Integrated Modeling Framework for Winter-Run Chinook Salmon

Funded by

California Urban Water Agencies

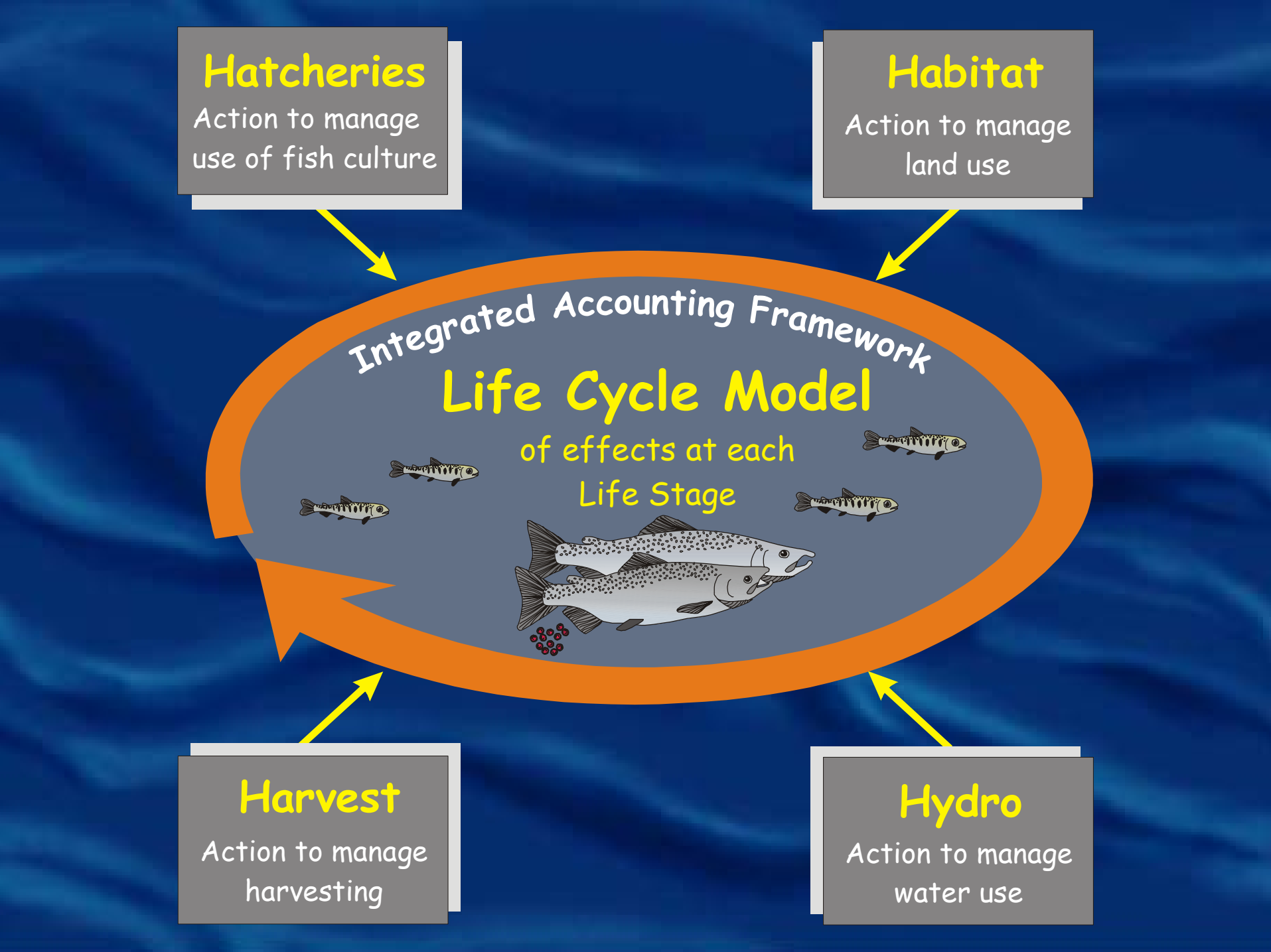
S.P. Cramer & Associates, Inc.
300 S.E. Arrow Creek Lane
Gresham, OR 97080
www.spcramer.com

Project Purpose: STEP 1

WHAT? Develop an accurate conceptual model, shared among basin biologists, of how human actions relate to production of key fish populations.

WHY? Such a system would help to guide restoration and management decisions to achieve the greatest fish benefits within available resources

HOW? Predict relative magnitude of fish production likely to result from alternative combinations of action


Hatcheries
Action to manage use of fish culture
Habitat
Action to manage land use
Integrated Accounting Framework
Life Cycle Model
of effects at each Life Stage
Harvest
Action to manage harvesting
Hydro
Action to manage water use

Dealing with Uncertainty

- We don't know it all
- We should proceed with what we can reasonably defend
- Upgrade systematically over time
- Points of model weakness or debate should become topics of study
- Steering committee should host annual reviews and approve model upgrades

FRAMEWORK GUIDELINES

- Build on Existing Analytical Foundations
- Rely on Demonstrated Cause-Effect Relationships
- Follow Fundamentals of Trophic and Stream Processes
- Use Readily Available Data
- Focus on Key Factors

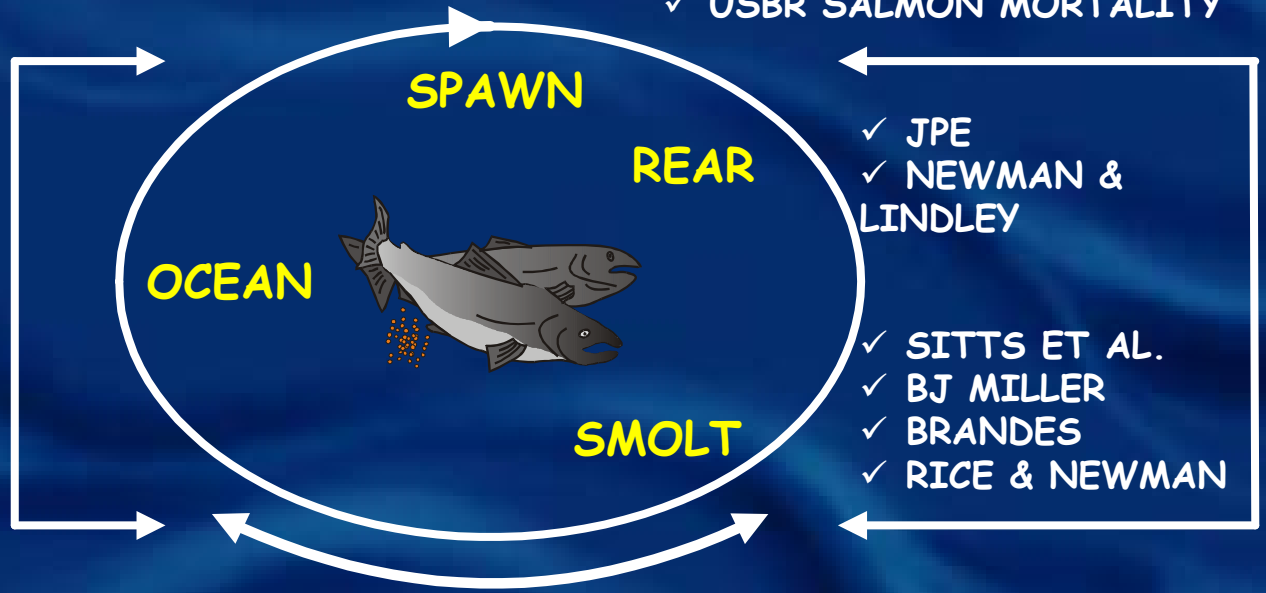
Collaboration Strategies

- Steering Committee with Policy-Level Representatives From Each Fisheries Agency
- Review Existing Modeling Efforts Before Proceeding with New Efforts
- Build Model in MS Excell for Easy Review and Use by All

STEP 1 Accomplishments

- Developed a conceptual framework for winter-run population dynamics, as influenced by human actions. This reflects our best understanding of functional relationships, regardless of our ability to quantify them
- Developed Prototype Quantitative Model that Expressed the Baseline for Quantitative Routines Presently in Use

