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## **4.11A QUANTIFICATION OF IN-RIVER RESIDENCY AND OPTIMIZATION OF RELEASE STRATEGIES FOR HATCHERY COHO SALMON SMOLTS IN THE LOWER LEWIS RIVER (2001) (AQU 11A)**

### **4.11A.1 Study Objectives**

This report describes general residency time and migration behavior of coho smolts released into the Lewis River. Traditionally, hatchery coho in the Lewis River are released in the spring from the Lewis River Hatchery. The hatchery (RM 15.7) is located approximately 3 miles downstream of Lake Merwin.

Coho smolts released into the Lewis River have the opportunity to feed on wild fall chinook salmon fry rearing in the lower river. Hawkins and Tipping (1999) estimated an average of 4.7 percent of hatchery coho smolts in the Lewis River system consumed at least one wild chinook fry at the time of sampling. Preliminary investigations of coho predation rates on salmon fry show an evacuation period of approximately 25 hours. This indicates that recovered prey items in hatchery coho stomachs represent daily feeding rates (S. Hawkins, WDFW, pers. comm.). The numbers of wild salmon fry consumed by hatchery coho smolts may be substantial in systems where hatchery smolts are residing in areas of concentrated wild fry.

The objective of this study is to monitor the movement and in-river residency time of hatchery coho smolts released into the Lewis River system from 2 locations. These locations were selected to assess the potential difference in time that juvenile wild fall chinook are exposed to hatchery released coho smolts. It is generally accepted that reducing interactions between hatchery reared coho and wild fall chinook is beneficial. This assessment will facilitate decisions relating to the potential release locations of smolts that may result from anadromous fish reintroduction efforts currently under consideration.

### **4.11A.2 Study Area**

Radio-tagged smolts were tracked from the Lewis River Hatchery outfall (RM 15.7) downstream to the mouth of the Lewis River where it enters the Columbia River (Figure 4.11-1). Particular attention was focused on the 2 release sites: Lewis River Hatchery and Pekins Ferry boat ramp (RM 3.4).

### **4.11A.3 Methods**

Radio telemetry is being used to monitor coho movements in the lower river. For studies conducted in 2001, radio-tagged smolts were monitored from 2 release locations: the Lewis River Hatchery and Pekins Ferry.

#### 4.11A.3.1 Radio-Tag Monitoring

Two groups of 15 hatchery coho smolts measuring at least 150 mm (fork length) were equipped with radio transmitters (tag) prior to release. Advanced Telemetry Systems® micro-transmitters (oral) sized at 1.3 grams with a pulse width of 15 milliseconds were used on all fish. Tag frequencies were between 40 and 41 megahertz. Tagged fish were monitored from time of release until the battery life was depleted or suspected of depletion.

On April 9, 2001, 30 coho smolts were tagged. Each smolt was individually anesthetized in a solution of MS-222. Once anesthetized, the fish was held and a tag was inserted orally into the stomach. A hypodermic syringe tube was used to guide the tag into the smolt's stomach. The part of the tube that the needle would normally attach to was rounded with a file and sandpaper to reduce the chance of trauma to the smolt.

Each smolt was held for 24 hours in a fry raceway partitioned into 30 separate holding areas to determine tag regurgitation and delayed mortality. No tag regurgitation or mortality was observed during this period.

One group of 15 tagged coho smolts were monitored directly from their release point at the Lewis River Hatchery. A second group of 15 smolts were transported downstream and released at the Pekins Ferry boat ramp at River Mile 3.4.

A jet sled was used to track fish on most sampling days. An ATS® receiver with bi-directional antenna was used on board. Typically, in the reach from the Lewis River Hatchery to Pekins Ferry, the boat was allowed to drift with the current, noting fish position when a signal was received. This allowed excellent coverage of the river due to the very slow speed. Often, the location of the signal could be marked within an area about 20 by 20 feet.

#### 4.11A.4 Key Questions

The study addresses the following “key” watershed questions identified during the Lewis River Cooperative Watershed Studies meetings:

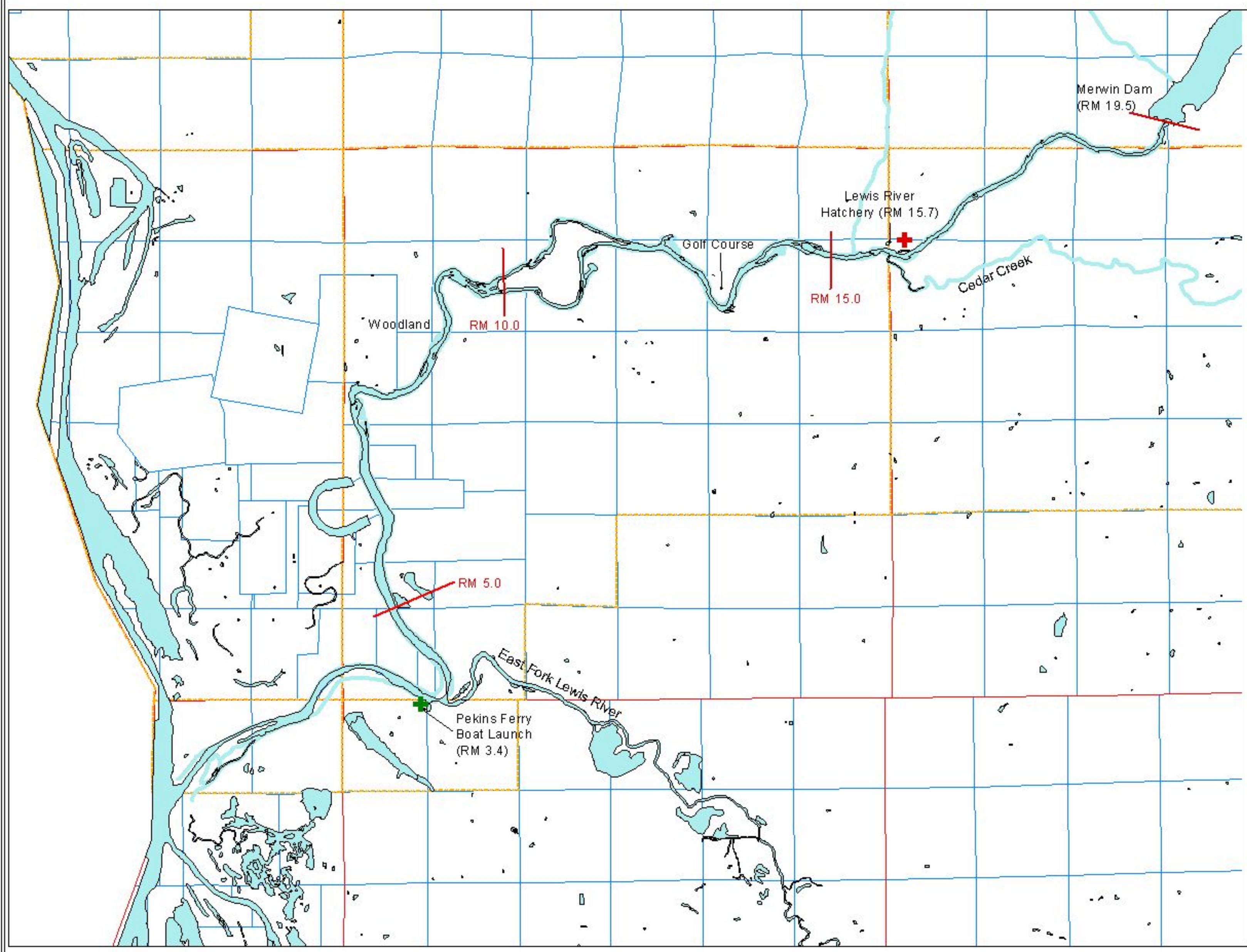
- What is the average length of time coho smolts reside in the Lewis River system following direct release from the hatchery?
- Upon release from sites downstream of the hatchery, where do coho smolts move in relation to their release points?

