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**Northwest  
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# Deploying protected species tools via cloud computing

Elizabeth Eli Holmes  
Northwest Fisheries Science Center  
November 18, 2015

# Web-based Protected Species Toolbox and Cloud-based Platform for Running Tools

- **PIs:** Eli Holmes and Eric Ward (NWFSC)
- **Goal:** To develop both a website/content manager for protected species tools and browser-based tool interfaces.
- **Importance/Application:**
  - NMFS scientists develop many applications/tools to run sophisticated analyses in support of NMFS Regional Offices.
  - There is currently no cross-center platform to host these tools. Tools existence often unknown across groups.
  - Browser-based interfaces allow NMFS scientists to develop tools that can be run by others with only a browser.

Webpage



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Human Dimensions

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Climate

## Welcome to the Protected Species Toolbox

The National Protected Species Toolbox (NPST) provides access to a variety of modeling and statistical tools used to support the protection, conservation and recovery of **marine mammals** and **endangered/threatened marine life** under the responsibility of **NOAA's** National Marine Fisheries Service (NOAA Fisheries Service, or **NMFS**), under the **U.S. Department of Commerce**. These tools are developed and maintained by individual NMFS science centers.

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ROSE — [Download files](#)

**Project members:** e2holmes eric.ward howard.coleman

Center	System	Category
NWFSC	Marine Mammals	Demographic Analysis

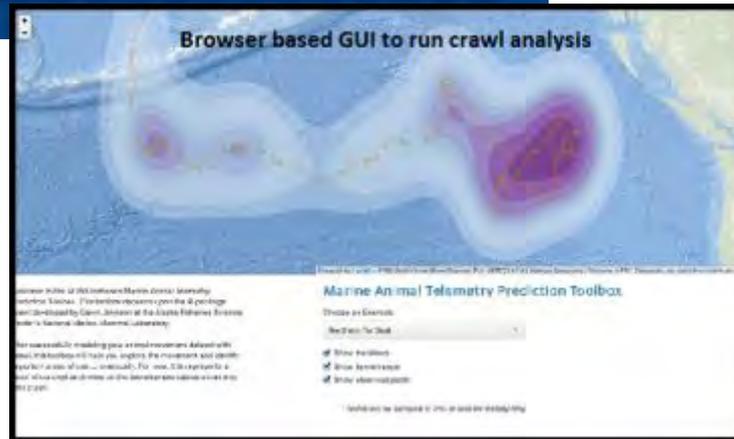
Version:	Language:	Keywords:
1.0	R, jags	risk assessment

**Summary**  
Several of the smaller populations that NMFS monitors have very detailed demographic data, where individual birth and deaths are known, in addition to the reproduction of each female in each year. The Resident Orca Salmon Emulator (ROSE) model is a tool estimate how survival and birth rates of these small populations changes over time, and whether any of these rates is affected by external drivers (climate, prey, etc). Small adjustments to these drivers may be important if the external driver is a prey species that is also commercially fished. Most recently, this tool has been applied to estimate how altering fishing levels of Chinook salmon may impact the viability and growth of endangered Southern Resident killer whales.

**How is ROSE used in analyses related to protected species management?**  
ROSE is used to understand how the viability of Southern Resident Killer Whales is related to covariates such as prey. ROSE was used in the bi-lateral workshops investigating the relationships between Chinook salmon fishing and Southern Resident Killer Whale viability (report) and was used in the 2013 NOAA Technical Memorandum Estimating the Impacts of Chinook Salmon Abundance and Prey Removal by Ocean Fishing on Southern Resident Killer Whale Population Dynamics.

