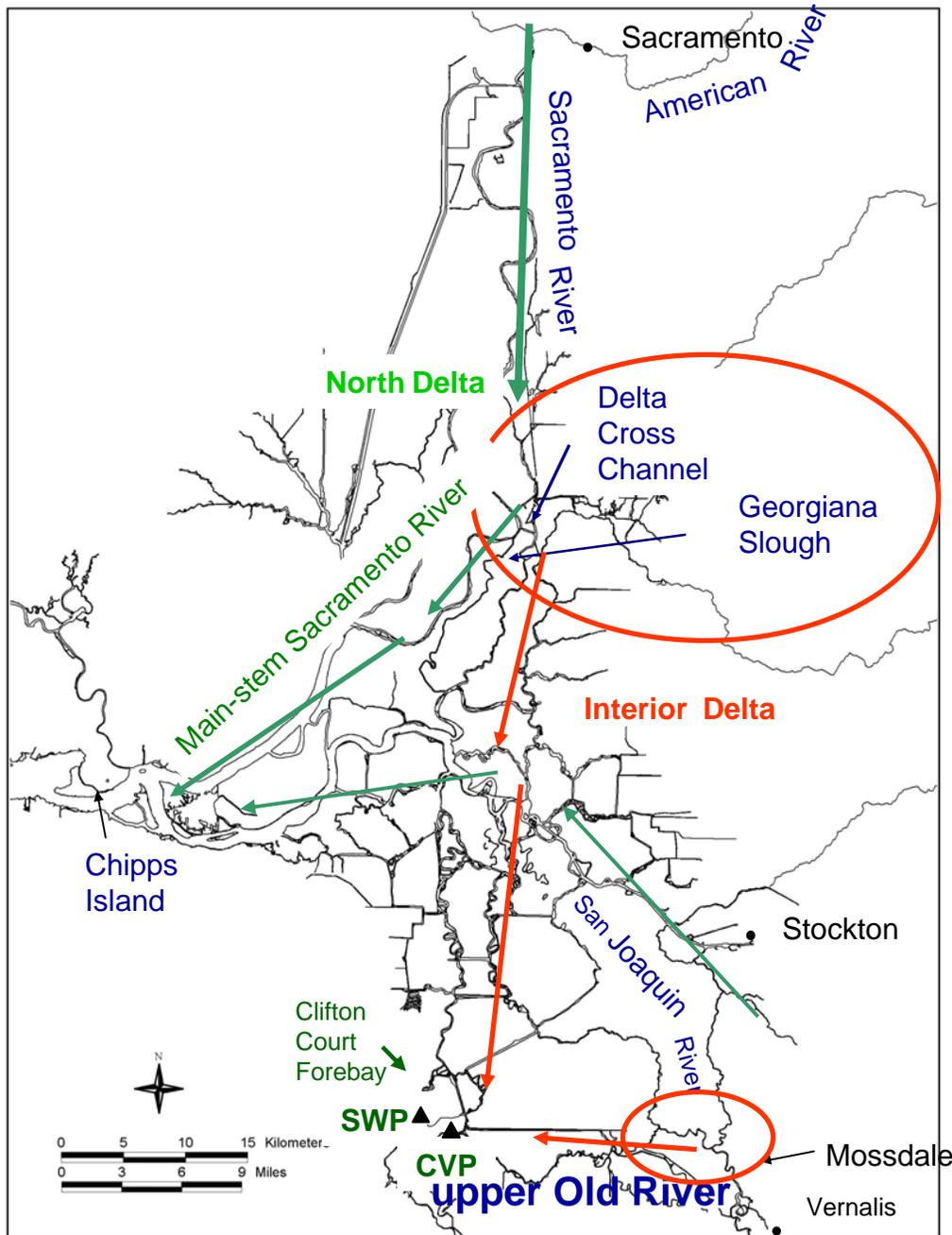


Juvenile Salmon Migration through the Delta

A Conceptual Model

Pat Brandes - USFWS



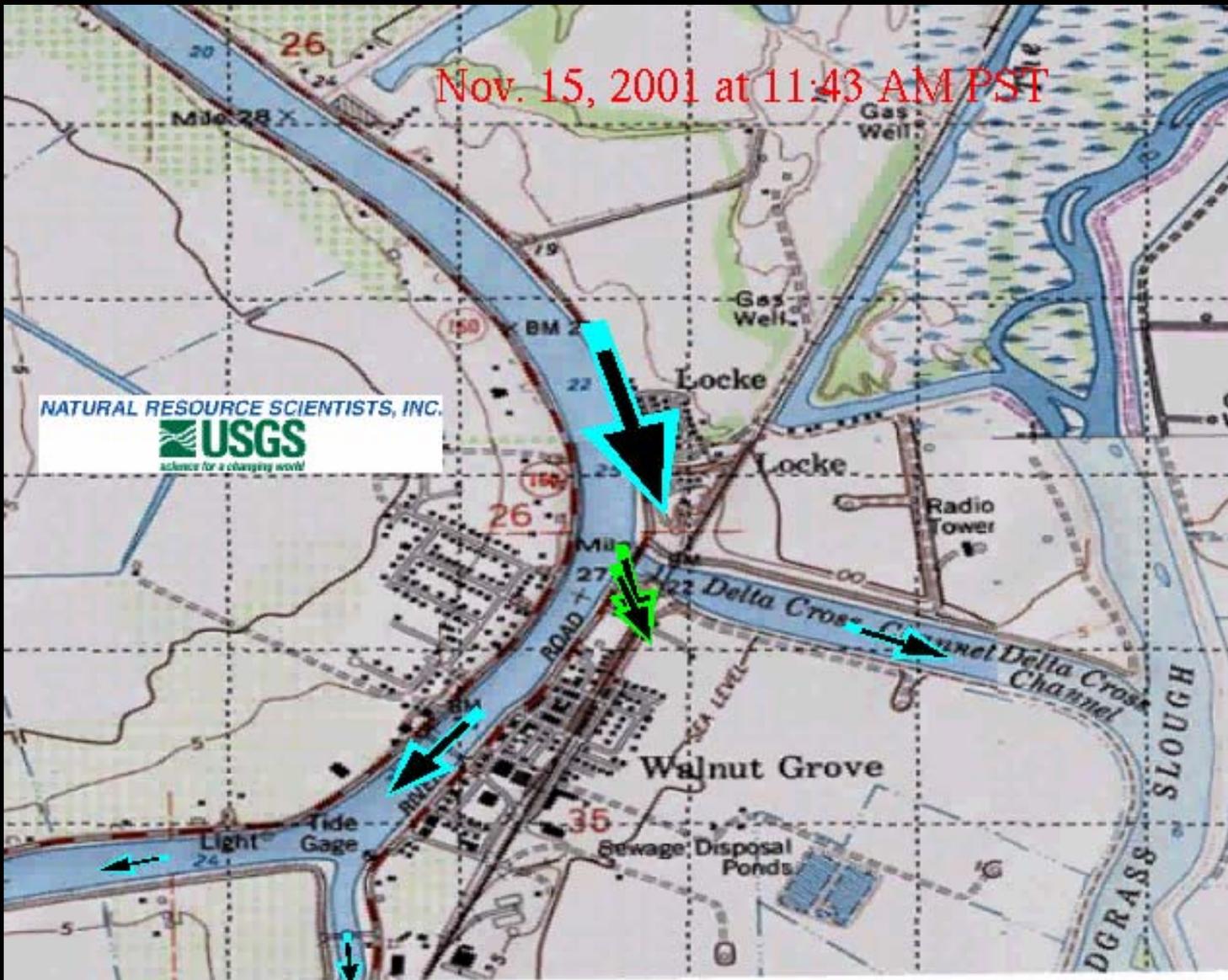
Conceptual Model of juvenile salmon migration through the Delta

- Sac Basin salmon move into interior Delta through the open DCC and GS (more with gate open)
- in the interior Delta survival is lower and a function of exports
- Survival is lower for S.J. Basin smolts migrating through upper Old River,
- survival will increase with increased Vernalis flow and flow/exports
- Juvenile salmon are vulnerable to entrainment during emigration to the ocean

