Innovative Technology for Deterrence of Marine Mammals with Non-Lethal Electric Gradients: Update on Field Trial Results

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Focus: Update on a Deterrence Technology to Minimize Pinniped/Human-Use Conflicts

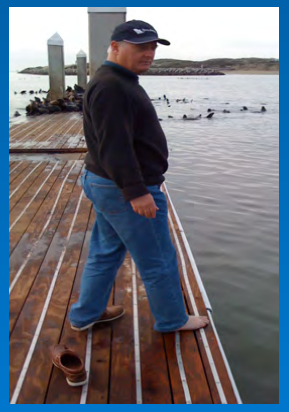
SMITH-ROOT, INC.
Technology For Fisheries Conservation

Non-Lethal Electric Barrier Technology for Marine Mammal Deterrence

Presentation Goals:

(1) Review the technology and how it works.

- Operating concepts and safety.



(2) Summarize some key pinniped applications to date (in B.C. and California).

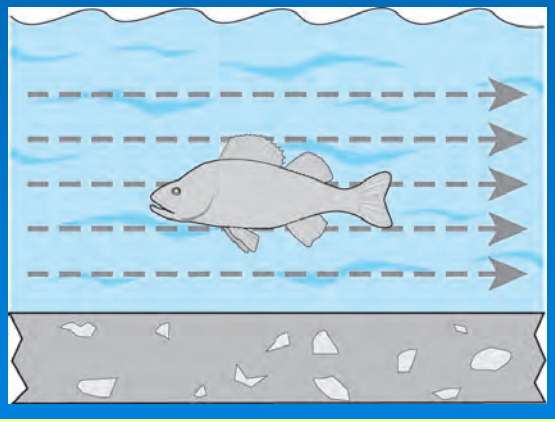
(3) Show several minutes of video-taped results.

(4) Show you new deterrence materials & successes.

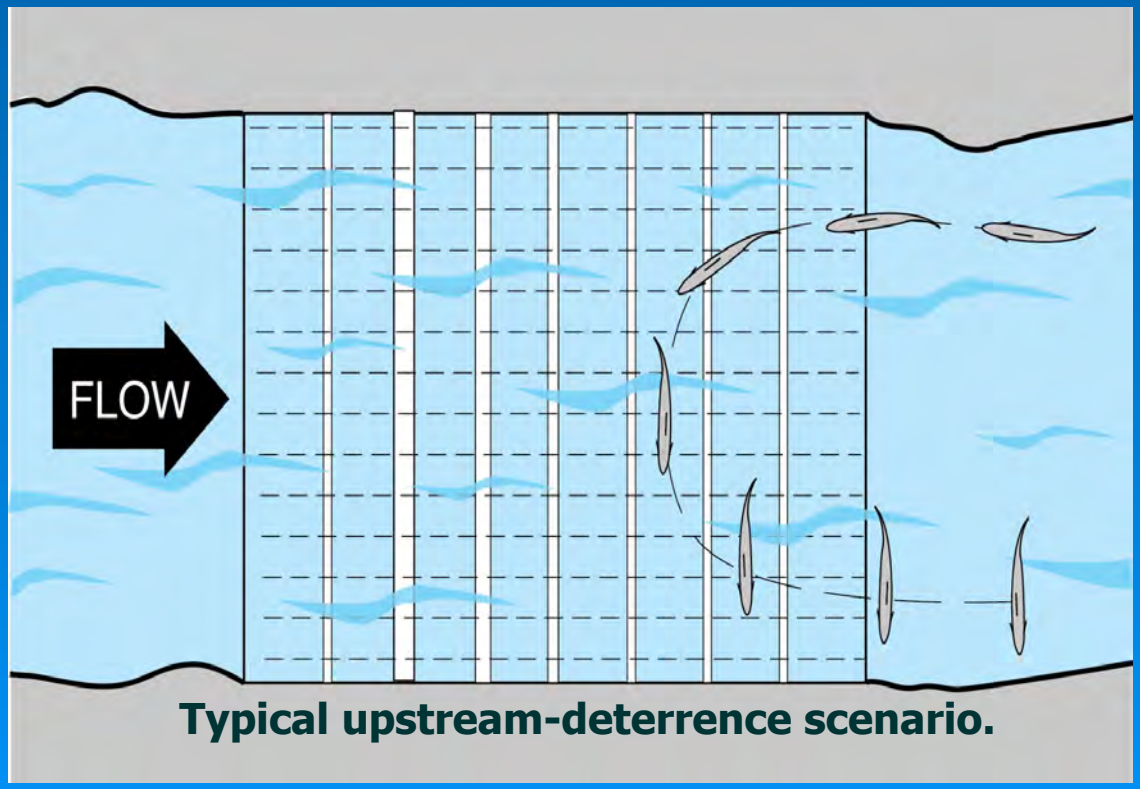
Non-Lethal Barrier Technology: How It Works