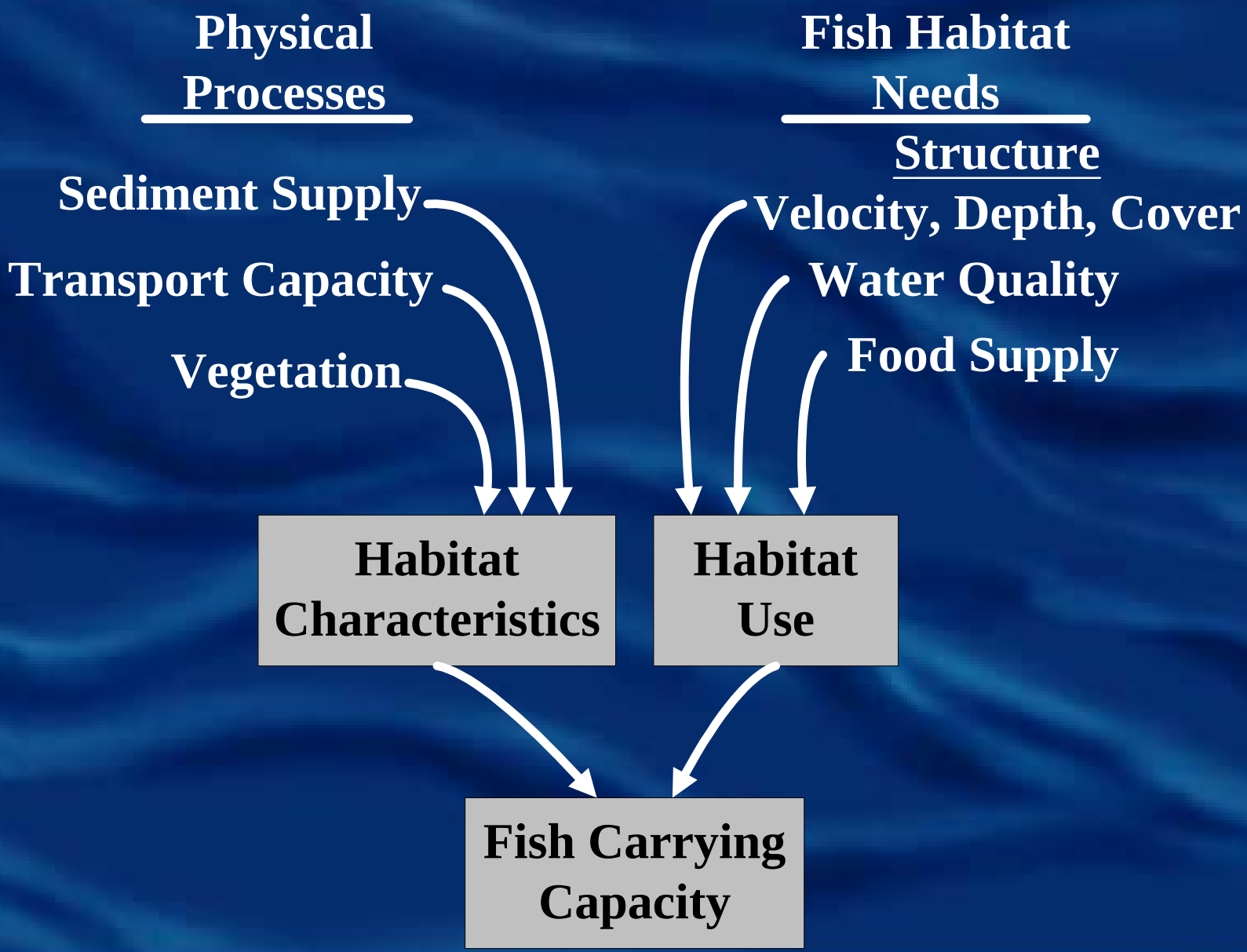
CV CHINOOK MODELING



Focus of Recovery Remedies Sacramento Winter-run Chinook

- Control Water Temperature
- Optimize Sacramento River Flow
- Improve Juvenile & Adult Passage at RBDD
- Screen Diversions
- Supplement with Hatchery Rearing
- Limit Export Pumping
- Schedule Delta Cross Channel Use
- Restrict Harvest in Ocean & River
- Reduce Contamination from Iron Mt Mine
- Re-establish Run in Battle Creek

