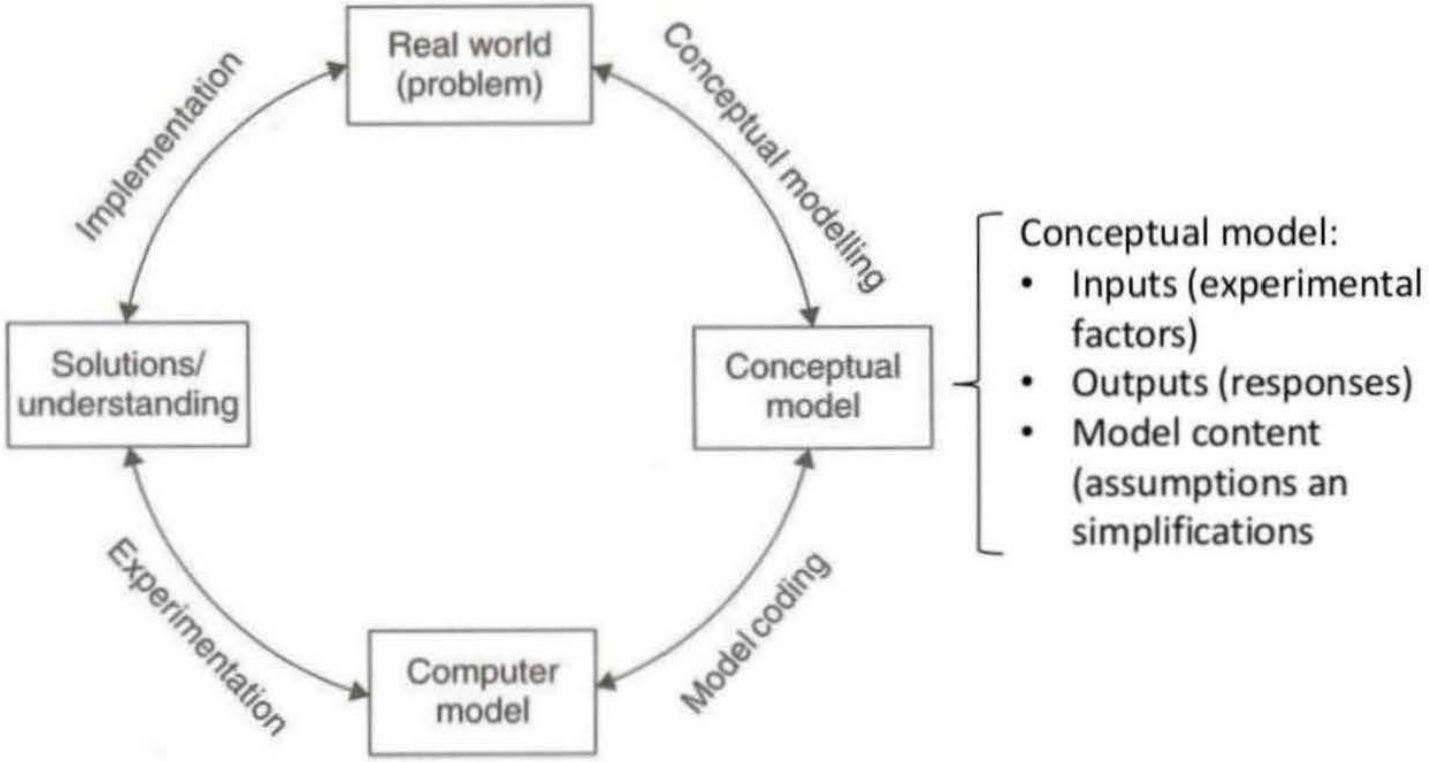
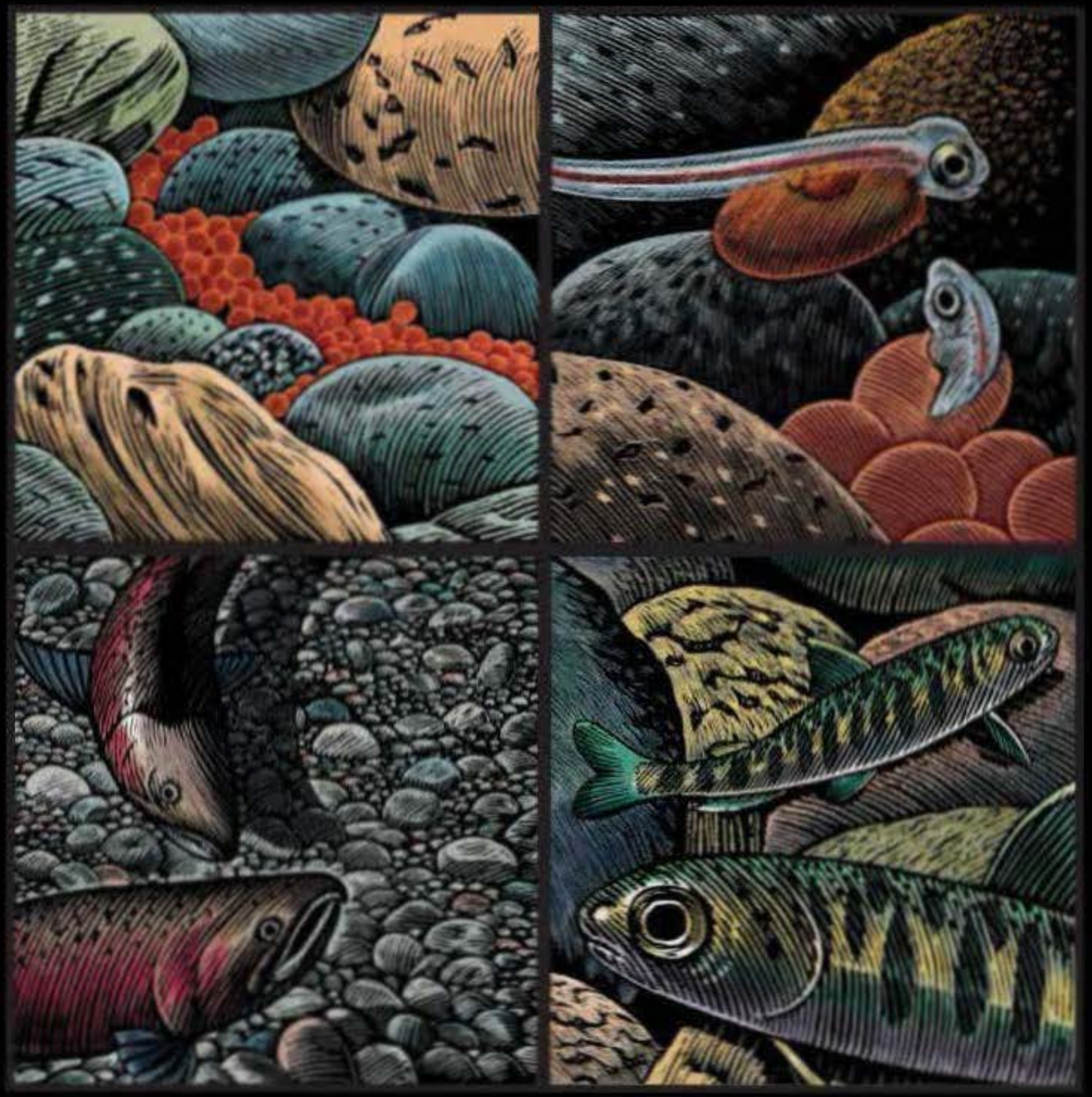
Connecting Concepts to Numbers: Visualization to Support Shared Understanding and Decisions


"If we have data, let's look at data. If all
we have are opinions, let's go with mine."
– Jim Barksdale, former Netscape CEO

Visualization Concepts

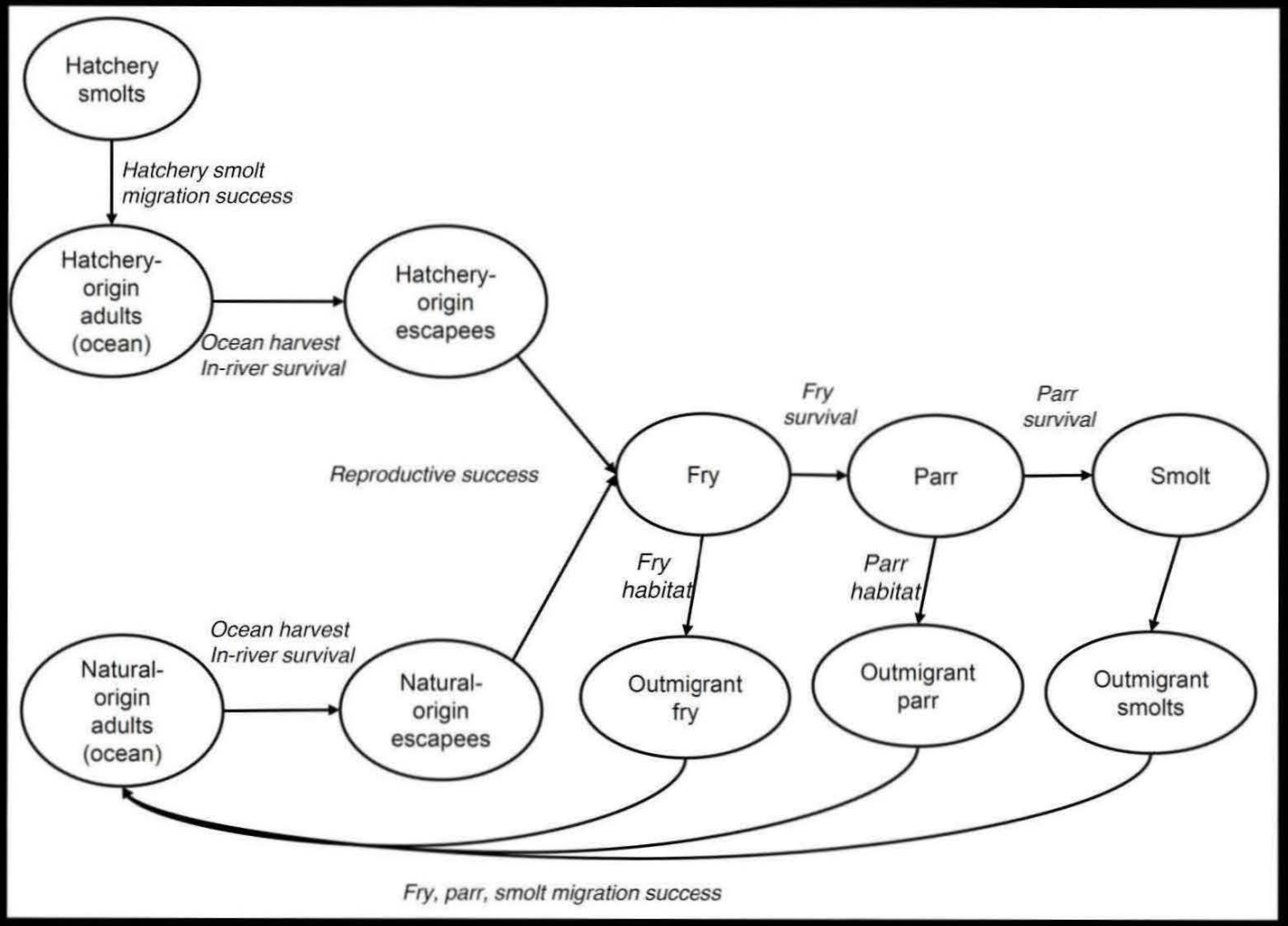


Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Wiley.

