Fish Benefits Workbooks – Juvenile Chinook and Steelhead Run Timing

DRAFT

U.S. Army Corps of Engineers-Portland District

CENWP-PM-E

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Contents

1 Purpose/Applicability

This document presents the rationale for changes to assumptions for juvenile Chinook and steelhead emigration (run) timing as used for modeling their at-dam passage survival using Fish Benefit Workbooks (FBWs). Original run-timing values used in the FBWs, and their rationale are found in Alden (2014). The Fish Benefit Workbooks are working tools that are continually being tweaked. Therefore, this is a "living" document that will evolve as the FBWs continue to evolve.

2 Background

The U.S. Army Corps of Engineers (USACE) Portland District (CENWP) is evaluating alternatives to improve downstream fish passage at dams in the Willamette River Basin. This work is being completed in accordance with the requirements of National Marine Fisheries Service's (NMFS) 2008 Biological Opinion. The Fish Benefit Workbooks (FBWs) are intended to provide a way to estimate the effect of improvements at the project that is less subjective than professional judgment and avoids preconceived notions about alternatives. The FBW allows for testing of operations (via HEC RES-SIM modeling) and structural fish passage improvements, as stand alone or combined improvements. This quantitative modeling is helpful to compare and prioritize alternatives.

The FBW spreadsheet tool was developed by CENWP and is being used to estimate annual dam passage survival for juvenile Chinook and steelhead at each dam under existing and alternative reservoir, discharge, and passage route conditions. CENWP has also obtained the assistance of the NOAA Northwest Fisheries Science Center to prepare and manage population models using the Species Life-cycle Analysis Modules (SLAM) and the Viable Salmonid Population (VSP) analysis framework. Output from the FBWs is incorporated by NOAA into the SLAM models. The FBWs and SLAM models will assist CENWP in their evaluation of alternative management measures intended to benefit juvenile Chinook and steelhead.

2.1 Juvenile Chinook Run Timing

Run-timing for FBW is defined as when fish are available to pass the dam. Other parameters in the model, defined specifically for each alternative, will determine what portion of the fish actually pass (dam passage efficiency) and how many survive (project survival). See the *Fish Benefits Workbook Users Guide* for more information.

We assume reservoir length likely influences when juvenile Chinook arrive in forebay (Monzyk 2013; Alden 2014 – see section 5, Reservoir survival). For alternatives which assume the same reservoir operation as under baseline conditions, then the same run timing should be used. These include the FSS,FSC FSO or SWS alternatives. Although we assume the same run timing for baseline and these alternatives, more fish would pass the dam with an FSS,FSC, or FSO compared to baseline conditions since the model assumes higher DPE and RE values.

For altered reservoir operations (early drawdown or delay refill scenarios), we assume run timing would be different than under baseline reservoir conditions. Since reservoir pool length is shorter when fry and subs are present, delaying reservoir refill could increase the number of fry passing, and potentially the number of subs if delayed long enough (depending on fry reservoir entry timing for each). Early reservoir drawdown could increase the number of subs passing since the reservoir length would be shortened when they are present and the water depth to an intake decreased.

We present run-timing assumptions for baseline reservoir conditions, and for alternative reservoir conditions below.

2.1.1 Cougar Dam Baseline

	Fry (Same as Alden)	Sub-yearling	Yearlings
Jan	0%	0%	35%
Feb	0%	0%	20%
Mar	1%	0%	15%
Apr	5%	0%	10%
May	27%	0%	10%
Jun	54%	15%	7%
Jul	9%	7%	1%
Aug	3%	5%	0%
Sep	2%	40%	0%
Oct	1%	22%	0%
Nov	0%	7%	1%
Dec	0%	4%	1%
	100%	**100%**	**100%**

Rationale

Fry	Most fry enter the reservoir from upstream and distribute within 5km of the head of the reservoir (Monzyk 2012). Those few that do move to the dam would be expected to arrive mostly in May and June. In late June most fry have grown into the sub-yearling size class (>60mm; MOnzyk 2012) and by definition are no longer available to pass the dam "as fry".
Subs	Subyearlings move offshore in June (Monzyk 2012) and actively move throughout reservoir (Beeman 2013), therefore many would be available to pass the dam beginning in June. Onieda trap catches were greatest in the lower reservoir in July. Fewer subs are expected to pass during August to September than July since juvenile chinook known to decline to deeper depths when reservoir surface temperatures warm (Monzyk 2013 adn Beeman 2013) and based on observations that few emigrate in Willamette Basin in general during these months (including past Leaburg Dam and Willamette Falls). As temperatures cool in fall, subs move to shallower depths, and more will pass the dam as the reservoir is drawn down (Monzyk 2012, Keefer 2012).
Yearling	Alden recommended based on Cougar tailrace data (2011 – 2012) from Monzyk, 2013. Yearlings by definition are available beginning in January, and we expect they will pass an FSO if available. Screwtrap data from Willamette Dam tailraces indicates yearlings pass during winter and earling spring months (Monzyk 2012; Keefer 2012).

