Survival & Migratory Patterns of Central Valley Juvenile Salmonids

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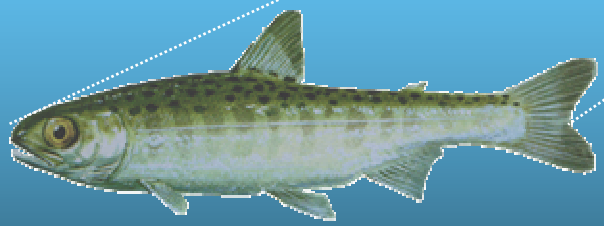


Objectives

1. Describe reach-specific rates of survival and movement
2. Explain variations in these rates

- Species: steelhead, late-fall Chinook salmon
- Origin: Coleman Nat'l Fish Hatchery
- Life Stage: smolts (yearling)
- Years: 2007-2009

Central Valley Salmonid Juvenile Movement and Survival: Some current knowledge

From release to ocean

	Sac R.	SF Estuary
Chinook Salmon		
Estimated time:		
Estimated survival:		
Yearling steelhead		
Estimated time:		
Estimated survival:		

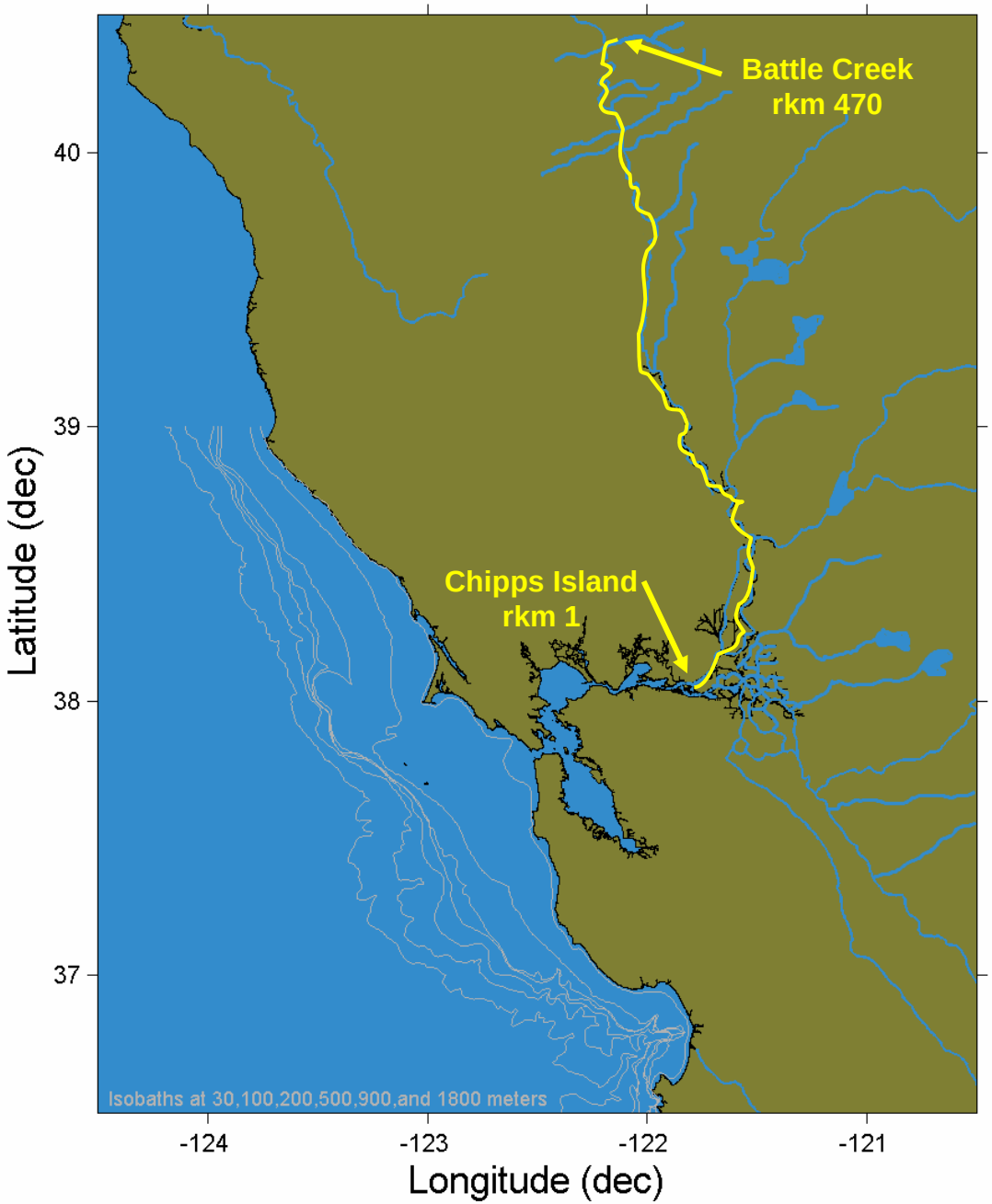
Movement

Late-fall juvenile Chinook salmon released at Battle Creek and recovered at Chipps Island*

1998 – 2003 Years
835 CWT fish recovered
Travel Time:
Mean of 22.5 days
Range of 5-150 days
Recovery Fork Length:
140.8 mm (15.8 mm SD)