Conceptual Model of juvenile salmon migration through the Sacramento Delta

-Sac Basin salmon move into interior Delta through the open DCC and GS

Nov. 15, 2001 at 11:43 AM PST

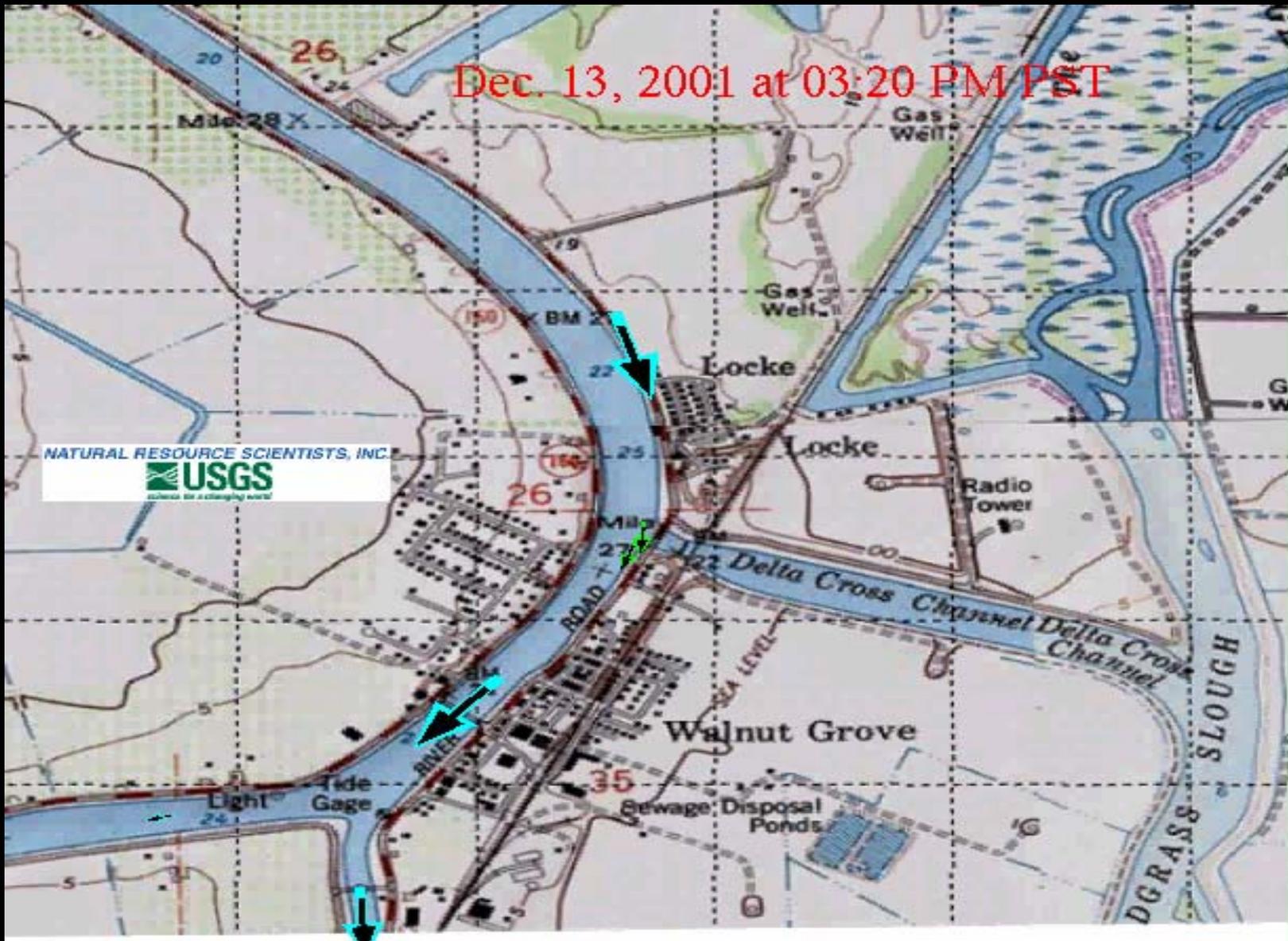


Flood Tide

Gates open

Source: Vogel 2002 Asilomar Presentation

Dec. 13, 2001 at 03:20 PM PST



EBB Tide

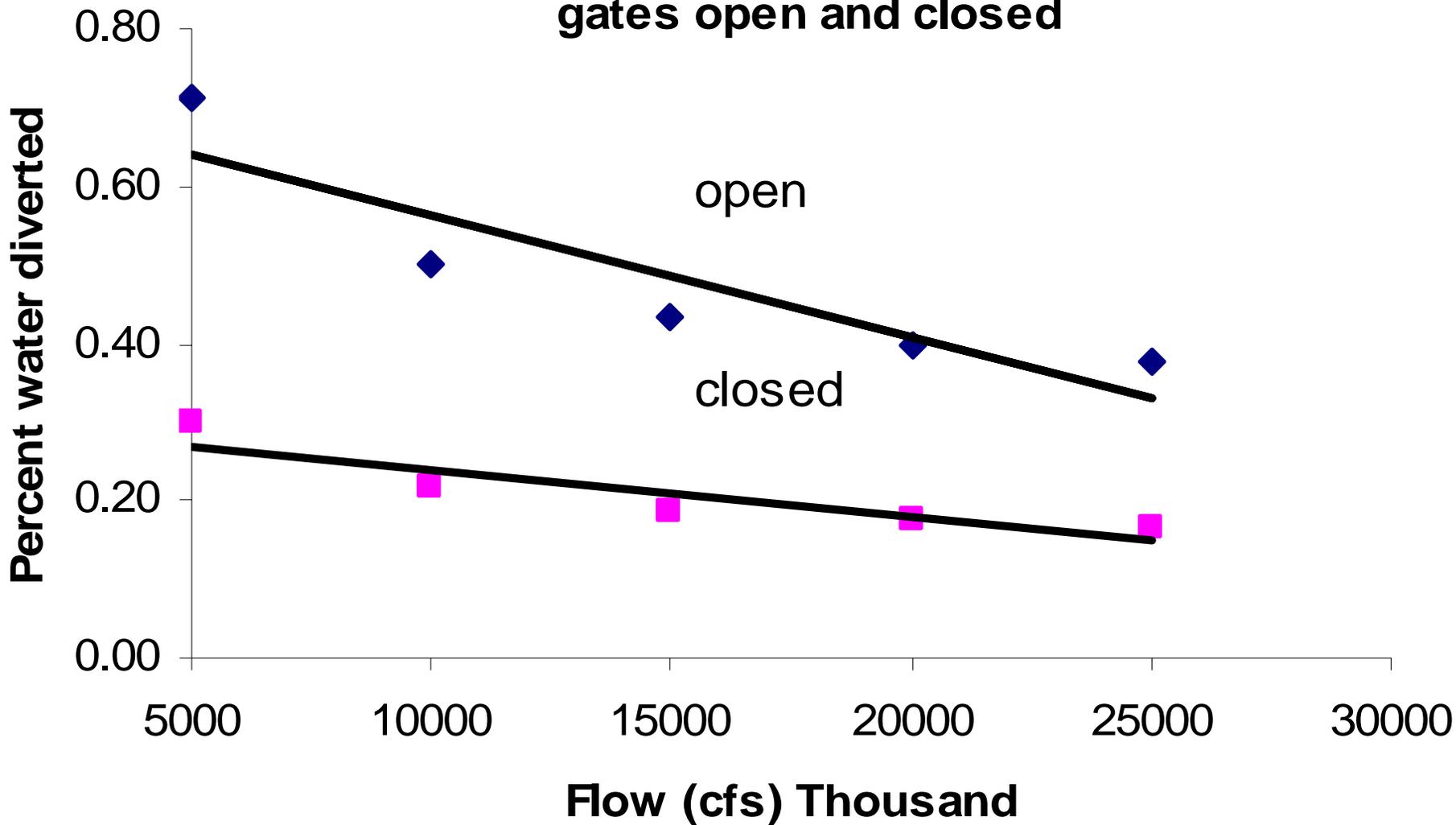
DCC gates closed

Conceptual Model of juvenile salmon migration through the Sacramento Delta

-Sac Basin salmon move into interior Delta through the open DCC and GS

-More move into interior Delta with gates open

% Freeport flow diverted into interior Delta with DCC gates open and closed



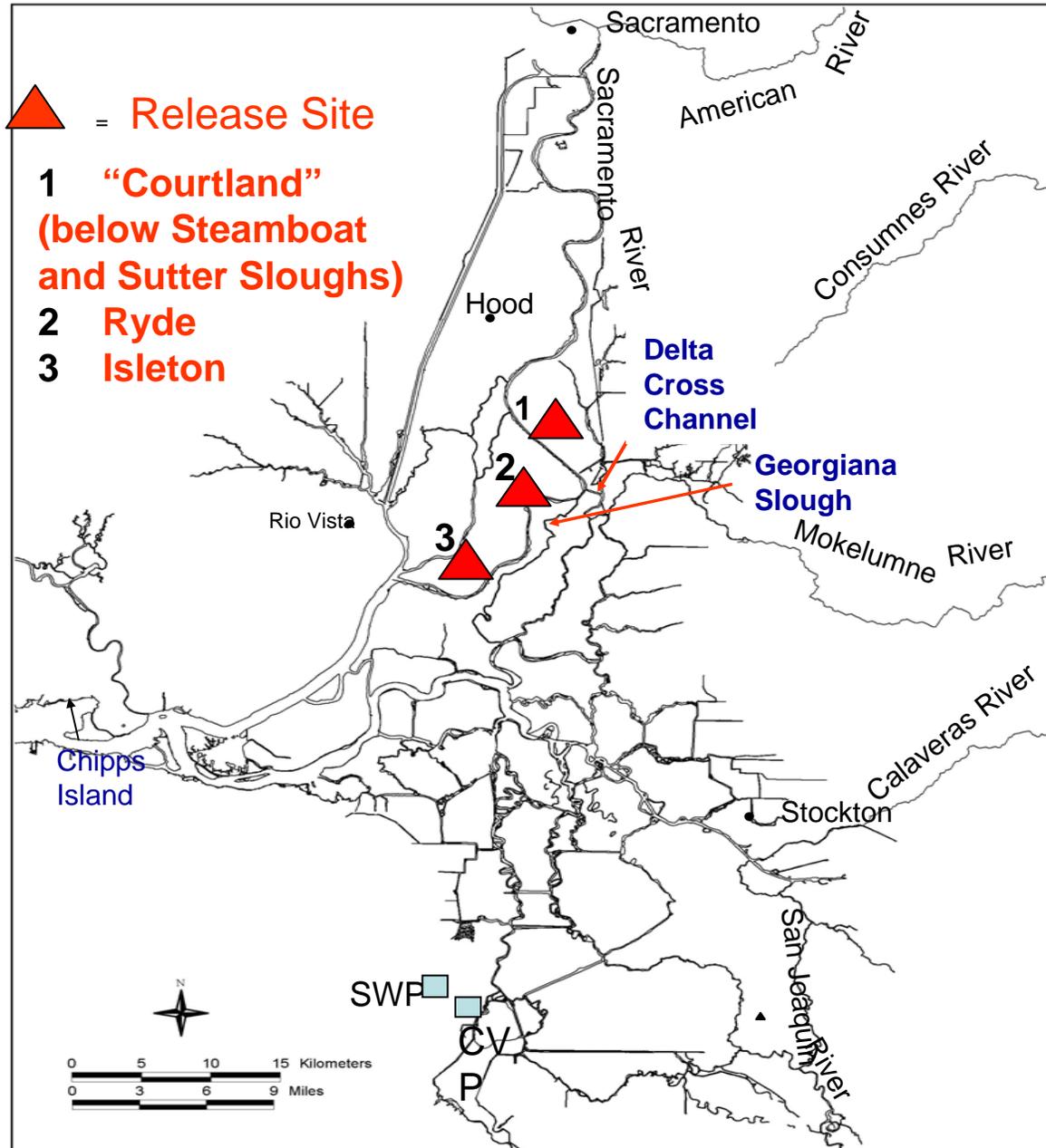
Assume more salmon move into the interior Delta when the DCC gates are open

Conceptual Model of juvenile salmon migration through the Sacramento Delta

-Sac Basin salmon move into interior Delta through the open DCC and GS

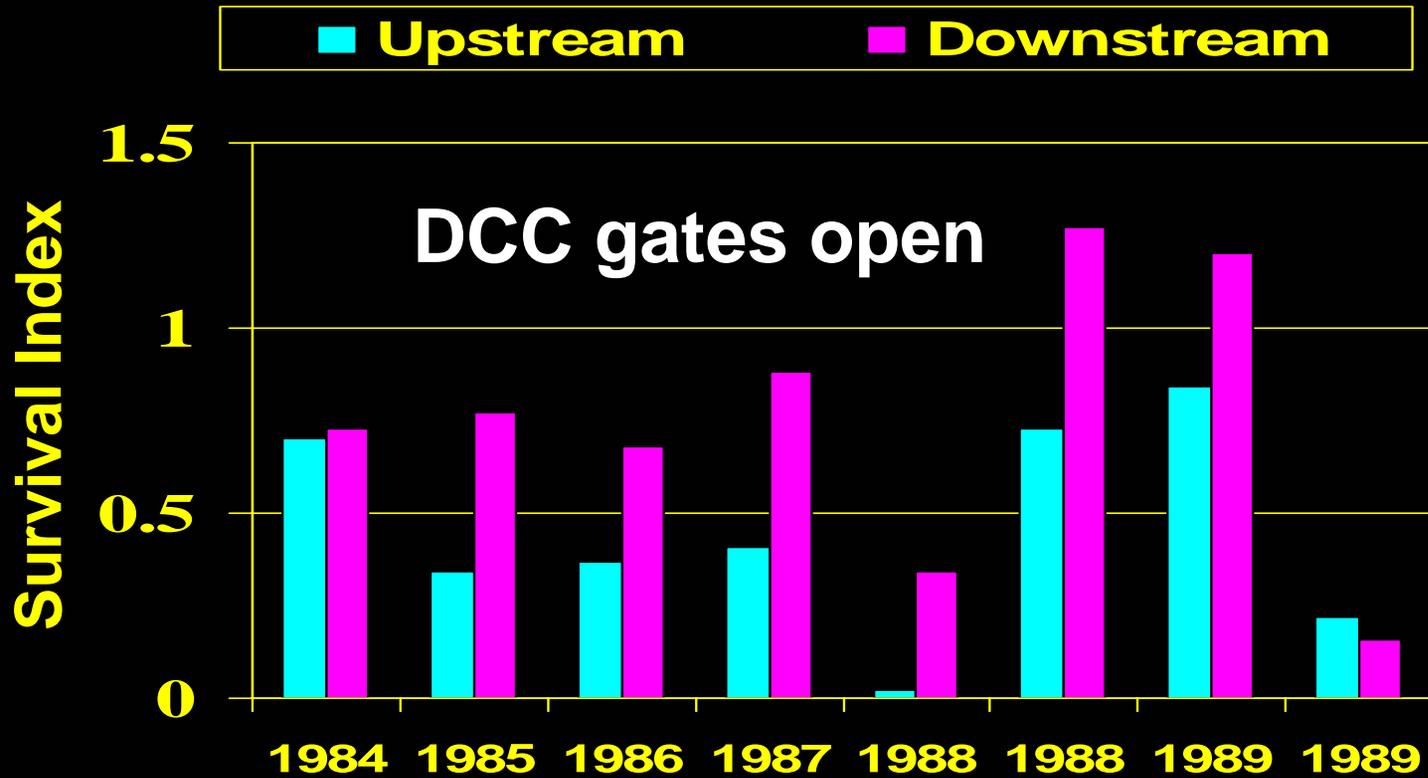
-More move into interior Delta with gates open