The following figures were inserted here as background from the supporting references noted in the "rationale" above -

From Monzyk (2012):

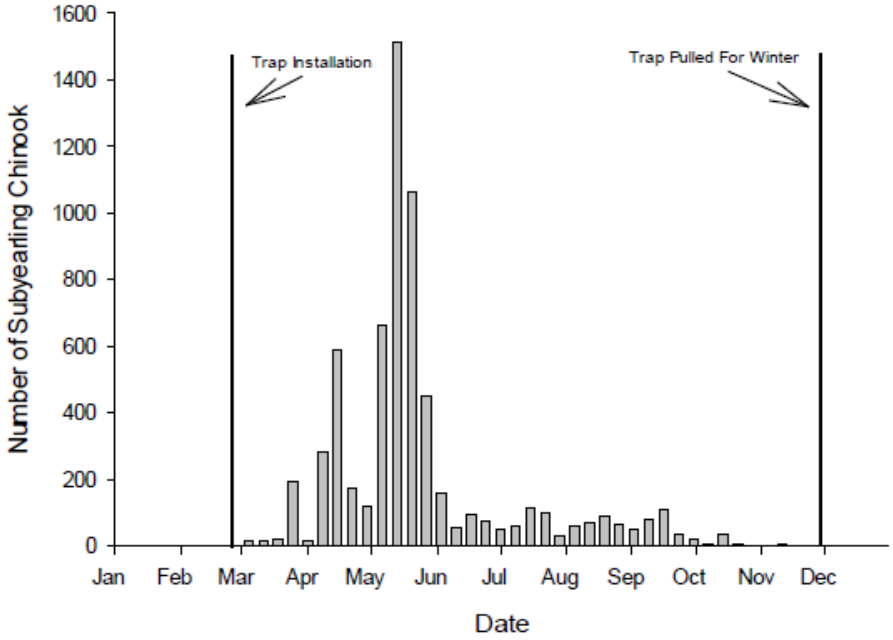
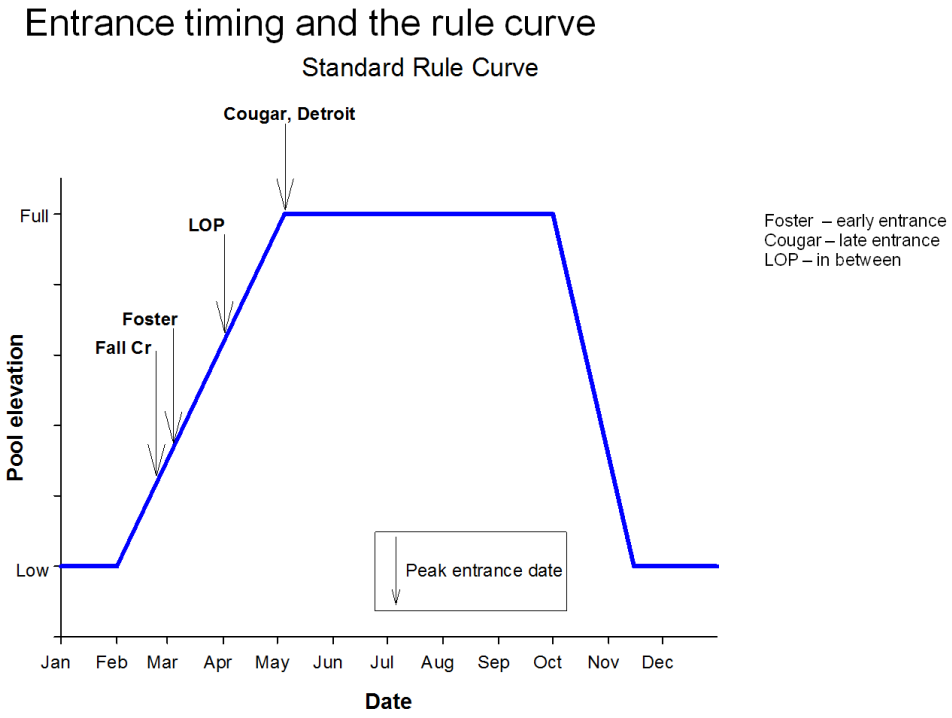


Figure 18. Weekly abundance of subyearling spring Chinook salmon captured in the South Fork McKenzie trap above Cougar Reservoir, 2012.

From Monzyk presentation to Willamette fisheries Science Review, February 6, 2014:



From Monzyk (2012):