Migration Rate = 20.9 km/d

Data from:
Bay Delta and Tributaries (BDAT) Project
http://baydelta.water.ca.gov/



Movement

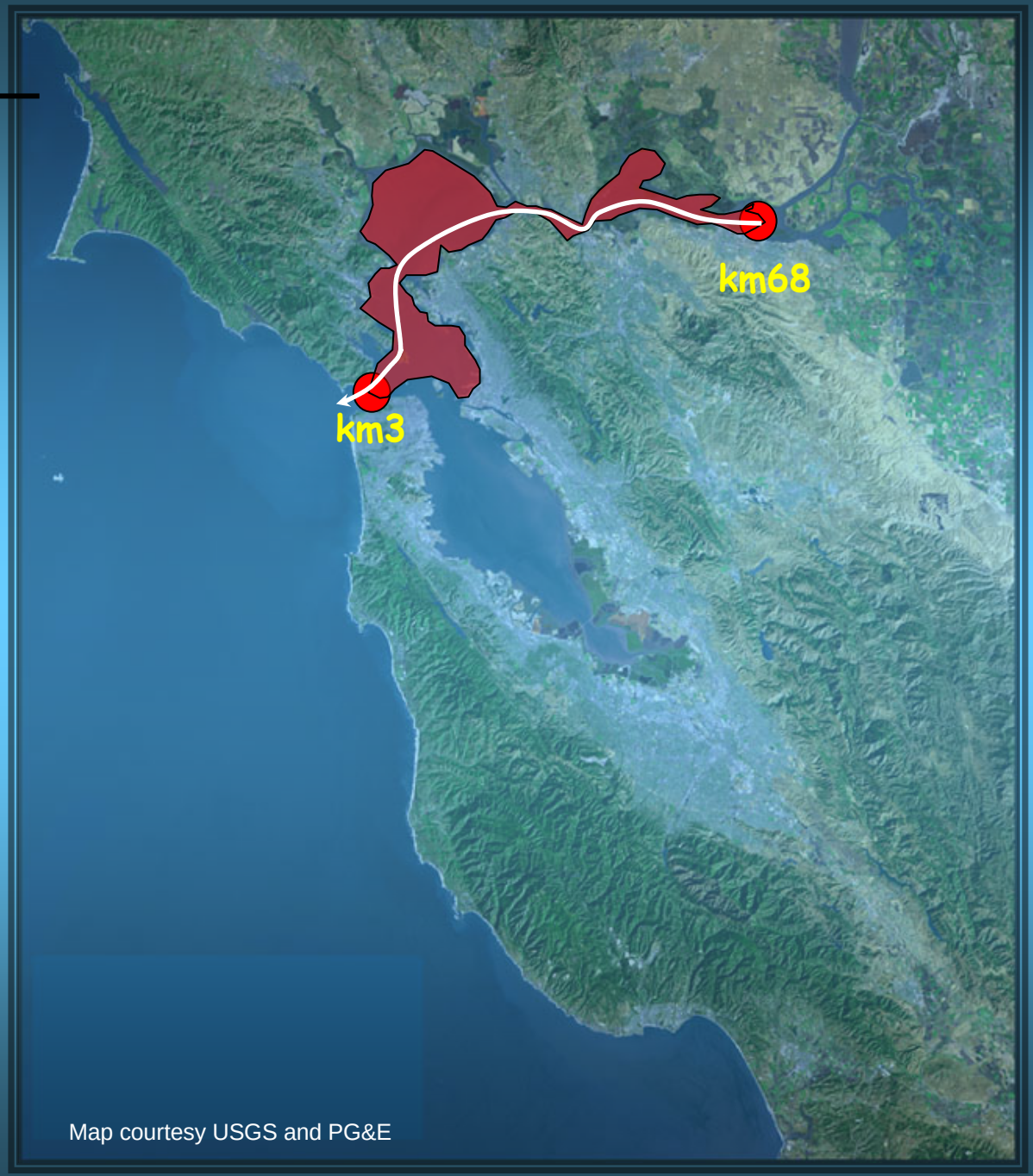
Fall-run juvenile Chinook Salmon Transit Time (days)

$$\frac{\bar{x}\ \text{age (km 3)} - \bar{x}\ \text{age (km 68)}}{\text{transit time}}$$

1995 – 28
1996 – 24
1997 – 40*
1998 – 8
1999 – 28
2000 – 22
2001 – 21

Migration Rate:
1.6 – 3.1 (8.1) km/d

*(MacFarlane & Norton 2002)



