

POST- A permanent continental-scale ocean observing array for fisheries research: Performance and scientific relevance

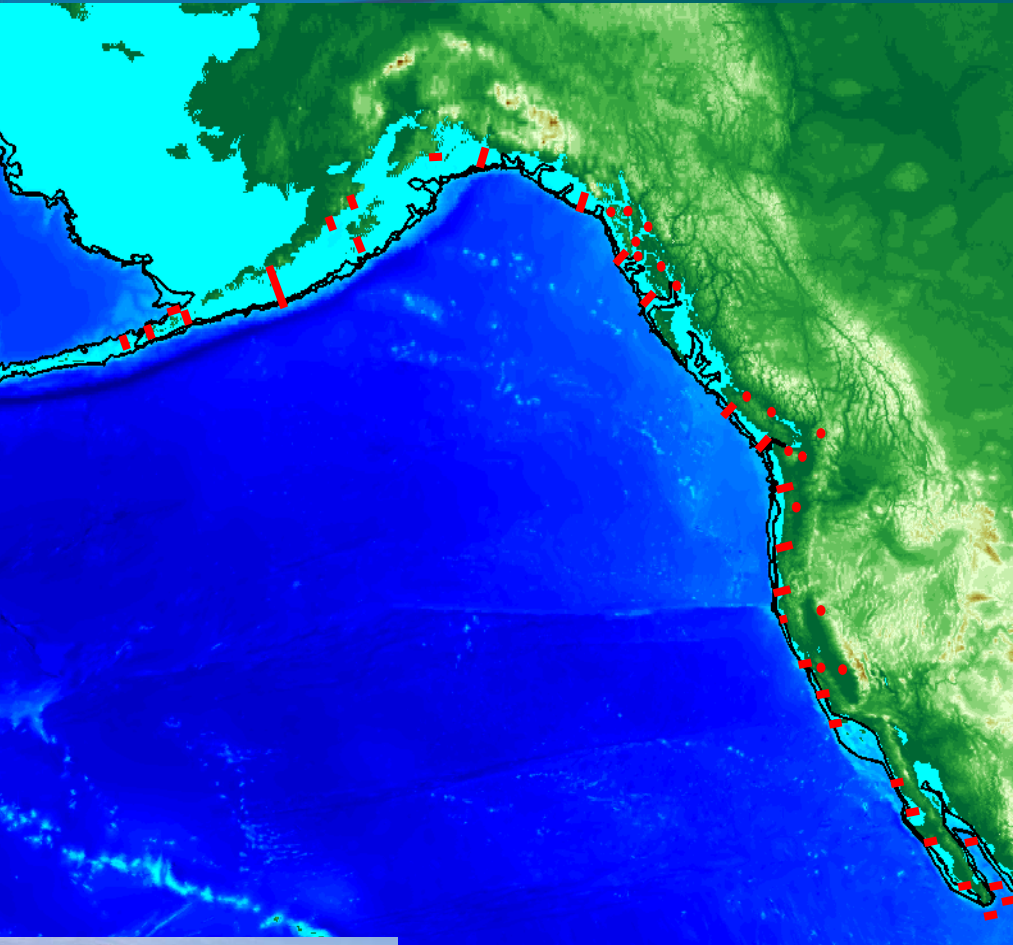
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Goals of the POST Project



- A permanent continental-scale array
- Directly measure movement, distribution and survival of fish-including salmon- in continental shelf waters
- Develop the ability to follow individual fish– or separate stocks – for decades.
- Expand the scientific observations to encompass a much wider range of oceanographic observations