- Deterrence in Water Uses Graduated Fields (Just 0.3-1.2 V/cm).
- Gradient Is Constant on Docks - Plus Sea Lions Carry Saltwater.
- The Unique Dock Waveform Uses < 24 Volts to Deter Sea Lions.

Operating Concept:



Max power transfer occurs in head-to-tail orientation (i.e. when animal is parallel with electric current flow).



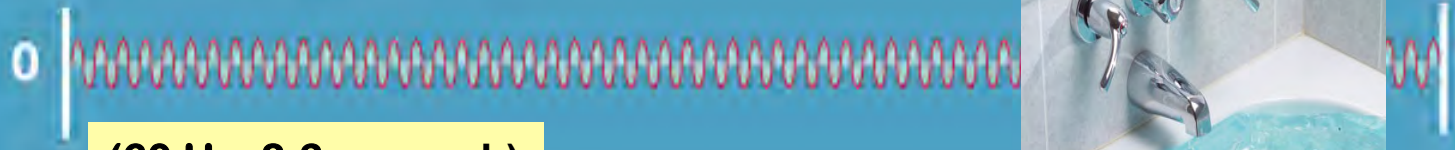
Typical upstream-deterrence scenario.

---- Dashed Horizontal Lines = Electric Current

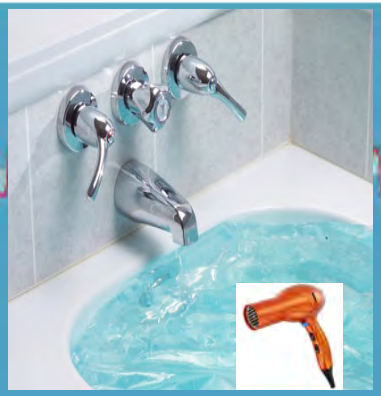
IIII Vertical Bars Represent Electrodes

Safety Aspects: AC vs DC (The Difference)

Alternating Current



(60 Hz, 8.3 ms each)

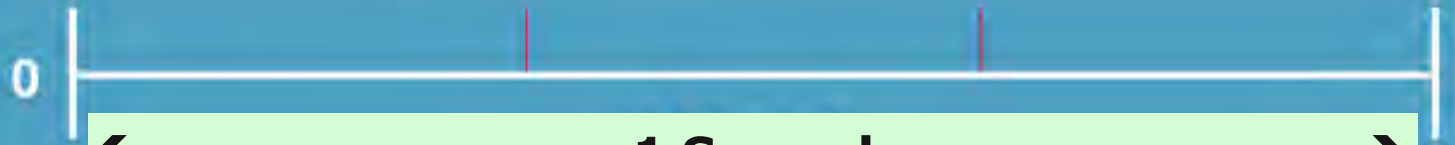


AC Produces Constant, Injurious Current

Pulsed DC Is Far Less Injurious (Non-Lethal)

(3 Hz, 1-5 ms each)

Pulsed Direct Current



1 Second

Barrier technology <u>is not</u> “the hairdryer in the bathtub.”

Where Is The Technology Located?

**Of 65+ deployments worldwide,
no human injury has ever been documented.**

Most applications are for fisheries management:

- **Keep fish from hydropower tailraces, turbines or intakes;**
- **Guide salmon into fishways or back to hatcheries; and**
- **Block range extensions by invasive species.**
- **But a few have also been used for marine mammals.**

Why Might Harbormasters Need Safe, Effective Deterrence Technology?