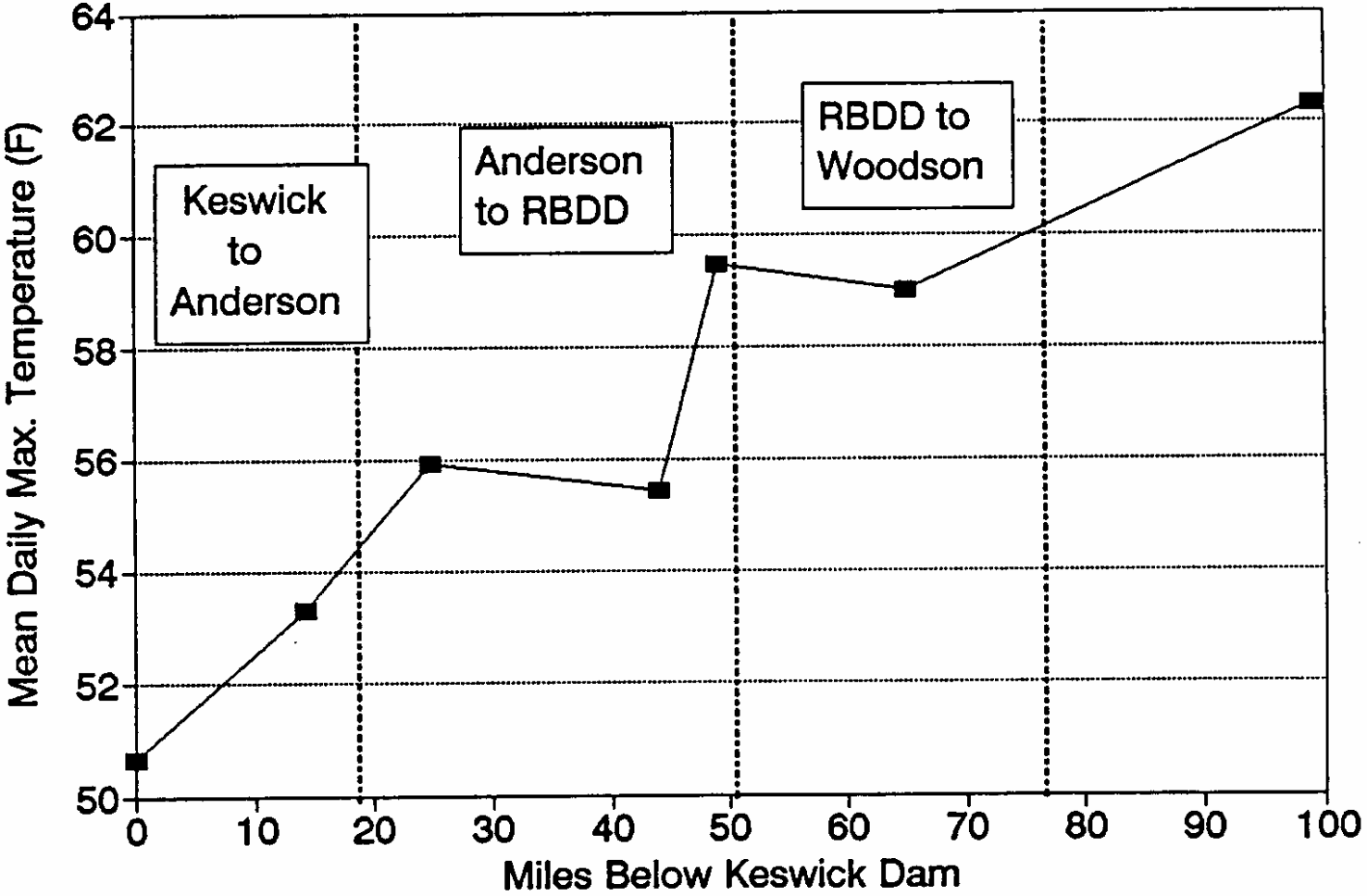
Salmon Production in Streams



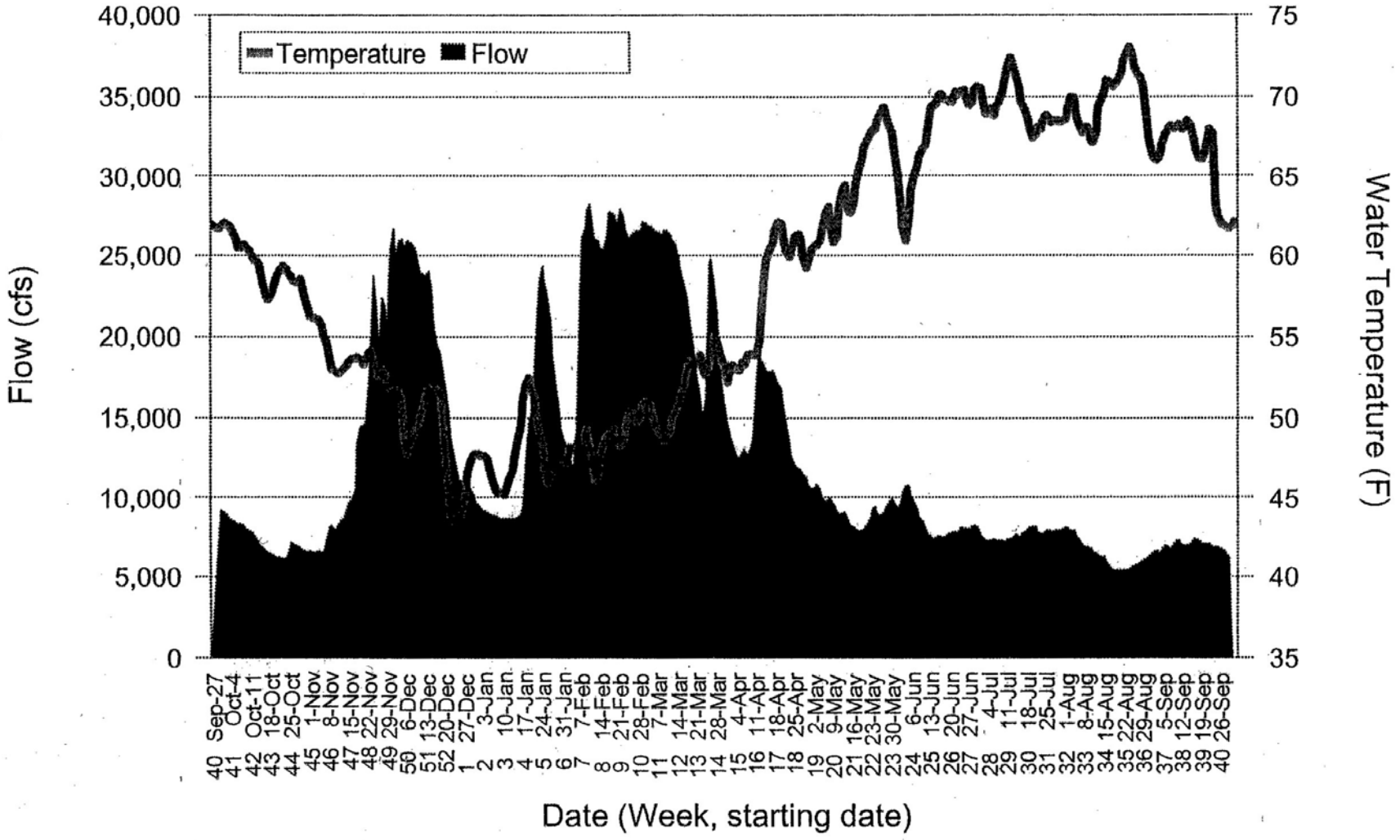
Key Findings from Monitoring

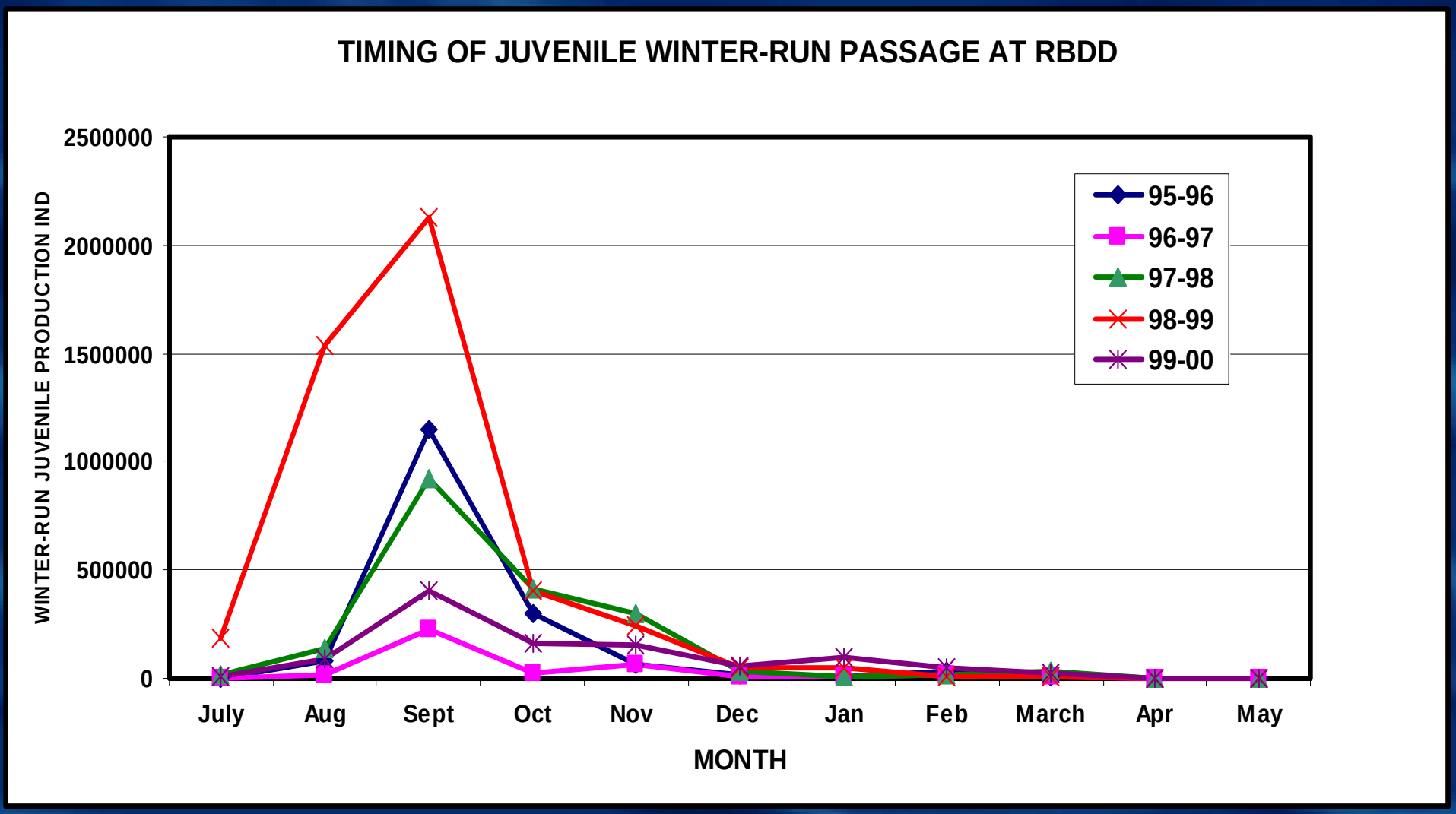
- Major passage issues for adults have been addressed
- Redd distribution shifted upstream from 46% below RM 283 (Airport Rd Bridge) during 1987-92 to only 6% below that point since 1993.
- Temperature control has reduced egg loss, but high temperatures may still cause some egg loss in dry years
- Most juveniles pass RBDD as fry
- Survival through the Delta is influenced by water operations