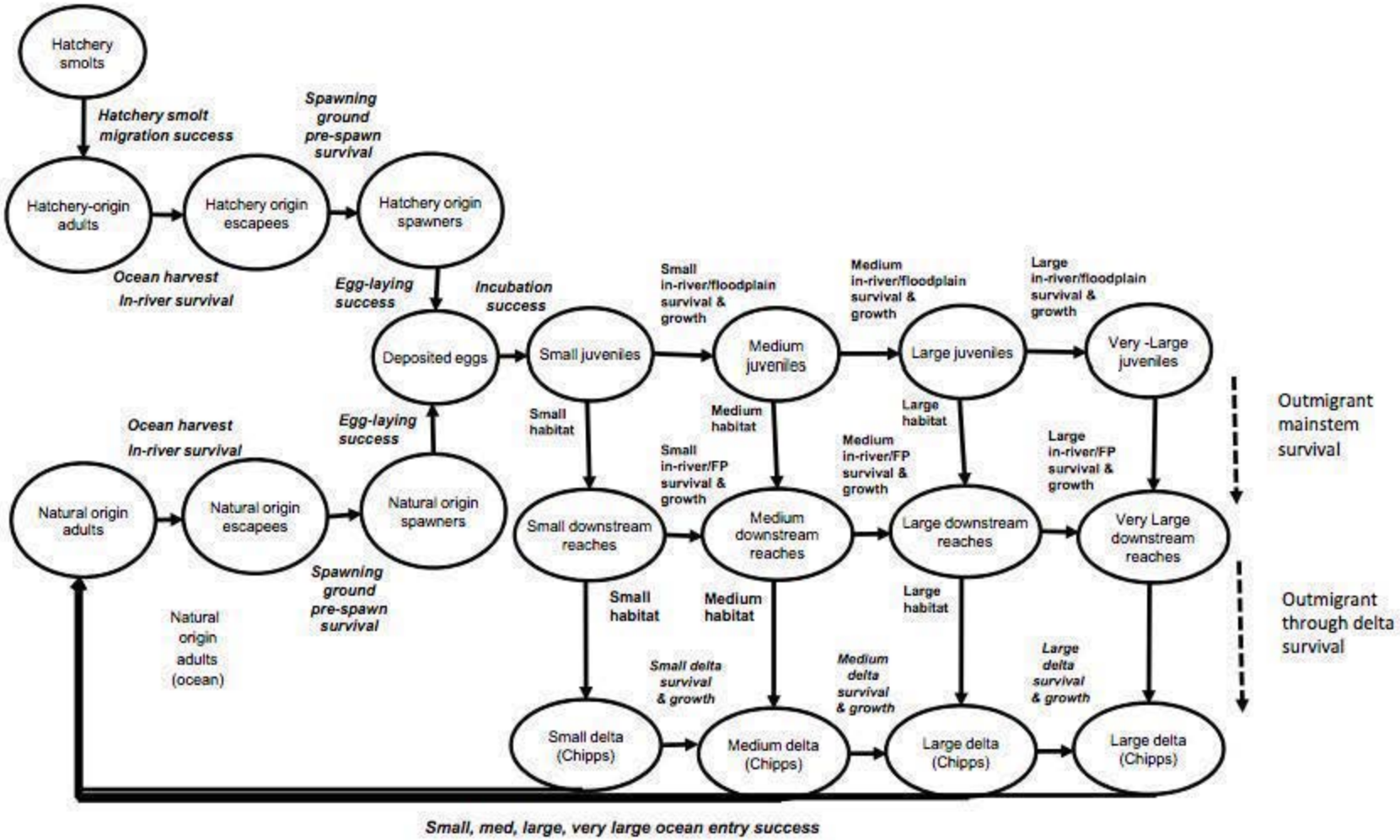


Recovery Strategy for California Coho Salmon

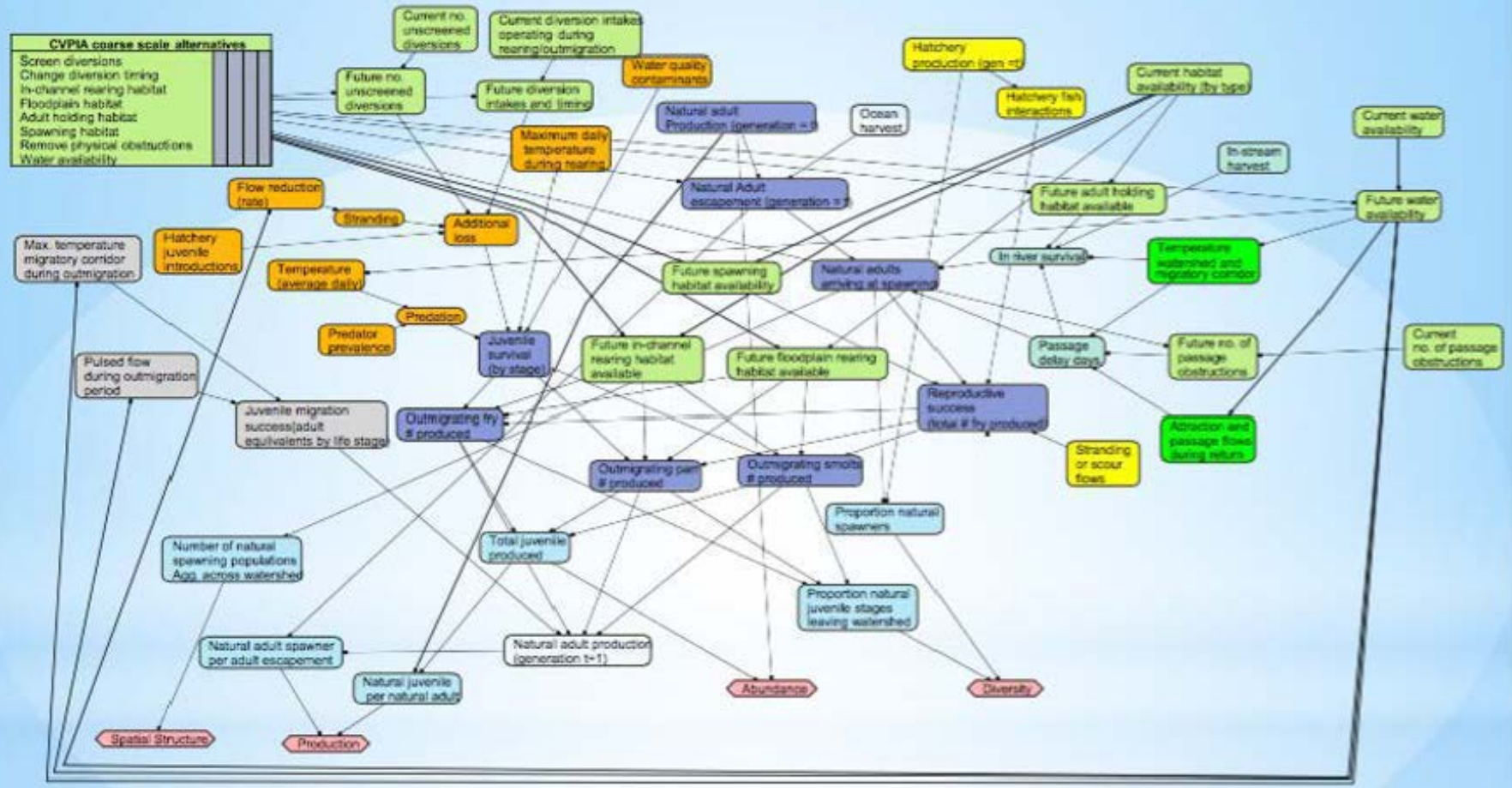
Chinook Salmon Model (v1)



Fall Chinook Salmon Base Conceptual Model (v. 2016)

