Modifications to the Juvenile Production Estimate using acoustically tagged Winter-run Chinook Salmon in 2013

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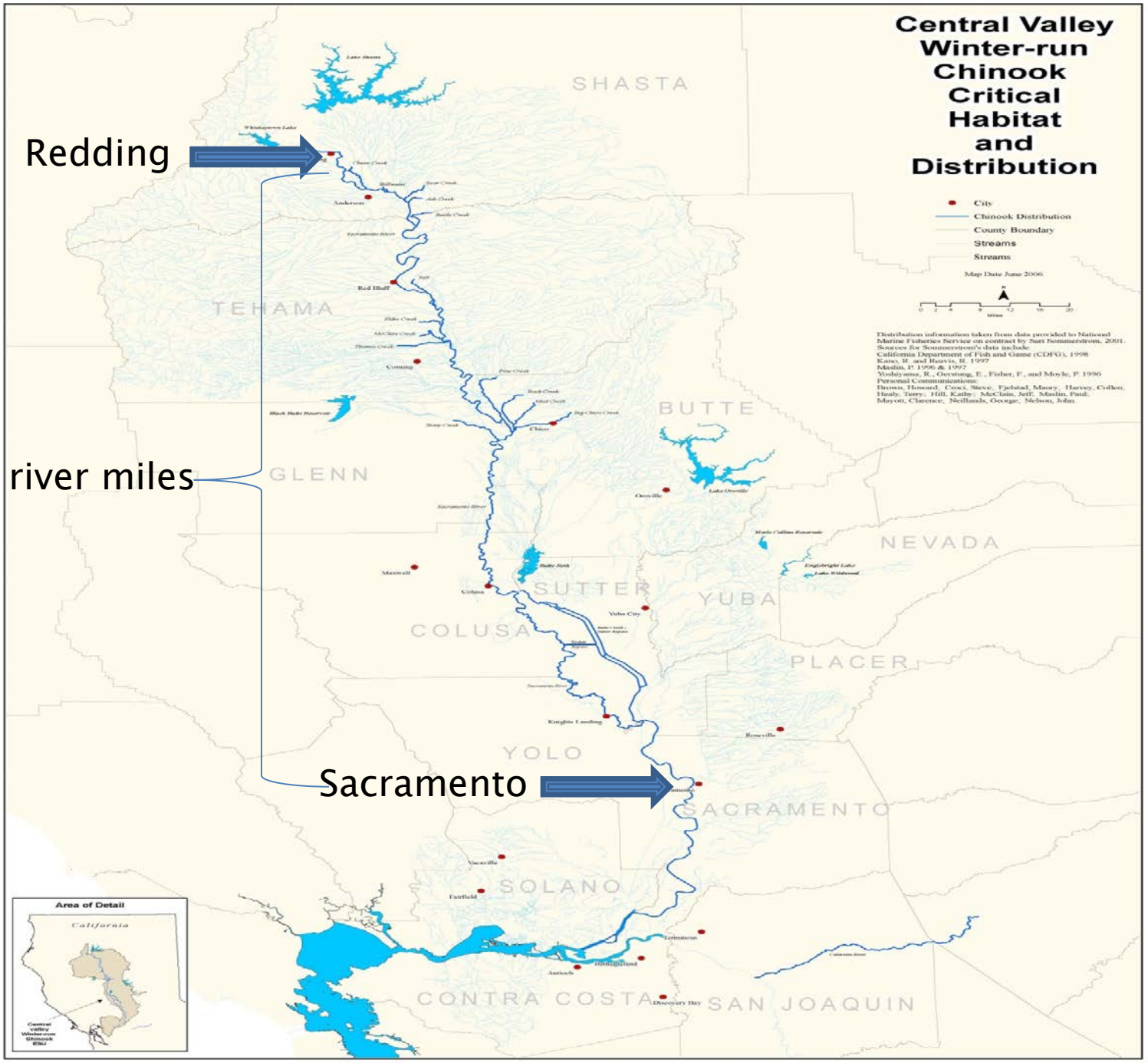
Overview