Map courtesy USGS and PG&E

Survival

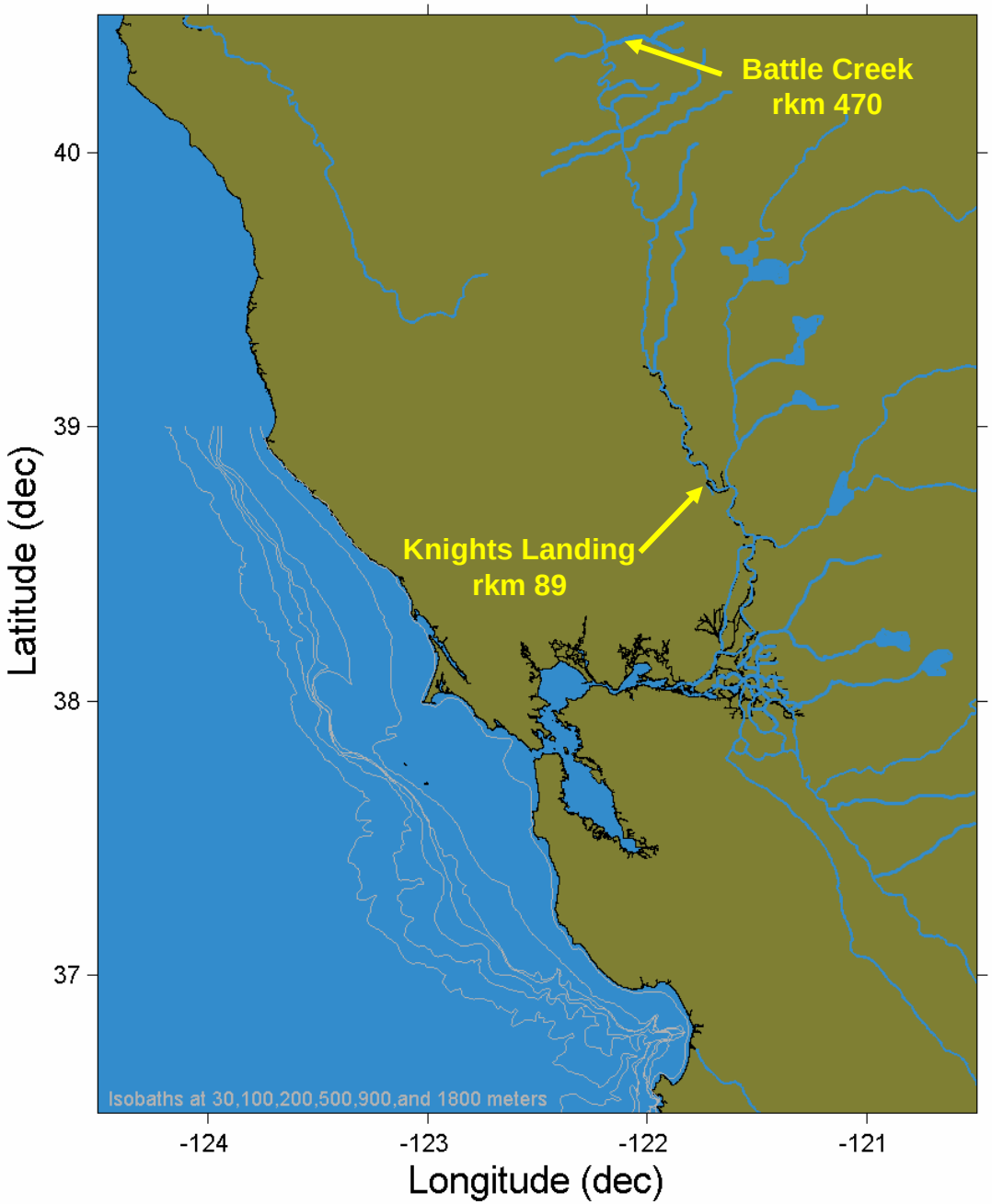
Late-fall juvenile Chinook

Snider & Titus 2000

- Battle Creek to Knights Landing (180 rkm)
- CWT, RST and trap efficiency
- Estimated 2.3%
- Underestimate – unknown portion of fish diverted thru Sutter Bypass at high flows

Brandes and McLain 2001

- **Survival Index lower if fish migrated through Delta**



Central Valley Salmonid Juvenile Movement and Survival: Some current knowledge

From release to ocean

	Sac R.	SF Estuary
Chinook Salmon		
Estimated time:	22 d	40 d
Estimated survival:	(>) 2.3%	?
Yearling steelhead		
Estimated time:		
Estimated survival:		