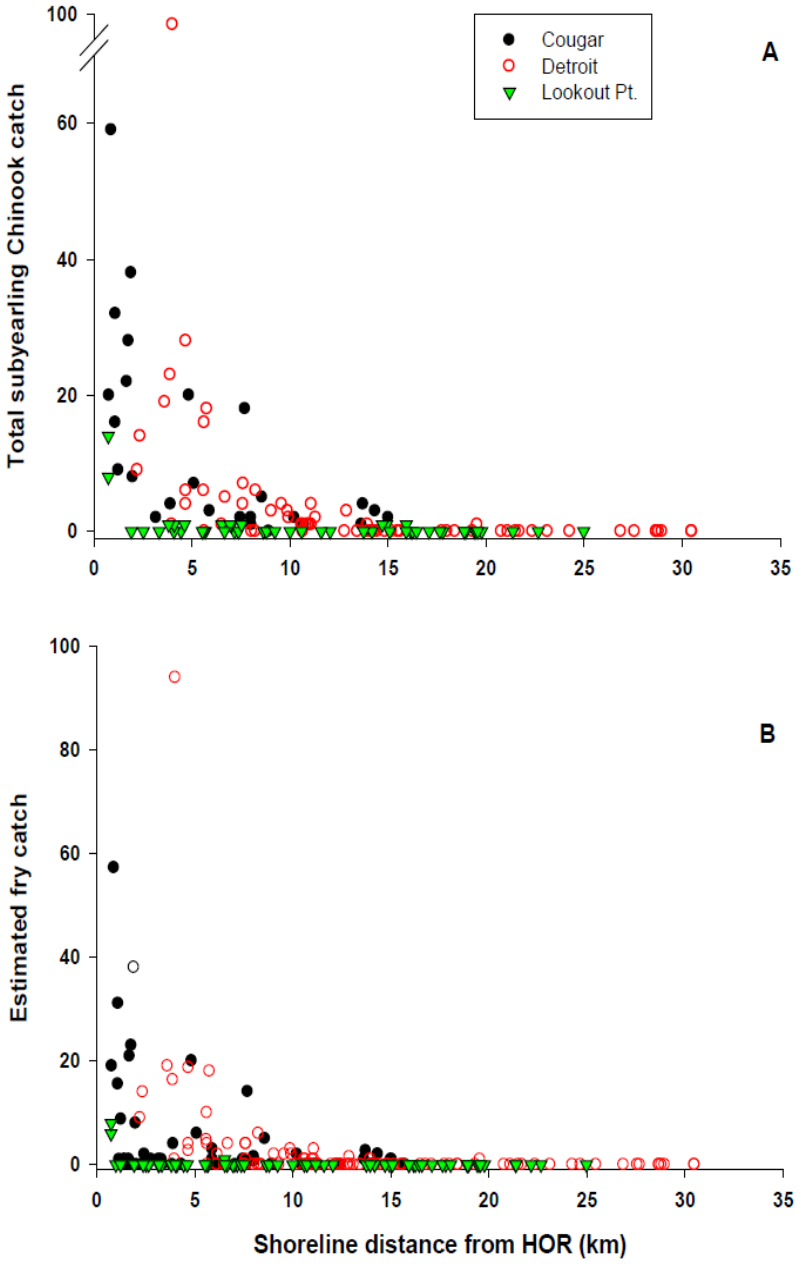
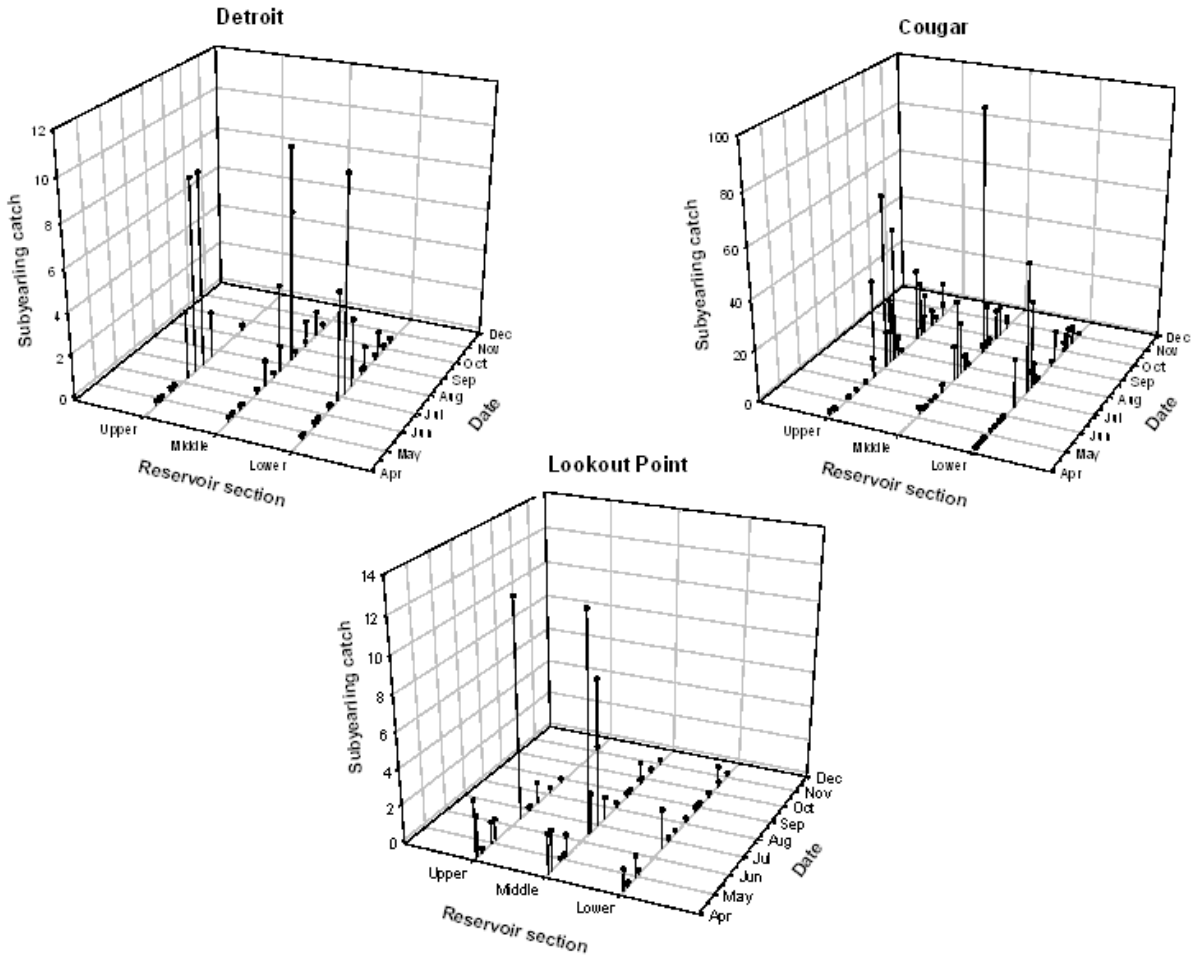


Figure 3. Relationship between juvenile Chinook salmon catch in floating box traps and shoreline distance from the head of the reservoir (HOR), 2011. Catch represented as all subyearling Chinook salmon caught in nearshore traps (A) and estimated number of fry (B) based on the proportion of subyearlings that were <50 mm FL.

