Skagit Creel Analysis

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Contents

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Purpose

The purpose of this document is to record the steps and code necessary to reproduce the Skagit steelhead fishery creel analysis for 2021.

Requirements

All analyses require R software **(link)** (v3.4.3) for data retrieval, data processing, and summarizing model results, and Stan software **(link)** for Hamiltonian Monte Carlo (HMC) simulation. For Stan to work, rtools must also be installed: **(link)**.

Functions

We also need a couple of helper functions which we will load from the functions folder, which we will load using sapply

```
wd_functions<-"functions"
sapply(FUN = source, paste(wd_functions, list.files(wd_functions), sep="/"))
```

Packages

In addition to purrr, we also need a few packages that are not included with the base installation of R, so we begin by installing them (if necessary) and then loading them.

```
#=================================================
# Load packages, install and load if not already
#=================================================
using("timeDate",
      "plyr",
      "tidyverse",
      "rstan",
      "RColorBrewer",
      "readxl",
      "readr",
      "ggplot2",
      "tinytex",
      "here",
      "lubridate",
      "devtools",
      "xlsx",
      "cowplot",
      "ggpubr",
      "chron",
      "suncalc",
      "shinystan",
      "loo",
      "data.table",
      "RColorBrewer",
      "reshape2",
      "MASS",
      "kableExtra"
      )
```

User inputs

```
#========================================================
# Specify relative working directories for sub-folders
#========================================================
wd_LUTs <-"lookup tables"       # Location of look-up tables (maybe could be merged with data files??)
wd_data   <-"data"              # Location where data files are stored
wd_source_files<-"source files" # Location of source file (code working "behind the scenes")
wd_models  <-"models"           # Location of model files
wd_outputs <-"results"          # Location of saved output (summary figures/tables and model results)
```

```
#=========================================================
# Specify names of .csv data files
#=========================================================
effort_file_name <-   "03_Effort_dat - 2019_Skagit_creel_JSH_thru_4-30-19.csv"
interview_file_name <-"03_Interview-dat_2019-Skagit_JSH_thru_4-30-2019.csv"
effort_xwalk_filename<-"02_Crosswalk_Table_for_Index_TieIn_Sections_2019-01-10.csv"
river_loc_filename<-"02_River.Locations_2019-01-07.csv"
creel_models_filename<-"02_Creel_Models_2021-01-20.csv"

#=========================================================
# Denote data of interest (used to filter data below)
#=========================================================
# Specify filter type(s) to extract data by (Enter "Y" or "N")
  by.Year<-      "N" # If "Y", will filter by full calendar year(s) (Jan. 1 - Dec. 31)
  by.YearGroup<- "N" # If "Y", will filter by a "Year Group", which go from May 1st Yr1 - April 30 Yr2
  by.Season<-    "N" # If "Y", will filter by "season", which is either Summer (May 1st - Oct 31st) or
  by.StreamName<-"Y" # If "Y", will filter by stream name
  by.Date<-      "N" # If "Y", will filter by a date range

# Specify date ranges for "Year Groups" and "Seasons"
  YearBegin<-  121 # day of year a "YearGroup" begins (FYI - 121 = May 1st in a non-leap year)
  summerBegin<-121
  summerEnd<-  304 # FYI - 304 = Oct. 31st (in a non-leap year)
  winterBegin<-305
  winterEnd<-  120

# Specify filter unit(s)
  YearGroup.of.Interest<- c("2017-2018")
  Season.of.Interest<-    c("Winter")
  Year.of.Interest<-      c("2017")
  StreamName.of.Interest<-c("Skagit")
  Begin.Date<-            c("2016-05-01") #Format must be "yyyy-mm-dd"
  End.Date<-              c("2017-03-31") #Format must be "yyyy-mm-dd"

#=========================================================
# Denote catch group of interest (species_origin_fate)
#=========================================================
  catch.group.of.interest<-c("SH_W_R")

#=========================================================
# Identify dates when fishery was closed by section
#=========================================================
  total.closed.dates<-0 # Total number of dates that at least one section of the river was closed (i.e.

# NOTE: if "total.closed.dates" >0, use the following format to enter closure dates and section, where
      # the first column is the list of individual dates (by row) the fishery was closed date
      # the number of additional columns equals the number of "final" sections based on "final.effort.s
      # the enter the following values below each section:
      # Enter 1 if the section was open and enter 0 if the section was closed

                           #    Date   , Section-1, Section-2
    closed.Dates.Sections<-c("2019-02-11",     0,         0 )
```