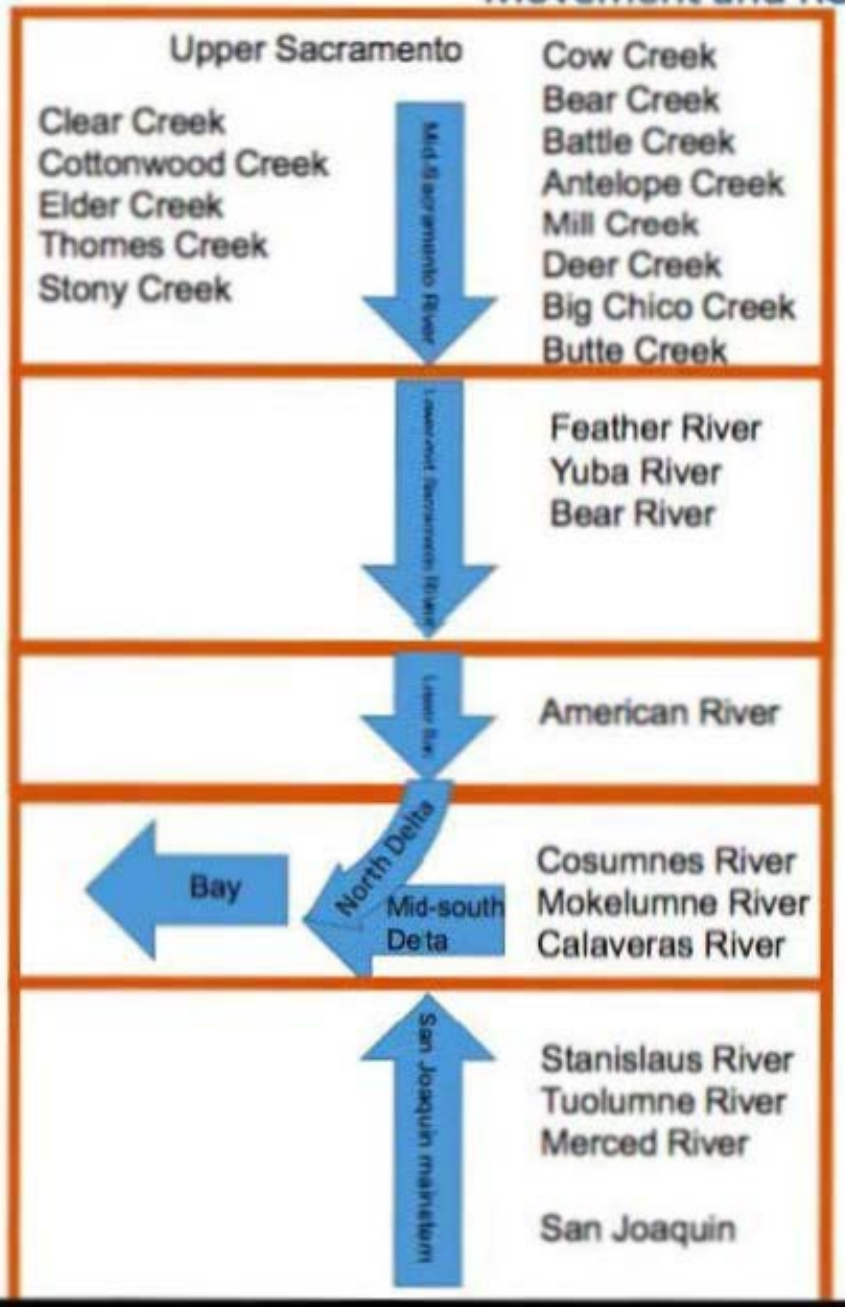


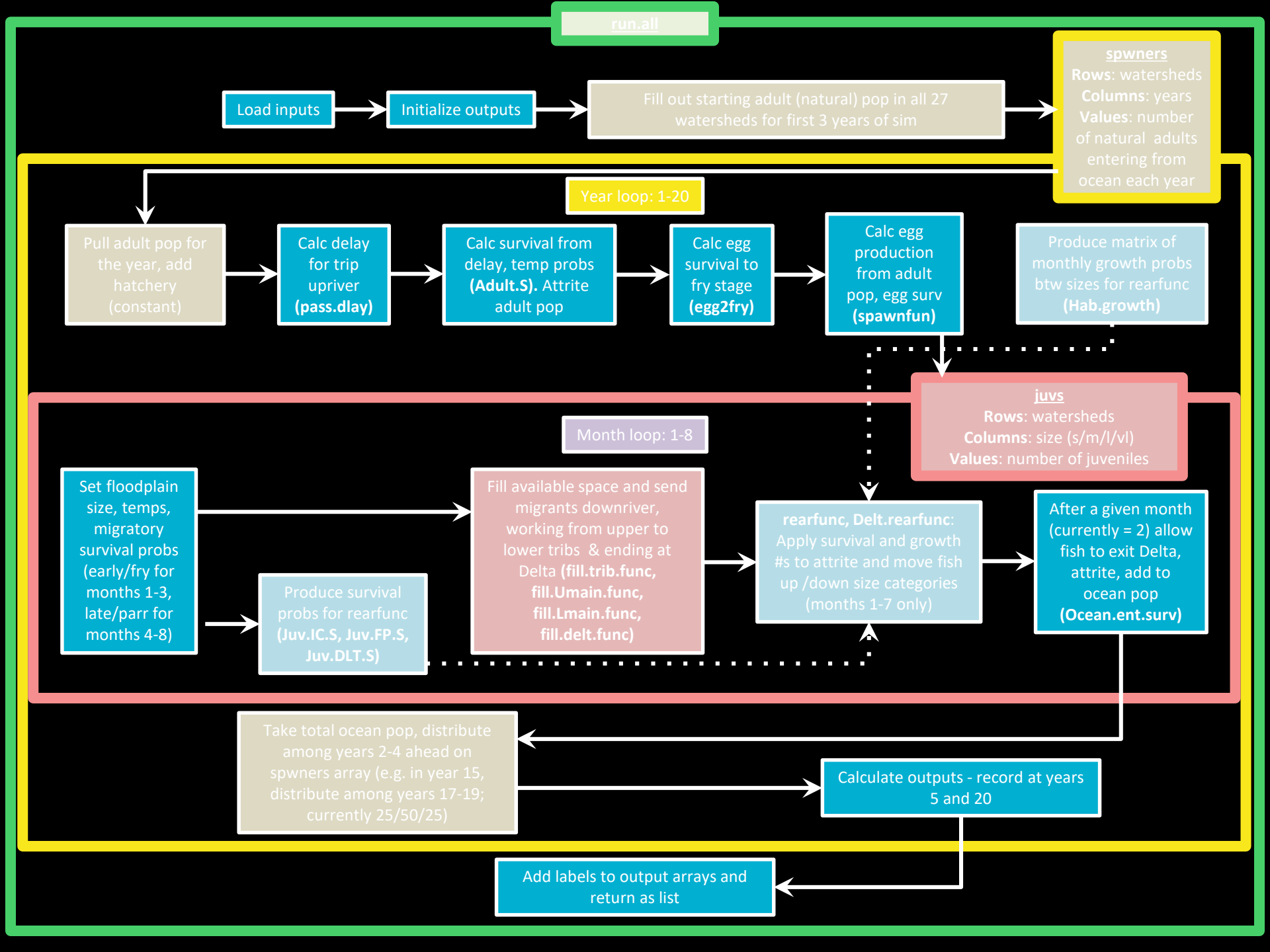
Chinook Salmon Conceptual Model



- Management action
- Juvenile survival
- Reproductive success
- Passage delays
- Population dynamic
- Adult in-river survival
- Juvenile migration success
- Utility

Movement and Rearing Watershed Groups




run.all
Load inputs
Initialize outputs
Fill out starting adult (natural) pop in all 27 watersheds for first 3 years of sim
spwners
Rows: watersheds
Columns: years
Values: number of natural adults entering from ocean each year
Year loop: 1-20
Pull adult pop for the year, add hatchery (constant)
Calc delay for trip upriver (pass.dlay)
Calc survival from delay, temp probs (Adult.S). Attrite adult pop
Calc egg survival to fry stage (egg2fry)
Calc egg production from adult pop, egg surv (spawnfun)
Produce matrix of monthly growth probs btw sizes for rearfunc (Hab.growth)
juvs
Rows: watersheds
Columns: size (s/m/l/vl)
Values: number of juveniles
Month loop: 1-8
Set floodplain size, temps, migratory survival probs (early/fry for months 1-3, late/parr for months 4-8)
Fill available space and send migrants downriver, working from upper to lower tribs & ending at Delta (fill.trib.func, fill.Umain.func, fill.Lmain.func, fill.delt.func)
rearfunc, Delt.rearfunc: Apply survival and growth #s to attrite and move fish up /down size categories (months 1-7 only)
After a given month (currently = 2) allow fish to exit Delta, attrite, add to ocean pop (Ocean.ent.surv)
Produce survival probs for rearfunc (Juv.IC.S, Juv.FP.S, Juv.DLT.S)
Take total ocean pop, distribute among years 2-4 ahead on spwners array (e.g. in year 15, distribute among years 17-19; currently 25/50/25)
Calculate outputs - record at years 5 and 20
Add labels to output arrays and return as list

Coarse resolution model mean values (1).R

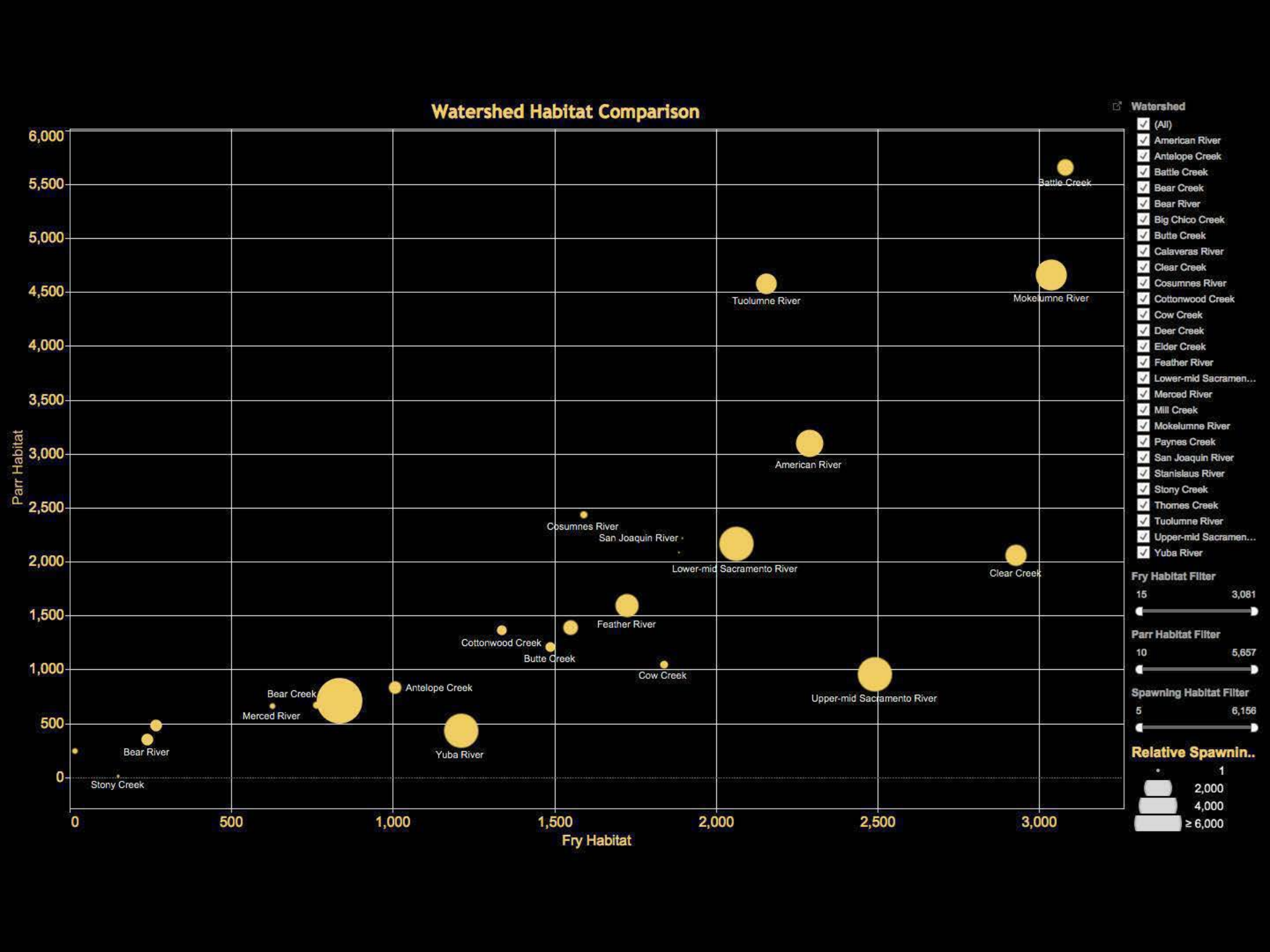
run.all

Help search

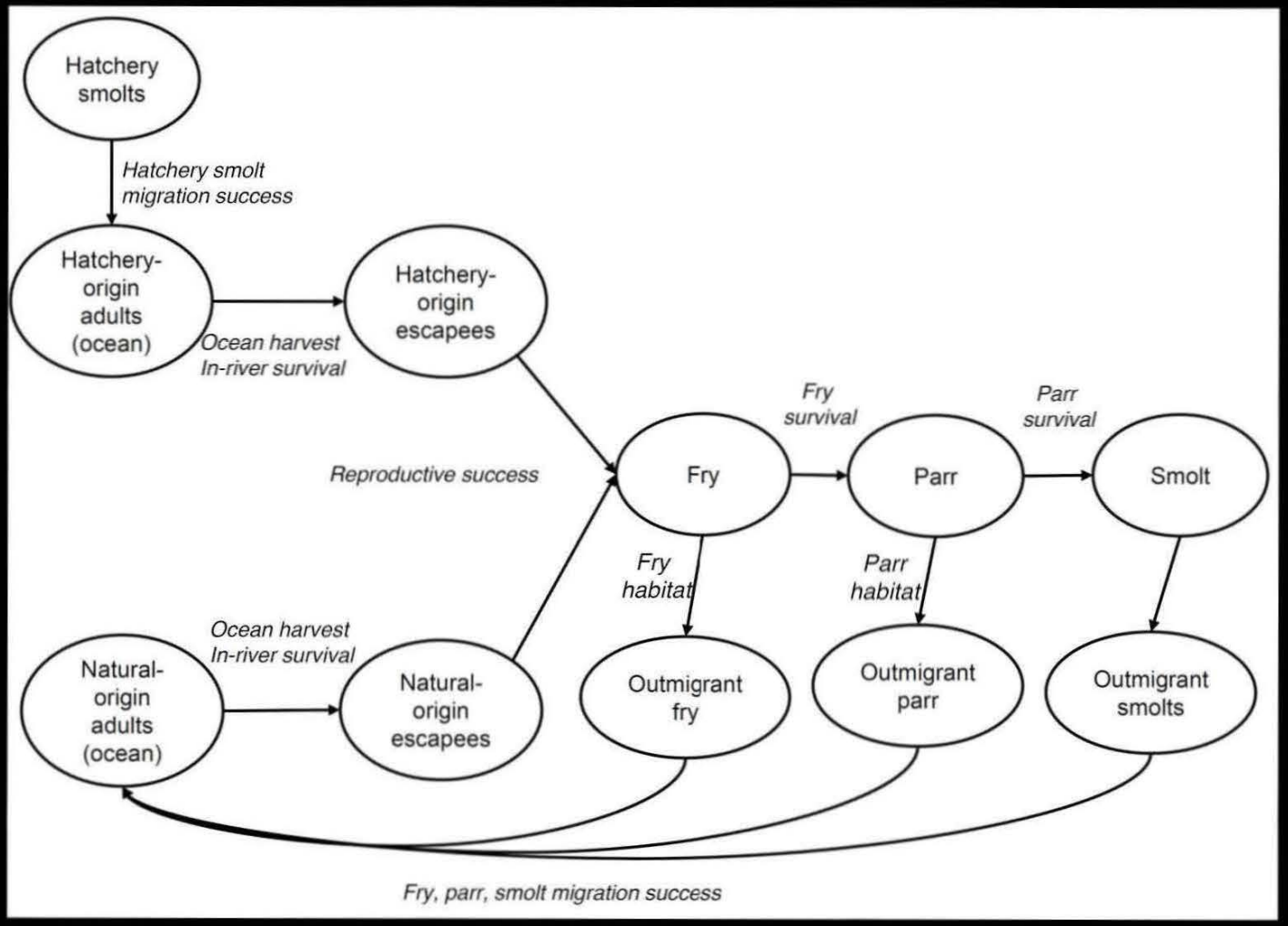
```
#################################################
####     FALL CHINOOK SIT MODEL JAN 22, 2016      ###
#################################################


#setwd("C:/Users/peterjam/jpeterson/Adapt Manage/CVPIA Phase I/Phase 2/Modifications to Chin CRM/Fall Chinook functions")

setwd("C:/SIT/mjw edits to model")

####### Read in functions from common location
functs<- dir(full.names = FALSE, pattern = ".R", recursive = FALSE)
functs<-functs[functs != "Coarse resolution model all.R" & functs != "Run_delay_example.R" &
               functs != "Coarse resolution model survival scenarios.R" &
               functs !="Coarse resolution model change all watersheds.R" &
                 functs != "Coarse resolution model mean values.R" &
                 functs != "mjw code.R"] # added mjw 031616
for(ia in 1:length(functs)) source(paste(functs[ia]))

shd.name<-c("Antelope Creek","Battle Creek","Bear Creek","Big Chico Creek","Butte Creek",
            "Clear Creek","Cottonwood Creek","Cow Creek","Deer Creek","Elder Creek","Mill Creek",
            "Paynes Creek","Stony Creek","Thomes Creek","Upper-mid Sacramento River","Bear River",
            "Feather River","Yuba River","Lower-mid Sacramento River","American River","Calaveras River",
            "Cosumnes River","Mokelumne River","Merced River","Stanislaus River","Tuolumne River",
            "San Joaquin River")

inps<-read.csv("All inputs.csv")
Dlt.inp<-read.csv("Delta inputs.csv")
juv.tmp<-read.csv("Juve temperatures.csv")
IC.hab.dat<- read.csv("habitat inputs.csv")
```