[View ROSE details](#)

# Browser-based GUIs



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e2holmes

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Forecasting and Simulation	Center	System	Lang	Vers
Count-based PVA	NWFSC		matlab	1.0
DARTER	NWFSC		Excel	
Selective Harvest Calculator (SHC)	NWFSC	Anadromous Fish	Java	1.0.5
Species Life-cycle Analysis Modules (SLAM)	NWFSC	Anadromous Fish	Java	
Viability and Risk Assessment Procedure (VRAP)	NWFSC	Anadromous Fish	R	1.0
<b>Demographic Analysis</b>				
ROSE	NWFSC	Marine Mammals	R, jags	1.0
Salmon Population AnalyzerZer (SPAZ)	NWFSC	Anadromous Fish	Java	1.3.4
<b>Analysis of Movement Data</b>				
<b>Genetic Analysis</b>				
gsi_sim	SWFSC	Anadromous Fish		
<b>Diet and Stable Isotope Analysis</b>				
<b>Statistical Packages</b>				
MARSS	NWFSC		R	3.13

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## Forecasting and Simulation

Count-based PVA  
DARTER  
Selective Harvest Calculator (SHC)  
Species Life-cycle Analysis Modules (SLAM)  
Viability and Risk Assessment Procedure (VRAP)

Center	System
NWFSC	
NWFSC	
NWFSC	Anadromous Fish
NWFSC	Anadromous Fish
NWFSC	Anadromous Fish

## Demographic Analysis

ROSE  
Salmon Population AnalyzerZer (SPAZ)

Center	System
NWFSC	Marine Mammals
NWFSC	Anadromous Fish

## Analysis of Movement Data

## Genetic Analysis

gsi\_sim

Center	System
SWFSC	Anadromous Fish

## Diet and Stable Isotope Analysis

## ROSE

PST Admin: [Remove 'ROSE' from P](#)

### Project information

Published : [Remove](#)

Project members  
e2holmes howard.coleman eric.ward  
[Manage users](#)

Sharing: Public | Center: NWFSC | System: Marine Mammals | Category: Demographic Analysis

#### Summary

Several of the smaller populations that NMFS monitors have very detailed demographic data, where individual birth and deaths are known, in addition to the reproduction of each female in each year. The Resident Orca Salmon Emulator (ROSE) model is a tool estimate how survival and birth rates of these small populations changes over time, and whether any of these rates is affected by external drivers (climate, prey, etc). Small adjustments to these drivers may be important if the external driver is a prey species that is also commercially fished. Most recently, this tool has been applied to estimate how altering fishing levels of Chinook salmon may impact the viability and growth of endangered Southern Resident killer whales.

#### How is ROSE used in analyses related to protected species management?

ROSE is used to understand how the viability of Southern Resident Killer Whales is related to covariates such as prey. ROSE was used in the bi-lateral workshops investigating the relationships between Chinook salmon fishing and Southern Resident Killer Whale viability ([report](#)) and was used in the 2013 NOAA Technical Memorandum [Estimating the Impacts of Chinook Salmon Abundance and Prey Removal by Ocean Fishing on Southern Resident Killer Whale Population Dynamics](#).

#### Detailed description

**To install:** Download the zip file for the package ([click to download](#)). Then use the devtools package in R.

### Announcements

[Discussion](#)  
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**Downloads**  
7 project downloads  
26 file downloads  
[View downloads](#)

R Shiny Server <https://dataexplorer.northwestscience.fisheries.noaa.gov/>



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## NWFSC Data Explorer : Conservation Biology Program

These R Shiny applications are based on packages developed in conjunction with the Conservation Biology Program of the Northwest Fisheries Science Center.

To run an application, or to learn more about it, click its link.

To return to this page, click "Display apps" in the bottom right-hand corner of the application display.