Data Preparation

```
# Load LUTs
  source(paste0(wd_source_files, "/Load_LUTs.R"))

# Load creel data and format
  source(paste0(wd_source_files, "/Import_Skagit_Creel_Data_and_Format.R"))

# Extract data of interest and format
  ## add code that shows options for filtering data by date/year/season/location
  source(paste0(wd_source_files, "/05_Extract_Data_of_Interest_and_Calculate_Fields_2019-04-08.R"))

#Run source summary file
  ## add code that shows options for "catch groups"
  source(paste0(wd_source_files, "/06_Summarize_Effort_and_Catch_Data_for_TimeSeries_Model_2019-04-23.R

##KB note: I will work on updating the code in the "05" and "06" file at some point soon; also, creatin
```

Run Analysis

```
#message=FALSE, warning=FALSE
#=======
#note for editing: any ner priors need to go here, also in "prepare data" and in "summarize inputs"
#=======

# Denote whether you want to run a new model or load "saved" results from a previous model run
  model_source<-c("load_saved")  #enter either "run_new" or "load_saved"

# Assign a "Model_Run" number (if model_source == run_new, results will be saved to a new sub-folder; i
  Model_Run<-1 #Enter numeric number (NOTE: be careful not to over-write previous models runs by enteri

# Denote which creel model you want to run
  creel_models[,1:3] #model summary table
  model_number<-c(2)

# Specify time period to stratify data by - day vs. week
  model_period<-c("day") #enter "day" or "week"

# Specify parameter values for model priors
  value_cauchyDF_sigma_eps_C = 1 # the hyperhyper scale (degrees of freedom) parameter in the hyperprio
  value_cauchyDF_sigma_eps_E = 1 # the hyperhyper scale (degrees of freedom) parameter in the hyperprio
  value_cauchyDF_sigma_r_E = 1  # the hyperhyper scale (degrees of freedom) parameter in the hyperprior
  value_cauchyDF_sigma_r_C = 1  # the hyperhyper scale (degrees of freedom) parameter in the hyperprior
  value_normal_sigma_omega_C_0 = 1  #the SD hyperparameter in the prior distribution omega_C_0; normal 
  value_normal_sigma_omega_E_0 =  3 # the SD hyperparameter in the prior distribution omega_E_0; normal
  value_lognormal_sigma_b = 1 # the SD hyperparameter in the prior distribution b; default = 1
  value_normal_sigma_B1 = 5 # the SD hyperparameter in the prior distribution B1; default = 5
  value_normal_mu_mu_C = log(0.02) # the mean hyperparameter in the prior distribution mu_C; median (lo
  value_normal_sigma_mu_C = 1.5 # the SD hyperparameter in the prior distribution mu_C; normal sd (log-
  value_normal_mu_mu_E = log(15) # the mean hyperparameter in the prior distribution mu_E; median effor
  value_normal_sigma_mu_E = 2  # the SD hyperparameter in the prior distribution mu_E; normal sd (log-s
  value_betashape_phi_E_scaled = 1 # the rate (alpha) and shape (beta) hyperparameters in phi_E_scaled;
  value_betashape_phi_C_scaled = 1 # the rate (alpha) and shape (beta) hyperparameters in phi_C_scaled;
  value_cauchyDF_sigma_mu_C = 1       # the hyperhyper SD parameter in the hyperprior distribution sigm
  value_cauchyDF_sigma_mu_E = 1       # the hyperhyper SD parameter in the hyperprior distribution sigm

# Specific Stan model arguments
  n_chain<-4        # set the number of Markov chains. The default is 4.
  n_iter<-200        # set the number of iterations for each chain (including warmup). The default is 2
  n_cores<-4         # set the number of cores to use when executing the chains in parallel. The defaul
  n_warmup<-100    # set the length of warm-up (aka burn-in) iterations per chain.  The default is n_it
  n_thin<-1          # set the thinning rate (aka, the period for saving samples). The default is 1, wh
  adapt_delta<-0.8  # set adapt delta, which is the target average proposal acceptance probability duri
  max_treedepth<-10 # set the max tree depth; default is 8; NOTE: this sets the max depth of tree used

# Create sub-folders for output (if they don't already exist)
    source(paste0(wd_source_files, "/Create_output_subfolder.R"), print.eval = TRUE)

# Run source code to prepare data for model
    source(paste0(wd_source_files, "/Prepare_Data_For_Model.R "))

# Run source code to generate creel estimates
  source(paste0(wd_source_files, "/RunNew_or_LoadSaved_Creel_Model.R"))

# Generate summaries of model inputs and outputs
  if(model_source == "run_new"){  source(paste0(wd_source_files, "/Summarize_Model_Inputs_and_Outputs.R
```