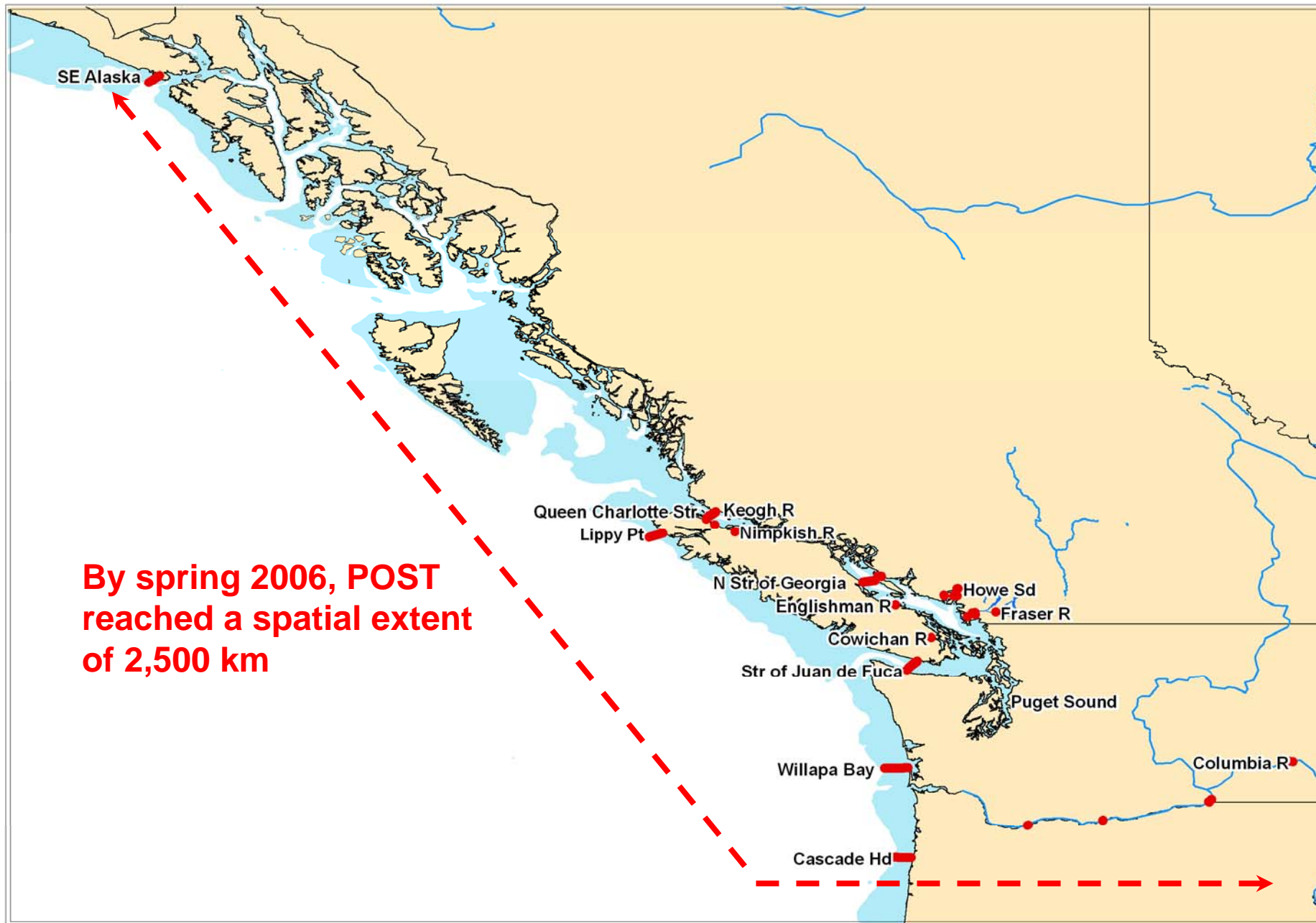


Gordon and Betty
MOORE
FOUNDATION

*Creating positive outcomes
for future generations.*



POST Array, 2006



What is POST/OTN?



POST is intended to be a vast Continental-Scale array of low-cost sensors

- Secretariat managed by Vancouver Aquarium
- Secretariat supported by funds from Census of Marine Life, & is 1 of 17 key CoML field programs
- Operational funding comes from Foundations with an interest in salmon conservation, and government agencies who need answers to key policy questions

