San Joaquin River Salmon Survival and the 2009 NMFS Biological Opinion

1/26/10

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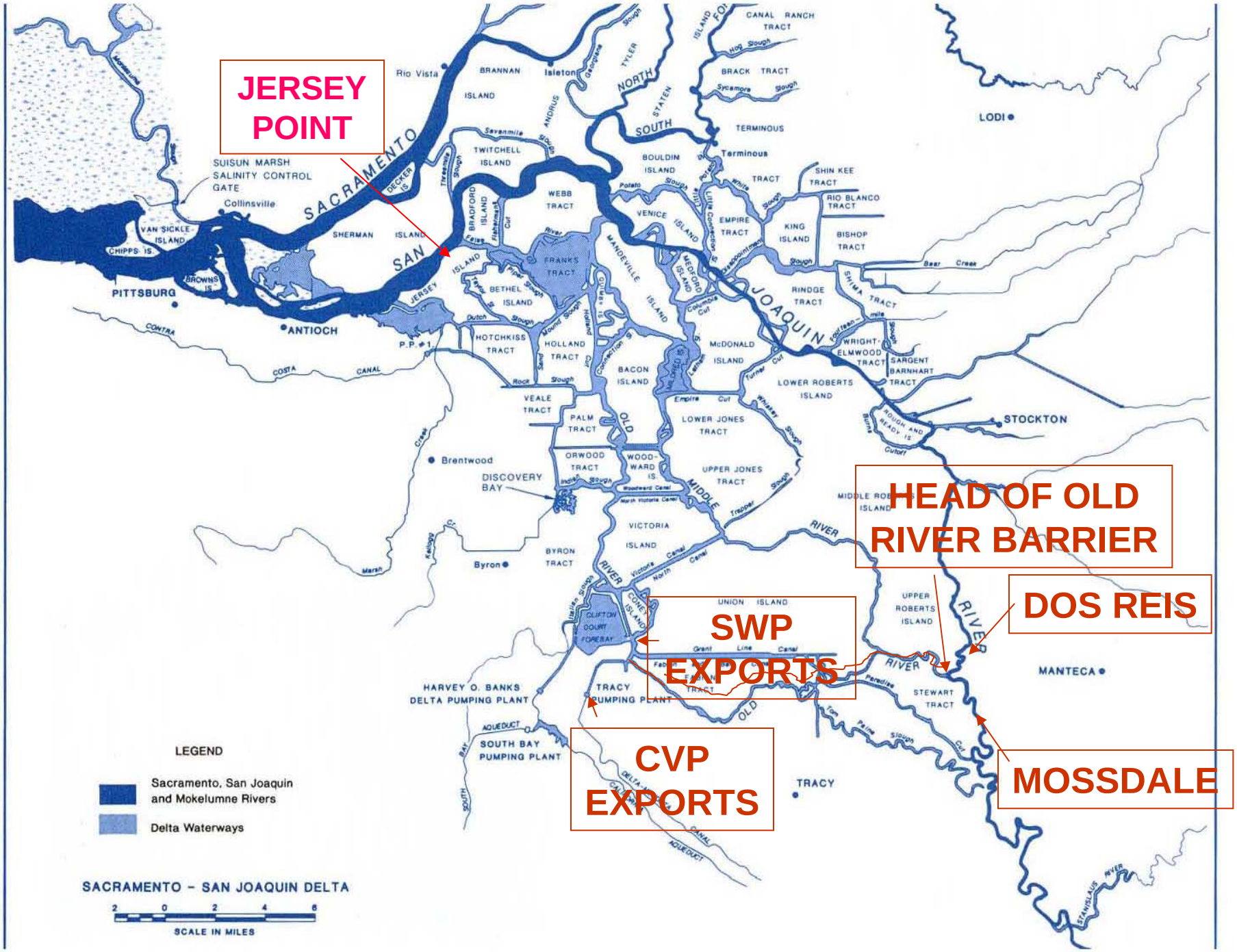
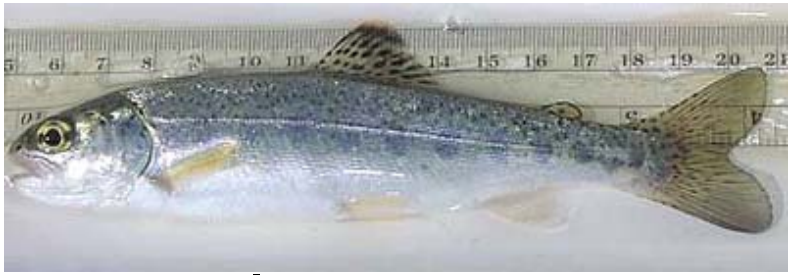
Deputy Director
California Department of Water Resources

Overview

- Steelhead and salmon movements
- Description of the NMFS RPA and its rationale
- Water Supply impacts of the RPA
- Review of other studies on the effect of flow and exports on San Joaquin Salmon
- Non-physical Barrier to keep salmon in the main stem of the San Joaquin River


JERSEY POINT
HEAD OF OLD RIVER BARRIER
DOS REIS
SWP EXPORTS
CVP EXPORTS
MOSSDALE
SACRAMENTO
SAN JOAQUIN
Rio Vista
Isleton
Collinsville
SUISUN MARSH SALINITY CONTROL GATE
PITTSBURG
ANTIOCH
Brentwood
DISCOVERY BAY
Byron
TRACY
LODI
STOCKTON
MANTECA
HARVEY O. BANKS DELTA PUMPING PLANT
TRACY PUMPING PLANT
SOUTH BAY PUMPING PLANT
CLIFTON COURT FOREBAY
LEGEND
Sacramento, San Joaquin and Mokelumne Rivers
Delta Waterways
SACRAMENTO – SAN JOAQUIN DELTA
SCALE IN MILES



Juvenile Chinook
Average 85 mm

Juvenile Steelhead
Average 250 mm

Similar
out-migration
timing

Cumulative Chinook Catch in Mossdale Trawl, 1994 - 2008

Cumulative Steelhead Catch in Mossdale Trawl, 1994 - 2008

0
200
400
600
800
1000
1200
1400
1600
1800

0
1
2
3
4
5
6
7

JAN
FEB
MAR
APR
MAY
JUN
JUL

1994 - 2008

NMFS Justification for SJR Inflow to Export ratio

- Action IV.2.1 San Joaquin River Inflow to Export ratio (April and May)
  - Ranges from 1:1 to 4:1 depending on year types
- Based on the 2006 VAMP report review of the Salmon Escapement data (1953 – 2005)
- Review of Salmon Escapement and SJR Flows and I/E ratio 2 ½ years previous
  - SJR Flows on Escapement R2 = 0.40 40%
  - SJR Flows/Exports ratio (ln) on Escapement R2 = 0.56 56%
  - Ratio R-squared better
  - "As you increase flows and decrease exports relative to flows there should be corresponding increases in smolt survival and adult escapement 2 ½ years later" (2006 annual VAMP report)

Water Supply Impacts of SJR I/E

- SWP/CVP Average Water Supply Impacts
  - 135 TAF
  - Smaller in dry years
  - Larger in wetter years

Overview of Most Recent Information Exports vs. SJR Salmon Survival

- Newman USFWS (2008) from VAMP studies
- Department of Fish and Game (2005) –
- DWR Analysis 2009

VAMP Studies Review by USFWS

- Vernalis Adaptive Management Program (VAMP) – Evaluating actual SJR Salmon survival through the Delta
  - Designed to Separate the effects of inflow, exports and Head of Old River Barrier placement on SJR Salmon Survival
- Newman (2008) (USFWS Statistician)
  - Most recent peer reviewed analysis
  - Coded wire tag experiments 1985 – 2006 – up to 20 experiments
  - Major Conclusions
    - Positive effects of SJR Inflows on SJR Salmon Survival through the Delta
    - Head of Old River Barrier (HOR) beneficial effect on SJR Salmon Survival
    - **Exports** have a "**weak to negligible"** effect on SJR Salmon Survival

Dept. of Fish and Game Analysis

- March 2005 report to the SWRCB
- DFG development of SJR salmon population model
- Major findings
  - **Spring-time San Joaquin River Inflow is the primary factor influencing fall-run Chinook Salmon populations in the SJR**
  - **SJR Inflow/Export ratio does not influence salmon survival**
  - **Some positive relationships with exports**
  - **“Delta exports are not having the negative influence upon salmon production they once were thought to have”**

DWR review of the Salmon Escapement data

- Reviewed salmon Escapement data from 1952 through 2008
- Found similar results to salmon Escapement as the VAMP report
  - San Joaquin Inflow - R2 - 0.31 31% (s)
  - SJR I/E ratio (ln) - R2 - 0.43 43% (s)
  - Exports - R2 - 0.18 18% (s)
- However export data has time trend
  - flow does not
  - results are driven by early 1950's extremely low exports as the CVP came on line

