Nisqually Indian Tribe
Squally-Absch
People of the river, people of the grass

January 8, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Nisqually Tribe, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use of this method in 2015 for the unmarked SPSdFF and the marked SPSdFF Chinook FRAM stock(s). Thank you for your concern.

Sincerely,

Craig Allen Smith
Nisqually Harvest Program Manager

Puyallup Tribe of Indians

January 12, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Puyallup Tribe of Indians, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use of this method in 2015 for the Marked and Unmarked Mid South Puget Sound fall fingerling and Marked and Unmarked White River spring fingerling Chinook FRAM stocks. Thank you for your concern.

Sincerely,

Chris Phinney
Harvest Manager
Puyallup Tribe of Indians Fisheries

FISHERIES DEPARTMENT
PHONE (360) 394-8450
Fax (360) 598-4666

THE SUQUAMISH TRIBE
PO Box 498 Suquamish, WA 98392-0498

January 16, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015."

We, the Suquamish Tribe, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use this method in 2015 for the marked, and unmarked Mid South Puget Sound fall fingerling and UW Accelerated fall fingerling (UW-A) Chinook FRAM stock(s). These stocks include: the Puyallup River, Misc. Area 10 Grover's Creek Hatchery, Area 10E Gorst, Lake Washington (including UW-A), and Green River Chinook stocks. Thank you for your concern.

Sincerely,

Jonathan Oleyar
Fisheries Biologist
Suquamish Tribe
360-394-8445

CC: Andy Rankis, NWIFC

MUCKLESHOOT INDIAN TRIBE
Fisheries Division

January 20th, 2015

D. O. McIsaac, Ph.D.
Executive Director
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Use of a Standardized Method to Calculate Chinook Age-2 FRAM Stock Recruit Scalars

Dear Mr. McIsaac,

I am writing in response to your written request for notification of our agreement with the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your 12/23/2014 letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015."

We support this methodology for generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use of this method in 2015 for the Marked and Unmarked Mid-South Puget Sound fall fingerling, Marked and Unmarked South Puget Sound fall yearling, and Marked and Unmarked White River spring fingerling Chinook FRAM stocks.

Sincerely,

Isabel Tinoco
Director

cc: Phil Anderson, WDFW Director
Mike Grayum, NWIFC Executive Director

JAMESTOWN S'KLALLAM TRIBE
1033 Old Blyn Highway, Sequim, WA 98382 360/683-1109 FAX 360/681-4643

January 23, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Jamestown S'Klallam Tribe, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use of this method in 2015 for the Hood Canal Fall Fingerling, Hood Canal Yearling, Elwha/Dungeness and Hoko Chinook FRAM stock(s). Thank you for your concern.

Sincerely,

Aaron Brooks
Fisheries Biologist
Jamestown S'Klallam Tribe
(360) 582-5784
(460) 460-0144

C:
Any Rankis
NWIFC

Stillaguamish Tribe of Indians

THE TULALIP TRIBES

January 28, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear Dr. McIsaac,

This letter is in response to your request for written notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. This letter specifically addresses the co-manager (Stillaguamish and Tulalip Tribes, Washington Department of Fish and Wildlife) agreed-to methodology for generating the Age 2 Chinook forecast in the Stillaguamish Watershed. We are using a Chinook life cycle model, nicknamed EMPAR (Environmental Model to Predict Adult Returns), to predict terminal runs sizes by age. FRAM's natural mortality and maturation rates are applied to terminal run size forecasts to estimate age-2 recruit scalars (ocean abundance). This letter will briefly describe EMPAR and how the model generates terminal run size forecasts.