From Monzyk (2012):



2.1.2 Cougar Dam Delayed Refill to 1-April

2.1.3 Cougar Dam Delayed Refill to 15-June

2.1.4 Detroit Dam Baseline

	Fry	Subyearlings	Yearlings
Sep	0%	25%	0%
Oct	0%	15%	0%
Nov	0%	5%	0%
Dec	0%	5%	5%
Jan	0%	0%	20%
Feb	5%	0%	30%
Mar	10%	0%	30%
Apr	40%	0%	10%
May	25%	5%	5%
Jun	15%	10%	0%
Jul	5%	20%	0%
Aug	0%	15%	0%
	100%	**100%**	**100%**

Rationale

Fry	Juveniles enter the reservoir from upstream mostly as fry and distribute within 5km of the head of the reservoir (Monzyk 2012). Those few fry that do move to the dam would be expected to arrive mostly in April and May. In June most fry have grown into the sub-yearling size class (>60mm; MOnzyk 2012) and by definition are no longer available to pass the dam "as fry".
Subs	Subyearlings move offshore in June (Monzyk 2012) and actively move throughout the reservoir (Beeman 2013), therefore many would be available to pass the dam beginning in June. Onieda trap catches were greatest in the lower reservoir in July. Fewer subs are expected to pass during August to September than July since juvenile Chinook are known to decline to deeper depths when the reservoir surface temperatures warm (Monzyk 2013 and Beeman 2013). Generally few juvenile Chinook emigrate downstream in Willamette Basin during these months (including past Leaburg Dam and Willamette Falls). As temperatures cool in fall, subyearlings move to shallower depths, and more will pass the dam as the reservoir is drawn down (Monzyk 2012, Keefer 2012).
Yearling	Alden recommended timing for yearlings is based on "Cougar tailrace data (2011 – 2012) from Monzyk, 2013 used in lieu of Detroit data, except for March, April and May which were adjusted to account for differences in fish behaviour at the two projects." Yearlings by definition in the FBW, are available beginning in January, and we expect they will pass a surface outlet if available. Screwtrap data from Willamette Dam tailraces indicates yearlings pass during winter and early spring months (Monzyk 2012; Keefer 2012).

2.1.5 Detroit Dam Run-of-River

	Fry	Subyearlings	Yearlings
Sep	0%	15%	0%
Oct	0%	10%	0%
Nov	0%	5%	0%
Dec	0%	5%	5%
Jan	0%	0%	20%
Feb	10%	0%	30%
Mar	20%	0%	30%
Apr	40%	0%	10%
May	20%	5%	5%
Jun	10%	25%	0%
Jul	0%	30%	0%
Aug	0%	5%	0%
	100%	**100%**	**100%**

Rationale

Fry	Most fry enter the reservoir from upstream and distribute within 5km of the head of the reservoir (Monzyk 2012). Under this alternative, the reservoir will not be refilled in spring. Most fry enter during May and therefore more will reach the dam forebay since the distance from the head of the reservoir to the dam will be shorter (see Monzyk 2013 and 2014 W. Fisheries Sc. Review presentations). Fry would be expected to arrive mostly in March April and May. In June most fry have grown into the sub-yearling size class (>60mm; Monzyk 2012) and by definition are no longer available to pass the dam "as fry".
Subs	Subyearlings move offshore in the reservoir in June (Monzyk 2012) and actively move throughout reservoir (Beeman 2013), therefore many would be available to pass the dam beginning in June. Onieda trap catches were greatest in the lower reservoir in July. Fewer subs are expected to pass during August to September than July since juvenile Chinook are known to decline to deeper depths when reservoir surface temperatures warm (Monzyk 2013 adn Beeman 2013) and based on observations that few emigrate in Willamette Basin in general during these months (including past Leaburg Dam and Willamette Falls). As temperatures cool in fall, subs move to shallower depths, and more will pass the dam as the reservoir is drawn down (Monzyk 2012, Keefer 2012).
Yearling	Alden recommended based on "Cougar tailrace data (2011 – 2012) from Monzyk, 2013 used in lieu of Detroit data, except for March, April and May which were adjusted to account for differences in fish behavior at the two projects." Yearlings by definition in the FBW, are available beginning in January, and we expect they will pass a surface

	outlet if available. Screwtrap data from Willamette Dam tailraces indicates yearlings pass during winter and early spring months (Monzyk 2012; Keefer 2012).