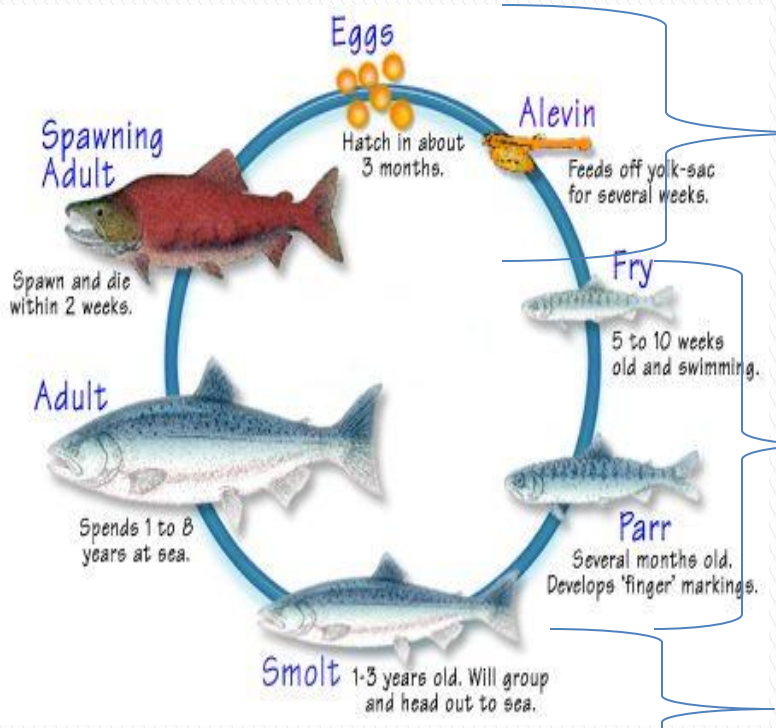
A. JPE model description
B. Modifications considered
C. Application of recent tag data
D. Results
E. Comparisons
F. Questions for review panel
G. Egg mortality & temp. impacts this year

JPE Background

- Simple spreadsheet model (Excel)
- Used to determine incidental take limit at the Federal and state pumping facilities in the Delta
- Originated with 1995 NMFS Biological Opinion on CVP/SWP operations
- Reviewed & updated by the Winter-run Project Work Team (PWT)
- Changes with latest science and annual variation in population parameters


Central Valley Winter-run Chinook Critical Habitat and Distribution
City
Chinook Distribution
County Boundary
Streams
Streams
Map Date June 2006
Distribution information taken from data provided to National Marine Fisheries Service on contract by Sari Sommerstrom, 2001. Sources for Sommerstrom's data include:
California Department of Fish and Game (CDFG), 1998
Kano, R. and Reavis, R. 1997
Maslin, P. 1998 & 1997
Yoshiyama, R., Gerstung, E., Fisher, F., and Moyle, P. 1996
Personal Communications:
Brown, Howard, Croci, Steve, Fjelstad, Maury, Harvey, Colleen, Healy, Terry, Hill, Kathy, McClain, Jeff, Maslin, Paul, Mayott, Clarence, Neilands, George, Nelson, John.
Redding
242 river miles
Sacramento
SHASTA
TEHAMA
GLENN
BUTTE
SUTTER
YUBA
COLUSA
NEVADA
PLACER
YOLO
SACRAMENTO
SOLANO
CONTRA COSTA
SAN JOAQUIN
Area of Detail
California

Breakdown of Components



1. Escapement
2. Pre-spawn mortality
3. Fecundity
4. Survival, egg to fry*
5. Survival, fry to smolt*
6. Survival, smolt to Delta*
7. Confidence Intervals

* Modified in 2014

(1)Escapement

- Based on CDFW carcass surveys
- Sex ratio from Keswick trap
- 90 % confidence intervals added in 2013

CDFW provides an official population estimate using Cormack Jolly-Seber Model (example from 2012)

Estimated Total In-river Escapement (hatchery and natural origin)	2,581
Estimated In-river Escapement (hatchery origin)	807
Estimated Number of In-river Adult Females (hatchery and natural origin)	1,498