-Survival is lower in the interior Delta



Marked juvenile salmon releases made on Sac River above and below the DCC and GS

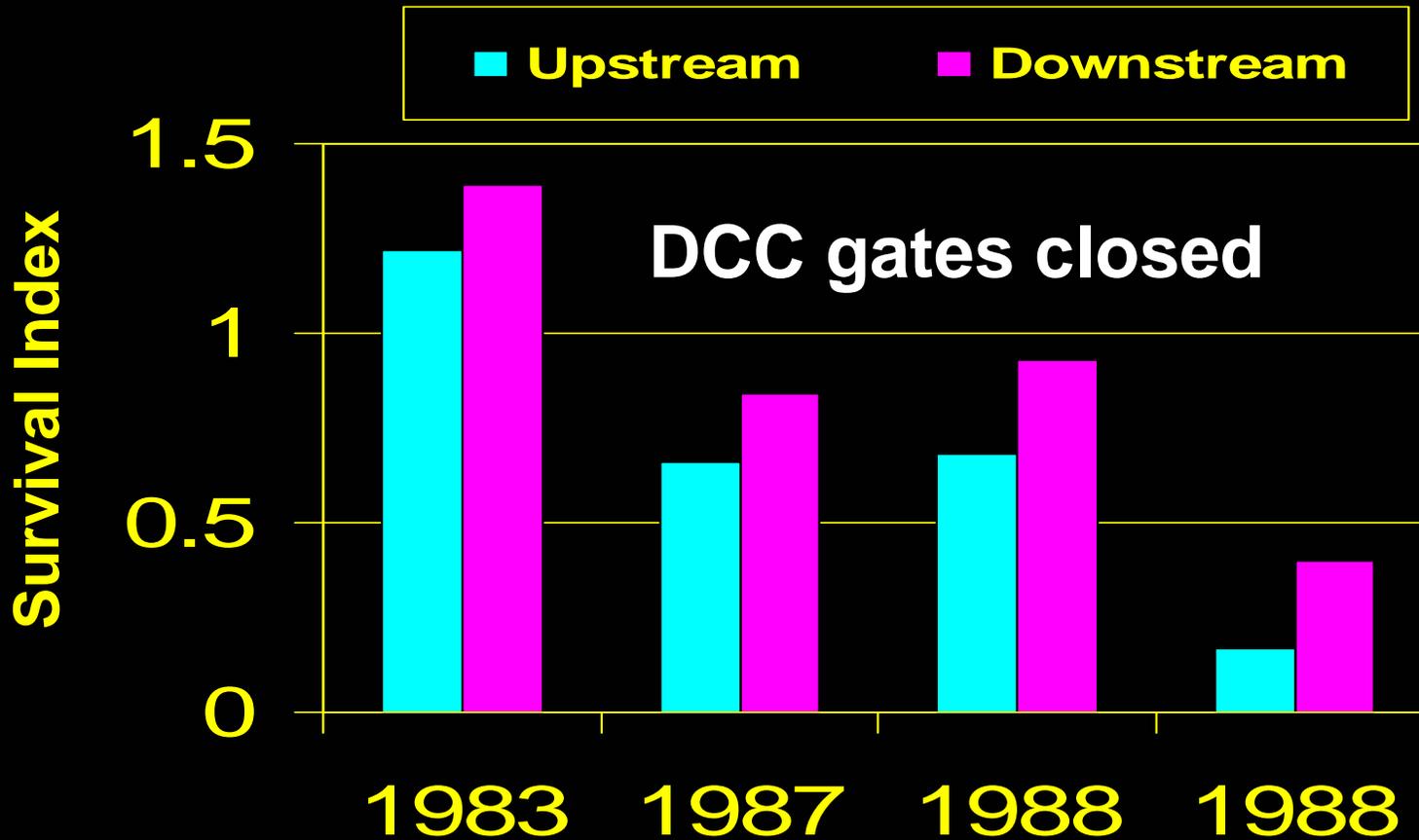
Survival indices to Chipps Island of marked juvenile salmon released upstream and downstream of the Delta Cross Channel and Georgiana Slough



Upstream < downstream (p<0.05)

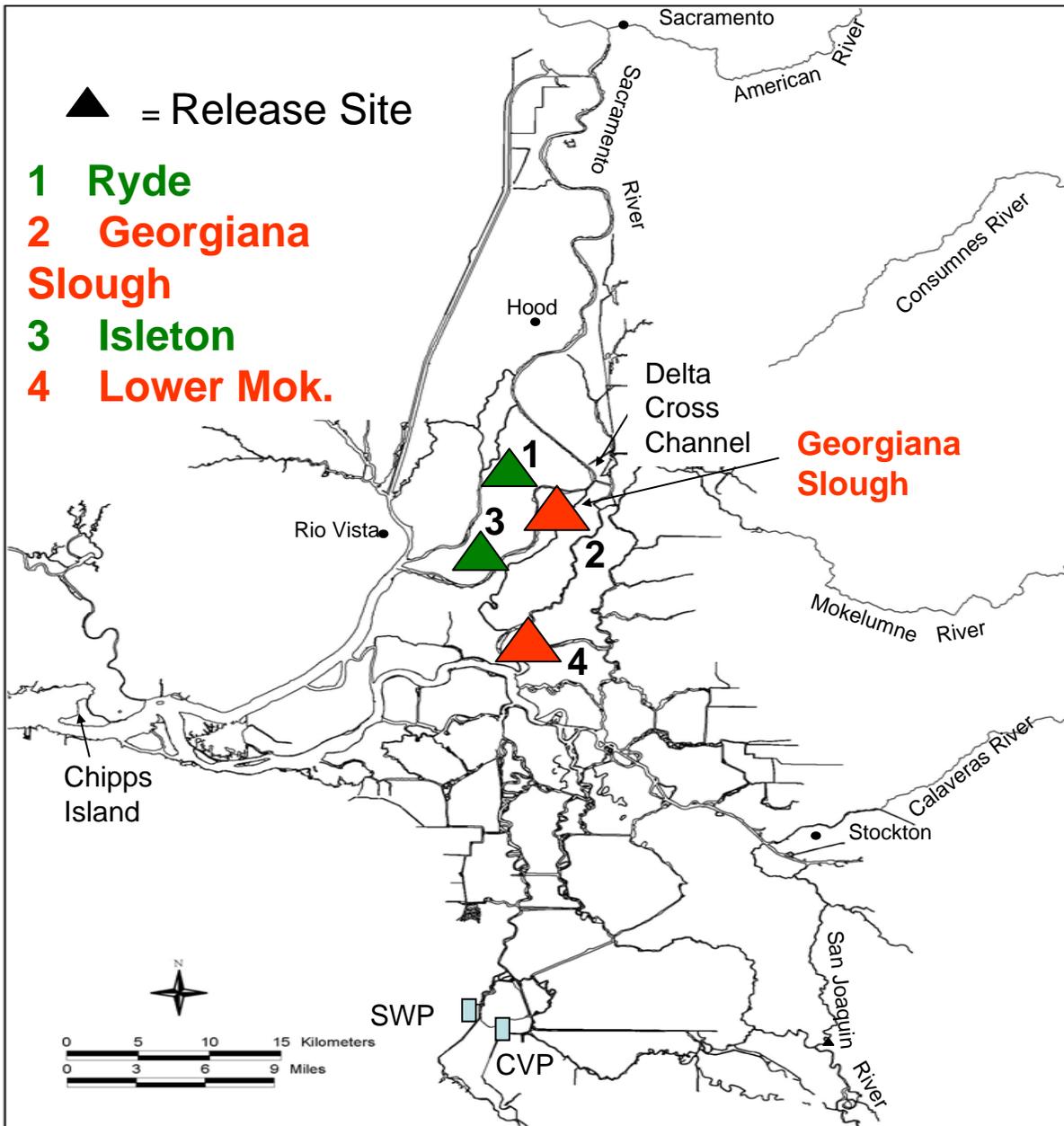
Data would infer additional mortality of upstream group due to some entering DCC and GS

Survival indices to Chipps Island of marked juvenile salmon released upstream and downstream of the Delta Cross Channel and Georgiana Slough



Upstream < downstream (p<0.05)

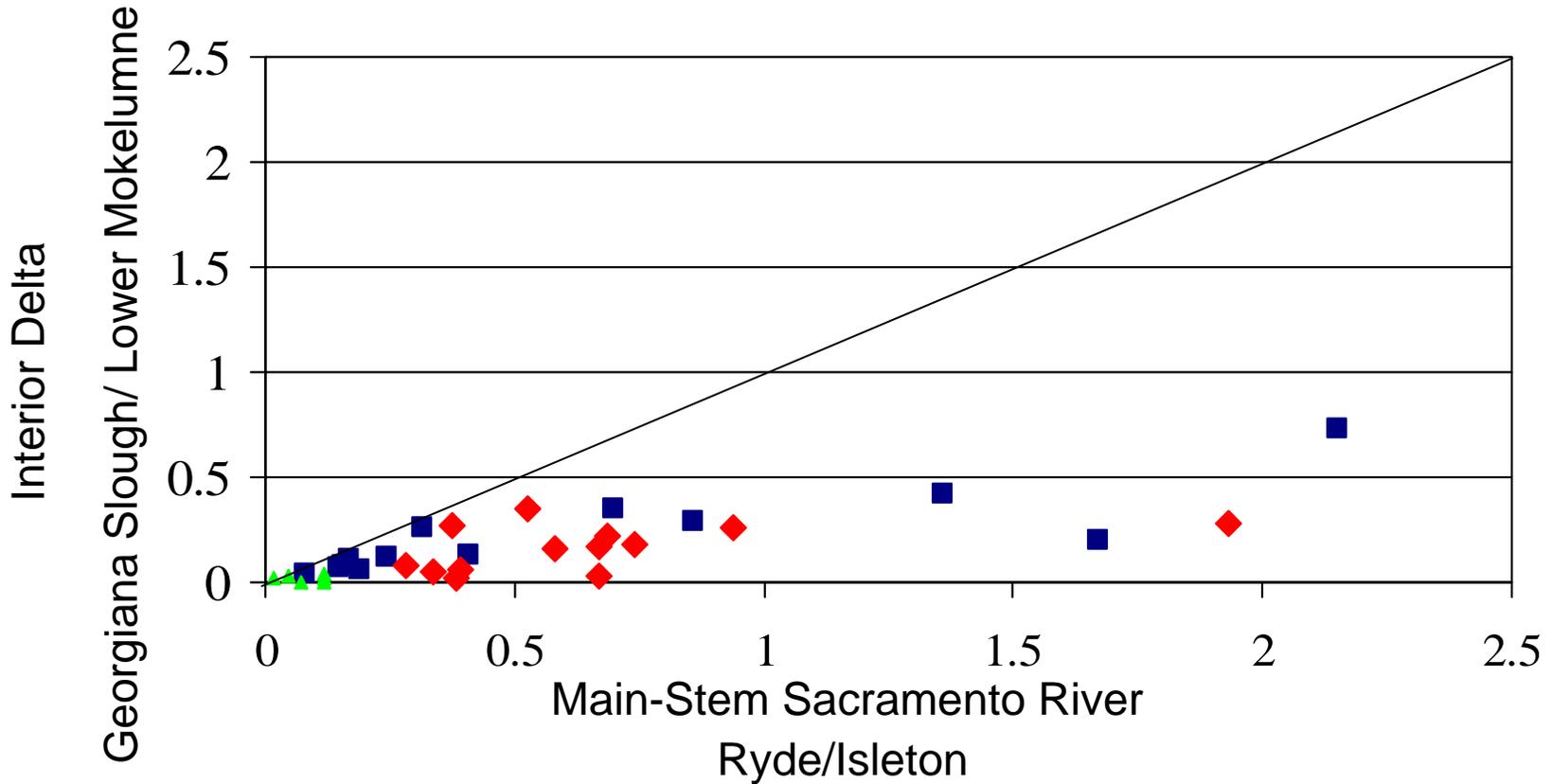
Data would infer additional mortality of upstream group due to some entering GS



Release sites for marked salmon released on Sacramento River (Ryde and Isleton) and interior Delta (Georgiana Slough and Lower Mokelumne)

Survival indices to Chipps Island

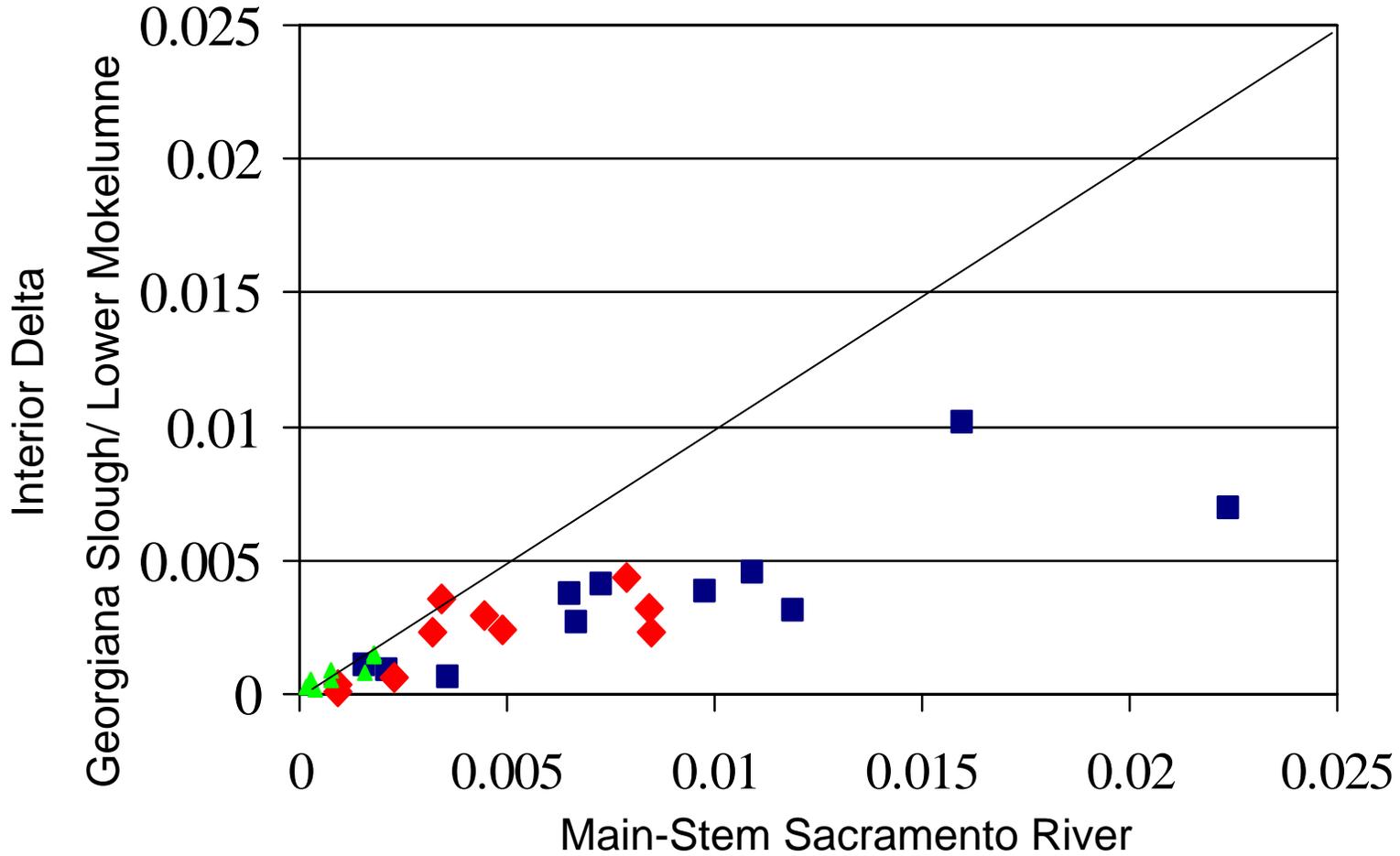
■ **Fall** ♦ **Late fall** ▲ **Fall Fry**