Approach:

We examined environmental predictors of return rates for natural and hatchery origin Chinook salmon from the Stillaguamish River. Two natural, and one hatchery population groups were considered; Stillaguamish Summer Natural, Stillaguamish Summer Hatchery, and Stillaguamish Fall natural. The relative influence of environmental conditions experienced during freshwater (August to February), estuarine tidal delta (February through June), nearshore (June through October), and ocean (October through September) residency periods were tested on adult return rates. Multiple linear regression techniques were used to develop EMPAR models of age-specific recruitment rates based on life-stage specific environmental predictors (see Table 1 for a list of environmental PCA factors considered). Subsets of raw life-stage specific environmental predictors and principle components of predictor sets were tested. Models were selected based on

a preliminary assessment of biological relevance, correlation coefficients, and Akaike's Information Criterion (AIC), which scores models based on their ability to reduce uncertainty but penalizes by the number of variables in the model. As more data are available, additional factors could be considered. The Stillaguamish Tribe is in the process of collecting nearshore water quality and productivity data from Northern Port Susan. In time, this data may be useful for refining the nearshore PCA factor.

Recruitment Rates:

For natural origin Chinook, age-specific spawner per spawner (SPS_t) rates were calculated based on the escapement of adults for each age class for each return year based on the escapement of adults contributing to that broodyear (t) using the following equation;

$$SPS_t = \sum_{x=2}^{5} \frac{P_{x,t+x} N_{t+x}}{N_t}$$

where N_t is the adult escapement in year t, and $P_{x,t}$ is the proportion of adults age x in the return in year t. Spawners per spawner estimates do not account for harvest and different broodyears are exposed to different harvest rates, therefore the spawners per spawner rates were adjusted based on broodyear harvest rates estimated from RMIS recoveries of coded wire tags. The RMIS based harvest rates were derived by broodyear based on RMIS estimated recoveries of pre-terminal and terminal harvest relative to RMIS estimated recoveries to escapement. The RMIS derived harvest rates were used to adjust SPS estimates using the following equation;

$$RPS_t = \frac{SPS_t}{(1 - h_t)}$$

where RPS_t is recruits per spawner in year t and h_t is the harvest rate for broodyear t. Given that the RMIS data set is incomplete and the derived harvest rates are based on hatchery origin stocks, refinement of the harvest rate inputs is one area of potential improvement to the current EMPAR model structure.

Age structure by return year was estimated from scale data collected on the spawning grounds by the Stillaguamish Tribe and WDFW. These ratios were applied to the natural origin escapement estimates to estimate the number of fingerling returns of each age class for each return year. As hatchery origin summer fish return to the spawning grounds they were handled in the same way as wild populations.

Model Selection:

The current set of selected models correlate well with observed recruitment rates within the training set, with R^2 values ranging from 0.39 to 0.65 (Table 2). The training set includes broodyears 1989 – 2010 for age 2 population groups, 1989 – 2008 for age 3 population groups, 1989 – 2007 for age 4 population groups, and 1989 – 2006 for age 5 population groups. The PCA for Freshwater Life Stage uses EGG, PKCM, HATCH, and QMAX factors, though 62% of the variance is explained with first two components. The final PCAs for Delta/Nearshore Life Stage use DO, TEMP, and SAL factors, though 50% of the variance is explained with first two components. The PCAs for Ocean Life Stage use SST, UWI, PDO, SOI, and SL factors, though 73% of the variance is explained with first two components.

Forecast:

The selected models were used to predict recruitment rates and 95% confidence intervals for each age class and population group the most recent forecast year. For hatchery and natural origin populations, the predicted age-specific recruitment rates were used to calculate the predicted adult returns with and without fishing for each age class and population by return year.

Thank you for reviewing this forecast methodology for the Stillaguamish, and please contact us with any questions or concerns.

Sincerely,

Jason Griffith
Fisheries Biologist
Stillaguamish Tribe of Indians

Diego Holmgren
Fisheries Manager
Tulalip Tribes

Jennifer Whitney
District 13 Fish Biologist
WDFW, Region 4

C: Andy Rankis, NWIFC

TABLES:

Table 1: List of environmental predictors during freshwater (August to February), estuarine tidal delta (February through June), nearshore (June through October), and ocean (October through September) residency periods. An X indicates which life stage the factor was used for. Principle components are based on PCA analysis of all factors from the respective life stage periods.

