

Relicensing Study 3.3.1

Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station

ADDENDUM 4

NEW SEA LAMPREY WEIGHTED USABLE AREA CURVES BASED ON AGENCY PROPOSED HABITAT SUITABILITY INDEX CURVES

**Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)**

Prepared for:



Prepared by:



MAY 2018

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LIST OF ABBREVIATIONS

CRC	Connecticut River Conservancy
FERC	Federal Energy Regulatory Commission
FirstLight or FL	FirstLight Hydro Generating Company
HSI	habitat suitability index
MADFW	Massachusetts Division of Fisheries & Wildlife
NMFS	National Marine Fisheries Service
USFWS	United States Fish and Wildlife Service
WUA	weighted usable area

1 INTRODUCTION

On October 14, 2016, FirstLight (FL) filed with the Federal Energy Regulatory Commission (FERC) Study Report No. 3.3.1 Instream Flow Habitat Assessment in the Bypass Reach and below Cabot Station. On October 31 and November 1, 2016, FL held its study report meeting in which Study No. 3.3.1 was discussed on October 31. After filing meeting minutes on November 15, 2016, comments on Study No. 3.1.1 were filed by the United States Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), the Massachusetts Division of Fisheries & Wildlife (MADFW), the Connecticut River Watershed Council (now called the Connecticut River Conservancy or CRC) and Karl Meyer. On January 17, 2017, FL filed its responsiveness summary.

On February 17, 2017 FERC issued its Determination on Requests for Study Modifications and New Studies. In its Determination Letter relative to Study No. 3.3.1 Instream Flow Habitat Assessments in the Bypass Reach and below Cabot Station it discussed habitat suitability index (HSI) curves for Sea Lamprey based on depth and velocity data collected at Sea Lamprey nest locations¹. Stakeholders requested that the habitat suitability index (HSI) curves originally developed from existing literature be modified based on the site-specific depth and velocity data collected at five Sea Lamprey nesting sites in the Connecticut, Ashuelot and Millers Rivers. FERC's Determination Letter stated:

“Because this site-specific habitat data is specific to the project area and would be useful for adjusting or verifying the HSI curves taken from the literature, we recommend FirstLight consult with the agencies and use the data collected at documented sea lamprey spawning sites in study 3.3.15 to make adjustments to (or verify) the literature-based curves. If use of this data result in adjustments to the HSI curves, we recommend that FirstLight incorporate the new curves into the PHABSIM model and produce revised estimates of WUA for sea lamprey spawning in the bypassed reach and downstream of Cabot Station and file an addendum to the study by May 15, 2017”.

On March 16, 2017, FirstLight held its study report meeting on five studies that had been filed with FERC on March 1, 2017. In the agenda for the March 16, 2017 meeting, FirstLight indicated it would also like to consult with stakeholders on a method of developing the Sea Lamprey spawning HSI curves. Based on feedback at the meeting, it was agreed that FirstLight would develop two sets of HSI curves based on a) using all five Sea Lamprey spawning locations and b) using only the two spawning locations on the Connecticut River mainstem.

On April 12, 2017 FirstLight emailed stakeholders a memo that included three sets of HSI curves based on a) using all five Sea Lamprey spawning locations, b) using only the two spawning locations on the Connecticut River mainstem and c) using only the two spawning locations (Hatfield S curve and Fall River) where ammocoetes were documented. FirstLight requested comments on the memo by April 21, 2017.

On May 11, 2017, FirstLight filed a letter with FERC stating that the Sea Lamprey spawning HSI curves had not been finalized as consultation was still ongoing. All correspondence to/from stakeholders were included in Attachment A of the May 11, 2017 filing.

On May 24, 2017, USFWS (via Don Pugh with CRC) provided a spreadsheet with its proposed HSI curves via email to FirstLight.

¹ As part of Study No. 3.3.15 *Assessment of Adult Sea Lamprey Spawning with the Turners Falls Project and Northfield Mountain Project Area* depth and velocity data were collected at Sea Lamprey nests.

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On June 1, 2017 there was a meeting in Northfield, MA where the Sea Lamprey HSI curves were discussed. At the meeting, FirstLight requested stakeholders to explain how the proposed Sea Lamprey spawning HSI curves were developed.

On June 2, 2017, Don Pugh emailed FirstLight an explanation of how the Sea Lamprey spawning HSI curves were developed.

Per Study Plan No. 3.3.1 Sea Lamprey spawning was to be assessed in Reaches 1, 2, 3 and 4. Section 2 includes the new Sea Lamprey spawning HSI curves for velocity/depth along with the weighted usable area (WUA) versus flow relationships.