### Shiny applications

[agTrend](#) : Estimating trends of aggregated abundance

[ROSE](#) : Resident Orca Salmon Emulator

[VRAP](#) : Viability Risk Assessment Procedure & Rebuilding Exploitation Rates

# agTrend: AFSC Steller sea lion trend analysis and data visualization

<https://dataexplorer.northwestscience.fisheries.noaa.gov/nwc/agTrend/>



## agTrend

Select data set Plot data Fit model Abundances

Select regions and sites:

### Regions:

- C ALEU
- E ALEU
- W ALEU
- C GULF

### Available sites

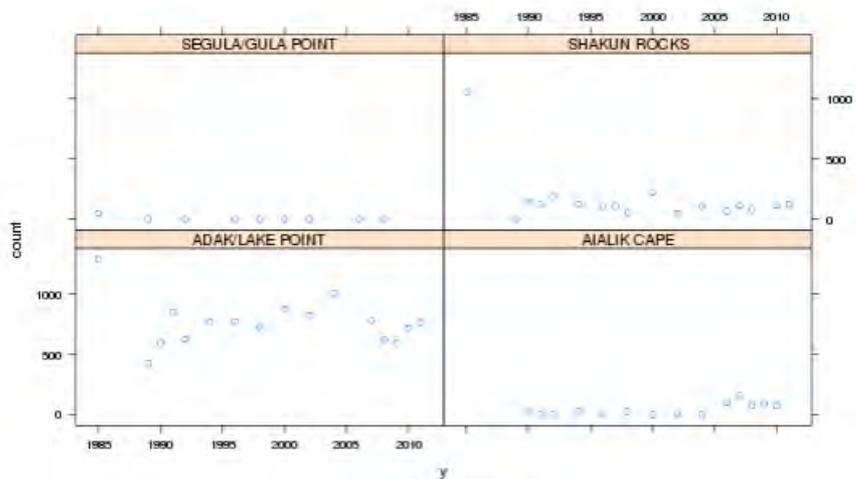
- SEAL ROCKS
- SEAL ROCKS (KENAI)
- SEGUAM/SADDLERIDGE
- SEGUAM/TURF POINT
- SEGULA/CHUGUL POINT
- SEMISOPOCHNOV/PETREL
- SEMISOPOCHNOV/POCHNOI
- SEMISOPOCHNOV/SW KNOB
- SHAW
- SHEMYA
- SILAK

### Selected sites

- ADAK/LAKE POINT
- AJALIK CAPE
- SEGULA/GULA POINT
- SHAKUN ROCKS

Plot data

Data plot Trend summary Trend plots Abundance plots Help About



Download data plot (pdf)



# VRAP: NWFSC Tool for estimation of impact of harvest on listed salmonids

<https://dataexplorer.northwestscience.fisheries.noaa.gov/nwc/VRAP/>

Table of target exploitation rate versus extinction risk

Data input Results Help About

R&PVIABILITY (R) Version 1.0 Date:2015-11-16

Title: ER example of Beverton-Holt VRAP with no marine survival or stream flow variability

Input File: demofiles/exampleB2ER.rav

Copy of Input File:demofiles/exampleB2ER.rav

Basic Simulation Input Parameters:  
 # of Years=25 # of Reps=1 HR Conv.Crit=0.001 Seed0  
 Range start 0 end 1.89189189189189 by 0.0675675675675676

Stock Recruit Function Input Parameters:  
 Function Type: BEV2  
 Recruits = 1/((1/b) + 1/(a\*Spawners)]  
 a=productivity=9.27599153996063 b=maxrecruits=3702.14272977426

Stock-Recruit Error Parameters (gamma distr.) [R=f(s)+e]:  
 A=0.967637142385205 B=1.09275572895311

Depensation at escap:400 QET:63fraction of depensation at QET0

Fishery Regime Parameters:  
 Base ER = 0.37

Management Variability Parameters:  
 Gamma A=65.2846 Gamma B=0.0158  
 mean=1.03223468 var=0.016925107944

AEQ for age class  
 Age2 AEQ =0.584052132848285  
 Age3 AEQ =0.825713254893611  
 Age4 AEQ =0.968504491293936  
 Age5 AEQ =1  
 recruits Ab Age 1= 0.175215639854485

Regime Evaluation Parameters: QET = 63  
 Lower Escapement Level (LEL)=416  
 Upper Escapement Level (UEL)=1040  
 Max Return (under average variability) =3702.14272977426