2.1.6 Detroit Dam Delayed Refill Until 1-June

	Fry	Subyearlings	Yearlings
Sep	0%	15%	0%
Oct	0%	10%	0%
Nov	0%	5%	0%
Dec	0%	5%	5%
Jan	0%	0%	20%
Feb	10%	0%	30%
Mar	20%	0%	30%
Apr	40%	0%	10%
May	20%	5%	5%
Jun	10%	25%	0%
Jul	0%	30%	0%
Aug	0%	5%	0%
	100%	**100%**	**100%**

Rationale

Fry	Most fry enter the reservoir from upstream and distribute within 5km of the head of the reservoir (Monzyk 2012). Under this alternative, the reservoir will begin refilling June 1, and will likely not refill to the target level. Most fry enter during May and therefore more will reach the dam forebay since the distance from the head of the reservoir to the dam will be shorter (see Monzyk 2013 and 2014 W. Fisheries Sc. Review presentations).Those few fry that do move to the dam would be expected to arrive mostly in March April and May. In June most fry have grown into the sub-yearling size class (>60mm; MOnzyk 2012) and by definition are no longer available to pass the dam "as fry".
Subs	Subyearlings move offshore in June (Monzyk 2012) and actively move throughout reservoir (Beeman 2013), therefore many would be available to pass the dam beginning in June. Onieda trap catches were greatest in the lower reservoir in July. Fewer subs are expected to pass during August to September than July since juvenile chinook known to decline to deeper depths when reservoir surface temperatures warm (Monzyk 2013 adn Beeman 2013) and based on observations that few emigrate in Willamette Basin in general during these months (including past Leaburg Dam and Willamette Falls). As temperatures cool in fall, subs move to shallower depths, and more will pass the dam as the reservoir is drawn down (Monzyk 2012, Keefer 2012).

Yearling	Alden yearling timing is recommended based on "Cougar tailrace data (2011 – 2012) from Monzyk, 2013 used in lieu ofDetroit data, except for March, April and May which were adjusted to account for differences in fish behaviour at the two projects." Yearlings by definition in FBW are available beginning in January, and we expect they will pass a surface outlet if available. Screwtrap data from Willamette Dam tailraces indicates yearlings pass during winter and earling spring months (Monzyk 2012; Keefer 2012).

The following figures from Monzyk (2012) are provided for background information:

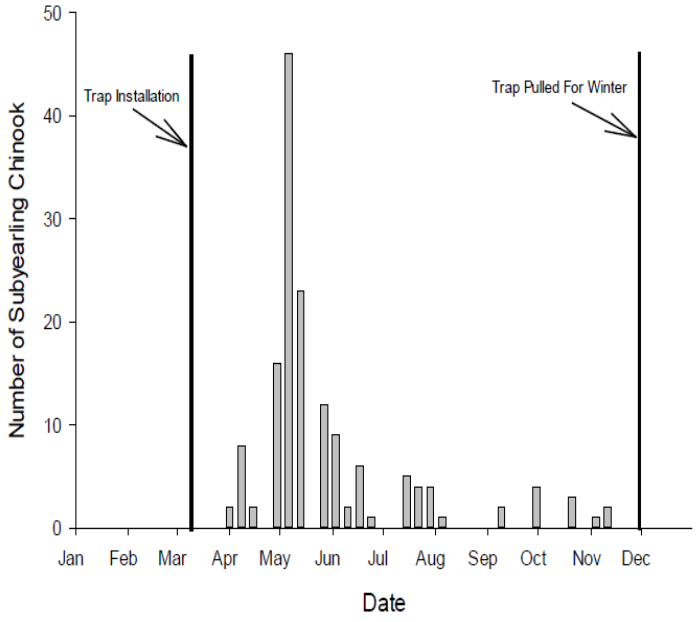


Figure 4. Weekly abundance of subyearling spring Chinook salmon captured in the North Santiam trap above Detroit Reservoir, 2012.

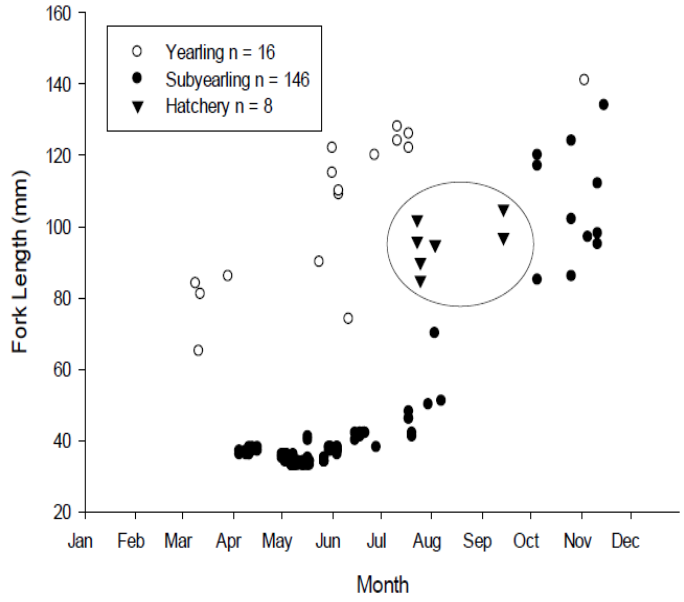


Figure 5. Fork lengths of juvenile Chinook salmon captured in the North Santiam trap upstream of Detroit Reservoir on a temporal scale, 2012. Suspected hatchery fish are circled.