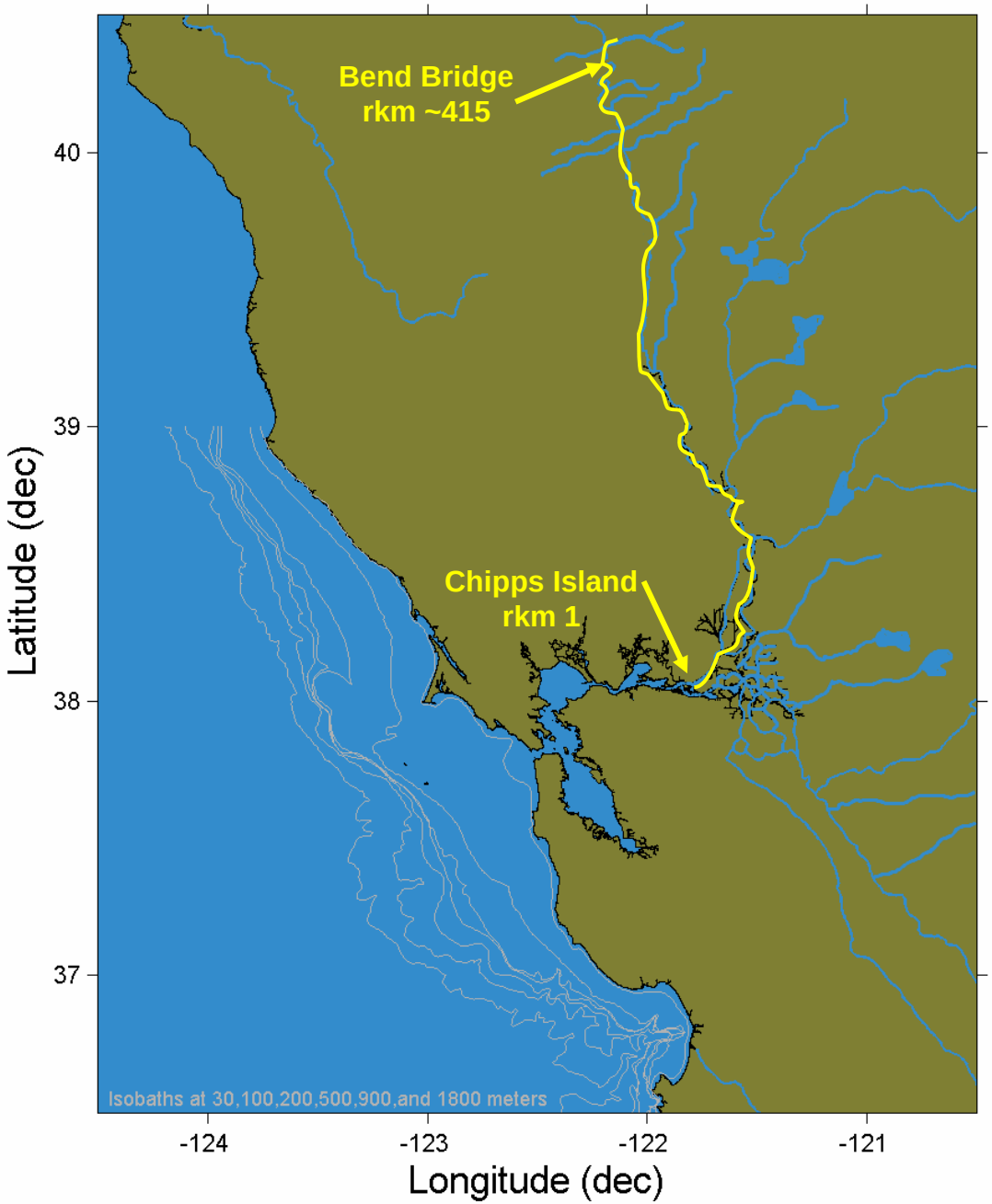
Movement

Yearling steelhead released at Bend Bridge and recovered at Chipps Island*

2000 – 2003 Years
53 CWT fish recovered
Travel Time:
Mean of 54.4 days
Range of 11-123 days
Recovery Fork Length:
225.3 mm (24.3 mm SD)

Migration Rate = 7.6 km/d

Data from:
Bay Delta and Tributaries (BDAT) Project
http://baydelta.water.ca.gov/