The following additional key questions were asked by the Aquatic Resources Group (ARG) for inclusion into this report:

- What have been the benefits and/or impacts of hatchery programs on wild and/or native salmonid stocks in the basin (including changes to abundance, genetic diversity, life history patterns, distributions, and behavior)?

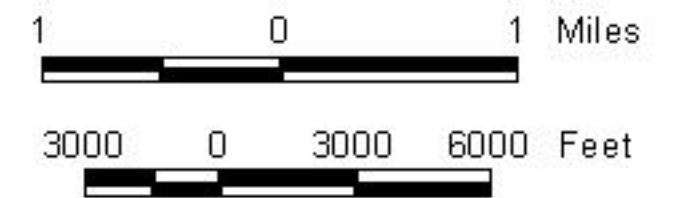
**Figure 4.11-1**

**Location of Pekins Ferry and Lewis River Hatchery Release Sites**



Release Sites

- + Pekins Ferry Release Site (n=15)
- + Lewis River Hatchery Release Site (n=15)



Implementation of hatchery programs undoubtedly has increased the abundance of naturally produced fish. This is especially true for coho in the Lewis River, where many returning coho have been left in river to spawn in recent years. The classification of the progeny is the subject of great debate and not at all connected to this study. Perhaps even more complicated is the fitness or survivability of these progeny and their impact to wild depressed stocks.

For a detailed analysis of this key question, please refer to AQU 8 (Study on Fish Management and Hatchery Operations in the Lewis River).

- What effects do hatchery operations have on competition for food and space in rearing areas used by wild or native salmonids?

Hatchery fish may outcompete native stocks for both food and space based largely on their size, which typically is significantly larger than naturally produced stocks.

- What effects might hatchery releases have on predation of wild juvenile salmonids (including direct predation by hatchery fish and increases in predation by other fish or avian predators)?

Hatchery smolts are known to prey upon wild fall chinook smolts in the Lewis River. Therefore, by decreasing the residency time, and thus potential interaction between the species, predation of wild fall chinook by hatchery produced coho and spring chinook smolts will be minimized. Steelhead smolts are also known to prey upon wild fall chinook, as are cutthroat. Residualization of any of these species is of particular concern. Spring chinook residuals known as “mini jacks” actively feed on fry and smolts.

- What types of interspecific interactions may occur with various options for reintroducing anadromous fish?

This study could not address this question.

#### 4.11A.5 Results

This section provides a summary of tagged fish with frequencies, fork lengths and release locations of individual fish (Table 4.11-1). Also, detailed maps are provided in figures 4.11-1 through 4.11-7 indicating the position of individual fish during the study period on each survey day.

##### 4.11A.5.1 Radio-Tag Monitoring

This section illustrates results obtained during surveys from April 11 to May 2, 2001. Results are presented as maps depicting the location of smolts detected during each survey.

**Table 4.11-1. Tagging summary of coho smolts documenting length, frequency, and release location.**

#	Frequency (MHz)	Fish Length (mm, fork length)	Release Location
1	40.011	158	Lewis River Hatchery
2	40.021	185	
3	40.031	176	
4	40.041	150	
5	40.051	156	
6	40.061	163	
7	40.091	167	
8	40.101	162	
9	40.111	156	
10	40.681	152	
11	40.691	162	
12	40.701	159	
13	40.711	165	
14	40.731	153	
15	40.741	150	
16	40.071	165	Pekins Ferry
17	40.080	166	
18	40.121	156	
19	40.131	163	
20	40.141	160	
21	40.151	150	
22	40.601	145	
23	40.611	159	
24	40.621	155	
25	40.631	153	
26	40.641	156	
27	40.651	157	
28	40.661	156	
29	40.671	155	
30	40.721	152	

A total of 6 surveys was completed (Figures 4.11-2 through 4.11-7). All surveys were conducted by boat. Surveys typically began at the Lewis River Hatchery and were completed by drifting to the mouth—a distance of about 15 miles. On April 13 (Figure 4.11-3), the reach (to RM 17.0) upstream of the Lewis River Hatchery was surveyed to determine if smolts had swum upstream from the Lewis River Hatchery release site.