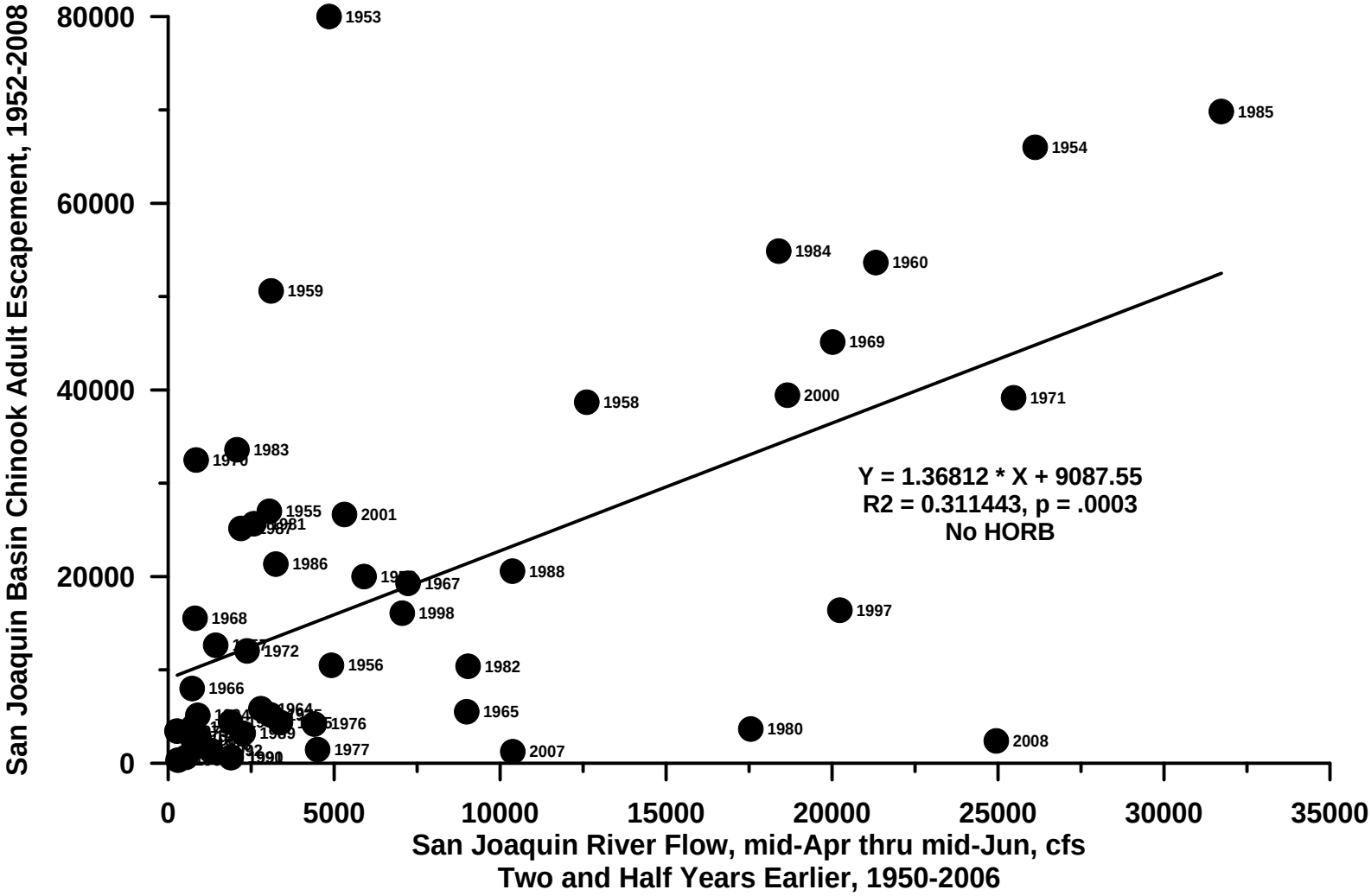


Figure 3. San Joaquin basin Chinook adult escapement from 1952 through 2008, and San Joaquin River flow, mid-April through mid-June, when they emigrated as juveniles through the Delta two and a half years earlier from 1950 through 2006. No Head of Old River Barrier years only.

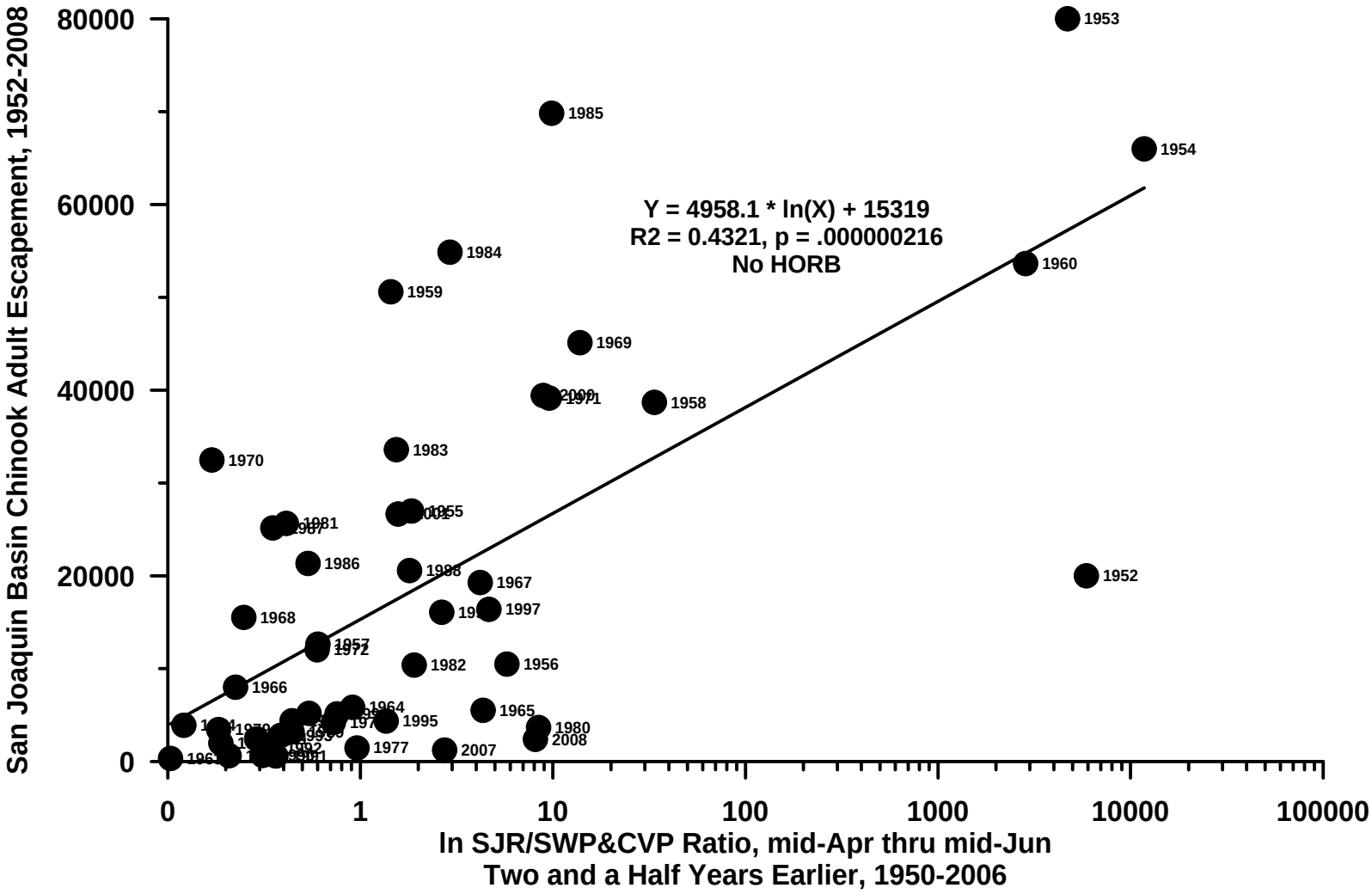


Figure 6. San Joaquin basin Chinook adult escapement from 1952 through 2008, and the natural log of the ratio of San Joaquin River flow to SWP and CVP south Delta exports from mid-April through mid-June when they emigrated through the Delta as juveniles two and half years earlier from 1950 through 2006. No Head of Old River Barrier years only.

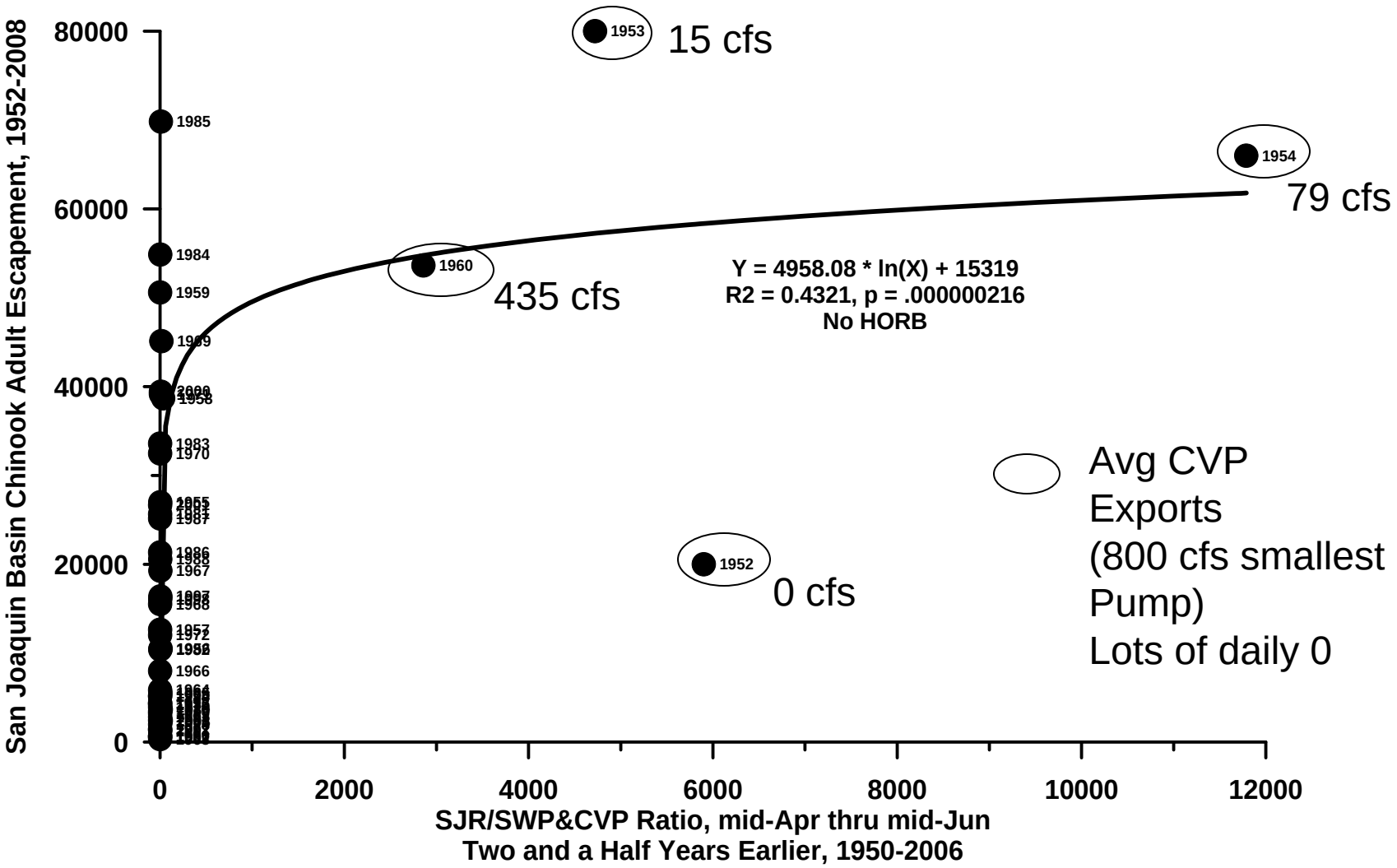


Figure 5. San Joaquin basin Chinook adult escapement from 1952 through 2008, and the ratio of San Joaquin River flow to SWP and CVP south Delta exports from mid-April through mid-June when they emigrated through the Delta as juveniles two and half years earlier from 1950 through 2006. No Head of Old River Barrier years only.

DWR review of the Salmon Escapement data (cont.)