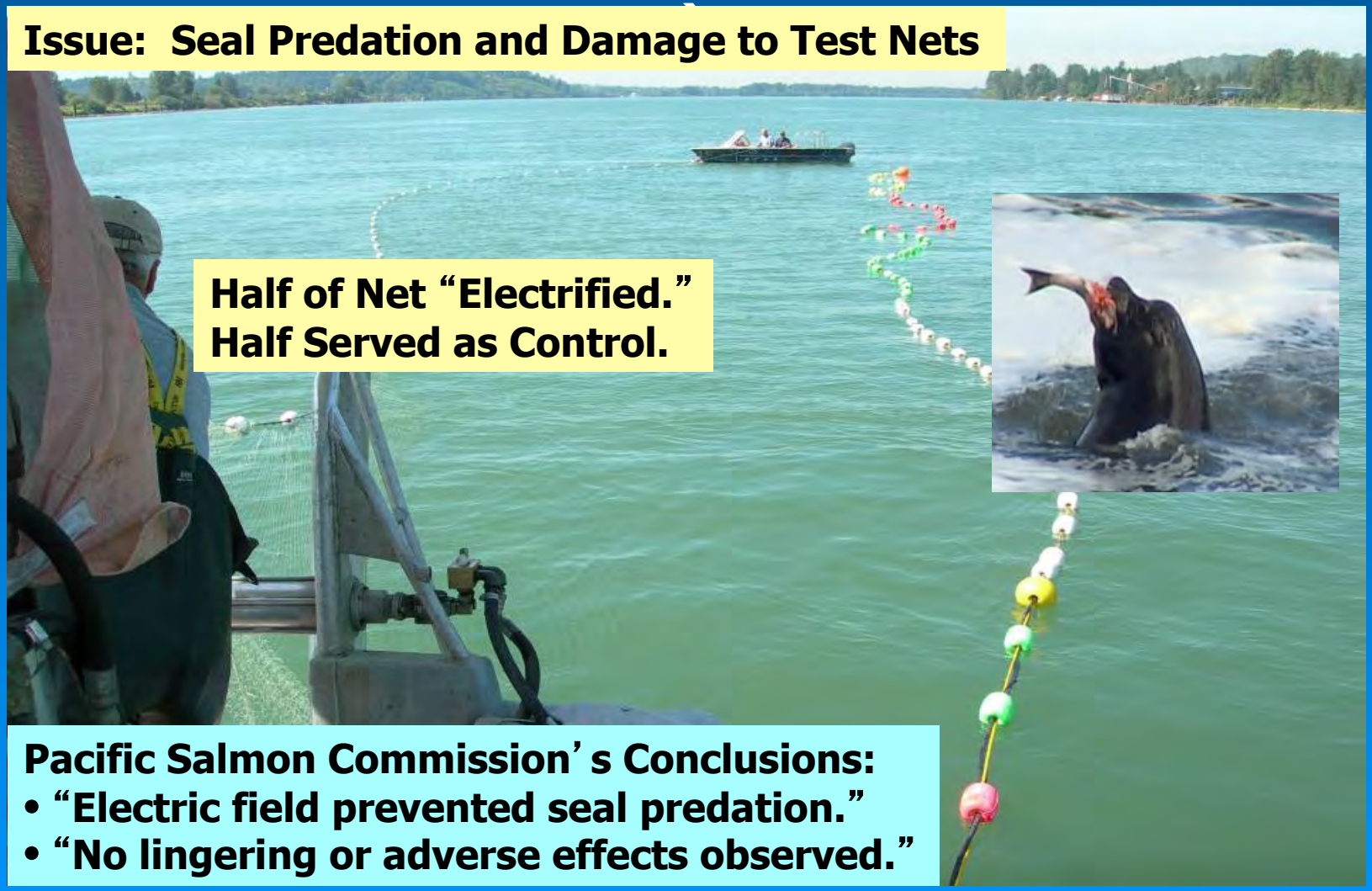
Here's Why (Introductory Video):

Why Do Our NW Fishery Managers Need Deterrence Technology?