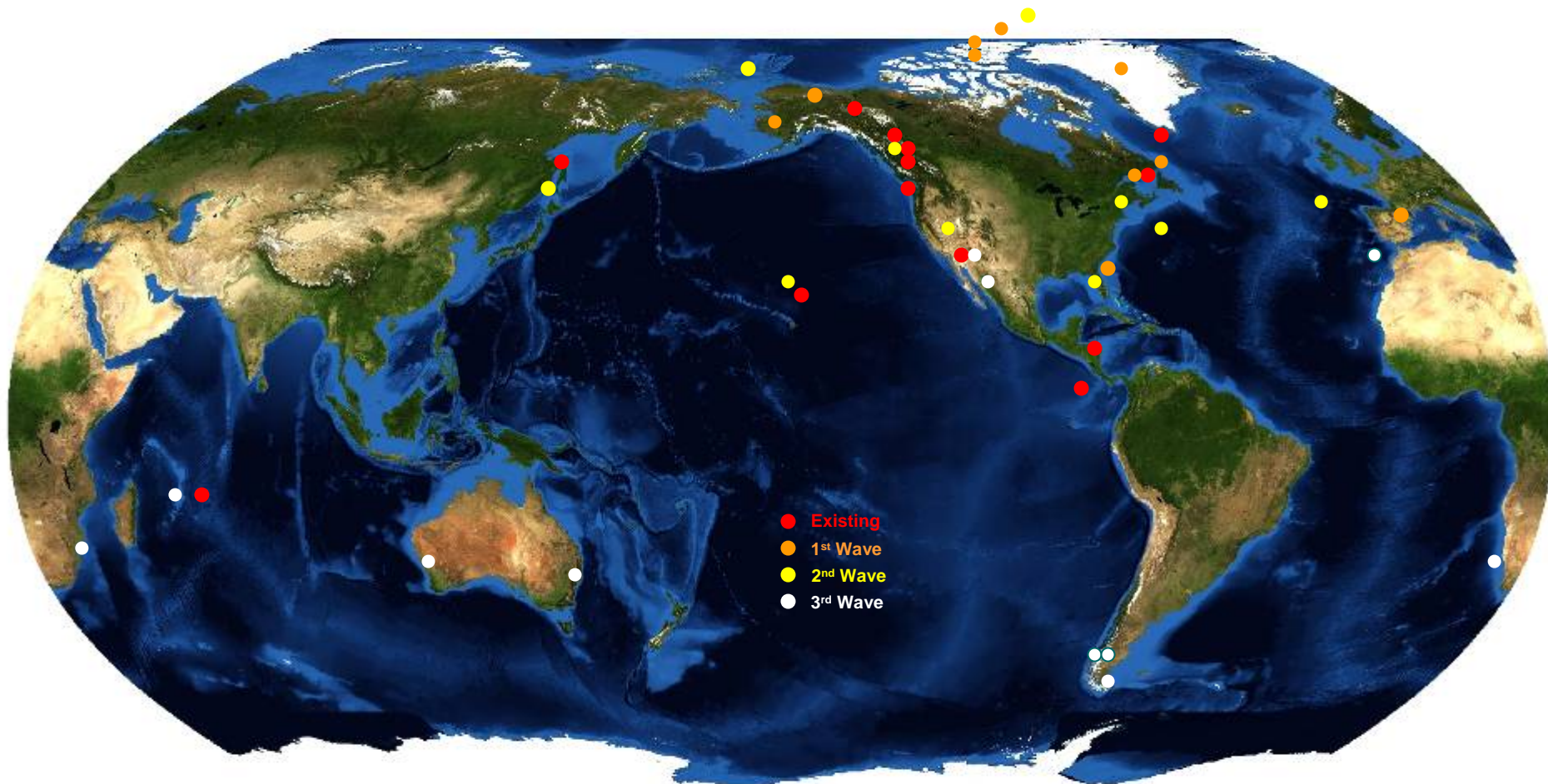


The Ocean Tracking Network (OTN) is a global-scale “array of POST arrays”

- Headquartered at Dalhousie University, Halifax
- Regional-scale arrays intended for all continents
- Funded with \$45M Cdn in 2007, OTN has so far leveraged \$160M in commitments world-wide



Ocean Tracking Network



Description of POST



Fish Tagging

- To make POST work, thousands of fish must be tagged
- Tagging must have minimal impacts