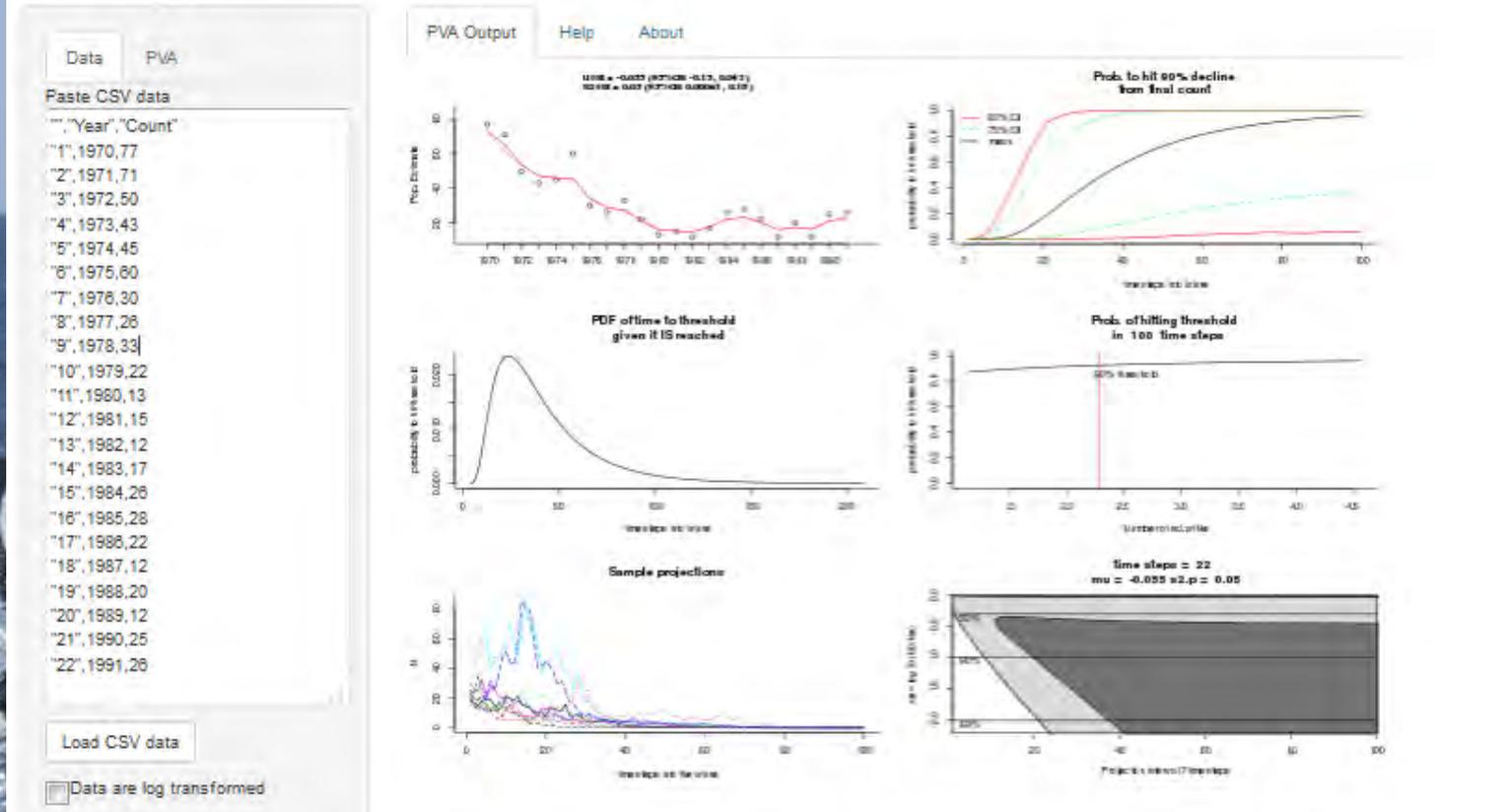
SUMMARY STATISTICS  
 All statistics are averaged over repetitions