Fall GS < Ryde (p < 0.05)

Late-fall GS < Ryde (p < 0.05)

Recovery Rates in the ocean fishery



Fall GS < Ryde (p < 0.05)

Late-fall GS < Ryde (p < 0.05)

Ryde/Isleton

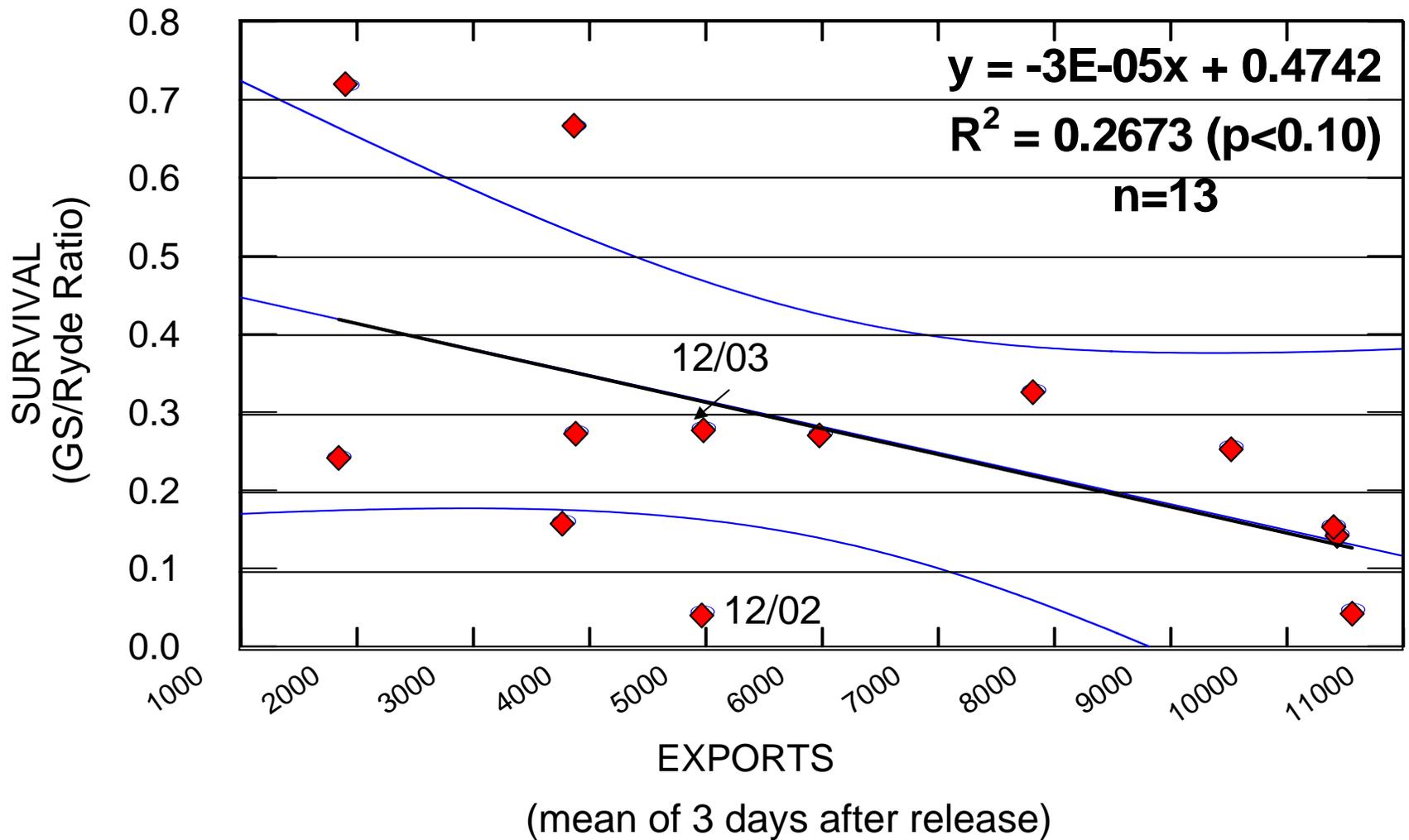
Conceptual Model of juvenile salmon migration through the Sacramento Delta

-Sac Basin salmon move into interior Delta through the open DCC and GS

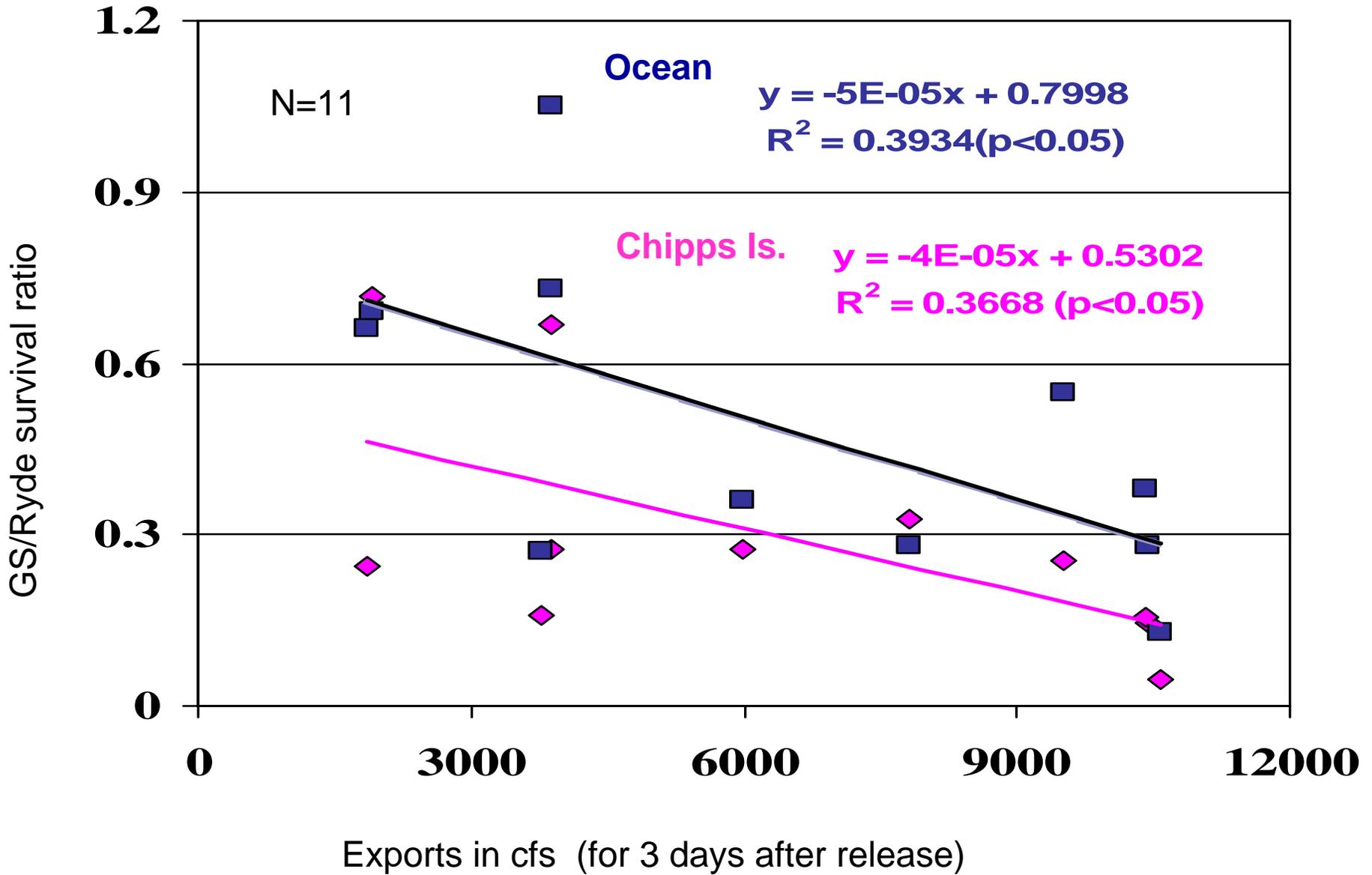
-More move into interior Delta with gates open

-Survival is lower In the interior Delta

-and a function of exports



Relationship between GS/Ryde survival ratio and CVP/SWP exports with 95% confidence intervals



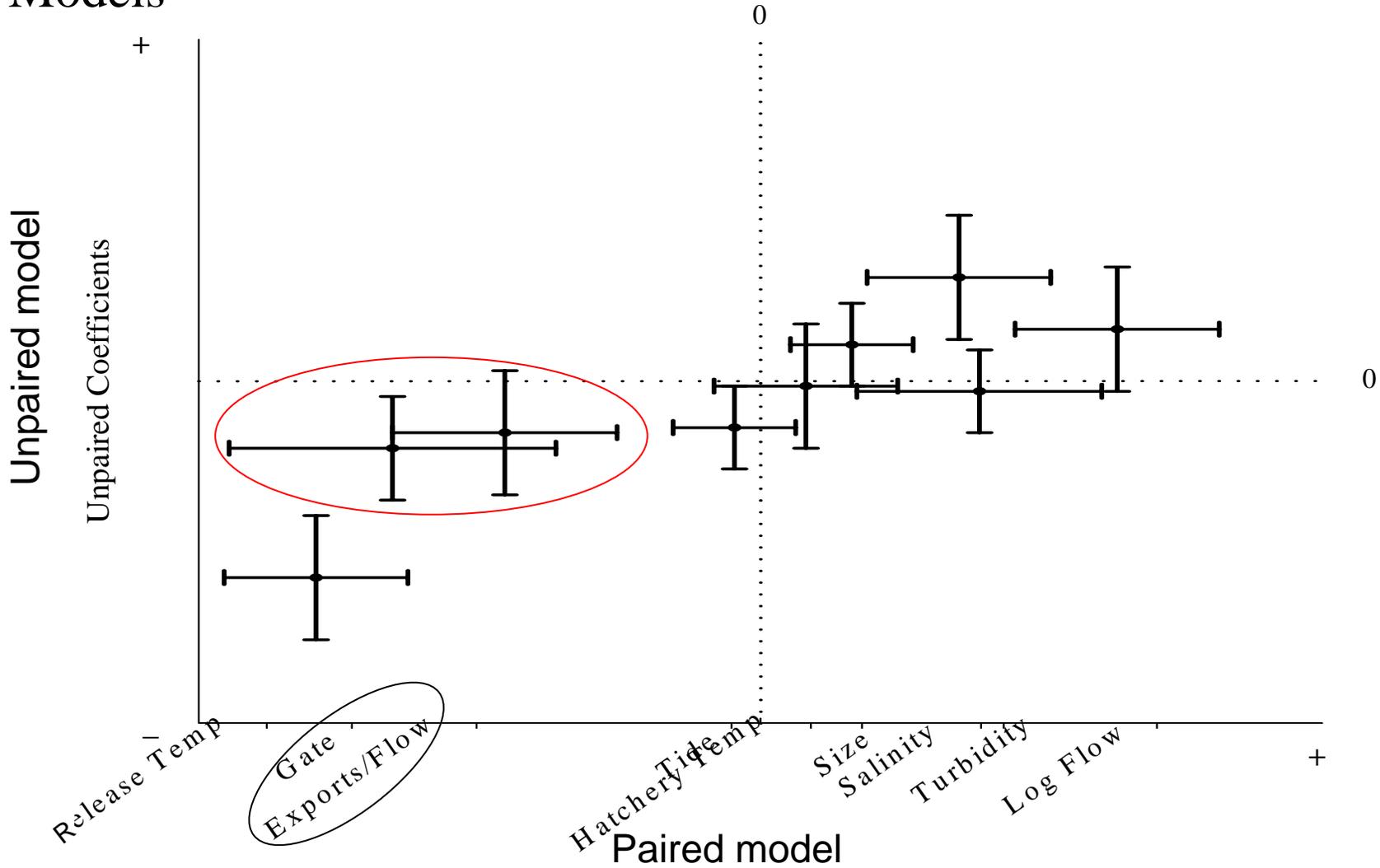
Relationships between GS/Ryde survival ratio and CVP/SWP exports

