

Sea Lions, Salmon, and Sturgeon: Using GPS-Phone Telemetry to Study Sea Lion Foraging Behavior in the Columbia River, USA

Bryan Wright¹, Robin Brown¹, Steve Jeffries², Matt Tennis³, Robert Stansell⁴, and Doug Hatch⁵

¹ Oregon Department of Fish and Wildlife, Marine Mammal Research Program, 7118 NE Vandenberg Avenue, Corvallis, OR 97330, USA; bryan.e.wright@state.or.us
² Washington Department of Fish and Wildlife, Wildlife Program, Marine Mammal Investigations, 7801 Phillips Road SW, Lakewood, WA 98498, USA
³ Pacific States Marine Fisheries Commission, 2001 Marine Drive, Room 120, Astoria, OR 97103, USA
⁴ US Army Corps of Engineers, Fisheries Field Unit, Bonneville Lock and Dam, Cascade Locks, OR 97370, USA
⁵ Columbia River Inter-Tribal Fish Commission, 729 NE Oregon St., St. 200, Portland, OR 97232, USA



INTRODUCTION

Each year for the past decade, Steller sea lions (*Eumetopias jubatus*) and California sea lions (*Zalophus californianus*) have increasingly occurred below Bonneville Dam on the lower Columbia River to feed on white sturgeon (*Acipenser transmontanus*) and multiple stocks of Pacific salmonids (*Oncorhynchus* spp.) (Figs. 1-3). Over this period, annual predation at Bonneville Dam by sea lions has increased from essentially zero, to a high of over 2000 sturgeon and 6000 salmonids. Many of the fish stocks preyed upon are threatened or endangered; all are of economic or cultural importance to the region's sport, commercial, and tribal anglers. These factors have set the stage for an acute resource management conflict for which state, tribal, and federal researchers have been working to find solutions. As part of this effort, we instrumented California sea lions and Steller sea lions with GPS-phone tags in order to better understand their use of Bonneville Dam and the lower Columbia River. This poster describes the preliminary results of that work.