- De-trended Data results
  - San Joaquin Inflow - R2 - 0.39 39% (s)
  - SJR I/E ratio (ln) - R2 - 0.39 39% (s)
  - Exports - R2 - 0.08 8% (s)
  - SJR + Exports - R2 - 0.39 Exports (NS)
- Difference between SJR Inflow and SJR Inflow/Export ratio r squared values does not exist
- Export effects “small to negligible” (same as found by Newman 2008)
- **Once SJR flows accounted for, Exports add no further value in explaining changes in SJR Salmon escapement**

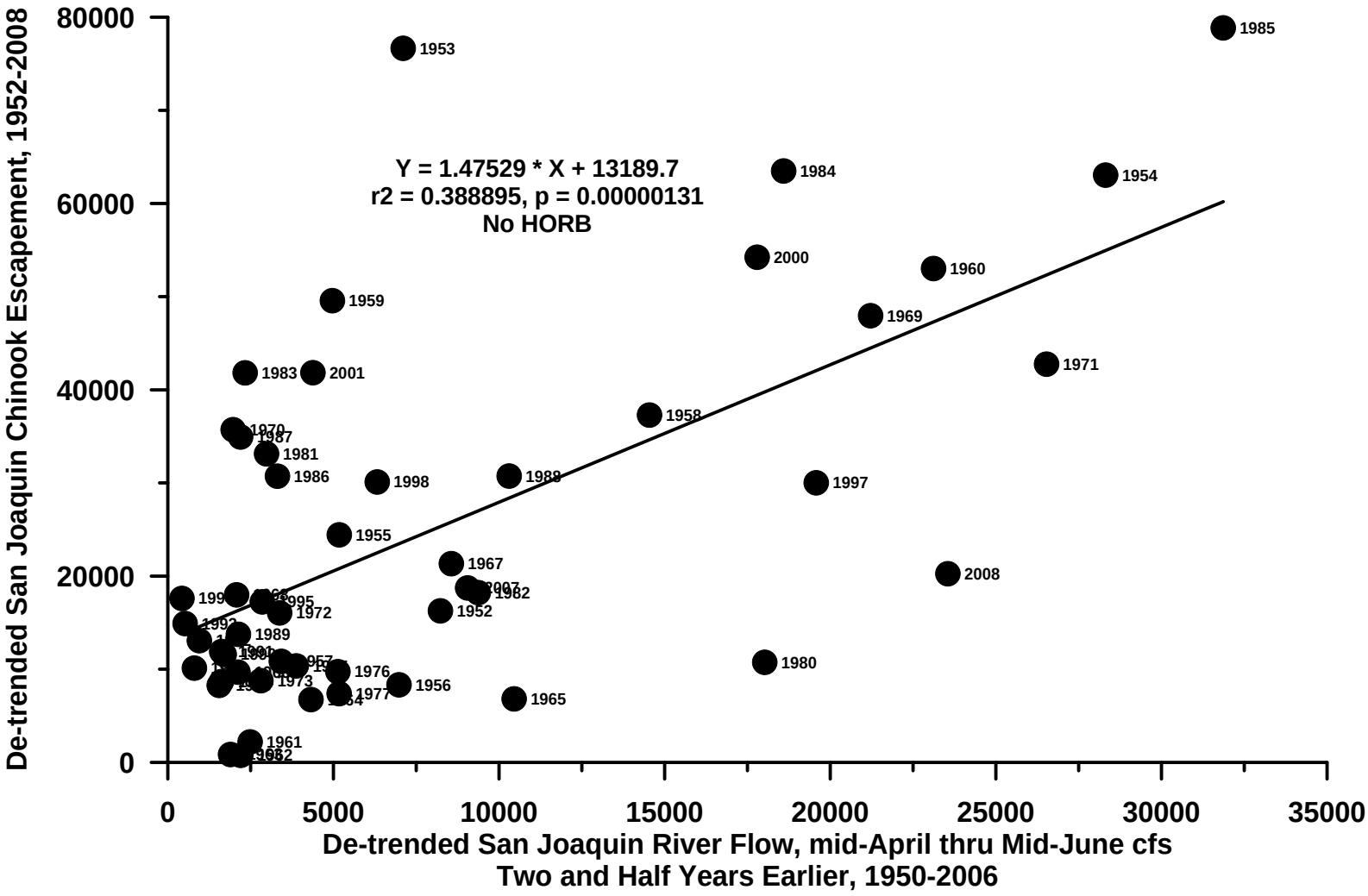


Figure 7. De-trended San Joaquin basin Chinook adult escapement from 1952 through 2008, and de-trended San Joaquin River flow from mid-April through mid-June when the juveniles emigrated through the Delta two and half years earlier, 1950 through 2006.

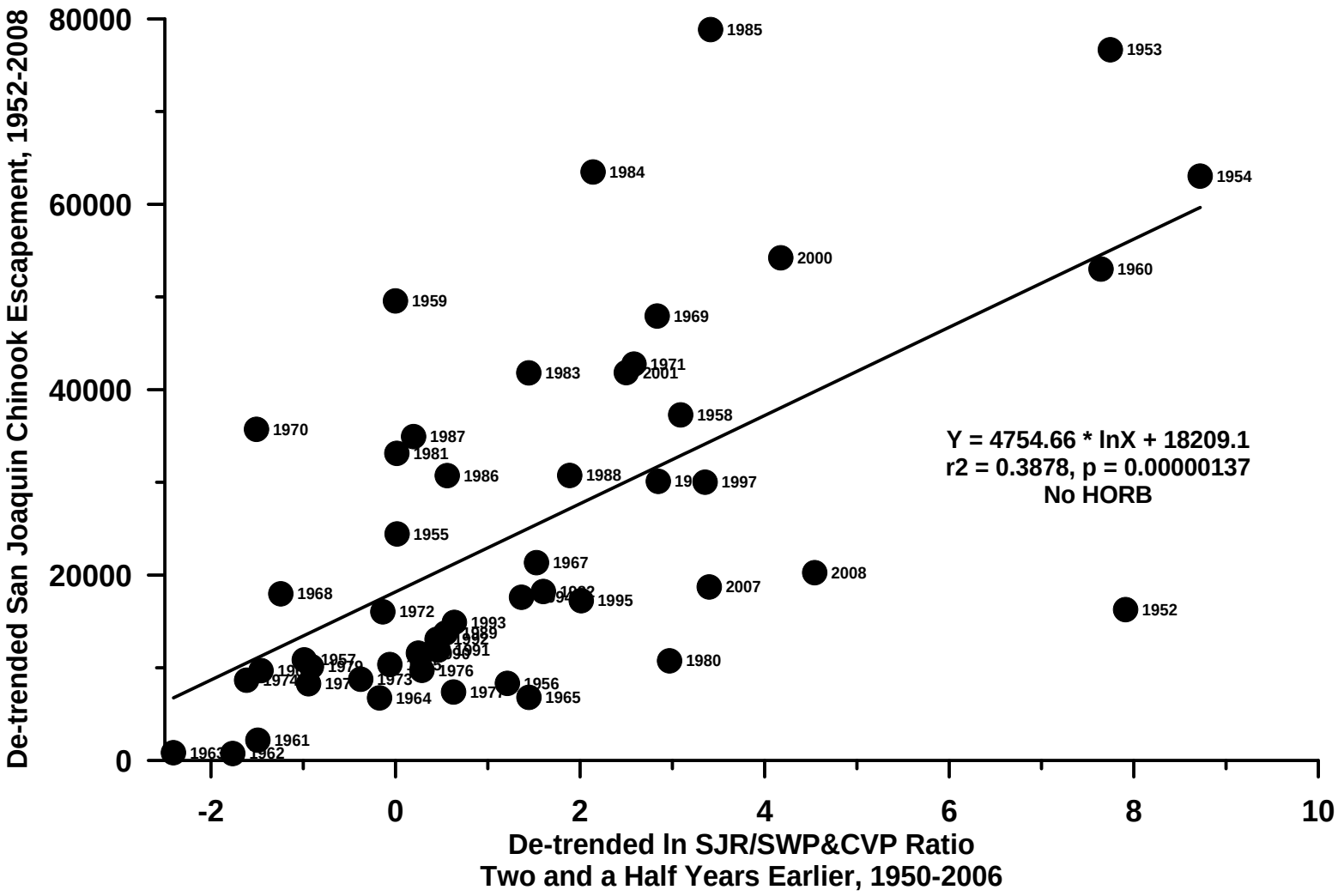
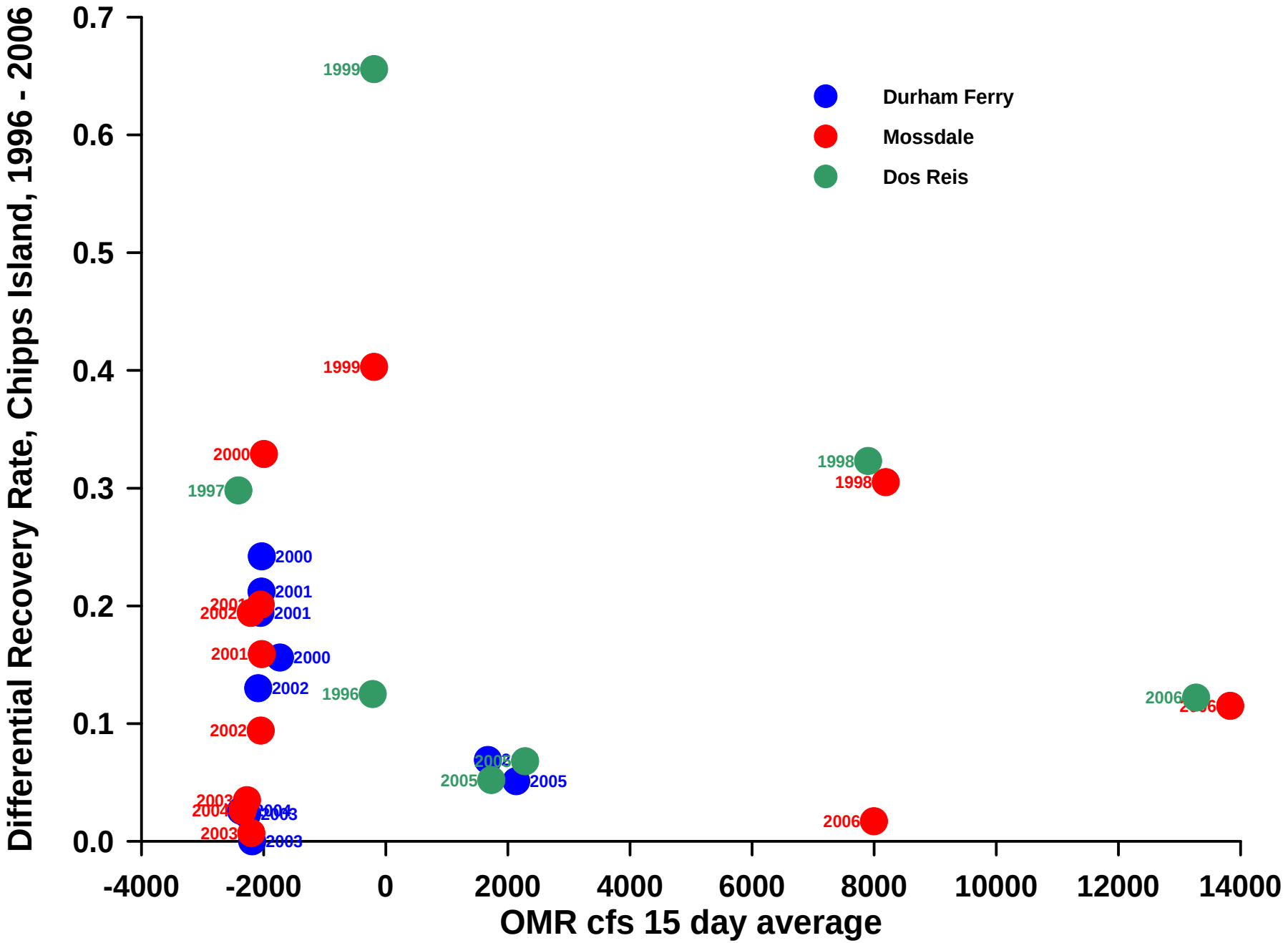
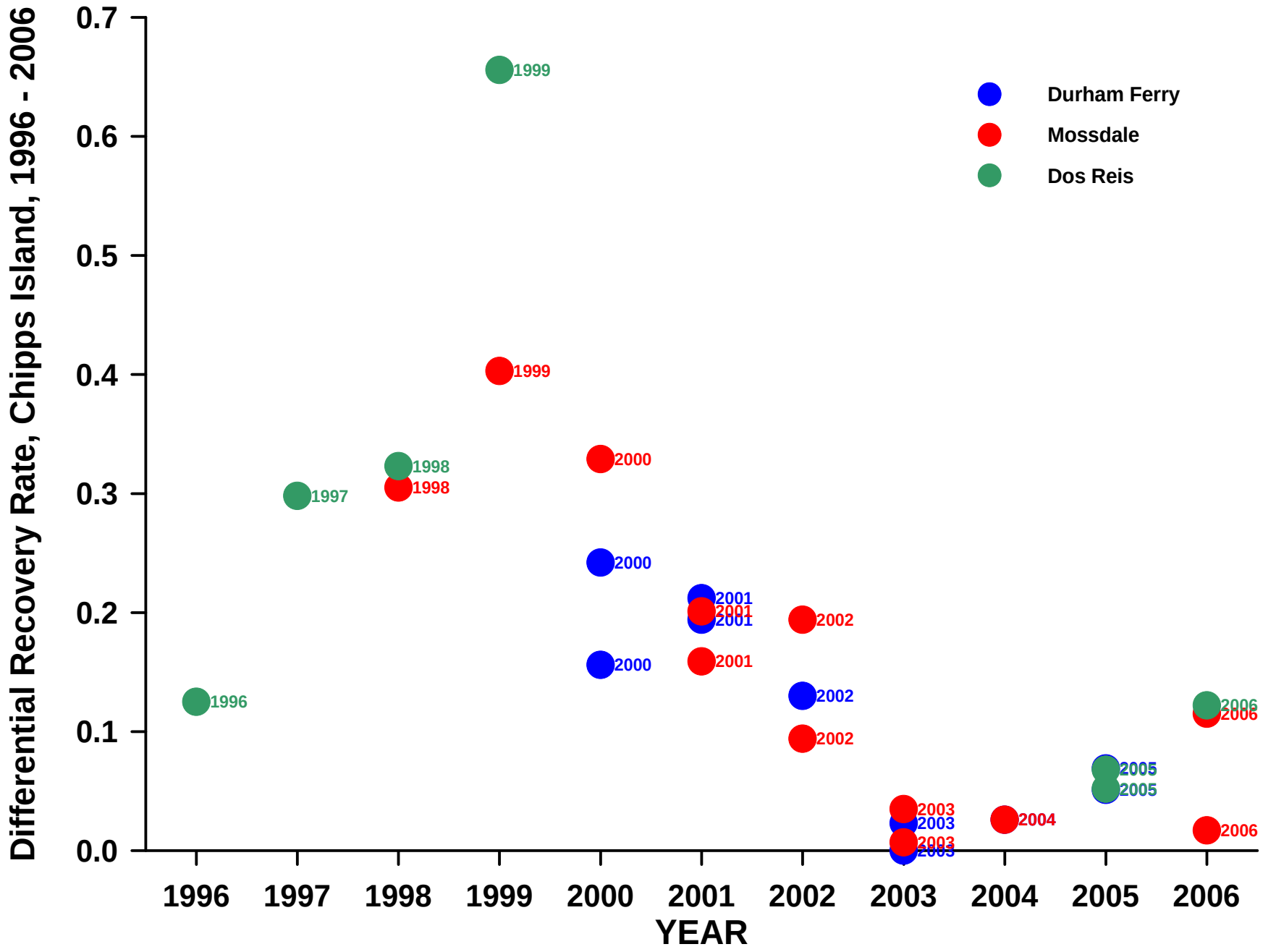