Factor Code	Factor Description	Freshwater	Delta	Nearshore	Ocean 1	Ocean 2	Ocean 3	Ocean 4
EGG	Total Stillaguamish Egg Deposition	X						
HATCH	Total Stillaguamish Chinook Hatchery Releases	X						
QMAX	Max Stillaguamish River NF Flow (USGS 12134500)	X						
SL	Sea Level at Neah Bay, WA		X	X	X	X	X	X
DO	Surface DO Possession Sound (DOE PSS019)		X	X				
SAL	Surface Salinity Possession Sound (DOE PSS019)		X	X				
TEMP	Surface Temp Possession Sound (DOE PSS019)		X	X				
UWI	Upwelling Index (NOAA)		X	X				
SOI	Southern Oscillation Index (NOAA)				X	X	X	X
SST	Sea Surface Temp (DFO Lighthouse Data)				X	X	X	X
PDO	Pacific Decadal Oscillation (NOAA)				X	X	X	X
Near.PC1	Nearshore PCA Component 1		X	X				
Ocean1.PC1	Ocean Year 1, PCA Component 1				X	X	X	X
Ocean1.PC2	Ocean Year 1, PCA Component 2				X	X	X	X
Ocean2.PC1	Ocean Year 2, PCA Component 1				X	X	X	X
Ocean3.PC1	Ocean Year 3, PCA Component 1				X	X	X	X

Table 2: Selected models for each population (SHOR: Summer Hatchery; SNOR: Summer Natural; FNOR: Fall natural) and age class, including the predictors and summary model statistics for multiple linear regressions. Factor codes references are provided in Table 1.

Population	Age	R^2	P-Value	F-Statistic	DF	Factor1*	Factor2*	Factor3*	Factor4*	Factor5*
NF HOR	2	0.47	0.083	2.474	5,14	(EGG)	(QMAX)	NEAR_PC1	OCEAN1_PC1	OCEAN1_PC2
NF HOR	3	0.65	0.009	4.929	5,13	(EGG)	(HATCH)	NEAR_PC1	(OCEAN1_PC1)	OCEAN1_PC2
NF HOR	4	0.46	0.138	2.084	5,12	(EGG)	QMAX	NEAR_PC1	OCEAN1_PC1	OCEAN1_PC2
NF HOR	5	0.39	0.302	1.388	5,11	(EGG)	(QMAX)	DELTA_DO	OCEAN1_PC1	OCEAN2_PC1
NF HOR	Total**	r=0.77								
NF NOR	2	0.49	0.065	2.701	5,14	(EGG)	QMAX	DELTA_DO	OCEAN1_PC1	(OCEAN1_PC2)
NF NOR	3	0.65	0.010	4.916	5,13	(EGG)	(QMAX)	DELTA_DO	(OCEAN1_PC1)	OCEAN2_PC1
NF NOR	4	0.45	0.163	1.930	5,12	(EGG)	(QMAX)	NEAR_PC1	OCEAN1_PC1	OCEAN2_PC1
NF NOR	5	0.48	0.157	2.000	5,11	(EGG)	(QMAX)	(NEAR_DO)	OCEAN2_PC1	(OCEAN3_PC1)
NF NOR	Total**	r=0.78								
SF NOR	2	0.43	0.126	2.099	5,14	(EGG)	QMAX	NEAR_PC1	(NEAR_PC2)	OCEAN1_PC1
SF NOR	3	0.59	0.025	3.772	5,13	(EGG)	(QMAX)	(NEAR_PC1)	(OCEAN1_PC1)	OCEAN2_PC1
SF NOR	4	0.39	0.257	1.515	5,12	(EGG)	(QMAX)	(NEAR_DO)	OCEAN1_PC1	OCEAN1_PC2
SF NOR	5	0.63	0.031	3.780	5,11	(EGG)	(QMAX)	DELTA_DO	OCEAN2_PC1	(OCEAN3_PC1)
SF NOR	Total**	r=0.61								

Oregon
John A. Kitzhaber, MD, Governor

Department of Fish and Wildlife
Office of the Director
4034 Fairview Industrial Dr SE
Salem, OR 97302-1142
503-947-6044
Fax: 503-947-6042
www.dfw.state.or.us

January 30, 2015

VIA EMAIL ONLY: donald.mcisaac@noaa.gov

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear ~~D. O. McIsaac~~ Don, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Oregon Department of Fish & Wildlife also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use of this method in 2015 for both the Marked and Umarked components of the following Chinook FRAM stocks:

LCRWild (Lower Columbia River Wild)

BPHTule (Bonneville Hatchery Tule)

UpCRSu (Upper Columbia River Summers)

UpCRBr (Upper Columbia River Brights)

Will Sp (Willamette River Springs)

Snake F (Snake River Falls)

OR NoF (Oregon-North of Falcon)

LColNat (Lower Columbia River Natural)

Thank you for your concern.