Table 2.4. Mean and standard deviation (in parenthesis) of Chinook Salmon adult holding habitat (pools/km) and spawning, fry and parr in-channel rearing, and juvenile floodplain habitat availability ($100m^2/km$) by watershed. Values in bold and underlined were based on empirical data and all others were based on expert opinion. See text for a description of each habitat type and source of data.

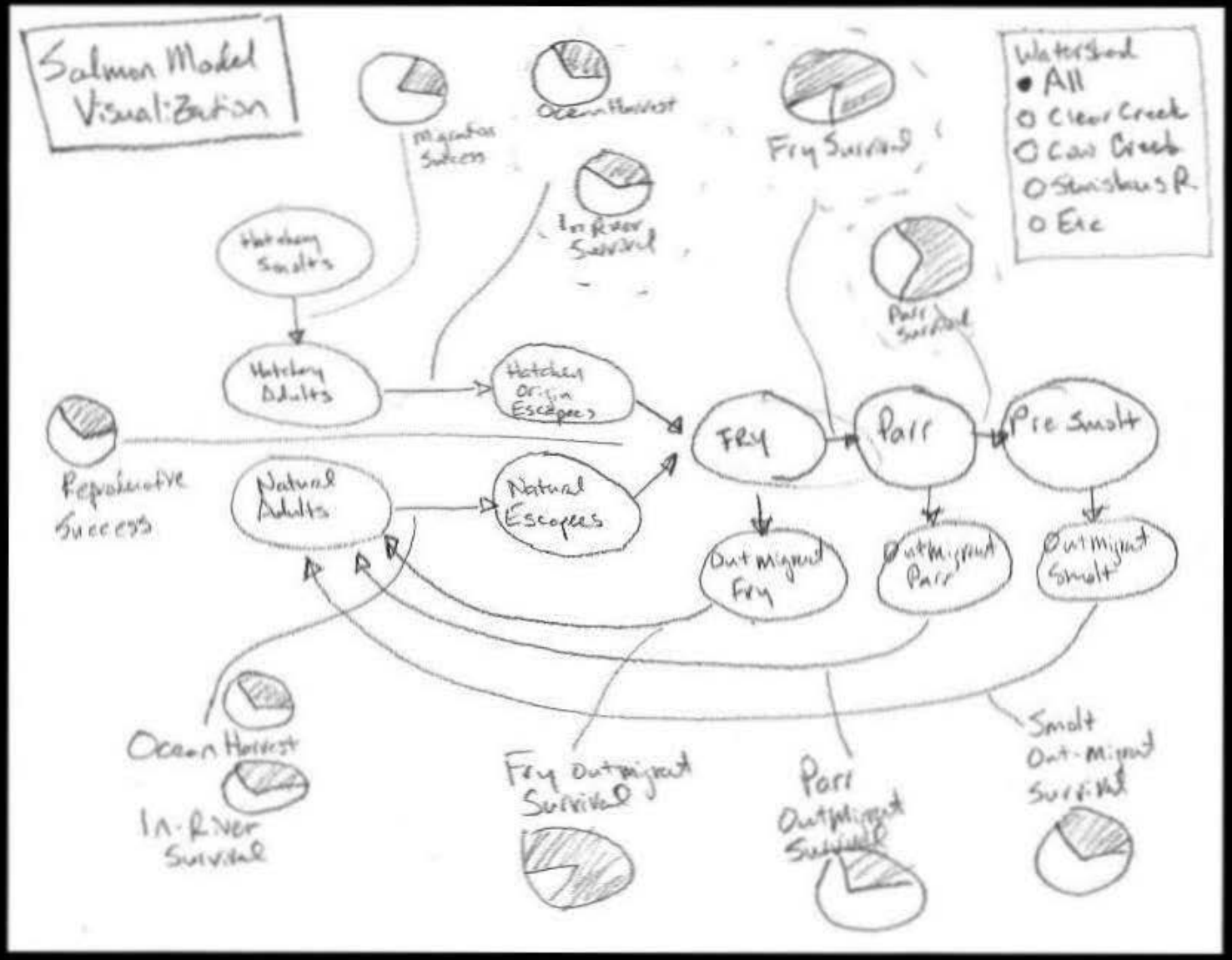
Watershed	Holding	Spawning	Fry	Parr	Floodplain
American River	1.3 (0.16)	**2156 (1078.0)**	2289 (1064.5)	3092 (1332.8)	14944 (6442.6)
Antelope Creek	11.3 (1.67)	460 (120.2)	1008 (304.5)	829 (262)	404 (149)
Battle Creek	6.2 (2.79)	776 (178.6)	3081 (736.5)	5657 (1137.1)	20 (40)
Bear Creek	4.6 (1.10)	152 (37.5)	764 (216.1)	671 (194.8)	437 (207.8)
Bear River	1.3 (1.96)	395 (149.1)	239 (90.8)	351 (131.9)	323 (124.5)
Big Chico Creek	2.3 (0.56)	101 (26.4)	15 (3.8)	246 (61.5)	20 (40)
Butte Creek	7.1 (4.94)	**265 (132.4)**	1488 (744)	1211 (726.4)	1768 (3536.3)
Calaveras River	0.5 (0.07)	11 (6.6)	1885 (461.1)	2085 (525.1)	2274 (968.6)
Clear Creek	20.6 (4.39)	**1303 (651.6)**	**2928 (585.5)**	**2055 (821.9)**	1768 (3536.3)
Cosumnes River	0.5 (0.10)	161 (62.5)	1591 (542.9)	2430 (651.2)	91763 (7021.2)
Cottonwood Creek	9.9 (3.91)	278 (129.9)	1338 (563.5)	1362 (460.9)	367 (80.2)
Cow Creek	4.6 (1.01)	182 (79.6)	**1838 (344.9)**	**1047 (421.5)**	650 (318.8)
Deer Creek	4.1 (1.23)	402 (73.7)	268 (50.6)	479 (156.5)	380 (94.2)
Elder Creek	4.3 (2.55)	116 (51.3)	270 (53.2)	473 (148.3)	391 (165.5)
Feather River	1.1 (0.13)	1543 (188)	1726 (615.3)	1593 (517.6)	671 (840.4)
Merced River	7.1 (4.94)	92 (69.3)	628 (464.8)	658 (488.3)	705 (535.5)
Mill Creek	14 (4.02)	624 (265.6)	1549 (301.9)	1384 (274)	399 (144.9)
Mokelumne River	0.2 (0.03)	2786 (809)	3039 (464)	4658 (628.3)	4758 (687)
Paynes Creek	9.7 (4.48)	152 (37.5)	848 (285.8)	715 (250.4)	384 (126.6)
San Joaquin River	0.1 (0.08)	5 (5)	1896 (732.5)	2217 (424.8)	1667 (1347.3)
Stanislaus River	4.6 (0.69)	6156 (2062.6)	**835 (286.2)**	**709 (242.3)**	2815 (1366)
Stony Creek	1.5 (1.47)	24 (25.5)	150 (300.0)	10 (10)	10 (10)
Thomes Creek	4.2 (1.20)	122 (46.6)	263 (48.5)	470 (143.6)	381 (151)
Tuolumne River	0.8 (0.35)	**335 (124)**	**532 (200.0)**	**1141 (575.3)**	836 (623.3)
Upper-mid Sacramento River	0.8 (0.53)	**3272 (1091.6)**	**2492 (747.7)**	**953 (6803.2)**	1660 (2068.7)
Lower-mid Sacramento River	2.9 (0.61)	**3316 (574.1)**	**2062 (839.4)**	**2161 (866.4)**	3593 (2157.1)
Yuba River	3.6 (2.48)	**3396 (1697.9)**	**1211 (363.2)**	**433 (343)**	755 (248.7)


Watershed Habitat Comparison
Parr Habitat
Fry Habitat
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
500
1,000
1,500
2,000
2,500
3,000
Battle Creek
Tuolumne River
Mokelumne River
American River
Cosumnes River
San Joaquin River
Lower-mid Sacramento River
Clear Creek
Feather River
Cottonwood Creek
Butte Creek
Cow Creek
Upper-mid Sacramento River
Bear Creek
Antelope Creek
Merced River
Yuba River
Bear River
Stony Creek
Watershed
(All)
American River
Antelope Creek
Battle Creek
Bear Creek
Bear River
Big Chico Creek
Butte Creek
Calaveras River
Clear Creek
Cosumnes River
Cottonwood Creek
Cow Creek
Deer Creek
Elder Creek
Feather River
Lower-mid Sacramen...
Merced River
Mill Creek
Mokelumne River
Paynes Creek
San Joaquin River
Stanislaus River
Stony Creek
Thomes Creek
Tuolumne River
Upper-mid Sacramen...
Yuba River
Fry Habitat Filter
15
3,081
Parr Habitat Filter
10
5,657
Spawning Habitat Filter
5
6,156
Relative Spawnin..
1
2,000
4,000
≥ 6,000

Chinook Salmon Model (v1)



Model Visualization



Simple Chinook Salmon Population Model

Watershed Example

Clear Creek

Starting Population 12,300

Watershed

Clear Creek

Spawners → Reproductive Success → Fry → Fry Survival → Parr → Parr Survival → Smolt

Spawning Habitat

Default

1,303	2,600

Fry Habitat

Default

2,928	6,000

Parr Habitat

Default

2,055	4,100

Migrant Fry

Migrant Parr

Migrant Smolt

Adults Produced
Clear Creek

Migration Success

Simple Chinook Salmon Population Model

Watershed Example

Clear Creek

Starting Population 120,000

Watershed

Clear Creek

Spawners → Reproductive Success → Fry → Fry Survival → Parr → Parr Survival → Smolt