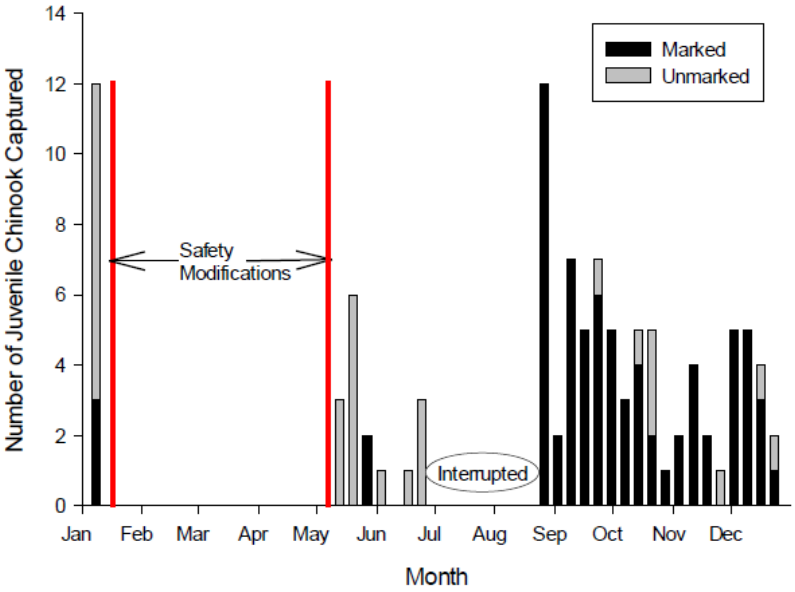


Figure 6. Weekly abundance of marked and unmarked Chinook salmon (subyearling and yearlings) captured in the rotary screw trap below Detroit Dam, 2012. Interrupted indicates a period when the cone was damaged or debris kept the trap from operating.

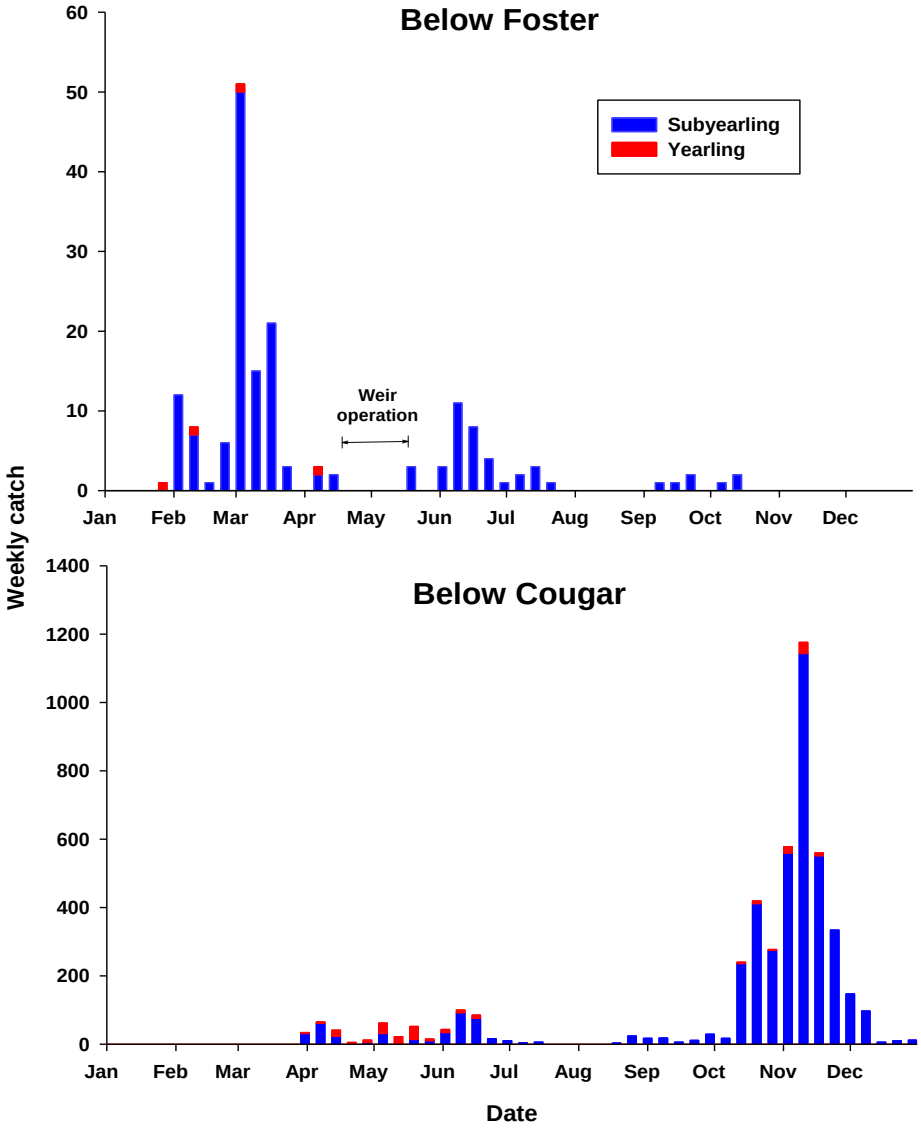
2.1.7 Foster Dam Baseline

Recommended

	Fry	Subyearlings	Yearlings
January	14.00%	0.00%	25.00%
February	32.00%	0.00%	25.00%
March	32.00%	0.00%	24.70%
April	10.00%	5.00%	15.00%
May	5.00%	12.00%	7.00%
June	0.00%	15.00%	3.00%
July	0.00%	13.00%	0.00%
Aug	0.00%	5.00%	0.00%
Sept	0.00%	10.00%	0.00%
Oct	0.00%	15.00%	0.10%
Nov	0.00%	15.00%	0.10%
Dec	7.00%	10.00%	0.10%
	100.00%	100.00%	100.00%