Here's Why:

Deterrence Trials in Fraser River, B.C.
(Test Gillnet Study by PSC — Not in Videos)

Issue: Seal Predation and Damage to Test Nets

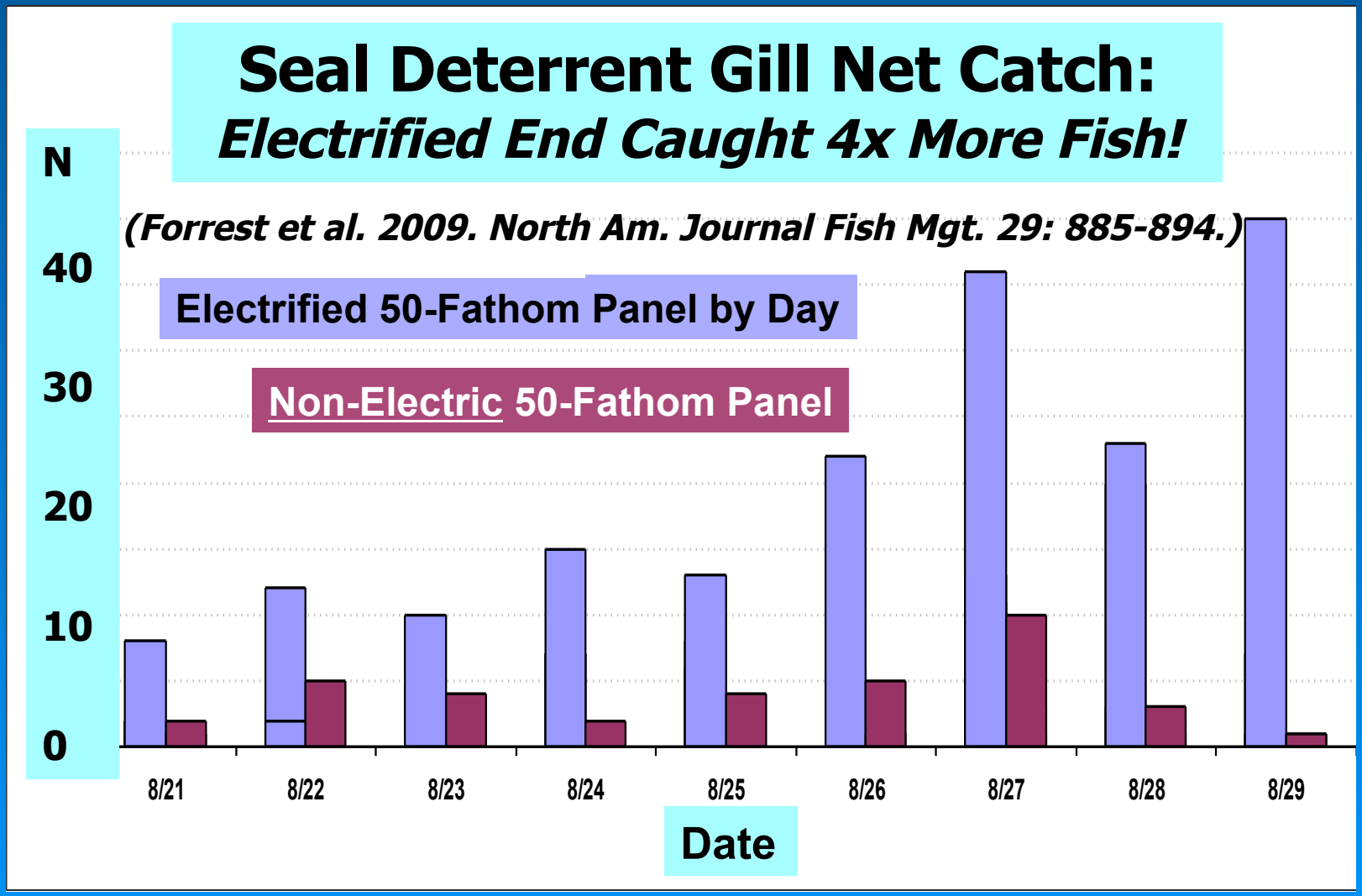


Half of Net "Electrified."
Half Served as Control.

Pacific Salmon Commission's Conclusions:
- **"Electric field prevented seal predation."**
- **"No lingering or adverse effects observed."**

Marine Mammal Deterrence Trials
(Fraser River, Test-Net Results - PSC 2007)

Seal Deterrent Gill Net Catch:
Electrified End Caught 4x More Fish!



