 fish) were wire-tagged and branded at McNary Dam and released into the McNary Dam tailrace during the period 15 June - 26 August 1981.

2. Additional mark releases of 13,746 and 14,273 0-age chinook salmon were made at Blalock, Oregon, (RKm 375) and at various purse seine sampling sites, respectively.

3. Approximately 55,000 0-age chinook salmon were sampled at the John Day Dam airlift collection facility between 31 May and 17 December 1981. Total passage, based on these collections, was estimated to be approximately 4.3 million fish.

4. Six hundred and twenty-three (623) marked fish were recovered at John Day Dam.

5. During the 0-age chinook salmon migration, 249 purse seine sets were made in John Day Reservoir. Purse seine catches amounted to 17,437 0-age chinook salmon.

6. Attempts to radio-tag 0-age chinook salmon were not successful due to extreme marking mortality. No additional radio-tagging will be attempted.

7. The average residence time in John Day Dam Reservoir for marked 0-age chinook salmon released into the McNary Dam tailrace was 22 d. This compares to 6 d for yearling chinook salmon.

8. A significant percentage of purse seine mark recaptures were made upstream from original release sites.

9. From their length of residence and upstream movement, it appears that a significant number of 0-age chinook salmon in John Day Reservoir were not actively migrating.

10. Based on the limited data developed in 1981, there was no statistically significant evidence to indicate that instream river flows were affecting the rate of downstream movement or residence time of 0-age chinook salmon in John Day Reservoir.

SUMMARY OF EXPENDITURES

Personnel	$54,514
Travel and Transportation	8,568
Contract Services (Fish Markers)	9,312
Supplies and Materials	3,665
Capital Equipment	0
Overhead (NOAA and DOC)	21,834
Miscellaneous	107
Total	$98,000

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APPENDIX A

Brand Recapture and River Flow Data, 1981

Appendix Table A1.--Brand recapture summary, 0-age chinook salmon, John Day Dam (Turbine Unit 3), 1981.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LAID1	RKm 470 (McNary Dam)	3,325	6/15	1	1	6/30
				3	4	7/01
				9	13	7/02
				5	18	7/03
				5	23	7/04
				1	24	7/06
				1	25	7/07
				2	27	7/08
				1	28	7/13
LAID2	RKm 470	4,654	6/18	1	1	6/25
				1	2	6/26
				1	3	6/30
				7	10	7/02
				2	12	7/03
				9	21	7/04
				8	29	7/06
				1	30	7/07
				1	31	7/08
				7	38	7/13
				2	40	7/14
				1	41	7/15
				1	42	7/28
				1	43	7/29
				1	44	8/08
LAID3	RKm 470	3,458	6/24	4	4	6/26
				3	7	6/30
				1	8	7/01
				3	11	7/02
				3	14	7/03
				3	17	7/04
				9	26	7/06
				1	27	7/14
				1	28	7/16
				3	31	7/17
				3	34	7/20
				1	35	7/30
				1	36	8/02
				1	37	8/10
LAID4	RKm 470	6,286	6/29	13	13	7/04
				8	21	7/06
				2	23	7/07
				1	24	7/08
				1	25	7/10
				1	26	7/13
				1	27	7/14
				4	31	7/15
				3	34	7/16
				1	35	7/20

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LAID4	RKm 470	6,286	6/29	1	36	7/23
				1	37	7/29
				1	38	8/07
LAIM1	RKm 470	10,115	7/10	2	2	7/14
				1	3	7/15
				2	5	7/17
				5	10	7/20
				1	11	7/21
				3	14	7/22
				2	16	7/24
				11	27	7/27
				10	37	7/28
				2	39	7/29
				2	41	7/30
				6	47	7/31
				4	51	8/01
				2	53	8/03
				4	57	8/04
				6	63	8/05
				2	65	8/07
				1	66	8/08
				1	67	8/11
				1	68	8/12
				1	69	8/13
				1	70	8/14
				1	71	8/17
				1	72	8/24
				1	73	9/02
				1	74	9/15
				1	75	9/20
				1	76	9/28
				1	77	10/09
				1	78	10/26
				1	79	12/17
LAIM2	RKm 470	10,012	7/22	7	7	7/27
				4	11	7/28
				4	15	7/29
				3	18	7/30
				2	20	7/31
				1	21	8/01
				1	22	8/03
				3	25	8/04
				6	31	8/05
				3	34	8/06
				5	39	8/07
				3	42	8/09
				1	43	8/12
				1	44	8/13
				1	45	8/14
				1	46	9/02

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LAIM2	RKm 470	10,012	7/22	2	48	9/28
				1	49	10/16
				1	50	10/23
LAIM3	RKm 470	10,143	7/16	2	2	7/24
				3	5	7/27
				1	6	7/28
				1	7	7/29
				1	8	7/30
				3	11	7/31
				4	15	8/01
				2	17	8/02
				5	22	8/03
				3	25	8/04
				4	29	8/05
				2	31	8/06
				5	36	8/07
				2	38	8/08
				2	40	8/12
				2	42	8/13
				2	44	8/14
				3	47	8/17
				1	48	8/18
				4	52	8/21
				3	55	8/22
				1	56	8/24
				1	57	9/01
				4	61	9/08
				1	62	9/20
				1	63	9/30
				1	64	10/26
				1	65	11/16
LAIM4	RKm 470	12,310	7/29	1	1	7/31
				1	2	8/02
				1	3	8/03
				2	5	8/04
				8	13	8/05
				4	17	8/06
				8	25	8/07
				3	28	8/08
				2	30	8/09
				1	31	8/12
				2	33	8/13
				1	34	8/14
				4	38	8/17
				5	43	8/21
				2	45	8/22
				2	47	8/24
				2	49	8/31
				1	50	9/04

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LAIM4	RKm 470	12,301	7/29	4	54	9/08
				1	55	9/14
				1	56	9/15
				1	57	9/17
				1	58	9/18
				1	59	10/09
				1	60	10/23
				1	61	10/26
				1	62	10/29
				1	63	11/05
				1	64	11/12
LAUP1	RKm 470	2,512	8/03	2	2	8/08
				3	5	8/09
				1	6	8/10
				2	8	8/13
				1	9	8/18
				1	10	8/21
				1	11	9/08
LAUP2	RKm 470	2,399	8/06	1	1	10/19
LAUP3	RKm 470	2,663	8/10	2	2	8/21
				2	4	8/22
				1	5	8/24
				2	7	8/25
				1	8	8/27
				1	9	9/04
				1	10	9/08
				1	11	9/20
				1	12	10/13
				2	14	11/16
				1	15	12/17
LAUP4	RKm 470	2,545	8/13	3	3	8/21
				1	4	8/31
				1	5	9/02
				2	7	9/08
				1	8	9/16
				1	9	9/20
				1	10	10/26
				1	11	10/29
				1	12	12/17
LA3X1	RKm 470	2,547	8/17	1	1	8/21
				2	3	8/25
				1	4	9/02
				1	5	9/04
				3	8	9/08
				1	9	9/10
				1	10	9/20

Appendix Table A 1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LA3X2	RKm 470	2,536	8/20	1	1	8/25
				1	2	8/27
				1	3	8/28
				4	7	8/31
				2	9	9/04
				2	11	9/08
				1	12	9/10
				3	15	9/14
				1	16	9/15
				2	18	9/20
				1	19	10/26
				1	20	10/29
				1	21	11/09
				1	22	12/17
LA3X3	RKm 470	1,577	8/26	1	1	8/31
				2	3	9/08
				1	4	9/15
				1	5	9/23
				1	6	9/28
LASP1	RKm 375 (Blalock Canyon)	721	7/06	1	1	7/08
				1	2	7/13
				1	3	7/15
				1	4	7/16
				1	5	7/20
				1	6	7/28
				1	7	8/08
LASP2	RKm 375	716	7/30	1	1	8/01
				1	2	8/08
				1	3	8/20
				1	4	9/09
LASP3	RKm 375	895	8/08	2	2	8/12
				1	3	8/14
				1	4	11/20
RASP1	RKm 375	1,204	7/06	3	3	7/16
				1	4	7/17
				1	5	7/22
				2	7	7/27
				1	8	7/28
				1	9	8/04
RASP2	RKm 375	548	7/14	1	1	7/17
				2	3	7/20
				1	4	7/22
				1	5	7/30
				1	6	8/05
				1	7	8/06

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
RASP3	RKm 375	2,168	7/20	1	1	7/21
				5	6	7/22
				1	7	7/23
				2	9	7/24
				4	13	7/27
				2	15	7/28
				1	16	8/04
				2	18	8/05
				1	19	8/08
				1	20	8/12
RASP4	RKm 375	929	7/21	1	1	7/23
				2	3	7/24
				1	4	7/27
				2	6	7/28
				2	8	7/29
				1	9	8/05
				2	11	8/07
				1	12	8/21
				1	13	9/20
RDSP1	RKm 375	613	7/22	1	1	7/27
RDSP2	RKm 375	2,370	7/27	1	1	7/28
				2	3	7/30
				1	4	7/31
				1	5	8/04
				2	7	8/08
				2	9	8/09
				1	10	8/10
				2	12	8/11
				1	13	8/14
				1	14	8/21
				1	15	8/24
				1	16	8/27
				1	17	8/31
				1	18	9/04
				1	19	12/09
RDSP3	RKm 375	1,424	7/28	4	4	7/30
				1	5	7/31
				1	6	8/01
				1	7	8/05
				2	9	8/07
				1	10	8/08
				1	11	8/13
				1	12	8/19
				1	13	8/21
				1	14	12/17

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
RDSP4	RKm 375	952	7/29	1	1	7/30
				2	3	8/04
				1	4	8/06
				2	6	8/07
				2	8	8/09
				1	9	8/20
LAX2	RKm 388 (Purse seine)	565	7/01	1	1	7/08
LDWV1	RKm 359	366	7/23	1	1	8/17
LDWV2	RKm 351	570	7/24	1	1	8/21
LPWV2	RKm 357	1,070	8/05	1	1	10/23
LAAR1	RKm 375	472	8/18	1	1	9/20
				1	2	10/09
LAAR2	RKm 359	206	8/19	1	1	8/27
LDAR2	RKm 389	623	8/27	1	1	9/08
				1	2	9/09
				1	3	9/20
				1	4	10/23
LPAR2	RKm 359	795	9/03	1	1	9/20
				1	2	11/05
LAD1	RKm 427	522	9/10	1	1	10/13
				1	2	10/26
LAD2	RKm 388	596	9/11	2	2	11/25
LAD3	RKm 377	268	9/15	1	1	9/23
				1	2	11/02
LAD4	RKm 359	64	9/16	1	1	9/28
				1	2	10/23
LDD1	RKm 427	327	9/23	1	1	11/02
				1	2	11/12
				1	3	11/16
				2	5	11/20
				1	6	11/25
				1	7	12/17

Appendix Table A1.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture
LDD2	RKm 410	213	9/24	1	1	11/02
				1	2	11/09
				1	3	12/09
LDD3	RKm 390	212	9/25	1	1	11/16
				1	2	12/02
LDD4	RKm 377	217	9/29	1	1	11/05
				1	2	11/12
				1	3	11/20

a/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals ⊐, 3 equals ⊏, and 4 equals ⊐).