Spawning Habitat

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Fry Habitat

Default

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Parr Habitat

Default

2,055	4,100

Migrant Fry

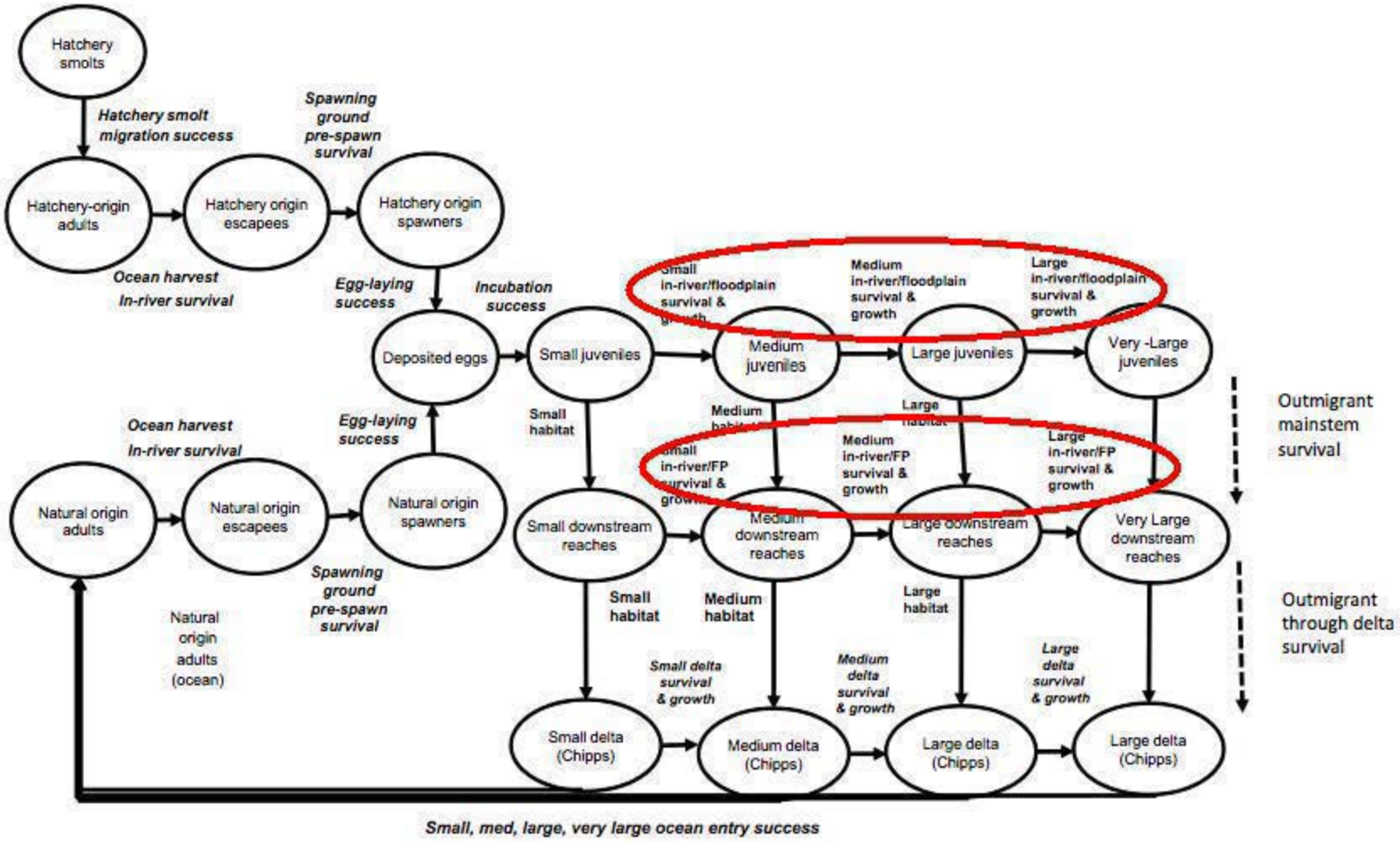
Migrant Parr

Migrant Smolt

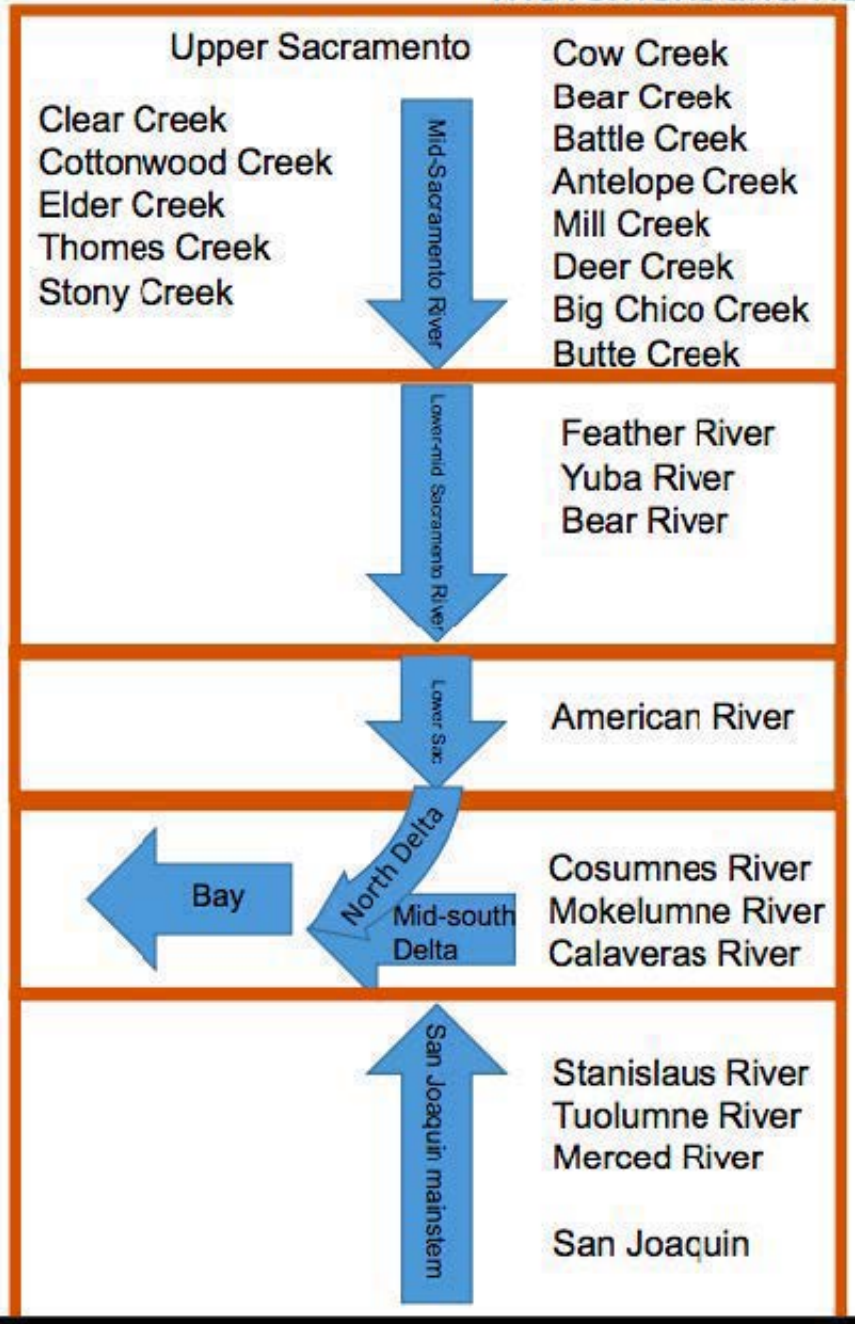
Adults Produced Clear Creek

Migration Success

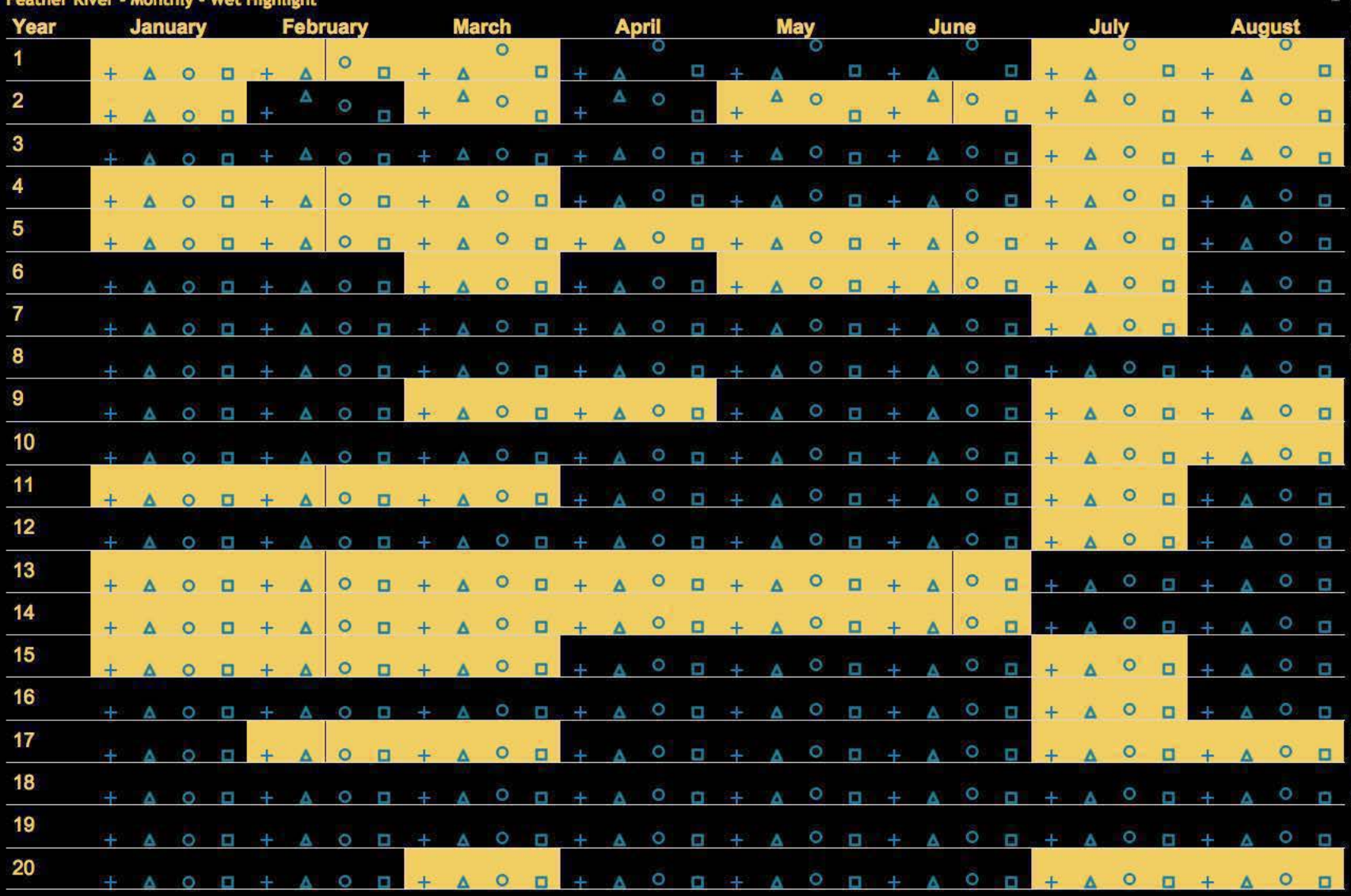
Fall Chinook Salmon Base Conceptual Model (v. 2016)



Movement and Rearing Watershed Groups



Feather River - Monthly - Wet Highlight



Scenario

(Multiple values)

Watershed

Feather River

Season

- Dry
- Wet

Metric

- Adults in Ocean (cum...
- delt.fsh.af
- Juveniles in Watershed
- Juveniles out of Wate...
- Juveniles past Chipp...
- low.sac.fsh.af
- Migrants at Golden G...
- up.sac.fsh.af

