

Migrations of salmon and trout in Puget Sound: New approaches to old questions

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Central question:

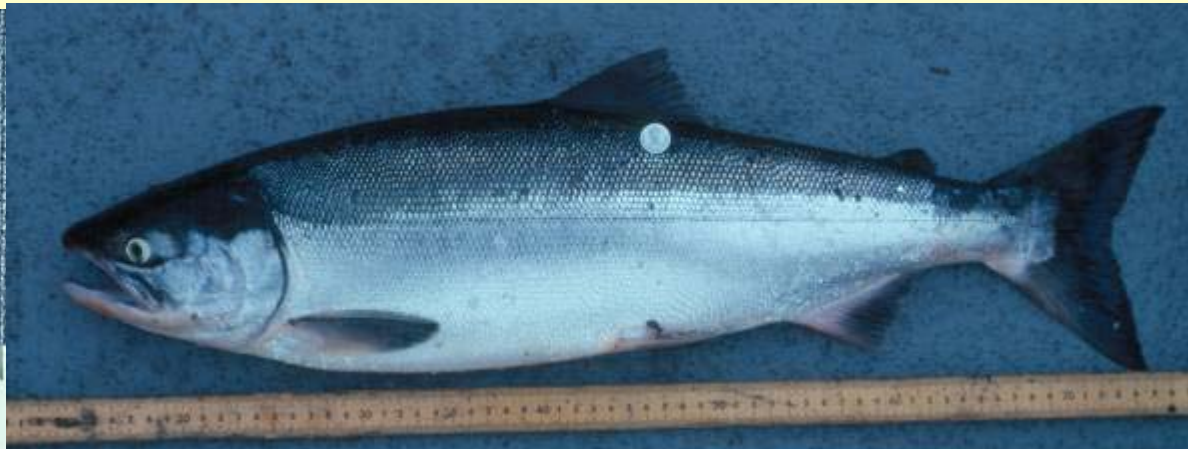
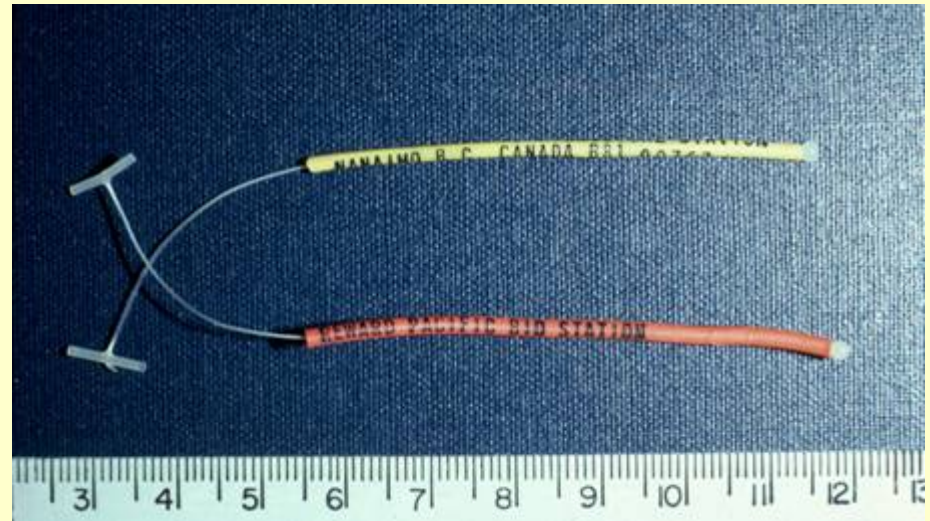
How do different species of salmon and trout use Puget Sound?

A) Is it a highway between breeding areas in streams and feeding areas in the Pacific Ocean, or a distinct rearing habitat?

B) How do individual fish behave: use of shorelines, rate of travel, time of day, tidal stage, home range, etc.?

Traditional methods for studying salmon migrations: 1) tag adults

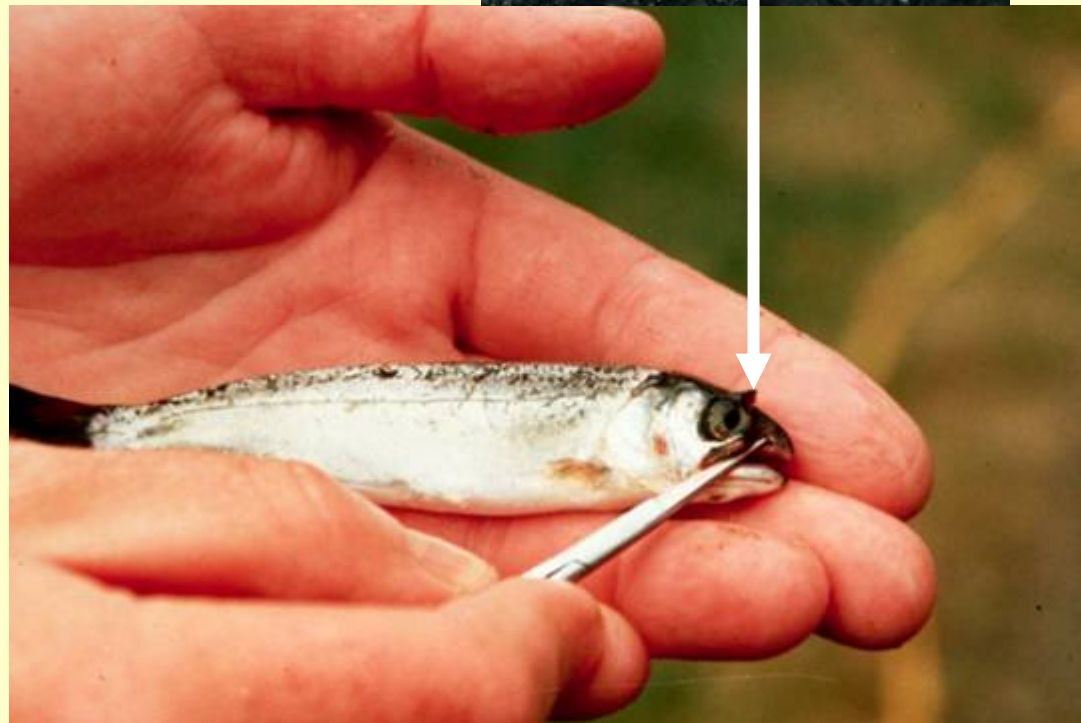
Tag immature or maturing salmon at sea and recover them in coastal areas or rivers



Traditional methods for studying salmon migrations: 2) tag juveniles

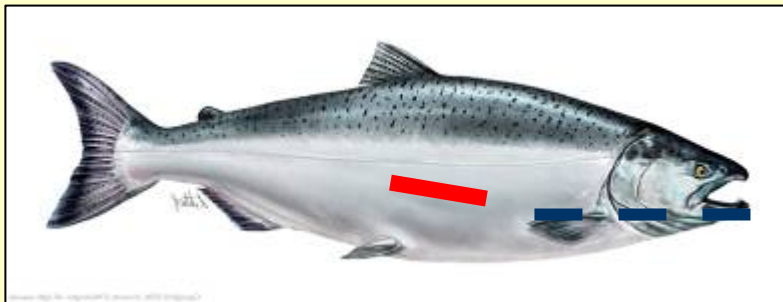
Tag juvenile salmon in freshwater and recover them at sea, defining the ocean range of that population

Magnetized coded wire tag and a coho salmon smolt



Radio and ultrasonic tracking

Transmitters allow us to gather more data on the movements of individual fish than simple tag-recapture studies. These techniques are costly and labor intensive but can provide fascinating insights.