2 UPDATED SEA LAMPREY HABITAT SUITABILITY INDEX CURVES AND WUA RESULTS

2.1 Updated Sea Lamprey Habitat Suitability Index Curves

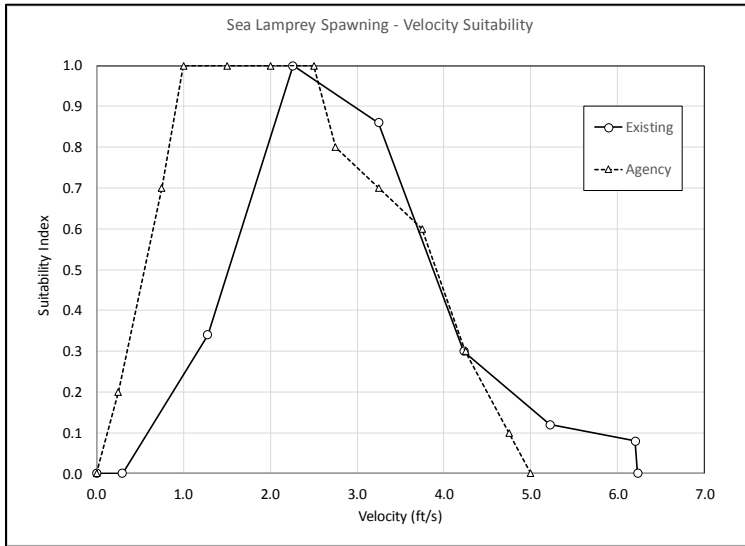
Shown in [Figure 2.1-1](#) are the Sea Lamprey HSI curves, which include the existing and new (Agency) velocity and depth curves. There was no change to the substrate curves.

2.2 Weighted Usable Versus Flow Curves

Using the new (Agency) Sea Lamprey HSI curves, new WUA versus flow relationships were developed. Sea Lamprey spawning was a target species for Reaches 1, 2, 3 and 4. Shown in [Appendix A](#) are the WUA versus flow curves, which are in the following order: Reach 1, Reach 2, Reach 3 and Reach 4.

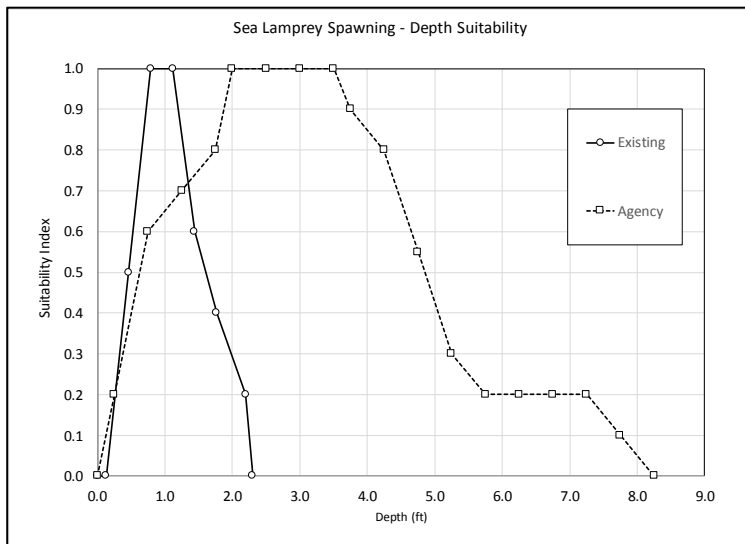
In addition, shown in [Appendix B](#) are the tables of WUA versus flow used to create the figures in [Appendix A](#).

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Existing	
Velocity (ft/s)	SI Value
0.00	0.00
0.30	0.00
1.28	0.34
2.26	1.00
3.25	0.86
4.23	0.30
5.22	0.12
6.20	0.08
6.23	0.00

Agency	
Velocity (ft/s)	SI Value
0.00	0.00
0.25	0.20
0.75	0.70
1.00	1.00
1.50	1.00
2.00	1.00
2.50	1.00
2.75	0.80
3.25	0.70
3.75	0.60
4.25	0.30
4.75	0.1
5	0



Existing	
Depth (ft)	SI Value
0.00	0.00
0.13	0.00
0.46	0.50
0.79	1.00
1.12	1.00
1.44	0.60
1.77	0.40
2.20	0.20
2.30	0.00

