

# Squid as common target:

# Do areas with fishery-related explosions and dolphin foraging habitats overlap?



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## Abstract

Risso's dolphins (*Grampus griseus*) are known to mainly prey on cephalopods. In Southern California, market and jumbo squid (*Doryteuthis opalescens* and *Dosidicus gigas*) are their main prey species. The commercial fishery for market squids is one of the largest fisheries in California.



Fig. 1: Seal bomb.

Using passive acoustic monitoring data, Risso's dolphin echolocation activity was compared to received sound exposure levels (SEL) and patterns of small-charge underwater explosion occurrence. These explosions are generated by the use of explosive deterrents in fisheries, so called "seal bombs". By comparing explosion patterns to catch origins and timing of landings from various fisheries, a significant relationship with the market squid fishery was found. As both the fishery and Risso's dolphins share squids as their main target, there is an overlap between areas and times of extensive seal bomb use and Risso's dolphin foraging habitats during peak fishery periods.



## Methods

- Three High-Frequency Acoustic Recording Packages (HARPs) with 200 kHz sampling frequency
- Data: Jun 2008 - Jul 2010 - including a peak fishery period
- Automated detection algorithm and manual verification for explosions, manual detection of Risso's dolphin click encounters
- Data on daily amounts of market squid landings and catch origins from California Department of Fish and Wildlife
- Comparison of seasonal/diel patterns of explosion and dolphin click encounter presence with sum of market squid landings per day and HARP site