Summarize Results

```
#convergence diagnostics
  launch_diagnostics<-c("No") #Enter "Yes" to launch ShinyShin diagnostics
  if(launch_diagnostics=="Yes"){launch_shinystan(output$res_stan)}

# generate plots and tables of creel estimates
  source(paste0(wd_source_files, "/Generate_Summaries_of_Creel_Estimates.R"))

# KB note: update so table/plots of results are shown in PDF document
```

Reproducing this pdf or html page

In order to reproduce this pdf or html page you need to have a LaTex application installed. Running this snippet of code will automatically install tinytex on your machine so you can render pdfs and html:

```
#tinytex::install_tinytex()
#tinytex::tlmgr_install("multirow")
#uninstall_tinytex(force = FALSE, dir = tinytex_root())
```

Results Table: Summary of Effort and Catch

```
results<-read_csv(file.path("results",catch.group.of.interest,paste0("Run_",Model_Run),"summarized_esti
  dplyr::rename(Variable=X1)%>%
  kbl(caption = "Table 1. Total Catch and Effort ",digits =1)%>%
```

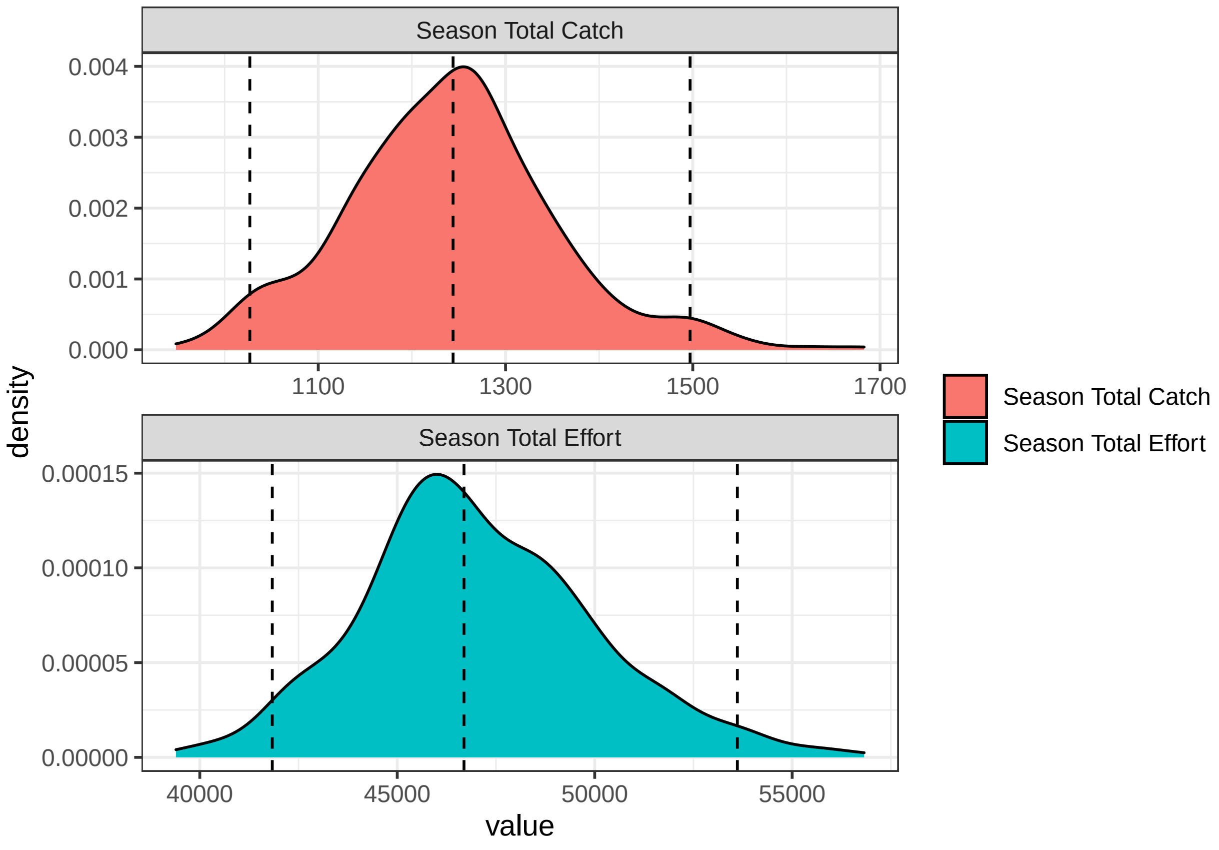
Table 1: Table 1. Total Catch and Effort