Figure 9. De-trended San Joaquin basin Chinook adult escapement from 1952 through 2008, and de-trended ln San Joaquin River flow from mid-April through mid-June when the juveniles emigrated through the Delta, two and a half years earlier, 1950 through 2006.

Salmon Survival issues

- SJR Salmon Travel time through the Delta not related to export rates
  - Coded wire tag studies of actual VAMP experiments show no relationship between actual travel times and those predicted by Particle tracking studies.
  - Two to three weeks regardless of PTM
- SJR Salmon Survival through the Delta not affected by OMR flows (see next slide)
- Note time trend in SJR salmon survival from 1999


Differential Recovery Rate, Chipps Island, 1996 - 2006
OMR cfs 15 day average
Durham Ferry
Mossdale
Dos Reis
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
-4000
-2000
0
2000
4000
6000
8000
10000
12000
14000
1999
1999
2000
1997
2000
2001
2001
2002
2001
2000
2002
1996
2002
2003
2005
2005
2006
1998
1998
2006

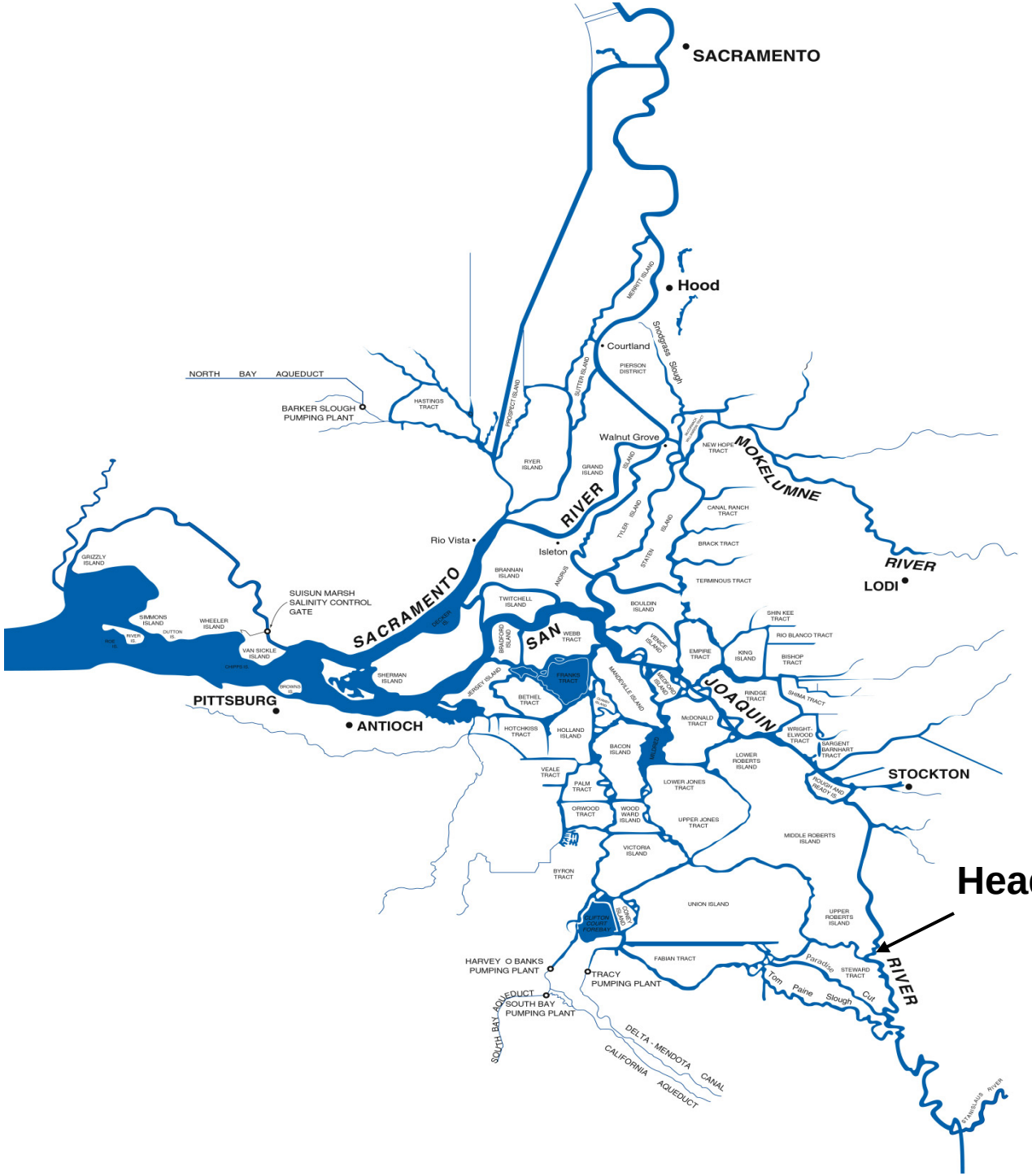

Differential Recovery Rate, Chipps Island, 1996 - 2006
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
YEAR
Durham Ferry
Mossdale
Dos Reis
1999
1999
1998
1998
1997
2000
2000
2001
2001
2001
2000
2001
2002
2002
2002
1996
2006
2006
2005
2005
2003
2003
2003
2003
2004
2006