Appendix Table A2.--Brand recapture summary, 0-age chinook salmon, purse seine catches John Day Reservoir, 1981.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
LAID1	RKm 470 (McNary Dam)	3,325	6/15	3	3	6/25	RKm 351
				2	5	6/30	RKm 423
				3	8	7/01	RKm 390
				2	10	7/02	RKm 375
				2	12	7/16	RKm 351
LAID2	RKm 470	4,654	6/18	1	1	6/25	RKm 351
				3	4	7/01	RKm 390
				2	6	7/02	RKm 375
				1	7	7/09	RKm 423
				1	8	7/16	RKm 351
				2	10	8/04	RKm 373
				1	11	8/05	RKm 357
				1	12	8/06	RKm 348
				2	14		RKm 351
				1	15	8/11	RKm 439
LAID3	RKm 470	3,458	6/24	1	1	6/25	RKm 351
				2	3	7/01	RKm 390
				3	6	7/02	RKm 375
				1	7	7/14	RKm 375
				2	9	8/04	RKm 373
				1	10	8/05	RKm 357
LAID4	RKm 470	6,286	6/29	1	1	7/02	RKm 375
				1	2	7/14	RKm 375
				4	6	7/16	RKm 351
				2	8	8/04	RKm 373
				1	9	8/05	RKm 357
				1	10	8/06	RKm 351
				1	11	8/13	RKm 390
				1	12	8/18	RKm 375
LAIM1	RKm 470	10,115	7/10	2	2	7/14	RKm 375
				1	3	7/15	RKm 362
				4	7	7/16	RKm 351
				4	11	7/24	RKm 351
				1	12	7/30	RKm 388
				1	13	7/13	RKm 348
				4	17		RKm 351
				5	22	8/04	RKm 373
				1	23		RKm 375
				1	24	8/06	RKm 348
				1	25		RKm 351
				2	27	8/18	RKm 375
				1	28	8/25	RKm 430
				1	29	8/27	RKm 390

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
LAIM1	RKm 470	10,115	7/10	1	30	9/09	RKm 457
				1	31	9/10	RKm 423
				3	34		RKm 430
				1	35	9/11	RKm 390
				1	36	9/15	RKm 375
				1	37	9/16	RKm 361
				1	38	9/23	RKm 430
LAIM2	RKm 470	10,012	7/22	3	3	7/30	RKm 388
				2	5	7/31	RKm 348
				6	11		RKm 351
				1	12	8/04	RKm 373
				2	14		RKm 375
				4	18	8/05	RKm 357
				1	19	8/06	RKm 351
				1	20	8/12	RKm 430
				1	21	8/13	RKm 390
				2	23	8/18	RKm 375
				1	24	8/26	RKm 407
				2	26	8/27	RKm 390
				2	28	9/03	RKm 361
				1	29	9/10	RKm 430
				1	30	9/23	RKm 430
				1	31	10/21	RKm 430
LAIM3	RKm 470	10,143	7/16	1	1	7/24	RKm 351
				5	6	7/30	RKm 388
				1	7	8/04	RKm 373
				2	9		RKm 375
				3	12	8/05	RKm 357
				1	13	8/06	RKm 348
				3	16		RKm 351
				1	17	8/18	RKm 375
				1	18	8/19	RKm 359
				1	19	8/27	RKm 390
				1	20	9/02	RKm 375
				3	23	9/03	RKm 361
				2	25	9/10	RKm 430
				1	26	9/11	RKm 390
				1	27	9/16	RKm 361
				1	28	9/23	RKm 430
				1	29	9/24	RKm 410
LAIM4	RKm 470	12,310	7/29	1	1	7/30	RKm 388
				3	4	8/04	RKm 373
				4	8		RKm 375
				1	9	8/05	RKm 357
				1	10	8/06	RKm 348
				2	12		RKm 351
				1	13	8/12	RKm 430
				1	14	8/18	RKm 375

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
LAIM4	RKm 470	12,310	7/29	3	17	8/19	RKm 359
				2	19	8/26	RKm 407
				2	21	8/27	RKm 390
				2	23	9/02	RKm 375
				4	27	9/03	RKm 361
				1	28	9/10	RKm 430
				2	30		RKm 432
				1	31	9/25	RKm 390
				1	32	9/30	RKm 361
				1	33	10/15	RKm 378
				1	34	10/21	RKm 430
				1	35	10/22	RKm 390
				1	36	10/28	RKm 351
				1	37	11/04	RKm 388
LAUP1	RKm 470	2,512	8/03	1	1	8/19	RKm 359
				1	2	8/20	RKm 351
				1	3	8/26	RKm 407
				1	4	8/27	RKm 390
				1	5	9/02	RKm 375
				3	8	9/03	RKm 361
				1	9	9/11	RKm 390
				1	10	9/15	RKm 375
				1	11	9/23	RKm 430
				1	12	9/24	RKm 410
				1	13	9/25	RKm 390
				1	14	11/11	RKm 348
LAUP2	RKm 470	2,399	8/06	1	1	8/13	RKm 390
				1	2	9/10	RKm 430
				1	3	9/15	RKm 375
				1	4	9/24	RKm 410
				1	5	10/21	RKm 430
LAUP3	RKm 470	2,663	8/10	1	1	8/13	RKm 390
				1	2	8/19	RKm 359
				1	3	9/02	RKm 375
				1	4	9/11	RKm 390
				1	5	9/23	RKm 430
				1	6	10/27	RKm 378
LAUP4	RKm 470	2,545	8/13	1	1	8/18	RKm 375
				1	2	8/27	RKm 390
				1	3	9/11	RKm 390
				1	4	9/23	RKm 430
LA3X1	RKm 470	2,547	8/17	1	1	8/26	RKm 407
				3	4	8/27	RKm 390
				2	6	9/02	RKm 375

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
LA3X1	RKm 470	2,547	8/17	4	10	9/03	RKm 361
				1	11	9/10	RKm 430
				1	12	9/11	RKm 390
				1	13	9/23	RKm 430
				1	14	9/24	RKm 410
				1	15	9/29	RKm 375
				1	16	10/15	RKm 378
				1	17	10/28	RKm 351
LA3X2	RKm 470	2,536	8/20	1	1	8/25	RKm 430
				1	2	8/26	RKm 407
				1	3	9/02	RKm 375
				2	5	9/03	RKm 361
				1	6	9/10	RKm 430
				1	7	9/11	RKm 390
				1	8	9/24	RKm 410
				1	9	9/25	RKm 390
				1	10	9/29	RKm 375
				1	11	10/22	RKm 390
				1	12	10/27	RKm 378
				1	13	10/28	RKm 351
LA3X3	RKm 470	1,577	8/26	2	2	9/03	RKm 361
				1	3	9/15	RKm 375
				1	4	10/21	RKm 430
				1	5	10/22	RKm 390
				1	6	11/03	RKm 422
LASP1	RKm 375 (Blalock Canyon)	721	7/06	1	1	7/06	RKm 351
LASP2	RKm 375	716	7/30	1	1	8/06	RKm 348
						9/15	RKm 375
LASP3	RKm 375	895	8/08	1	1	8/12	RKm 430
				2	3	8/19	RKm 359
				1	4	8/26	RKm 407
				1	5	9/02	RKm 375
				1	6	10/21	RKm 430
				1	7	11/11	RKm 348
LDSP1	RKm 375	503	9/08	1	1	9/29	RKm 375
				1	2	10/22	RKm 390
LDSP3	RKm 375	475	8/17	1	1	8/26	RKm 407
				1	2	8/27	RKm 390

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
RASP1	RKm 375	1,204	7/13	2	2	7/15	RKm 362
				1	3	7/16	RKm 351
				2	5	7/24	RKm 351
				1	6	8/25	RKm 430
				1	7	9/10	RKm 430
				1	8	9/25	RKm 390
RASP2	RKm 375	548	7/14	2	2	8/04	RKm 373
				1	3	8/18	RKm 375
				1	4	8/26	RKm 407
				1	5	9/03	RKm 361
				1	6	9/10	RKm 423
RASP3	RKm 375	2,168	7/20	1	1	7/24	RKm 351
				1	2	7/30	RKm 388
				1	3	7/31	RKm 348
				1	4		RKm 351
				1	5	8/04	RKm 373
				3	8		RKm 373
				3	11	8/05	RKm 357
				1	12	8/11	RKm 439
				1	13		RKm 449
				1	14	8/12	RKm 430
				2	16	8/18	RKm 373
				1	17	8/26	RKm 407
				1	18	9/10	RKm 430
				1	19	9/16	RKm 361
				1	20	9/23	RKm 439
				1	21	9/24	RKm 410
RASP4	RKm 375	929	7/21	2	2	7/24	RKm 351
				1	3	8/04	RKm 375
				1	4	8/06	RKm 351
				1	5	8/13	RKm 390
				1	6	9/25	RKm 390
RDSP1	RKm 375	613	7/22	1	1	8/06	RKm 351
				1	2	9/24	RKm 410
RDSP2	RKm 375	2,370	7/27	1	1	7/30	RKm 388
				1	2	7/31	RKm 348
				2	4	8/04	RKm 373
				1	5		RKm 375
				2	7	8/05	RKm 357
				2	9	8/06	RKm 351
				2	11	8/13	RKm 390
				1	12	8/18	RKm 375
				1	13	8/19	RKm 359
				2	15	8/27	RKm 390
				1	16	9/02	RKm 375
				1	17	9/15	RKm 375
				1	18	9/24	RKm 410

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
RDSP3	RKm 375	1,424	7/28	1	1	7/31	RKm 351
				1	2	8/06	RKm 348
				1	3	8/13	RKm 390
				1	4	9/23	RKm 439
				1	5	9/24	RKm 410
RDSP4	RKm 375	952	7/29	4	4	7/31	RKm 348
				2	6		RKm 351
				1	7	8/05	RKm 357
				1	8	8/06	RKm 348
				1	9	8/13	RKm 390
				1	10	8/18	RKm 375
LAWV1	RKm 431 (Purse seine)	157	7/08	1	1	9/17	RKm 351
LAWV4	RKm 351	654	7/16	1	1	8/27	RKm 390
				1	2	9/29	RKm 359
LDWV2	RKm 351	570	7/24	1	1	8/13	RKm 390
				1	2	8/18	RKm 359
LDWV3	RKm 386	328	7/30	1	1	8/19	RKm 359
				1	2	9/02	RKm 375
				1	3	9/25	RKm 390
LDWV4	RKm 351	614	7/31	1	1	9/03	RKm 361
LPWV1	RKm 373	1,110	8/04	3	3	8/05	RKm 357
				3	6	8/06	RKm 351
				1	7	9/10	RKm 430
LPWV2	RKm 359	1,070	8/05	1	1	9/11	RKm 390
				1	2	9/23	RKm 430
LPWV3	RKm 351	1,238	8/06	1	1	8/12	RKm 430
				1	2	8/18	RKm 375
				1	3	8/25	RKm 439
				1	4	8/26	RKm 407
				1	5	8/27	RKm 390
				1	6	9/03	RKm 361
LPWV4	RKm 430	332	8/13	1	1	9/02	RKm 375
				1	2	9/15	RKm 375
LAAR1	RKm 375	472	8/18	1	1	8/25	RKm 430
				1	2	8/27	RKm 390
				1	3	9/02	RKm 375
				1	4	9/15	RKm 375
				1	5	9/23	RKm 430
				1	6	9/24	RKm 410

Appendix Table A2.--Continued.

Brand	Release site	Number released	Date released	Recaptures No.	Recaptures Cumulative	Date recapture	Recapture site
LAAR2	RKm 359	206	8/19	1	1	9/02	RKm 375
				1	2	9/03	RKm 361
				2	4	9/15	RKm 375
				1	5	9/23	RKm 439
				1	6	10/15	RKm 378
LDAR1	RKm 407	512	8/26	1	1	9/03	RKm 361
				1	2	9/10	RKm 423
				1	3	9/16	RKm 361
LDAR2	RKm 388	623	8/27	1	1	9/10	RKm 430
				1	2	9/11	RKm 390
				1	3	9/16	RKm 361
				1	4	9/25	RKm 390
LPAR1	RKm 377	246	9/02	1	1	9/10	RKm 430
				1	2	9/25	RKm 390
LPAR2	RKm 359	795	9/03	2	2	9/11	RKm 390
				1	3	9/24	RKm 410
				1	4	10/21	RKm 430
LAD1	RKm 430	522	9/10	1	1	9/15	RKm 375
				1	2	9/23	RKm 430
				1	3	9/25	RKm 390
LAD2	RKm 388	596	9/11	1	1	10/15	RKm 378
				1	2	10/27	RKm 378
				1	3	11/11	RKm 348
LAD3	RKm 375	268	9/15	1	1	9/23	RKm 430
				1	2	10/21	RKm 430
LAD4	RKm 359	64	9/16	1	1	9/24	RKm 410
LDD2	RKm 410	213	9/24	1	1	10/21	RKm 430
LDD1	RKm 430	327	9/23	1	1	10/22	RKm 390
				1	2	11/04	RKm 388

a/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals normal orientation, ID; 2 equals  , 3 equals  , and 4 equals).

Appendix Table A3.--Average daily discharge McNary Dam, 1981.