Fish + transmitter + receiver

Project RASTAMAN

Radio And Sonic Tracking Applied to Migration And Navigation



Old way: Follow tagged fish from a boat

Current system: Use fixed listening stations to detect fish as they swim by

Both approaches are costly but now we get longer-term data on individuals



This collaborative research effort involves:



U of W: Fred Goetz and Josh Chamberlin



NOAA-Fisheries: Barry Berejekian, Skip Tezak, Anna Kagley, Kurt Fresh, Correigh Greene, John Ferguson

Nisqually and Puyallup tribal fisheries offices, and the Northwest Indian Fisheries Commission: Sayre Hodgson, Scott Steltzner

Seattle City Light: Ed Connor

USGS: Reg Reisenbichler, Mike Hayes, Steve Rubin

Evergreen State College: Sarah Haque

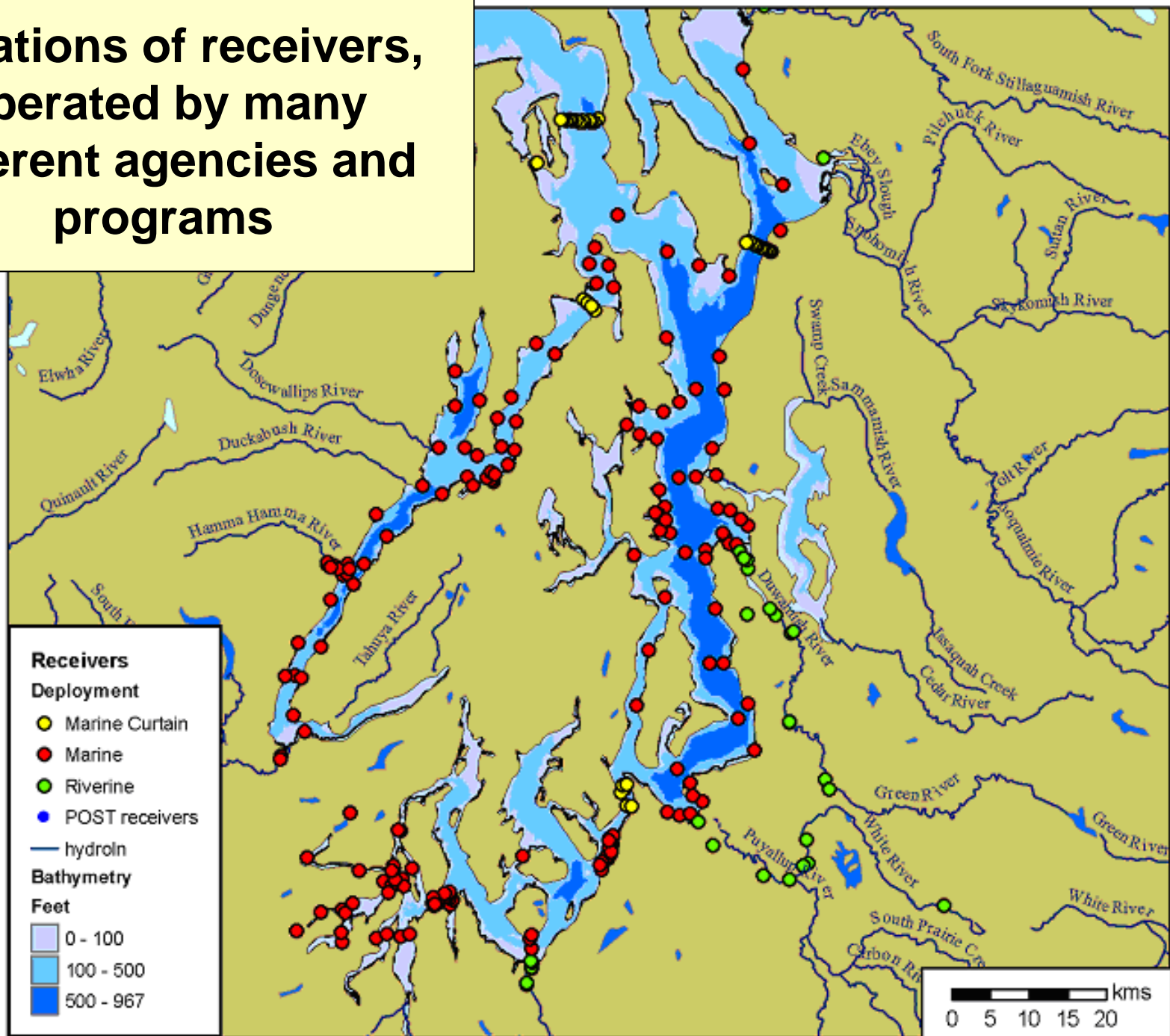
Canadian POST system: David Welch, UBC

And many other individuals, including but not limited to Eric Jeanes, Curt Cramer, Chris Ellings, Joe Jacquet...

Fred Goetz



Locations of receivers, operated by many different agencies and programs



Different species - different patterns: The conventional wisdom

- 1) Steelhead: smolts go out to the open ocean**
- 2) Chinook and coho salmon: most go to the coast but “residents” rear in Puget Sound**
- 3) Cutthroat trout and bull trout: remain in Puget Sound, near their natal stream**

Movement and survival of steelhead smolts: 2006 - 2008

- **Puget Sound steelhead listed are Threatened under the ESA, also declining in southern B.C.**
- **Sites: Skagit, Green, Puyallup, Nisqually rivers**
- **Goal: Assess movement and survival as smolts migrate from river to estuary, nearshore, and marine waters**