Actual JPE from 2012

Version 3 12/19/2012

WINTER RUN CHINOOK SALMON draft Juvenile Production Estimate	Carcass Survey Factors	Carcass Survey Estimate
Total In-river Escapement - 1/		2581
Adult Female Estimate - 2/	56%	1498
Estimate of Female Spawners - 3/	100.00%	1498
Average Fecundity - 4/	4518	6767964
Egg Loss Due To Temperature - 5/	0	0
Total Viable Eggs		6767964
Estimated Survival - egg to fry (at RBDD) -6/	0.25	1691991
Estimated Survival - fry to smolts in mid-Sac- 7/	0.59	998275
(based on fish coming out of Tehama-Colusa spawning channel)		
Estimated Survival - Smolts to Delta - 8/	0.53625	535325
(locations of downstream control: Courtland, Sac, Ryde, Isleton)		
Total Natural Production Entering Delta		535325
Hatchery Release - 9/		180000
Total Hatchery Production Entering Delta	0.53625	96525
Level of Concern for wild fish (1%)		5353
Level of Concern for hatchery fish (0.5%)		483
Incidental Take Level for Natural Production (2%)		10706
Incidental Take level for Hatchery Production (1%)		965

(2) Prespawn Mortality

- Number of females that die prior to spawning
- Estimated from carcass surveys
- Typically, 1–2% for winter-run
- Subtracted from total females

(3) Fecundity

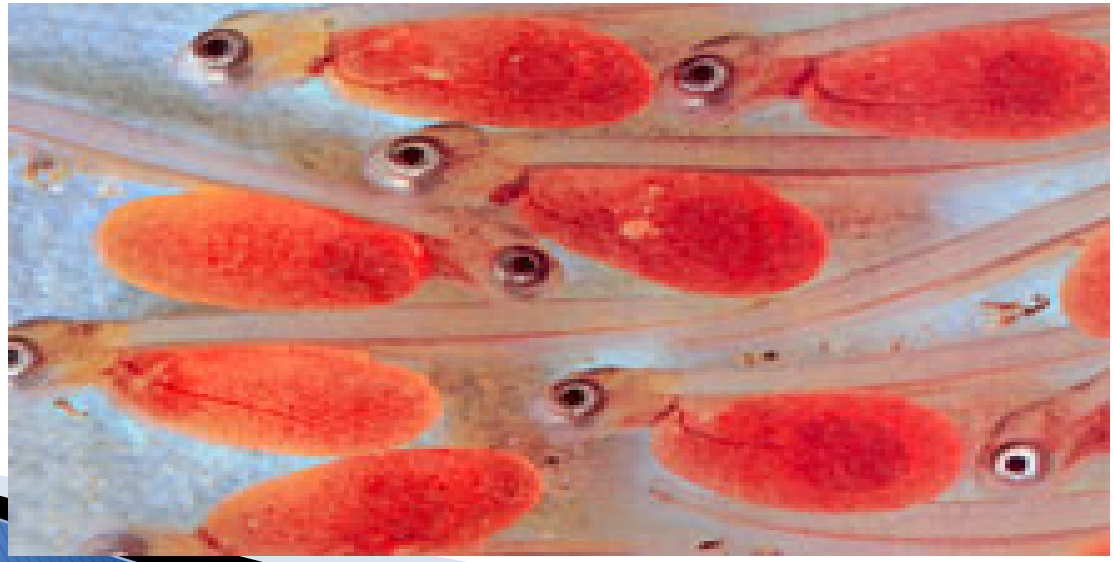
- Number of eggs/female
- Derived annually from hatchery returns
- Small sample size, typically n < 50
- Depends on size (4,000–5,800 eggs)
- For BY 2013, it was 4,596 eggs

Egg loss due to temperature

- Based on number of redds below the 56°F temperature compliance point (TCP)
- # redds vary depending on visibility & location
- Mortality assumed 100% below TCP
- Subtract number of eggs from total produced

(4) Survival – Egg to Fry (25%)

- life stages = egg, alevin, & fry
- Spatially = spawning grounds to RBDD
- Temporally = 3-4 months (May-September)
- Size = <34 mm
- Based on RBDD passage data



(5) Survival – Fry to Smolt (59%)