Figure 4.11-2

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch

Survey Date: April 11, 2001  
Survey Type: Boat  
Surveyors: Erik Lesko  
No. of Fish Found:  
LRH = 8/15 60%  
PF = 6/15 40%  
Survey Reach: RM 0.0 - 5.0  
RM 11.0 - 15.7

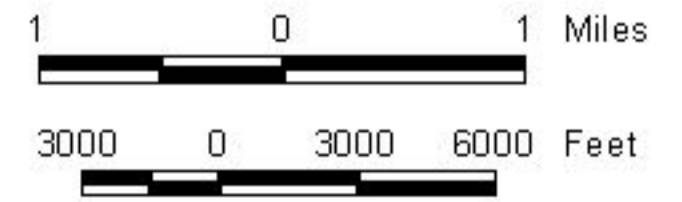
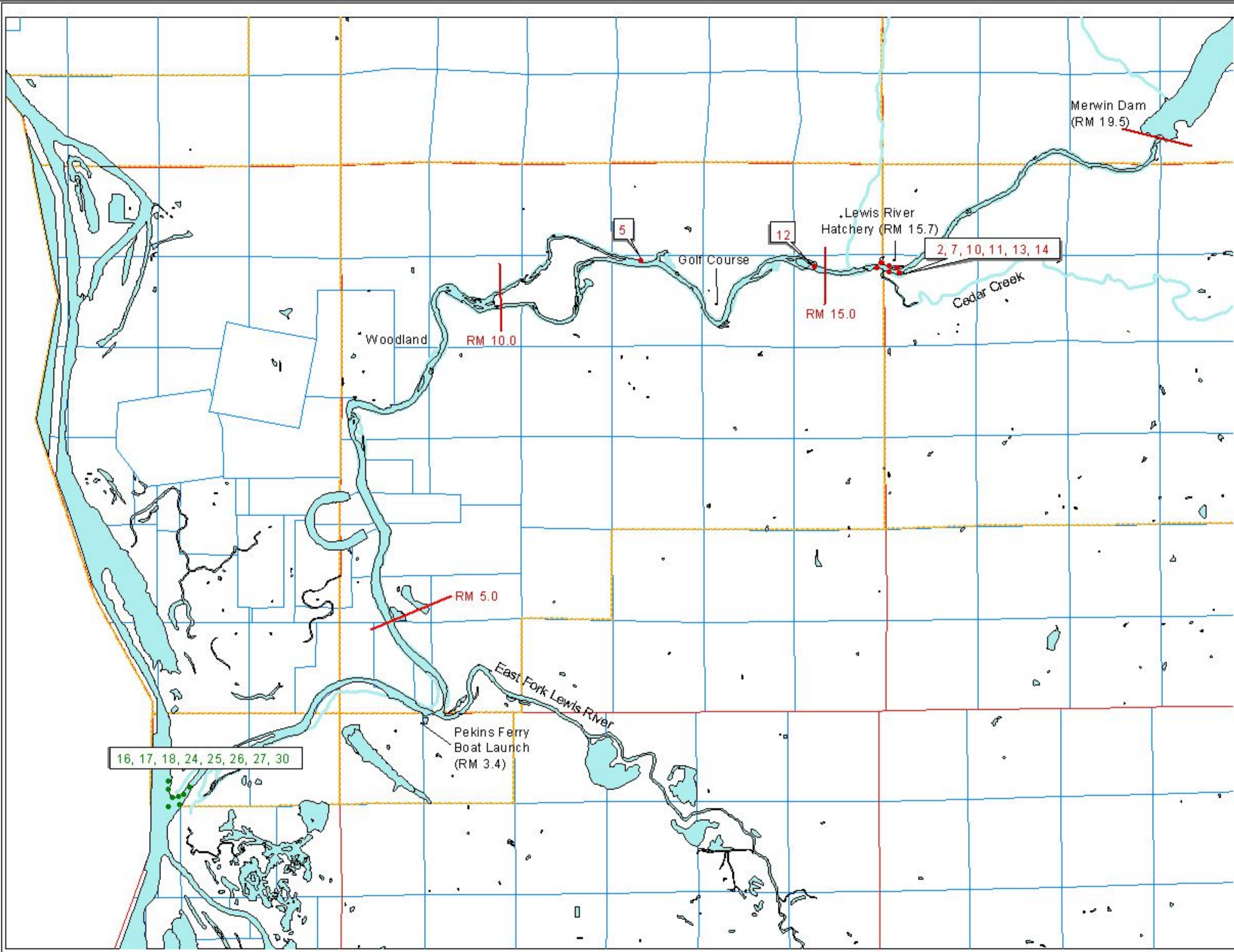




Figure 4.11-3

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch

Survey Date: April 13, 2001  
Survey Type: Boat  
Surveyors: Erik Lesko  
Found: No. of Fish  
LRH = 12/15 80%  
PF\* = 0/15 0%  
Survey Reach: RM 0.0 - 17.0

\* (all Pekins Ferry Smolts have  
emigrated from Lewis River)