Detections of 46 wild Nisqually River steelhead in 2006

Analysis courtesy of Sayre Hodgson, Nisqually Tribal Fisheries Office

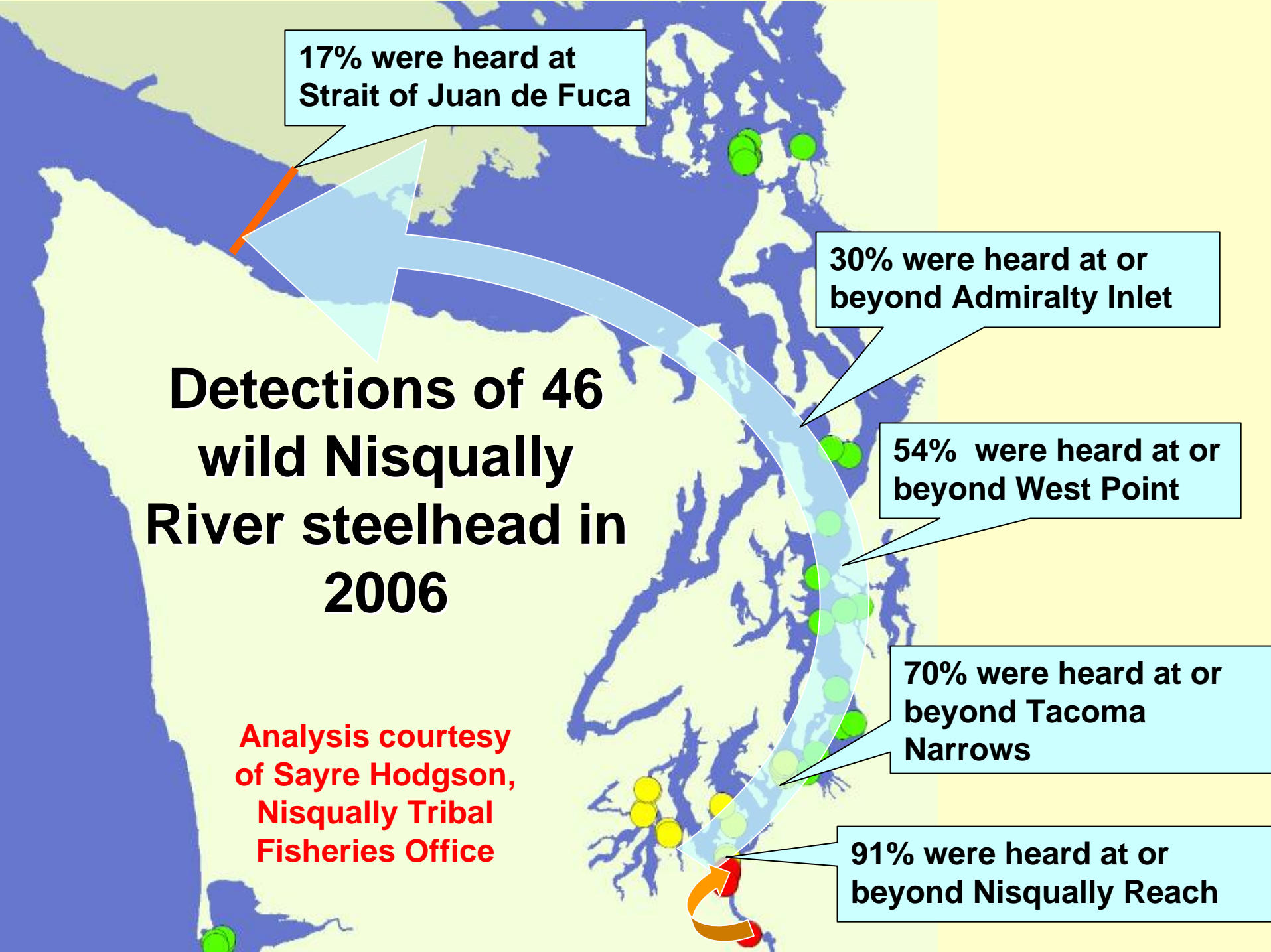
17% were heard at Strait of Juan de Fuca

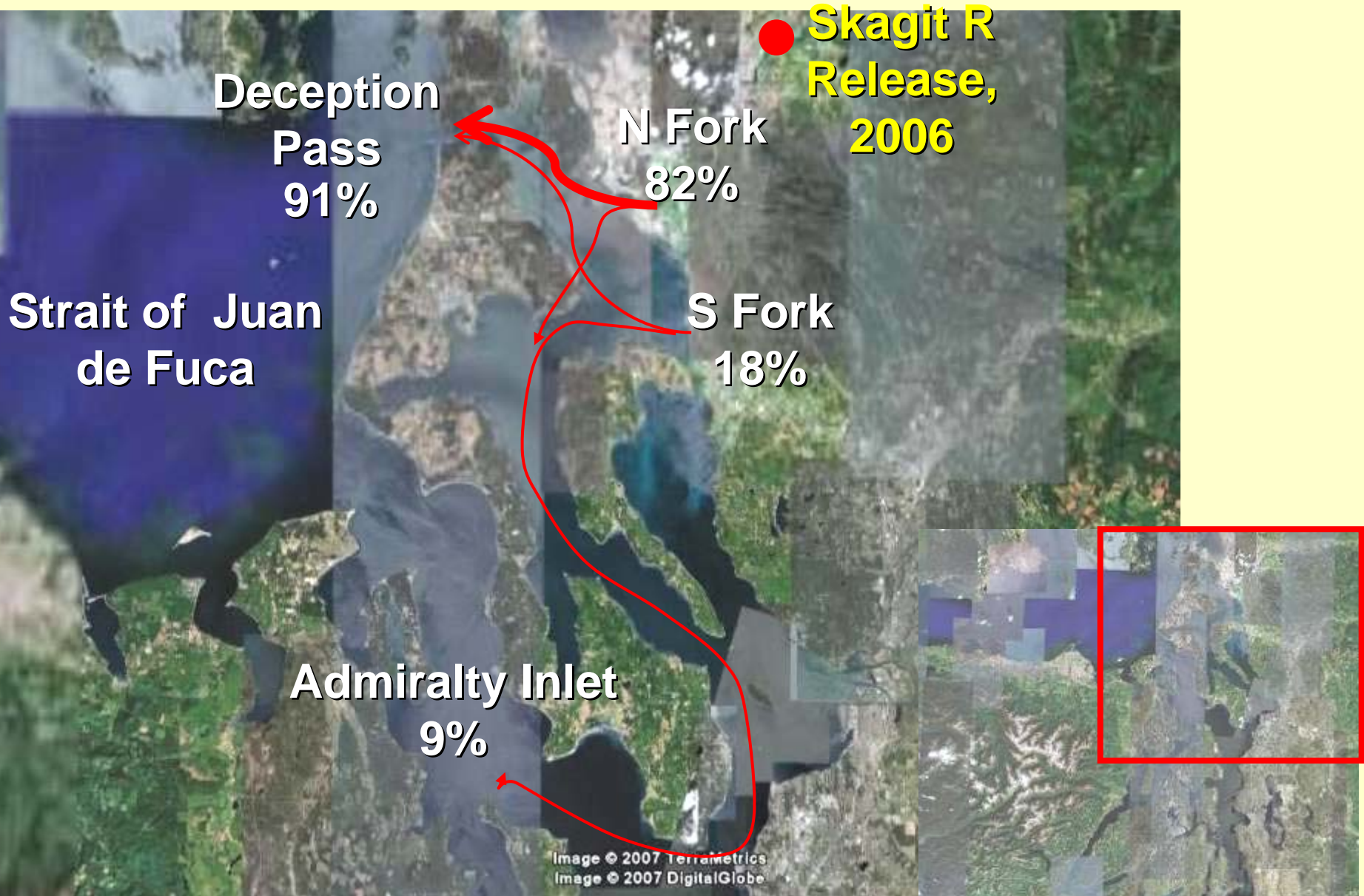
30% were heard at or beyond Admiralty Inlet