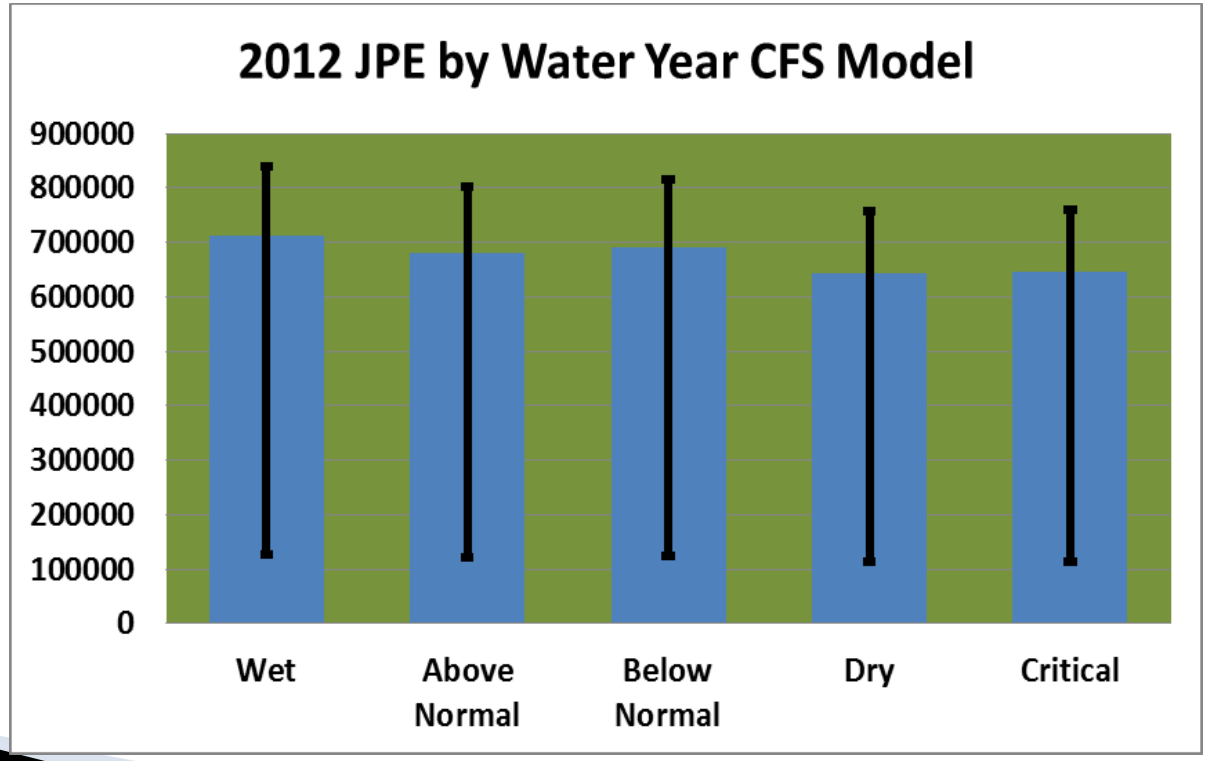
- Life stages = parr, pre-smolt
- Spatially = RBDD to Colusa (mid Sac. R)
- Temporally = 4-6 months of age (Sept.-Nov)
- Size = 35-60 mm
- Based on fall-run survival at Tehama-Colusa Spawning Channel (1972-1985)

(6) Survival – Smolts (53%)

- Life stage = pre-smolt to smolt
- Spatially = Colusa to Delta entrance at Sacramento (Hwy 80 Bridge)
- Temporally = 6-8 months of age (Nov-Jan)
- Size = 61-120 mm
- Based on difference in survival between CWT late fall-run (LFR) releases 1994-2001

(7) Confidence Intervals

- Developed by CFS after 2010,
- Uses standard Ricker stock-recruitment curve
- At 95% level wide range on error bars



Factors that vary

- Escapement (annual)
- Sex ratio (annual)
- Pre-spawn mortality (annual)
- Temperature (annual)
- Fecundity (annual)
- Survival (static)
  - Egg to fry
  - Fry to smolt
  - Smolt to Delta

Old Method Based on CWTs

- No direct measure of survival
- late fall-run (LFR) similar in size and timing
- The difference in survival rates between LFR releases upstream (Battle Creek) and downstream (in the Delta) would reflect the in river conditions.