Fraser River Test Gillnet Application: A New, Suspended Deterrence Technology

This "Seal Chaser" Concept Uses Floating (Electric) Rechargeable Pods

Published Findings Suggest the Possibility for Select Port and Harbor Deterrence:

Forrest et al. 2009. North Am Journal Fish Mgt 29: 885-894


2007: We Wanted to Test Our Electric Fish Barrier Technology on Pinnipeds. But …
(Where Do We Begin? What Are Their Thresholds?)
No Data Available. Solution: Vancouver BC Aquarium!

Marine Mammal Deterrence Trials (Additional Video Results Will Include):

(1) Pacific Harbor Seals in Canada: Determine Sensitivity of Captive Seals in Water for PSC (2007-08).

(2) Moss Landing Marine Labs: Pool Trials on Captive Sea Lions with Food Present (2008).

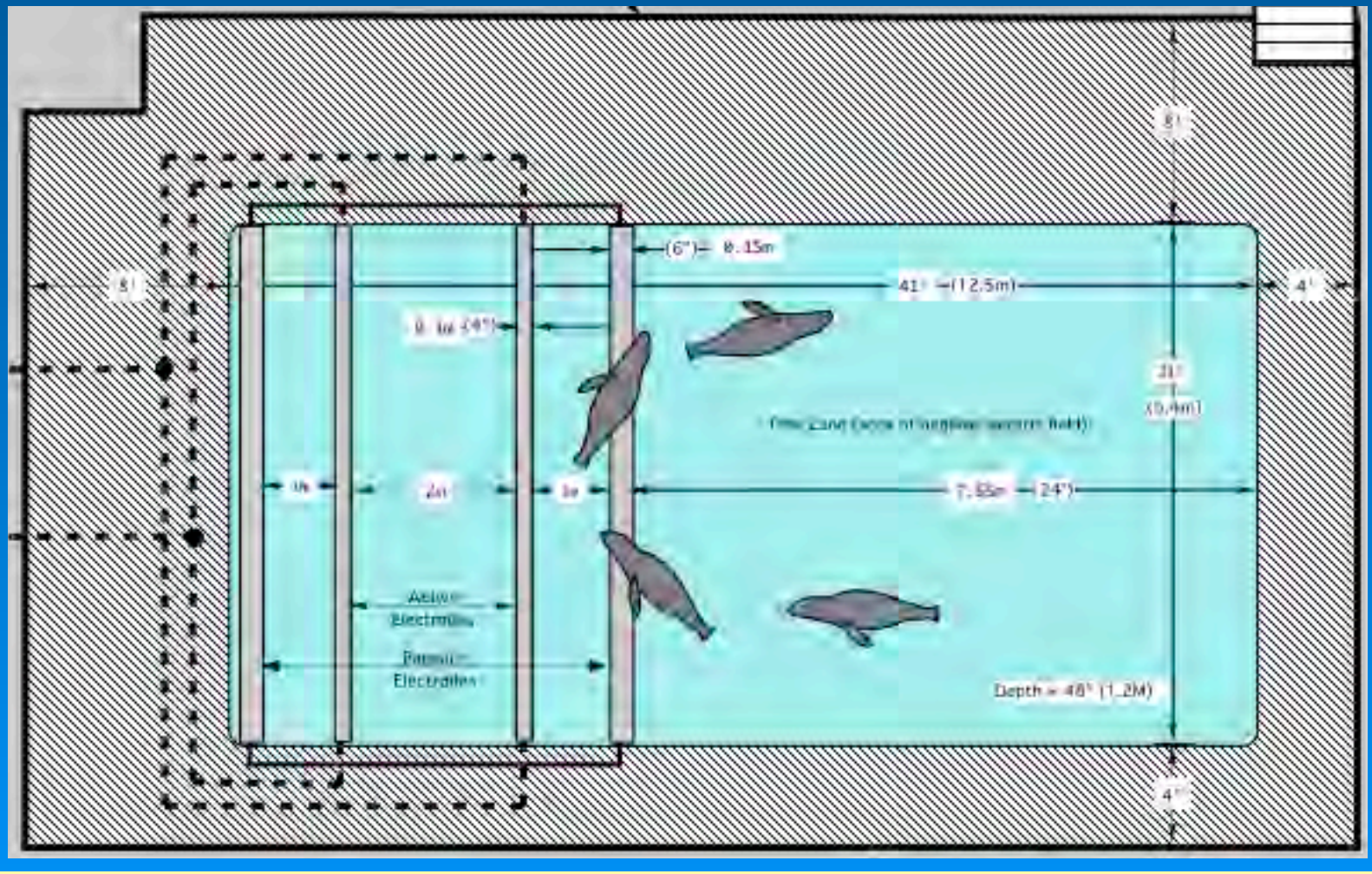
(3) Moss Landing Harbor District: Deterrence Trials on Visitor's Dock (2012).