54% were heard at or beyond West Point

70% were heard at or beyond Tacoma Narrows

91% were heard at or beyond Nisqually Reach





Migration paths of Skagit River smolts

Are there linkages between migration routes, travel rates, and survival?

- 1) Do fish that migrate down the North Fork of the Skagit River tend to use Deception Pass more than those migrating down the South Fork?**
- 2) Do fish that migrate out via Deception Pass reach the Strait of Juan de Fuca sooner than those migrating around the south end of Whidbey Island?**
- 3) Are fish that migrated via Deception Pass more likely to survive and leave Puget Sound than those migrating around Whidbey Island?**

Movements of Chinook salmon: Migratory and resident behavior patterns

Sub-adults caught in Puget Sound with purse seines, tagged, and detected as they move around



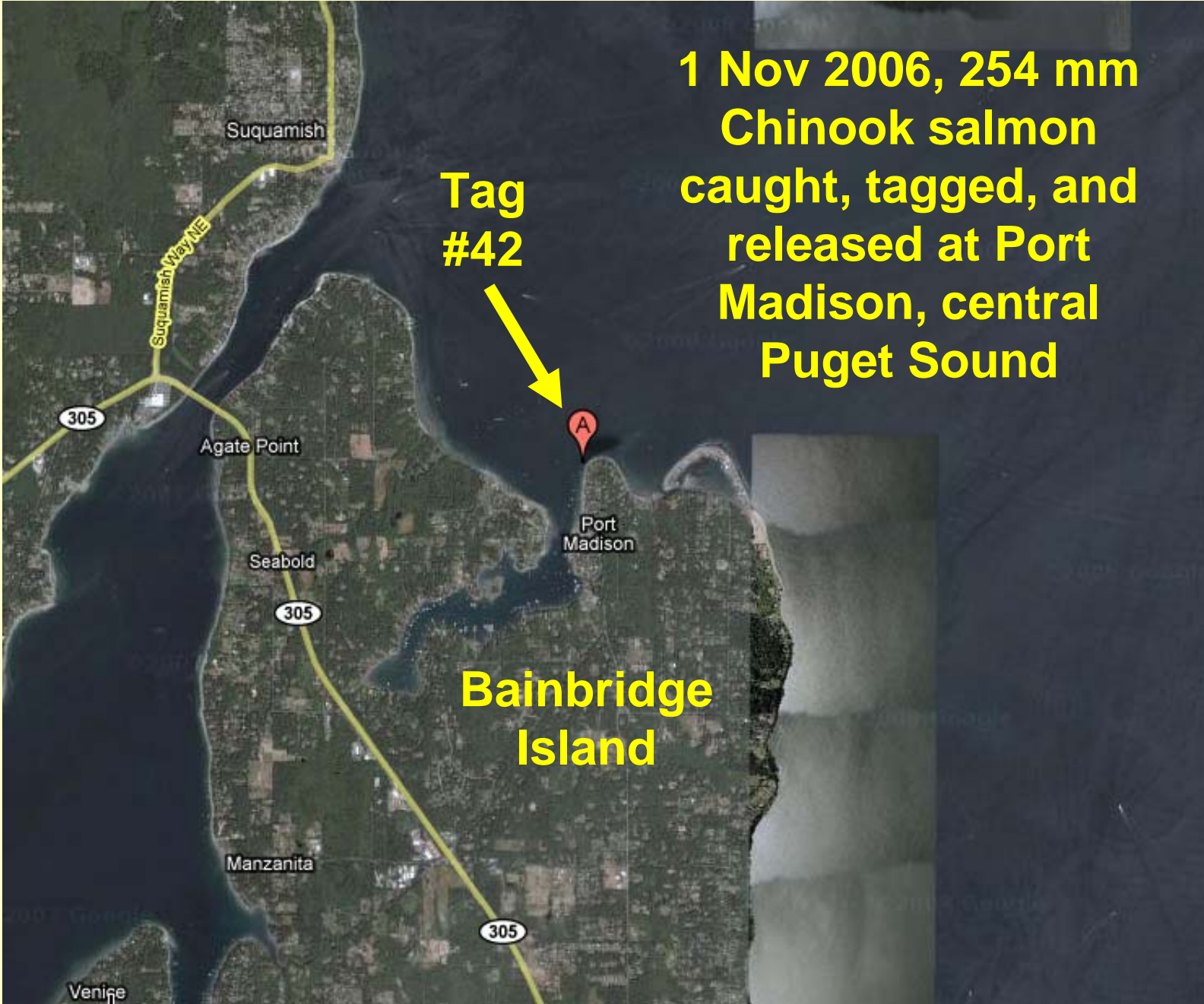
**1 Nov 2006, 254 mm
Chinook salmon
caught, tagged, and
released at Port
Madison, central
Puget Sound**

**Tag
#42**



A

**Bainbridge
Island**



- 1. **Departure:** Tag 42 - Strait of Juan de Fuca, detected at receivers 28 and 29 on Nov 16 – Average Depth 12.5 m
- 2. **Return:** March 14 2007 detected at receiver 12, 5.5 m



March 14 2007

November 16 2006

SJF 28 - Nov 16
SJF 29 - Nov 16



Strait of Juan de Fuca

Chinook #42: detected at the Strait of Juan de Fuca on Nov 16 and then off the coast from Dec 3 2006 to Jan 1 2007. It covered the ~280 km in 17 days (16.5 km/day)

It then was detected at the Strait of Juan de Fuca in March 2007, two months after it was last detected along the coast.

