Draft

Run Characteristics and Current Distribution of Pacific Lamprey in the Columbia River Basin, 2011

Prepared for Consideration in Developing Recommendations

for Passage Objectives in the Columbia River Basin

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March 2011

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# Introduction

The Lamprey Technical Workgroup (LTWG) was tasked with developing lamprey passage objectives and related performance standards and measures in 2007. The Passage Standards Subgroup was formed to address the inherent challenges with establishing such metrics. At the April 15th, 2009 meeting, the LTWG determined that the current goal of passage – that metrics must be equal to or superior than those established elsewhere in the region – was inadequate for current and future management objectives. The Passage Standards Subgroup subsequently reconvened on June 22nd, 2009, and decided on a three-phase approach to make progress on the assignment. The steps are as follows:

* Phase One: Identify potential research metrics that quantify indirect or direct effects on survival and fitness of juvenile and adult Pacific lamprey related to up- or downstream passage.
* Phase Two: Determine which of the above-listed metrics are measurable with scientific rigor and quantify effects of biological relevance.
* Phase Three: Develop and recommend basin-wide passage standards or objectives for metrics deemed as measurable and biologically relevant in Phase Two.

Initial drafts of Phase One and Phase Two were completed and submitted to the LTWG during 2010, leaving the final task of using this information to develop recommendations regarding basin-wide passage objectives. The Passage Standards Subgroup reconvened in January, 2011, and determined that more information would be required to supplement the metrics assessed during the above-mentioned process of identifying appropriate metrics. Specifically, the Subgroup decided that an up-to-date assessment of (1) Columbia River geography, (2) migratory characteristics and trends, and (3) recent passage evaluations relevant to upstream passage of adult Pacific lampreys would be fundamental in developing recommendations. A lack of information precludes a similar approach to juvenile lampreys, although as data are forthcoming the Passage Standards Subgroup will reassess technologies to address gaps in passage objectives.

This document is solely intended to provide supporting information for the Passage Metrics Subgroup in their consideration of developing recommendations for passage objectives for adult Pacific lamprey in the Columbia River Basin.

# Relevant Geography

## Hydroelectric Projects

### Columbia River

A total of nine (9) hydroelectric projects with adult upstream passage facilities (i.e., fish ladders) are located on the mainstem of the Columbia River. Construction of these projects began with Rock Island in 1933 and finished with John Day in 1971. Project locations range from Bonneville at river mile (RM) 146, ending at Wells at RM 516. Chief Joseph Hydroelectric Project (RM 545), upstream of Wells does not have upstream fish passage facilities (Table 1).

### Snake River

A total of four (4) hydroelectric projects with adult upstream passage facilities are located on the mainstem of the Snake River. Construction of these projects began with Ice Harbor in 1962 and finished with Lower Granite in 1975. Project locations range from Ice Harbor 334 RM from the ocean, ending at Lower Granite, 432 RM from the ocean (Table 1).

## Tributaries

Several tributaries to the Columbia River Basin exist downstream of Chief Joseph at RM 545. The number and size of tributaries between each hydroelectric project varies greatly. For example, 13 of the 29 major tributaries are below Bonneville, totaling more than 600 miles in length. In contrast, no major tributaries exist between Wanapum and Rock Island. Other reservoirs – such as McNary’s Lake Wallula – have few tributaries, but cover more drainage than all other tributaries combined. The length of the Snake (1,040 miles), Yakima (214 miles), and Walla Walla (61 miles) rivers represent close to 50% of the combined length of all Columbia River tributaries downstream of Chief Joseph.

Juvenile lampreys – including Pacific lamprey – have been identified in most tributaries below Chief Joseph, from the Okanogan River to rivers below Bonneville. Crab Creek, a tributary to Priest Rapids Lake, is the only tributary where lampreys have not been identified, and many of the tributaries below Bonneville have not been surveyed. Particular tributaries likely have varying levels of suitability for lampreys, though a basin-wide survey has not been conducted to date. Likewise, it is not known what extent the hundreds of miles of reservoirs in the Columbia River Basin contributes to larval, juvenile, or adult spawning habitat. Table 2 lists major tributaries and hydroelectric projects, along with their relative location, length, and presence or absence of Pacific lamprey.