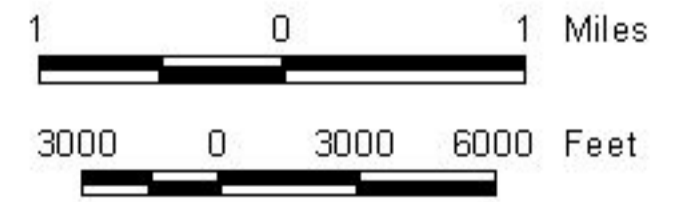
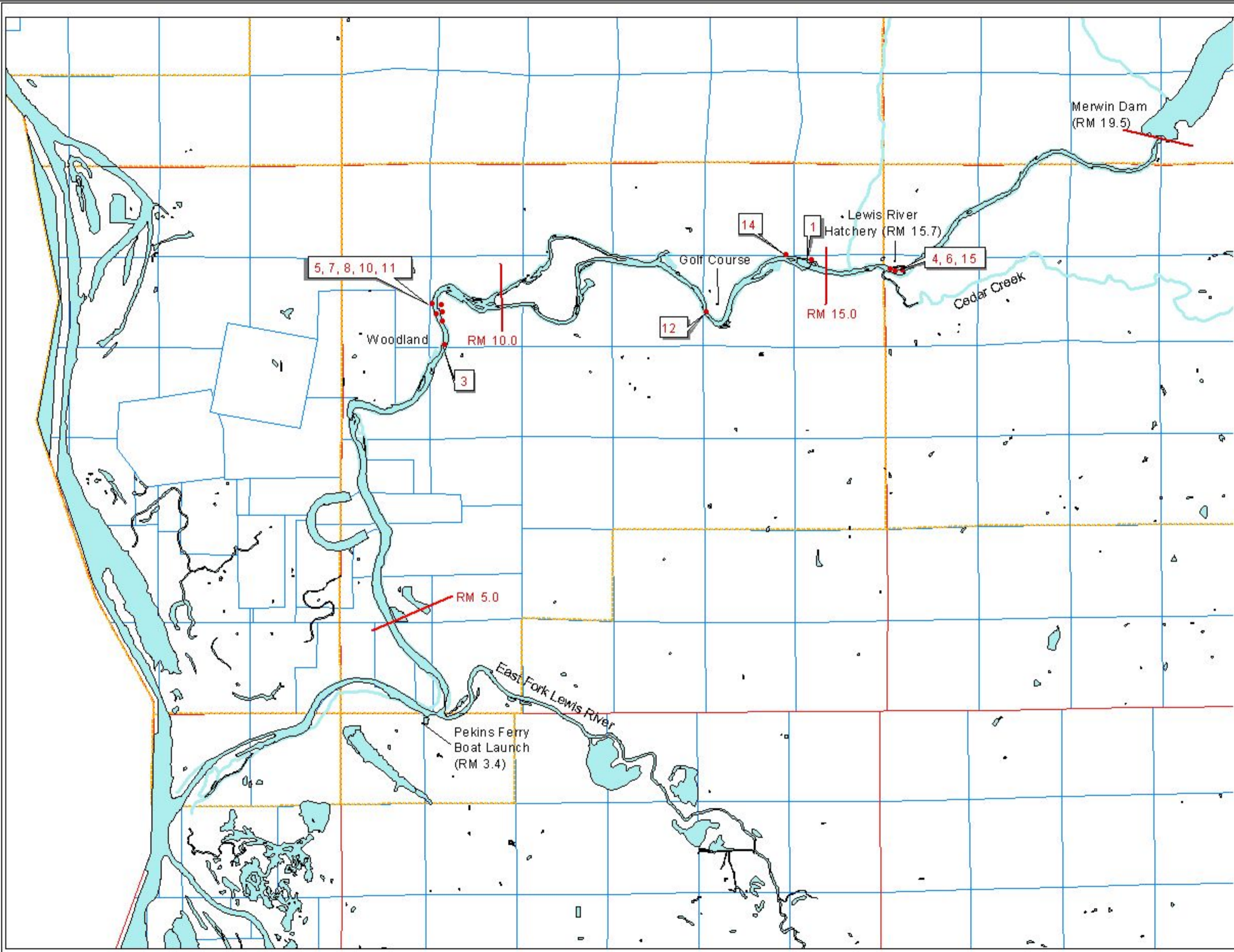


Figure 4.11-4

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch

Survey Date: April 20, 2001  
Survey Type: Boat  