Date	Disch. (KCFS)	Date	Disch. (KCFS)	Date	Disch. (KCFS)	Date	Disch. (KCFS)
Jun. 10	416.0	Jul. 1	228.4	Aug. 1	198.0	Sep. 1	129.8
11	417.9	2	227.9	2	176.4	2	235.0
12	390.0	3	226.6	3	177.3	3	114.2
13	390.3	4	224.4	4	188.9	4	127.2
14	405.4	5	231.2	5	187.8	5	98.0
15	365.1	6	239.9	6	184.7	6	81.8
16	391.1	7	276.2	7	201.2	7	74.0
17	333.8	8	315.9	8	175.6	8	126.8
18	341.7	9	293.1	9	141.5	9	124.3
19	345.2	10	280.8	10	192.5	10	112.2
20	331.4	11	231.1	11	167.6	11	132.5
21	358.1	12	231.4	12	175.3	12	115.4
22	333.5	13	219.2	13	180.8	13	78.6
23	338.1	14	235.6	14	170.4	14	117.2
24	360.0	15	225.2	15	200.4	15	107.6
25	316.0	16	210.9	16	147.9	16	126.1
26	308.2	17	228.2	17	144.1	17	136.0
27	295.4	18	228.2	18	160.9	18	119.7
28	286.6	19	219.8	19	156.6	19	92.7
29	265.5	20	220.6	20	145.6	20	91.8
30	268.2	21	221.4	21	137.2	21	104.2
		22	213.5	22	152.1	22	120.6
		23	219.2	23	116.4	23	128.6
		24	209.5	24	162.8	24	118.7
		25	170.8	25	141.8		
		26	163.5	26	145.6		
		27	207.2	27	145.6		
		28	210.7	28	138.5		
		29	193.5	29	129.0		
		30	217.6	30	99.7		
		31	213.3	31	147.8		

a/ Position, brand, and orientation. LA indicates left anterior, LD indicates left dorsal, and LP indicates left posterior. Orientation refers to rotation of the brand around its center point (i.e., 1 equals

APPENDIX B

Chart of Purse Seine Sampling Areas

Showing John Day Reservoir, 1981

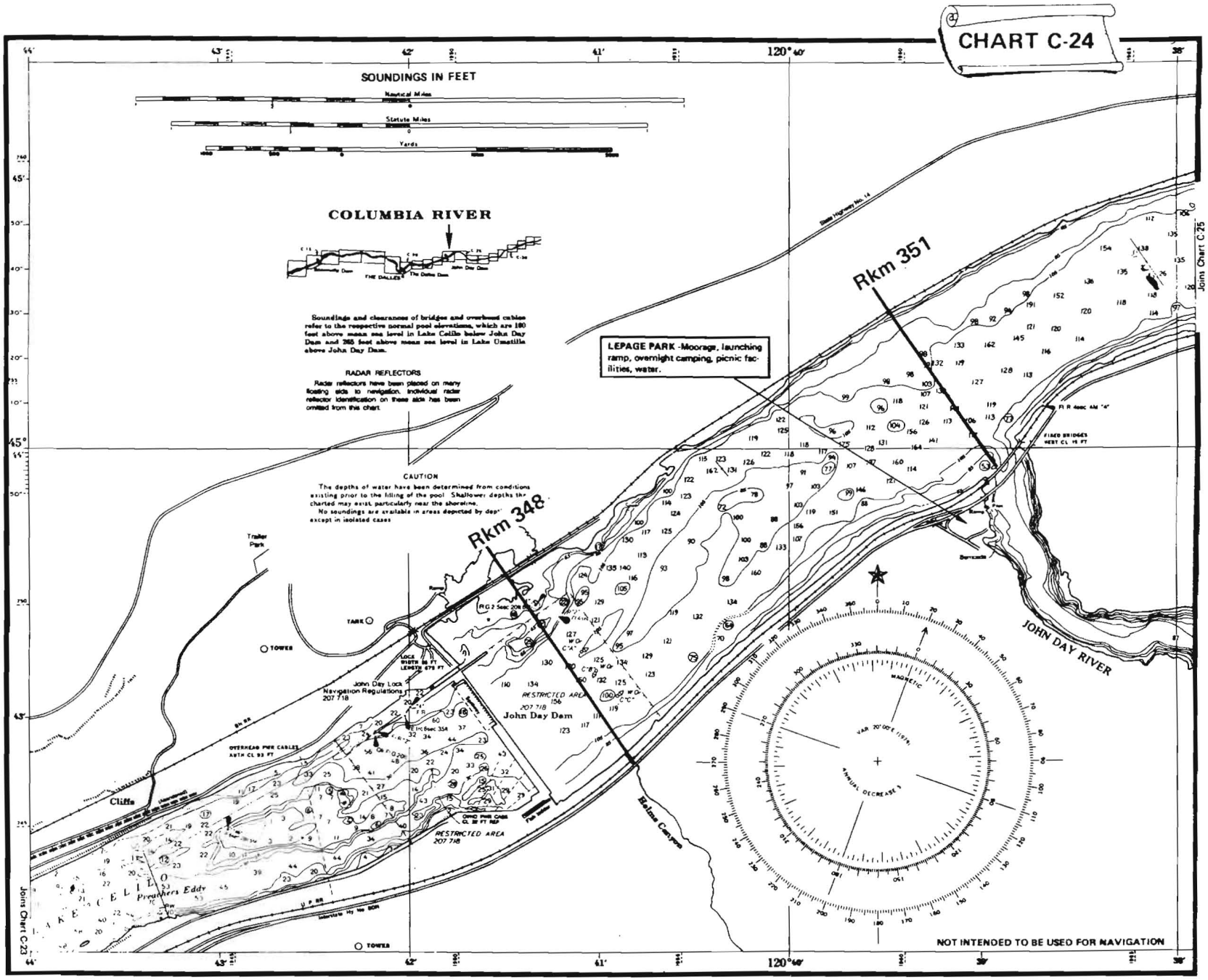
CHART C-24
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
COLUMBIA RIVER
Soundings and clearances of bridges and overhead cables refer to the respective normal pool elevations, which are 180 feet above mean sea level in Lake Celilo below John Day Dam and 265 feet above mean sea level in Lake Umatilla above John Day Dam.
RADAR REFLECTORS
Radar reflectors have been placed on many floating aids to navigation. Individual radar reflector identification on these aids has been omitted from this chart.
CAUTION
The depths of water have been determined from conditions existing prior to the filling of the pool. Shallower depths than charted may exist, particularly near the shoreline. No soundings are available in areas depicted by dep... except in isolated cases
LEPAGE PARK -Moorage, launching ramp, overnight camping, picnic facilities, water.
Rkm 351
Rkm 348
JOHN DAY RIVER
John Day Dam
John Day Lock
Navigation Regulations 207.718
RESTRICTED AREA 207.718
Preachers Eddy
Radium Canyon
Cliffs
Trailer Park
TOWER
TANK
Joins Chart C-25
Joins Chart C-23
NOT INTENDED TO BE USED FOR NAVIGATION

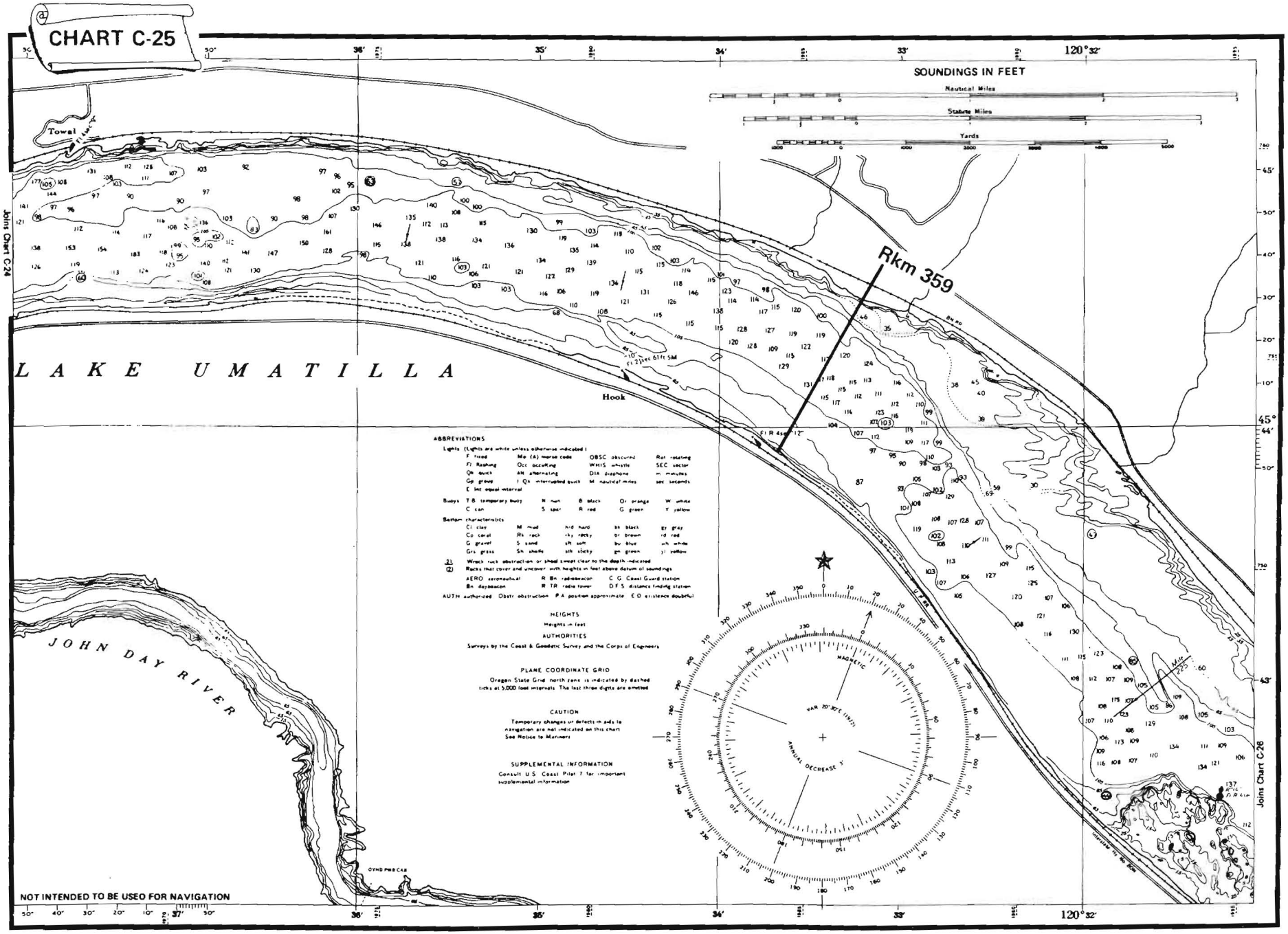
CHART C-25
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
Towal
LAKE UMATILLA
Hook
Rkm 359
JOHN DAY RIVER
Joins Chart C-24
Joins Chart C-26
ABBREVIATIONS
Lights (Lights are white unless otherwise indicated)
F fixed
Fl flashing
Qk quick
Gp group
E sec equal interval
Mo (A) morse code
Occ occulting
AN alternating
I Qk interrupted quick
OBSC obscured
WHIS whistle
DIA diaphone
M nautical miles
Rot rotating
SEC sector
m minutes
sec seconds
Buoys T B temporary buoy
C can
N nun
S spar
B black
R red
Or orange
G green
W white
Y yellow
Bottom characteristics
Cl clay
Co coral
G gravel
Grs grass
M mud
Rk rock
S sand
Sh shells
hrd hard
rky rocky
sft soft
sfty sticky
bk black
br brown
bu blue
gn green
gy gray
rd red
wh white
yl yellow
Wreck rock obstruction or shoal swept clear to the depth indicated
Rocks that cover and uncover with heights in feet above datum of soundings
AERO aeronautical
Bn daybeacon
R Bn radiobeacon
R TR radio tower
C G Coast Guard station
D F S distance finding station
AUTH authorized Obstr obstruction P A position approximate E D existence doubtful
HEIGHTS
Heights in feet
AUTHORITIES
Surveys by the Coast & Geodetic Survey and the Corps of Engineers
PLANE COORDINATE GRID
Oregon State Grid north zone is indicated by dashed ticks at 5,000 foot intervals The last three digits are omitted
CAUTION
Temporary changes or defects in aids to navigation are not indicated on this chart See Notice to Mariners
SUPPLEMENTAL INFORMATION
Consult U S Coast Pilot 7 for important supplemental information
MAGNETIC
VAR 20° 30' E (1972)
ANNUAL DECREASE 5'
NOT INTENDED TO BE USED FOR NAVIGATION