CWT late fall-run survival rates at Chipps Island (USFWS unpublished)

		Differential Ocean Recovery Rate	
Year	**Reach**	**2001**	**Revised 2004**
1994	Battle Cr to Ryde	0.41	0.40
1995	Battle Cr to Isleton	0.67	0.62
1996	Battle Cr to Courtland	0.90	0.50
1997	Battle Cr to Miller Park, Sacramento	0.46	0.72
1998	Battle Cr to Ryde	0.59	0.70
1999	Battle Cr to Ryde	0.34	0.60
2000	Battle Cr to Isleton		0.48
2001	Battle Cr to Vorden		0.27
2002	Battle Cr to Vorden and Ryde		
2003	Battle Cr to West Sacramento		
2004	Battle Cr to Vorden		
	6 year average in 2001	0.56	
	8 year average in 2004		0.53

Use of CWT data in the JPE

- Survival rates varied between release groups
- Flow conditions varied between releases
- Subjective rationale for choosing rate depended on a number of factors; such as number recovered and first storm pulse
- 3 year lag between release & ocean recovery
- LFR do not behave similar to winter-run

Modifications considered for BY 2013

- Incorporate recent data from acoustic tag studies, such as:
  - 5 years data on hatchery late-fall run
  - 1 year data on hatchery winter-run
- Consideration of:
  - Surrogacy
  - Water year type
  - Behavior

Use of best available science

- Technical subteam reviews & analyzes data
- Finds significant differences between data
- Recommended changes to WRPWT:

1) use WR survival rate (16%);
2) or, combine LFR + WR survival (39%);
3) apply 2 significant figures, and update egg-fry survival.

Use of new data

- NMFS utilizes best available, including consideration of subteam analysis
- NMFS confers with Fisheries Science Center; which advises:
  - Use direct data from WR, where feasible
  - Combine data similar to 2013 dry conditions
  - Weight data equally, to avoid use of 1 year data
  - Continue WR acoustic tag studies to incorporate more years.
  - Consider tagging wild WR, review JPE next year

Summary of Late Fall cumulative survival rates 2007-2011, average=.43, (Michel et al 2013)

Year	WY	S	UCI	LCI	River Segment*
2007	D	0.213	0.331	0.095	RBDD to I-80/50 bridge in Sacramento
2008	C	0.378	0.494	0.262	RBDD to I-80/50 bridge in Sacramento
2009	D	0.501	0.615	0.387	RBDD to I-80/50 bridge in Sacramento
2010	BN	0.419	0.523	0.315	RBDD to I-80/50 bridge in Sacramento
2011	W	0.672	0.748	0.596	Jelly's Ferry to I-80/50 bridge in Sacramento

Winter-run cumulative survival (Hassrick & Hayes 2013, unpublished)

Year	WY	S	UCI	LCI	River Segment*
2013	C	0.156	0.228	0.104	RBDD to Tower Bridge in Sacramento

*Cumulative reach survival measured from Salt Creek, 4 rkm (2.5 miles) downstream of RBDD