Year

- (All)
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Month

- January
- February
- March
- April
- May
- June
- July
- August

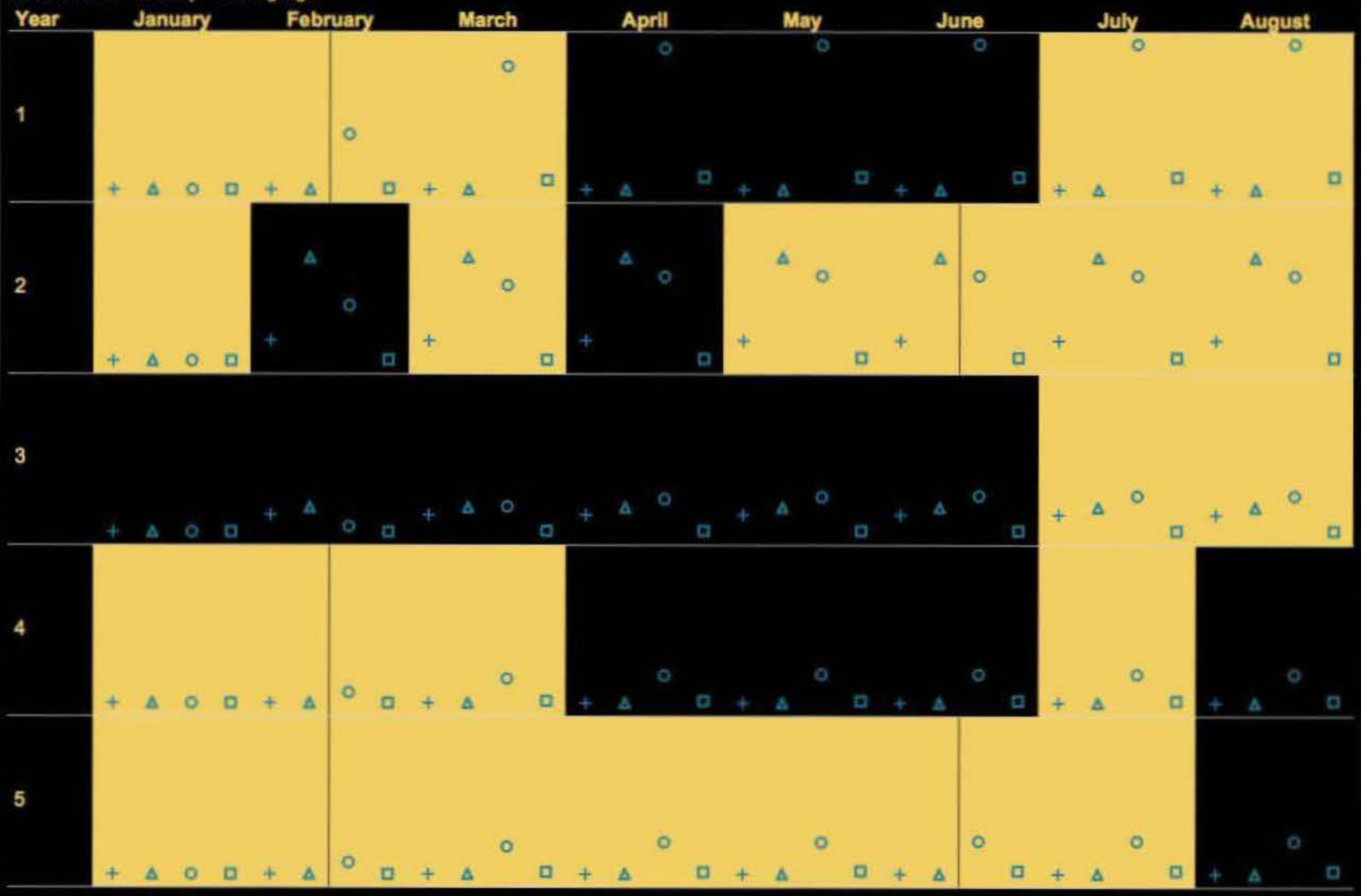
Scenario

- NoAction
- ProposedFloodplain Fe..

Size

- s
- m
- l
- vl

Feather River - Monthly - Wet Highlight



Scenario

(Multiple values)

Watershed

Feather River

Season

- Dry
- Wet

Metric

- Adults in Ocean (cum...
- delt.fish.af
- Juveniles in Watershed
- Juveniles out of Wate...
- Juveniles past Chipp...
- low.sac.fish.af
- Migrants at Golden G...
- up.sac.fish.af

Year

- (All)
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Month

- January
- February
- March
- April
- May
- June
- July
- August

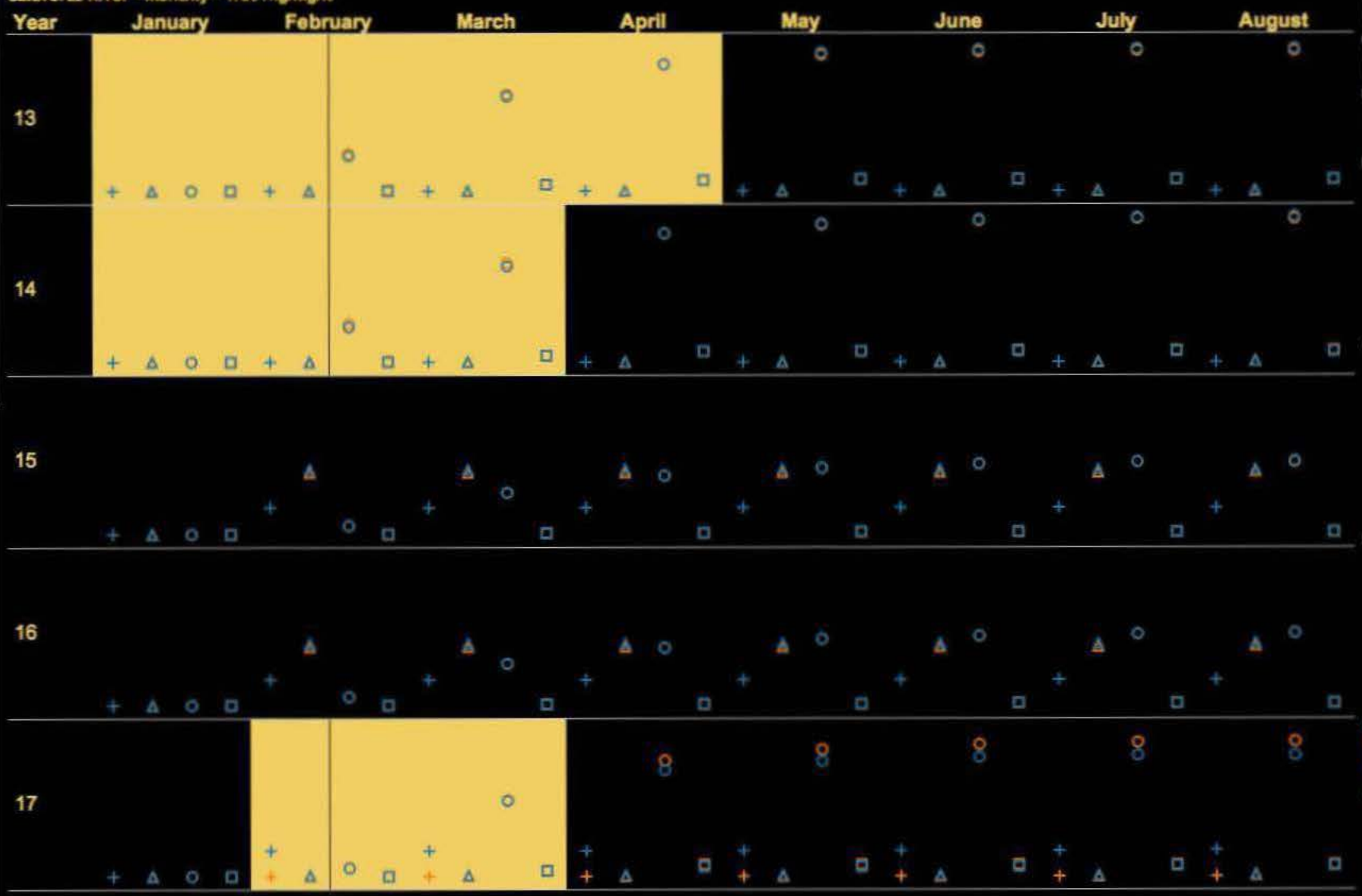
Scenario

- NoAction
- ProposedFloodplain Fe...

Size

- s
- m
- l
- vl

Calaveras River - Monthly - Wet Highlight



Scenario
(Multiple values)

Watershed
Calaveras River

Season
Dry
Wet

Metric
Adults in Ocean (cum...
delt.fish.af
Juveniles in Watershed
Juveniles out of Wate...
Juveniles past Chipp...
low.sac.fish.af
Migrants at Golden G...
up.sac.fish.af

Year
(All)
1
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3
4
5
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Month
January
February
March
April
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June
July
August

Scenario
NoAction
ProposedFloodplain Ca...

Size
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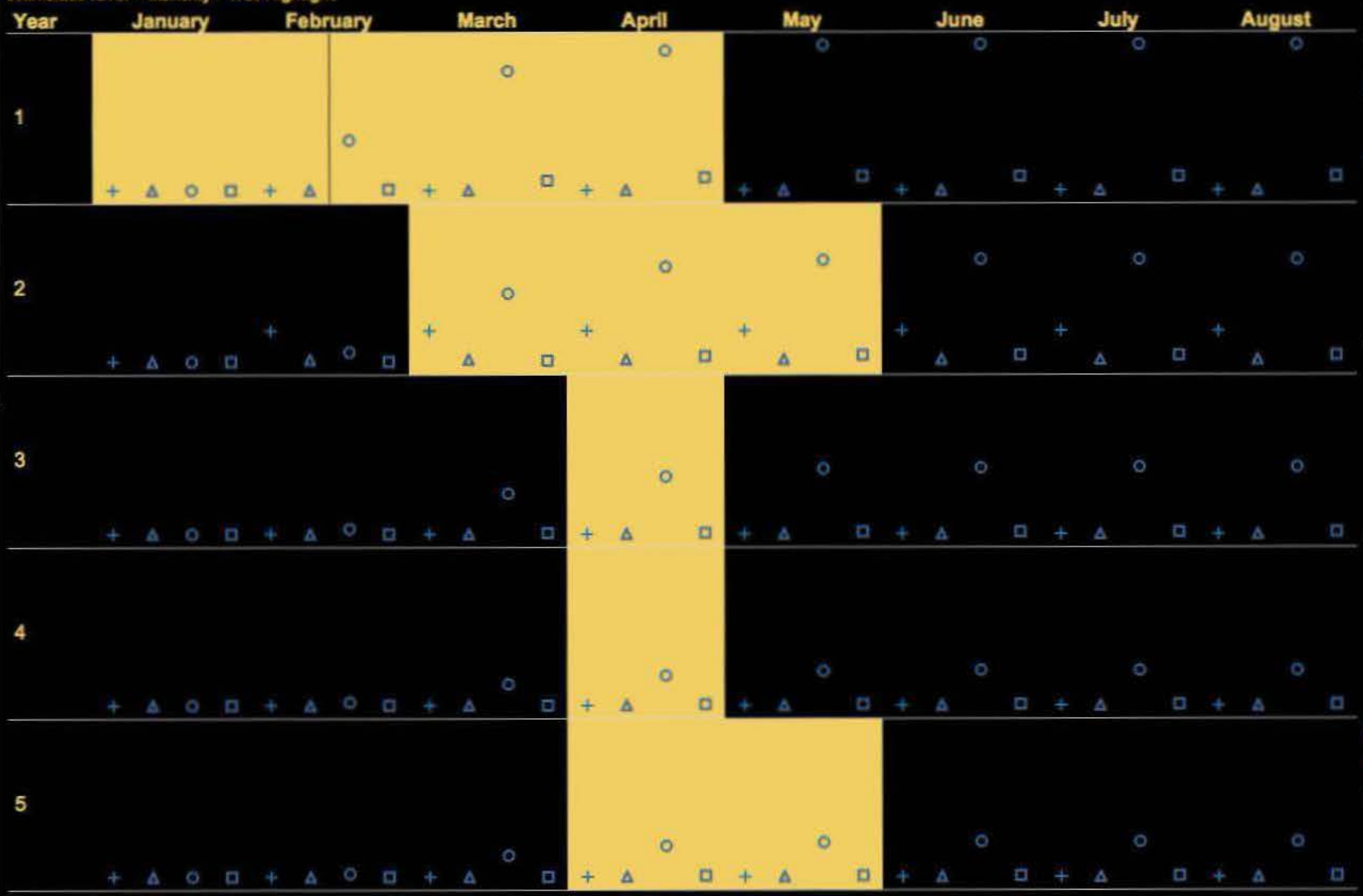
Stanislaus River - Monthly - Wet Highlight