Rationale:
Alden recommendation was based on fry data from Monzyk (2012) and for subyearling and yearling data from Wagner and Ingram (1973). Adjustments to Alden timing made here considered data presented by Monzyk and Romer at 2013 and 2014 WFSR's from above and below resevoir screwtrapping. We assume subs (>60 mm) are from those that entered the reservoir as fry, grew, and then move further from shore in May- June then emigrate.

From Monzyk presentation to Willamette fisheries Science Review, February 6, 2014 – data from 2013:



From Monzyk (2012):

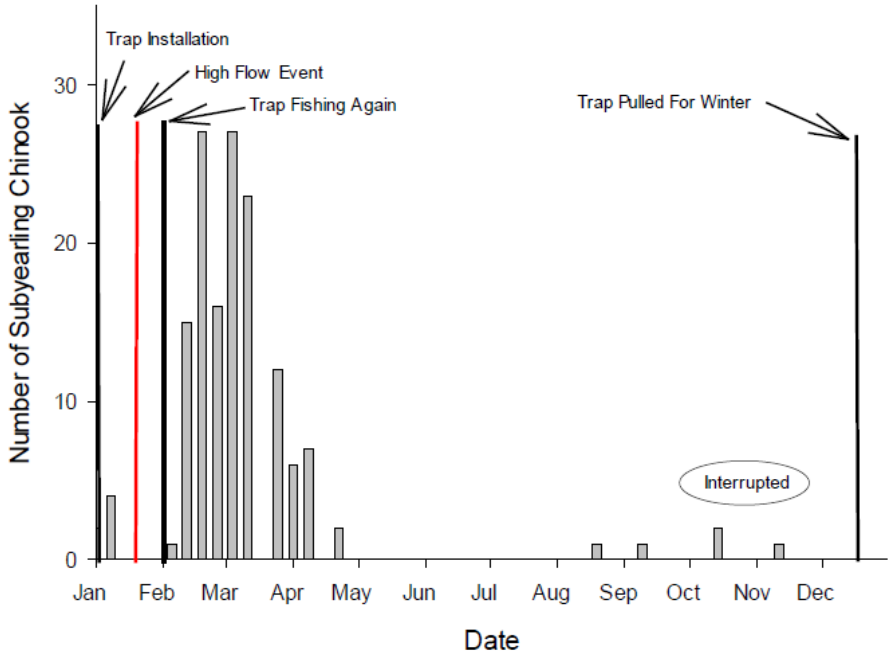


Figure 8. Weekly abundance of subyearling spring Chinook salmon captured in the South Santiam trap above Foster Reservoir, 2012. Interrupted indicates periods when the trap was running intermittently due to low flows or debris stopping rotation of the trap.

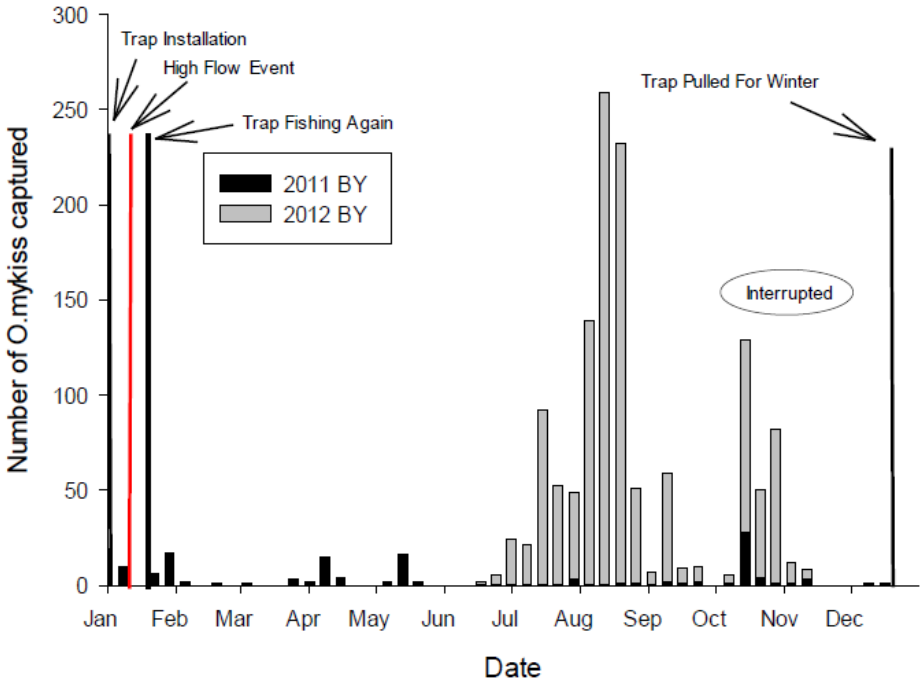


Figure 10. Weekly abundance of juvenile *O. mykiss* captured in the South Santiam trap above Foster Reservoir, 2012. Catch includes 2011 and 2012 brood years (BY). Interrupted indicates a period when the trap was not operating consistently because of low flow or debris.