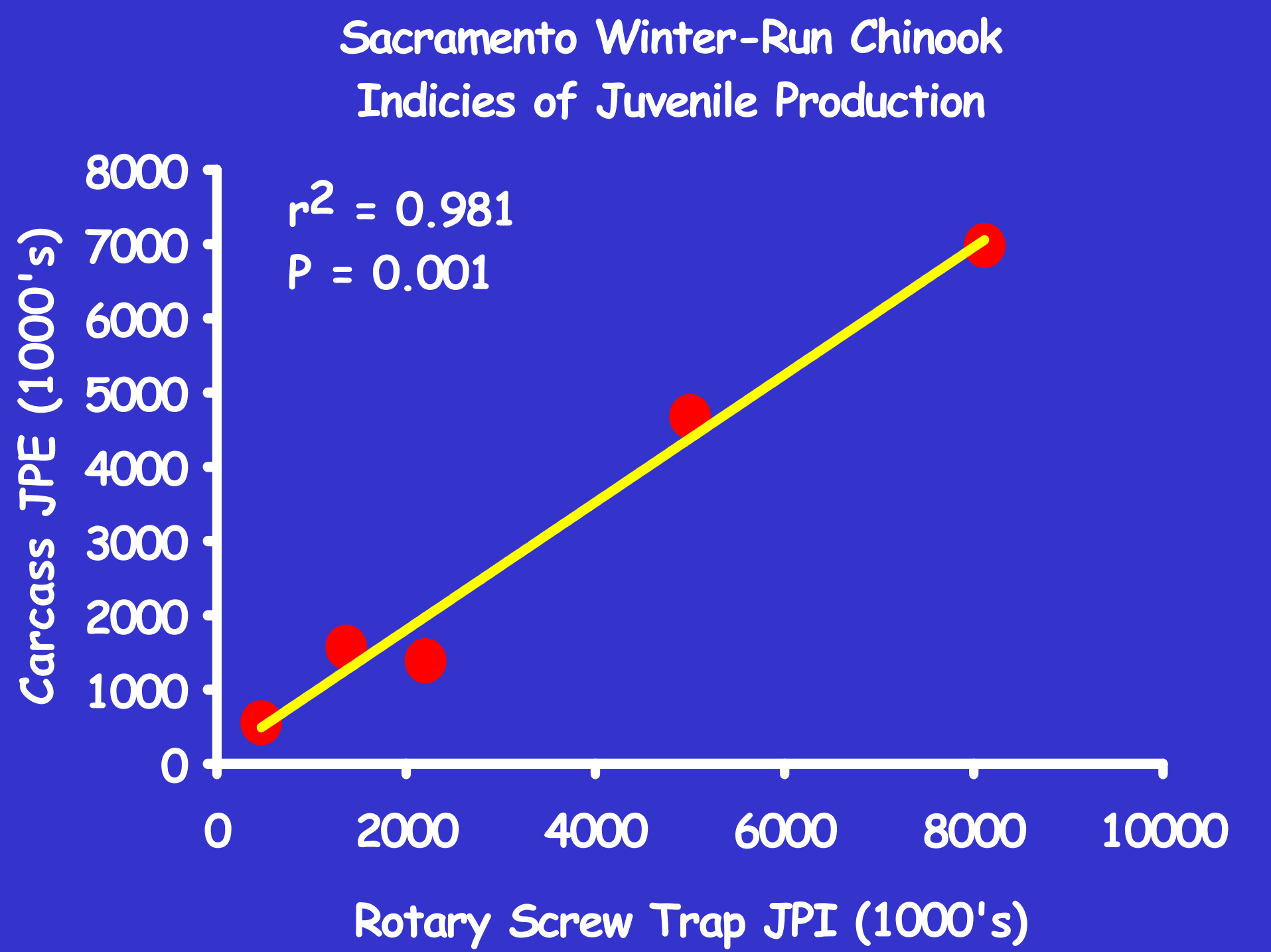
Sacramento River Temperature - June 88

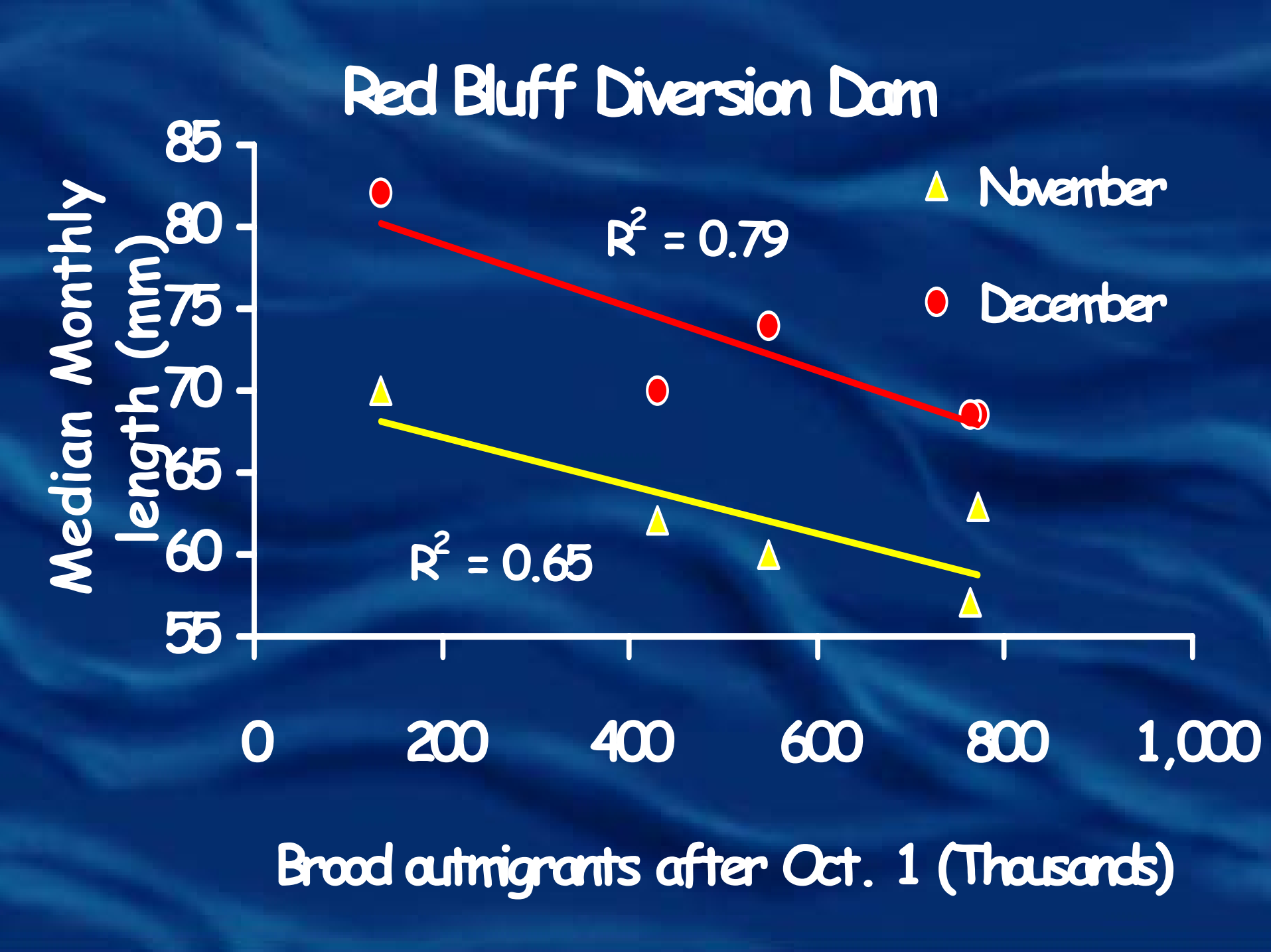


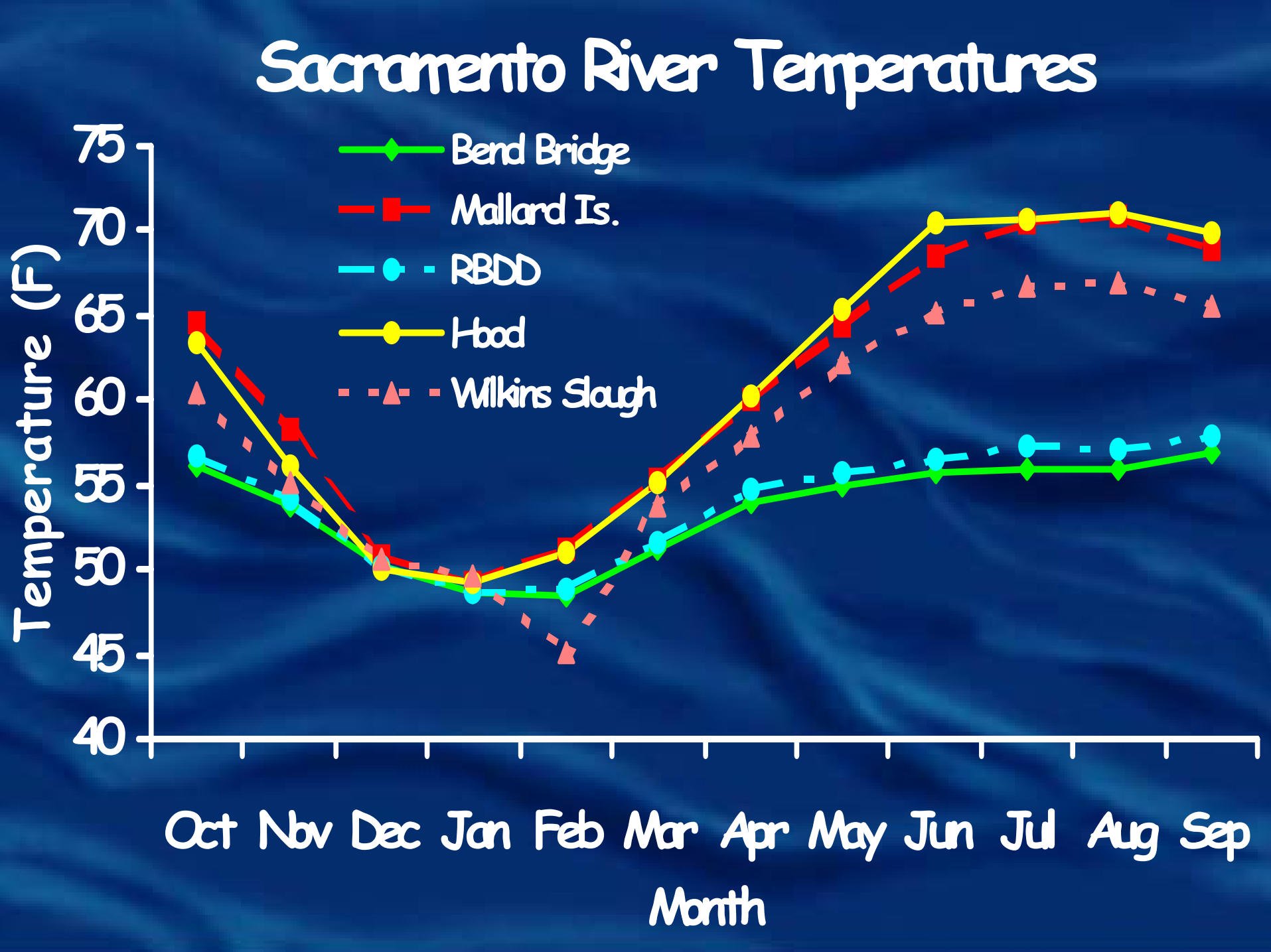
Sacramento River flow and water temperature near Knights Landing