Sincerely,

Curtis E. Melcher
Interim Director

January 31, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Skagit River System Cooperative representing the Swinomish Indian Tribal Community and Sauk-Suiattle Indian Tribe, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use this method in 2015 for the following Chinook FRAM stocks: unmarked Skagit summer/fall fingerlings and yearlings, marked Skagit summer/fall fingerlings, unmarked Skagit spring yearling and fingerlings, and marked Skagit spring yearlings. Thank you for your concern.

Sincerely,

Casey Ruff
Director of Harvest Management
Skagit River System Cooperative
11426 Moorage Way
La Conner, WA 98257

Cc: Brett Barkdull, Bob McClure, Pete Kairis, Grant Kirby, Andy Rankis

From: **Bob McClure** <bobm@upperskagit.com>
Date: Mon, Feb 2, 2015 at 12:19 PM
Subject: Response to Chinook age 2 recruit scalar forecast methodology
To: "pfmc.comments@noaa.gov" <pfmc.comments@noaa.gov>
Cc: "Barkdull, Brett C (DFW)" <Brett.Barkdull@dfw.wa.gov>, Casey Ruff <cruff@skagitcoop.org>, Pete Kairis <pkairis@skagitcoop.org>, "gkirby@sauk-suiattle.com" <gkirby@sauk-suiattle.com>, Andy Rankis <arankis@nwifc.org>

February 2,2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear Dr. McIsaac,

In response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process: The new method proposed by the SSC, SIT, and the Model Evaluation Workgroup support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars and will use this method in 2015 for the following Chinook FRAM stocks: unmarked Skagit summer/fall fingerlings and yearlings, marked Skagit summer/fall fingerlings, unmarked Skagit spring yearling and fingerlings, and marked Skagit spring yearlings.

Sincerely,

Robert McClure, Harvest Management Biologist
-- for --
Scott Schuyler, Director of Natural Resources
25944 Community Plaza Drive
Sedro Woolley, WA 98284

Cc: Brett Barkdull (WDFW), Casey Ruff (SRSC), Pete Kairis (Swinomish Tribe), Grant Kirby (Sauk-Suiattle Tribe), Andy Rankis (NWIFC)

Skokomish Indian Tribe

Fisheries Department

N. 541 Tribal Center Road
Skokomish Nation, WA 98584
Tel: (360) 877-5213 Fax: (360) 877-5148

February 3, 2015
D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Use of a Standardized Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

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Dear D. O. McIsaac, Ph.D:

This letter is in response to your written request for notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. As stated in your letter, "This new method was reviewed and approved by the Council's Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT), and the Model Evaluation Workgroup for use beginning in 2015." We, the Skokomish Indian Tribe, also support this methodology of generating Chinook Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars for those affected stocks of concern. However, the co-managers will not be applying this new methodology in 2015 and continue to use the methodology already developed for Age 2 recruits for the 2015 Hood Canal Chinook FRAM stock(s). Thank you for your concern.

Sincerely,

Cynthia Gray
Finfish Harvest Manager
Skokomish Tribe
N. 541 tribal Center Road
Shelton, WA 98584

Washington Department of FISH and WILDLIFE

THE TULALIP TRIBES

February 4, 2015

D. O. McIsaac, Ph.D.
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

Re: Pacific Fishery Management Council (Council) Written Request on the Method to Calculate Chinook Age-2 Fishery Regulation Assessment Model (FRAM) Stock Recruit Scalars

Dear Dr. McIsaac,

This letter is in response to your request for written notification of the regional methodology being used to generate stock specific age-2 recruit scalars for the 2015 preseason FRAM modeling process. This letter specifically addresses the co-manager (Tulalip, and Washington Department of Fish and Wildlife) agreed-to methodology being used to generate the Age 2 Chinook forecast in the Snohomish Watershed. Rather than generating Age 2 FRAM recruit scalars (forecasts) from stock specific Age 3 FRAM recruit scalars, we are using the Chinook life cycle model EMPAR (Environmental Model to Predict Adult Returns). This letter will briefly describe this methodology and summarizes results. Methodology for generating stock specific age-2 recruit scalars for the Wallace hatchery will follow in a separate letter.