. param.	TgtER	CtYrER	BYrER	Mort.	extinct	Escapement		1st LastYrs	pop_size.	at_equil.
						UEL	Year			
3702	0.00	0.000	0.000	0	0.0	0.0	100.0	722	1565	
3702	0.03	0.027	0.026	72	0.0	0.0	100.0	707	5322	
3702	0.05	0.051	0.051	111	0.0	0.0	100.0	700	2384	
3702	0.08	0.081	0.079	200	0.0	0.0	100.0	683	2243	
3702	0.10	0.100	0.098	214	0.0	4.0	100.0	677	4294	
3702	0.13	0.126	0.124	446	0.0	0.0	100.0	658	1807	
3702	0.15	0.152	0.148	589	0.0	0.0	100.0	657	4447	
3702	0.18	0.189	0.185	596	0.0	0.0	100.0	624	2867	
3702	0.20	0.206	0.202	679	0.0	0.0	100.0	608	1400	
3702	0.23	0.222	0.216	918	0.0	0.0	100.0	604	4149	

# PVAwidget: NWFSC Tool for estimation of extinction risk from count data

<https://dataexplorer.northwestscience.fisheries.noaa.gov/nwc/PVAwidget>

## PVAwidget



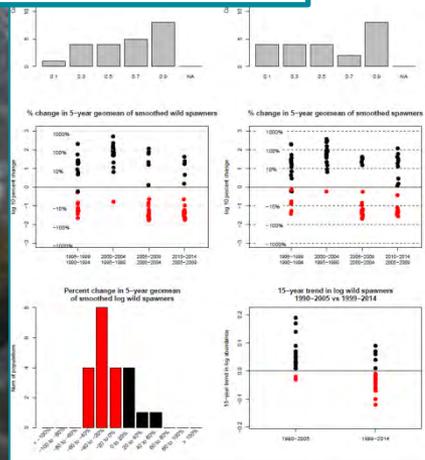
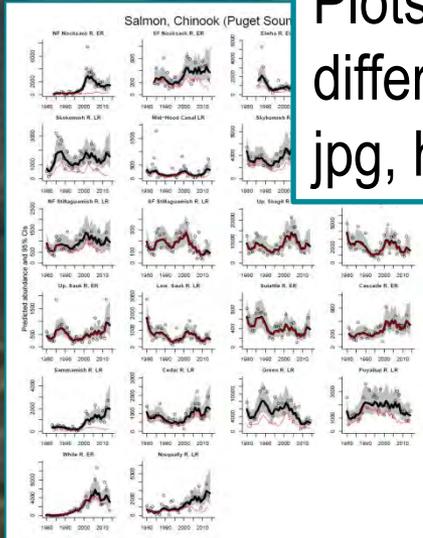
# R-based Automated Report (plots/tables) generation

## Example from a 5-year status review update

Database (raw data)