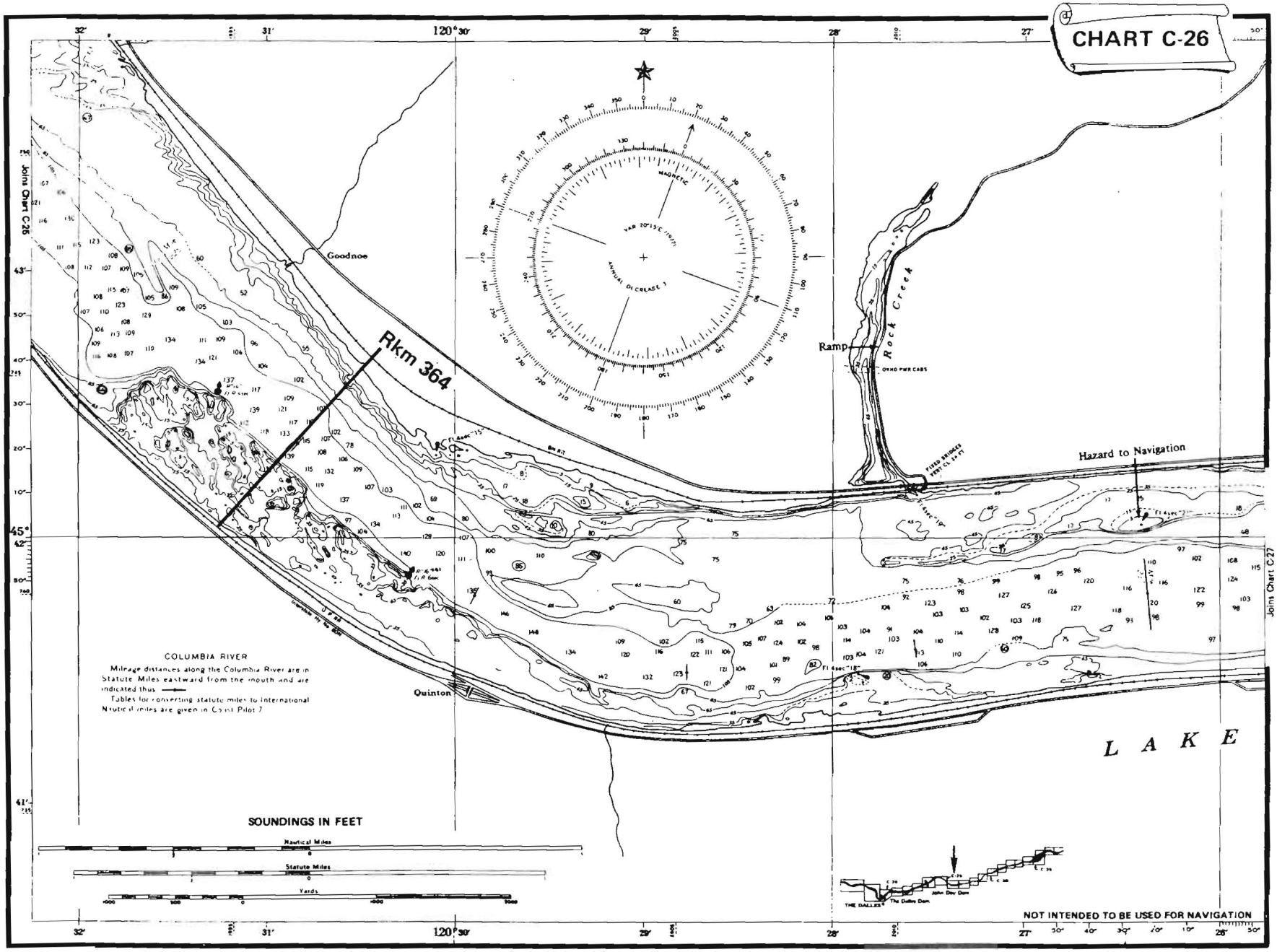
CHART C-26
120°30'
Goodnoe
Rkm 364
Ramp
Rock Creek
Hazard to Navigation
Quinton
LAKE
COLUMBIA RIVER
Mileage distances along the Columbia River are in Statute Miles eastward from the mouth and are indicated thus
Tables for converting statute miles to International Nautical miles are given in Coast Pilot 7
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
THE DALLES
The Dalles Dam
John Day Dam
NOT INTENDED TO BE USED FOR NAVIGATION
Joins Chart C-25
Joins Chart C-27

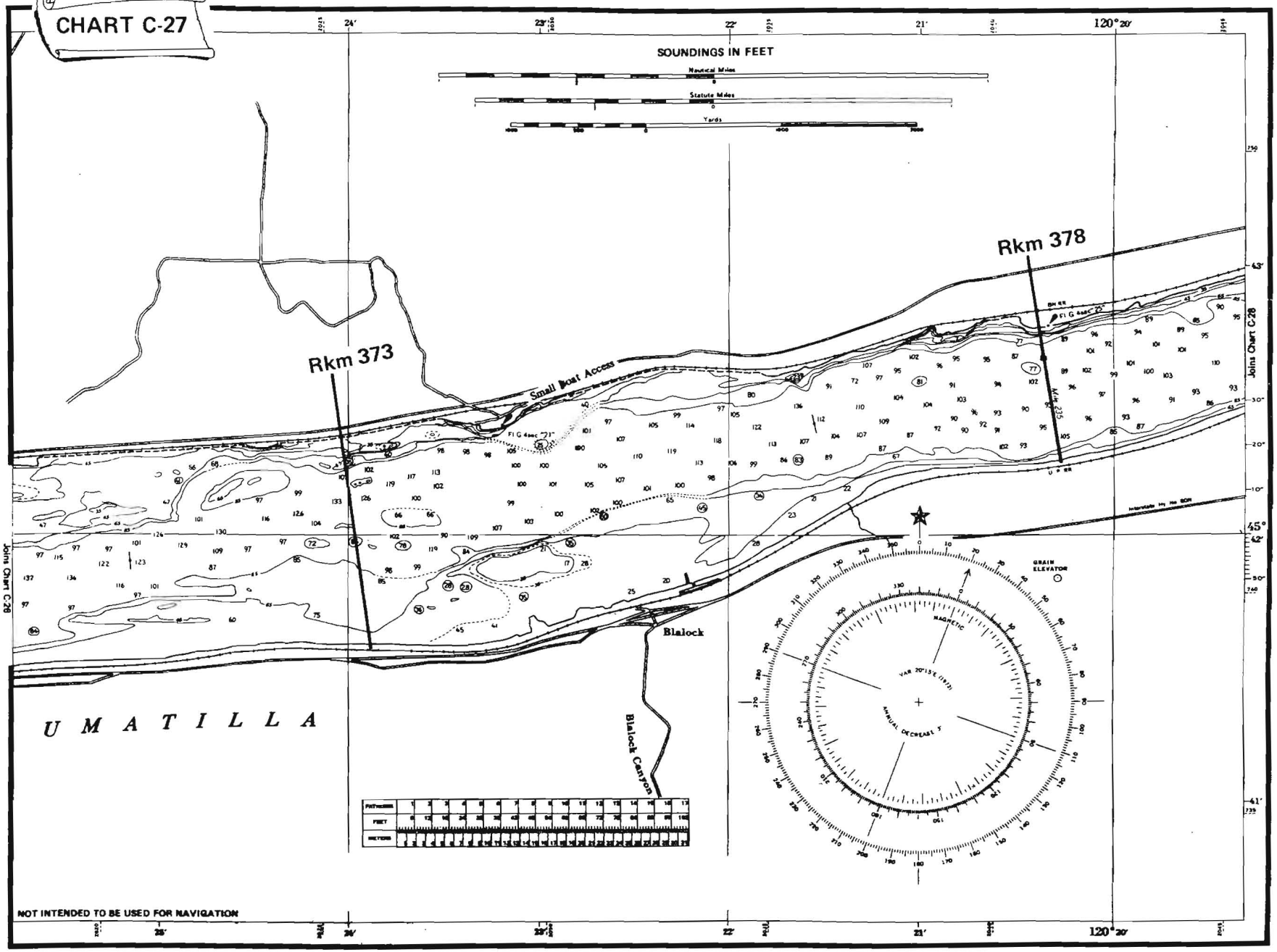
CHART C-27
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
Rkm 373
Rkm 378
Small Boat Access
Blalock
Blalock Canyon
U M A T I L L A
Joins Chart C-28
Joins Chart C-28
GRAIN ELEVATOR
MAGNETIC
VAR 20°13'E (1972)
ANNUAL DECREASE 5'
NOT INTENDED TO BE USED FOR NAVIGATION

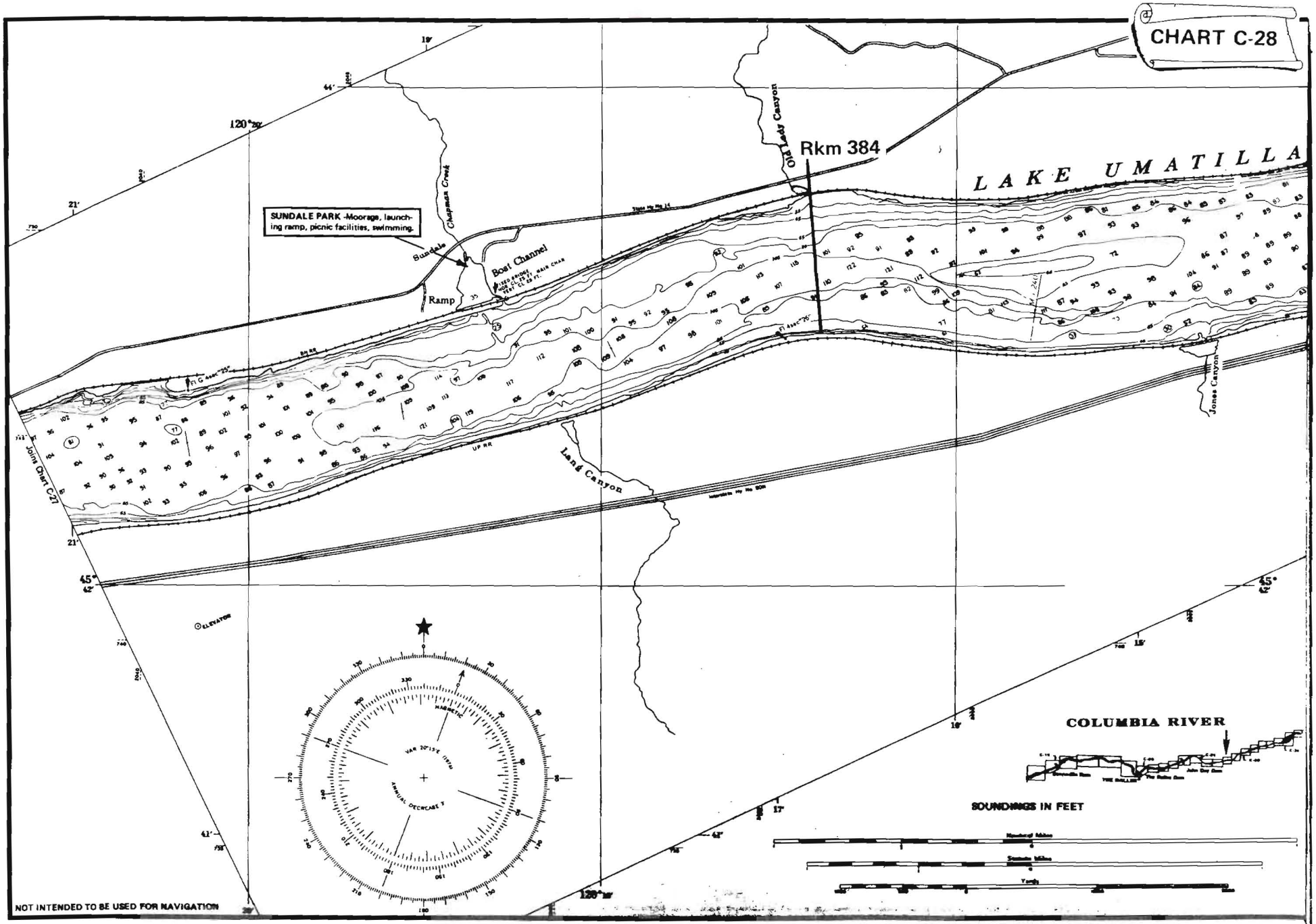
CHART C-28
Rkm 384
LAKE UMATILLA
SUNDALE PARK -Moorage, launching ramp, picnic facilities, swimming.
Sundale
Ramp
Boat Channel
Chapman Creek
Old Lady Canyon
Jones Canyon
Land Canyon
John Day Chart C-27
ELEVATOR
COLUMBIA RIVER
SOUNDINGS IN FEET
NOT INTENDED TO BE USED FOR NAVIGATION