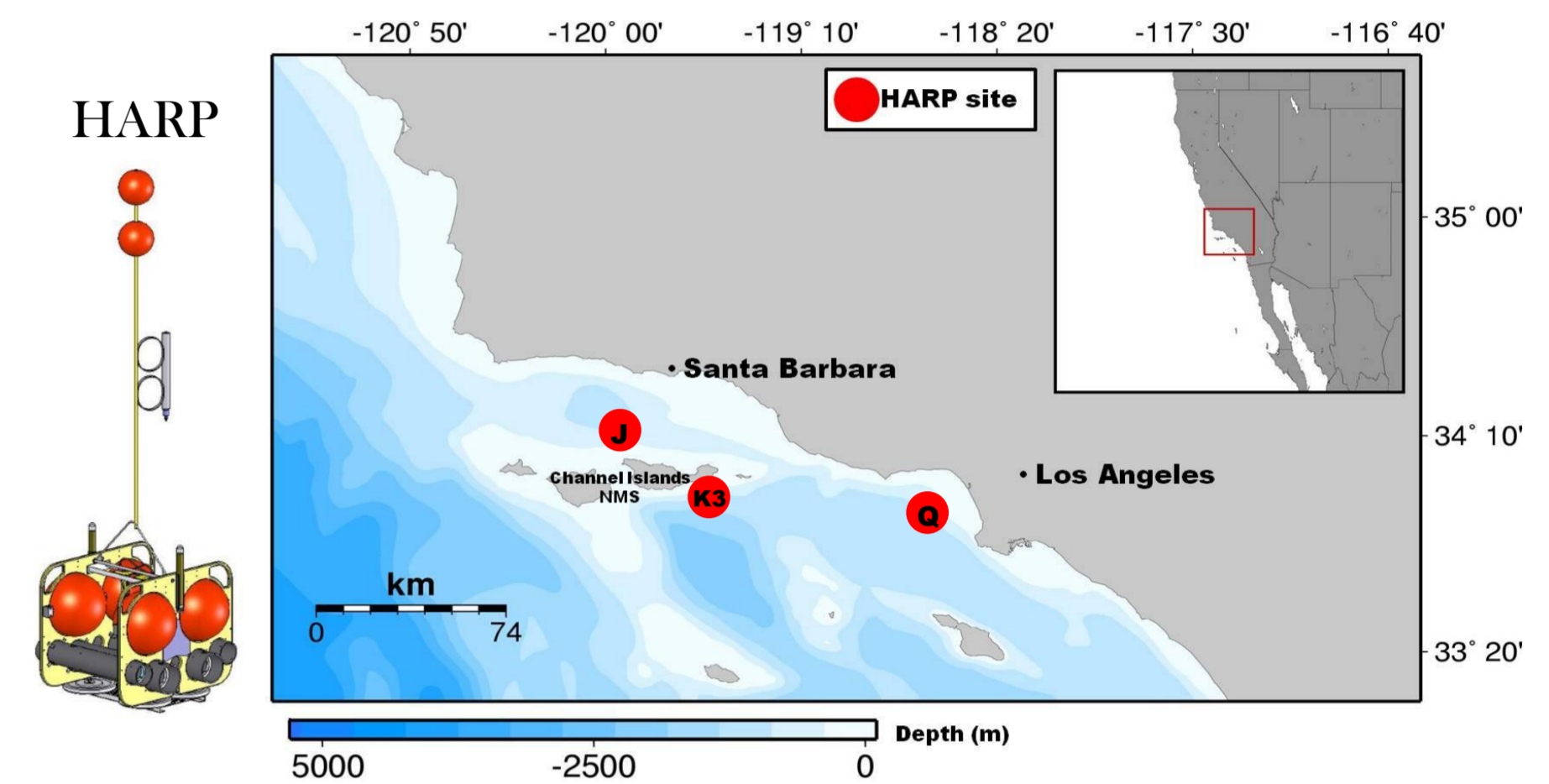


Fig. 2: Map of 3 HARP sites J, K3, Q (red circles) in the Southern California Bight (SEATURTLE.org's Maptool).

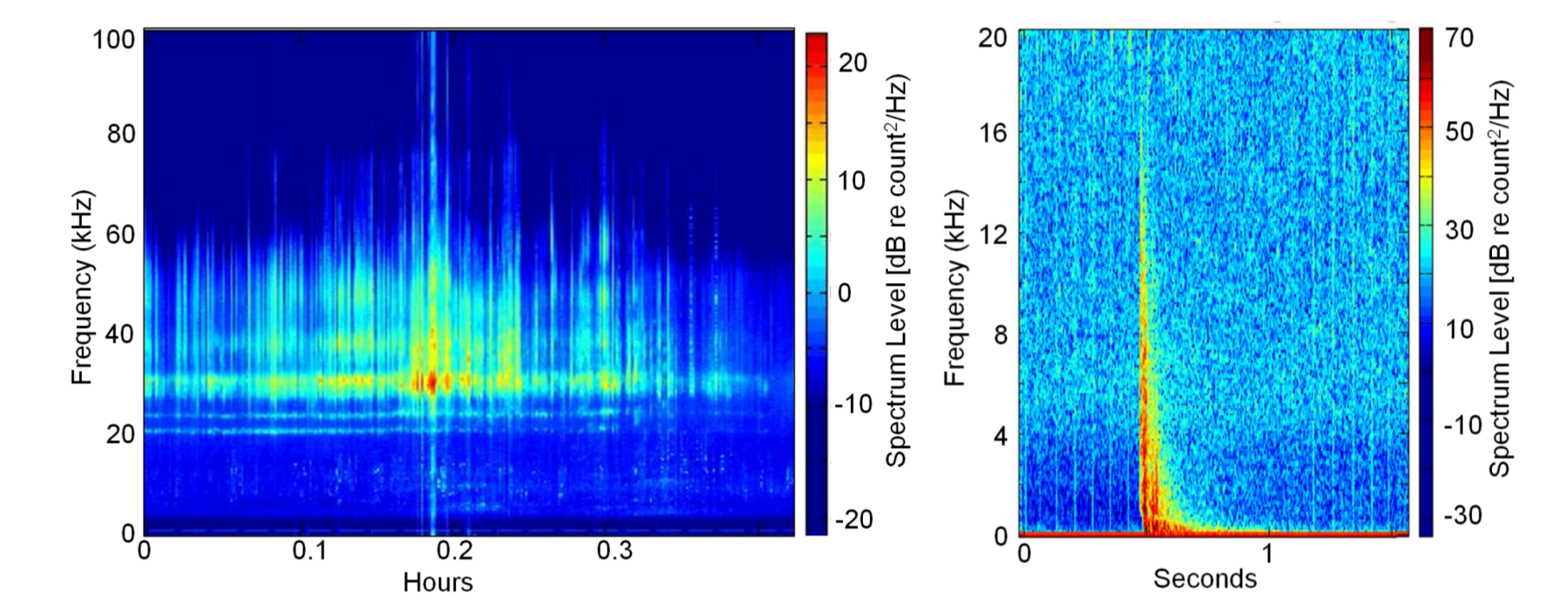


Fig. 3 a-b: Spectrogram of a) echolocation click encounter of Risso's dolphins with typical frequency banding, b) seal bomb explosion.