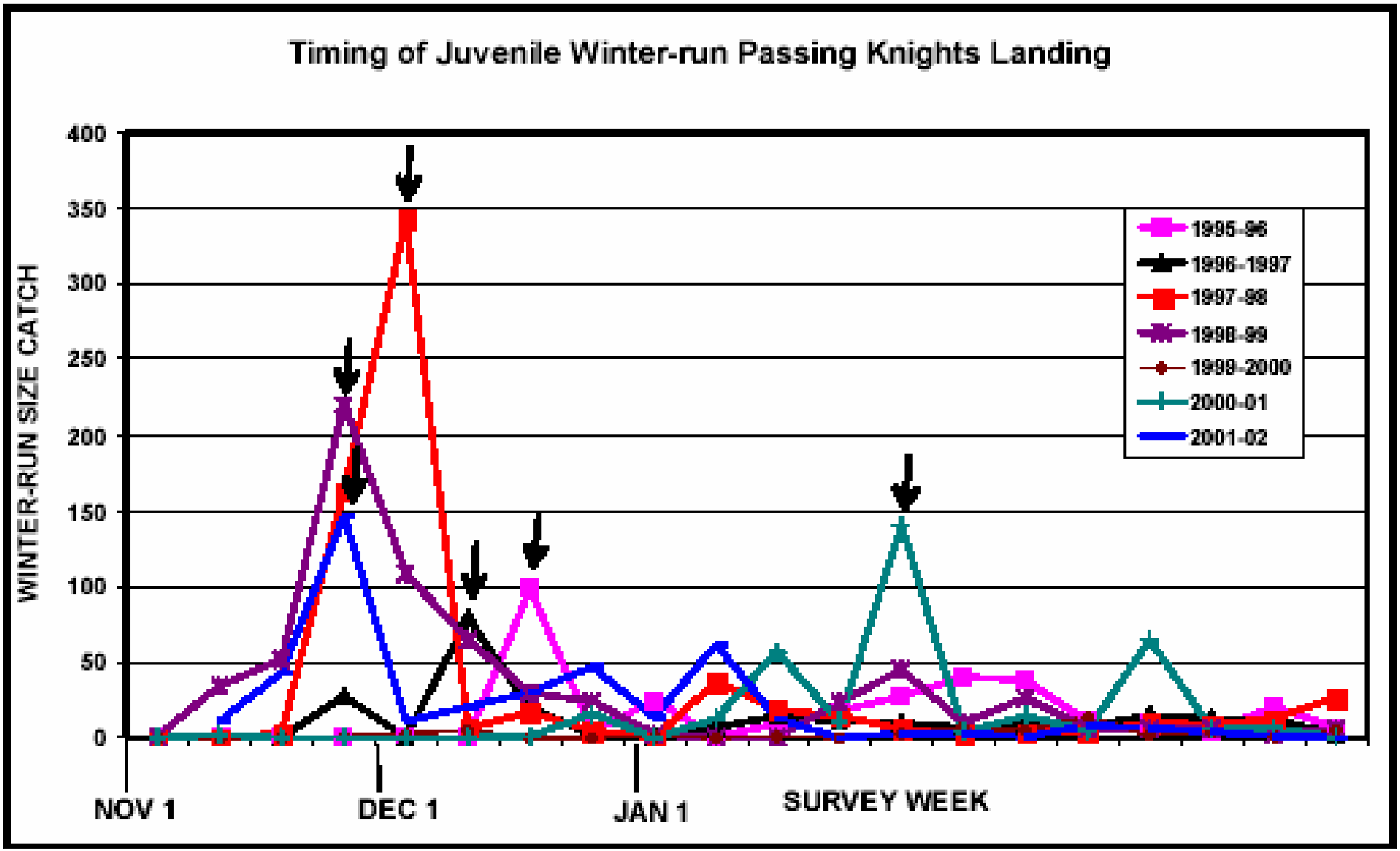



TIMING OF JUVENILE WINTER-RUN PASSAGE AT RBDD
WINTER-RUN JUVENILE PRODUCTION IND
2500000
2000000
1500000
1000000
500000
0
July
Aug
Sept
Oct
Nov
Dec
Jan
Feb
March
Apr
May
MONTH
95-96
96-97
97-98
98-99
99-00


Sacramento Winter-Run Chinook
Indicies of Juvenile Production
r^2 = 0.981
P = 0.001
Carcass JPE (1000's)
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2000
4000
6000
8000
10000
Rotary Screw Trap JPI (1000's)


Red Bluff Diversion Dam
Median Monthly length (mm)
85
80
75
70
65
60
55
November
December
R^2 = 0.79
R^2 = 0.65
0
200
400
600
800
1,000
Brood outmigrants after Oct. 1 (Thousands)


Sacramento River Temperatures
Bend Bridge
Mallard Is.
RBDD
Hood
Wilkins Slough
Temperature (F)
75
70
65
60
55
50
45
40
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Month


Timing of Juvenile Winter-run Passing Knights Landing
WINTER-RUN SIZE CATCH
400
350
300
250
200
150
100
50
0
NOV 1
DEC 1
JAN 1
SURVEY WEEK
1995-96
1996-1997
1997-98
1998-99
1999-2000
2000-01
2001-02

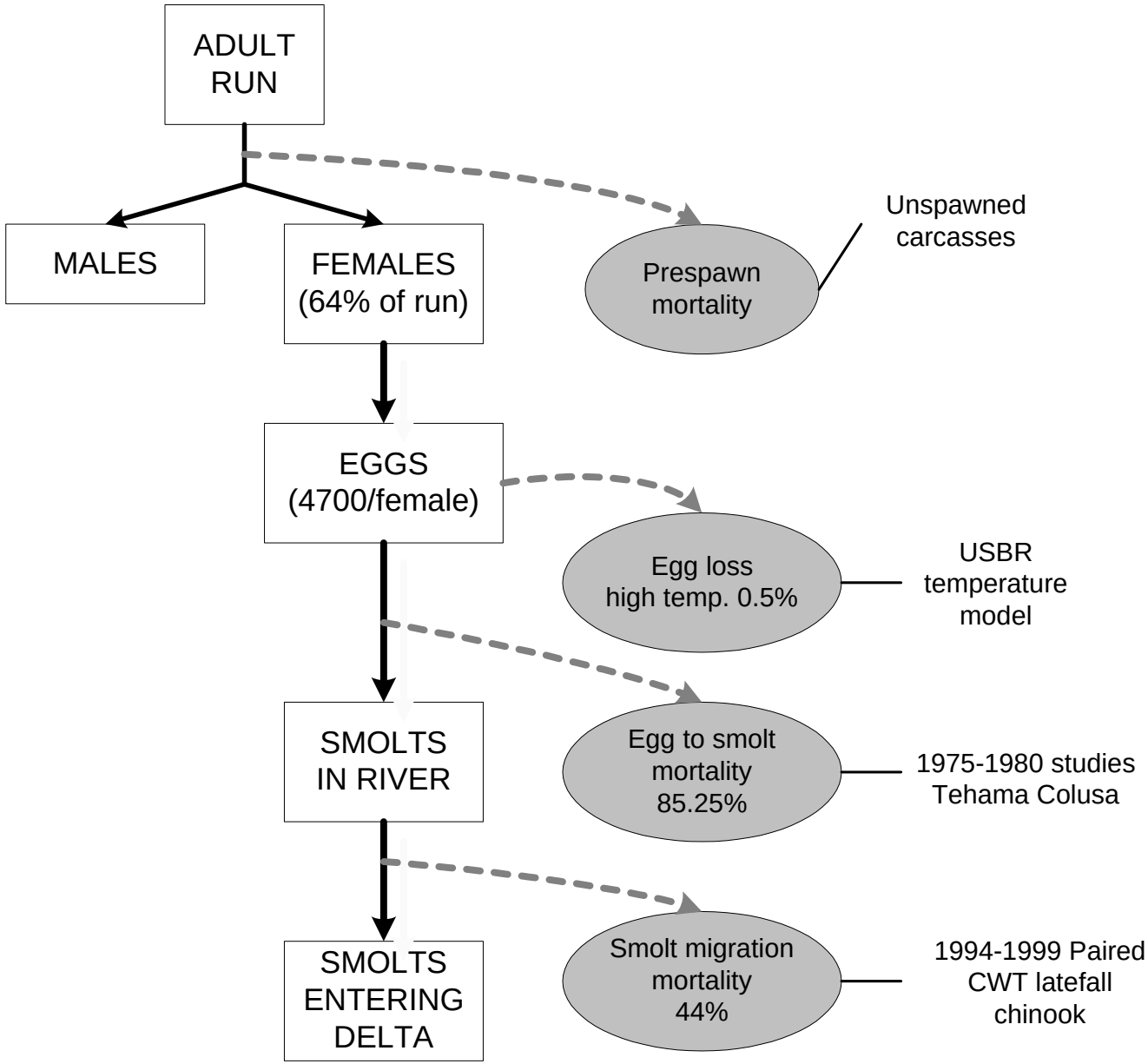
Estimated Winter-run Passage at Chipps Island