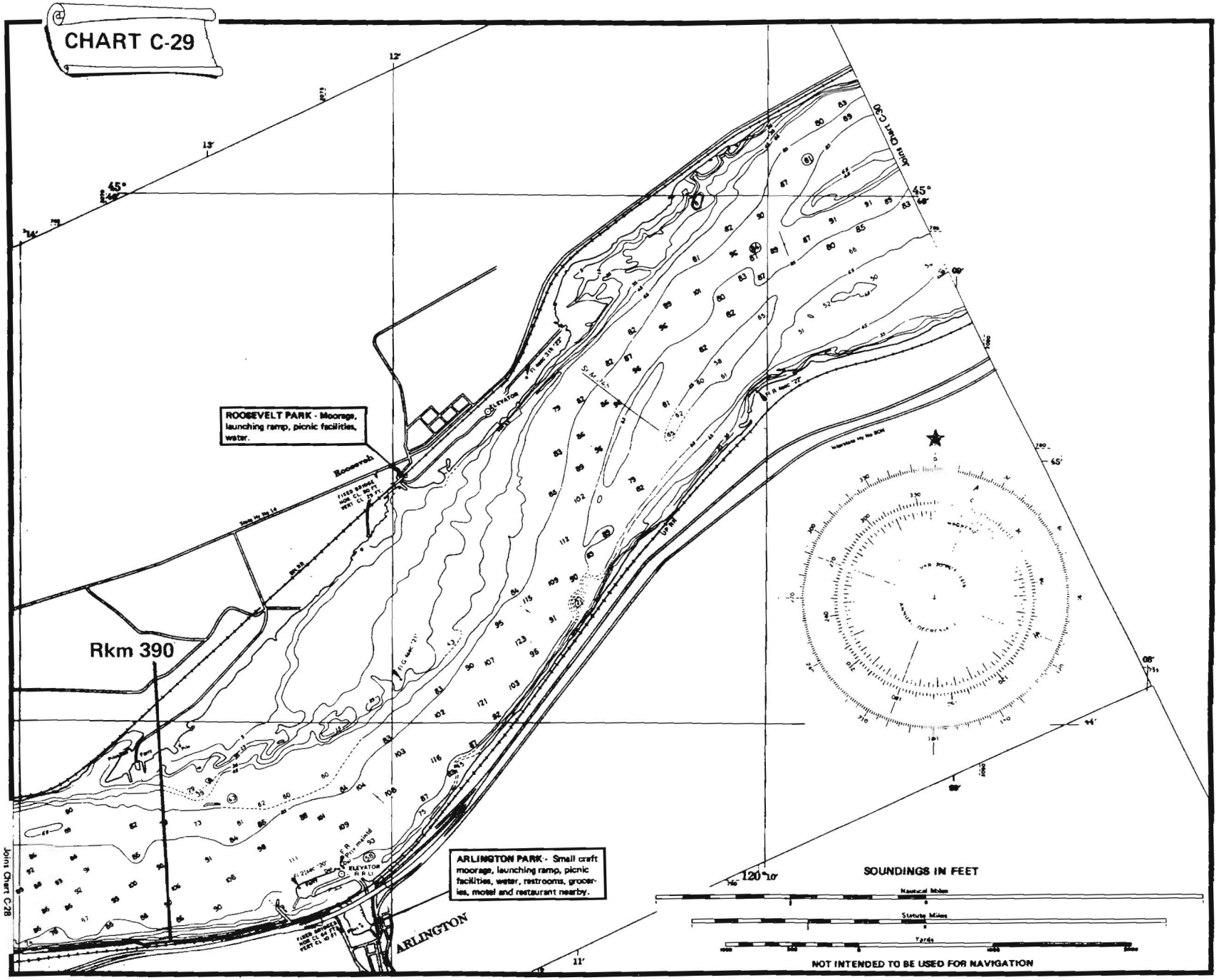
CHART C-29
ROOSEVELT PARK - Moorage, launching ramp, picnic facilities, water.
Rkm 390
ARLINGTON PARK - Small craft moorage, launching ramp, picnic facilities, water, restrooms, groceries, motel and restaurant nearby.
ARLINGTON
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
NOT INTENDED TO BE USED FOR NAVIGATION
Joins Chart C-28
Joins Chart C-30

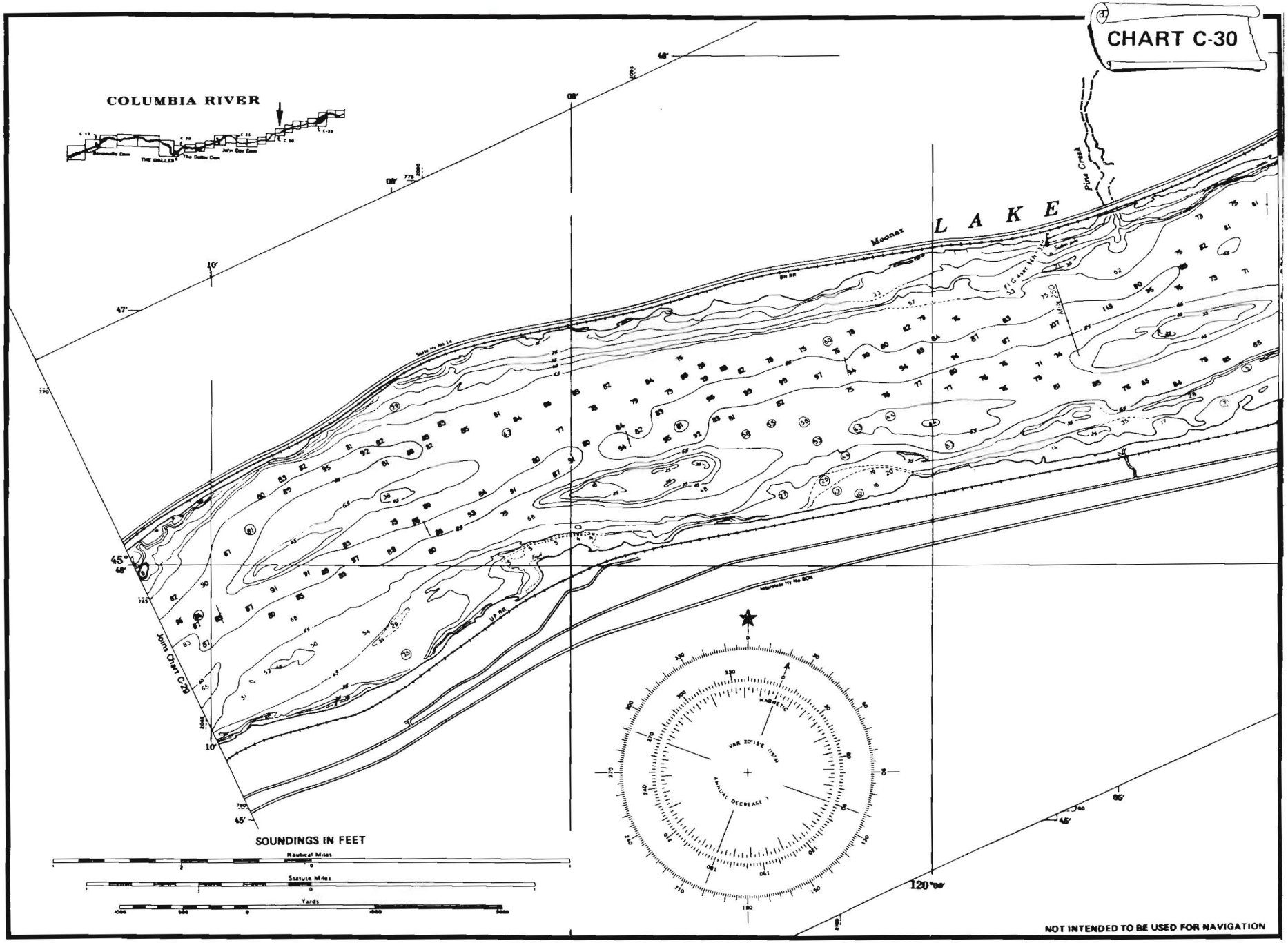
CHART C-30
COLUMBIA RIVER
LAKE
Moonax
Pine Creek
Joins Chart C-29
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
120°00'
NOT INTENDED TO BE USED FOR NAVIGATION

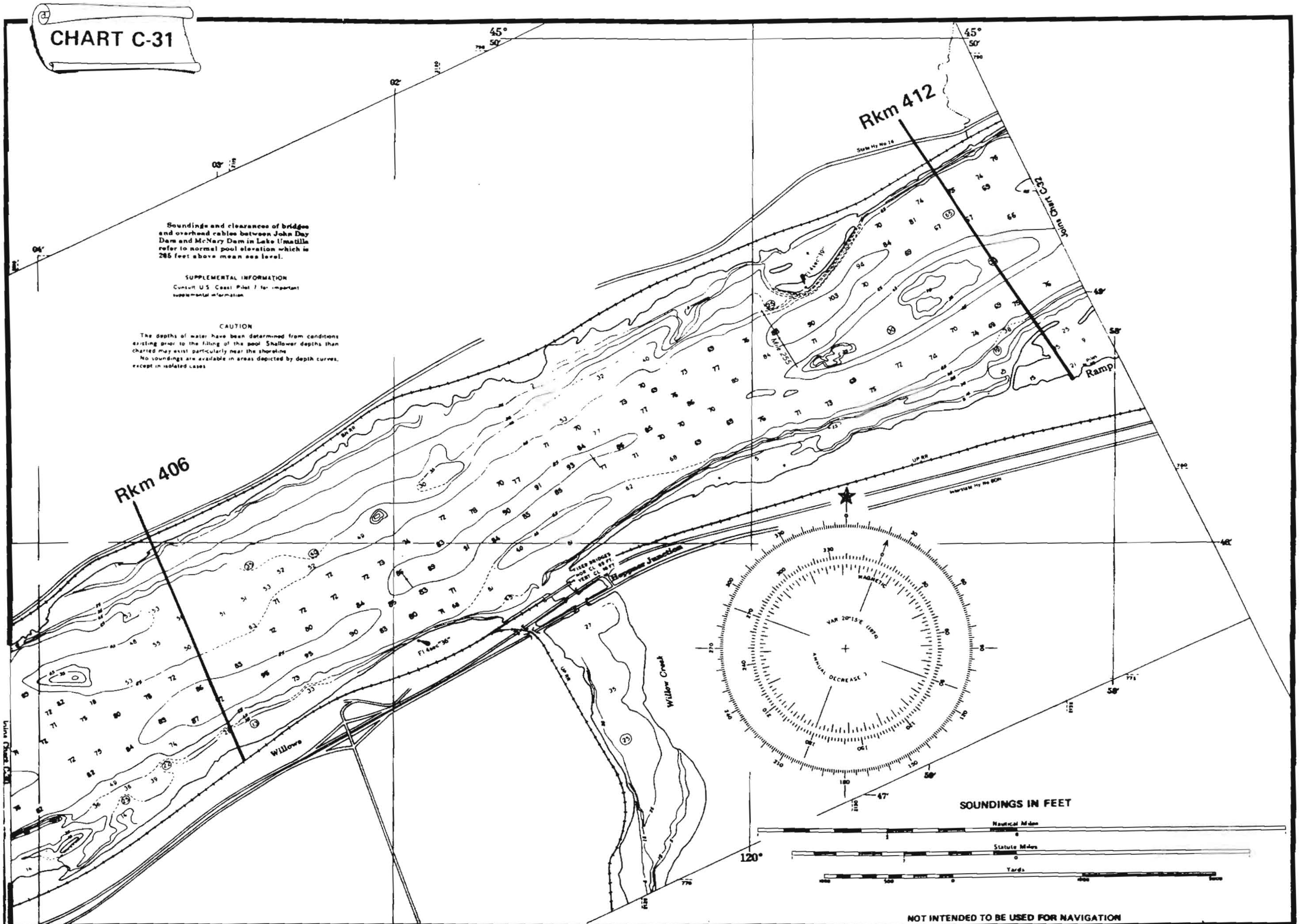
CHART C-31
Rkm 406
Rkm 412
Soundings and clearances of bridges and overhead cables between John Day Dam and McNary Dam in Lake Umatilla refer to normal pool elevation which is 265 feet above mean sea level.
SUPPLEMENTAL INFORMATION
Consult U.S. Coast Pilot 7 for important supplemental information
CAUTION
The depths of water have been determined from conditions existing prior to the filling of the pool. Shallower depths than charted may exist, particularly near the shoreline.
No soundings are available in areas depicted by depth curves, except in isolated cases.
Heppner Junction
Willows
Willow Creek
Ramp
Joins Chart C-32
SOUNDINGS IN FEET
NOT INTENDED TO BE USED FOR NAVIGATION