APPROACH:

We examined environmental predictors of return rates for natural and hatchery origin ocean-type and stream-type Chinook salmon from the Snohomish River. A total of four natural and one hatchery population groups were considered;

1. Skykomish Chinook Ocean-Type (Skykomish Yearling),
2. Skykomish Chinook Stream-Type (Skykomish Fingerling),
3. Snoqualmie Chinook Ocean-Type (Snoqualmie Yearling),
4. Snoqualmie Chinook Stream-Type (Snoqualmie Fingerling),
5. Tulalip Hatchery Ocean-Type (Tulalip Fingerling),

For each of these populations, we adjusted terminal run sizes (escapement plus terminal harvest 8A and 8D net and recreational fisheries, and by age structure. The terminal run size by population was then adjusted for broodyear specific pre-terminal harvest using adult equivalent adjusted exploitation rates during ocean residency. Age-specific recruitment rates were then derived based on releases for hatchery populations and natural spawners for wild populations. These age-specific recruits per release (RPR, hatchery populations) and recruits per spawner (RPS, natural spawners) were natural log transformed and modeled using single factor linear regressions with life-stage specific environmental conditions (Table 1 and Figures 1-5 show only those environmental conditions selected in the final forecast models). We tested the relative influence of environmental conditions experienced during the expected period of incubation in freshwater (August to February) and ocean conditions in the year of the broodyear and year following the broodyear.

Forecasts are presented in Table 2.

Table 1: Metrics selected in the forecast models (see Figures 1-6)

Environment	Factor Code	Description
Freshwater	SNO.QMAX	Maximum mean daily discharge at USGS 12150800 Snohomish River during incubation period (August – February).
Freshwater	SNQ.QMAX	Maximum mean daily discharge at USGS 12149000 Snoqualmie River during incubation period (August – February).
Freshwater	SKY.QMAX	Maximum mean daily discharge at USGS 12134500 Skykomish River during incubation period (August – February).
Ocean	Winter_NPGO	Cumulative monthly winter (December to March) North Pacific Gyre Oscillation index from OCES for broodyear or year following broodyear.
Ocean	Summer_PDO	Cumulative monthly summer (May to September) Pacific Decadal Oscillation index from NOAA for broodyear or year following broodyear.
Ocean	Winter_PDO	Cumulative monthly winter (December to March) Pacific Decadal Oscillation index from NOAA for broodyear or year following broodyear.
Ocean	Winter_SOI	Cumulative monthly winter (December to March) Southern Oscillation Index (Stand Tahiti - Stand Darwin Sea Level Press Standardized Data) for broodyear or year following broodyear.
Ocean	Winter_UWI	Cumulative monthly winter (December to March) coastal upwelling index for four NOAA stations (48N125W, 51N131W, 54N134W, and 57N137W) for broodyear or year following broodyear.