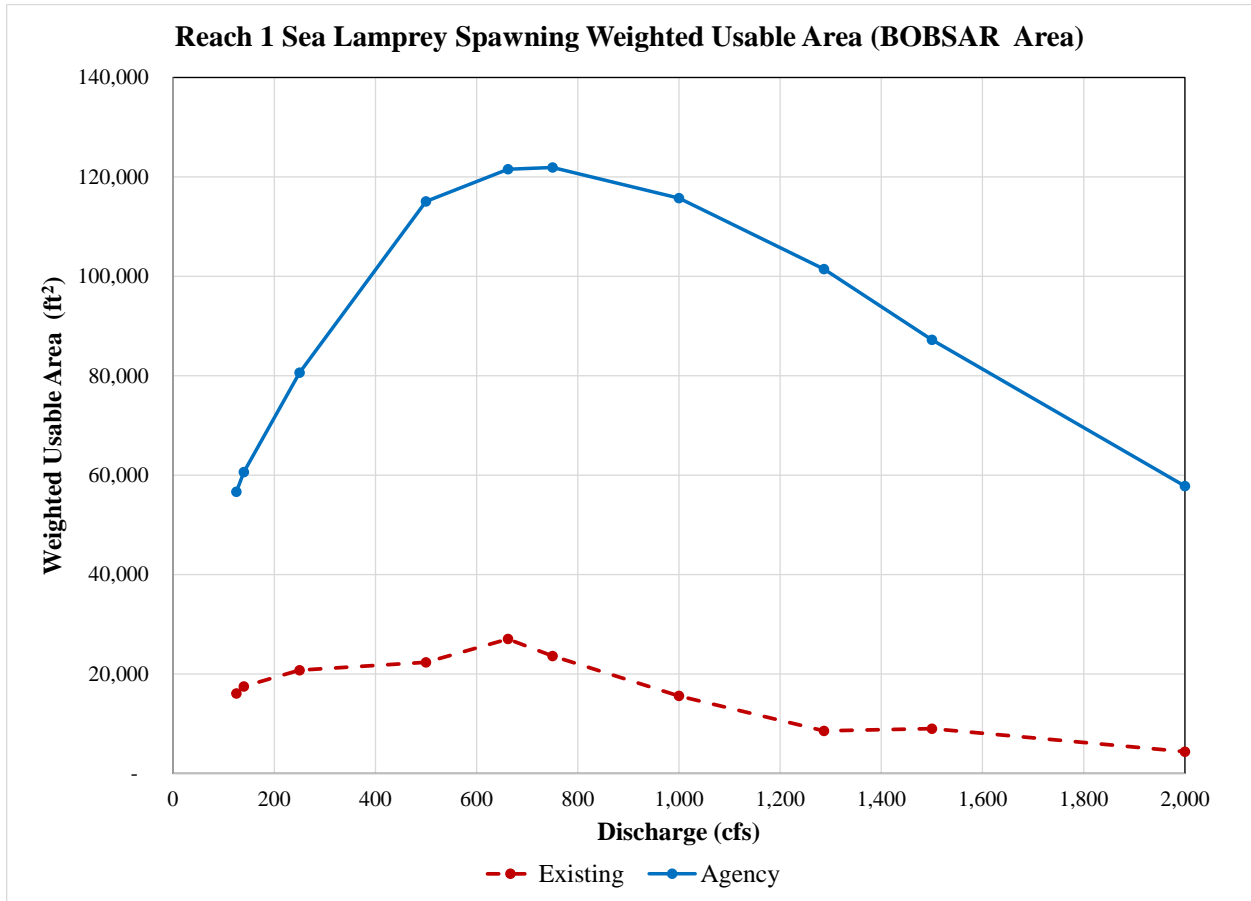
Agency	
Depth (ft)	SI Value
0.00	0.00
0.25	0.20
0.75	0.60
1.25	0.70
1.75	0.80
2.00	1.00
2.50	1.00
3.00	1.00
3.50	1.00
3.75	0.90
4.25	0.80
4.75	0.55
5.25	0.30
5.75	0.20
6.25	0.20
6.75	0.20
7.25	0.20
7.75	0.1
8.25	0

Figure 2.1-1: Existing and New (Agency) Sea Lamprey Spawning HSI Curves for Velocity and Depth

**APPENDIX A: SEA LAMPREY
SPAWNING- WEIGHTED AREA VERSUS
FLOW CURVES BASED ON NEW
(AGENCY) HSI CURVES**

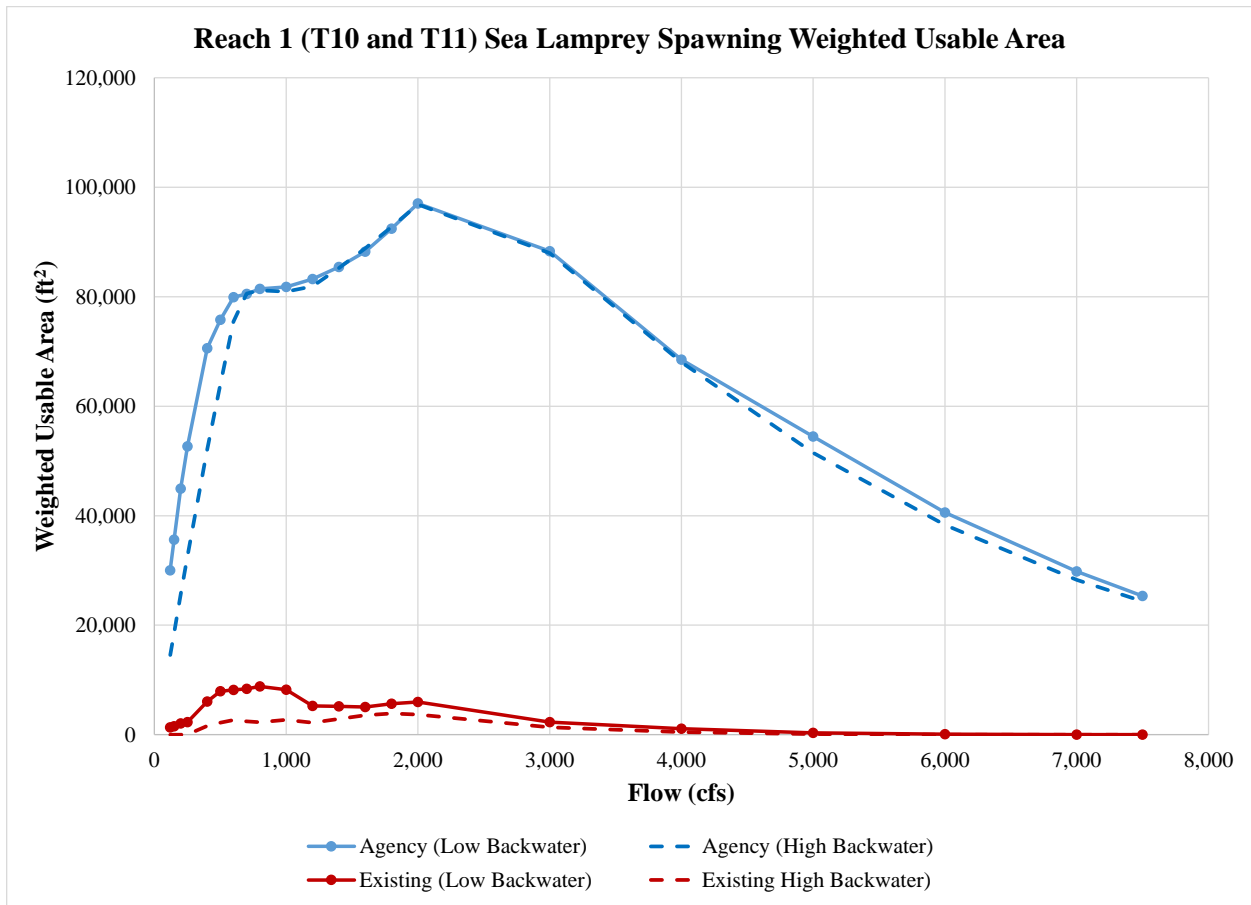
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Reach 1 (BOBSAR Area)