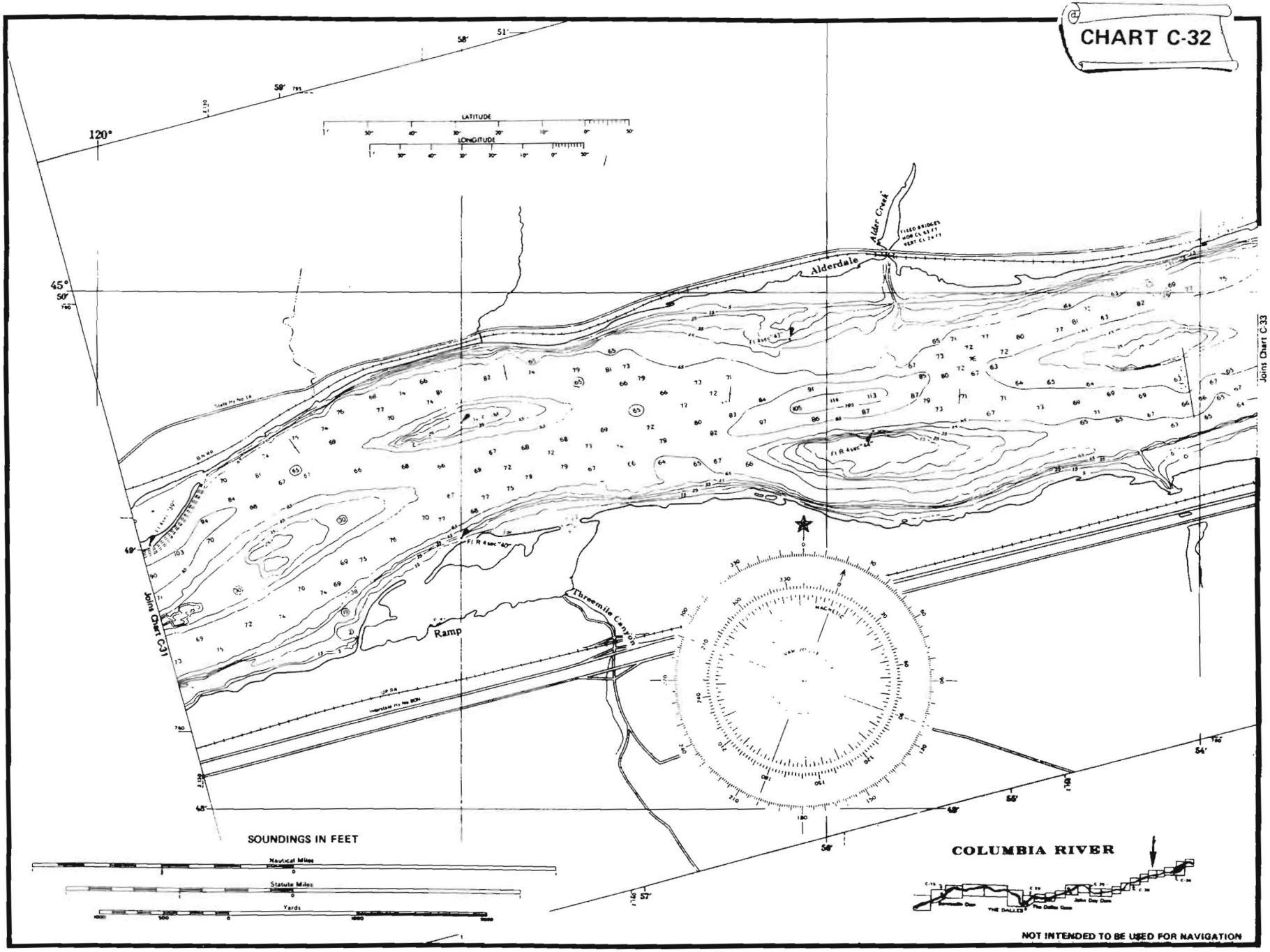
CHART C-32
LATITUDE
LONGITUDE
120°
58'
51'
45°
50'
48'
54'
57'
Alder Creek
FIXED BRIDGE
HOR CL 49 FT
VERT CL 76 FT
Alderdale
Threemile Canyon
Ramp
Joins Chart C-31
Joins Chart C-33
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
COLUMBIA RIVER
NOT INTENDED TO BE USED FOR NAVIGATION

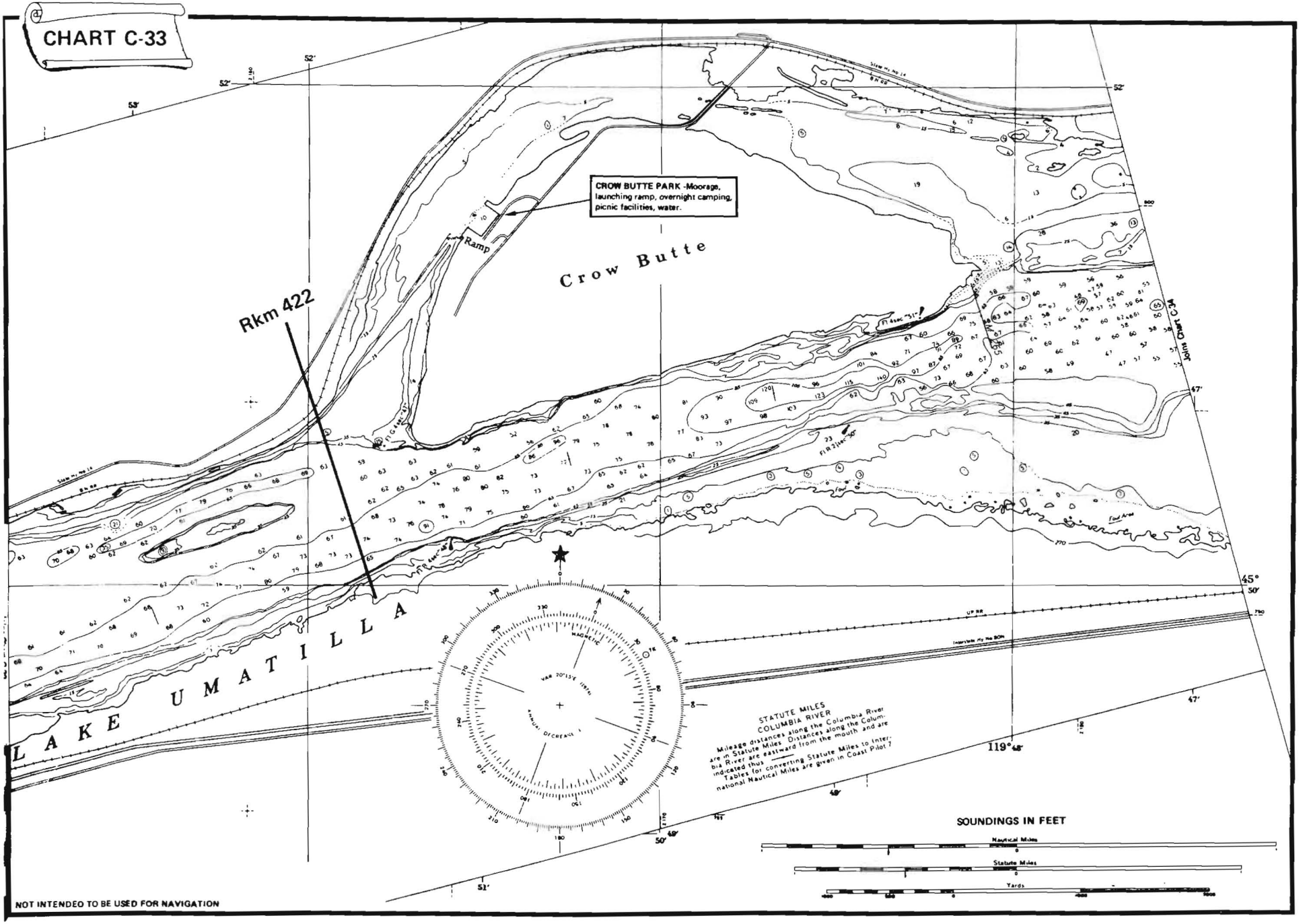
CHART C-33
CROW BUTTE PARK -Moorage, launching ramp, overnight camping, picnic facilities, water.
Ramp
Crow Butte
Rkm 422
LAKE UMATILLA
STATUTE MILES
COLUMBIA RIVER
Mileage distances along the Columbia River are in Statute Miles. Distances along the Columbia River are eastward from the mouth and are indicated thus ——. Tables for converting Statute Miles to International Nautical Miles are given in Coast Pilot 7
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
NOT INTENDED TO BE USED FOR NAVIGATION