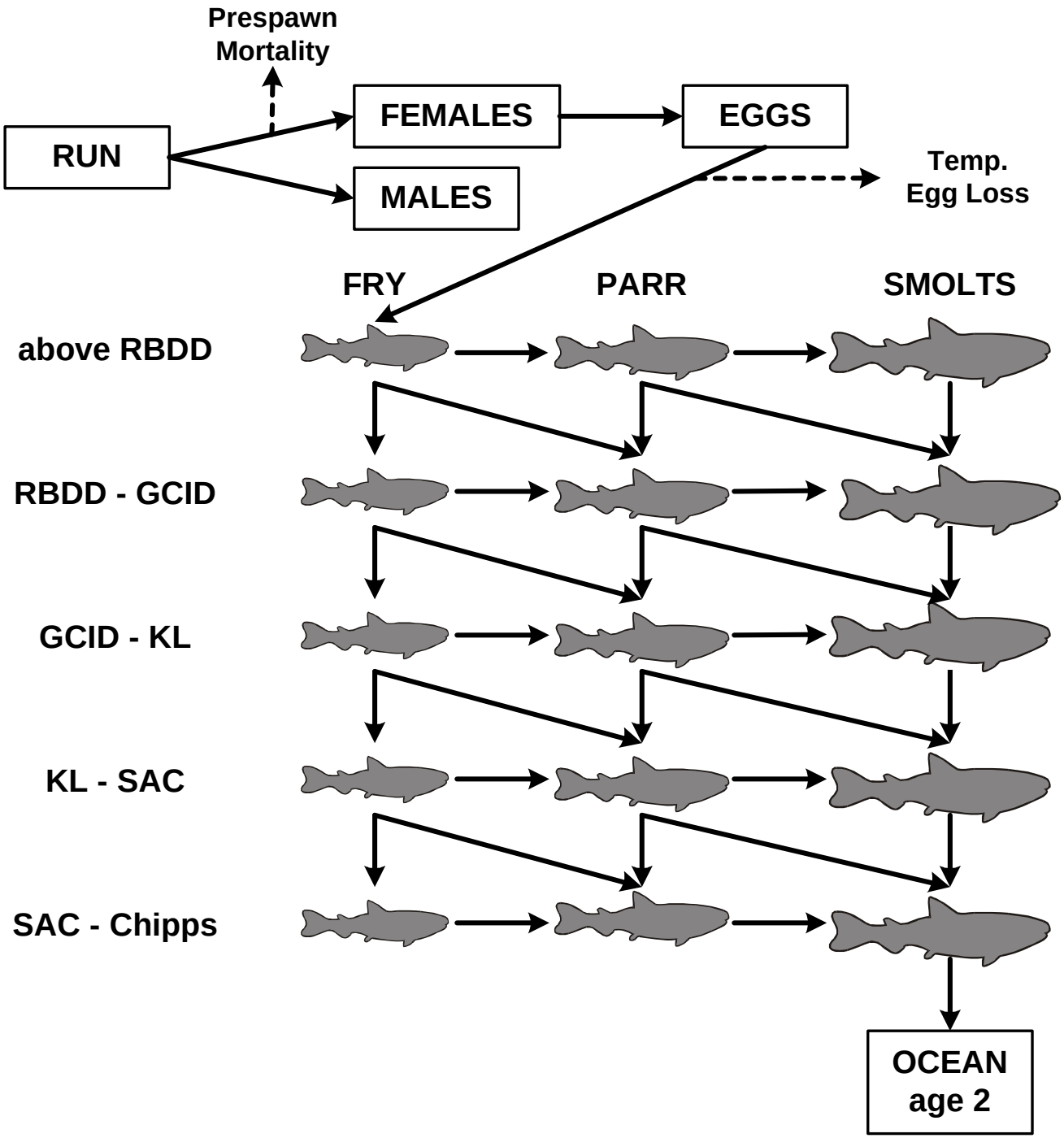
	Year of Jan-May		
Month	**2000**	**2001**	**2002**
November	0	0	0
December	0	0	13,466
January	6,649	7,155	9,766
February	57,385	33,012	13,133
March	180,806	152,746	83,125
April	30,340	18,972	28,711
May	1,163	487	489

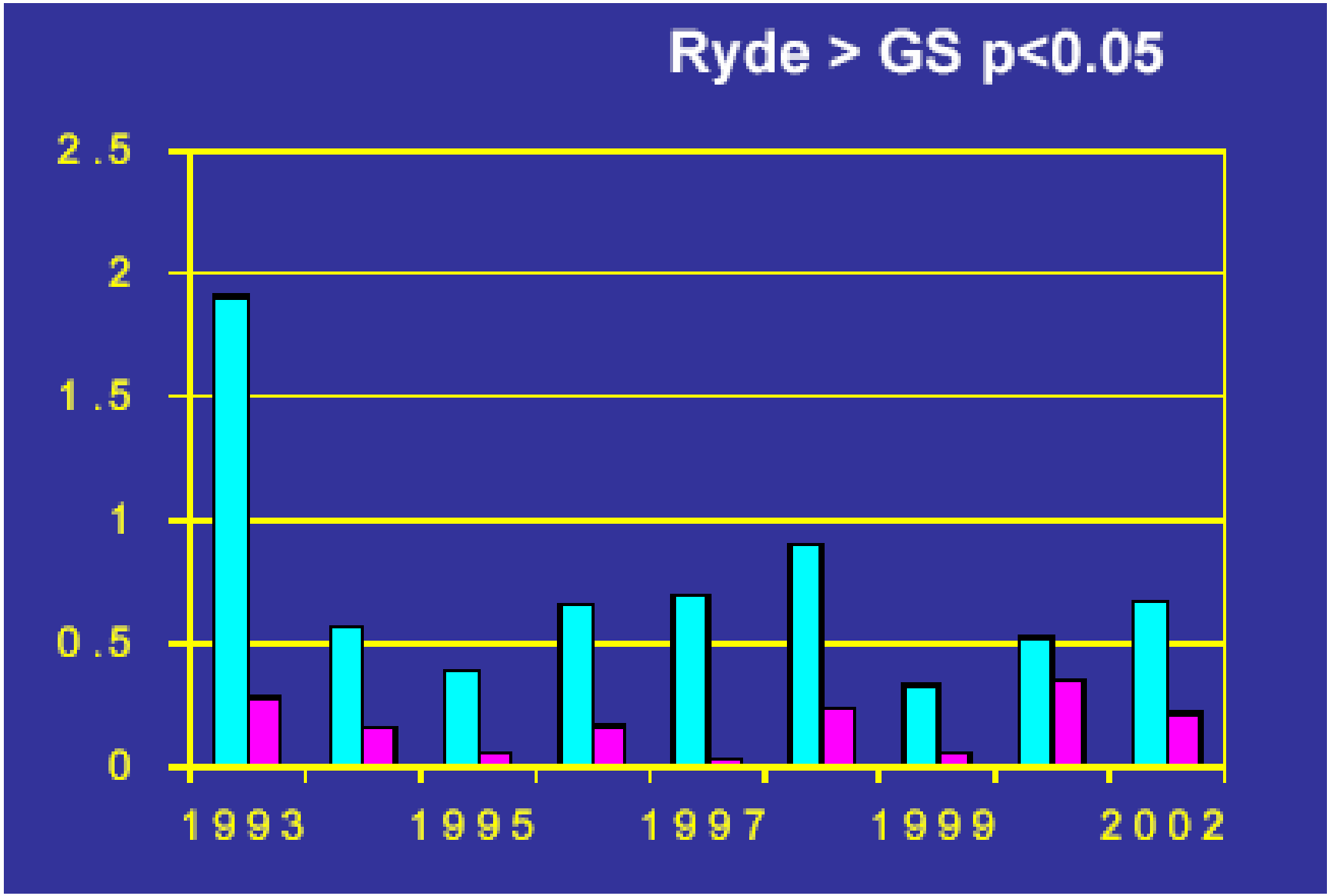
Prototype Quantitative Model

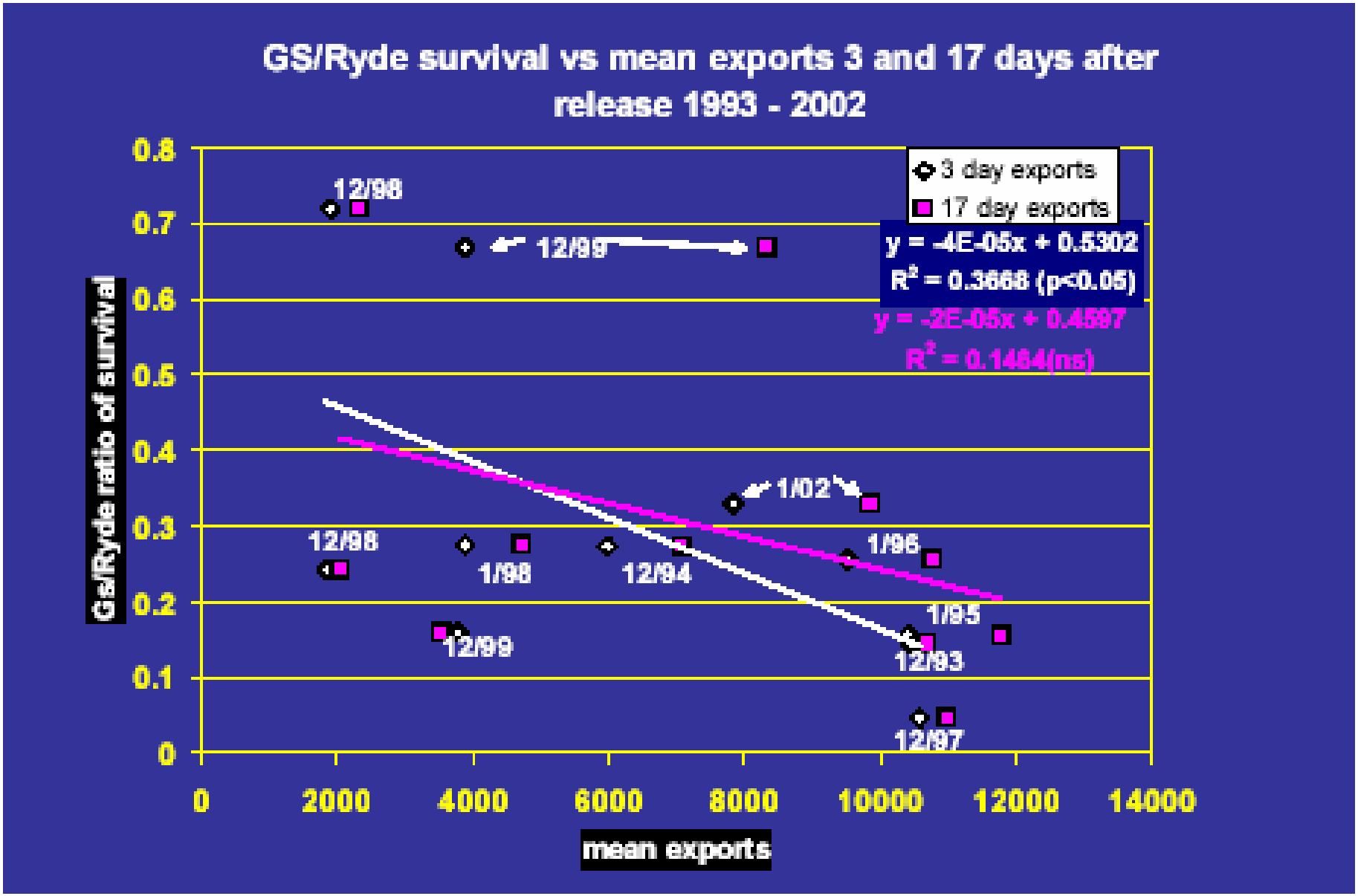
- Juvenile Production Predicted Following JPE
- Carrying Capacity adopted from SALMOD based on WUA for fry above Battle Ck
- Delta Survival Based on Newman (2000)
- Maturity Rates Based on Winter Run Ocean Harvest Model (WCOHM)