(4) Offshore Oil Rigs: Deploy Deterrence Technology on a Drilling Platform (2014).

Video #1: Harbor Seal Deterrence Trials in British Columbia (2007-2008)

(Pacific harbor seals were extremely sensitive to mild fields of pulsed DC … much more sensitive than fish).

Video #2: California Sea Lion Pool Deterrence Trials at MLML (2008)



(Deterrence achievable even when food was present.)

Video #3: Deterrence Trials on Moss Landing Harbor District Visitor Dock (2012)

(100% dock deterrence achieved.)

Video #3 Trial Results (Continued):

Before Deterrence Array Installed

During Operation

After Installation

Deterrence Trials on Moss Landing Visitor's Dock (Human Touch-Testing)

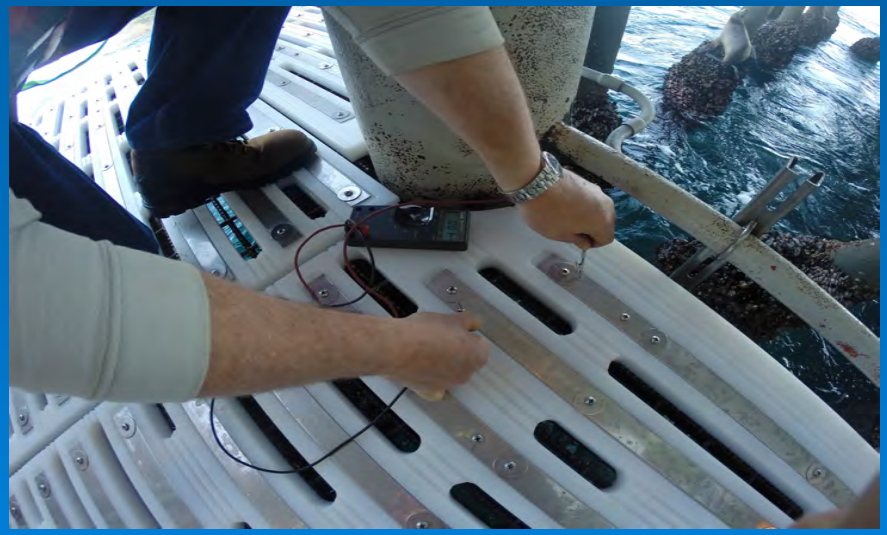
(Basically Imperceptible!)

Humans Touching Energized (Live) Electrodes at the Sea Lion Deterrence Setting.

Electrical Barrier Test
Vancouver Aquarium
3/27/07

Video #4: Deterrence Trials on an Offshore Oil Production Platform (Santa Barbara, CA 2014)

This Initial Deterrence Substrate Was Quite Rigid:



Deterrence Trials on Offshore Oil Production Platform, Santa Barbara, CA (Continued):

Our Demonstration Study Occurred Over 5 Days (May 2014). Deterrence Was 100% Successful.

And all sea lion deterrence technology is solar powered.

Deterrence Trials on Offshore Oil Production Platform, Santa Barbara, CA

Marine Mammal Deterrence Technology:

What Did We Learn?

(1) Electric arrays can non-lethally deter marine mammals with high success, even with food present. (Acclimation not likely.)

(2) Animals are quite sensitive to the waveform we developed … both in water and on dock surfaces.

(3) The technology is safe for humans and animals. Deterrence was achieved at ≤ 0.3 V/cm (a level most humans cannot even detect).

(4) On docks, it's an irritant (not injurious or harmful).

(5) Deployments will reduce/eliminate marina and oil platform conflicts between humans and animals.