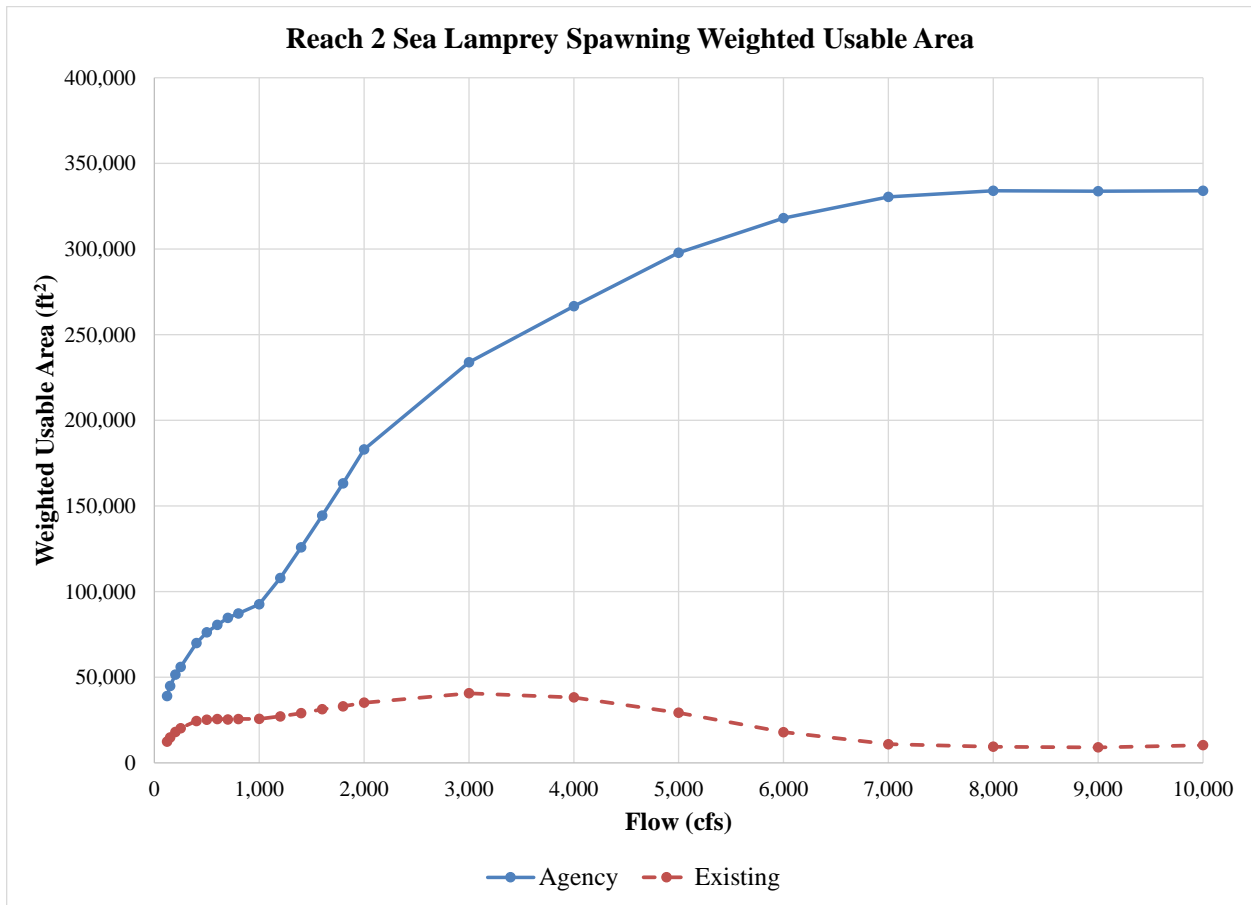
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Reach 1 (Transects 10 and 11)