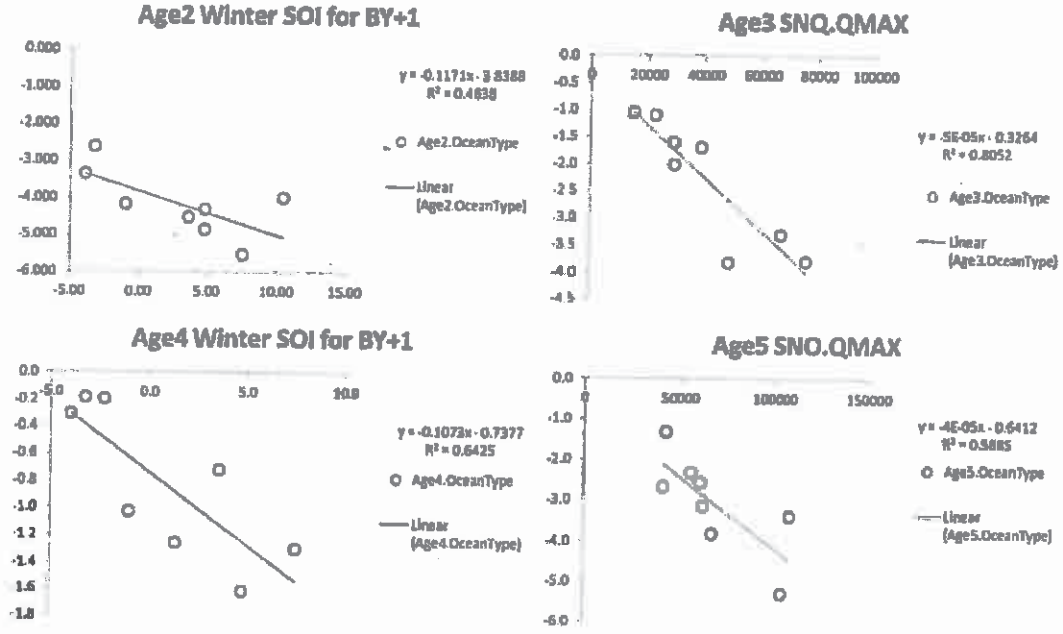

Figure 1,- Snoqualmie Wild Ocean Type: Age Specific Recruit per Spawner (natural log transformed RPS) vs Life Stage Specific Environmental Conditions: Age 2, 4 and Winter Southern Oscillation Index ; Age 3, 5 and Snoqualmie Maximum Flow.

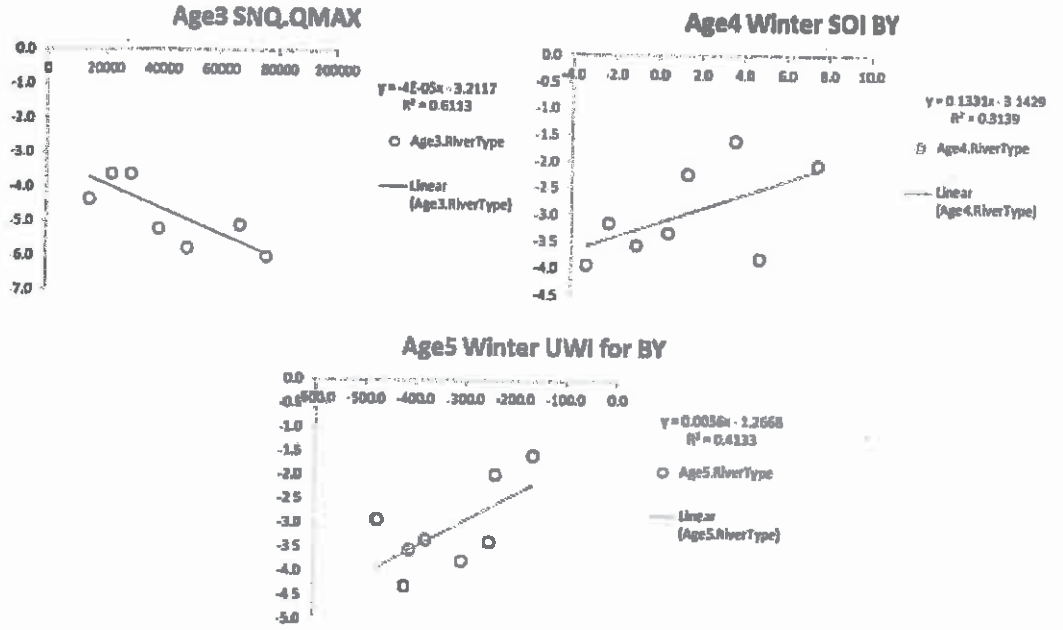

Figure 2,- Snoqualmie River Type: Age Specific Recruit per Spawner (natural log transformed RPS) vs Life Stage Specific Environmental Conditions: Age 3 and Snoqualmie Maximum Flow, Age 4 and Winter Southern Oscillation Index and Age 5 and Winter Upwelling Index.