Conceptual Model of juvenile salmon migration through the Sacramento Delta

- Sac Basin salmon move into interior Delta through the open DCC and GS
- More move into interior Delta with gates open
- In the interior Delta, their survival is lower
- and a function of exports

Statistical Modeling of fall run CWT recoveries is supportive of this conceptual model

Results of two Fall run CWT Sacramento Delta Salmon Smolt Survival Models



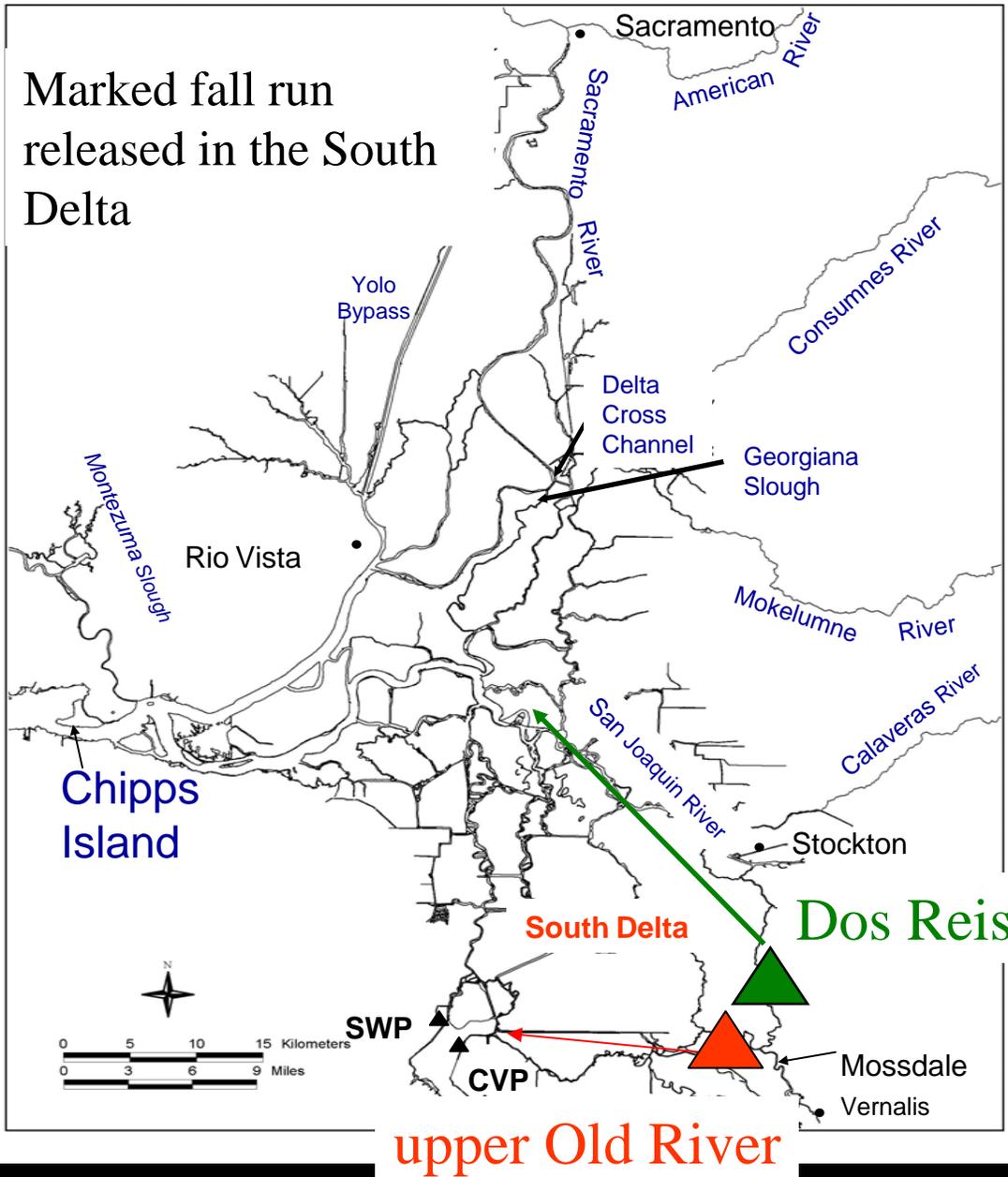
Hierarchical Coefficients

Standardized coefficients and ± 2 standard errors of two separate Newman models estimating fall run salmon smolt survival through the Delta

Conceptual Model of juvenile salmon migration through the San Joaquin Delta

-Survival appears lower for S.J. Basin smolts migrating through upper Old River

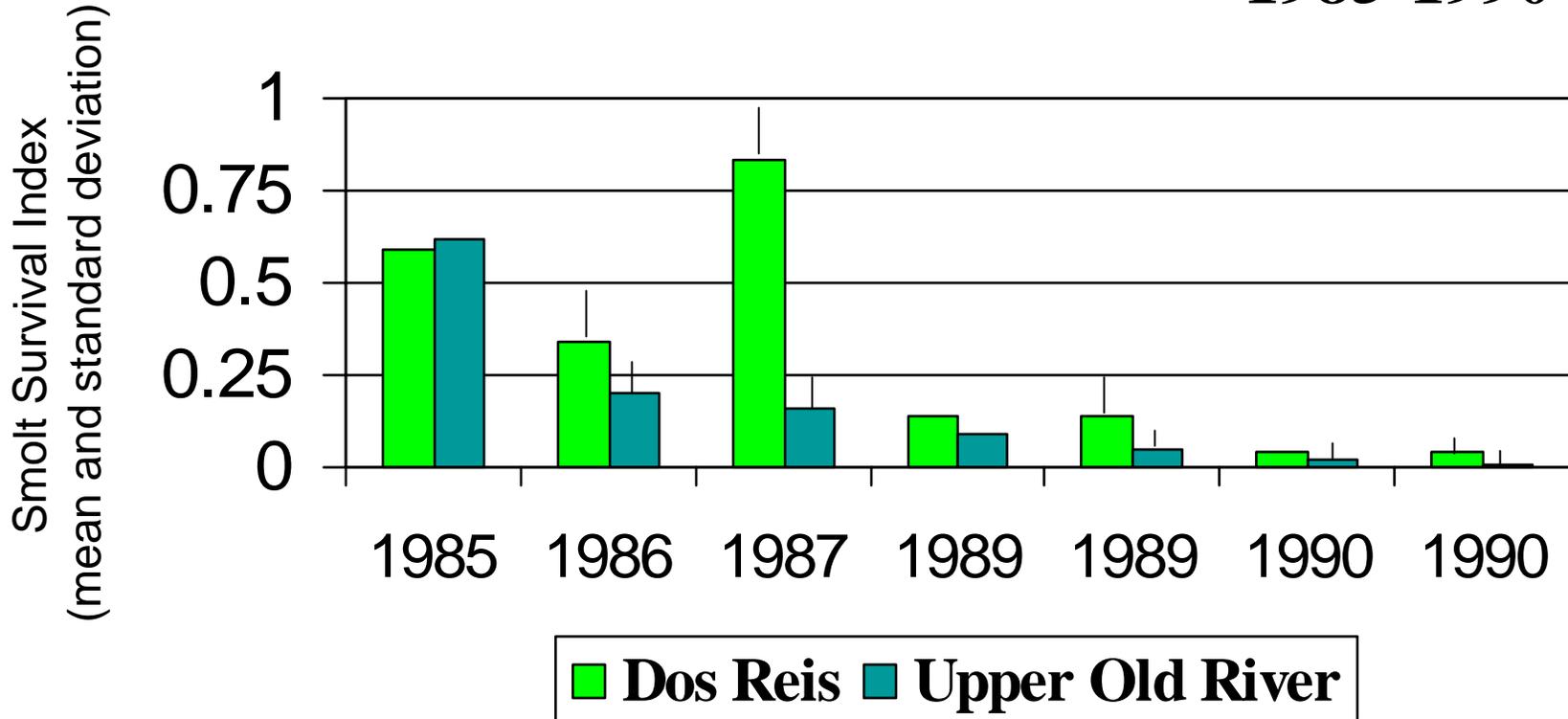
Marked fall run
released in the South
Delta



**Marked releases
made at Dos Reis
(main-stem San
Joaquin River) and
upper Old River
between 1985-1990**

Smolt Survival to Chipps Island of Spray dye (1985) and CWT paired releases

1985-1990

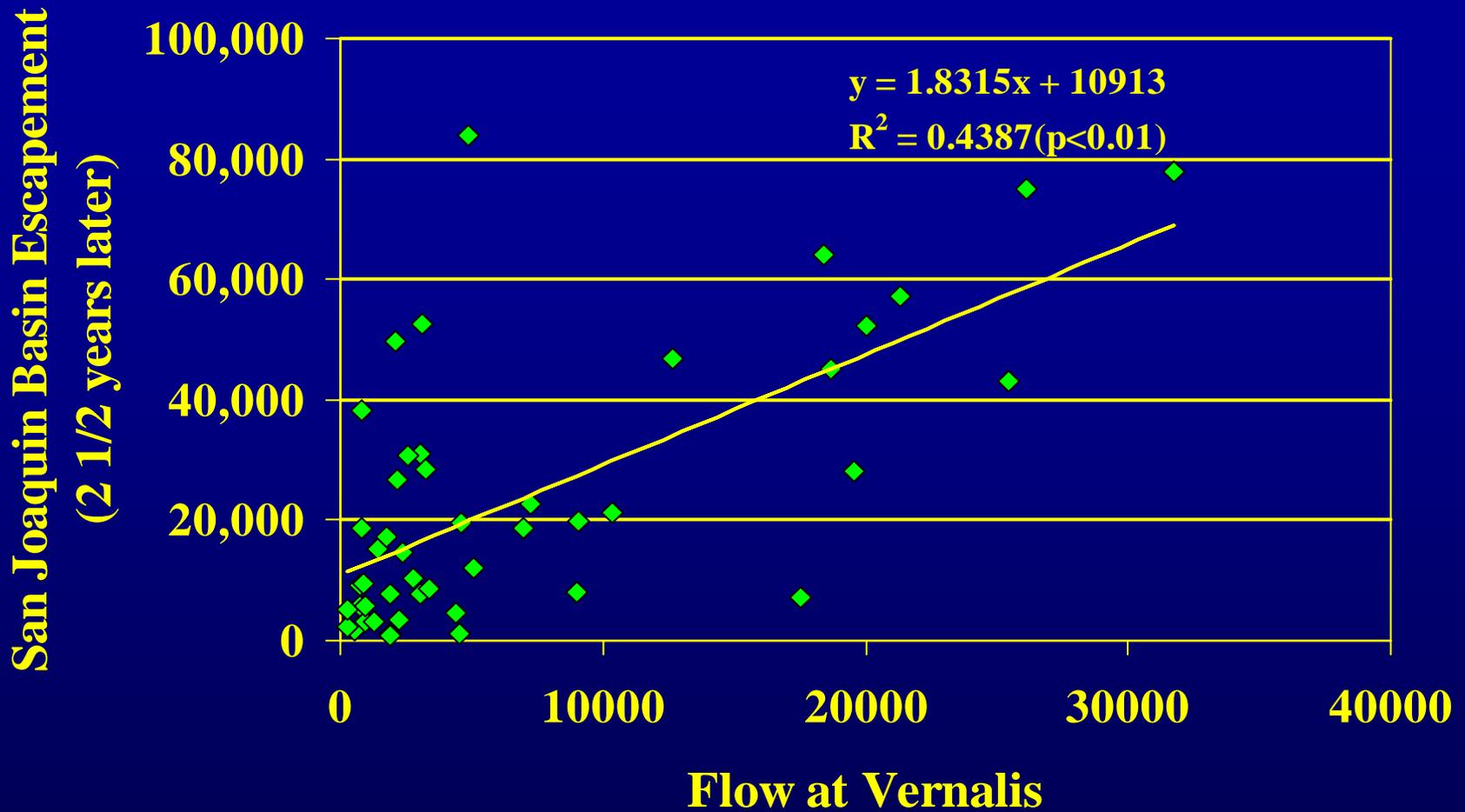


Results suggest higher survival for smolts that stay in the San Joaquin River. Not statistically significantly at $p < 0.05$. (n=7)