Scenario

(Multiple values)

Watershed

Stanislaus River

Season

- Dry
- Wet

Metric

- Adults in Ocean (cum...
- delt.fish.af
- Juveniles in Watershed
- Juveniles out of Wats...
- Juveniles past Chipp...
- low.sac.fish.af
- Migrants at Golden G...
- up.sac.fish.af

Year

- (All)
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Month

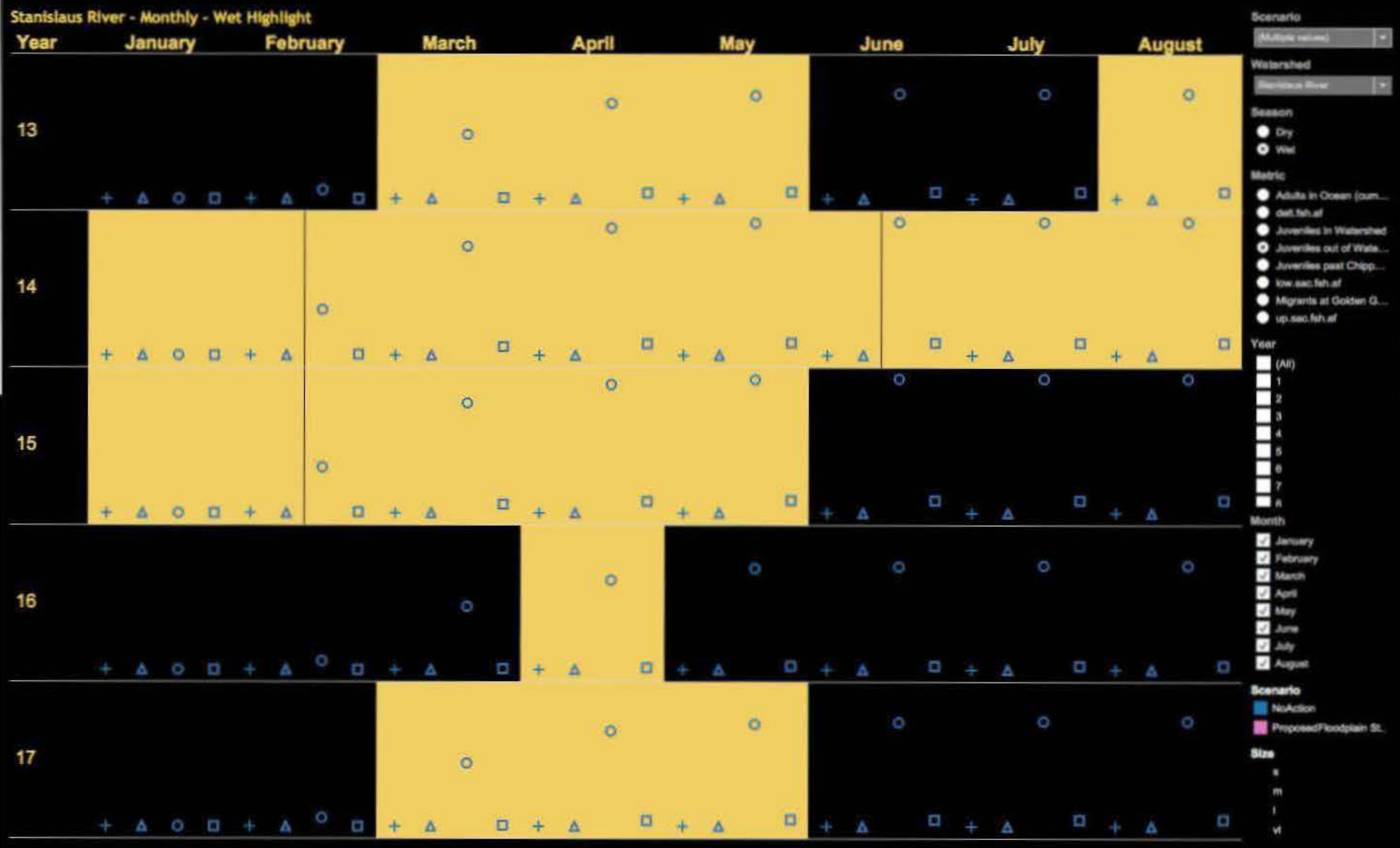
- January
- February
- March
- April
- May
- June
- July
- August

Scenario

- NoAction
- ProposedFloodplain St...

Size

- s
- m
- l
- vl


Stanislaus River - Monthly - Wet Highlight
Year
January
February
March
April
May
June
July
August
13
14
15
16
17
Scenario
(Multiple values)
Watershed
Stanislaus River
Season
Dry
Wet
Metric
Adults in Ocean (cum...
delt.fish.af
Juveniles in Watershed
Juveniles out of Wate...
Juveniles past Chipp...
low.sac.fish.af
Migrants at Golden G...
up.sac.fish.af
Year
(All)
1
2
3
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5
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7
8
Month
January
February
March
April
May
June
July
August
Scenario
NoAction
ProposedFloodplain St...
Size
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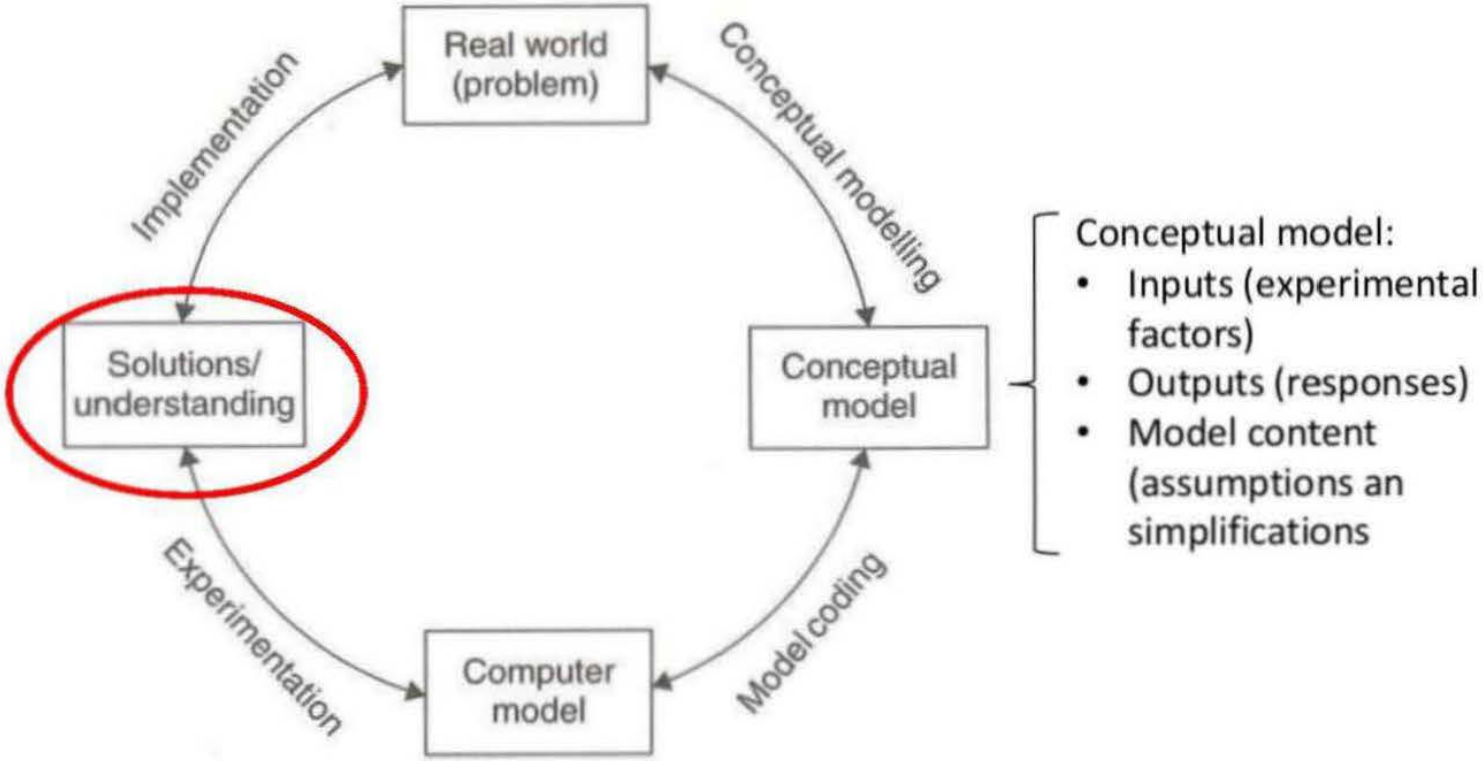
Visualization Concepts



Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Wiley.

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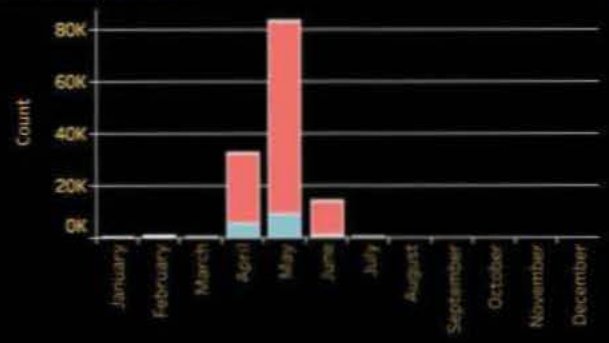
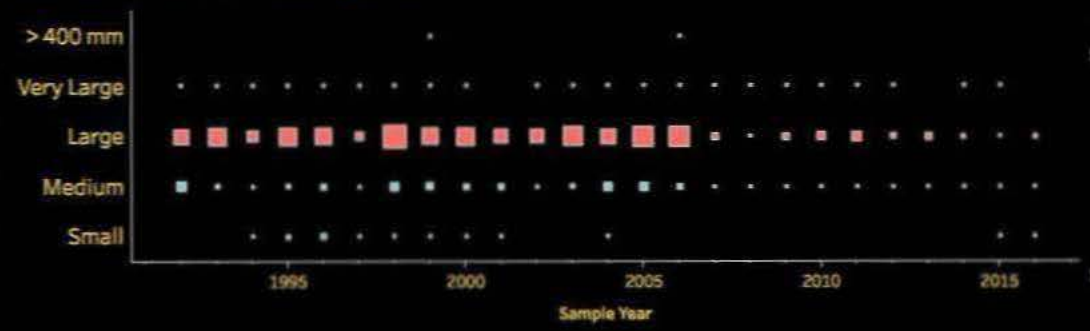
Count by Month