Data courtesy of POST (Pacific Ocean Shelf Tracking)

Willamette Line

SJF 28 - Nov 16
SJF 29 - Nov 16

Will 27 - Dec 3
Will 26 - Dec 29
Image NASA
Image © 2009 DigitalGlobe
Image © 2009 TerraMetrics
Image State of Oregon



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Questions about movement patterns

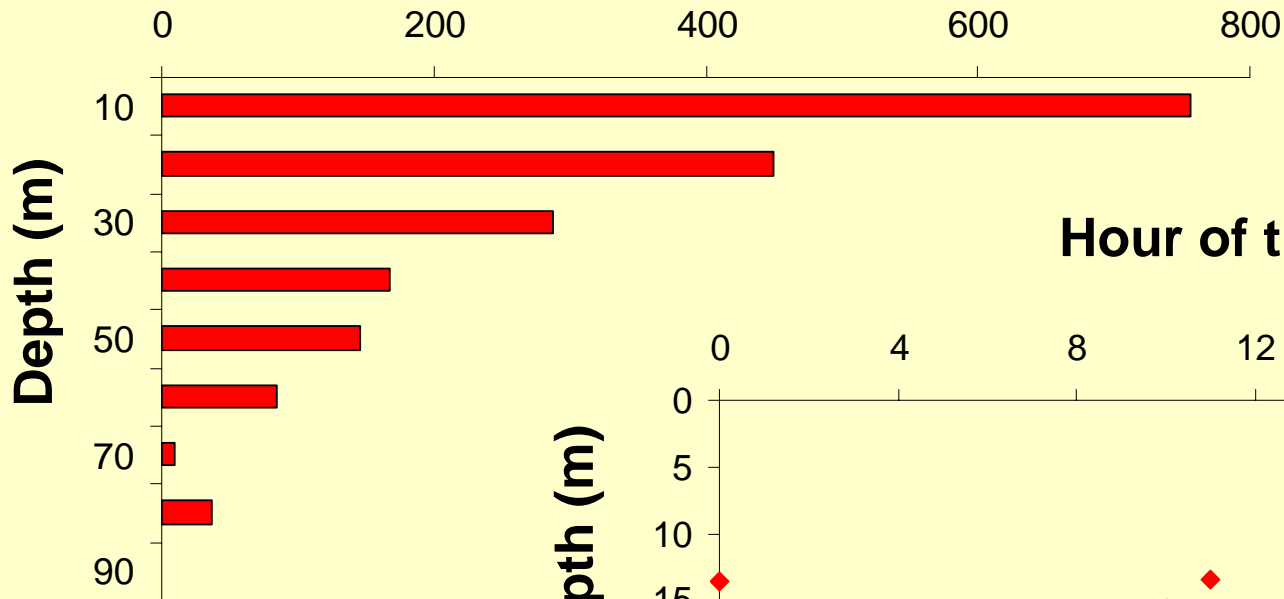
- 1) Do resident and migratory Chinook salmon represent distinct types, or extremes of a continuum of patterns?**
- 2) How often and how far do salmon move within Puget Sound?**
- 3) Do salmon show home ranges or regular, repeated use of selected but distant sites?**

Some of the transmitters have pressure transducers, indicating the ambient depth

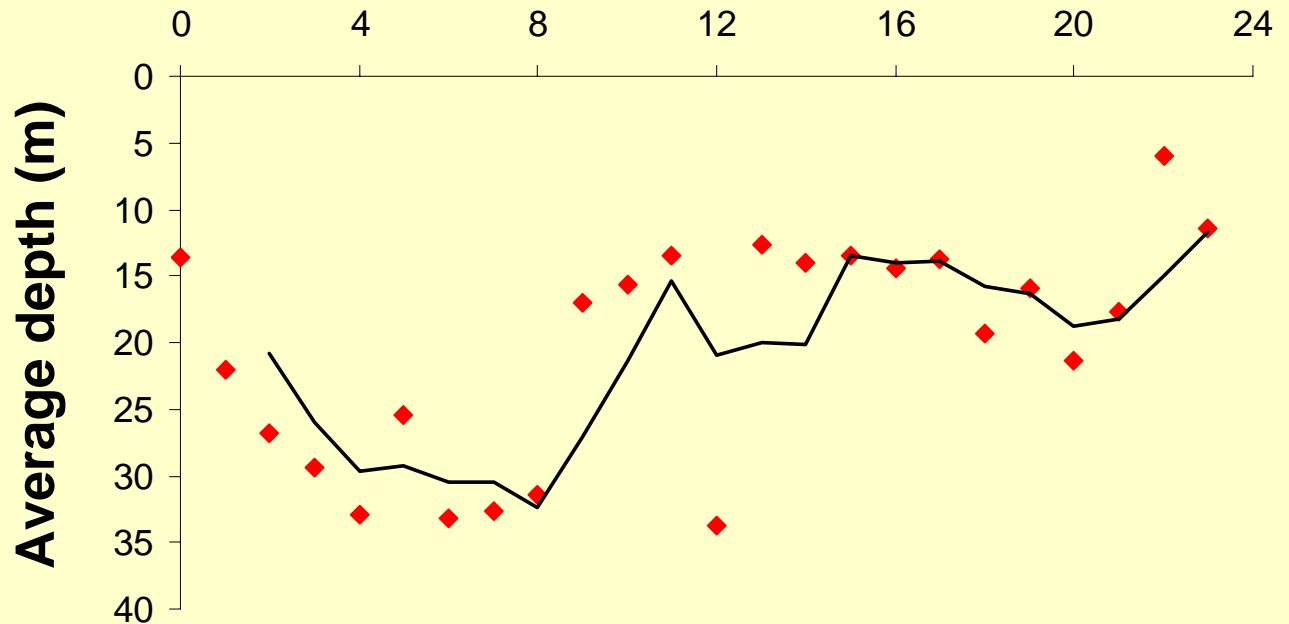
- 1) What is the overall depth distribution of the fish?**
- 2) Does the depth distribution change as the fish increase in age and size?**
- 3) Are there seasonal changes in depth of travel?**
- 4) Are there diel (day – night) patterns of vertical distribution?**

Vertical distribution of maturing Chinook salmon off West Point, Seattle

Number of detections



Hour of the day



**N = 21 fish
and 1941
detections**

Puget Sound cutthroat trout

- **Very little information on the behavior of cutthroat trout in marine waters**
- **Believed to remain near shore and near their natal stream during seasonal marine periods**
- **Catch and release fishing in Puget Sound**