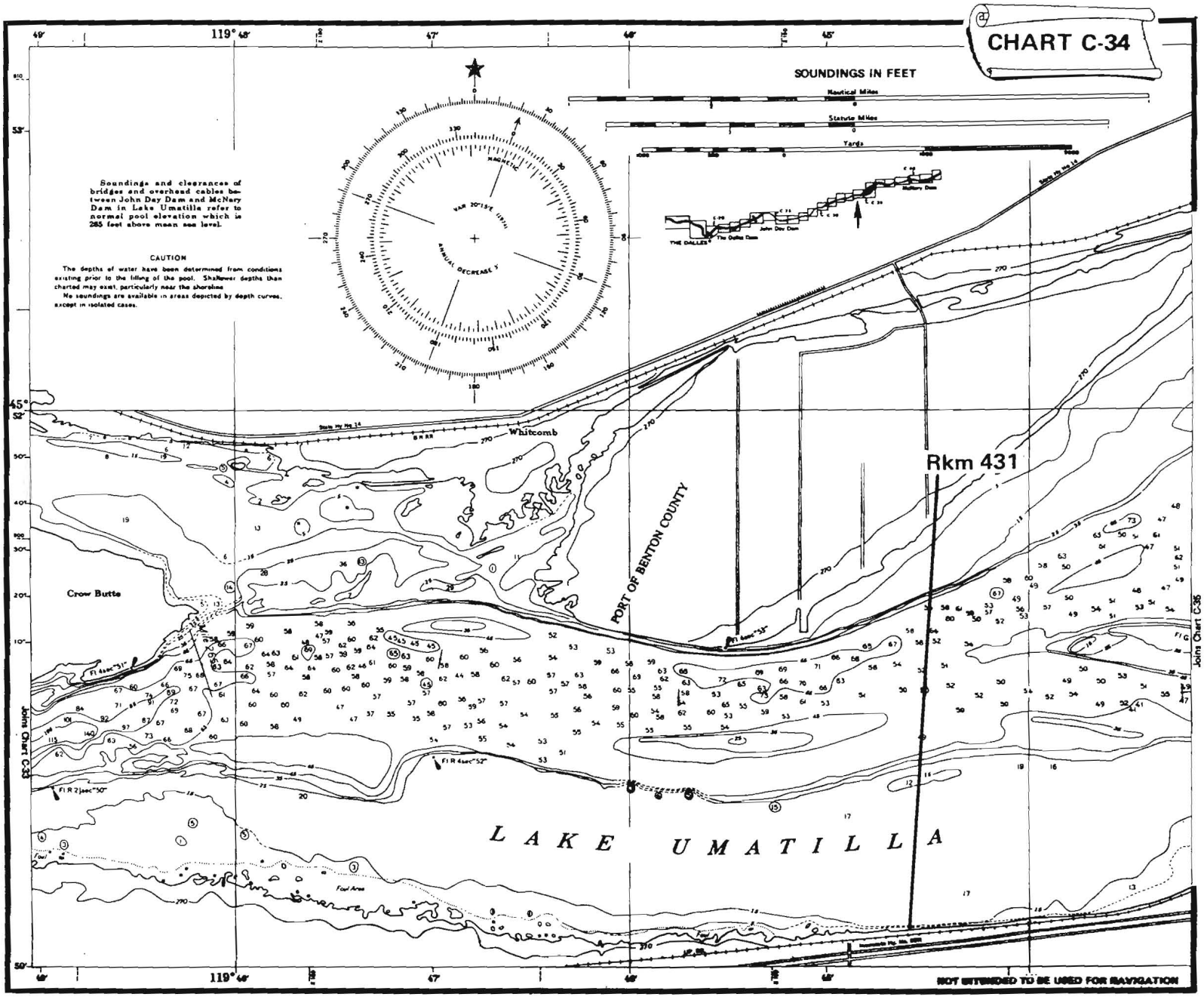
CHART C-34
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
Soundings and clearances of bridges and overhead cables between John Day Dam and McNary Dam in Lake Umatilla refer to normal pool elevation which is 285 feet above mean sea level.
CAUTION
The depths of water have been determined from conditions existing prior to the filling of the pool. Shallower depths than charted may exist, particularly near the shoreline.
No soundings are available in areas depicted by depth curves, except in isolated cases.
MAGNETIC
VAR 20°15'E (1994)
ANNUAL DECREASE 5'
Whitcomb
Rkm 431
PORT OF BENTON COUNTY
Crow Butte
LAKE UMATILLA
Fl R 4sec 52'
Fl R 2½sec 50'
Fl 4sec 31'
Fl 4sec 35'
Fl G
Foul Area
John Day Dam
The Dalles Dam
McNary Dam
THE DALLES
John Day Pool
John Chart C-33
John Chart C-35
119° 48'
119° 46'
45° 52'
45° 50'
NOT INTENDED TO BE USED FOR NAVIGATION

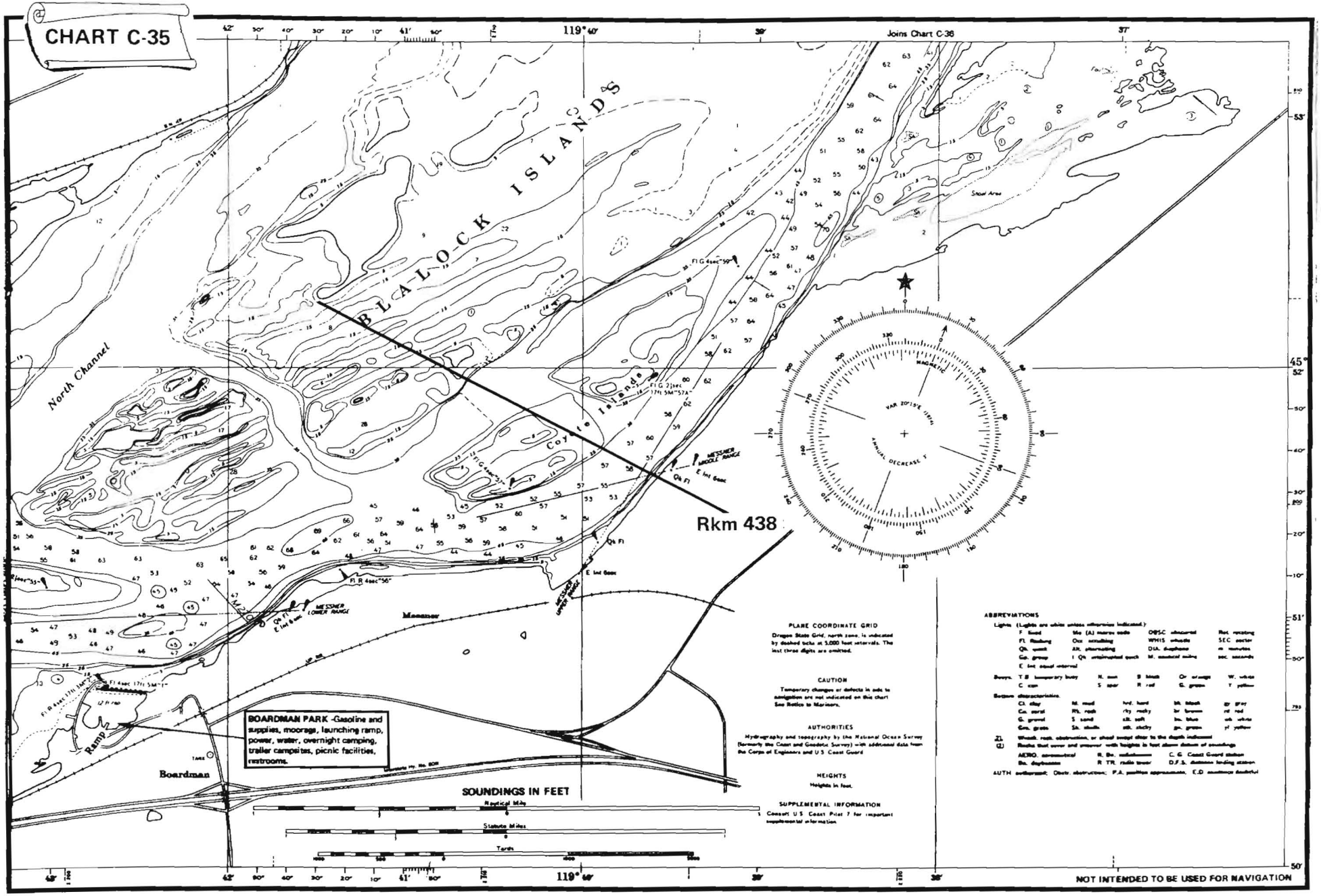
CHART C-35
Joins Chart C-36
BLACKLOCK ISLANDS
North Channel
Cove Island
Rkm 438
Manitou
Boardman
Ramp
BOARDMAN PARK -Gasoline and supplies, moorage, launching ramp, power, water, overnight camping, trailer campsites, picnic facilities, restrooms.
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
PLANE COORDINATE GRID
CAUTION
AUTHORITIES
HEIGHTS
SUPPLEMENTAL INFORMATION
ABBREVIATIONS
NOT INTENDED TO BE USED FOR NAVIGATION

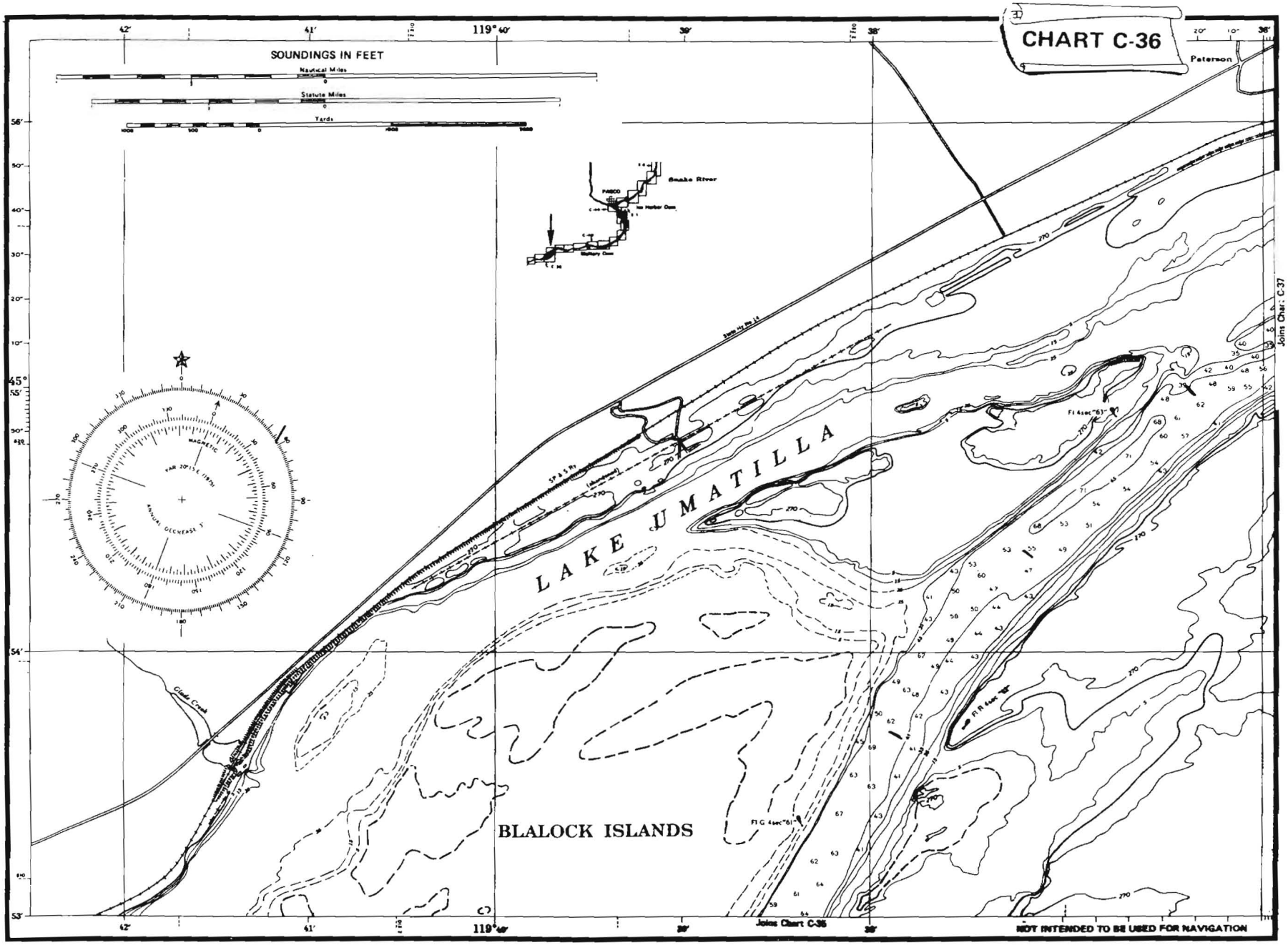
CHART C-36
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
LAKE UMATILLA
BLALOCK ISLANDS
Snake River
Glade Creek
Paterson
Joins Chart C-37
Joins Chart C-36
NOT INTENDED TO BE USED FOR NAVIGATION