Distribution of Size Class by Sample Year



Year of Sample Date

1992 2016

Select Race By Length

- (All)
- Adult
- Fall
- LateFall
- NA
- Spring
- Winter

Select Fork Length

- (All)
- > 400 mm
- Large
- Medium
- Small
- Very Large

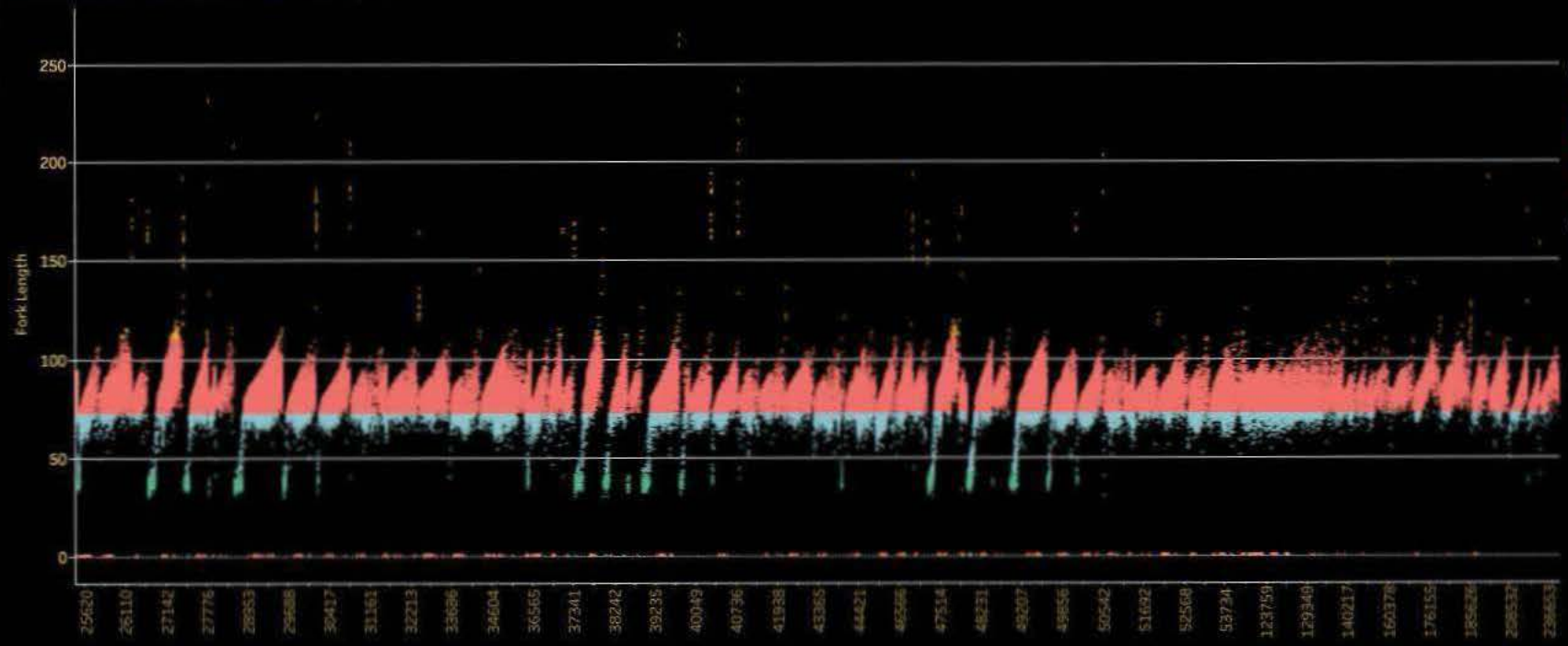
Highlight Fork Length

- > 400 mm
- Very Large
- Large
- Medium
- Small

Custom Fork Length

0 1062

Distribution by Individual Sample



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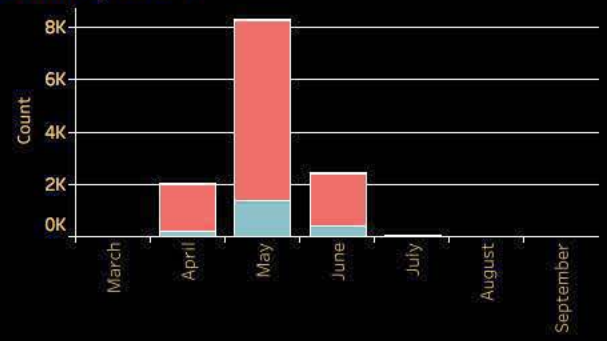
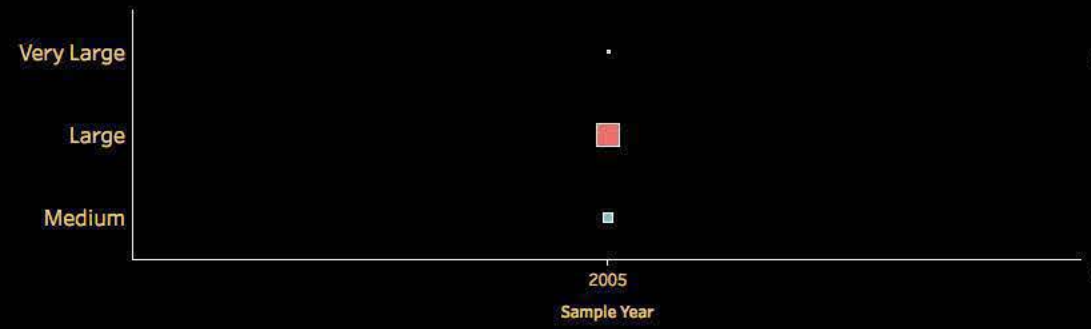


Distribution of Size Class by Sample Year



Year of Sample Date

2004 — 2005

Select Race By Length

- (All)
- Adult
- Fall
- LateFall
- NA
- Spring
- Winter

Select Fork Length

- (All)
- > 400 mm
- Large
- Medium
- Small
- Very Large

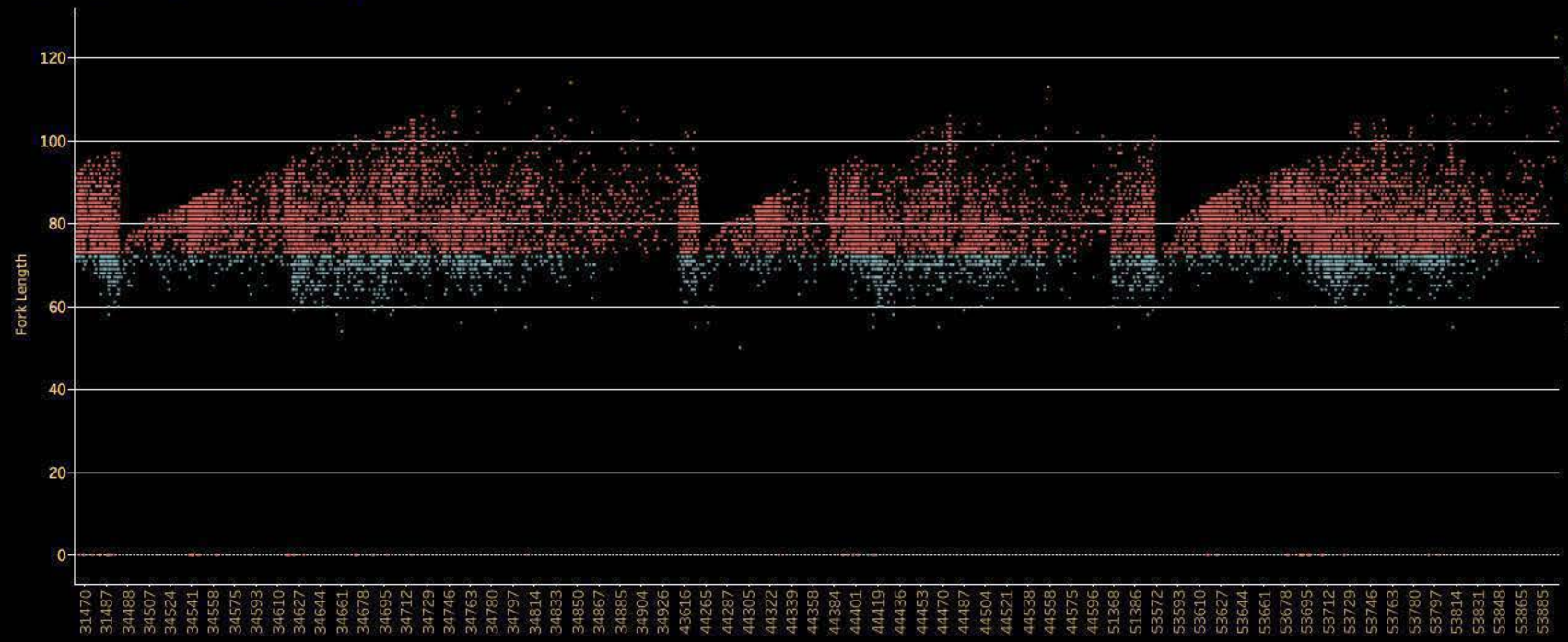
Highlight Fork Length

- Very Large
- Large
- Medium

Custom Fork Length

0 — 1062

Distribution by Individual Sample



Conclusion

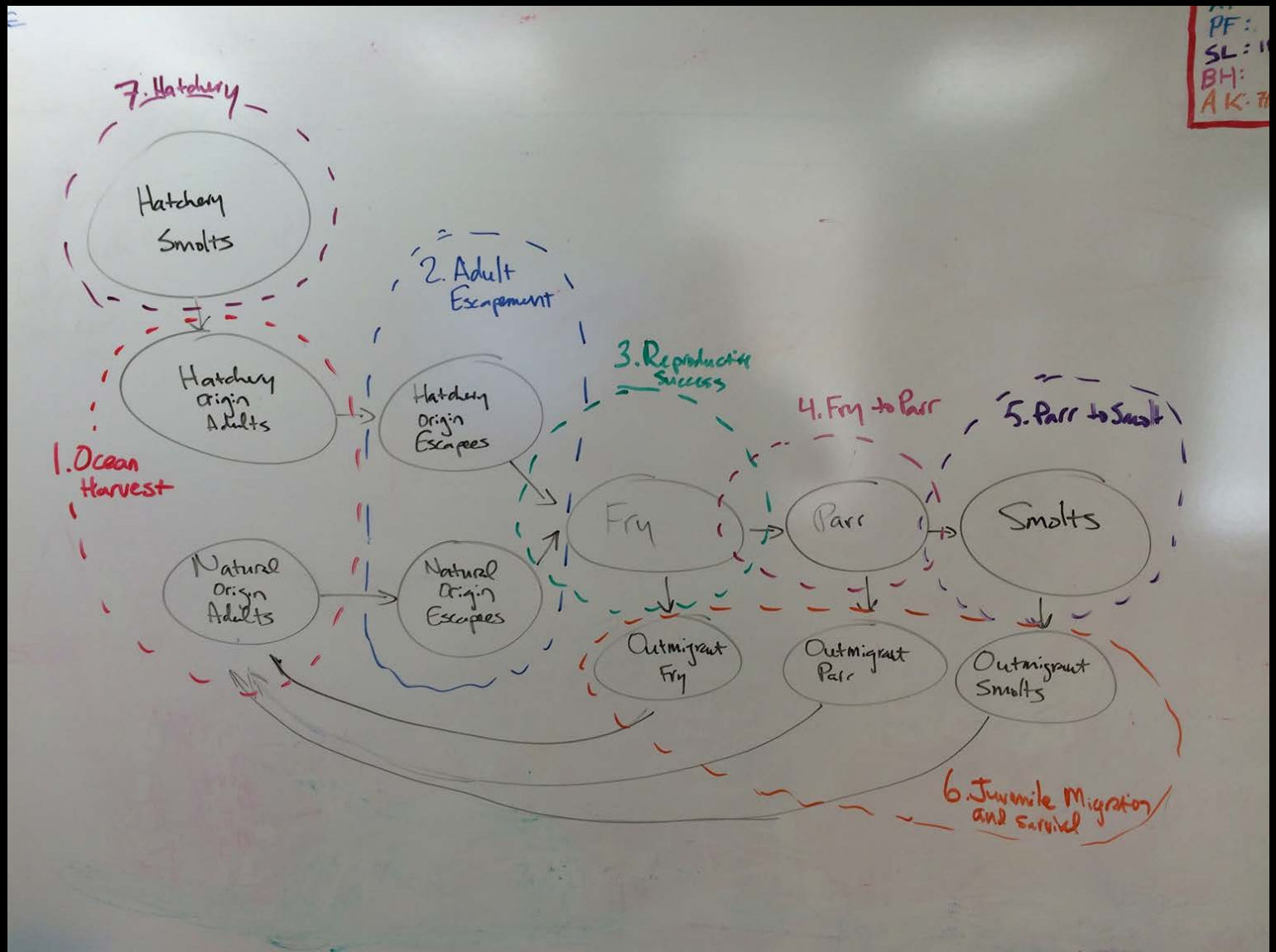
- Visualizations help support shared understanding
- Modern tools can handle large data sets
- Decisions supported directly with data are more defensible

Next steps:

- Take the population model back to the watershed experts
- Refine model inputs (parameritization)
- Repeat

Questions?

CVPIA Chinook Salmon Population Model



CVPIA Chinook Salmon Population Model