Scale of Array

- To make POST work, an array of 100s to 1,000s of sensors must be deployed to detect the tagged fish
- Many nodes means low deployed cost per node

Performance of Array

- A near-complete census of animals must be achieved
- Node attrition rates must be kept low & operational lifespans must be for many years

Building the POST Array- Initial Phase



- Develop an “optimal” geometry
- Develop a way to deploy (& retrieve!) the prototype array
- Develop a permanent, long-lived, “wireless” system—lower costs, increased data recovery
 - “Operational Perfection” means lower real costs
 - Leads to much more rapid scientific progress
 - Higher data yields (less holes)
 - Reduces uncertainty in the data interpretation
 - The “might be” factor....

POST as a Large-Scale Constrained Optimization Problem



MINIMIZE Array Cost (Geometry)

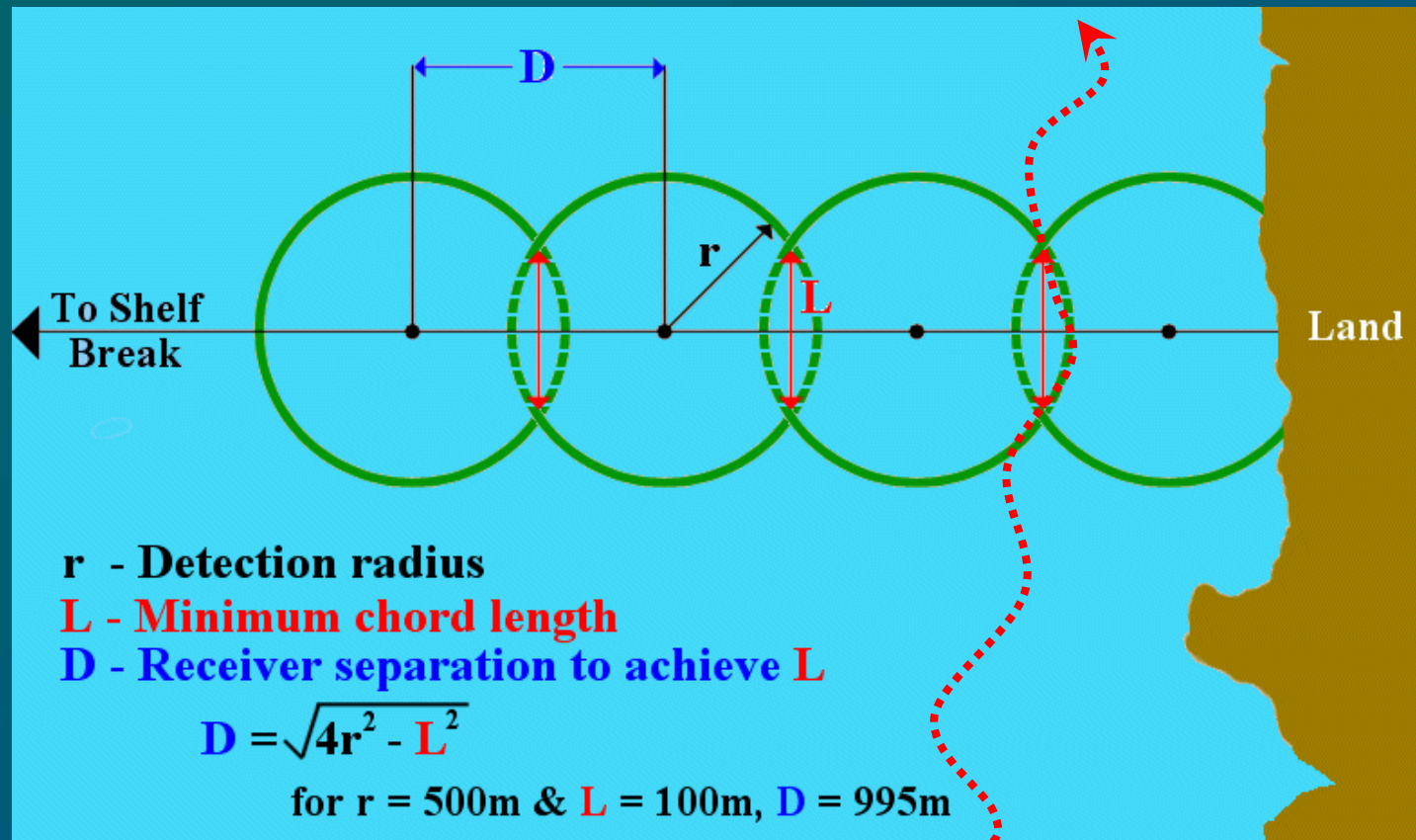
Subject to: -Maximizing Tag Detection Rates