Study areas

Skagit Bay/River
Whidbey Basin



Big Beef Creek
Hood Canal



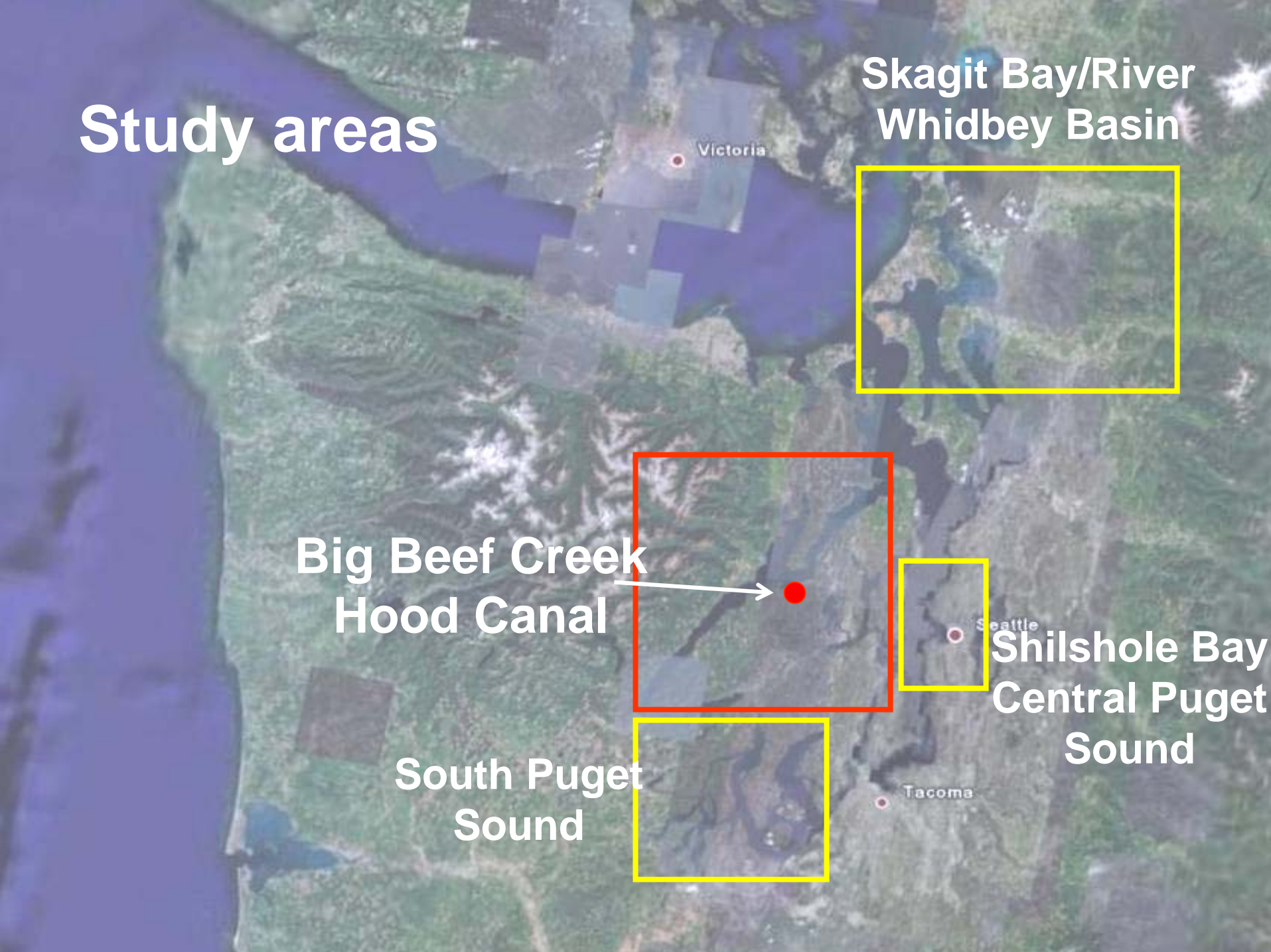
Seattle
Shilshole Bay
Central Puget
Sound



South Puget
Sound



Tacoma

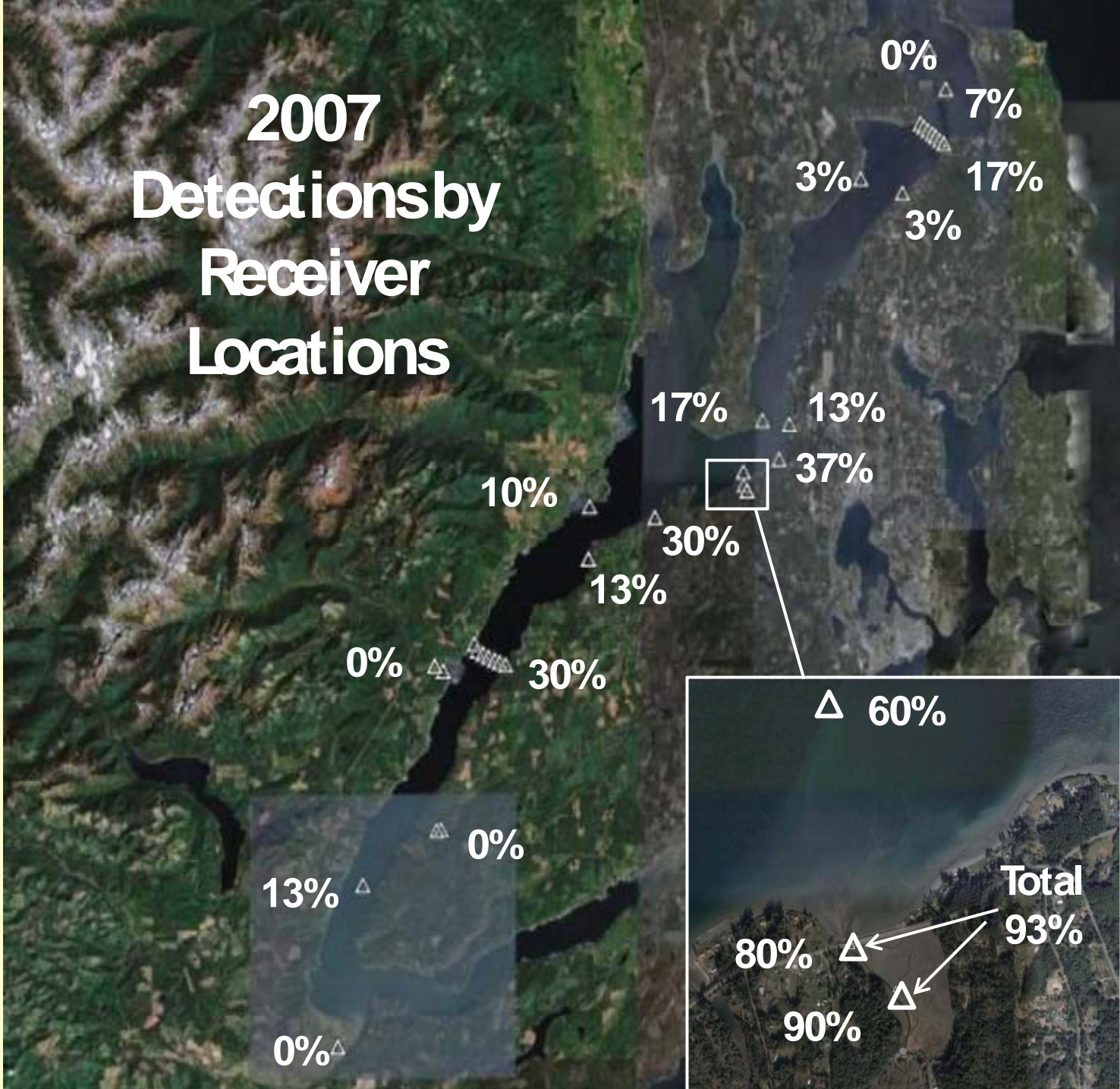


Hood Canal cutthroat trout

- **Big Beef Creek – Kitsap Peninsula tributary**
- **Tagged ~ 30 fish per year in spring 2006, 2007 and 2008; detections through fall**
- **Receivers near shore and the Hood Canal Bridge**