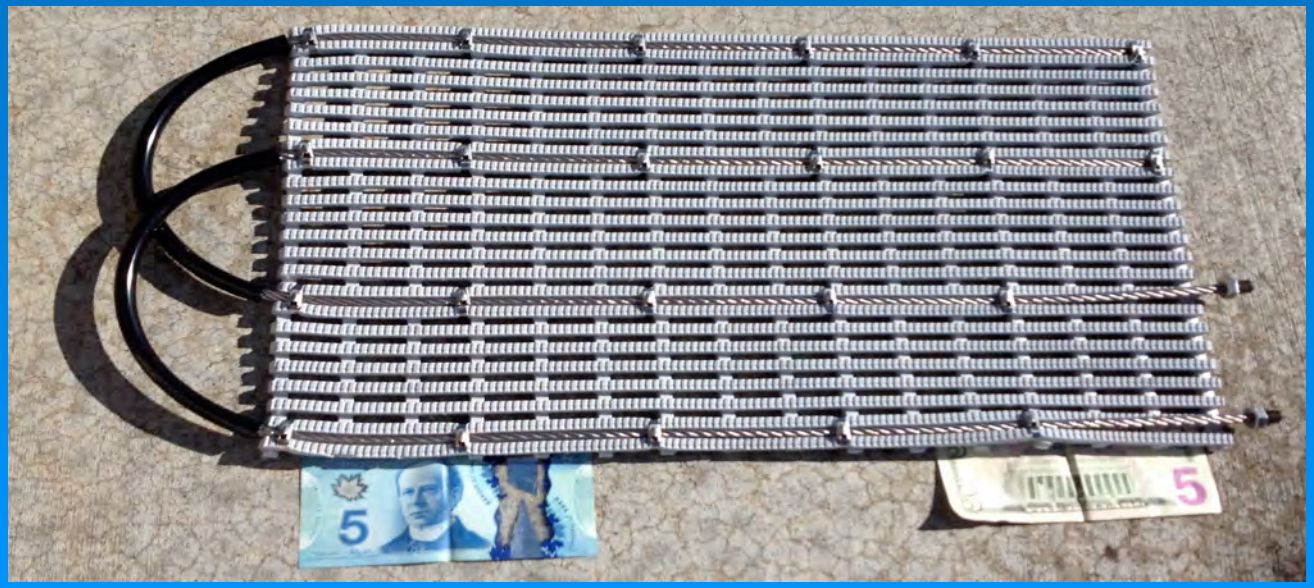
Deterrence Trials on Offshore Oil Platforms Led Us to a New Deterrence Substrate:

This is Why It Was Needed

We Also Achieved 100% Deterrence with the New Substrate.

The New, Flexible Mat for Marine Mammal Deterrence in Harbors

- **Tough, Rugged. Withstands Wind Up to 60 mph (Even Higher Resilience When Weight of Electrode Cables Included).**
- **Easily Attached Directly to Docks;**
- **Can Be Wrapped Around Irregular Surfaces;**
- **Completely Solar Powered (No Electric Bills); and Portable.**



Next Steps: Additional Demonstration Trials

- Smith-Root could install its newest mat technology on a segment of your dock (30 feet?) for first-hand evaluation.
- This would allow a test for effectiveness determination.
- If interested, please leave us your contact info.

Reverse Side of Solar-Powered Mat

Finally, We Have a "Bigger Picture" Underway to Help Get Harbormasters Funding

Our Coastal Community Concept and Vision:

(1) Install the deterrence technology on publically used marina infrastructure (docks where human-animal risks occur).

(2) ID existing or build new haul-out docks (close to shore) for the exclusive use of marine mammals. (Include a shoreline observation platform for public viewing, photography, etc.)

(3) Include a public outreach & education center (to inform citizens about marine mammal behavior, life histories and conservation).

(4) Involve business owners and leaders, Chambers of Commerce, and Congressional Members. The Benefits? Sea lion issues resolved. More jobs, more tourism & more commerce … with docks reclaimed for safe public use!