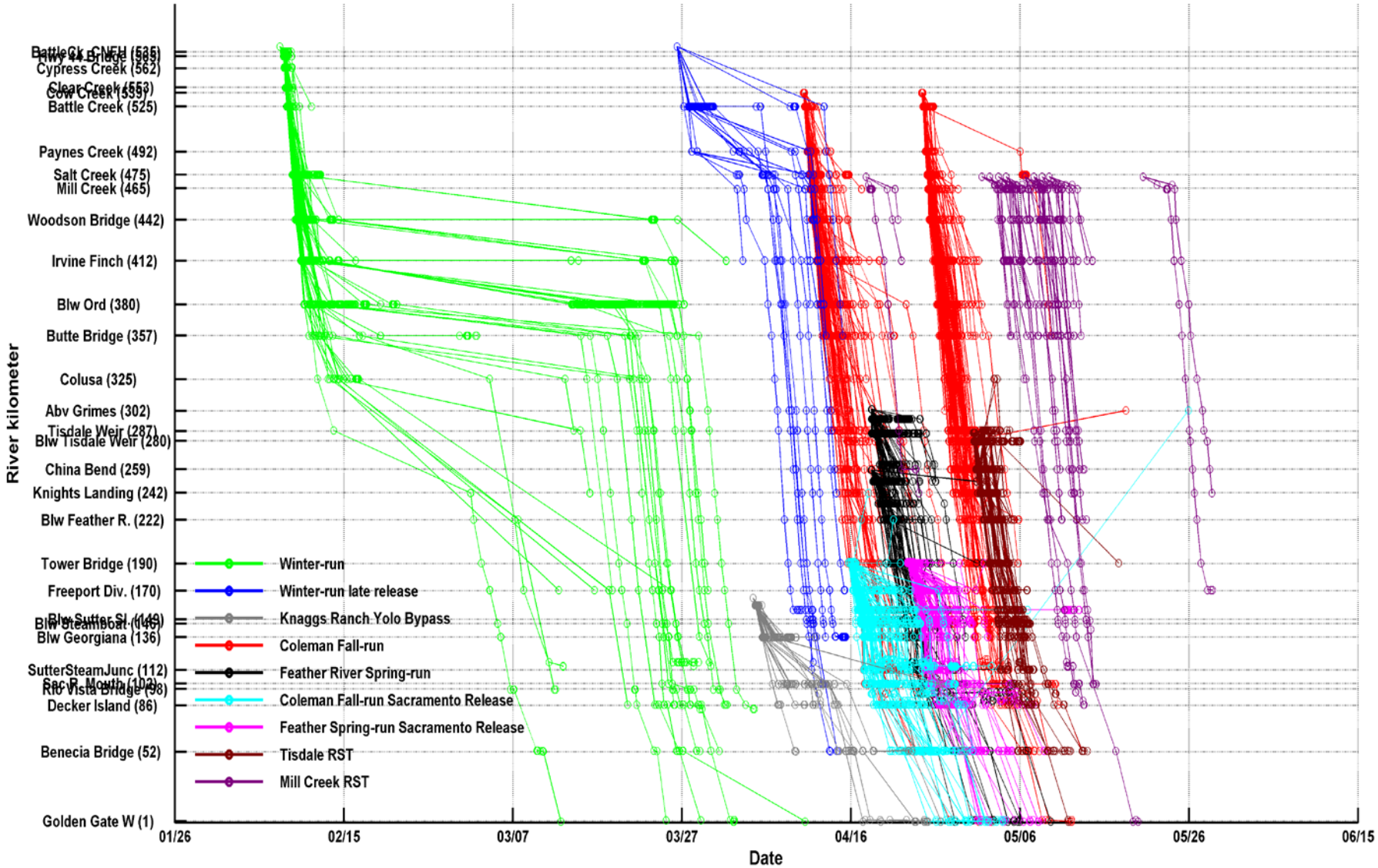
Comparison of LF and WR releases

Release	WY	Size (mm)	Number tagged	Date of Release	Location of Release
Late-fall run	C,D,BN,W	152-168	200-300	December - January	Battle Cr, Jelly's Ferry, Chico, Butte City
Winter-run	C	90	148	February	Caldwell Park, Redding

Problems with using only 1 year of Winter-run acoustic data

- No clear advice from PWT
- WR behave differently than LFR
  - a) Dry years hold upstream
  - b) Wet years rear in Delta
- WR emigration strategy is <u>really</u> different than other Chinook runs

Comparison of Winter-run (green & blue), Fall-run (red), and Spring-run (purple) acoustic tag releases



Application of more recent data

1) Egg-fry survival increased with more recent RBDD data.

2) Fry-smolt survival was combined based on recent acoustic tag data.

3) Applied weighting factor to account for only one year of WR data.

New Methodology for BY 2013:

Applied average LF survival during dry years 2007-2010, similar to conditions in 2013. Excluded wet year 2011data (.38 X .50 weighting = .19).

Used 2013 WR data = .16 X .50 (weighting) = .08

Summed weighted survivals = (.19 + .08) = .27

In the future, if and when more data on winter-run become available, weighting can change to reflect the variability in years and differences in hydrologic conditions.

Results of New Method in 2014

- Slight decrease in JPE

- Old method = 1,247,260
- New method = 1,196,387

- Difference is 50,873, or < 5%
- Not significant at 95% CI

Comparison of 2014 modifications

Survival Term	Old	Basis	New	Basis
Egg-to-Fry	.25	RBDD data (direct)	.27	2 years additional data (direct)
Fry-to-Smolt	.59	Fall-run survival, Tehama-Colusa Canal (indirect)	N/A	Combined with term below, to prevent overlap (more direct)
Smolt (spawning grounds to Delta)	.54	Differential ocean recovery rate CWT late-fall run survival (indirect)	.27	Combined weighted average of late-fall run + winter-run acoustic tag data (direct)

Comparison of survival rates (green) to locations (red):