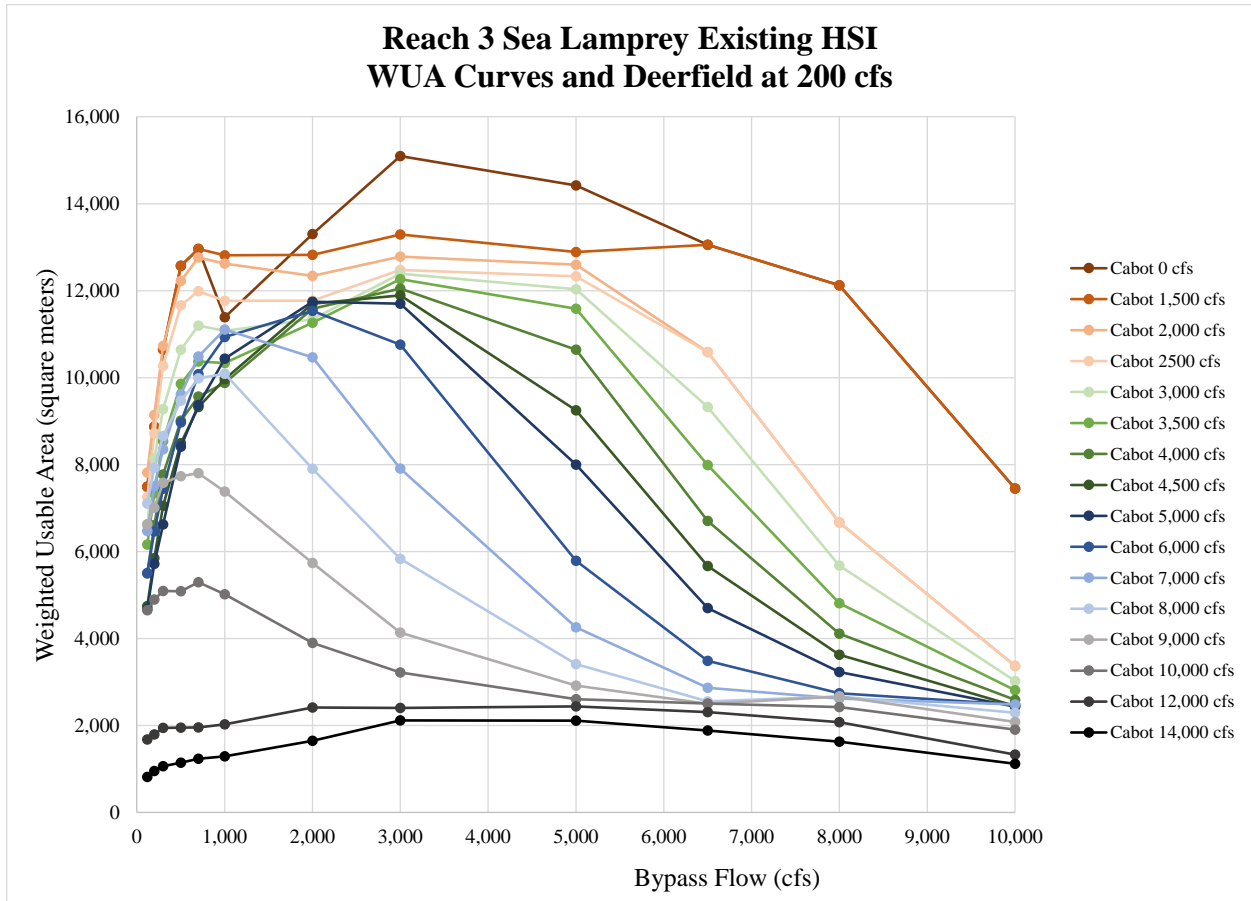
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Reach 2