Our Coastal Community Concept and Vision

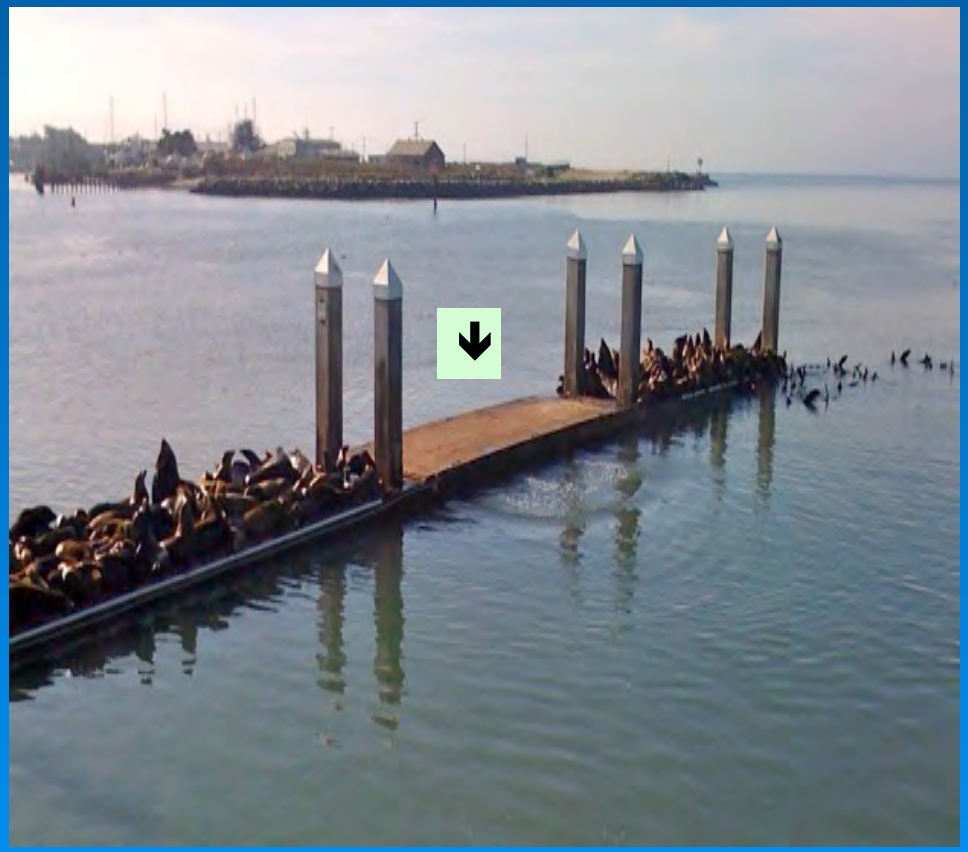
Progress to Date:

- A white paper is being developed to build consensus among regulatory agencies and attract new partners (Carl Burger);
- Visits and meetings are underway with key harbor and business leaders along the Pacific Coast (Gary Bock); and
- We've already briefed Senator Murray & Rep. Herrera Beutler (WA). We have their interest and their support in identifying new funding. We will do likewise in other states.

<u>The Goal</u>: We have asked their help in identifying grants & other possible funding scenarios (add-ons?) for harbormasters to directly address their critical coast-wide issues for public safety.

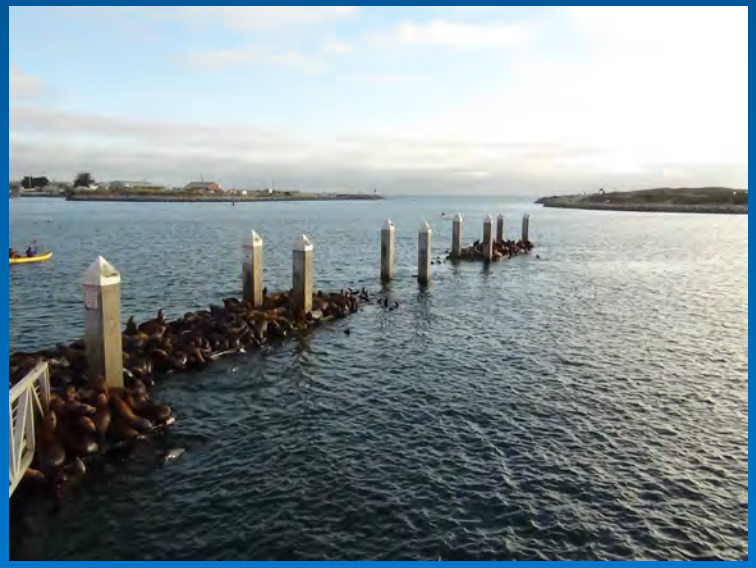
The Real Goal?

This …



An Interesting Achievement: The Vacant Dock Segment Is Not Even Energized!

Instead of This!



Thanks for the Opportunity to Present Today

Questions?