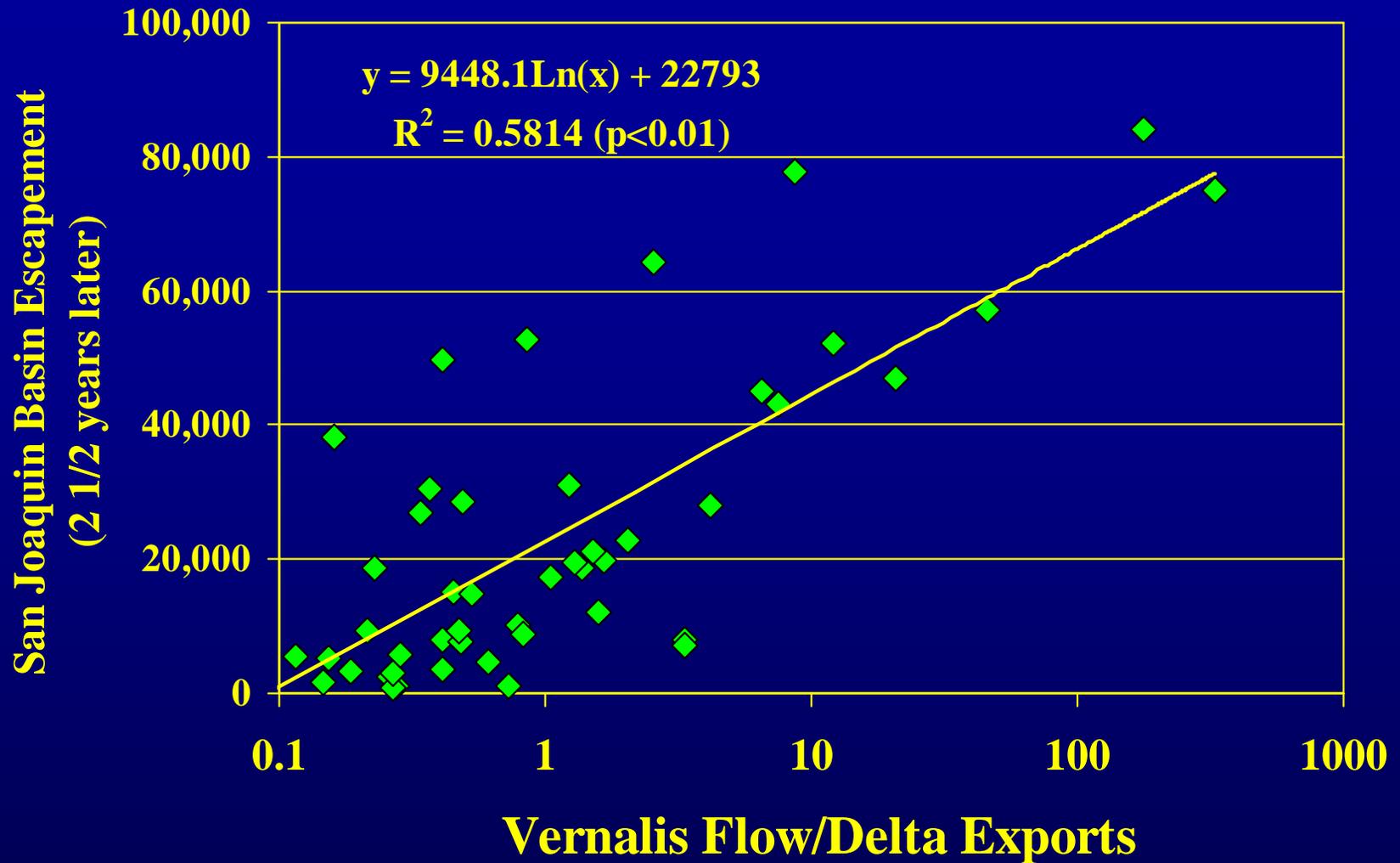
Conceptual Model of juvenile salmon migration through the San Joaquin Delta

-Survival appears lower for S.J. Basin smolts migrating through upper Old River

- Survival will increase with increased Vernalis flow and Vernalis flow/exports



Flow at Vernalis (mean April 15 - June 15) between 1951- 1998 versus San Joaquin Basin Escapement 2 1/2 years later



Mean spring flows /Delta exports (mean April 15- June 15) between 1951-1998 and San Joaquin Basin Escapement (2 1/2 years later).

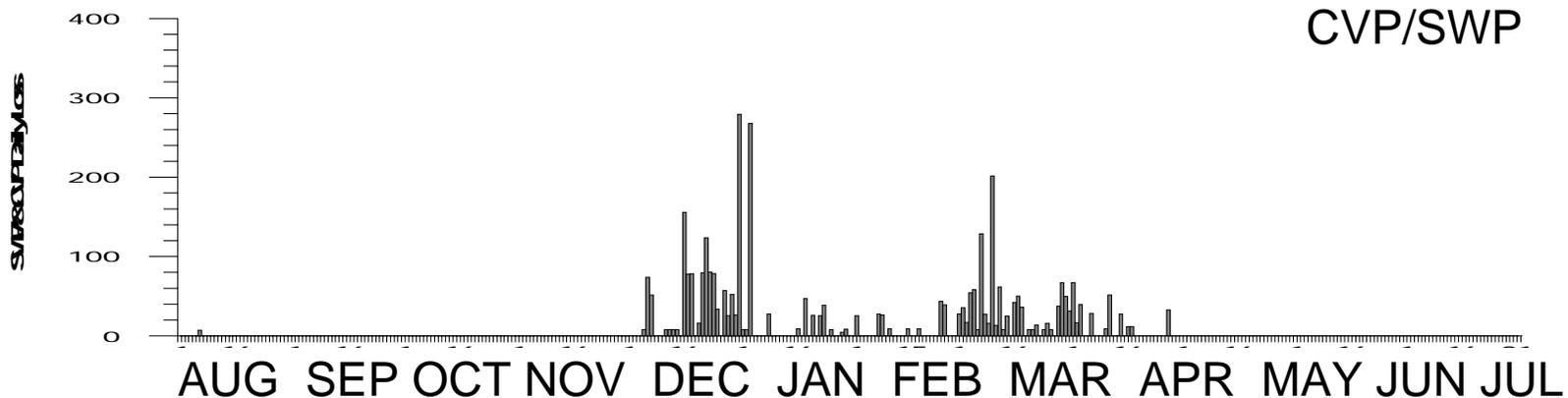
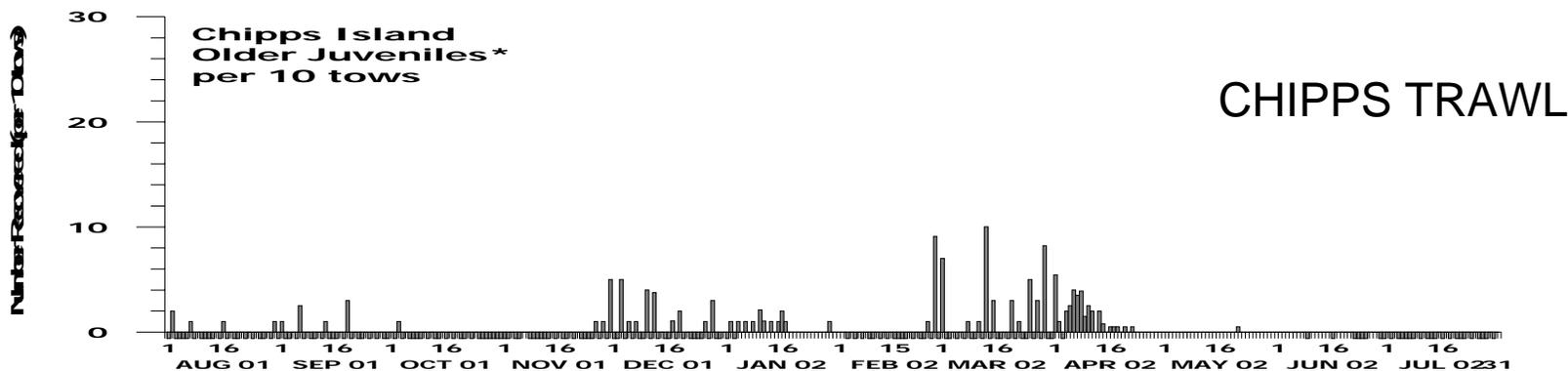
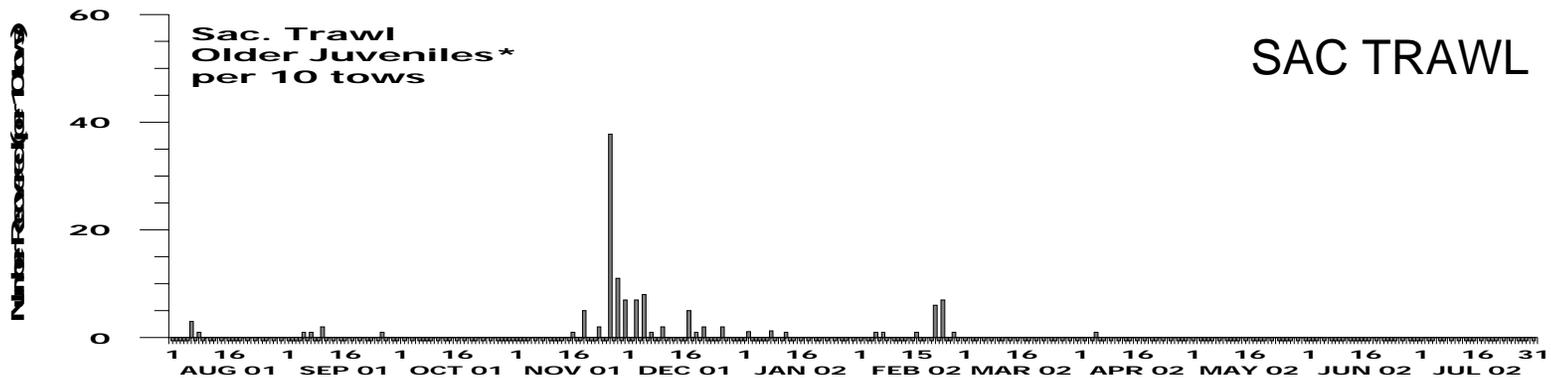
Conceptual Model of juvenile salmon migration through the Sacramento and San Joaquin Delta