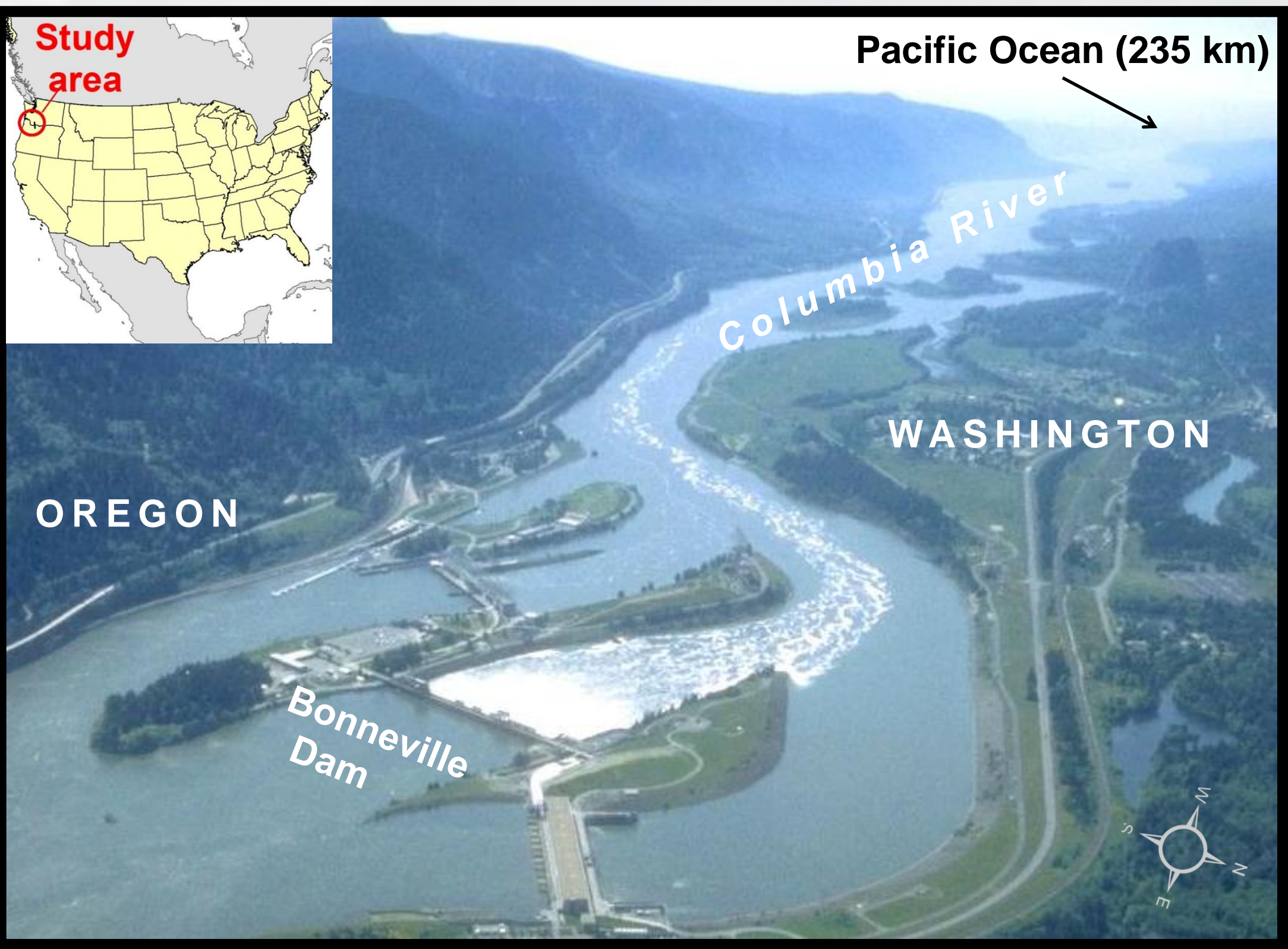


Figure 1. Aerial view of study area looking west over Bonneville Dam on the Columbia River.



Figure 2. Steller sea lion consuming a white sturgeon below Bonneville Dam.



Figure 3. California sea lion consuming a salmon below Bonneville Dam.

METHODS

We captured sea lions on floating haul-out traps (Fig. 4). Sea lions were anaesthetized, hot-branded, and instrumented with GPS-Phone tags (Sea Mammal Research Unit (SMRU), University of St. Andrews, Scotland). Tag features included: Fastloc GPS (location fixes attempted every 15 minutes); sensors to quantify time spent hauled out, at the surface, or diving (Fig. 5); and data transmission via mobile phone technology.

METHODS (CONT.)



Figure 4. Trapping Steller sea lions and California sea lions at Bonneville Dam.