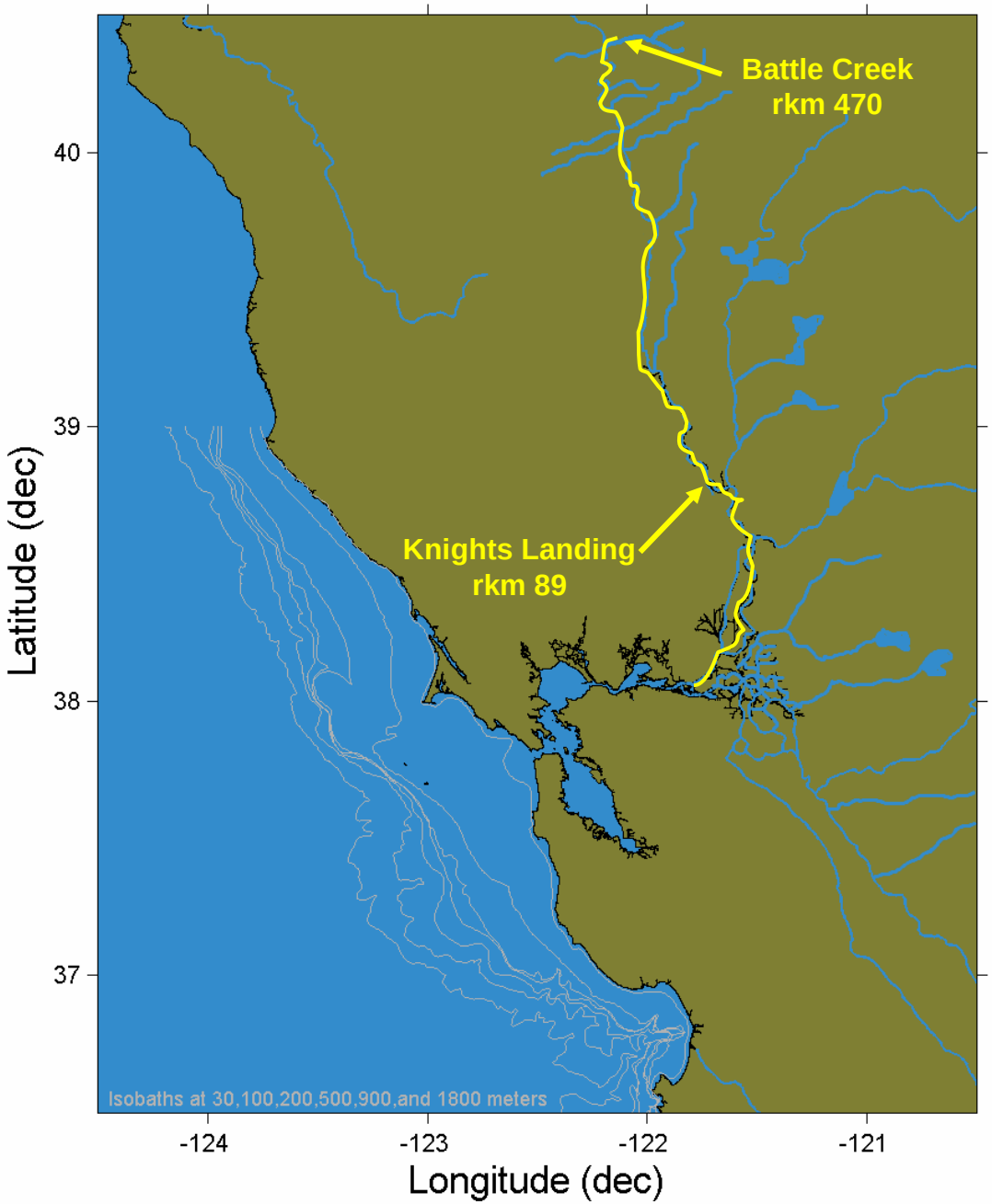


Survival

Yearling Steelhead

Snider & Titus 2000

- Battle Creek to Knights Landing (180 rkm)
- CWT, RST and trap efficiency
- Estimated 4.1%
- Underestimate – unknown portion of fish diverted thru Sutter Bypass at high flows



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From release to ocean

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Estimated time:	54.5 d	?
Estimated survival:	(>) 4.1%	?

*** Transmitter battery life > 63 days**

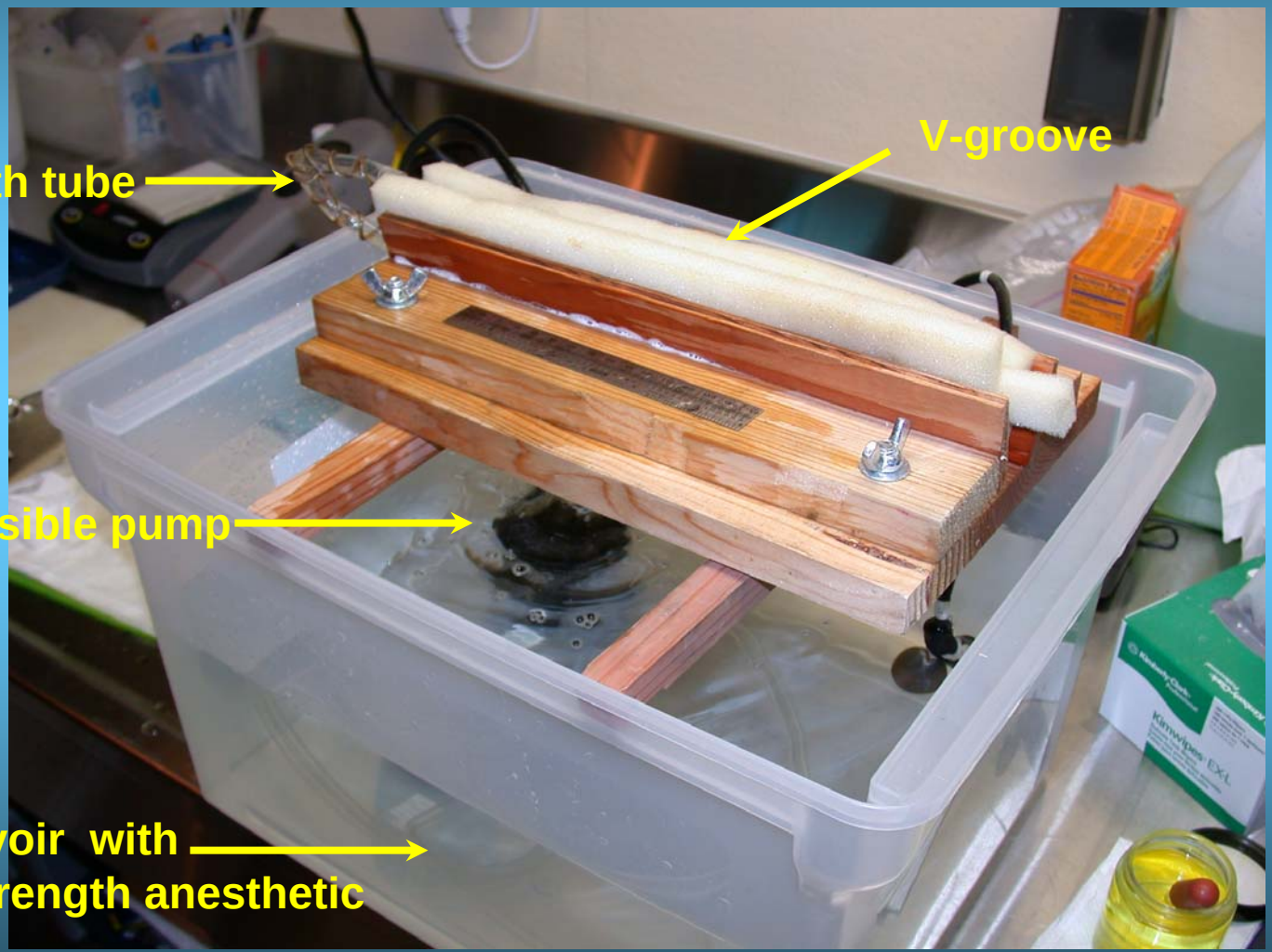
Benefits of Ultrasonic tagging:

- **Ease of “recapture”**
- **Inexpensive monitoring stations that work unattended for months at a time**
- **Tags are individually coded**

Overall: Movement and survival rates can be determined at a very fine scale (river segments)

Pilot Study: Surgically implanting transmitters

Prototype surgical table



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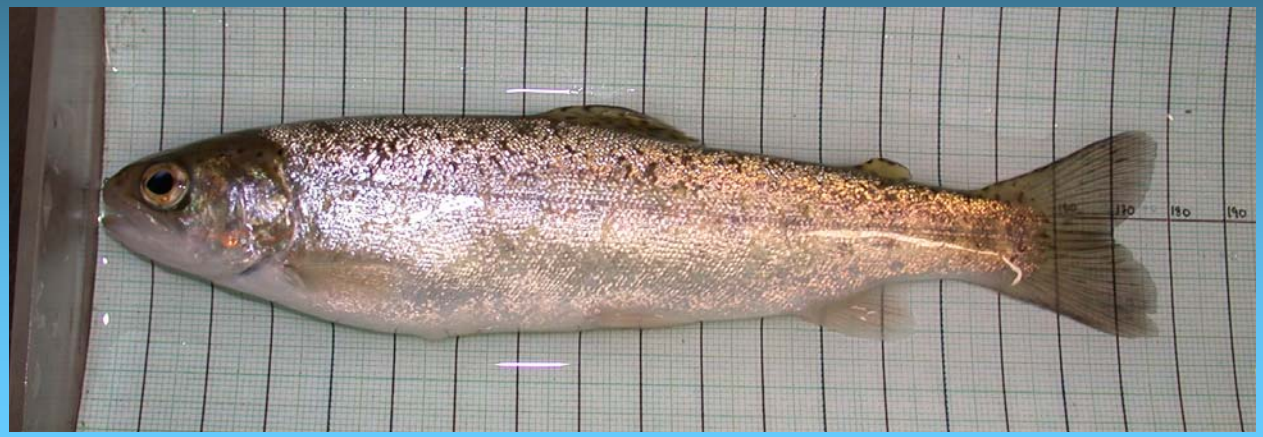
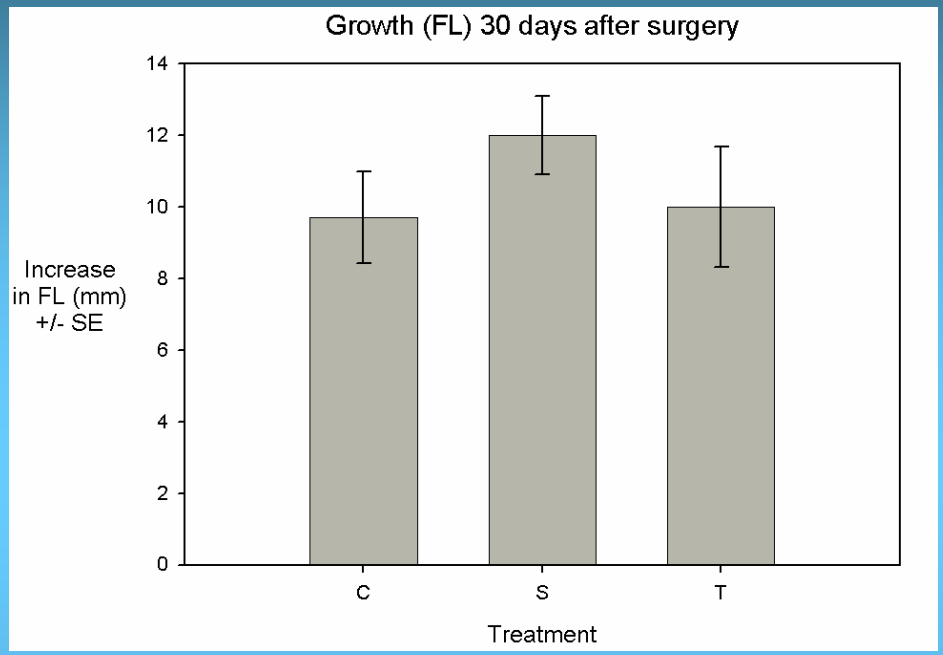
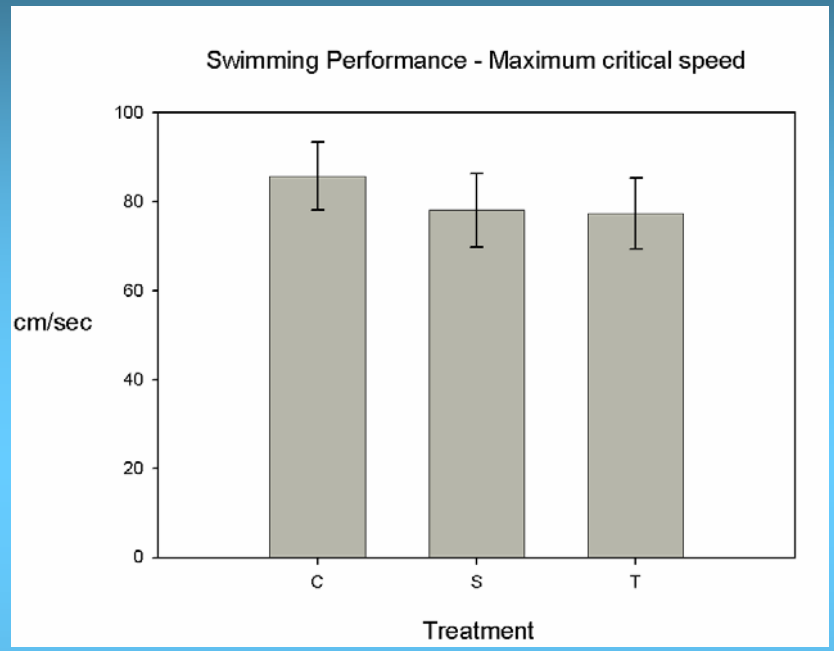