Surveyors: Erik Lesko  
Found: No. of Fish  
LRH = 6/15 40%  
PF = 0/15 0%  
Survey Reach: RM 0.0 - 15.0

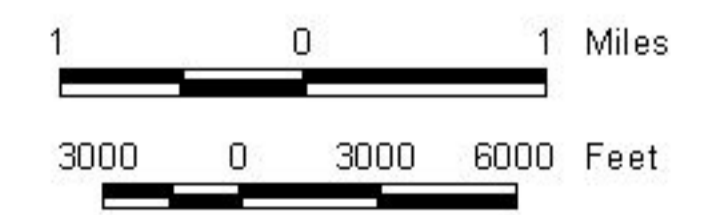
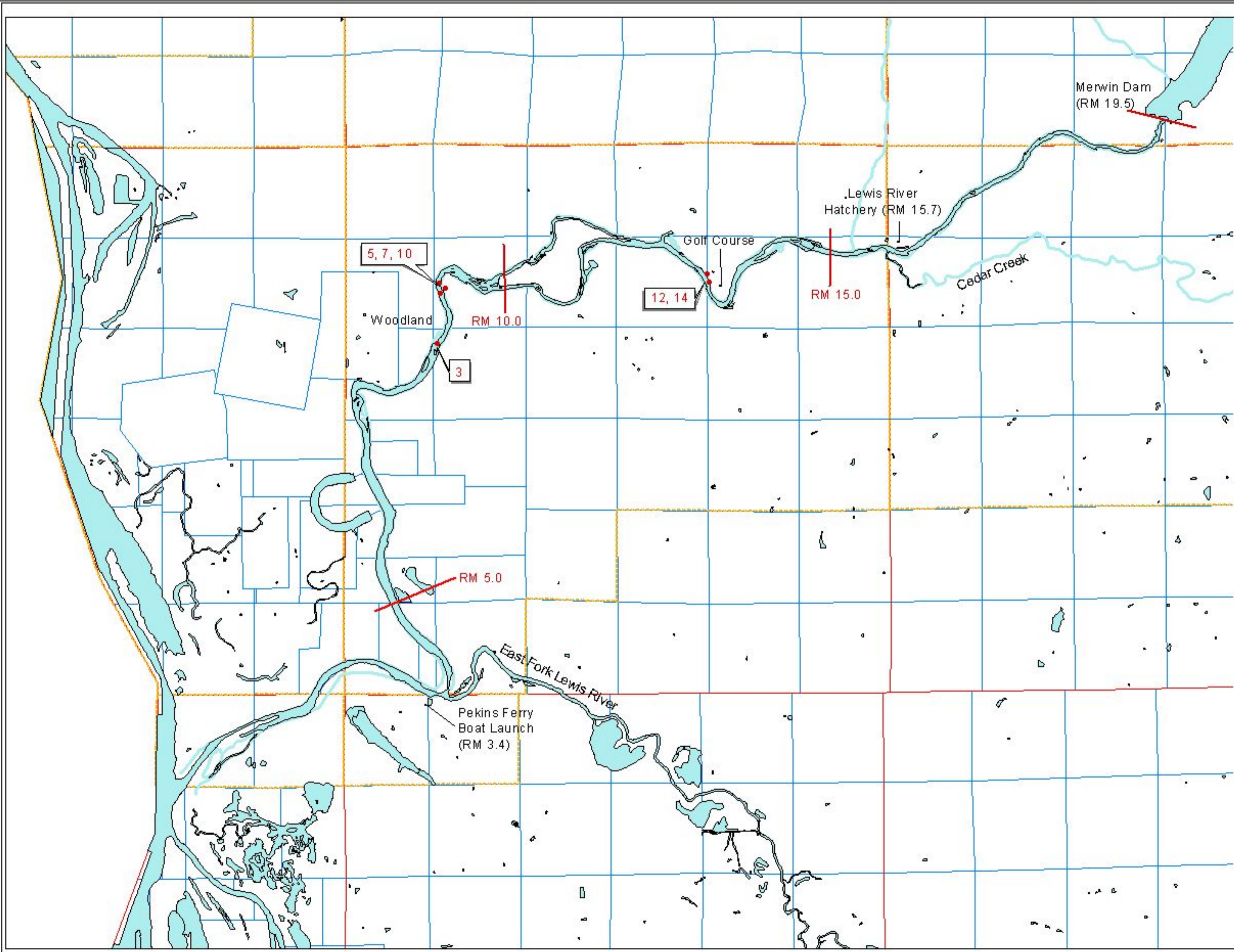