Conclusions

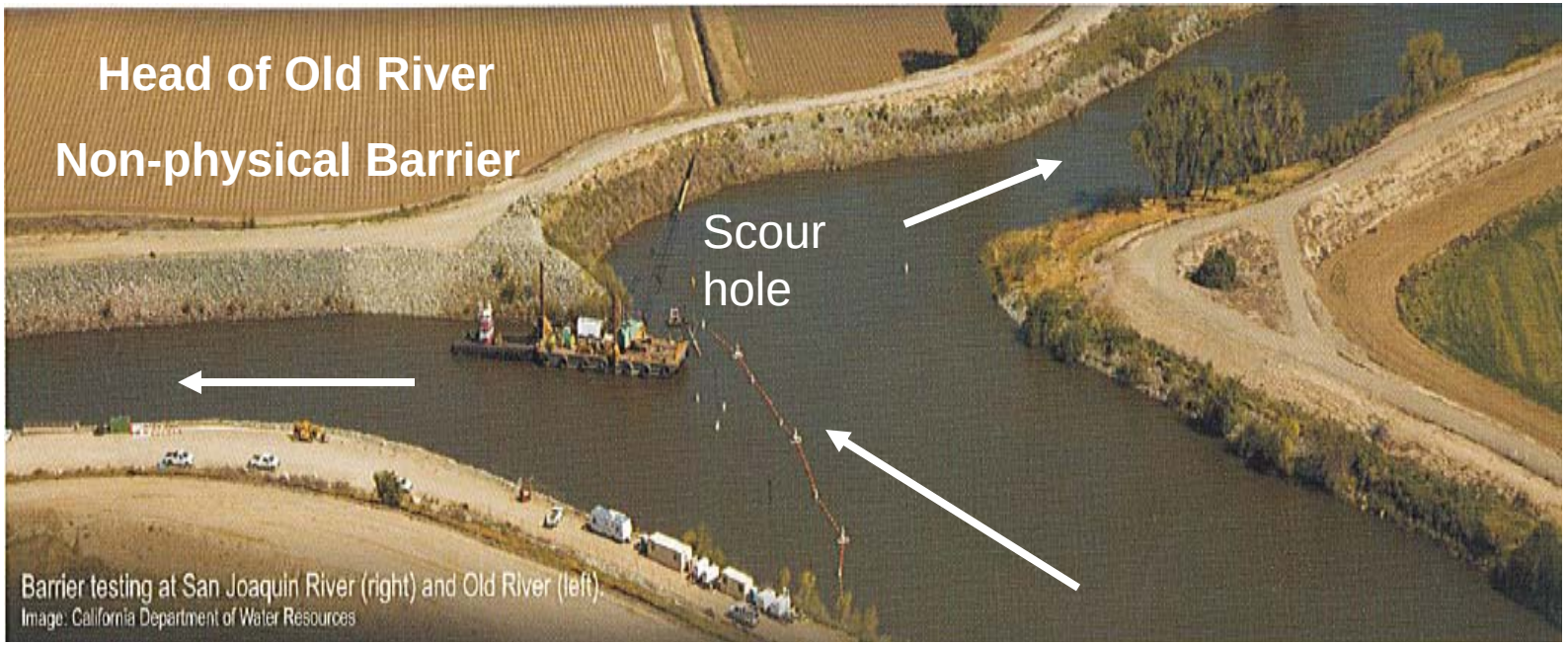
- Export constraints will not effectively improve salmon survival
- Three separate reviews do not support SJR I/E
- Need to use Better Action
  - Keep D1641 export constraints
  - Non-Physical Barrier at HOR

Non-Physical Barriers Instead of Export Constraints

- Exports constraints will not benefit San Joaquin salmon survival
- VAMP studies show that keeping salmon in the main-stem of the San Joaquin River does provide benefits to salmon Survival
- Historic Physical Barrier at the Head of Old River (HOR)
  - Spring barrier - Salmon- 1992 to 2007 (most years)
  - Fall Barrier - DO improvement - 1968 to today as needed for DO improvement near Stockton


SACRAMENTO
Hood
Courtland
Walnut Grove
Rio Vista
Isleton
LODI
STOCKTON
ANTIOCH
PITTSBURG
MOKELUMNE
RIVER
SACRAMENTO
RIVER
SAN
JOAQUIN
RIVER
NORTH BAY AQUEDUCT
BARKER SLOUGH PUMPING PLANT
SUISUN MARSH SALINITY CONTROL GATE
HARVEY O BANKS PUMPING PLANT
TRACY PUMPING PLANT
SOUTH BAY AQUEDUCT
SOUTH BAY PUMPING PLANT
DELTA - MENDOTA CANAL
CALIFORNIA AQUEDUCT
Head of Old River


Head of Old River
Physical Barrier

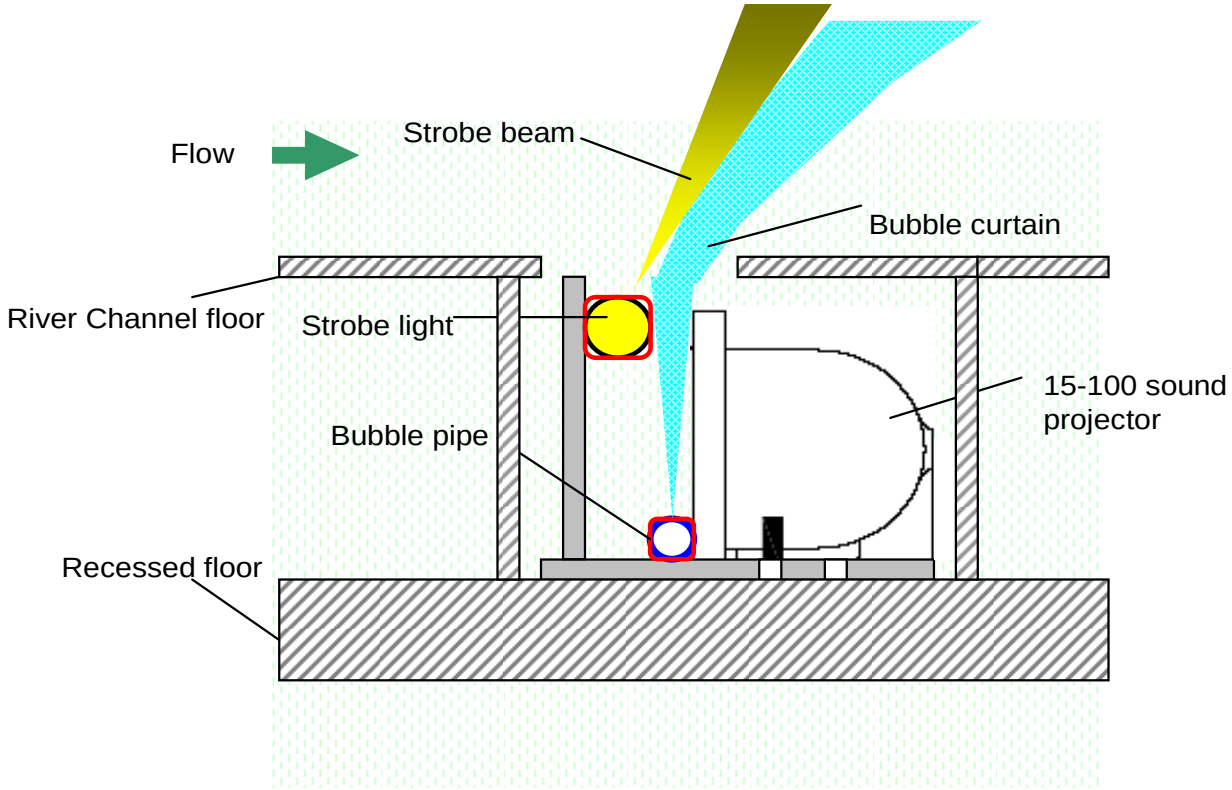

Head of Old River
Non-physical Barrier
Scour hole
Barrier testing at San Joaquin River (right) and Old River (left).
Image: California Department of Water Resources

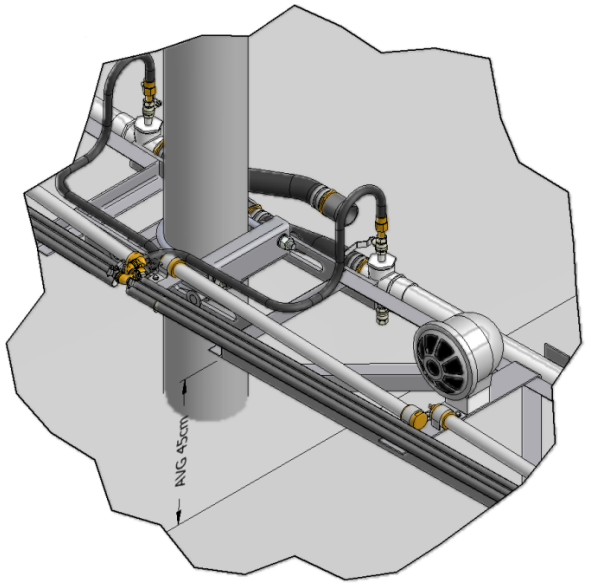
Use of HOR Physical Barrier no longer possible

- Judge Wanger Decision on Dec 2007
  - Disallowed the Physical Spring Salmon Barrier due to hydrologic concerns related to Delta Smelt
  - About half the SRJ flows split at HOR and head down Old River
  - With no other changes, the HOR physical barrier results in higher reverse flows in Old and Middle River
- USFWS 2008 BiOp
  - Makes installation of the HOR Physical Barrier all but impossible

Non-Physical Barrier

Three factors - Lights - Sound - Air Bubble Curtain





Why does the NPB Work

- Air Bubble Curtain contains the sounds
- Strobe lights allow the fish to identify the source of the sounds
- Fish sense the risk of passing through the barrier to an uncertain future was greater than the risk of swimming away