Table 1. List of Columbia and Snake (shaded) river basin mainstem hydroelectric projects with adult salmon upstream passage facilities, 2011.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Project** | **Year built** | **Miles upstream** | **Full forebay elevation (ft)** | **Spillway** | **Nameplate capacity (MW)** | **Owner** |
| BON | 1938 | 146.1 | 77.0 | 1450 feet, 18 gates | 1,050 | U.S.A.C.E., Portland District |
| TDA | 1960 | 191.5 | 160.0 | 1380 feet, 23 gates | 1,780 | U.S.A.C.E., Portland District |
| JDA | 1971 | 215.6 | 268.0 | 1228 feet, 20 gates | 2,160 | U.S.A.C.E., Portland District |
| MCN | 1957 | 292.0 | 356.5 | 1310 feet, 22 gates | 980 | U.S.A.C.E., Walla Walla District |
| IHR\* | 1962 | 333.7 | 446.0 | 590 feet, 10 gates | 603 | U.S.A.C.E., Walla Walla District |
| LMN\* | 1969 | 365.6 | 548.3 | 572 feet, 8 gates | 810 | U.S.A.C.E., Walla Walla District |
| LGS\* | 1970 | 394.3 | 646.5 | 512 feet, 8 gates | 810 | U.S.A.C.E., Walla Walla District |
| PRD | 1961 | 397.1 | 486.0 |  | 956 | Grant County PUD No. 2 |
| WAN | 1964 | 415.8 | 570.0 |  | 1,038 | Grant County PUD No. 2 |
| LWG\* | 1975 | 431.5 | 746.5 | 512 feet, 8 gates | 810 | U.S.A.C.E., Walla Walla District |
| RIS | 1933 | 453.4 | 613.0 | 31 gates | 623 | Chelan County PUD No. 1 |
| RRH | 1961 | 473.7 | 707.0 | 12 gates | 1,347 | Chelan County PUD No. 1 |
| WEL | 1967 | 515.8 | 781.0 | 10 gates | 774 | Douglas County PUD No. 1 |

\* Based on Snake River confluence at Columbia River Mile 324.

Table 2. Columbia River tributaries and potential use by Pacific lamprey.



# Describing the Migration

## Counts and Trends

Between 2001 and 2010, nearly a half million adult lampreys have been enumerated in the Columbia River Basin (Table 3). Average annual counts are greatest at Bonneville, and descend upstream in the Columbia and Snake rivers (Table 4). Following a four-fold increase of adult lampreys observed at Bonneville between 2001 and 2003, annual counts have declined to a record low of 6,234 fish in 2010 (excluding LPS counts). Despite the lack of precision in adult enumeration at many projects, an obvious decline in the number of adults returning to the Columbia River has occurred over the past decade (Figure 1).

Table 3. Annual counts of adult Pacific lamprey in the Columbia River Basin by project, 2001-2010.

|  | **Project** | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **YEAR** | **BON** | **TDA** | **JDA** | **MCN** | **IHR** | **LMN** | **LGS** | **PRD** | **WAN** | **LWG** | **RIS** | **RRH** | **WEL** |
| 2001 | 27,947 | 9,061 | 4,005 | 2,539 | 203 | 59 | 104 | 1,624 | . | 27 | 1,460 | 805 | 262 |
| 2002 | 100,476 | 23,417 | 26,821 | 11,282 | 1,127 | 284 | 365 | 4,007 | . | 138 | 4,878 | 1,842 | 342 |
| 2003 | 117,029 | 28,995 | 20,922 | 13,325 | 1,702 | 476 | 660 | 4,340 | . | 282 | 5,000 | 2,521 | 1,410 |
| 2004 | 61,780 | 14,873 | 11,663 | 5,888 | 805 | 194 | 243 | 2,647 | . | 122 | 2,362 | 1,043 | 403 |
| 2005 | 26,667 | 8,361 | 8,312 | 4,158 | 461 | 222 | 213 | 2,598 | . | 42 | 2,267 | 404 | 214 |
| 2006 | 38,941 | 6,894 | 9,600 | 2,459 | 277 | 175 | 125 | 4,383 | 4,381 | 35 | 1,326 | 370 | 21 |
| 2007 | 19,304 | 6,083 | 5,753 | 3,454 | 290 | 138 | 72 | 6,593 | 4,771 | 34 | 1,300 | 696 | 35 |
| 2008 | 14,562 | 4,599 | 6,625 | 1,530 | 264 | 145 | 104 | 5,083 | 1,519 | 61 | 880 | 368 | 7 |
| 2009 | 8,622 | 2,318 | 2,044 | 676 | 57 | 58 | 34 | 2,713 | 718 | 12 | 375 | 278 | 9 |
| 2010 | 6,234 | 1,726 | 1,662 | 833 | 114 | 44 | 29 | 1,114 | 707 | 15 | 318 | 268 | 2 |
| **All** | **421,562** | **106,327** | **97,407** | **46,144** | **5,300** | **1,795** | **1,949** | **35,102** | **12,096** | **768** | **20,166** | **8,595** | **2,705** |