-Maximizing Tag Lifespans

- Minimizes capital cost of the array
- Reduces acoustic tag costs
- Reduces use of animals (Ethics & staff time)
- Increases number of populations under study

POST's initial Pilot Phase

- Initial version was "a cheat"



POST's Operational Statistics



POST currently has 182 permanent nodes

- Core array formed of Vemco VR-3 acoustic receivers
- Each seabed node has ~7 yr battery lifespan
- Wireless acoustic modem link

Some temporary nodes also seasonally in use

2006: Rollout of POST's Permanent (7yr), Wireless Platform



2006: Rollout of POST's Permanent (7yr), Wireless Platform





Array Attrition Rates



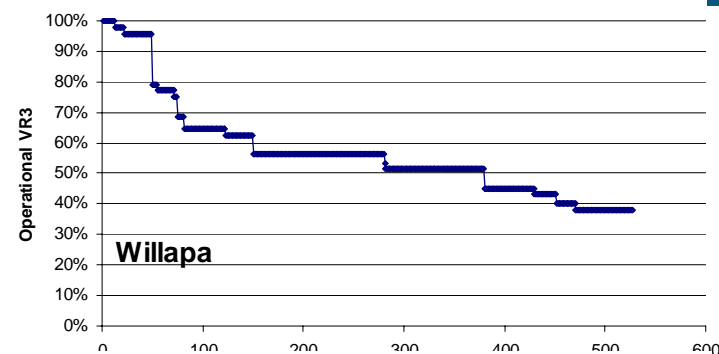
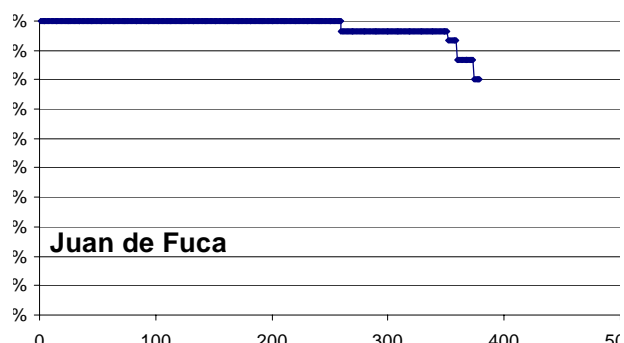
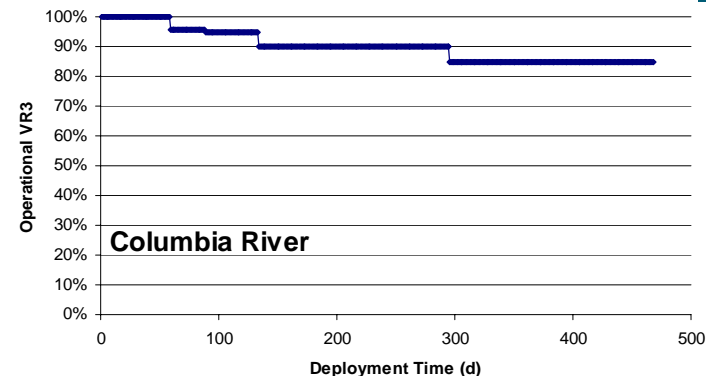
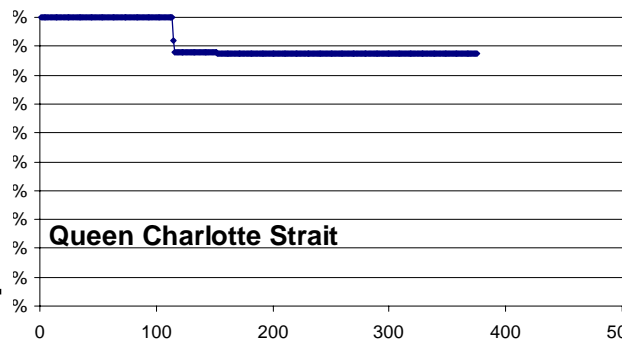
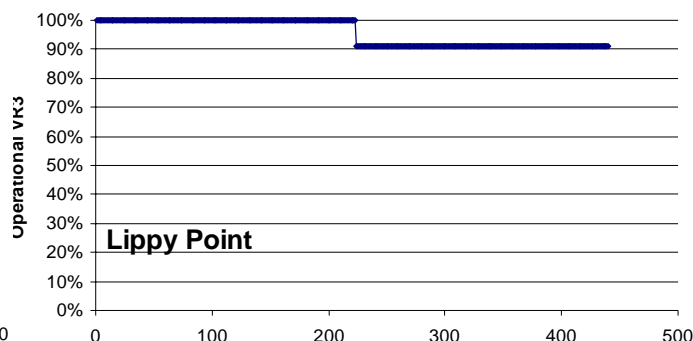
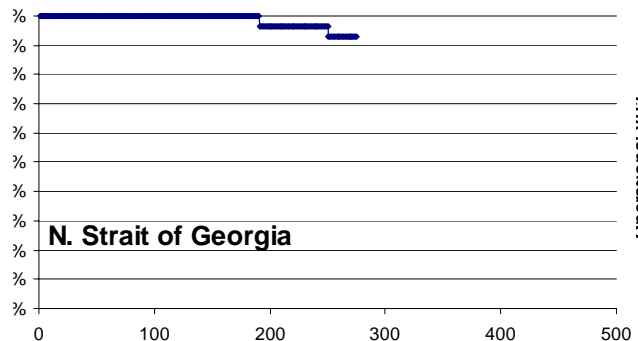
<i>Listening Line</i>	<i>Units deployed</i>	<i>Missing</i>	<i>Found & Stil Operational</i>	<i>Destroyed</i>
NSOG	29	1	2	
QCS	27	3		
Juan de Fuca	31	1	1	
Columbia	23	1	2	
Lippy	24	2		
<u>Willapa</u>	<u>48</u>	<u>15</u>	<u>7</u>	<u>1</u>
<i>Total</i>	182	23	12	1