2.1.8 Green Peter Dam Baseline

Recommended:

month	fry	subs	yearlings (same as Alden)
Sep	0%	40%	0%
Oct	0%	15%	0.10%
Nov	0%	5%	0.10%
Dec	0%	4%	0.10%
Jan	0%	0%	20.10%
Feb	5%	0%	30.60%
Mar	10%	0%	25.30%
Apr	40%	0%	14.50%
May	25%	5%	6.60%
Jun	15%	12%	2.60%
Jul	5%	9%	0%
Aug	0%	10%	0%

Rationale:

Fry: Alden (2014) timing for fry is based on above Foster Reservoir HOR trap timing, We adjusted considering fry likley emigrate into Green Peter later (since spawned at higher elevation), and fry do not immediately distribute throughout the reservoir and therefore their availablility to pass should be delayed from HOR timing.
Subs: Alden timing based on Wagner and Ingram 1973 and noted bias in data since GP fish trap was not operated very much in summer months. Adjusted timing assuming most juveniles will enter as fry into reservoir and reach sub size class in June, and move offshore and actively move thoughout reservoir in June (based on work by Monzyk and Beeman in other WP reservoirs), however will move down in water column with few passing in July and August, and then many passing in Sep and Oct.
Yearlings: No change recommended from Alden, since values based on actual trap records at GP dam.

From Wagner and Ingram (1973):

Table 8. Wild-Reared Juvenile Chinook Counted at the Evaluator, Green Peter Dam, 1968-71 1/

Year	Month 2/	1966 Brood	1967 Brood	1968 Brood	1969 Brood
1968	Jan. 3/	4,791			
	Feb.	-			
	March	-			
	April	29,621			
	May	21,683	79		
	June	3,502	1,311		
	July 3/	40	8,804		
	Oct. 3/	33	14,353		
	Nov.	-	-		
	Dec.	77	89,124		
1969	Jan. 3/	36	64,786		
	Feb. 3/	0	5,793		
	March	8	93,437		
	April	62	55,756	168	
	May	49	16,323	94	
	June	13	7,080	1,864	
	July 3/		27	28	
	Oct. 3/		355	7,053	
	Nov.		355	36,141	
	Dec.		355	10,227	
1970	Jan.		320	4,256	
	Feb. 3/		27	14,413	
	March	1	78	15,453	
	April		600	9,174	11
	May	1	473	4,908	422
	June		126	3,147	5,574
	Oct. 3/			80	32,535
	Nov.			94	204,602
	Dec.			14	157,769
1971	Jan. 3/			25	64,183
	Feb.			44	182,337
	March			57	58,522
	April			153	32,061
	May			186	22,503
	June			25	6,930
TOTALS		59,917	359,562	107,604	767,449

1/ *Includes live and dead fish.*
2/ *Downstream-migrant facility initially activated January 16, 1968. Facility deactivated August and September each year of the study and during July 1970-71.*
3/ *Months when downstream-migrant facility was operated less than 20 days.*

2.1.9 Lookout Point Dam Baseline

2.1.10 Hills Creek Dam Baseline

2.2 Juvenile steelhead Run Timing

2.2.1 Detroit Dam Baseline

2.2.2 Detroit Dam Delayed Refill

2.2.3 Detroit Dam Run-of-River

2.2.4 Foster Dam Baseline

2.2.5 Green Peter Dam Baseline

3 References

Alden BioAnalysts Inc 2014, “Willamette River Fish Benefit Workbook Parameterization: Chinook”, Technical Memo, 01 April 2014.

Beeman, J.W., Evans, S.D., Haner, P.V., Hansel, H.C., Hansen, A.C., Smith, C.D., and Sprando, J.M., 2014, Passage and survival probabilities of juvenile Chinook salmon at Cougar Dam, Oregon, 2012:: U.S. Geological Survey Open-File Report 2014-1038, 64 p., http://dx.doi.org/10.3133/ofr20141038/.

Beeman, J.W., Hansel, H.C., Hansen, A.C., Evans, S.D., Haner, P.V., Hatton, T.W., Kofoot, E.E., Sprando, J.M., and Smith, C.D., 2013, Behavior and Dam Passage of Juvenile Chinook Salmon at Cougar Reservoir and Dam, Oregon, March 2012–February 2013: U.S. Geological Survey Open-File Report 2013-xxx, xx p.

Keefer, M. L., G. A. Taylor, D. F. Garletts, C. K. Helms, G. A. Gauthier, T. M. Pierce and C. C. Caudill. 2012. High-head dams affect downstream fish passage timing and survival in the Middle Fork Willamette River. River Research and Applications: online publication DOI: 10,1002/rra.1613.

Monzyk, F. R., J. D. Romer, R. Emig, and T. A. Friesen. 2012. Life-history characteristics of juvenile spring Chinook salmon rearing in Willamette Valley reservoirs. Annual Report of Oregon Department of Fish and Wildlife (ODFW) to U.S. Army Corps of Engineers, Portland, Oregon.USACE 2011, “Standardization of Passage and Survival Metrics”, Draft Guide, Willamette Valley Ops, 22 May 2011.

USACE 2013, “Model Documentation Report: Willamette Basin HEC-ResSim Model”, Draft Guide, CENWP-EC-HY, 4 October 2013.