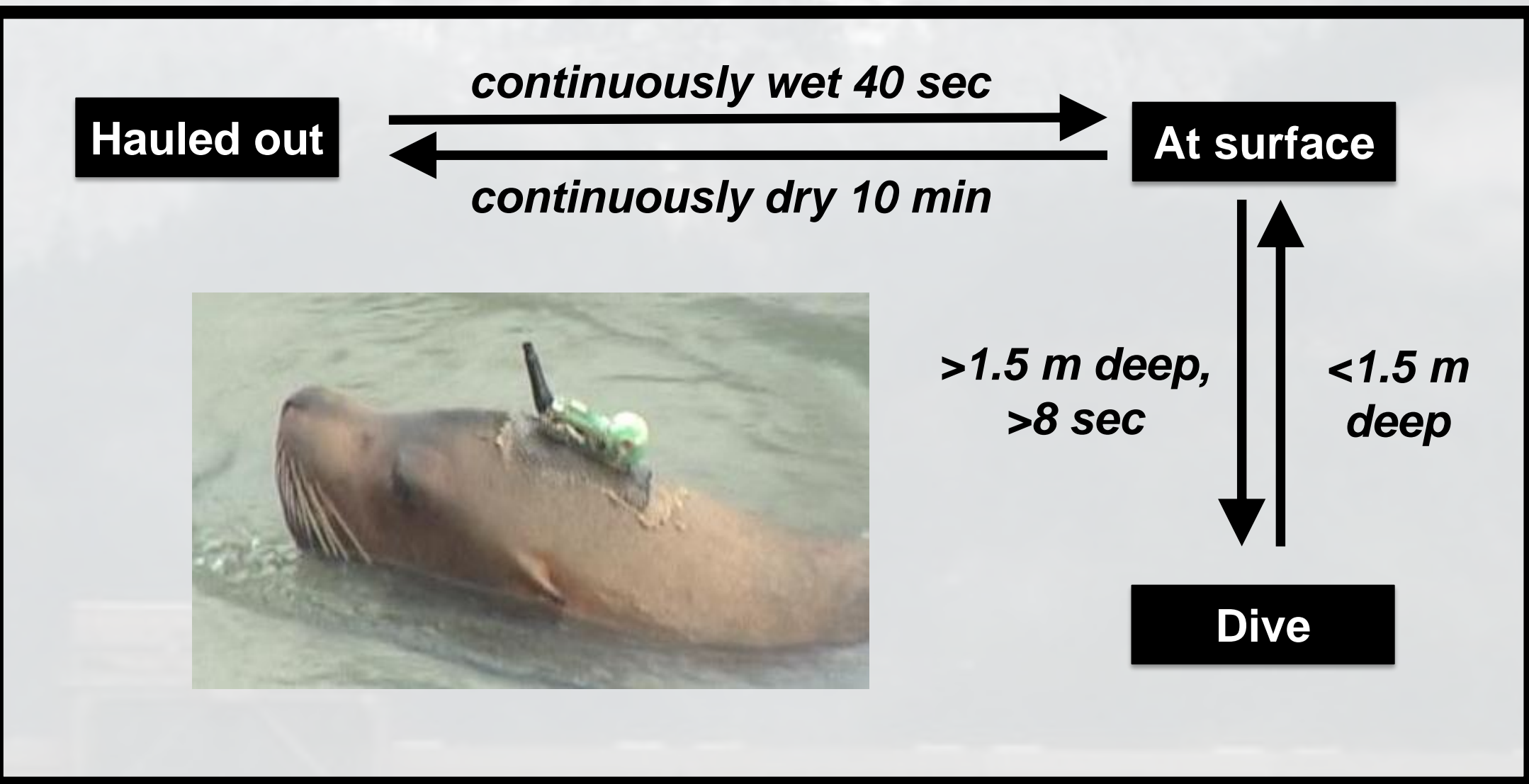


Figure 5. Three-state behavioral model used by SMRU's GPS-phone tag, shown here epoxied to the head of a Steller sea lion.

RESULTS

Of the seven GPS-phone tags we deployed, five provided sufficient data for meaningful summary (Table 1). GPS data showed that sea lions generally transited the river directly between the estuary and Bonneville Dam, as opposed to stopping mid-river to forage or haul-out. Foraging behavior at the dam generally followed a diurnal pattern, diving during the day and hauling out at night (Fig. 6). Pairing dive data with above-water observations has resulted in some success at detecting "predation signatures" and other behaviors (Fig. 7).

Table 1. Summary of GPS-phone tag deployment at Bonneville Dam. All animals were sub-adult or adult males.

Species	California sea lion		Steller sea lion		
Brand	C287	C930	O009	O11	O12
Tag duration (days)	48	61	62	84	118
Days in river	38	60	45	56	37
Mean GPS fixes per day	35	36	49	46	29
Trips between river mouth and dam	2	4	1	2	2
Mean daily behavior*					
Hauled out	27%	30%	31%	31%	19%
At surface	50%	30%	35%	23%	35%
Diving	23%	40%	34%	46%	46%
Mean dives per day*	340	520	535	503	710

* Based on days in river.

RESULTS (CONT.)