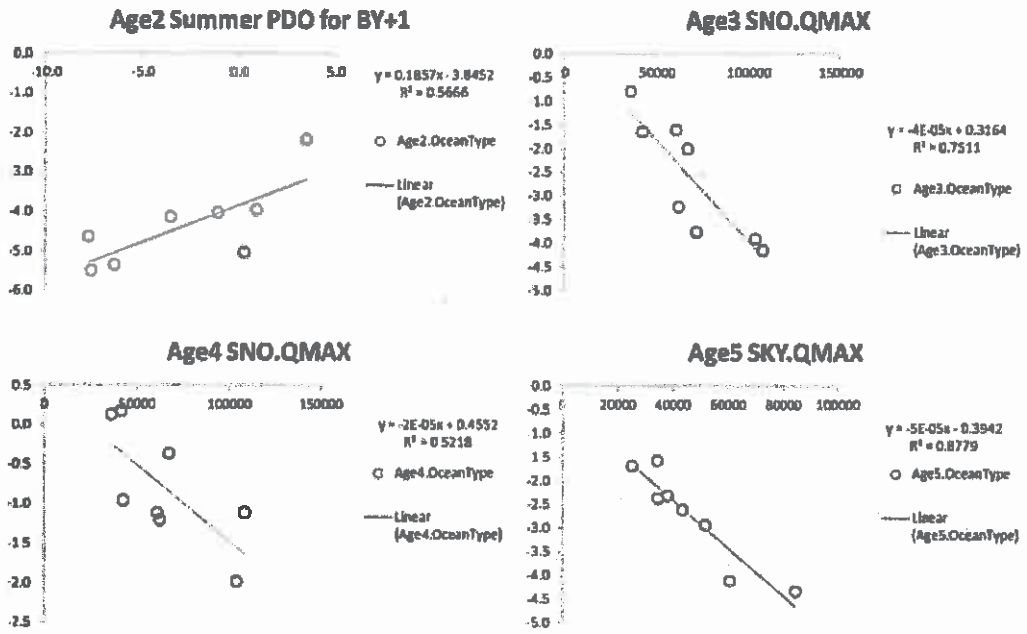

Figure 3,- Skykomish Wild Ocean Type: Age Specific Recruit per Spawner (natural log transformed RPS) vs Life Stage Specific Environmental Conditions: Age 2 and Summer PDO Index; Age 3, 4 and Snohomish Maximum Flow; Age 5 and Skykomish Maximum Flow.