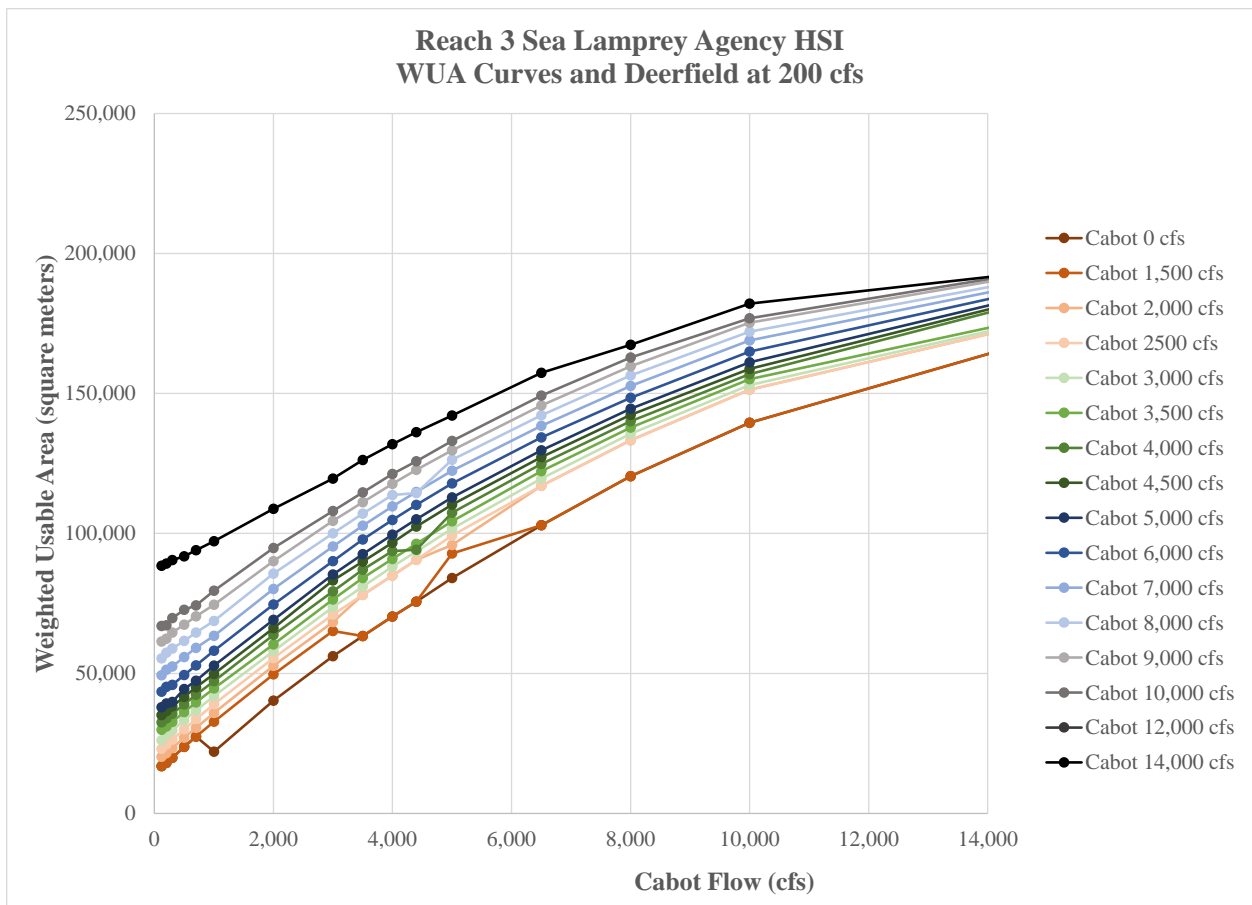


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Reach 3

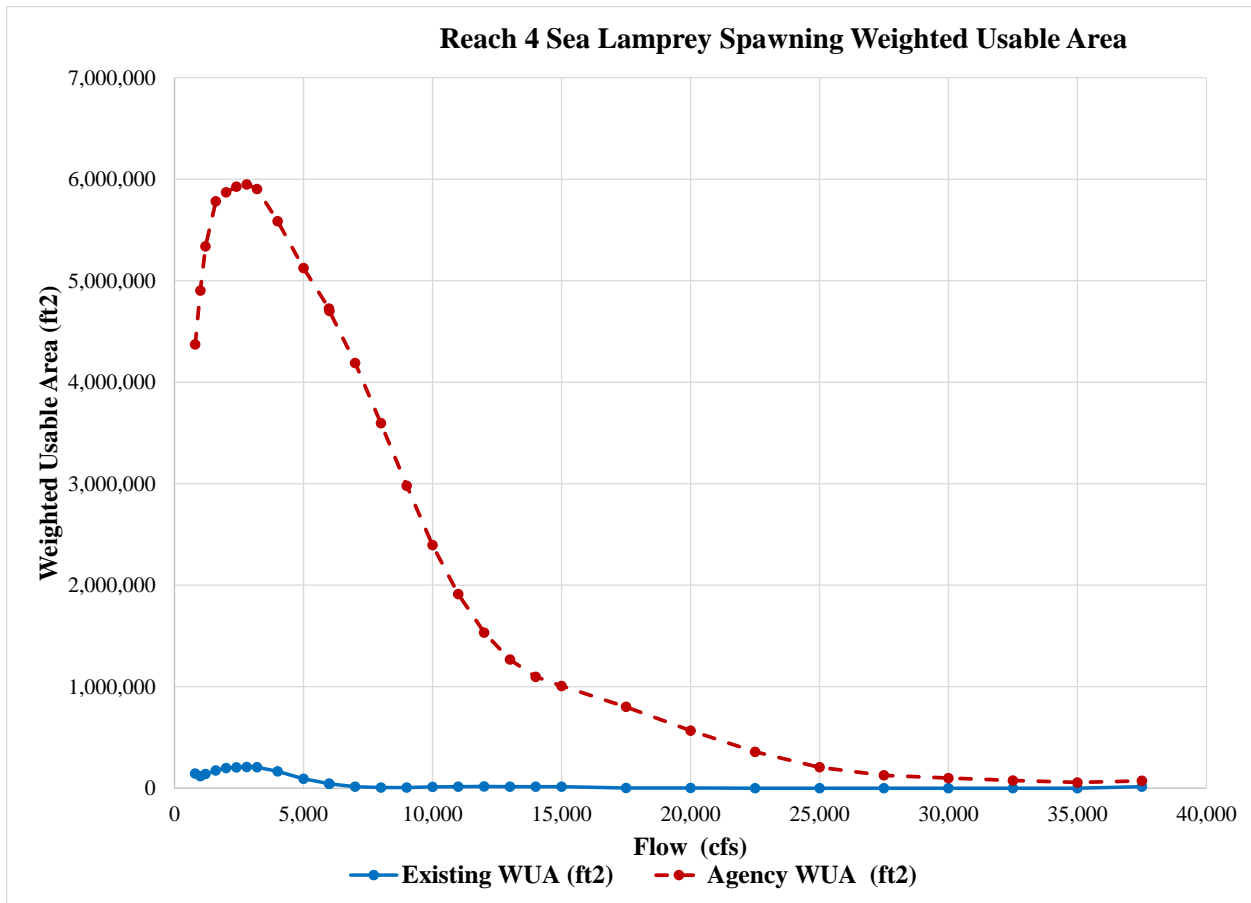


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Reach 4



**APPENDIX B: Sea Lamprey Spawning-
Weighted Area versus Flow tables based on
New (Agency) HSI Curves**

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Reach 1 (BOBSAR Area)

Reach 1 WUA Sea Lamprey Spawning (BOBSAR Area)		
Discharge (cfs)	Agency (ft ²)	Existing (ft ²)
125	56,645	16,086
140	60,627	17,496
250	80,597	20,766
500	115,082	22,347
662	121,542	27,031
750	121,903	23,622
1000	115,706	15,571
1286.5	101,444	8,562
1500	87,227	8,998
2000	57,782	4,376

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Reach 1(Transects 10 and 11)

Reach 1 (T10 and T11) WUA Sea Lamprey Spawning				
Discharge (cfs)	Agency (Low Backwater) ft ²	Agency (High Backwater) ft ²	Existing (Low Backwater) ft ²	Existing High Backwater) ft ²
120	30,025	14,572	1,322	0
150	35,624	18,686	1,512	0
200	44,941	25,704	2,053	0
250	52,684	32,476	2,281	13
400	70,592	52,026	6,048	1,604
500	75,785	63,920	7,913	2,192
600	79,936	75,453	8,155	2,687
700	80,514	80,586	8,385	2,429