Variable	Mean	2.5%	25%	50%	75%	97.5%	CV
Total_season_catch	1242	1027	1169	1244	1308	1497	0.1
Total_season_effort	47064	41836	45179	46690	48895	53613	0.1

```
  kable_classic(full_width = F, html_font = "Cambria")
print(results)
```

Results Figures: Summary of Effort, CPUE, and Catch

\begin{figure}

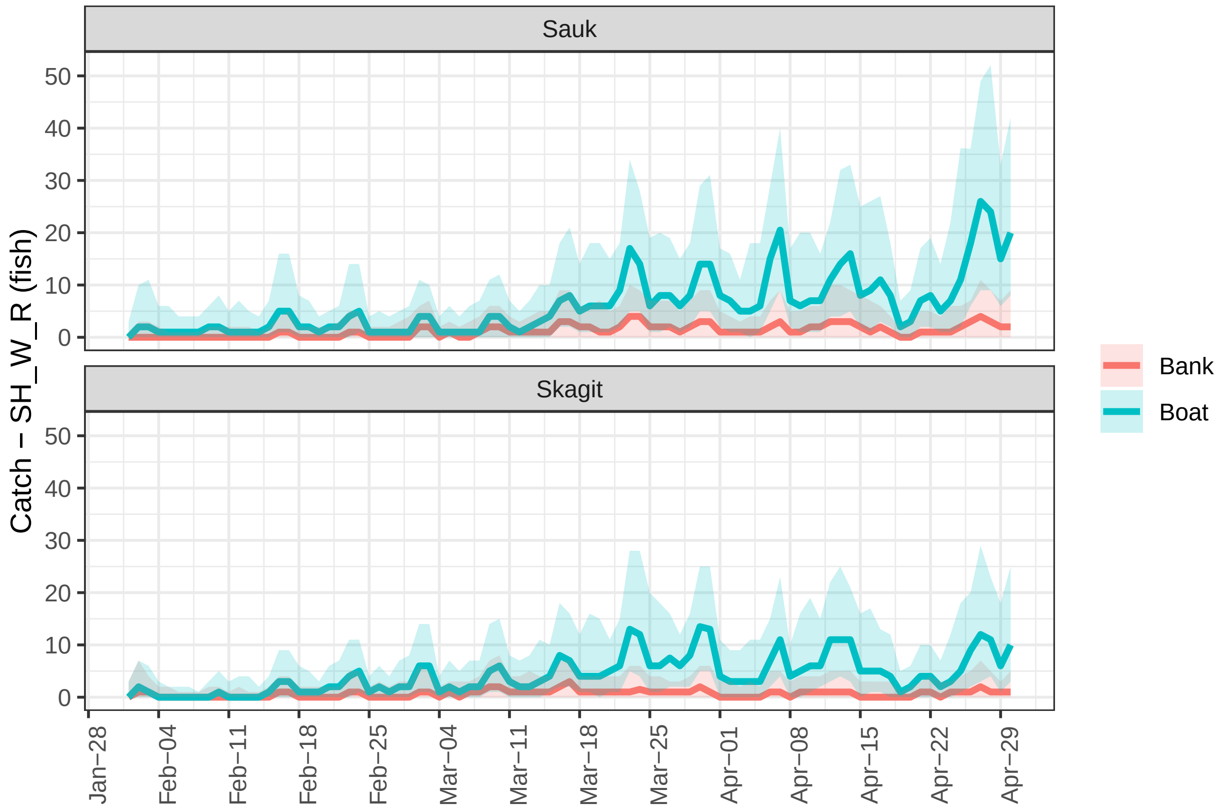


{

}

\caption{Figure 1. Season total catch and effort. Dashed lines show posterior medians 95% CI} \end{figure}