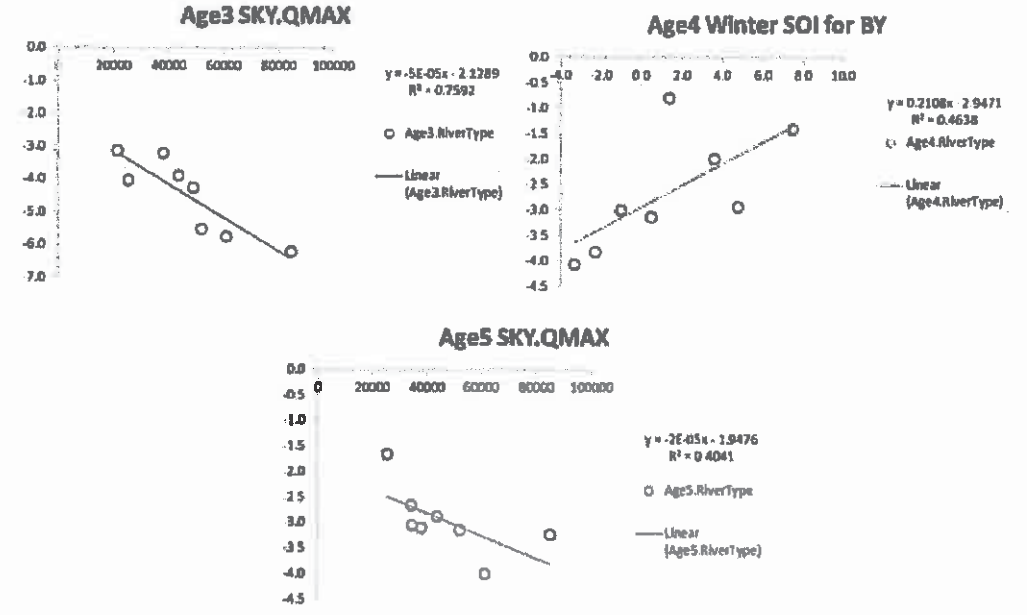

Figure 4,- Skykomish River Type: Age Specific Recruit per Spawner (natural log transformed RPS) vs Life Stage Specific Environmental Conditions: Age 3, 5 and Skykomish Maximum Flow; Age 4 and Winter Southern Oscillation Index.

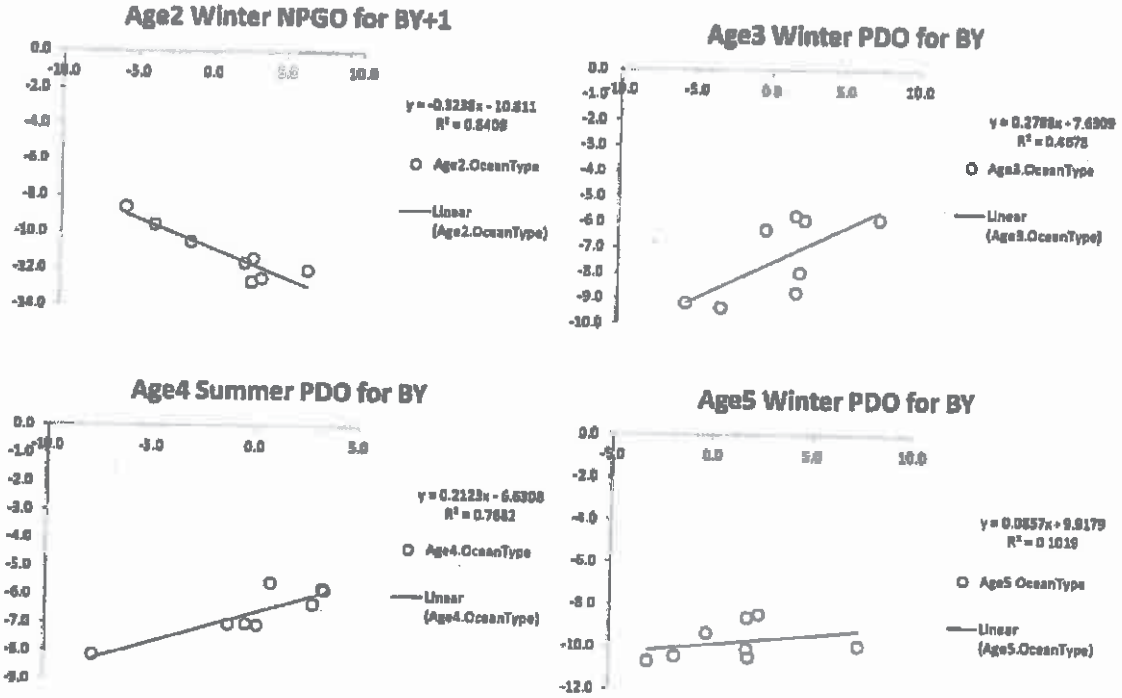

Figure 5,- Tulalip Wild Ocean Type: Age Specific Recruit per Spawner (natural log transformed RPS) vs Life Stage Specific Environmental Conditions: Age 2 Winter NPGO Index, Age 3, 5 and Winter PDO Index, Age4 and Summer PDO Index.

Table 2.- 2015 EMPAR Forecasts without fishing for Snohomish (Natural) and Tulalip (Hatchery) stocks.

	Ocean Type				River Type			
Population	Age2	Age3	Age4	Age5	Age3	Age4	Age5	Total
Snoqualmie*	18	534	201	73	35	57	14	932
Skykomish*	129	1300	795	143	184	555	121	3227
Tulalip**	102	216	842	146	0	0	0	1305
*Escapement								
**Terminal Run Size								

Thank you for reviewing this proposed forecast methodology for the Snohomish, and please contact us with any questions or concerns.

Best regards,

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