800	81,441	81,162	8,809	2,282
1,000	81,803	80,945	8,223	2,702
1,200	83,243	81,912	5,241	2,183
1,400	85,448	85,208	5,185	2,863
1,600	88,239	88,866	5,067	3,532
1,800	92,464	92,795	5,638	3,870
2,000	97,048	96,870	5,988	3,668
3,000	88,317	87,974	2,306	1,352
4,000	68,514	68,034	1,093	477
5,000	54,470	51,486	313	88
6,000	40,583	38,341	94	0
7,000	29,807	28,260	0	0
7,500	25,333	24,346	0	0

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Reach 2

Reach 2 WUA Sea Lamprey Spawning		
Discharge (cfs)	Agency (ft ²)	Existing (ft ²)
120	39,028	12,435
150	44,891	14,823
200	51,528	18,000
250	56,055	20,214
400	69,954	24,481
500	76,261	25,144
600	80,640	25,630
700	84,634	25,333
800	87,289	25,594
1,000	92,598	25,704
1,200	107,898	27,167
1,400	125,864	29,019
1,600	144,444	31,280
1,800	163,222	33,030
2,000	183,051	35,140
3,000	233,904	40,615
4,000	266,615	38,225
5,000	297,906	29,250
6,000	318,032	17,934
7,000	330,428	10,900
8,000	334,075	9,421
9,000	333,803	9,039
10,000	334,029	10,323

INSTREAM FLOW HABITAT ASSESSMENTS IN THE BYPASS REACH AND BELOW CABOT STATION ADDENUM 4- NEW SEA LAMPREY WEIGHTED USABLE AREA CURVES BASED ON AGENCY PROPOSED HABITAT SUITABILITY INDEX CURVES