- Vulnerable to entrainment during emigration to the ocean

Older juveniles, winter run and fry/smolts

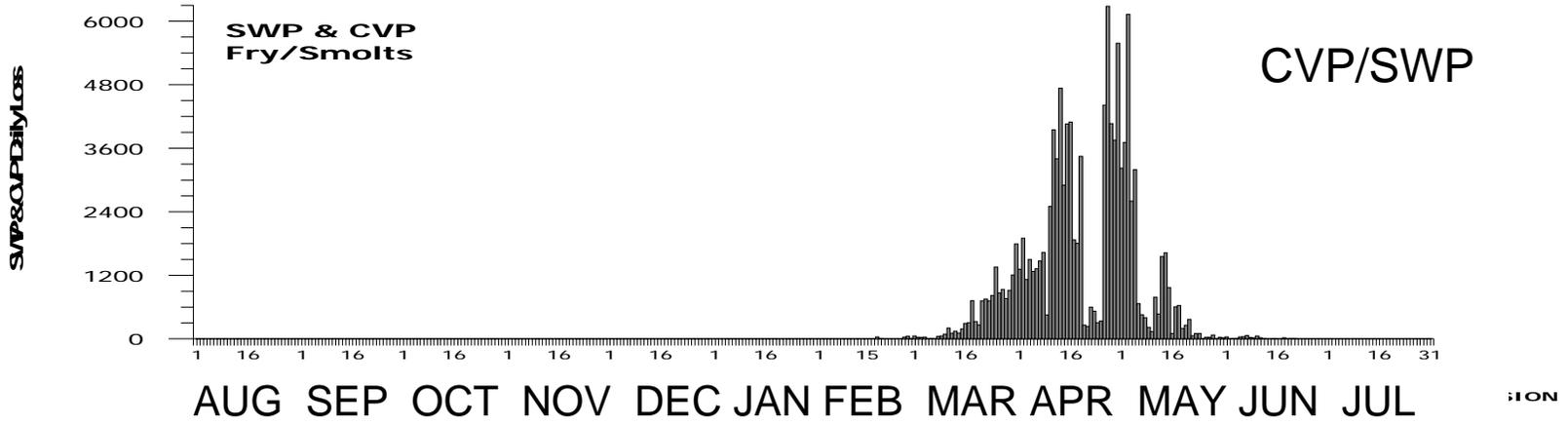
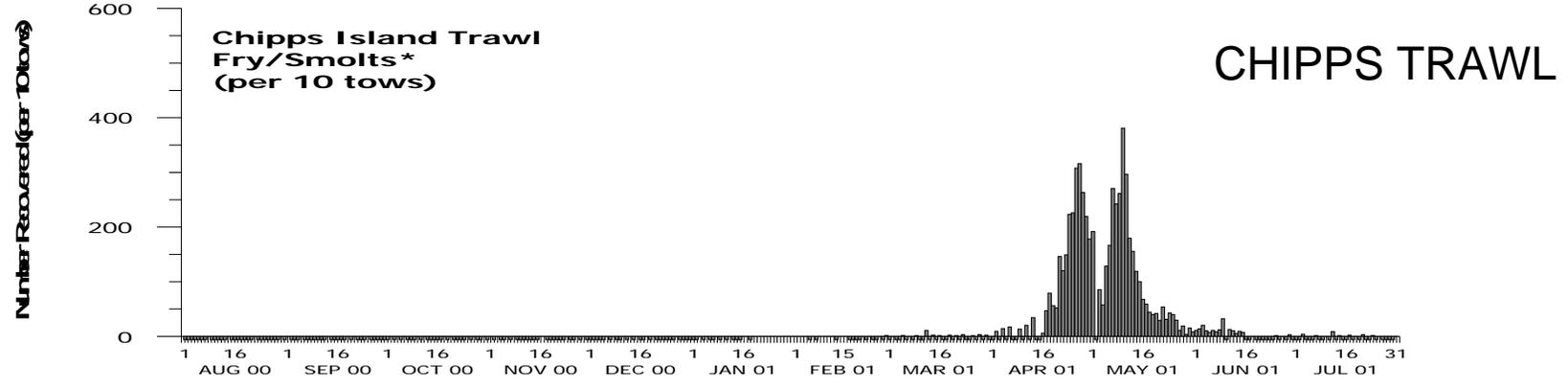
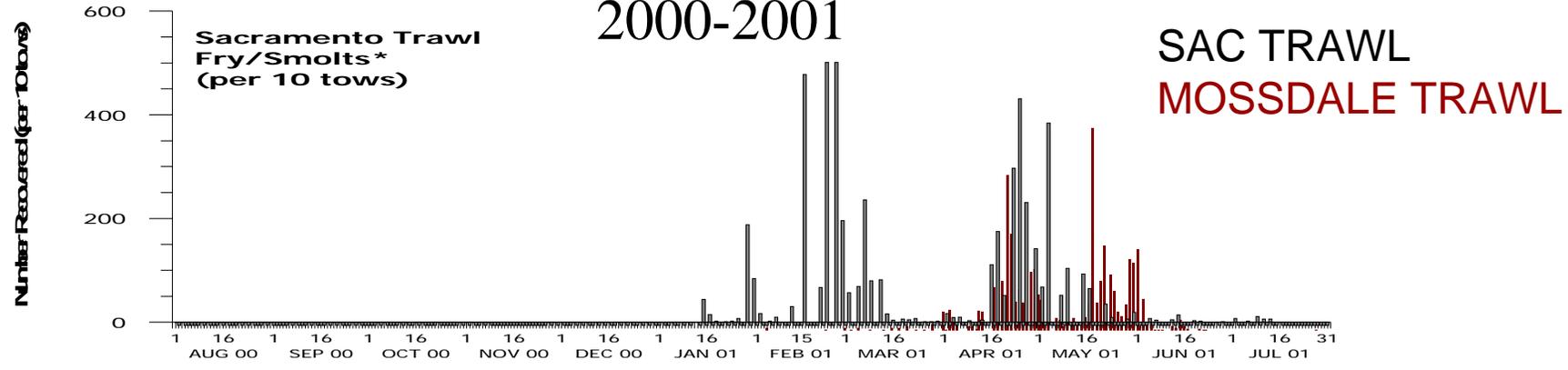
OLDER JUVENILES

2001-2002



NUMBER OF FRY/SMOLT CHINOOK RECOVERED IN THE SACRAMENTO RIVER AND DELTA

2000-2001



The basis of fish protective actions in the Delta for juvenile salmon

is based on the body of evidence that indicates:

closing the DCC,

reducing exports,

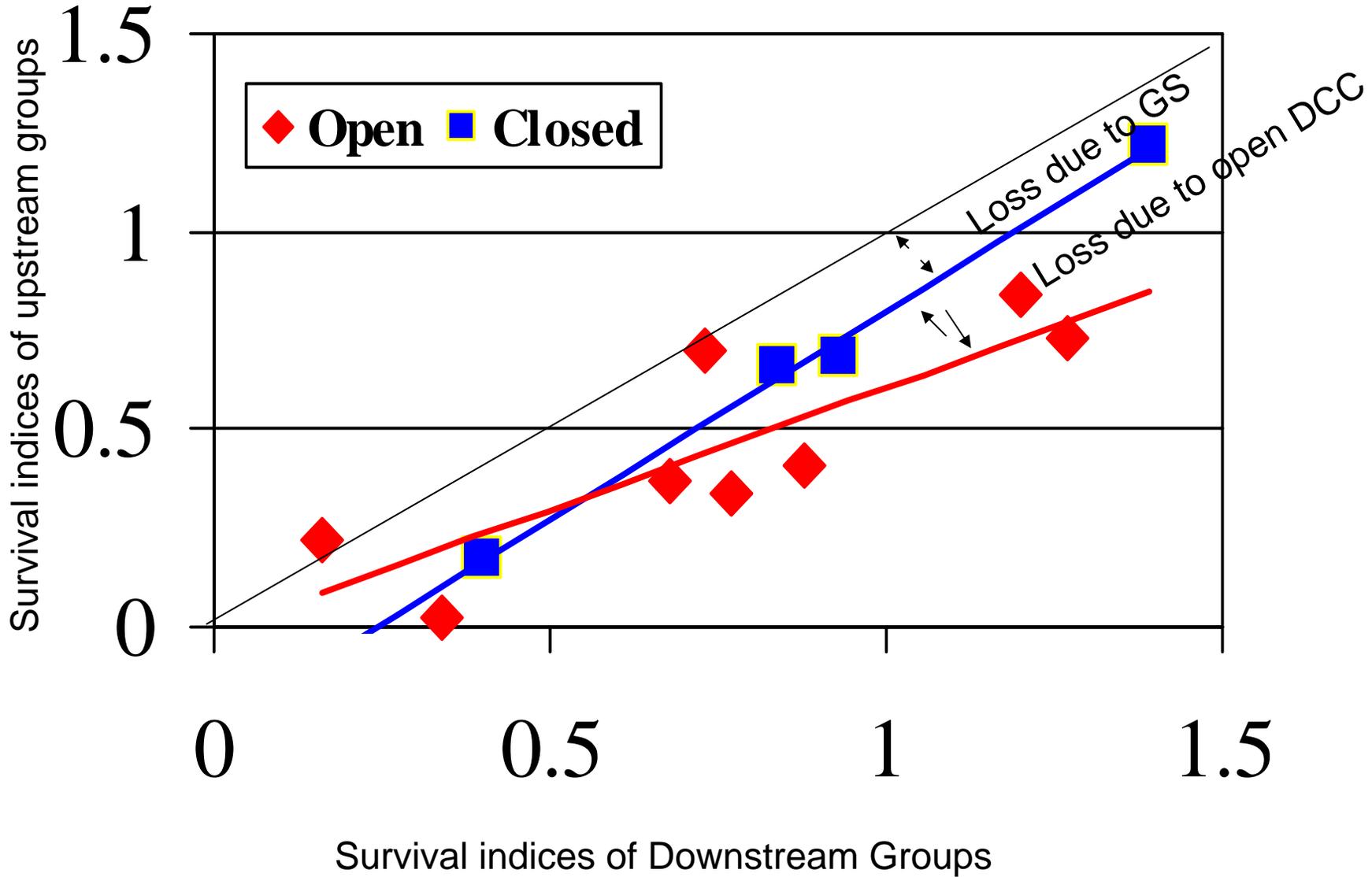
installing a HORB

increasing flows and flows/exports

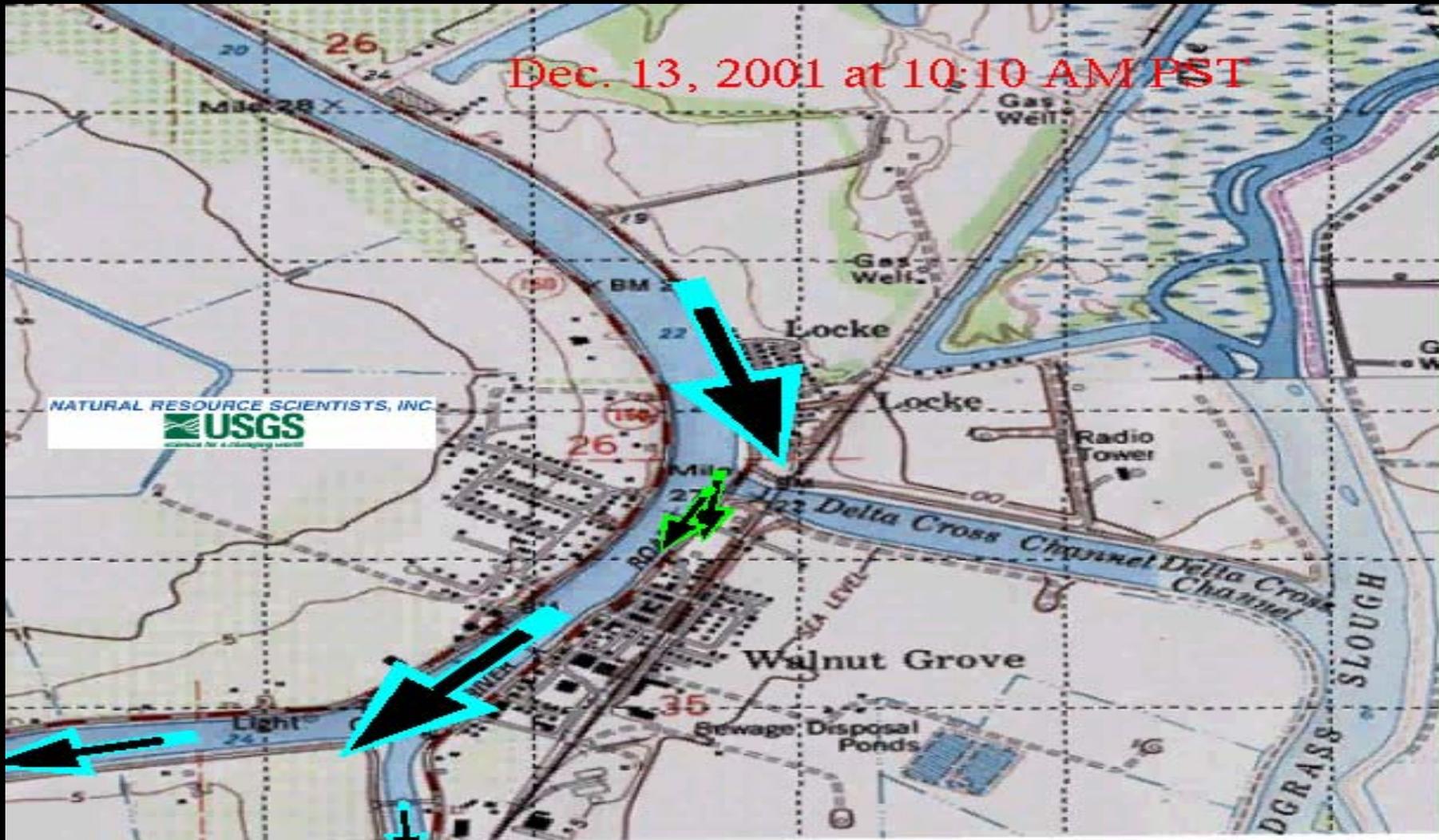
will likely increase the survival of juvenile salmon through the Delta

The timing of actions is designed to increase survival during periods of high abundance of the various races/runs

Survival indices to Chipps Island of marked juvenile salmon released upstream and downstream of the Delta Cross Channel and Georgiana Slough with DCC gates open and closed