% Missing Since Deployment: $23/182 \approx 13\%$

% Found & Re-usable: $12/182 \approx 7\%$ (12 of 23 lost)



Time & Area Effects

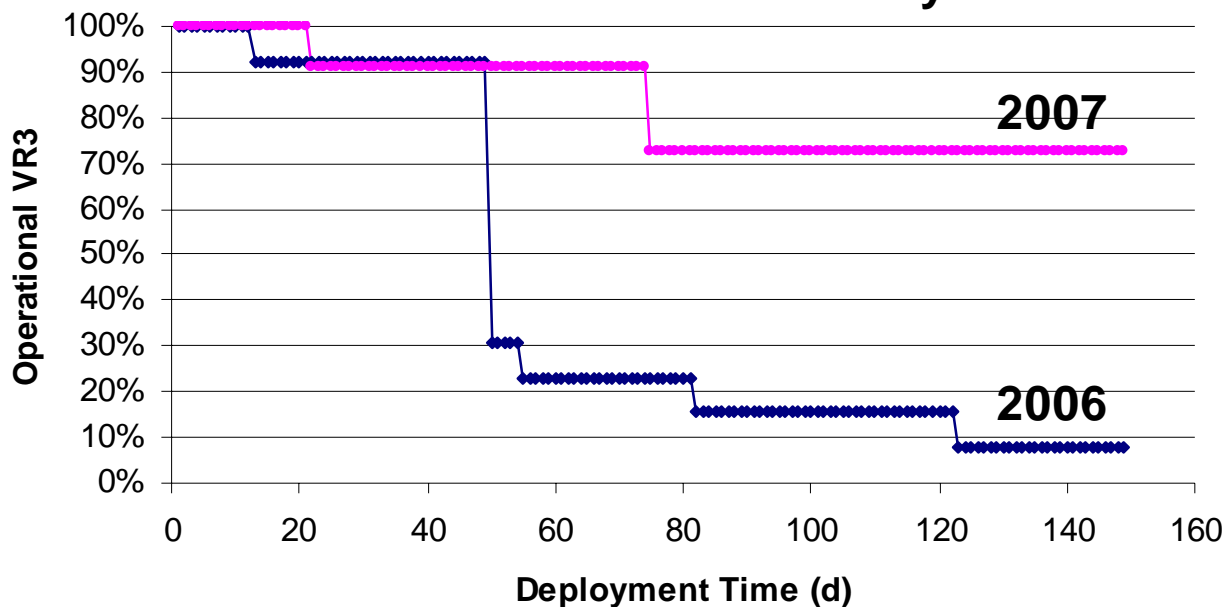


- Attrition rates low in most cases, but variable
- Most known losses due to trawling, mainly on Willapa Bay line (in 2006)

Deployment Duration (days)

Time & Area Effects

**Willapa Bay Performance
2006 Problematic Sites Only**



- 2007 Operational changes substantially reduced loss rates
- This figure is for specific sites where units were lost in 2006
- Other locations on this cross-shelf line have operated largely without incident for 18 months

Incremental New Designs-Improved Trawler Resistance??



Animations of Sockeye Movement- All Adult Sockeye (2006)



Array Efficiency-Adult Sockeye

Number of
Fish in
Common,
Line and
Further
Along the
Migration
Route

Detection
Efficiency
(p_i)

Line (i)	Number of Fish Detected on the Line (m_i)	Number of Fish Missed on the Line (z_i)
QCS	11	0
NSOG	90	0
JdF	35	0
SSOG	194	7
Fraser	129	0

(r_i)	(p_i)
2	100.0%
78	100.0%
21	100.0%
121	94.5%
73	100.0%

POST's Operational Statistics



At full scale, POST should grow to 1,500-2,000 nodes

- 10% attrition p.a. -> replace 200 units per year at steady state
- Industrial scale technology, which is probably just manageable