Table 4. Descriptive statistics of annual counts of adult Pacific lamprey in the Columbia River Basin by project, 2001-2010.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Annual adult Pacific lamprey counts** | | | | | |
| **Project** | **N** | **Min** | **Max** | **Median** | **Mean** | **Std Err** |
| BON | 10 | 6,234 | 117,029 | 27,307 | 42,156 | 12,267 |
| TDA | 10 | 1,726 | 28,995 | 7,628 | 10,633 | 2,879 |
| JDA | 10 | 1,662 | 26,821 | 7,469 | 9,741 | 2,594 |
| MCN | 10 | 676 | 13,325 | 2,997 | 4,614 | 1,382 |
| IHR | 10 | 57 | 1,702 | 284 | 530 | 167 |
| LMN | 10 | 44 | 476 | 160 | 180 | 41 |
| LGS | 10 | 29 | 660 | 115 | 195 | 61 |
| PRD | 10 | 1,114 | 6,593 | 3,360 | 3,510 | 529 |
| WAN | 5 | 707 | 4,771 | 1,519 | 2,419 | 895 |
| LWG | 10 | 12 | 282 | 39 | 77 | 27 |
| RIS | 10 | 318 | 5,000 | 1,393 | 2,017 | 532 |
| RRH | 10 | 268 | 2,521 | 550 | 860 | 240 |
| WEL | 10 | 2 | 1,410 | 125 | 271 | 135 |













Figure 1. Annual adult Pacific lamprey counts at Columbia River Basin projects by region (lower, middle, and Snake River) and project, 2001-2010.

## Seasonal Distribution

The adult Pacific lamprey migration generally begins in early June when 10% of the run has typically passage Bonneville. Adults arrive at each project later in the season as fish move upstream, ending at Wells when adults begin arriving in early- to mid-August (Table 5; Figure 2). The migration tapers off as fish move upstream and near the overwintering period: median passage dates at Wells are over two months later than those observed at Bonneville. The migration of adult lampreys in the Snake River is generally earlier than median counts observed in Columbia River projects similar distances from the ocean: Average runs at Little Goose (RM 394) are 13 days earlier than at Priest Rapids (RM 397), and runs at Lower Granite (RM 431) are 18 days earlier than at Wanapum (RM 416). Despite the varying timing of the migration, the average temperature during observations at each project is typically 19-20°C, with cooler temperatures observed at Bonneville (earlier in the year) and middle-Columbia River projects (later in the year), and warmer temperatures observed in the Snake River (Table 7).

Table 5. Passage dates (quantiles) of adult Pacific lamprey at Columbia and Snake (shaded) river basin mainstem hydroelectric projects, 2001-2010.