Reach 3

Reach 3 WUA (meters ²) Sea Lamprey Spawning Existing Curves																
Bypass Flow (cfs)	Cabot Flow (cfs)															
	0	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	6,000	7,000	8,000	9,000	10,000	12,000	14,000
120	7,492	7,492	7,818	7,252	6,607	6,160	5,495	4,745	4,679	5,505	6,474	7,104	6,628	4,651	1,679	817
200	8,871	8,871	9,144	8,718	8,141	7,338	6,607	5,847	5,718	6,464	7,503	7,926	7,008	4,898	1,795	954
300	10,650	10,650	10,731	10,269	9,278	8,539	7,775	7,053	6,625	7,444	8,353	8,660	7,582	5,093	1,943	1,062
500	12,571	12,571	12,225	11,661	10,644	9,858	9,009	8,494	8,412	8,969	9,616	9,469	7,734	5,087	1,951	1,142
700	12,959	12,959	12,762	11,987	11,198	10,371	9,568	9,325	9,368	10,081	10,485	9,981	7,801	5,296	1,956	1,235
1,000	11,389	12,812	12,621	11,767	11,078	10,337	9,880	9,963	10,437	10,938	11,108	10,091	7,380	5,019	2,023	1,292
2,000	13,303	12,825	12,340	11,769	11,343	11,261	11,586	11,701	11,747	11,535	10,469	7,906	5,740	3,898	2,415	1,647
3,000	15,094	13,294	12,785	12,476	12,390	12,267	12,047	11,893	11,701	10,760	7,906	5,834	4,138	3,219	2,405	2,116
5,000	14,423	12,892	12,598	12,329	12,034	11,584	10,644	9,248	8,000	5,787	4,256	3,411	2,916	2,605	2,438	2,109
6,500	13,058	13,058	10,586	10,586	9,321	7,991	6,706	5,668	4,700	3,488	2,865	2,556	2,499	2,503	2,305	1,886
8,000	12,123	12,123	6,669	6,669	5,676	4,812	4,113	3,625	3,228	2,740	2,618	2,663	2,663	2,424	2,075	1,629
10,000	7,452	7,452	3,372	3,372	3,023	2,814	2,590	2,450	2,433	2,478	2,484	2,294	2,079	1,903	1,330	1,120

Reach 3 WUA Sea Lamprey Spawning Agency Curves																
Bypass Flow (cfs)	Cabot Flow (cfs)															
	0	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	6,000	7,000	8,000	9,000	10,000	12,000	14,000
120	16,900	16,900	20,233	23,080	26,147	29,845	32,564	35,116	37,943	43,517	49,332	55,344	61,405	66,945	78,208	88,444
200	18,056	18,056	21,504	24,614	28,304	31,085	33,963	36,525	39,234	45,175	51,320	57,422	62,383	67,194	79,127	89,220
300	19,882	19,882	23,298	26,373	29,651	32,709	35,554	38,258	39,844	45,914	52,476	58,918	64,600	69,756	79,660	90,501
500	23,746	23,746	27,031	30,057	33,269	36,243	38,976	41,586	44,431	49,455	55,875	61,636	67,414	72,751	82,087	91,854
700	27,445	27,445	30,613	33,714	36,796	39,675	42,354	45,018	47,410	52,904	59,116	64,592	70,375	74,263	85,038	94,016
1,000	22,023	32,788	35,934	39,023	41,926	44,626	47,241	49,801	52,793	58,090	63,397	68,736	74,509	79,519	89,117	97,211
2,000	40,255	49,695	52,712	55,456	57,919	60,406	63,766	66,152	69,151	74,627	80,148	85,627	90,122	94,820	101,365	108,793
3,000	56,142	65,114	68,332	71,053	73,700	76,436	79,291	83,204	85,299	90,123	95,326	100,020	104,469	108,002	113,021	119,598
3,500	63,332	63,332	78,094	78,094	81,044	84,107	87,039	89,944	92,642	97,846	102,789	107,045	111,135	114,625	120,599	126,199
4,000	70,320	70,320	84,944	84,944	88,109	90,861	93,727	96,676	99,565	104,820	109,667	113,754	117,706	121,209	126,978	131,886
4,400	75,648	75,648	90,589	90,589	93,527	96,309	94,153	102,426	105,016	110,207	114,795	114,407	122,680	125,793	131,373	136,209
5,000	84,114	92,832	95,874	99,268	101,684	104,345	107,382	110,285	112,884	117,879	122,406	126,326	129,674	133,064	138,673	142,147
6,500	102,946	102,946	116,997	116,997	119,575	122,240	124,806	127,264	129,697	134,297	138,474	142,177	145,743	149,249	154,014	157,347
8,000	120,457	120,457	133,306	133,306	135,662	137,803	140,078	142,314	144,566	148,417	152,662	156,454	159,748	162,863	166,924	167,390
10,000	139,552	139,552	151,335	151,335	152,970	155,090	156,936	158,754	161,102	164,950	168,968	172,034	175,277	176,880	181,166	182,100

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Reach 4

Reach 4 WUA Sea Lamprey Spawning		
Discharge (cfs)	Agency WUA (ft ²)	Existing WUA (ft ²)
800	4,372,206	144,933
1,000	4,901,927	118,123
1,200	5,338,994	140,833
1,600	5,783,641	175,606
2,000	5,870,660	197,783
2,400	5,927,468	205,594
2,800	5,949,595	209,778
3,200	5,904,376	207,870
4,000	5,585,480	165,314
5,000	5,126,023	92,253
5,988	4,725,831	45,819
6,000	4,703,155	42,182
7,000	4,189,692	14,247
8,000	3,596,227	7,117
9,000	2,980,486	7,535
10,000	2,395,750	12,663
11,000	1,912,465	14,165
12,000	1,533,892	17,401
13,000	1,267,523	16,053
14,000	1,098,035	14,658
15,000	1,007,879	14,379
17,500	801,238	2,599
20,000	567,563	1,119
22,500	358,452	557
25,000	205,965	521
27,500	126,581	367
30,000	99,233	537
32,500	75,568	501
35,000	56,772	286
37,500	73,262	14,058