## Results & Discussion

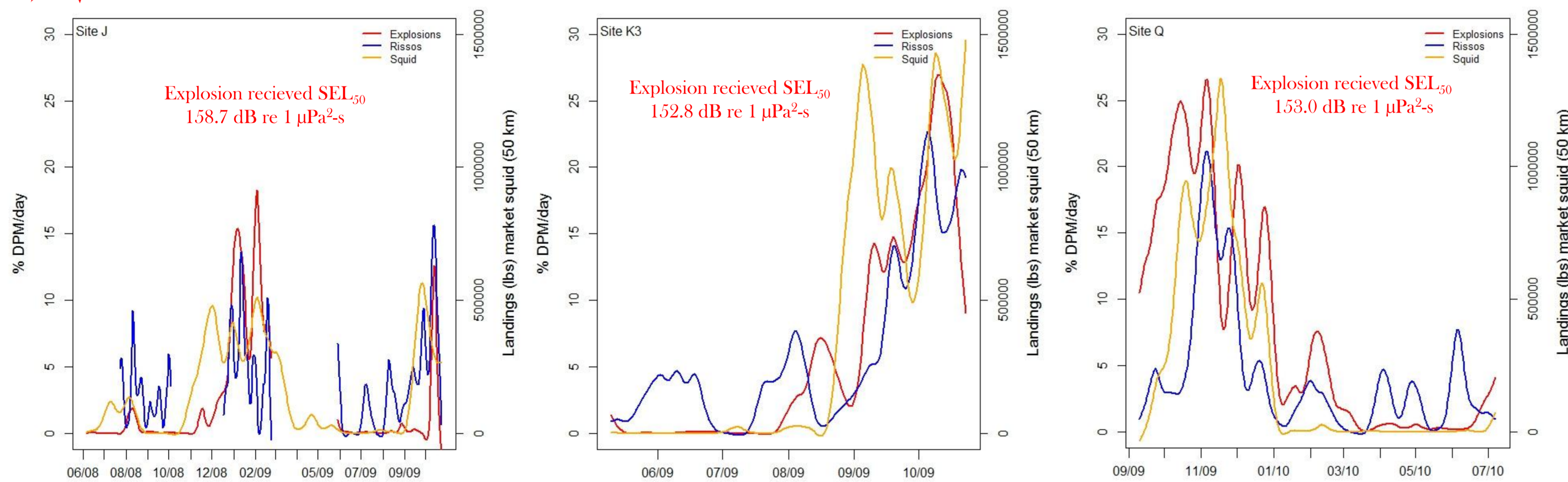


Fig. 4 a-c: Moving averages of % Detection Positive Minutes (DPM) per day for explosions (red) and Risso's dolphin click encounters (blue) as well as sum of commercial market squid landings per day (orange) for a) site J (Jun 2008 - Oct 2009, mean HARP deployment depth 264 m), b) site K3 (May 2009 - Nov 2009, mean depth 991 m) and c) site Q (Sep 2009 - Jul 2010, mean depth 678 m) together with median received peak-peak sound exposure levels (SEL<sub>50</sub>) of explosions per site (red font). Only squid landings with catch origins (11x9 miles fishing blocks) within a 50 km radius around the HARP sites, respectively were included in the analysis.

### Seasonal overlap and noise exposure:

- At all three sites explosion and Risso's dolphin presence as well as commercial fishery landings for squids show simultaneous peaks in autumn/early winter in 2009 & 2010
- Explosions with median SEL<sub>pp</sub> received at the hydrophones of -153 - 159 dB per site, and maximum SEL<sub>pp</sub> of 183 dB (distance to signal origins unknown)

### Diel pattern: Example Site Q

- Majority of explosions (up to ~2500 per day), as well as market squid fishery activity, happen at night
- Risso's dolphin clicks occur during day and night, especially in autumn/early winter (peak fishery period)