\begin{figure}

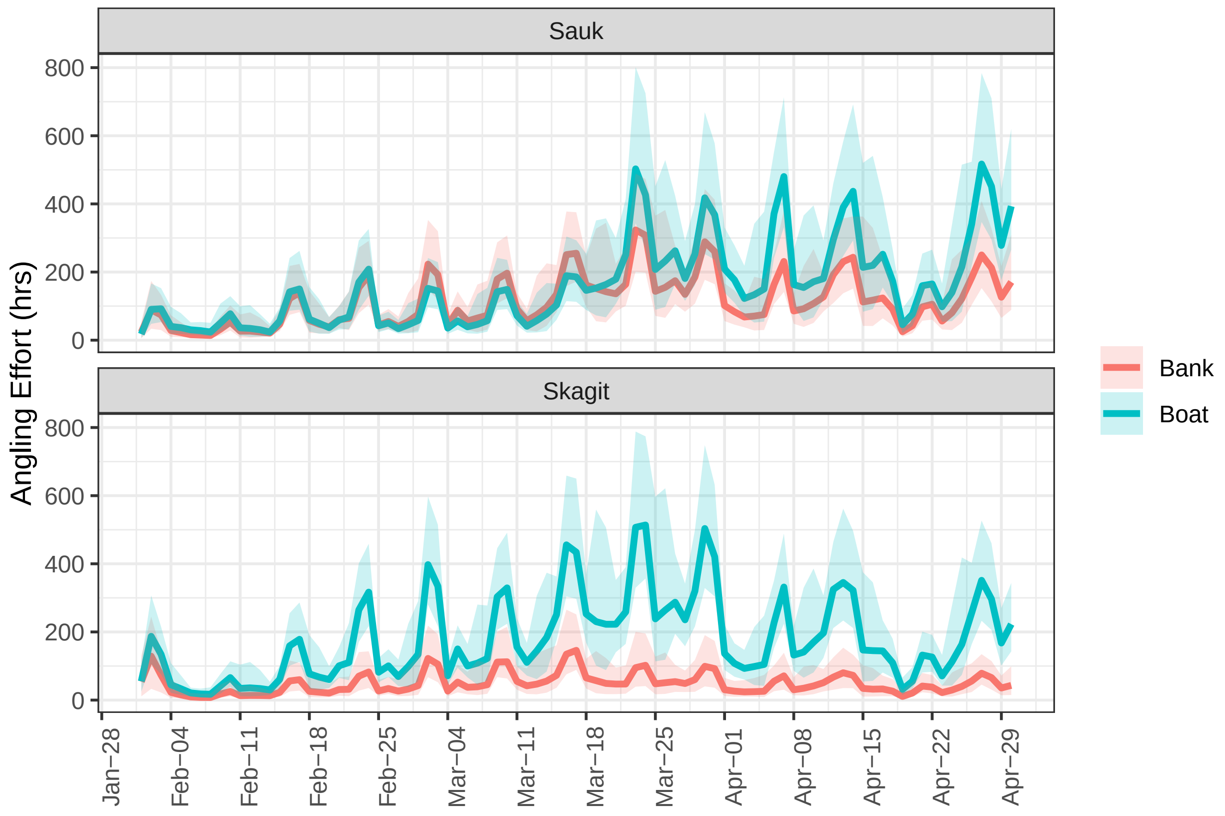


{

}

\caption{Figure 2. Daily catch. Lines are posterior medians and shading shows 95% CI} \end{figure}