2007 Detections by Receiver Locations



2007 Single Fish

- 1) North *and* South Movement;
- 2) Multiple canal crossings

Hood Canal
Bridge

19 km/ day

9 km/ day

Hamma
Hamma
River



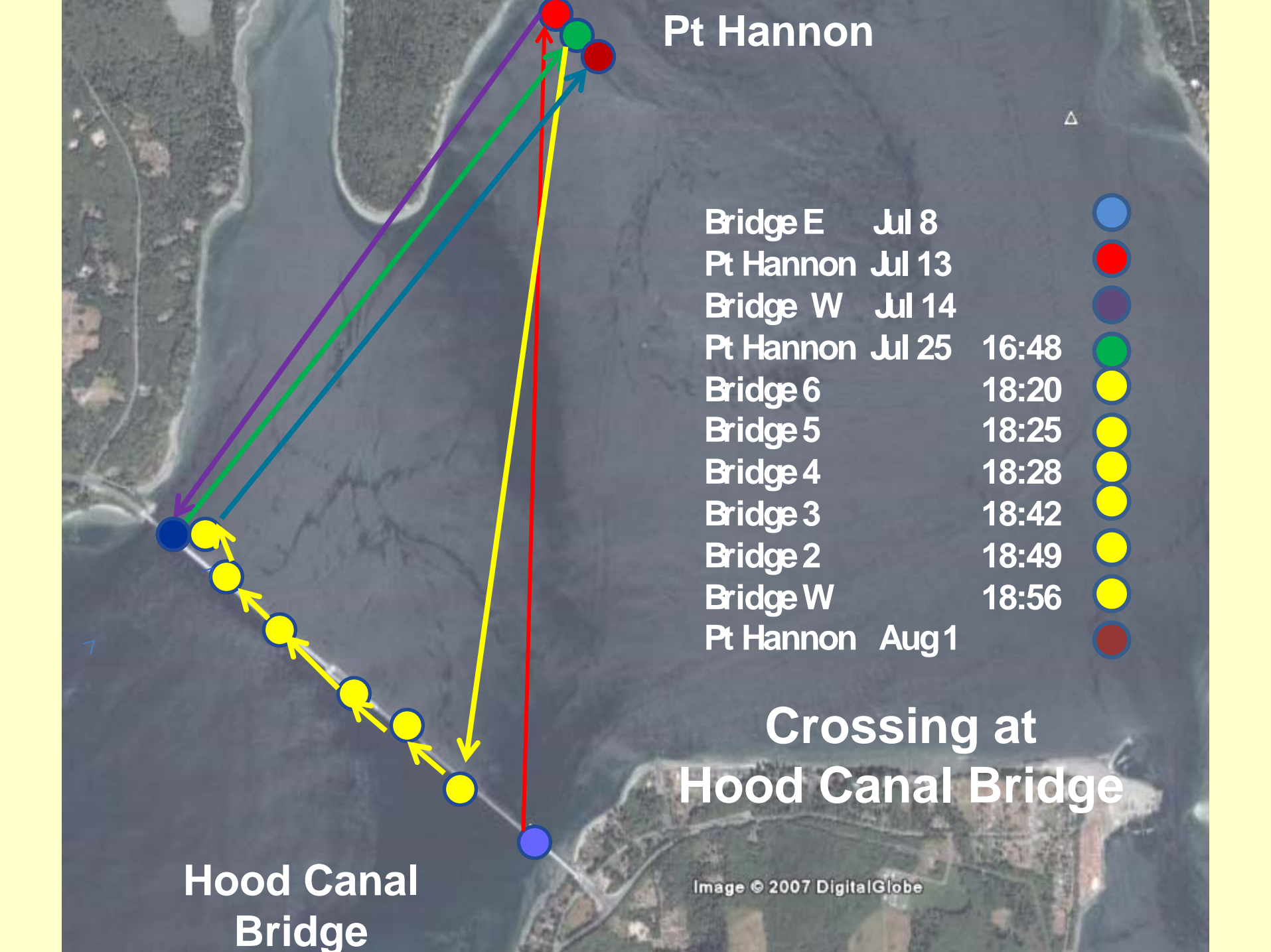
Pt Hannon

Bridge E	Jul 8	
Pt Hannon	Jul 13	
Bridge W	Jul 14	
Pt Hannon	Jul 25	16:48
Bridge 6		18:20
Bridge 5		18:25
Bridge 4		18:28
Bridge 3		18:42
Bridge 2		18:49
Bridge W		18:56
Pt Hannon	Aug 1	

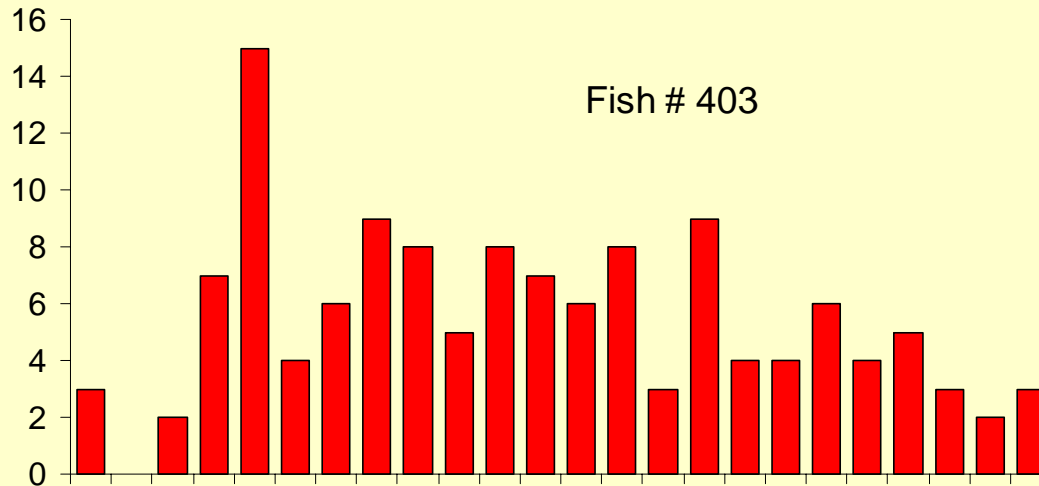
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Crossing at Hood Canal Bridge