Steelhead 30-days after tag implantation

Pilot Study: Surgically implanting transmitters



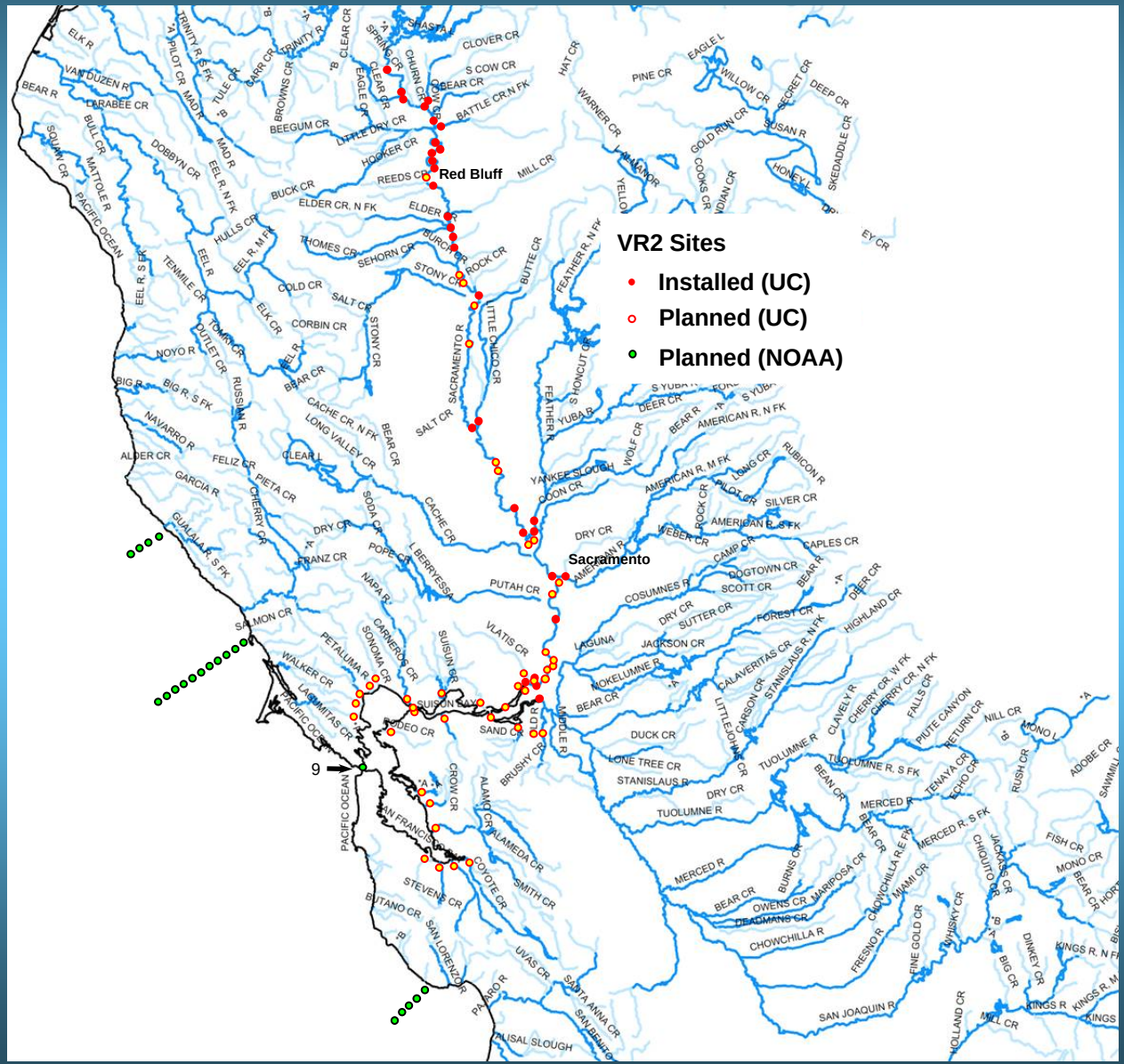


6 fish per treatment; ave FL = 160mm

Methods

- **Tag 200 Chinook and 200 steelhead per year for 2007, 2008, and 2009.**
- **Release 10 Chinook and 10 steelhead/day for 20 days during January**
- **Record reach-specific movement patterns and mortality with over 70 monitoring locations from Battle Creek to Golden Gate**

Monitor (node) Locations



Generalized Analysis: Movement

Question:

Does migration rate vary among reaches, and if so, why?