Figure 4.11-5

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch

Survey Date: April 25, 2001  
Survey Type: Boat  
Surveyors: Lesko, Leonhart  
Found: No. of Fish  
LRH = 8/15 53%  
PF = 0/15 0%  
Survey Reach: RM 0.0 - 16.0

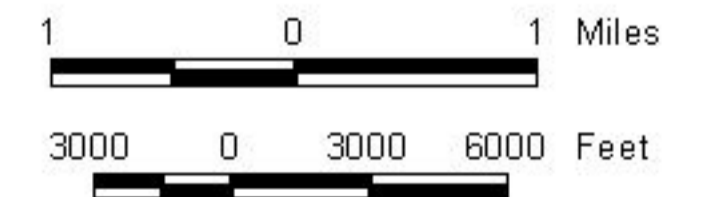
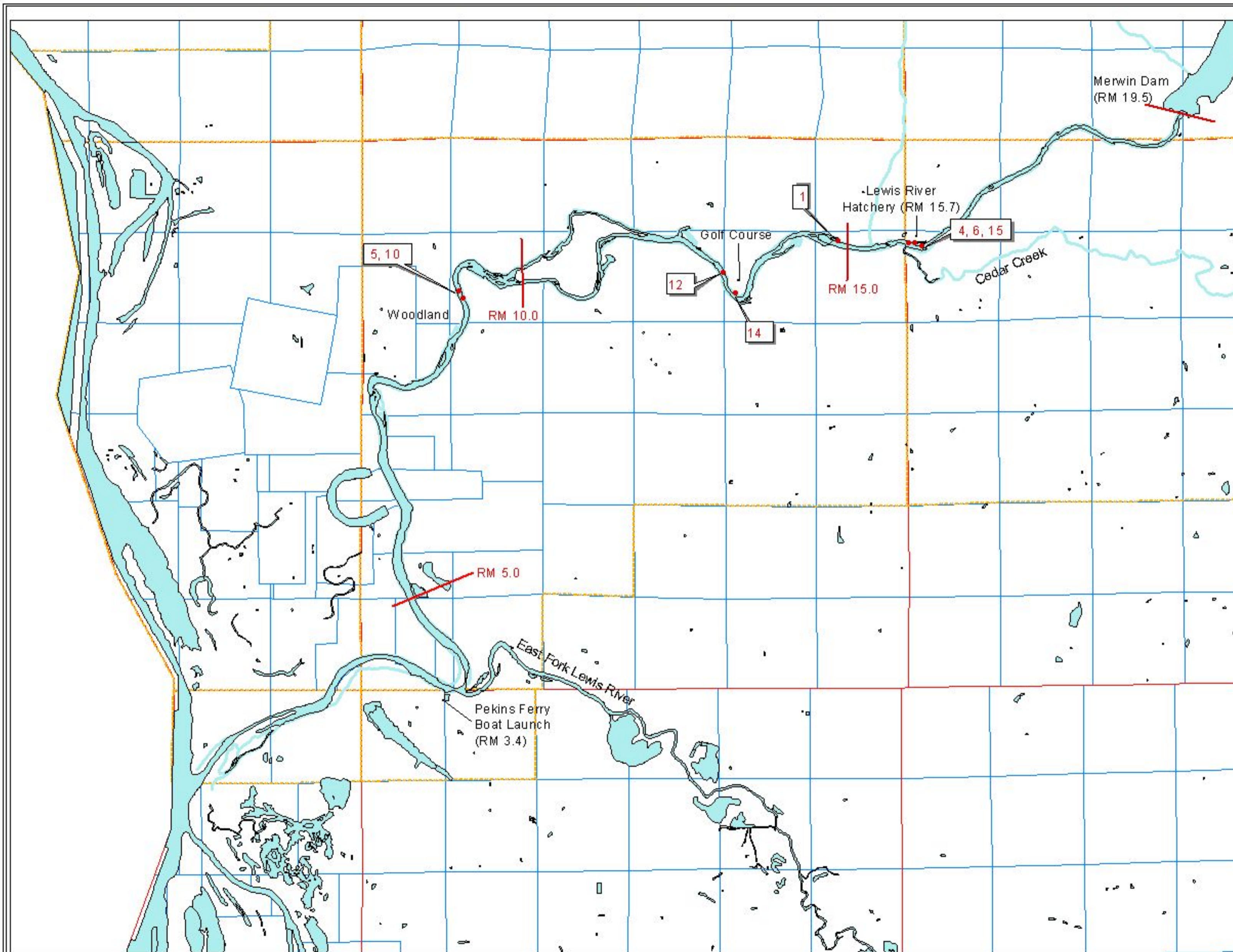
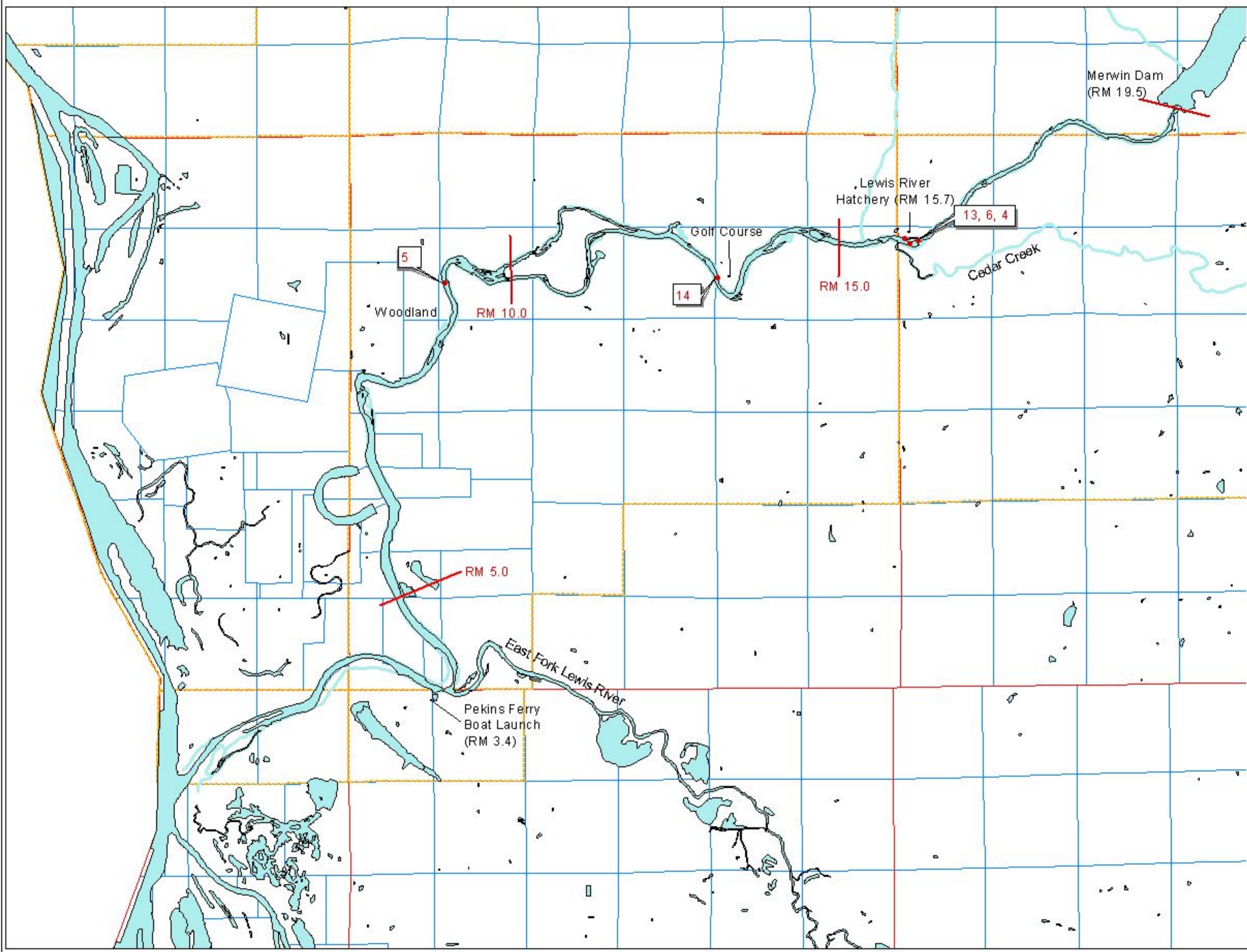


Figure 4.11-6

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch



Survey Date: May 11, 2001  
Survey Type: Boat  
Surveyors: Lesko  
Found: No. of Fish  
LRH = 5/15 33%  
PF = 0/15 0%  
Survey Reach: RM 6.0 - 16.0