Winter-run Chinook JPE




Prespawn
Mortality
RUN
FEMALES
MALES
EGGS
Temp.
Egg Loss
FRY
PARR
SMOLTS
above RBDD
RBDD - GCID
GCID - KL
KL - SAC
SAC - Chipps
OCEAN
age 2


Ryde > GS p<0.05
2.5
2
1.5
1
0.5
0
1993
1995
1997
1999
2002


GS/Ryde survival vs mean exports 3 and 17 days after release 1993 - 2002
3 day exports
17 day exports
y = -4E-05x + 0.5302
R² = 0.3668 (p<0.05)
y = -2E-05x + 0.4597
R² = 0.1464(ns)
Gs/Ryde ratio of survival
mean exports
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
2000
4000
6000
8000
10000
12000
14000
12/98
12/99
1/02
12/98
1/98
12/94
1/96
1/95
12/99
12/93
12/97

Newman (2000)

Survival through Delta =

- **- 6.4917**
- **+ 1.4004 (log Sacramento R. Flow at Freeport)**
- **– 0.0960 (Release Temperature)**
- **– 1.9878 (Export/Inflow)**
- **– 0.6589 (DCC Gate Position)**

Microsoft Excel - CUWA IMF 101103.xls

File Edit View Insert Format Tools Data Window Help

Integrated Modeling Framework for Winter-Run Chinook Salmon

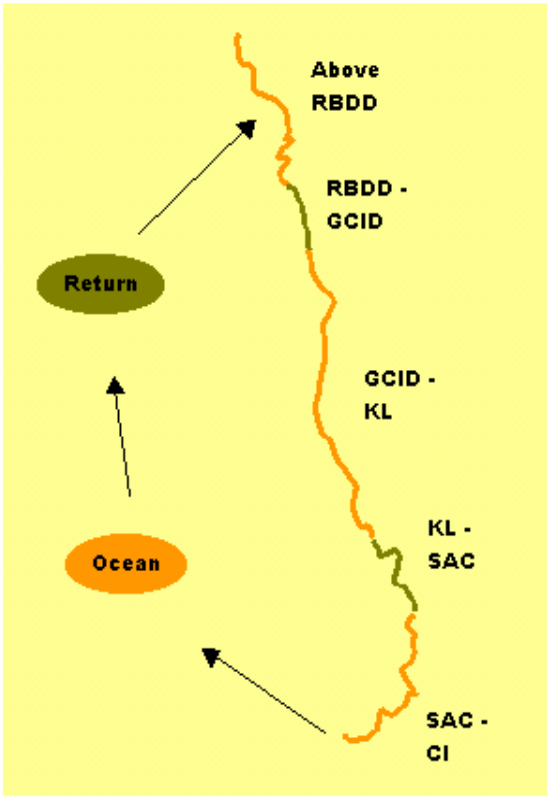
Prepared for: California Urban Water Agencies

Prepared by: S.P. Cramer and Associates and Larix Systems, Inc.

October 13, 2003

SIMULATION FRAMEWORK

Select a segment to view/edit parameter values



Refresh Graph

Graph parameter

Natural Smolt

Graph timeframe

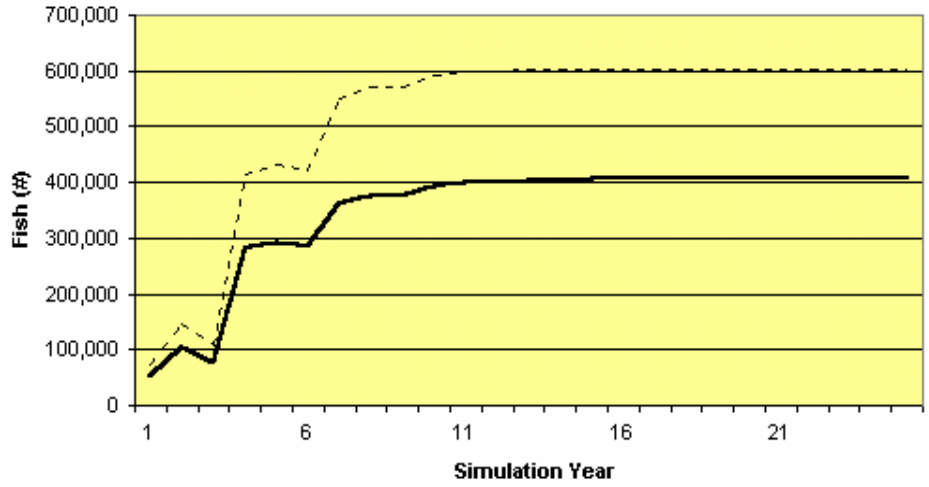
25 Years

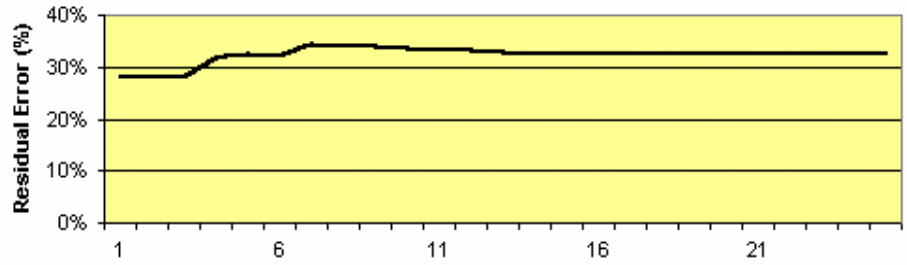
Make Benchmark

Clear Benchmark

SIMULATION RESULTS

Graphs depict simulation results (solid line) compared to benchmark results (dashed line) and percent residual error (benchmark - simulation) relative to benchmark results.





Home | Parameters | Worksheet | Benchmark

Draw AutoShapes

Select destination and press ENTER or choose Paste

Microsoft Excel - CUWA IMF.xls

File Edit View Insert Format Tools Data Window Help

B38 = 15000

Integrated Modeling Framework for Winter-Run Chinook Salmon

Prepared for: California Urban Water Agencies

Prepared by: S.P. Cramer and Associates and Larix Systems, Inc.

August 15, 2003

SIMULATION PARAMETERS

Juvenile Life Stage

Weighted Usable Area (Fry) (sqft/ft)	4.28
Fry Capacity (#/WUA)	7.99
Prespawning Adult Survival Rate	75.00%
Female Spawner Ratio	64.00%
No. Eggs per Female Spawner	4,700
Egg to Fry Survival Rate	30.00%
Fry to Parr Survival Rate	60.00%
Parr to Smolt Survival Rate	80.00%
No. Hatchery Smolts Released	500,000
Post-Release Survival Rate	50.00%
Smolt to Age 2 Survival Rate	5.00%

Juvenile Pathways

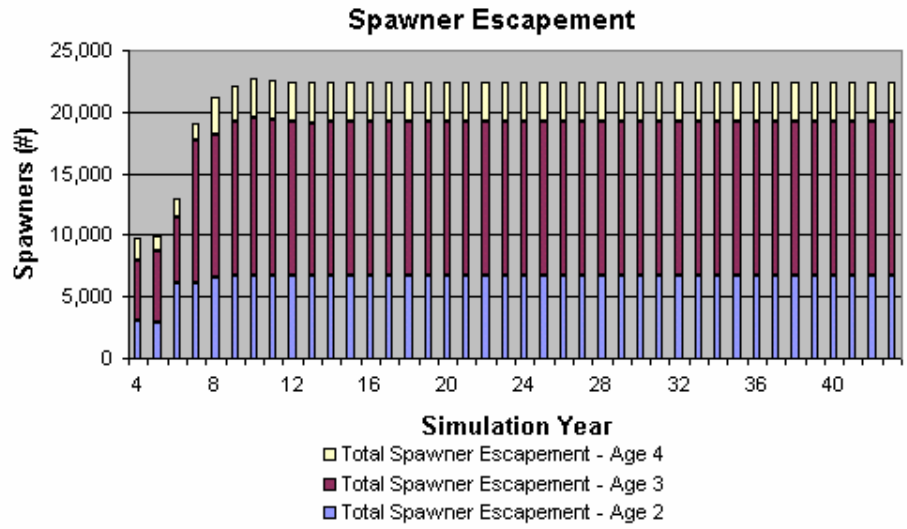
Percent Migration fr Upstream Reach	Fry	Parr	Smolt
to Red Bluff Diversion Dam - GCID	75.00%	80.00%	100.00%
to GCID - Knight's Landing	86.00%	86.00%	100.00%
to Knight's Landing - Sacramento		86.00%	100.00%
to Sacramento to Chipps Island		86.00%	100.00%
Overall Migration Survival Rate	55.00%	75.00%	85.00%