Laboratory and Field Tests

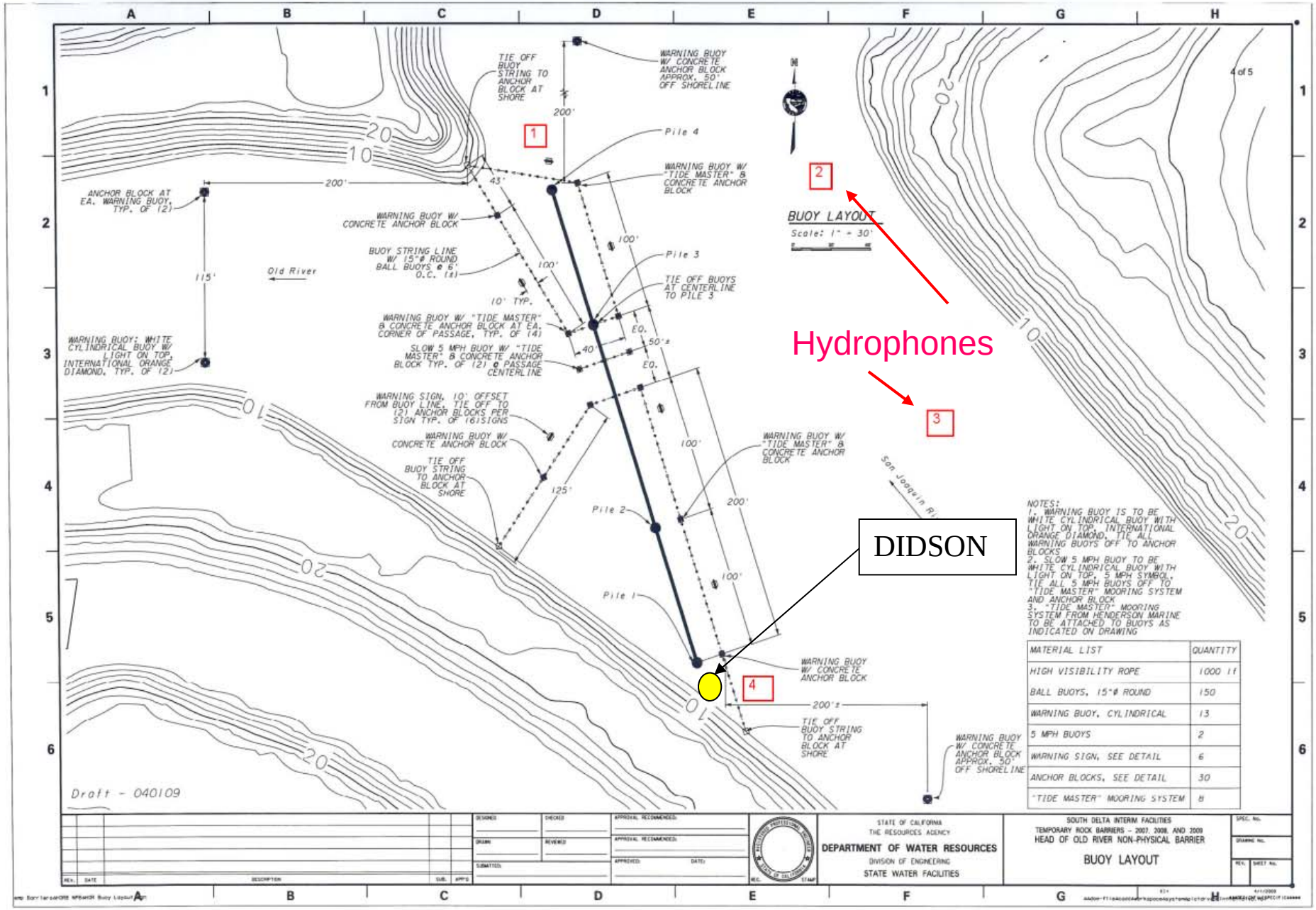
- USBR Denver Lab evaluations looking at the Georgiana Slough area on The Sacramento River
  - Mixed results but promising
- HOR NPB Field installation in 2009
  - Concept in early January 2009
  - Installation by early April 2009
  - Light speed in today's permitting environment
  - Largest installation of this technology

Installation Process

Operation

Evaluation of effectiveness

- Acoustic tagged salmon released at Durham Ferry 10 miles upstream
  - Part of the VAMP experiments
  - 4 hydrophones at the NPB
- A Dual-frequency Identification Sonar (DIDSON) camera - immediately upstream of the barrier
  - To observe the behavior of fishes in the vicinity of the barrier


TIE OFF BUOY STRING TO ANCHOR BLOCK AT SHORE
WARNING BUOY W/ CONCRETE ANCHOR BLOCK APPROX. 50' OFF SHORELINE
200'
Pile 4
WARNING BUOY W/ "TIDE MASTER" & CONCRETE ANCHOR BLOCK
ANCHOR BLOCK AT EA. WARNING BUOY, TYP. OF (2)
WARNING BUOY W/ CONCRETE ANCHOR BLOCK
BUOY STRING LINE W/ 15"ø ROUND BALL BUOYS @ 6' O.C. (4)
Old River
115'
100'
Pile 3
TIE OFF BUOYS AT CENTERLINE TO PILE 3
10' TYP.
WARNING BUOY W/ "TIDE MASTER" & CONCRETE ANCHOR BLOCK AT EA. CORNER OF PASSAGE, TYP. OF (4)
SLOW 5 MPH BUOY W/ "TIDE MASTER" & CONCRETE ANCHOR BLOCK TYP. OF (2) @ PASSAGE CENTERLINE
40'
EQ.
50'±
WARNING BUOY: WHITE CYLINDRICAL BUOY W/ LIGHT ON TOP, INTERNATIONAL ORANGE DIAMOND, TYP. OF (2)
WARNING SIGN, 10' OFFSET FROM BUOY LINE, TIE OFF TO (2) ANCHOR BLOCKS PER SIGN TYP. OF (6)SIGNS
WARNING BUOY W/ CONCRETE ANCHOR BLOCK
TIE OFF BUOY STRING TO ANCHOR BLOCK AT SHORE
125'
Pile 2
WARNING BUOY W/ "TIDE MASTER" & CONCRETE ANCHOR BLOCK
200'
Pile 1
WARNING BUOY W/ CONCRETE ANCHOR BLOCK
200'±
TIE OFF BUOY STRING TO ANCHOR BLOCK AT SHORE
WARNING BUOY W/ CONCRETE ANCHOR BLOCK APPROX. 50' OFF SHORELINE
1
2
3
4
BUOY LAYOUT
Scale: 1" = 30'
Hydrophones
DIDSON
San Joaquin R.
4 of 5
NOTES:
1. WARNING BUOY IS TO BE WHITE CYLINDRICAL BUOY WITH LIGHT ON TOP, INTERNATIONAL ORANGE DIAMOND, TIE ALL WARNING BUOYS OFF TO ANCHOR BLOCKS
2. SLOW 5 MPH BUOY TO BE WHITE CYLINDRICAL BUOY WITH LIGHT ON TOP, 5 MPH SYMBOL, TIE ALL 5 MPH BUOYS OFF TO "TIDE MASTER" MOORING SYSTEM AND ANCHOR BLOCK
3. "TIDE MASTER" MOORING SYSTEM FROM HENDERSON MARINE TO BE ATTACHED TO BUOYS AS INDICATED ON DRAWING
MATERIAL LIST | QUANTITY
HIGH VISIBILITY ROPE | 1000 lf
BALL BUOYS, 15"ø ROUND | 150
WARNING BUOY, CYLINDRICAL | 13
5 MPH BUOYS | 2
WARNING SIGN, SEE DETAIL | 6
ANCHOR BLOCKS, SEE DETAIL | 30
"TIDE MASTER" MOORING SYSTEM | 8
Draft - 040109
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF ENGINEERING
STATE WATER FACILITIES
SOUTH DELTA INTERIM FACILITIES
TEMPORARY ROCK BARRIERS - 2007, 2008, AND 2009
HEAD OF OLD RIVER NON-PHYSICAL BARRIER
BUOY LAYOUT

- Insert animations here.

Results

- Extremely high degree of predation upstream and in the area of the NPB
  - Predation scour hole in the HOR area

Release	Number Released	Proportion Never Arrived at NPB	Proportion Consumed in NPB area	Total Dead Combined Proportion (before and in NPB area)
1	136	0.478	0.118	0.596
2	136	0.279	0.346	0.625
3	135	0.252	0.400	0.652
4	136	0.485	0.279	0.765
5	136	0.360	0.353	0.713
6	133	0.616	0.135	0.752
7	135	0.385	0.296	0.681