\begin{figure}



{

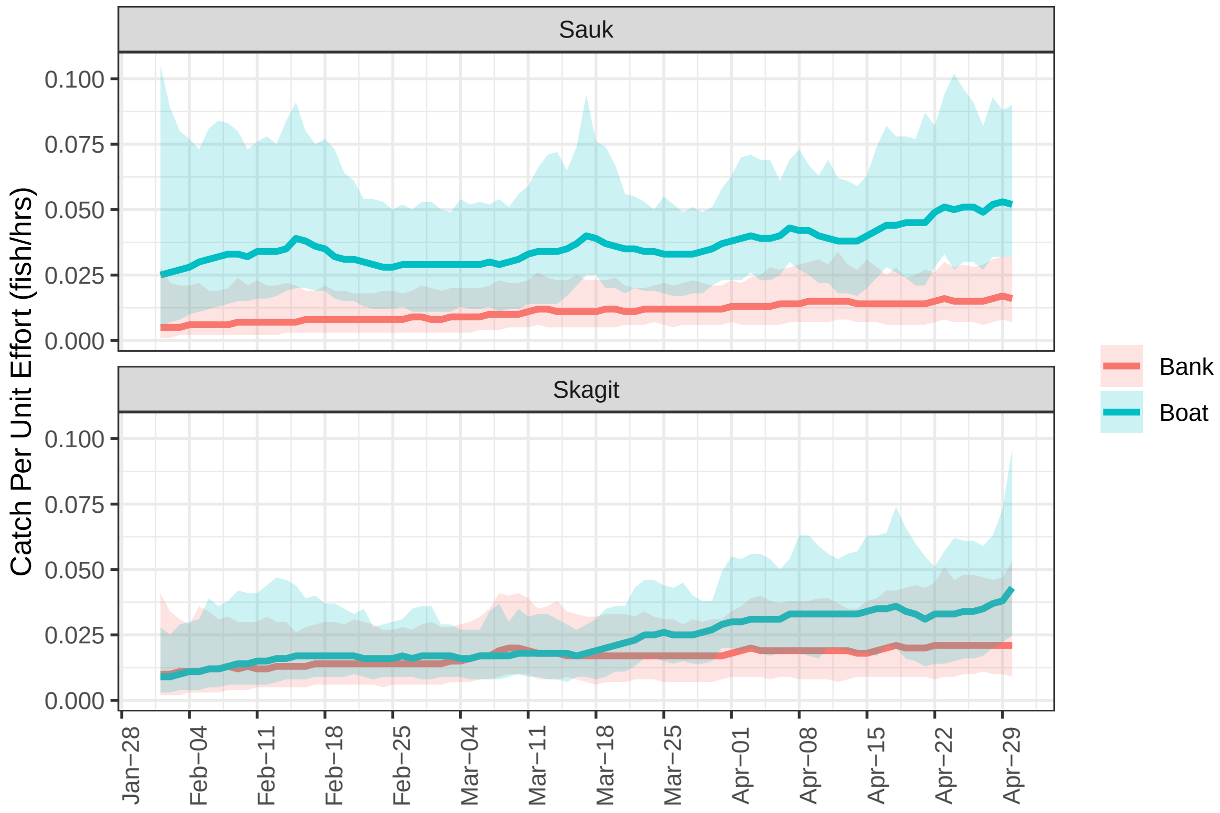
}

\caption{Figure 3. Daily effort. Lines are posterior medians and shading shows 95% CI} \end{figure}

\begin{figure}

Table 2: Table 2. Runsize

Run Size	Quantile
2283.296	0.025
3470.260	0.250
4297.101	0.500
5322.188	0.750
8165.904	0.975



{

}

\caption{Figure 4. Daily CPUE. Lines are posterior medians and shading shows 95% CI} \end{figure}

Fishery Impacts Relative to RMP Limits

Now we will compare the estimated catch, assuming 10% C&R mortality, with the forecasted run size.

First, the run size forecast is below:

Second, the allowable harvest rates in the RMP are:

```
hcr<-read_csv(file.path("data","hcr.csv"))
hcr%>%mutate(MaxRunsize=format(MaxRunsize, scientific = FALSE))%>%
  rename(`Exploitation Rate` = ER)%>%
  kbl(caption = "Table 2. Allowable Harvest Rates, Skagit RMP ",digits =3)%>%
  kable_classic(full_width = F, html_font = "Cambria")
```