| **Project** | **Minimum** | **10%** | **25%** | **Median** | **75%** | **90%** | **Maximum** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| BON | 01/01 | 06/10 | 06/22 | 07/09 | 07/25 | 08/18 | 11/02 |
| TDA | 01/01 | 06/30 | 07/11 | 07/23 | 08/09 | 08/28 | 10/30 |
| JDA | 01/01 | 07/05 | 07/16 | 07/29 | 08/17 | 09/05 | 11/01 |
| MCN | 01/01 | 07/14 | 07/25 | 08/09 | 08/26 | 09/12 | 12/31 |
| IHR | 01/01 | 07/14 | 07/23 | 08/05 | 08/20 | 09/04 | 12/30 |
| LMN | 01/01 | 07/01 | 07/22 | 08/03 | 08/19 | 09/06 | 12/30 |
| LGS | 01/01 | 07/06 | 07/24 | 08/07 | 08/25 | 09/13 | 12/30 |
| PRD | 01/01 | 07/25 | 08/06 | 08/20 | 09/04 | 09/17 | 12/30 |
| WAN | 01/08 | 07/29 | 08/12 | 08/25 | 09/07 | 09/20 | 11/10 |
| LWG | 01/01 | 07/05 | 07/27 | 08/07 | 08/21 | 09/03 | 12/31 |
| RIS | 01/01 | 08/04 | 08/14 | 08/26 | 09/06 | 09/21 | 12/30 |
| RRH | 01/01 | 08/05 | 08/15 | 08/27 | 09/07 | 09/21 | 12/30 |
| WEL | 01/01 | 08/10 | 08/27 | 09/16 | 10/19 | 10/31 | 12/30 |

Table 6. Passage dates (means and standard deviation) of adult Pacific lamprey at Columbia and Snake (shaded) river basin mainstem hydroelectric projects, 2001-2010.

| **Project** | **Number** | **Mean** | **Std Dev (days)** |
| --- | --- | --- | --- |
| BON | 42,1562 | 07/11 | 26 |
| TDA | 106,327 | 07/26 | 22 |
| JDA | 97,407 | 08/01 | 25 |
| MCN | 46,144 | 08/10 | 23 |
| IHR | 5,300 | 08/06 | 22 |
| LMN | 1,795 | 08/03 | 27 |
| LGS | 1,949 | 08/08 | 27 |
| PRD | 35,102 | 08/20 | 23 |
| WAN | 12,096 | 08/24 | 21 |
| LWG | 768 | 08/06 | 24 |
| RIS | 20,166 | 08/26 | 19 |
| RRH | 8,595 | 08/27 | 18 |
| WEL | 2,705 | 09/17 | 32 |

Table 7. Mean water temperature during observations of adult lampreys at Columbia and Snake (shaded) river projects, 2001-2011.

| **Level** | **Number** | **Mean** | **Std Dev** | **Std Err Mean** | **Lower 95%** | **Upper 95%** |
| --- | --- | --- | --- | --- | --- | --- |
| BON | 421,175 | 18 | 37 | 0.1 | 18 | 18 |
| TDA | 104,436 | 20 | 15 | 0.0 | 20 | 20 |
| JDA | 92,735 | 20 | 14 | 0.0 | 20 | 21 |
| MCN | 45,923 | 21 | 8 | 0.0 | 21 | 21 |
| IHR | 5,233 | 21 | 4 | 0.1 | 21 | 21 |
| LMN | 1,750 | 20 | 4 | 0.1 | 20 | 20 |
| LGS | 1,853 | 20 | 3 | 0.1 | 20 | 20 |
| PRD | 30,984 | 19 | 8 | 0.0 | 19 | 19 |
| WAN | 11,854 | 19 | 5 | 0.0 | 19 | 20 |
| LWG | 766 | 20 | 3 | 0.1 | 20 | 21 |
| RIS | 16,407 | 19 | 6 | 0.0 | 19 | 19 |
| RRH | 6,775 | 19 | 3 | 0.0 | 19 | 19 |
| WEL | 1,516 | 19 | 3 | 0.1 | 19 | 19 |



Figure 2. Passage dates (quantiles) of adult Pacific lamprey at Columbia and Snake river basin mainstem hydroelectric projects, 2001-2010.

# Passage Evaluations

## Columbia River Projects

### Bonneville Dam

Start.

### The Dalles Dam

Start.

### John Day Dam

Start.

### McNary Dam

Start.

### Priest Rapids Dam

Start.

### Wanapum Dam

Start.

### Rock Island Dam

Start.

### Rocky Reach Dam

Start.

### Wells Dam

Start.

## Snake River Projects

### Ice Harbor Dam

Start.

### Lower Monumental Dam

Start.

### Little Goose Dam

Start.

### Lower Granite Dam

Start.

# Literature Cited