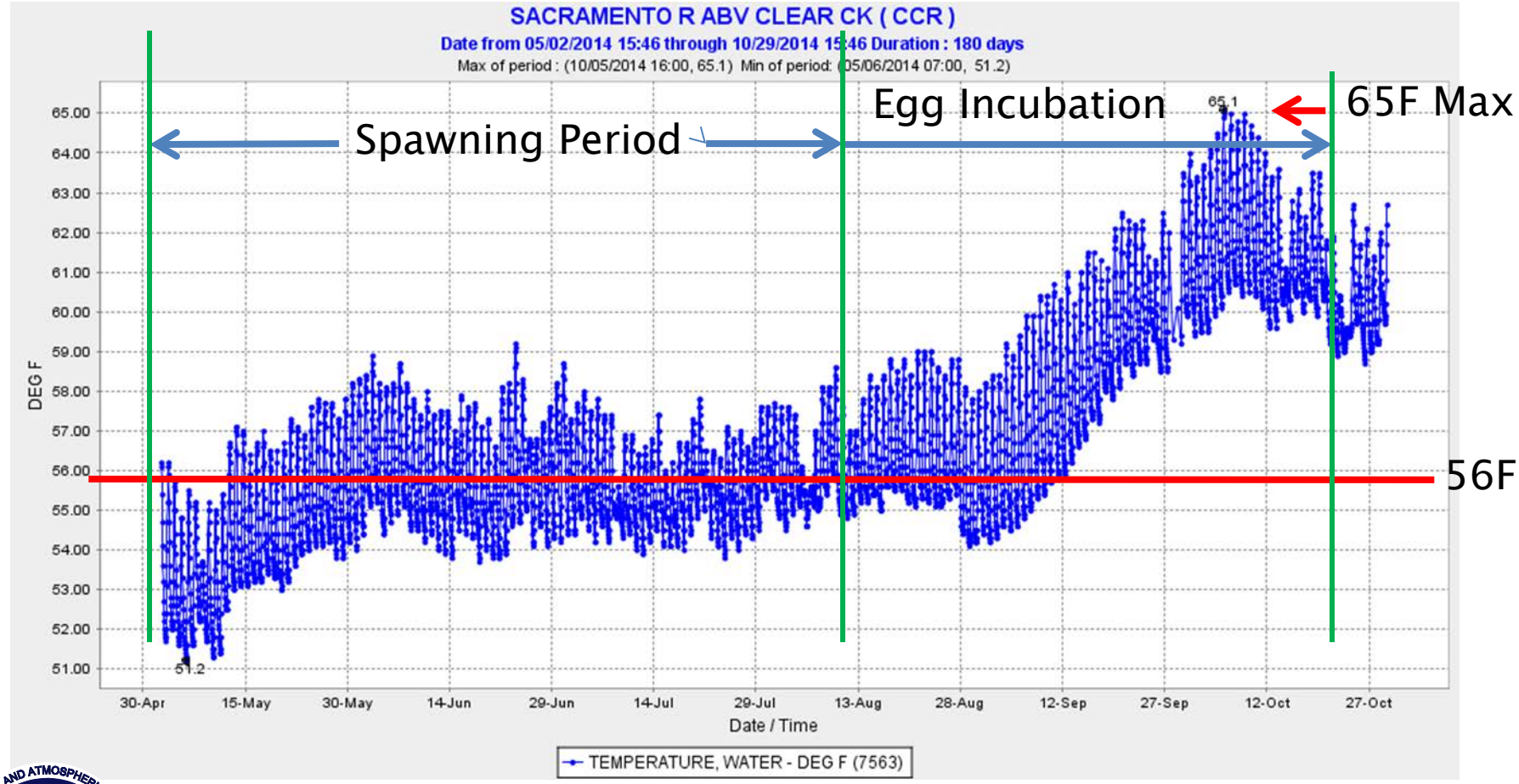
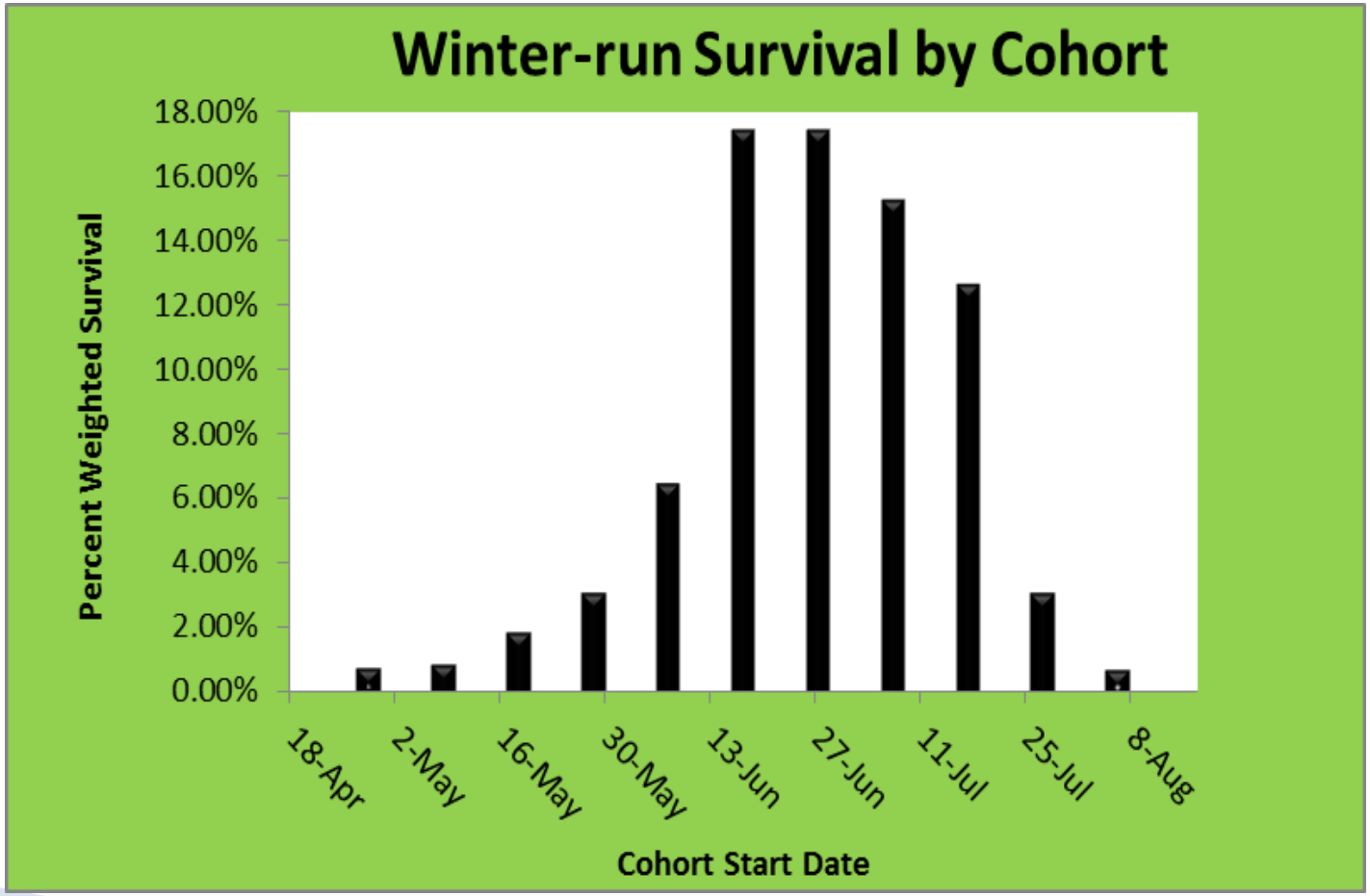
Old Method	New Method	Alternative considered	
RBDD		RBDD	
↓		↓	
(59% fry to smolt)	Salt Creek (~2.5 RM downstream)	(59% fry to smolt)	Salt Creek (~2.5 RM downstream)
↓	↓	↓	Overlap ↓
Mid-Sac		Mid-Sac	
↓			
(53% smolt)	(27% smolt, weighted average of WR & LFR)		(16% smolt, WR only)
↓	↓		↓
Delta (Total survival RBDD to Delta: 31%)	Delta (Total survival RBDD to Delta: 27%)		Delta (Total survival RBDD to Delta: 16%)

Questions for Panel?

1. How important is it to eliminate overlap in survival terms vs leaving out life stage?
2. How to account for gaps in rearing?
3. Should we include holding behavior?
4. How to weight data sets (WR & LFR) and include water year types, if so, for how many years?
5. What additional studies or methods would improve accuracy of the JPE?
6. How should conflicting data (RBDD vs JPE) be interpreted ?

Considerations for Broodyear 2014 JPE:

2014 CDEC data during winter-run spawning period



Considerations for Broodyear 2014 JPE:
Incorporate Egg & Fry Mortality Model?