Plots and tables in different formats: jpg, html, pdf, ...



```

60 ~~~~~[r_summary_fig, echo=FALSE,fig.width=8.5,fig.height=11]-
61 par(mfrow=c(3,2))
62 source("fracwild_tables.R")
63 total.spawners=matdat.spawners[esus==esuname,.drop=FALSE]-
64 wild.spawners=matdat.wildspawners[esus==esuname,.drop=FALSE]-
65 a=fracwild_table(wild.spawners[pop.to.plot,.drop=FALSE],total.spawners[pop.to.plot,.drop=FALSE])
66 ~~~~~
67
68 barplot(table(cut(as.numeric(as.character(a[,5]))),seq(0,1,.9,0.2)),names.arg=c(as.character(seq(0.1,.9,0.2)),"NA"),ylim=c(0,dim(a)[1]))-
69
70 title("Fraction wild across populations 2005-2009")-
71
72
73 barplot(table(cut(as.numeric(as.character(a[,6]))),seq(0,1,.9,0.2)),names.arg=c(as.character(seq(0.1,.9,0.2)),"NA"),ylim=c(0,dim(a)[1]))-
74
75 title("Fraction wild across populations 2010-2014")-
76
77
78 source("geomean_tables.R")-
79 a=geomean_table(pops.to.plot, mpg.to.plot, ifit.total, ifit.wild, vals1=vals2=c())-
80
81 geo.start=which(names(a)=="MPG")+1-
82 geo.end=which(names(a)=="% Change")-1-
83 for(i in 1:dim(a)[1]){-
84   vals1=rbind(vals1, as.numeric(apply(a[i,geo.start:geo.end],2,function(x){strsplit(x,"D")[[1]][1]})))-
85   vals2=rbind(vals2, as.numeric(apply(a[i,geo.start:geo.end],2,function(x){strsplit(x,"D")[[1]][1]})))-
86   vals=apply(vals,function(x){strsplit(x,"D")[[1]][1]}))-
87   vals2=rbind(vals2, as.numeric(vals))-
88 }-
89
90 plot(0:5,0:5,xlim=c(0,4.5),ylim=c(-1*log10(1000),log10(1000)),ylab="log 10 percent change",xlab="")-
91 for(i in 1:(dim(vals1)[2]-1)){-
92   n=dim(vals2)[1]-
93   vals=100*(vals1[,i+1]-vals1[,i])/vals1[,i]-
94   points(i+rnorm(n,0,0.01),ifelse(vals<0,-1,1)*log10(abs(vals)),cex=1.5, pch=19,col=ifelse(vals<0,"red","black"))-
95 }-
96 axis(side=1, at=1:4, label=c("1995-1999","1999-1994"))-
  
```

R code embedded in a report generation framework (knitr/Sweave)

Population	MPG	1990-2005	1999-2014
NF Nooksack R. ER	Strait of Georgia	0.07 (0.04, 0.09)	0.04 (0, 0.07)
SF Nooksack R. ER	Strait of Georgia	0.03 (0, 0.06)	-0.06 (-0.1, -0.02)
Elwha R. ER	SJF	-0.02 (-0.06, 0.02)	-0.06 (-0.1, -0.03)
Dungeness R. SR	SJF	0.14 (0.08, 0.19)	0.09 (0.03, 0.14)
Skokomish R. LR	Hood Canal	0.02 (-0.01, 0.05)	-0.07 (-0.11, -0.02)
Mid-Hood Canal LR	Hood Canal	0.03 (0, 0.07)	-0.07 (-0.11, -0.02)
Skykomish R. LR	Whidbey Basin	0.03 (0, 0.06)	-0.02 (-0.04, 0.01)
Snoqualmie R. LR	Whidbey Basin	0.09 (0.05, 0.12)	-0.05 (-0.08, -0.03)
NF Stillaguamish R. LR	Whidbey Basin	0.04 (0.02, 0.06)	-0.04 (-0.06, -0.01)
SF Stillaguamish R. LR	Whidbey Basin	0.01 (-0.01, 0.03)	-0.1 (-0.12, -0.08)
Up. Skagit R. LR	Whidbey Basin	0.07 (0.05, 0.09)	-0.03 (-0.06, 0)
Low. Skagit R. LR	Whidbey Basin	0.05 (0.02, 0.09)	-0.03 (-0.06, -0.01)
Up. Sauk R. ER	Whidbey Basin	0.01 (-0.02, 0.04)	0.06 (0.04, 0.08)
Low. Sauk R. LR	Whidbey Basin	0.05 (0.01, 0.08)	-0.04 (-0.07, -0.01)
Suittelle R. ER	Whidbey Basin	0.01 (-0.01, 0.03)	-0.01 (-0.04, 0.01)
Cascade R. ER	Whidbey Basin	0.06 (0.04, 0.08)	0.01 (-0.01, 0.03)
Sammamish R. LR	Central/South Sound	0.17 (0.11, 0.23)	-0.02 (-0.06, 0.02)
Cedar R. LR	Central/South Sound	0.03 (0, 0.06)	0.07 (0.05, 0.1)
Green R. LR	Central/South Sound	0.02 (-0.02, 0.06)	-0.12 (-0.16, -0.09)
Puyallup R. LR	Central/South Sound	-0.03 (-0.05, -0.02)	-0.06 (-0.08, -0.03)
White R. ER	Central/South Sound	0.19 (0.17, 0.21)	-0.03 (-0.08, 0.01)
Nisqually R. LR	Central/South Sound	0.05 (0.03, 0.06)	-0.01 (-0.05, 0.03)