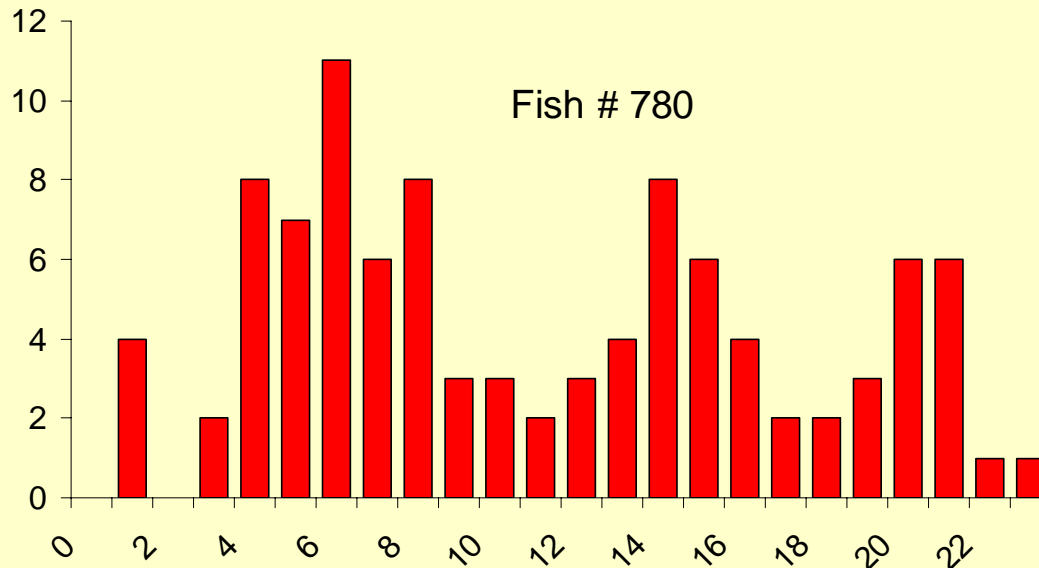
Hood Canal Bridge



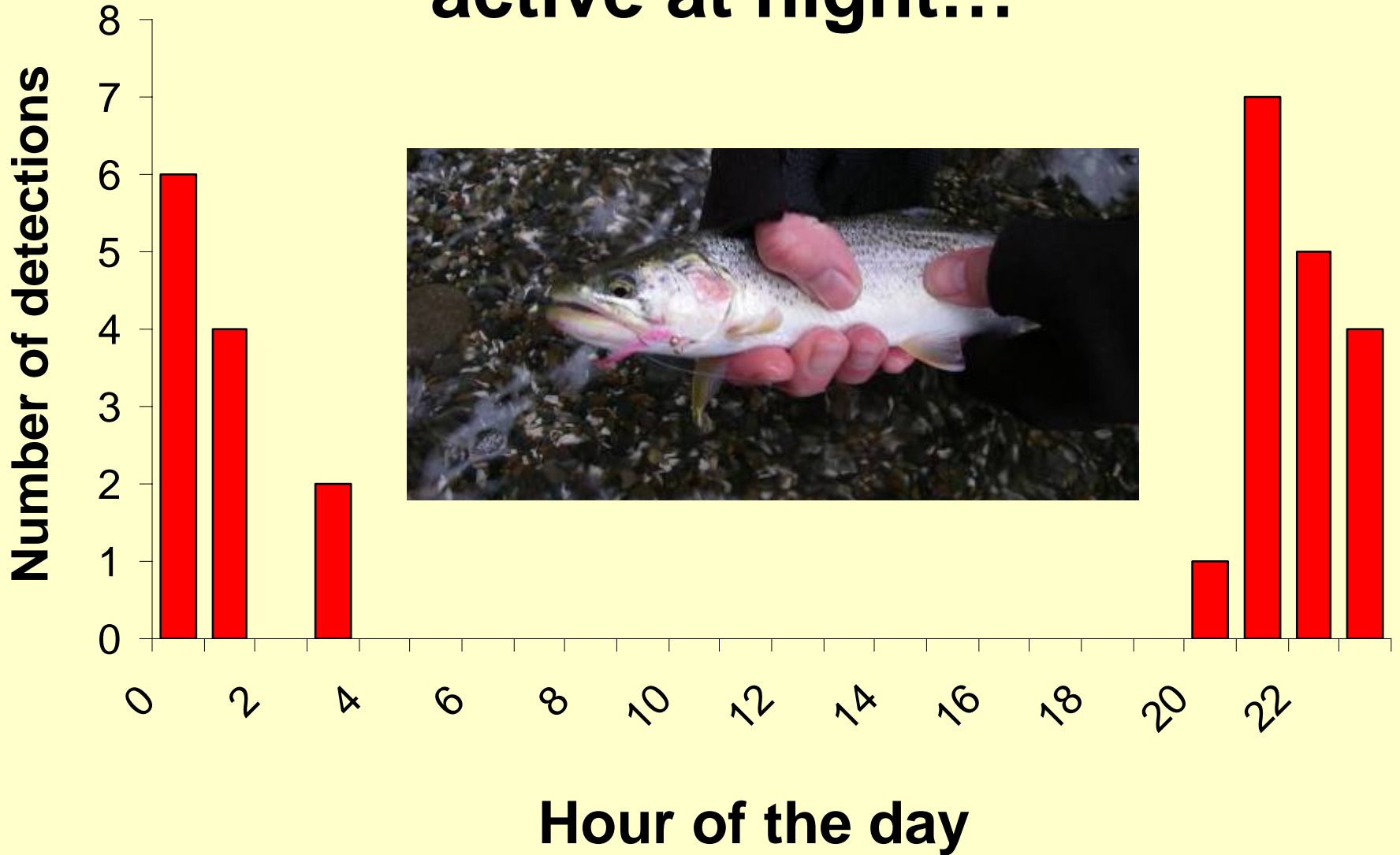
Are cutthroat trout more active in the day or at night?



Two fish that were most active during the day



But one individual was most active at night...



Big Beef Creek cutthroat trout: Summary

Wide range of behaviors:

- Transients with complex movements: some moved over 200 km, up and down both shorelines of Hood Canal**
- 25% (2006) and 33% (2007) crossed Hood Canal (3 km open water); some fish crossed repeatedly**
- Habitat use – some fish remained in localized areas for days to weeks but occupied multiple sites over time**

Patterns of movement with respect to the time of day and stage of tide are being assessed





Coho salmon also show resident migration patterns, and we are tracking them as well

Summary

Collaborative work is taking place to further our understanding of salmon and trout in Puget Sound, and to use this information for their conservation. Thanks to NOAA-Fisheries for primary funding, and everyone who is helping.