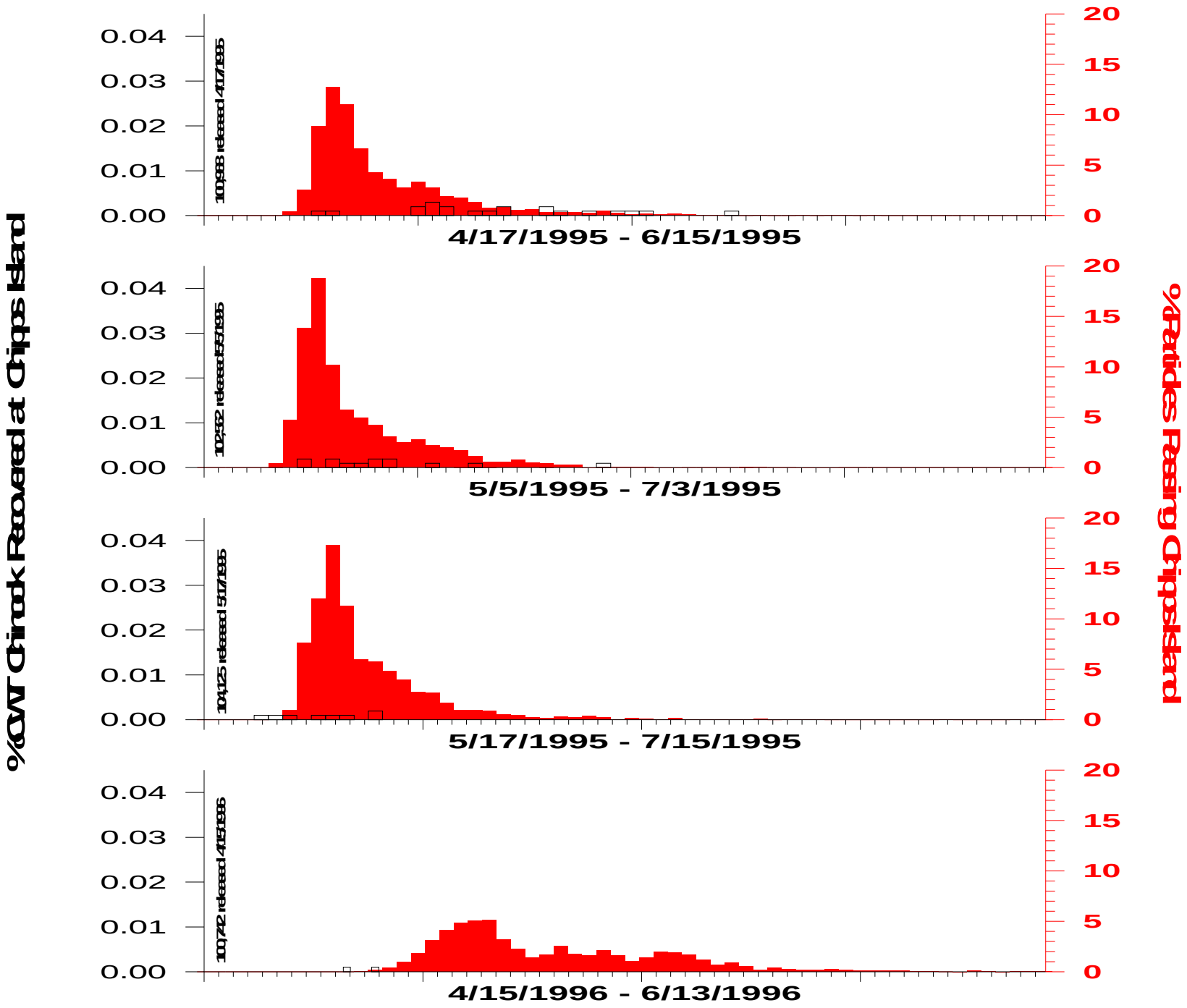
Results

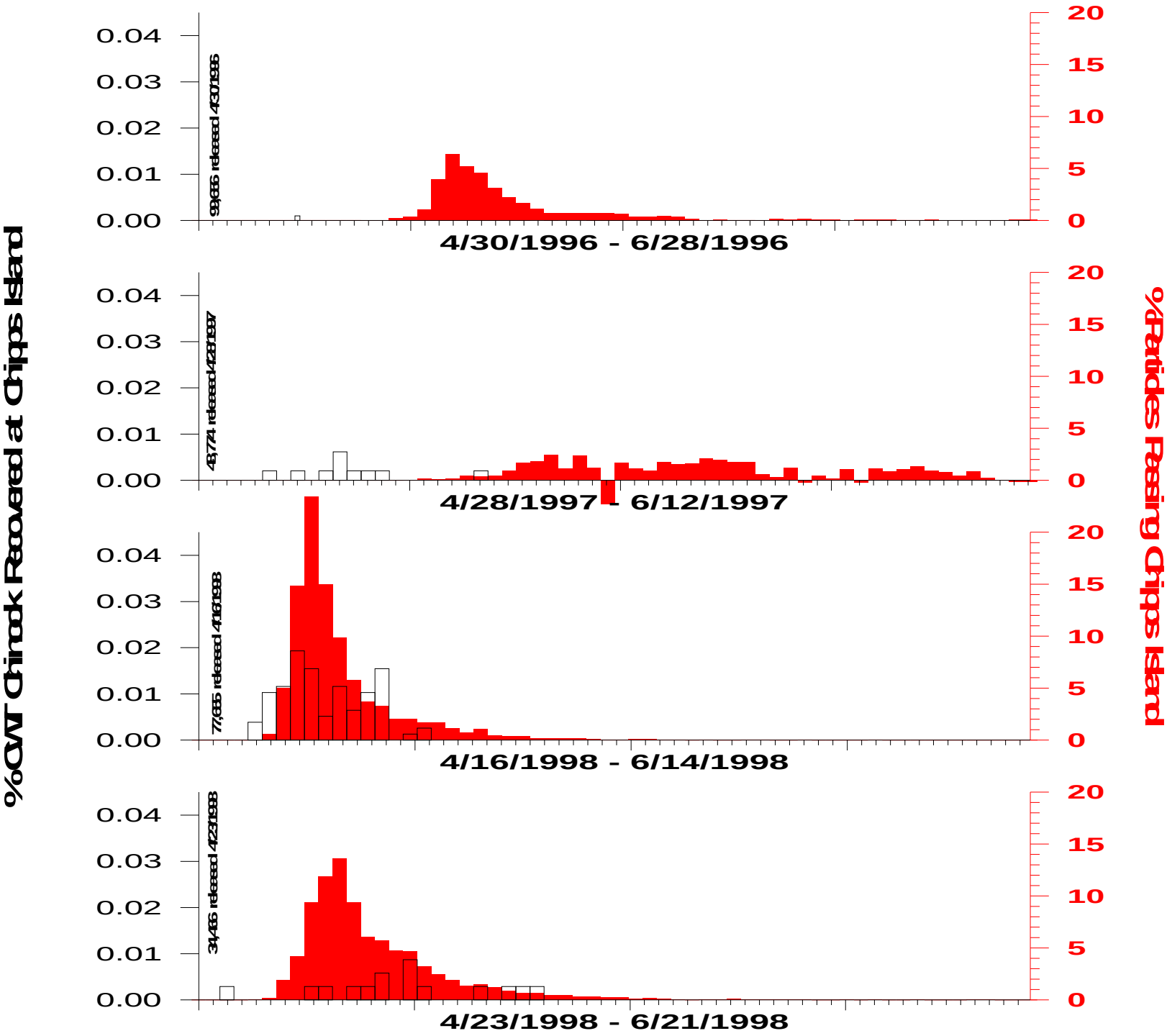
- Non-Physical Barrier operation
  - **Deterrence rate of fish reaching the NPB was 81.4%**
  - However, many of the Smolts that stayed in the SJR were eaten before they left the area
- Smolts continuing downstream in the SJR
  - With NPB Off - 24.5% of smolts released
  - With NPB On - 30.8% of smolts released
    - 26% increase in salmon into the SJR
    - Need larger sample size to test statistical sig.
- While the NPB is effective – predation needs to be addressed in future installations

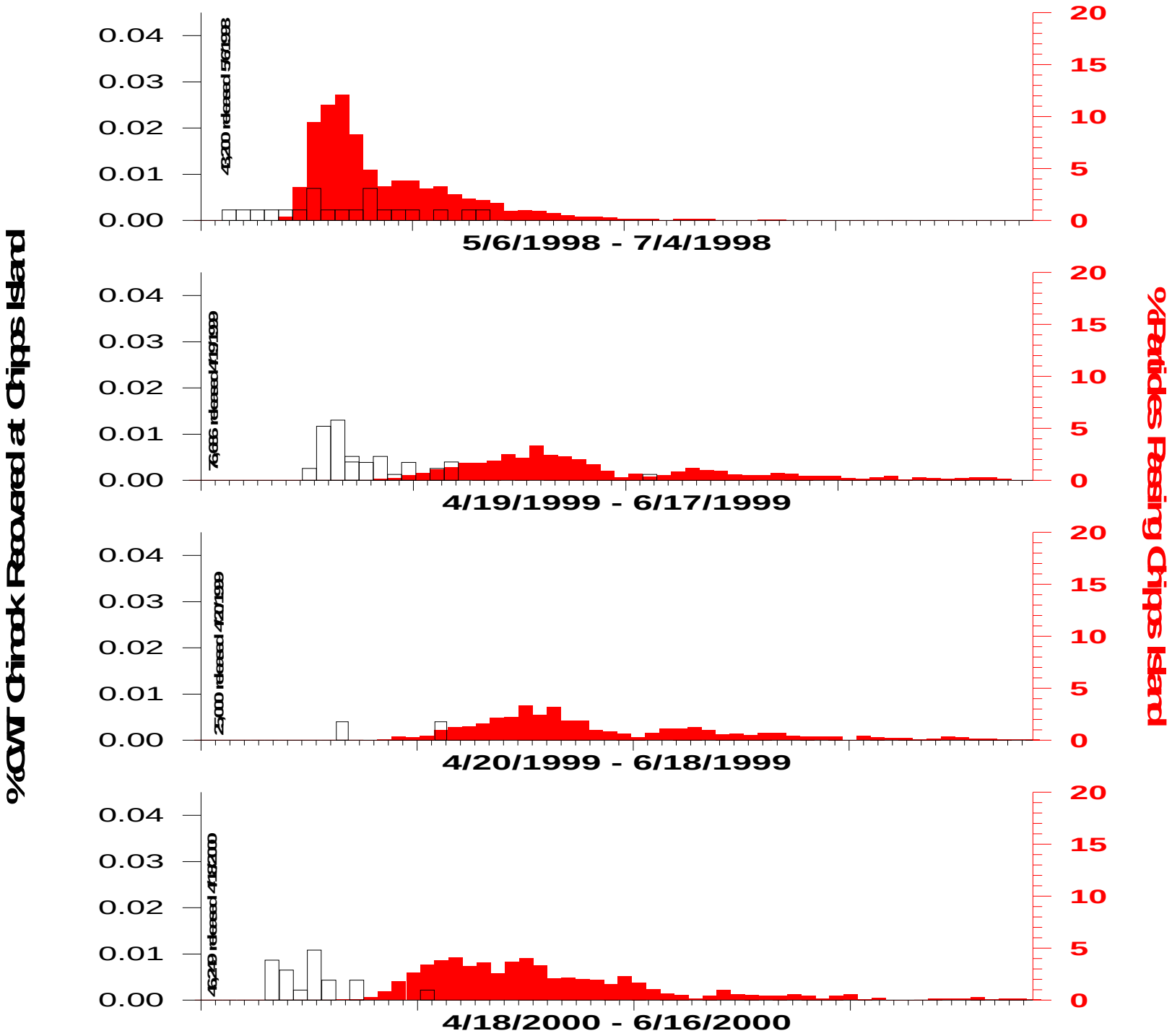
2010 NPB Planning

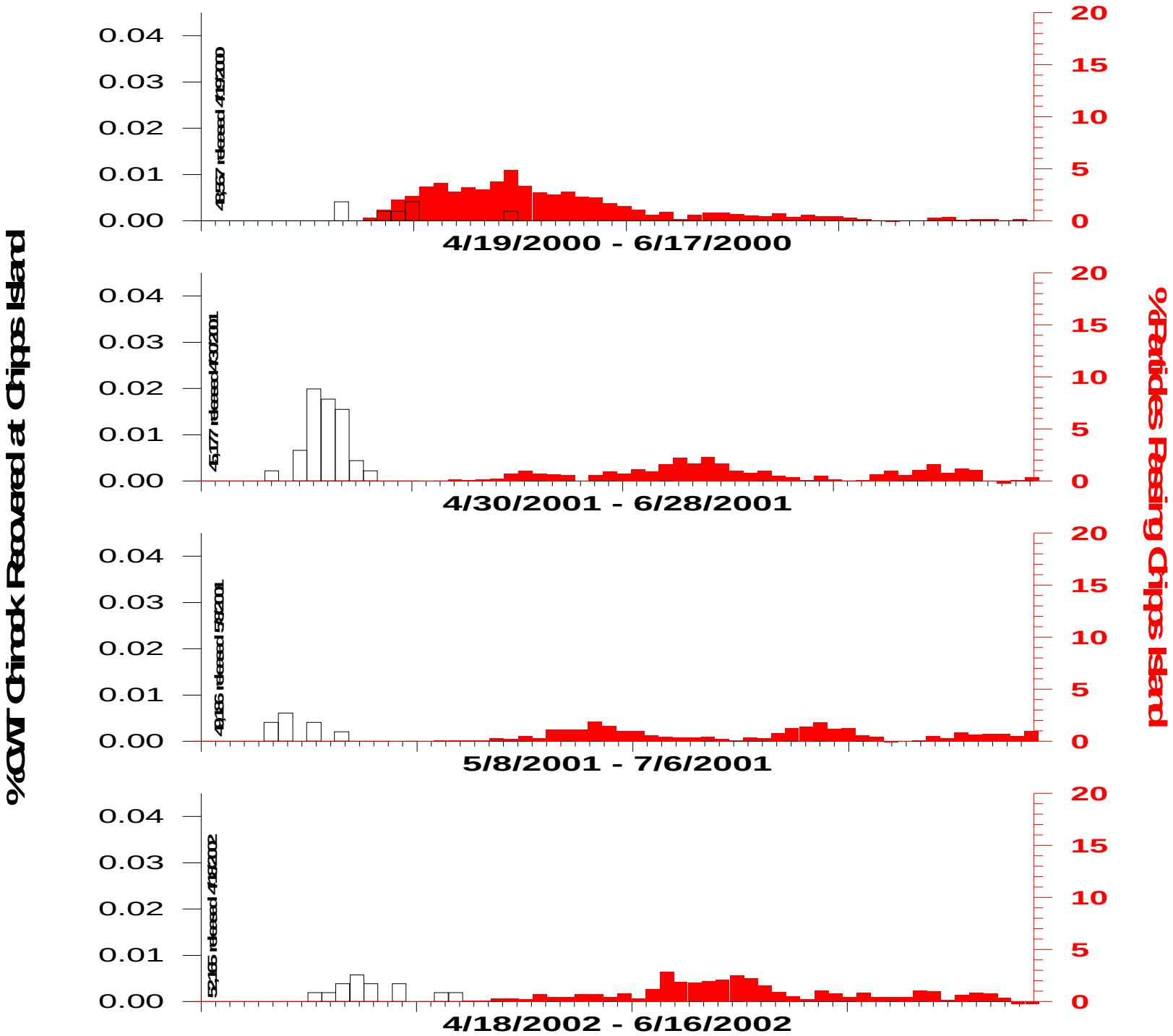
- Install NPB In 2010
- Keep Exports at previous VAMP Levels
- Add “Kicker” frame extension to help fish avoid the predation scour hole
- Evaluate use of concrete piers instead on steel piles
- Improvements to wiring harness design
- Add number of tagged fish
- More hydrophones
- Develop short-term predation control method