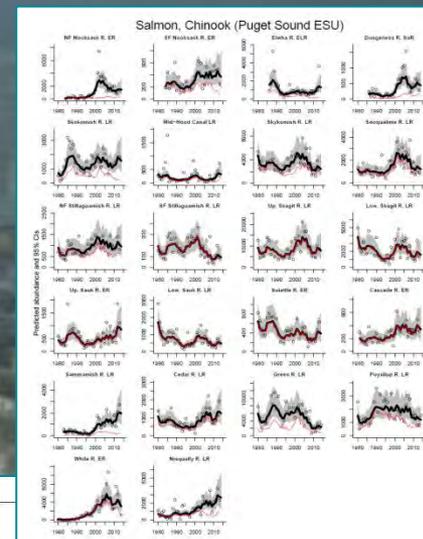
# R-based Automated Report (plots/tables) generation

## Example from a 5-year status review update

### Advantages

- Standardization
- Transparency (“reproducibility”)
- Vastly reduces time to update tables and figures
- Reduces errors
- Easily make analyses available (shiny apps)

6-8 plots  
3-5 tables  
13 DPS  
1-22 pops per DPS



Population	MPG		
NF Nooksack R. ER	Strait of Georgia		
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NF Stillaguamish R. LR	Whidbey Basin	0.04 (0.02, 0.06)	-0.04 (-0.06, -0.01)
SF Stillaguamish R. LR	Whidbey Basin	0.01 (-0.01, 0.03)	-0.1 (-0.12, -0.08)
Up. Skagit R. LR	Whidbey Basin	0.07 (0.05, 0.09)	-0.03 (-0.06, 0)
Low. Skagit R. LR	Whidbey Basin	0.05 (0.02, 0.09)	-0.03 (-0.06, -0.01)
Up. Sauk R. ER	Whidbey Basin	0.01 (-0.02, 0.04)	0.06 (0.04, 0.08)
Low. Sauk R. LR	Whidbey Basin	0.05 (0.01, 0.08)	-0.04 (-0.07, -0.01)
Suiattle R. ER	Whidbey Basin	0.01 (-0.01, 0.03)	-0.01 (-0.04, 0.01)
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Sammamish R. LR	Central/South Sound	0.17 (0.11, 0.23)	-0.02 (-0.06, 0.02)
Cedar R. LR	Central/South Sound	0.03 (0, 0.06)	0.07 (0.05, 0.1)
Green R. LR	Central/South Sound	0.02 (-0.02, 0.06)	-0.12 (-0.16, -0.09)
Puyallup R. LR	Central/South Sound	-0.03 (-0.05, -0.02)	-0.06 (-0.08, -0.03)
White R. ER	Central/South Sound	0.19 (0.17, 0.21)	-0.03 (-0.08, 0.01)
Nisqually R. LR	Central/South Sound	0.05 (0.03, 0.06)	-0.01 (-0.05, 0.03)

# Web-based Protected Species Toolbox and Cloud-based Platform for Running Tools

- **Project accomplishments:**
  - Content manager website built (meets NOAA IT certifications)
  - <https://www.st.nmfs.noaa.gov/npst>
  - Public R/Shiny server established at NWFSC
  - <https://dataexplorer.northwestscience.fisheries.noaa.gov/>
  - Multiple R shiny applications (agTrend, VRAP, ROSE, Growth, PVAwidget)