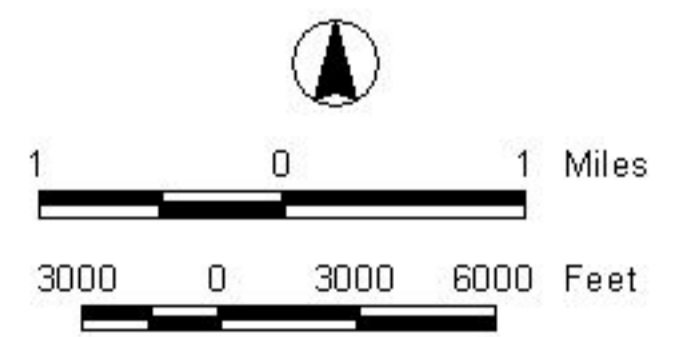
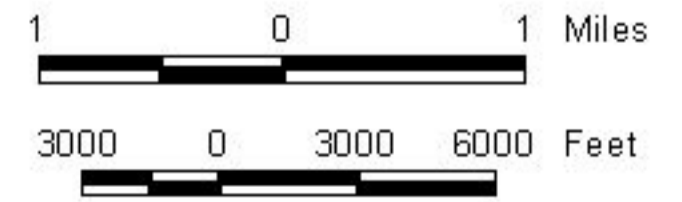
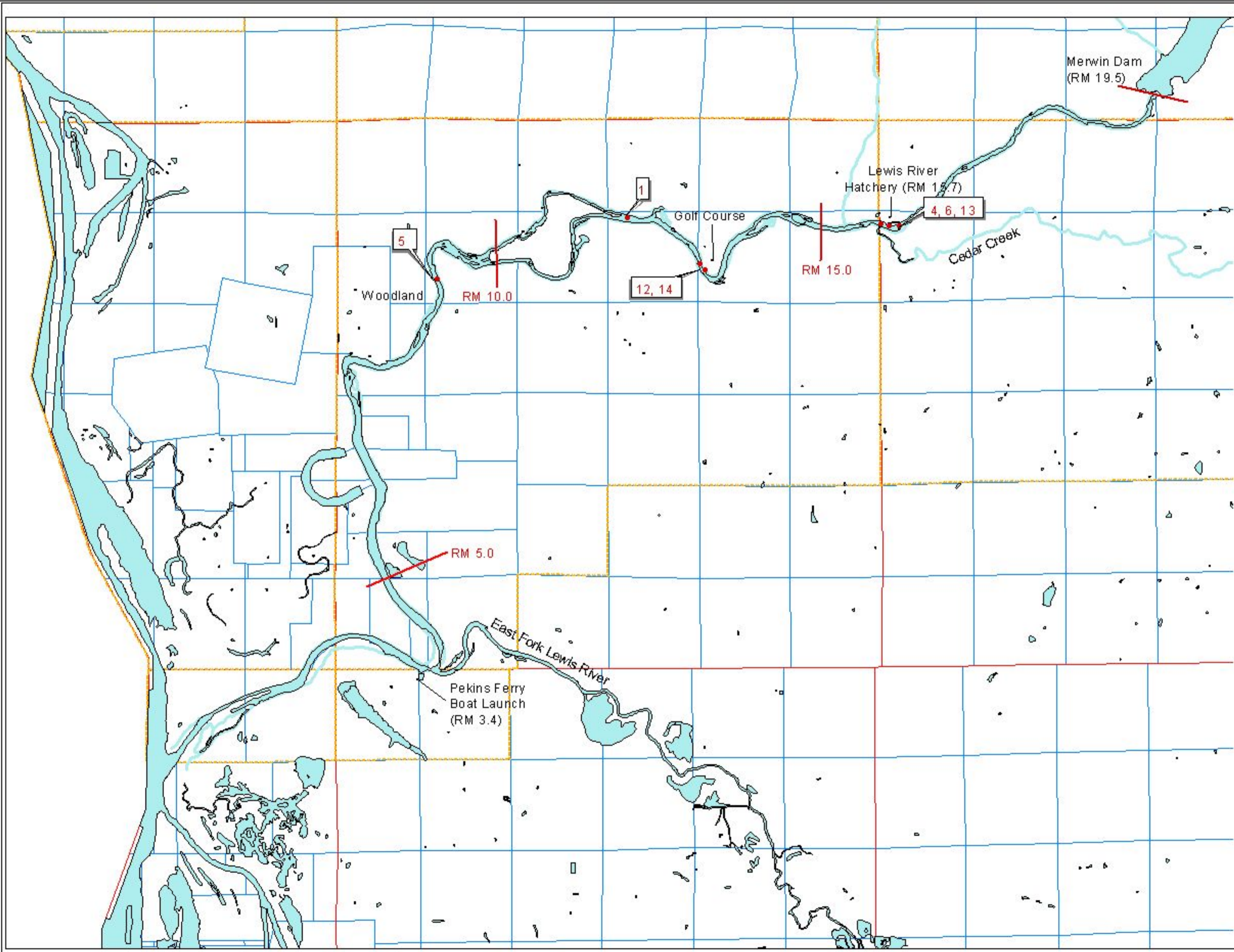


Figure 4.11-7

Tracking results of  
radio-tagged coho smolts  
released at Lewis River  
Hatchery (LRH) and Pekins Ferry  
(PF) boat Launch

Survey Date: May 02, 2001  
Survey Type: Boat  
Surveyors: Lesko, Leonhardt  
Found: No. of Fish  
LRH = 7/15 47%  
PF = 0/15 0%  
Survey Reach: RM 6.0 - 16.0



#### 4.11A.6 Discussion

The purpose of this study was to describe the migration behavior of hatchery-reared coho smolts released into the Lewis River. Specifically, residency time and migration behavior were examined.

Residency time is one of many indices used in assessing the effect hatchery programs may have on native stocks within the same watershed. It is generally considered detrimental to have hatchery smolts interspersed with native stocks, due mainly to concerns over predation and intraspecific competition. Large hatchery programs such as on the Lewis River can have significant effects on native populations (Hawkins and Tipping 1999).

Migration behavior is associated with residency time, but focuses on the movement pattern while in the river system. For example, coho smolts tend to select backwater or side channel habitat in river systems. During outmigration coho smolts may use these areas during the day to rest, feed and avoid predators. Knowledge of these preferred locations may help in future salmonid management in the Lewis River and hatcheries.

##### 4.11A.6.1 Residency Time

Residency time for smolts released at both the Lewis River Hatchery and Pekins Ferry boat launch differed substantially. This was anticipated due to distance of each release location from the confluence of the Lewis River with the Columbia River (Figure 4.11-1).

Smolts were released into the Lewis River at both release points on April 10, 2001. Coincidentally, this was the same release schedule for the hatchery coho plantings. In 2001, hatchery program smolts were released at Pekins Ferry instead of the typical Cedar Creek pool due to low water and the potential for increased interaction between hatchery coho and fall chinook fry.

Fish were tracked within 24 hours after release. All of the Pekins Ferry smolts emigrated from the Lewis within this period. Eight of the 15 smolts (53 percent) released were located at the mouth of the Lewis River on the first tracking day (April 11), indicating a travel distance of about 3.5 miles (Figure 4.11-2). No more signals were received from these fish during the remainder of the study. This suggests that all Pekins Ferry fish emigrated from the Lewis River within 24 hours and did not re-enter the Lewis during the study period.

For smolts released at the Lewis River Hatchery, residency time for some was longer. On April 13, 3 days after release, 80 percent of the radio tagged smolts were located. Of the fish detected, half were located between the hatchery and golf course (RM 13). The remaining detections were all located downstream of Eagle Island in a large deep pool immediately downstream of the Lewis River Inn Bed and Breakfast between RM 9 and 10 (Figure 4.11-3). This suggests that the remaining 20 percent that were not detected either emigrated from the Lewis River or were preyed upon (e.g., birds).