Performance of POST

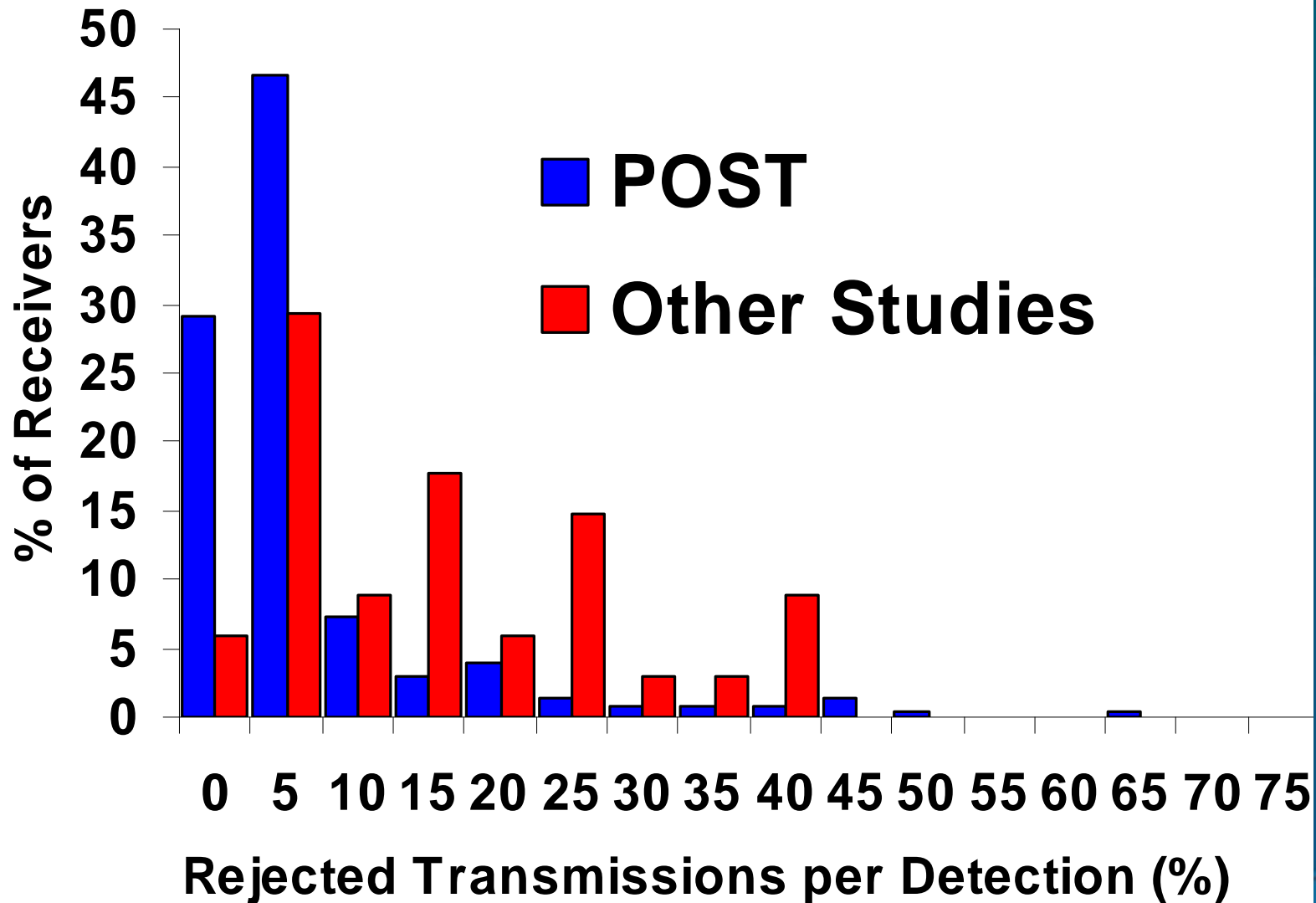
- Detection Efficiencies per Line: 95~100%
- POST's Design v Other studies

Data Volumes & Error Rates



	2004	2005	2006
POST Array Total Detections	364,356	1,817,061	1,275,462
Accepted by First Scan	363,981	1,815,797	1,272,194
Rejected Detections	675	1,264	3,268
% “False Positives” (Max)	0.19%	0.07%	0.25%

Array Siting & Performance



POST's "optimal" array geometry

- POST was conceived of in 2000, and the architecture was designed from 2001-2003 based on available technology
- At that time, the smallest acoustic tag was the V9
 - 9mm diameter, ~3 g, 139-149 dB re 1 μ P/m; 14+cm fish
- POST was designed to have (semi)-optimal performance for the V9 & tested in 2004-06
- Newer tags are now available
 - V7, 7mm diameter, 136 dB; 12.5+cm fish
 - V6, 5.5~6mm, 180 KHz, louder; 10+ cm fish
- Use of these tags really means that POST needs a makeover

Summary:



1. Direct measurement of movements & survival in the ocean & large rivers is now possible, even for very small fish (10~12 cm)
2. Our own view is that the “10,000 meter” view of salmon (& other) resource issues is critical
3. Fish stocks generally are not collapsing from mis-counting the numbers; stocks collapse because ocean productivity is changing under a changing climate

Summary:



3. These behaviors/responses to the ocean & major rivers are now measurable year-round.
4. POST/OTN can change marine fisheries science from an observational science to one based on a much more rigorous quantitative (& potentially) experimental basis.

Where POST is Going: Key Points to Keep in Mind

- Technological advances usually lead scientific breakthroughs
- POST can allow direct experimental study of fish in the ocean & large rivers, leading to direct tests of hypotheses
- The history of science shows that the shift to an “*experimental science model*” from an “*observational model*” leads to rapid progress

“Going POSTal”



Building POST creates a vast geo-referenced sensor grid

- A telecommunication network for Ocean data!!
- Affords the opportunity to host a wide range of sensors
- Key criteria for hosting new sensors:
 - Stability
 - Low Power
 - Low Bandwidth
 - Low Individual Cost



Thanks!!