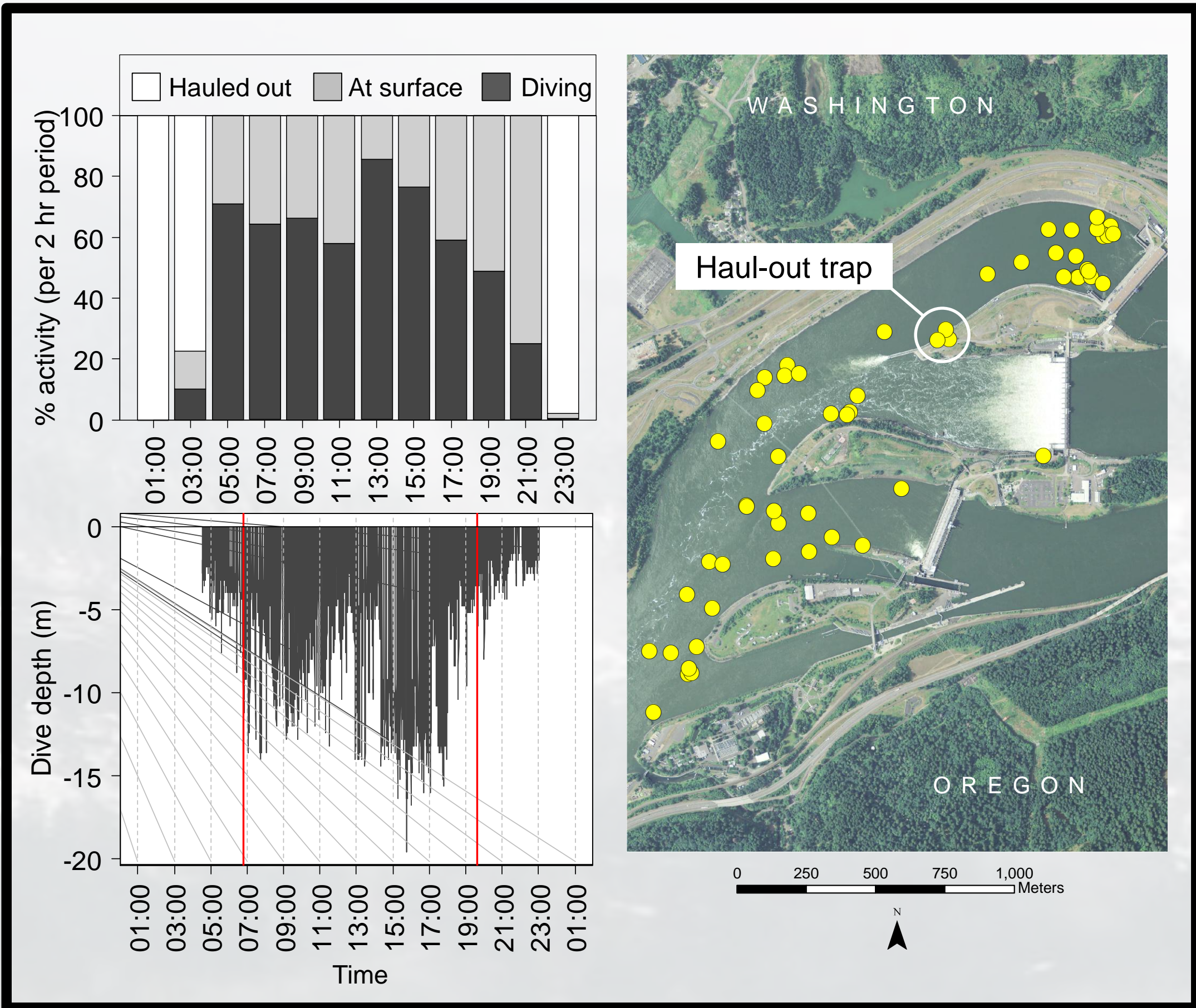


Figure 6. A day in the life of Steller sea lion O009: 24-hr summary of three-state activity budget (upper left), dive profile (lower left), and location (right). Red lines in lower left panel denote sunrise and sunset.