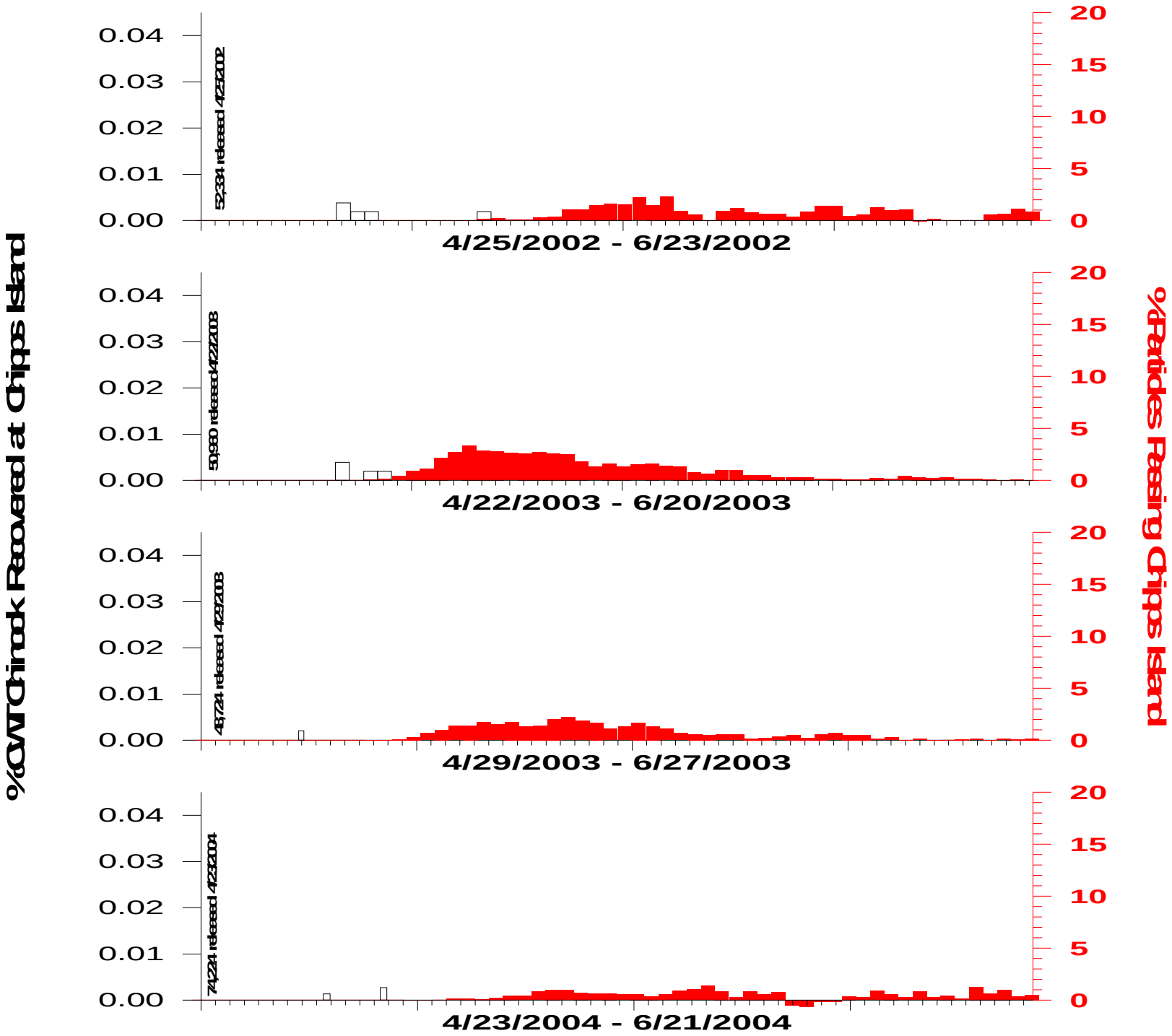
END

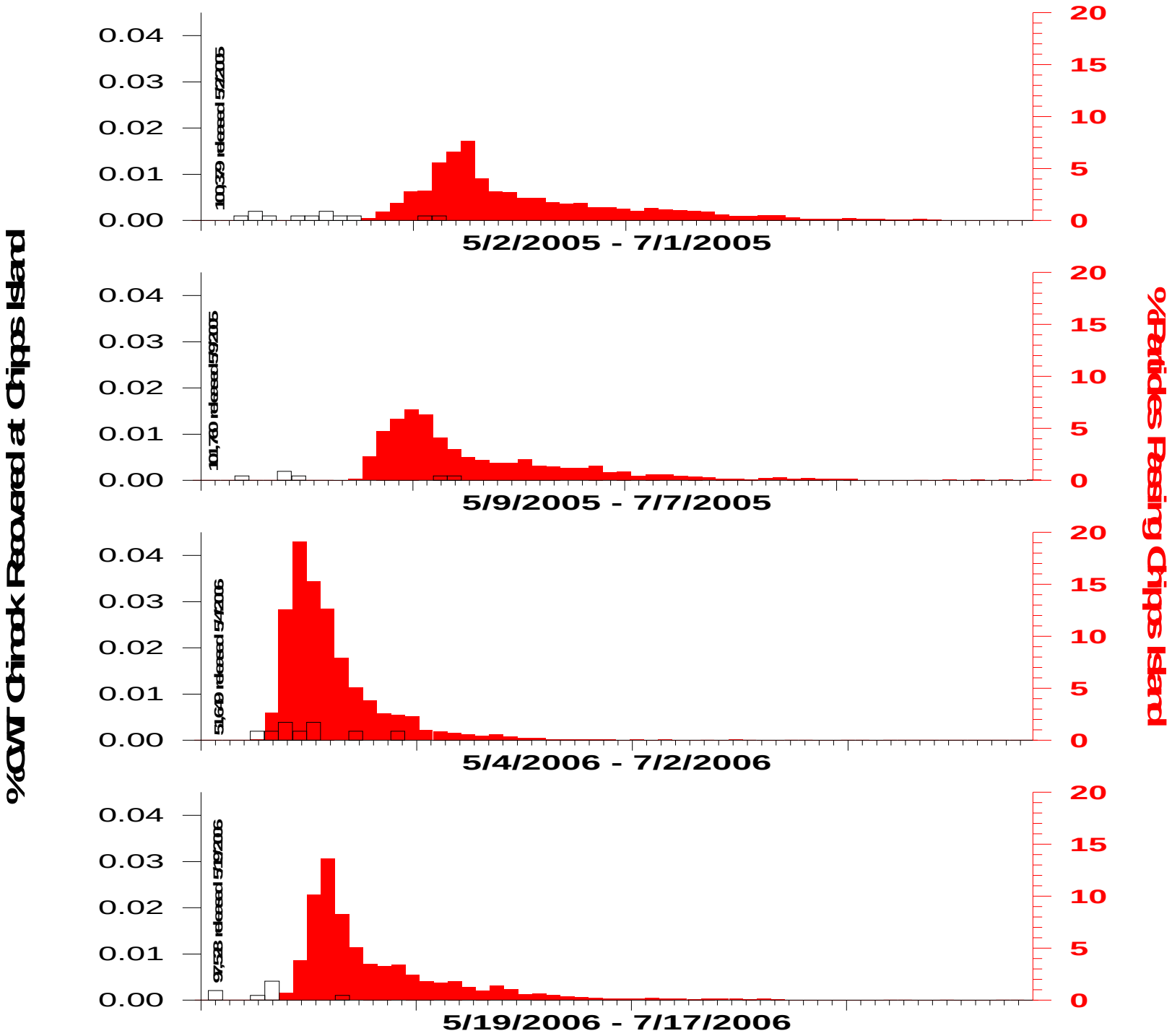

% CWT Chinook Removed at Chipps Island
% Rides Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
10,938 released 4/17/1995
4/17/1995 - 6/15/1995
10,252 released 5/5/1995
5/5/1995 - 7/3/1995
10,125 released 5/17/1995
5/17/1995 - 7/15/1995
10,742 released 4/15/1996
4/15/1996 - 6/13/1996


% CWT Chinook Recovered at Chipps Island
% Particles Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
9,966 released 4/30/1996
4/30/1996 - 6/28/1996
48,774 released 4/28/1997
4/28/1997 - 6/12/1997
77,685 released 4/16/1998
4/16/1998 - 6/14/1998
34,486 released 4/23/1998
4/23/1998 - 6/21/1998


%CWT Chinook Recovered at Chipps Island
%Particles Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
5/6/1998 - 7/4/1998
4/19/1999 - 6/17/1999
4/20/1999 - 6/18/1999
4/18/2000 - 6/16/2000


%CWT Chinook Recovered at Chipps Island
%Particles Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
4/19/2000 - 6/17/2000
4/30/2001 - 6/28/2001
5/8/2001 - 7/6/2001
4/18/2002 - 6/16/2002


%CWT Chinook Recovered at Chipps Island
%Particles Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
52334 released 4/23/2002
4/25/2002 - 6/23/2002
50980 released 4/22/2003
4/22/2003 - 6/20/2003
48724 released 4/29/2003
4/29/2003 - 6/27/2003
74224 released 4/23/2004
4/23/2004 - 6/21/2004


% CWT Chinook Recovered at Chipps Island
% Particles Passing Chipps Island
0.04
0.03
0.02
0.01
0.00
20
15
10
5
0
10,339 released 5/2/2005
5/2/2005 - 7/1/2005
101,760 released 5/9/2005
5/9/2005 - 7/7/2005
51,669 released 5/4/2006
5/4/2006 - 7/2/2006
97,538 released 5/19/2006
5/19/2006 - 7/17/2006