Dec. 13, 2001 at 10:10 AM PST



DCC gates closed

Ebb to flood

Source: Dave Vogel, Asilomar presentation 2002

Nov. 08, 2001 at 04:22 PM PST

NATURAL RESOURCE SCIENTISTS, INC.
USGS
science for a changing world

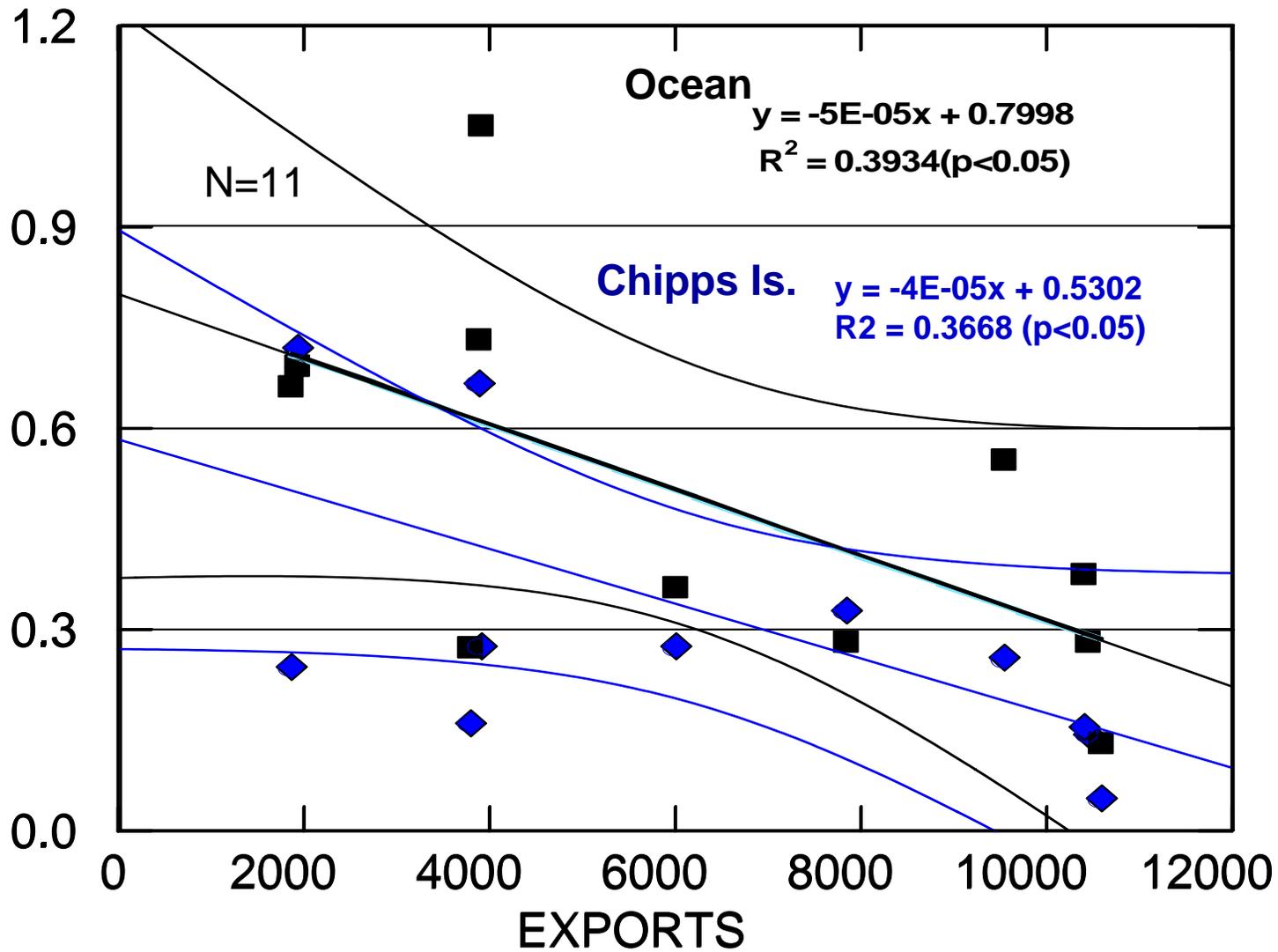


DCC Gates open

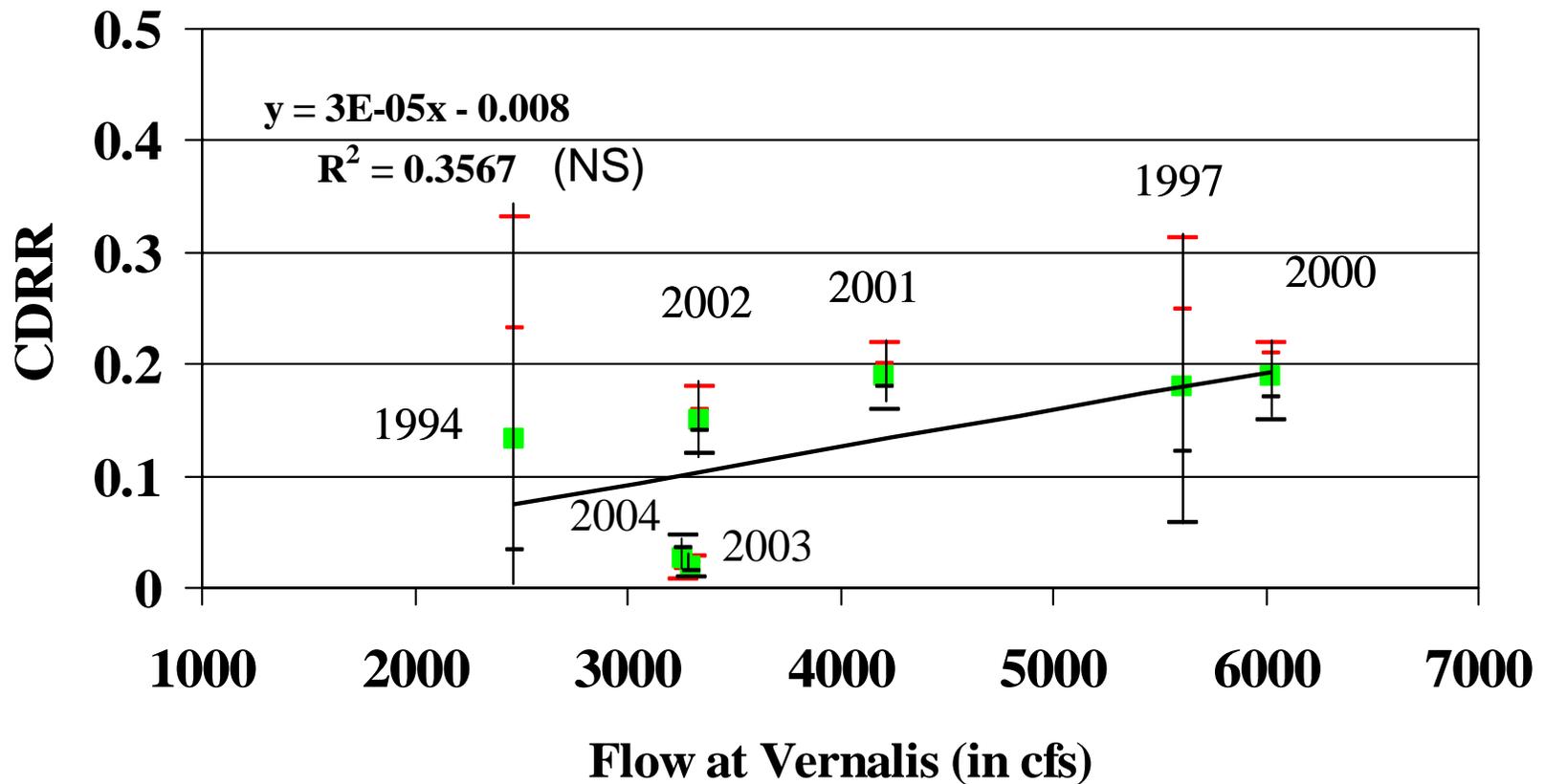
Ebb to flood

Source: Dave Vogel, 2002 Asilomar presentation

GS/Ryde Survival Ratio (with 95% confidence intervals)

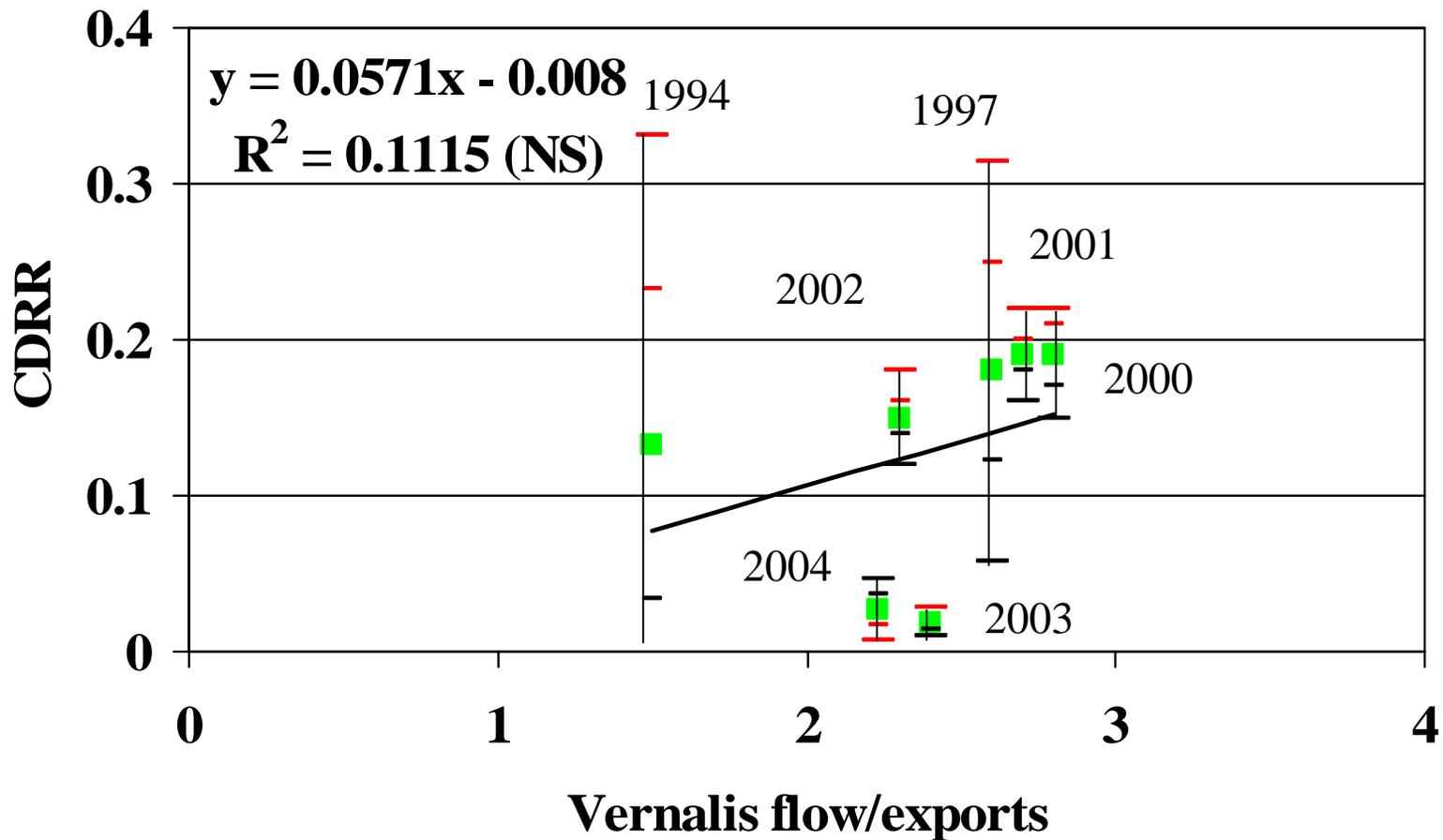


Exports in cfs (for 3 days after release)



— +2 SE
 - +1 SE
 ■ MEAN
 - -1 SE
 — -2 SE

Combined Differential Recovery Rate (CDRR) and (+/- 1 and 2 Standard Errors) from Durham Ferry and Mossdale to Jersey Point with HORB in place versus San Joaquin River flow at Vernalis in cfs, 1994, 1997, 2000-2004.



— +2 SE — +1 SE ■ MEAN — -1 SE — -2 SE

Combined Differential Recovery Rate (CDRR) and (+/- 1 and 2 Standard Errors) from Durham Ferry and Mossdale to Jersey Point with the HORB in place, versus inflow at Vernalis / exports, 1994, 1997 and 2000-2004.