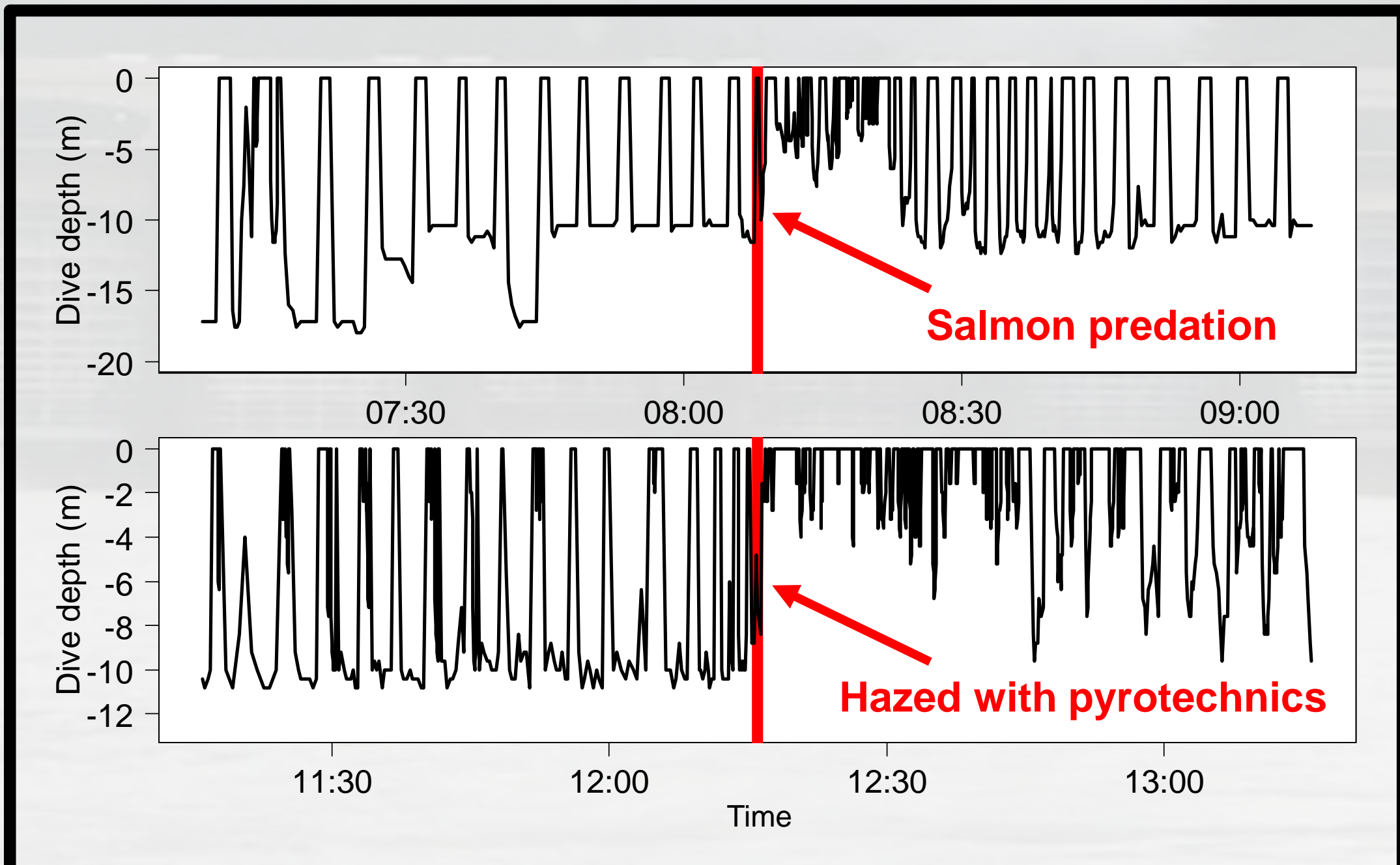


Figure 7. Matching above-surface observations to below-surface behavior. Dive profiles from California sea lion C930 coinciding with an observed salmon predation (top) and being 'hazed' with pyrotechnics (i.e., seal bombs, shell crackers) to deter foraging at the dam (bottom).

CONCLUSIONS

GPS-phone tags provided us with a wealth of high-quality information, especially when compared to our previous efforts with acoustic and satellite tags. Besides providing a detailed spatio-temporal picture of sea lion use of the lower Columbia River, we are also using tag data to validate shore-based observations of sea lions, assess the efficacy of non-lethal deterrent methods, and parameterize bioenergetic consumption models.

ACKNOWLEDGEMENTS

We express our thanks and appreciation to: Dan Heiner and Dave Colpo (PSMFC); Mike Brown, Josh Oliver, Dyanna Lambourn, and Dean Pyzik (WDFW); Colin Gillin and Julia Burco (ODFW); Garth Griffin and Tom Gelatt (NMFS); Simon Halliwell (SMRU); and the field crews from USACE and CRITFC. Sea lion research and management in the Columbia River by ODFW/WDFW was conducted under NMFS Permit Nos. 14326 and 13430, and MMPA Section 109 (h).