Delta Migration Survival Parameters	91.27%
Sacramento River Flow	15,000
Release Temperature	59.0
Export/Inflow Ratio	20.00%
Gate Position (1=Open; 0=Closed)	0

Adult Life Stage

Ocean Survival/Recruitment	Age 2	Age 3	Age 4
Ocean Harvest Rate	21.00%	16.00%	25.00%
Natural Maturity Rate	20.00%	70.00%	100.00%
Hatchery Maturity Rate	20.00%	70.00%	100.00%
Overwinter Survival Rate	80.00%	80.00%	

SIMULATION RESULTS

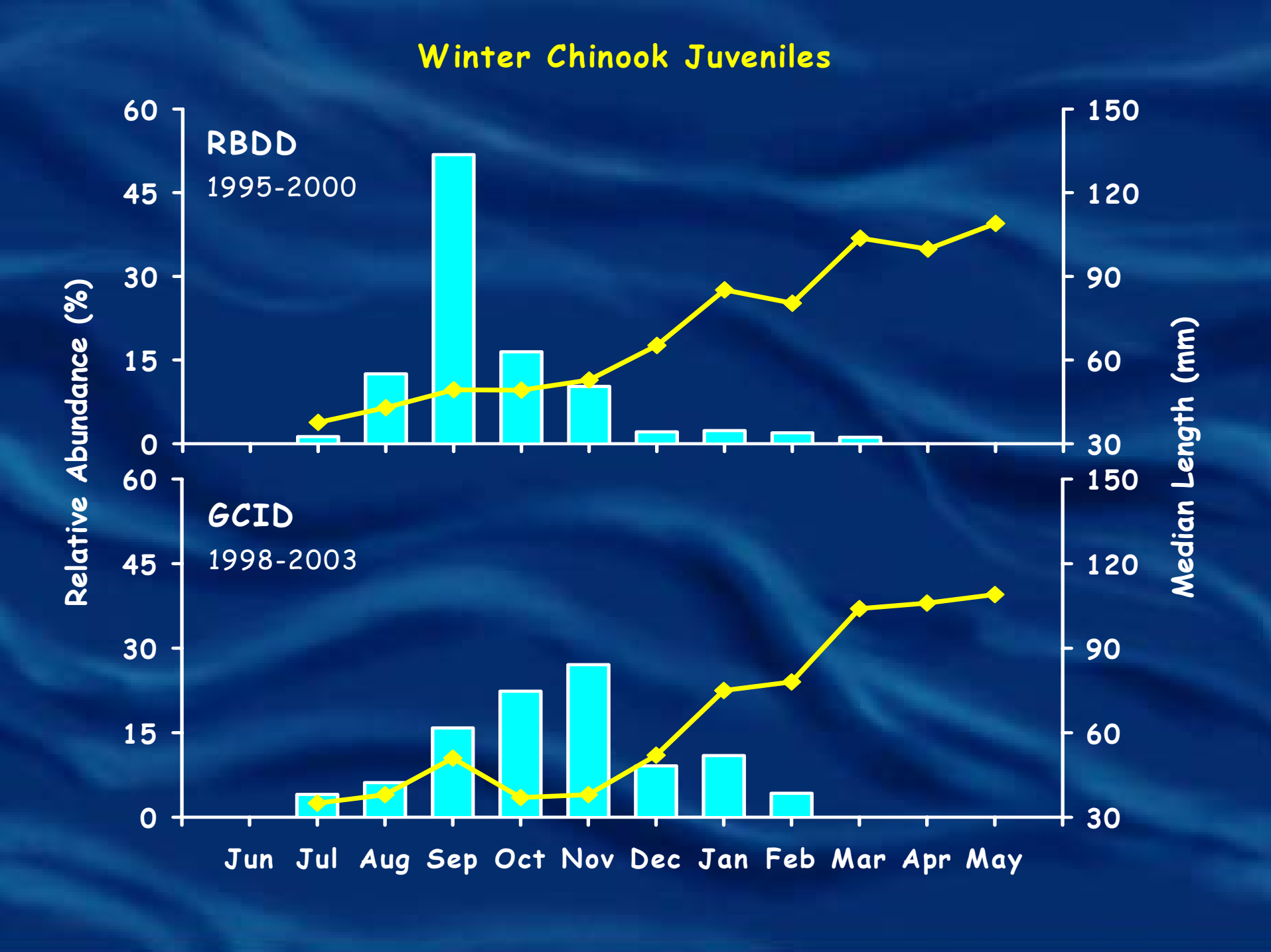


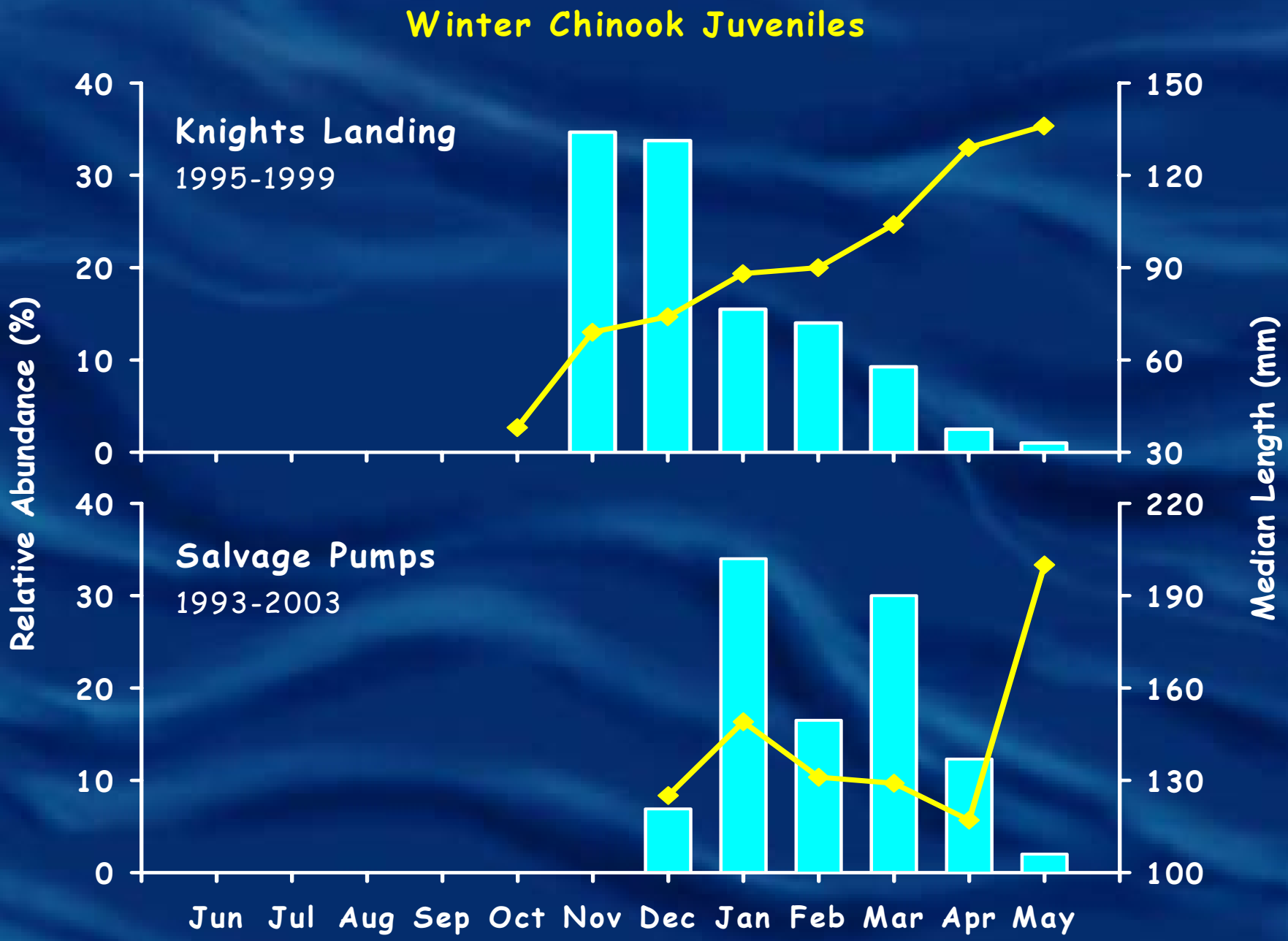
Year	Run (#)	Year	Run (#)	Year	Run (#)	Year	Run (#)
4	9,800	14	22,345	24	22,374	34	22,374
5	9,937	15	22,367	25	22,374	35	22,374
6	12,977	16	22,378	26	22,374	36	22,374
7	19,075	17	22,378	27	22,374	37	22,374
8	21,139	18	22,375	28	22,374	38	22,374
9	22,135	19	22,373	29	22,374	39	22,374
10	22,638	20	22,373	30	22,374	40	22,374
11	22,561	21	22,374	31	22,374	41	22,374
12	22,413	22	22,374	32	22,374	42	22,374
13	22,342	23	22,374	33	22,374	43	22,374

Home Page | Worksheet

Draw AutoShapes

Ready


Winter Chinook Juveniles
RBDD
1995-2000
GCID
1998-2003
Relative Abundance (%)
Median Length (mm)
60
45
30
15
0
150
120
90
60
30
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May


Winter Chinook Juveniles
Knights Landing
1995-1999
Salvage Pumps
1993-2003
Relative Abundance (%)
Median Length (mm)
0
10
20
30
40
30
60
90
120
150
100
130
160
190
220
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May