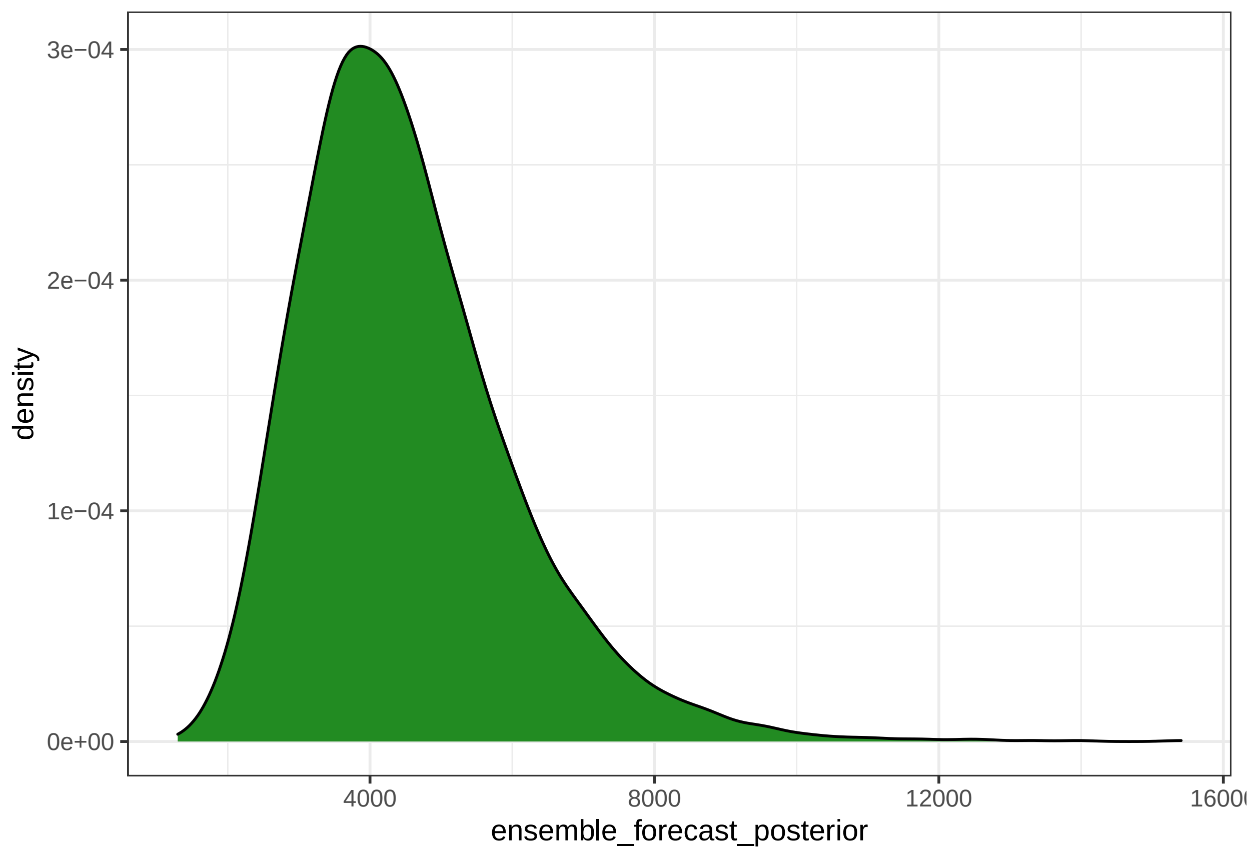


Figure 1: Figure 5. Runsize Forecast

Table 3: Table 2. Allowable Harvest Rates, Skagit RMP

MinRunsize	MaxRunsize	Exploitation Rate
0	4000	0.04
4001	6000	0.10
6001	8000	0.20
8001	1000000	0.25

Third, We will calculate the allowable harvest by combining the forecast uncertainty with the harvest rate matrix. We will then plot the probability that the allowable harvest will exceed a particular value, factoring in the uncertainty in the run size based on the preseason forecast:

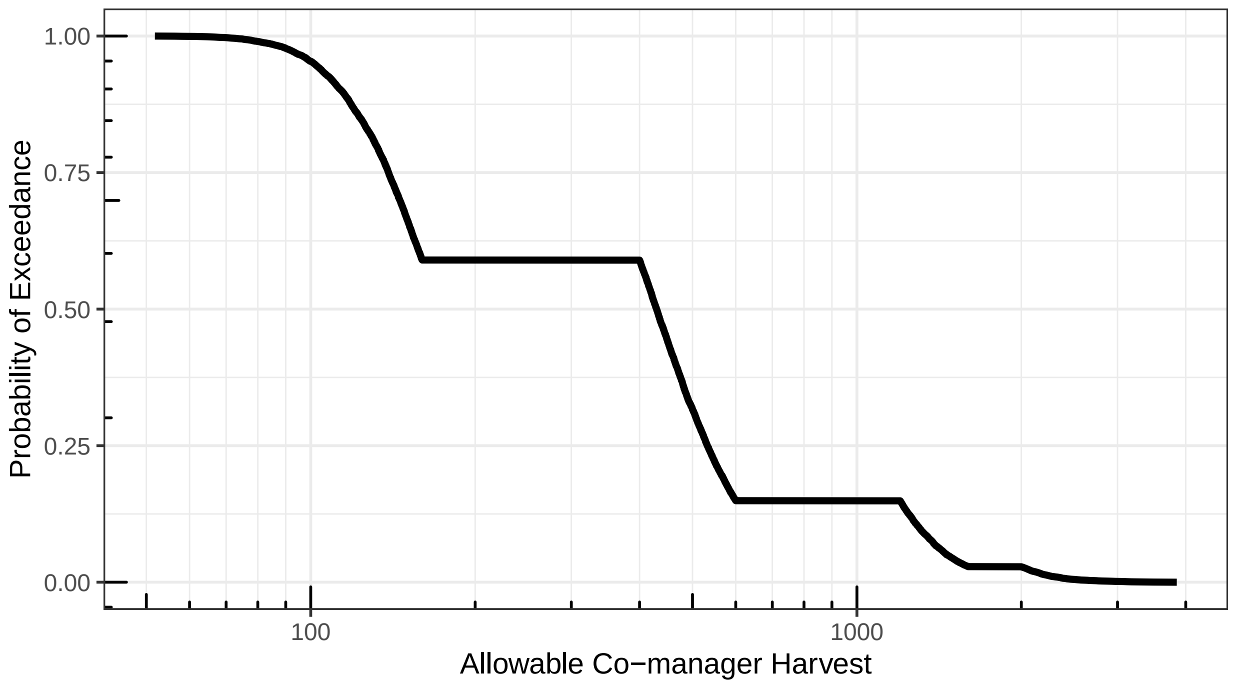
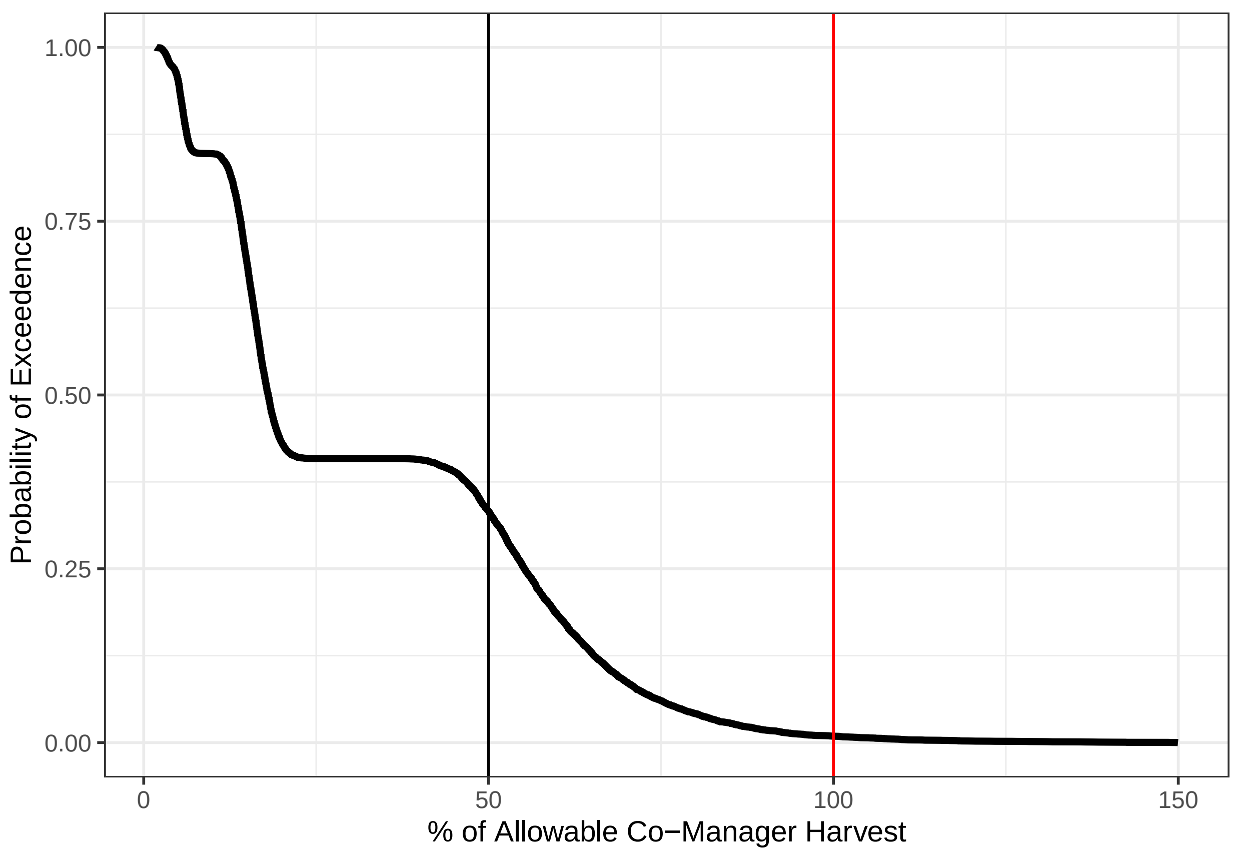


Figure 2: Figure 6. Probability that the allowable harvest exceeds a particular number of fish based on the RMP

Finally, we will compare the sport fishery harvest with the allowable harvest to estimate the probability that the allowable harvest has been exceeded:

\begin{figure}



{

}

\caption{Figure 7. Probability that the sport fishery harvest exceeds the allowable harvest under the RMP. Vertical lines denote 50% of the allowable harvest, which is shared between the state and tribes, and 100% of the allowable harvest} \end{figure}