Null: migration rates are constant

Model migration rates and physical factors using multiple linear regression

Generalized Analysis: Survival

Question:

- **Does survival rate vary among reaches, and if so, why?**

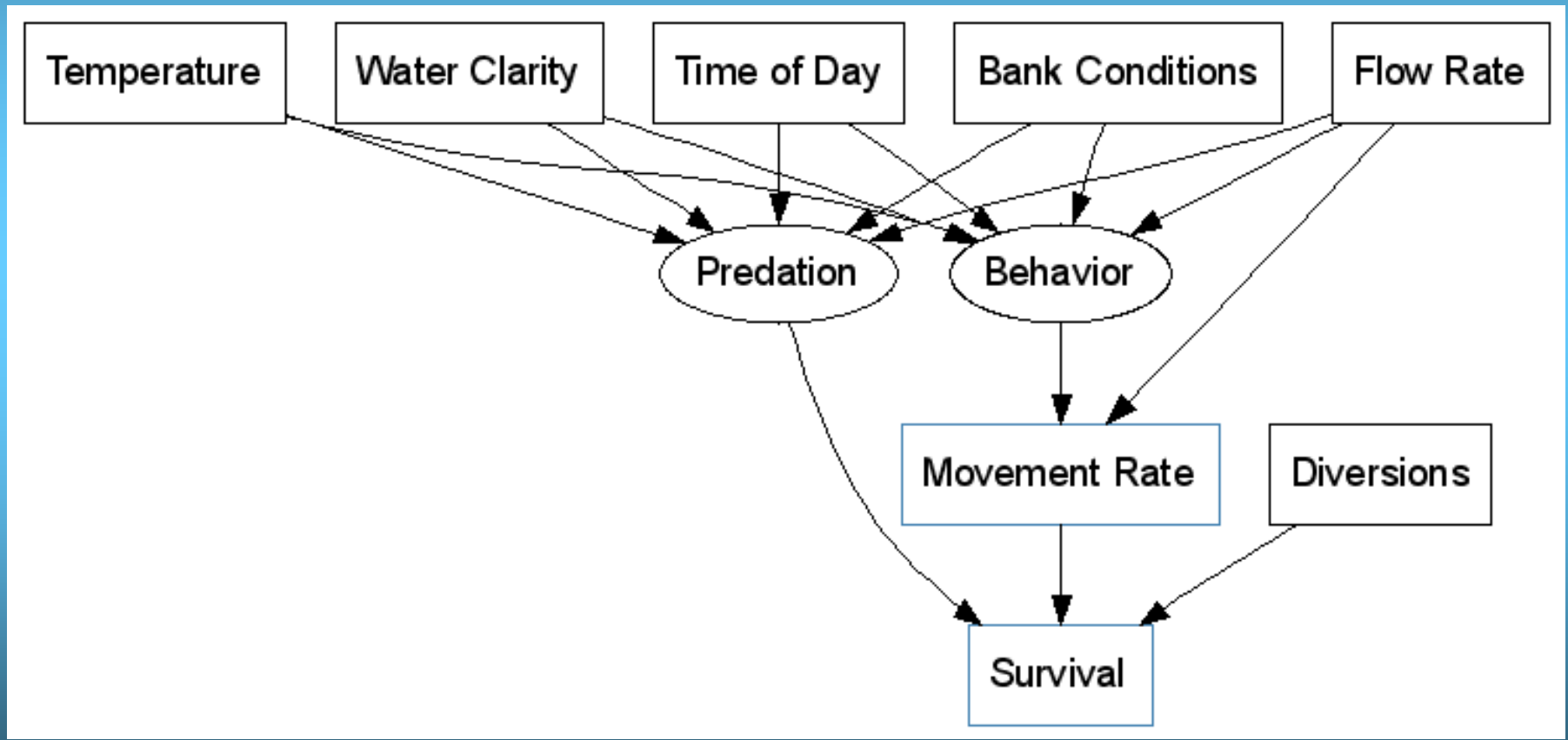
Detections arise from combined effect of:

- **Probability of survival to that point**
- **Probability of detection given survival**

Infer probabilities using maximum likelihood method

Model using program MARK

Model of factors that determine movement and survival



Variable	Source	Description
Water velocity	USGS	model local velocities with gage data velocities
	various	hydrodynamic model outputs
Water temperature	UC Davis	measured by each hydrophone mooring
Riparian vegetation	CDF	25 m resolution, derived from black and white air photos and Landsat TM
	ACoE	0.6 m resolution, derived from color air photos
Rip-rap	ACoE	0.6 m resolution, derived from color air photos

Dealing with ‘What ifs?’

What if survival is really high?

Define longer reaches

What if survival is really low?

Release some groups well below Battle Creek

What if a fish gets eaten by a predator?

Tags ‘behavior’ may be unusual compared to most other tags – assume tagged fish was eaten

Node placement

currents
&
turbulence

ships

bottom obstructions