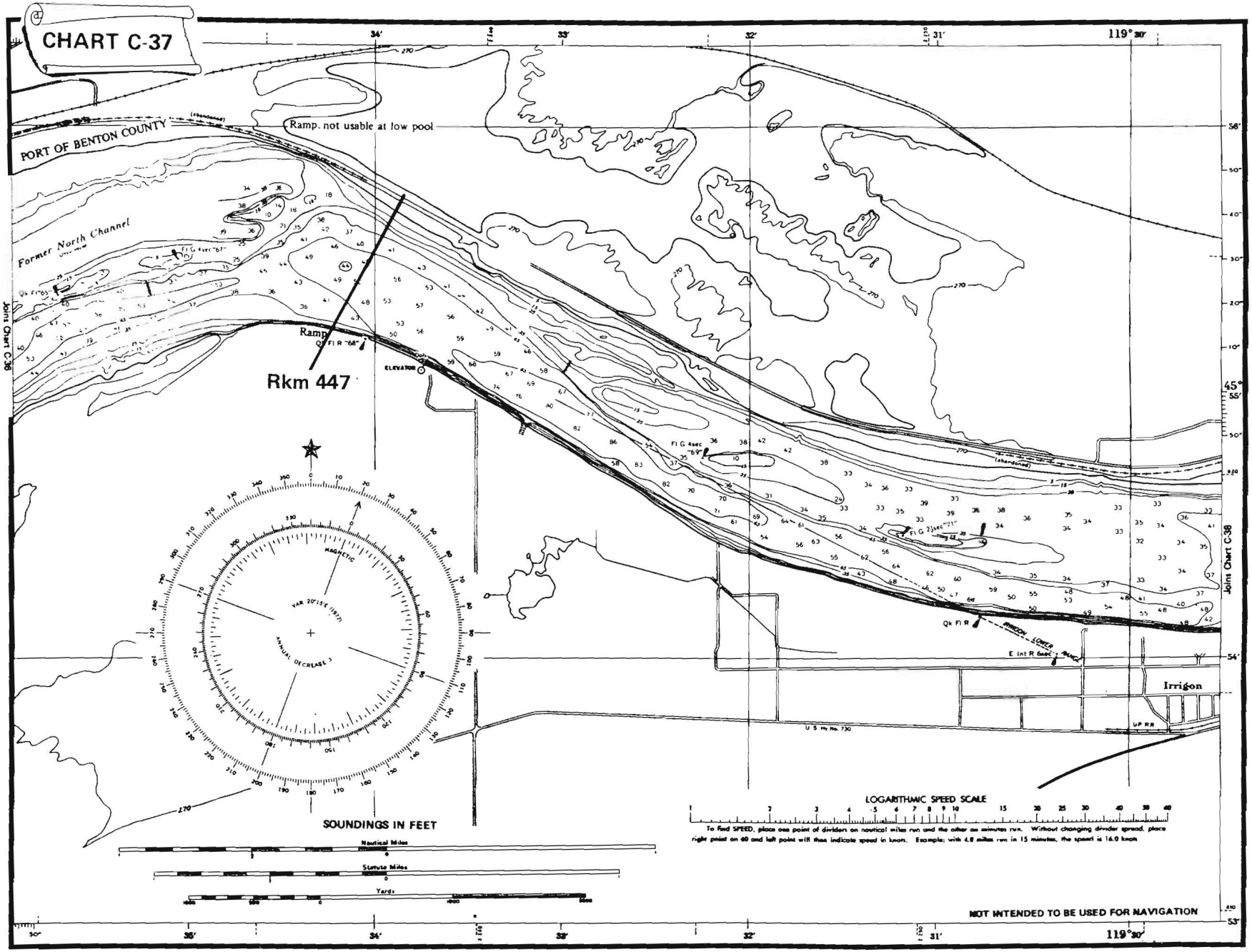
CHART C-37
PORT OF BENTON COUNTY
Ramp. not usable at low pool
Former North Channel
Rkm 447
Ramp
ELEVATOR
Irrigon
U S Hy No. 730
UP RR
Joins Chart C-36
Joins Chart C-38
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
LOGARITHMIC SPEED SCALE
To find SPEED, place one point of dividers on nautical miles run and the other on minutes run. Without changing divider spread, place right point on 60 and left point will then indicate speed in knots. Example: with 4.8 miles run in 15 minutes, the speed is 16.0 knots
NOT INTENDED TO BE USED FOR NAVIGATION

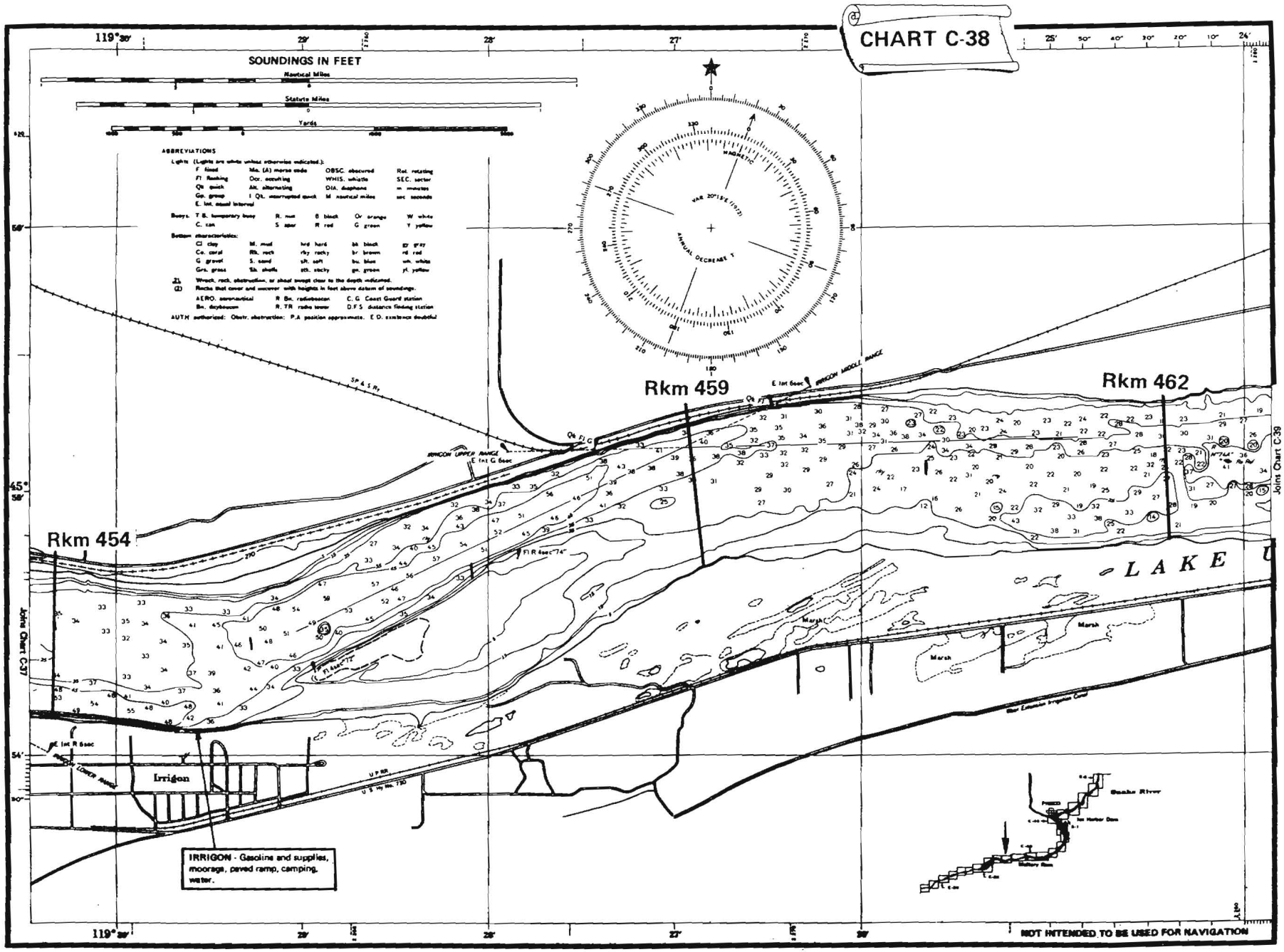
CHART C-38
SOUNDINGS IN FEET
Nautical Miles
Statute Miles
Yards
ABBREVIATIONS
Rkm 459
Rkm 462
Rkm 454
LAKE
Irrigon
IRRIGON - Gasoline and supplies, moorage, paved ramp, camping, water.
Marsh
Marsh
Marsh
Joins Chart C-37
Joins Chart C-39
NOT INTENDED TO BE USED FOR NAVIGATION

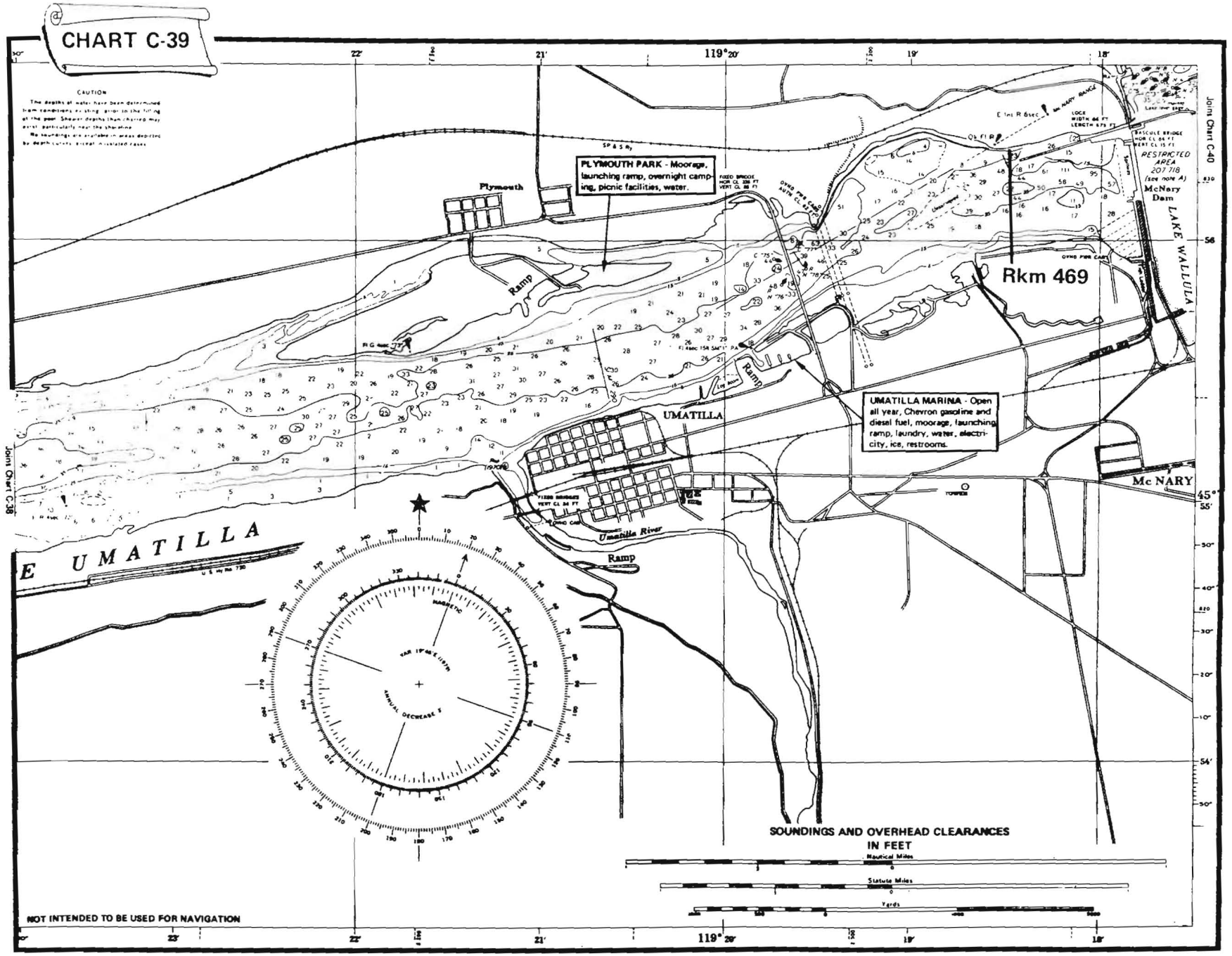
CHART C-39
CAUTION
PLYMOUTH PARK - Moorage, launching ramp, overnight camping, picnic facilities, water.
Plymouth
Ramp
Rkm 469
LAKE WALLULA
McNary Dam
RESTRICTED AREA 207.718 (see note A)
UMATILLA MARINA - Open all year, Chevron gasoline and diesel fuel, moorage, launching ramp, laundry, water, electricity, ice, restrooms.
UMATILLA
Ramp
Umatilla River
Ramp
McNARY
E UMATILLA
119°20'
John Chart C-40
John Chart C-36
SOUNDINGS AND OVERHEAD CLEARANCES IN FEET
Nautical Miles
Statute Miles
Yards
NOT INTENDED TO BE USED FOR NAVIGATION