#### 4.11A.6.2 Migration Behavior

Surveys (Figures 4.11-4 through 4.11-7) showed a preference of some smolts to inhabit 3 specific pools and backwater areas for prolonged periods: the Cedar Creek pool (RM 15.7) golf course pool (RM 13.2) and Lewis River Inn pool (RM 9.1). The farthest downstream pool (Lewis River Inn) was significant in that it appeared to be the last point of detection for smolts. That is, from this point downstream, it was unlikely the smolts would rest for any prolonged period before reaching the Columbia River. This observation is based on the fact that no detections (other than smolt #3) were observed downstream of this pool after repeated surveys.

Although not measured, tidal influences may influence outmigration of smolts. Tidal effects are quite noticeable at Pekins Ferry boat launch and it is likely that smolts released at this location migrate out with the tide. For fish released at the Cedar Creek pool, tidal influences are negligible, and perhaps the influence of tidal activity does not become perceptible to smolts until they reach the Lewis River Inn pool at RM 9.1. At this point, the smolts will follow the outgoing tide to the Columbia River. This is supported by residency time below this pool, which was less than 24 hours.

The in-river difference that exist upstream and downstream of RM 9.1 are visually noticeable. Upstream of RM 9.1, the river is composed of distinct pools, riffles and glides, while downstream, the river is composed primarily of pools and glides that are more difficult to separate. This characteristic is typical of habitat near the mouths of rivers where habitat units tend to be relatively long compared to upstream habitat units. The “blending” of habitat units is also the result of channelization. This man-made channelization has, in effect, reduced the amount of backwater pools available to migrating smolts (as compared to habitat upstream of RM 9.1) and contributes to the speed of emigration and lack of detections downstream of RM 9.1 noted in the study.

#### 4.11A.6.3 Conclusion

Results from this study indicate that smolts planted in areas downstream of RM 9.1 are likely to emigrate from the Lewis River within 24 hours. This is based on results from the Pekins Ferry release and the lack of detections of smolts released at Lewis River Hatchery downstream of RM 9.1. The rapid outmigration of smolts downstream of RM 9.1 is likely a result of tidal influences. That is, smolts use the outgoing tide to facilitate their outmigration from the Lewis River to the Columbia River (and Pacific Ocean).

The differences observed between the 2 release sites may be significant in the context of protecting outmigrating chinook fry; smolts downstream of RM 9.1 tended to leave the system in 24 hours, thereby reducing the potential for interspecies interaction (predation). Also, because coho tended to seek out pool habitat for prolonged periods between the Lewis River Hatchery and RM 9.1, the potential for predation by coho on chinook fry increases.

It is important to note that planting of coho smolts downstream of the Lewis River Hatchery may affect return rates to the hatchery. Also, there may be increased straying of adult returns with downstream plants.

#### 4.11A.7 Schedule

Radio telemetry studies continued in spring 2002, with results presented in Study AQU 4.11B. Methods differ from the 2001 study in that only 1 release site was used—the Lewis River Hatchery.

The adoption of additional radio telemetry studies in 2002 was agreed to by the ARG to describe variability associated with river flows. The additional radio telemetry work was agreed to in lieu of the mark-recapture component of the original study plan.

#### 4.11A.8 References

Hawkins, S.W., and J.M. Tipping. 1999. Predation by juvenile hatchery salmonids on wild fall chinook salmon fry in the Lewis River, Washington. *California Fish and Game* 85(3):124-129.



4.11A.9 Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

<b>Commenter</b>	<b>Volume</b>	<b>Page/ Paragraph</b>	<b>Statement</b>	<b>Comment</b>	<b>Response</b>	<b>Response to Responses</b>
WDFW – KAREN KLOEMPKE	1	AQU 11A		Missing pages 3-4, 7-18.	Pages 11-3 through 11-4 is an 11x17 figure (Fig. 4.11-1). Pages 11-7 through 11-18 is where Figures 4.11-2 through 4.11-7 are placed. If these were omitted from WDFW's copy, we regret the printer's error.	
WDFW – CURT LEIGH	1	AQU 11A	Lower River release.	Should explain why 2002 work is being conducted, i.e.: drought, unusual hatchery release location, etc.	This will be added to the final report.	
WDFW – JIM BYRNE	1	AQU 11A	Lower river coho.	Poor Spring 2001 flows affected the normal contingent of coho, which were not released from Lewis River Hatchery. Instead of 1.5 million smolts release there were only 15-tagged coho. Their behavior would not be the same as a normal release. Flow patterns in the river were not typical of a normal release. This study needs to be repeated.	A comparison of results from 2001 and 2002 will be made to determine any difference between these years on fish behavior and flow rates.	
WDFW – JIM BYRNE	1	AQU 11A- 5	Predation.	Predation impact of hatchery fish not addressed. Normal plant not released from hatchery. No attempt to recover tagged fish to see if fall chinook in stomachs.	Predation impacts were beyond the objectives of this study.	
WDFW – JIM BYRNE	1	AQU 11A- 7 – 18		Missing pages.	Pages 11-7 through 11-18 are 11x17 figures, number Figure	

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
WDFW – JIM BYRNE	1	AQU 11A- 20	Residence time.	Residence time of 15 fish may not be the same as for 1.5 million plant plus 15 fish. “Pied Piper” effect not accounted for. “Outgoing tidal” justification is speculation. Tidal influence, I believe extends upstream of the Lewis River Inn. The conclusions provide no description of the reductions in flow for this year or even mention it was an anomalous flow year.	4.11-2 through 4.11-7.  Anglers in the lower river have described differences in river conditions downstream and upstream of the Lewis River Inn. Predominately backwater pools and glides downstream with riffles and pools upstream. A comparison between the 2 studies will occur.	Tidal effect was not apparent in 2002 data. <b>Licensees’ Response:</b> <i>This report is not yet final. A description of any tidal effect will be included in the final report in late 2002.</i>

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