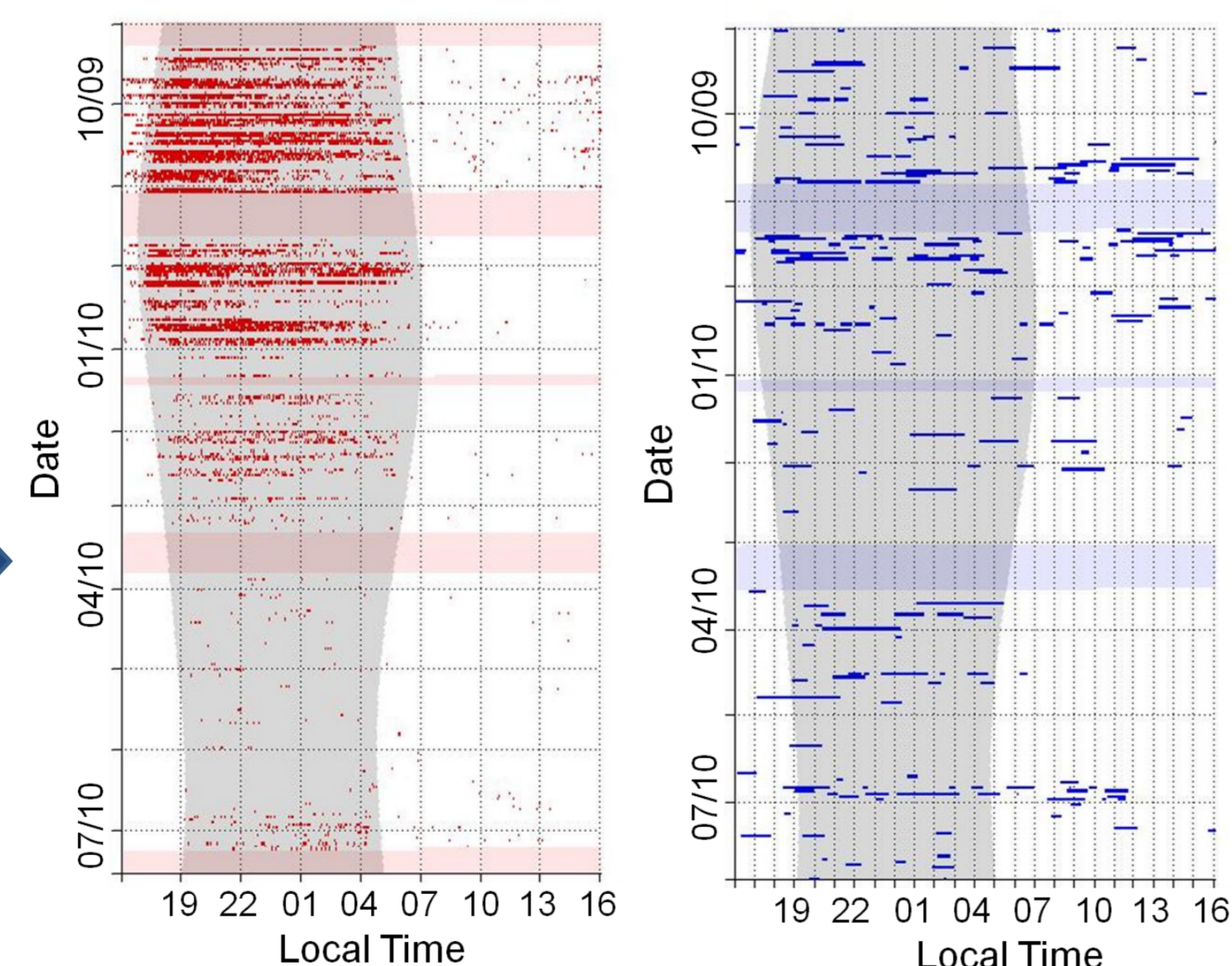


Fig. 5 a-b: Detection Positive Minutes of a) explosions (red) and b) Risso's dolphin click encounters (blue) at site Q during daytime (white area) and night-time (grey area).

## Conclusions & Outlook

- During peak fishery periods in nearshore areas, there is an overlap of seal bomb explosions and Risso's dolphins activity in the Southern California Bight.
- As seal bomb usage is associated with the California purse-seine fishery for market squids, which is also one of the main prey species for Risso's dolphins, peaks in explosions and fishery landings as well as dolphin activity during autumn months, might reflect seasonal availability of their common main "target", the squids.
- During times of seal bomb usage the foraging dolphins are exposed to strong and persistent explosion noise with median SEL<sub>pp</sub> received at the HARPs of up to - 159 dB.
- Diel patterns are different for explosion occurrence (at night) and Risso's dolphin click encounters (day and night) during peak fishery periods at site Q.
- Work to be done: 1. Test explosions at known distances to measure seal bombs sound pressure and propagation characteristics, 2. Modeling the potential influence of seal bomb noise on Risso's dolphins acoustic behavior including more stations and years



Fig. 6: Risso's dolphin in the Southern California Bight in 2009 (Photo: Michael H. Smith)