# Small autonomous landers for exploring nearshore submarine canyon ecology

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## Introduction

Nearshore submarine canyons bring the deep sea close to shore, potentially functioning as highways connecting shallow and deep-sea ecosystems. Additionally, canyons are keystone structures for local fisheries and have interesting oceanographic characteristics, including increased environmental variability. This study aimed to evaluate the extent of government protection on these unique ecosystems along the California coast. The traditional definition of submarine canyons that is used for global bathymetric studies often excludes smaller nearshore canyons which tend to be understudied and unprotected. We defined smaller nearshore canyons along the California coast as features within 5 km of shore that are deeper than 200 m and incised at least 100 m into the slope. In applying this new definition, we found that these features were more common in Southern California than in Central and Northern California due to differing shelf characteristics along the coast. To study the ecology of these nearshore submarine canyons, we developed two low-cost, spatially flexible autonomous lander systems: the Nanolander *DOV BEEBE* and Picolander *DOV JEAN*. The Nanolander has three spherical housings containing a camera system, an acoustic communication system, as well as an SBE MicroCAT for measuring conductivity, temperature, pressure, and dissolved oxygen over several weeks (Gallo et al. 2020). The smaller, two-sphere Picolander is equipped with a Zebra-Tech sensor for measuring temperature and pressure, a camera system, and timed release for 48-hour deployments. Both systems are positively buoyant and deployed by hand from a small boat. The landers were deployed at depths of 100-400 m near the La Jolla Canyon and tested for their ability to collect meaningful ecological data from these nearshore deep-sea features.

## Map of lander deployment locations

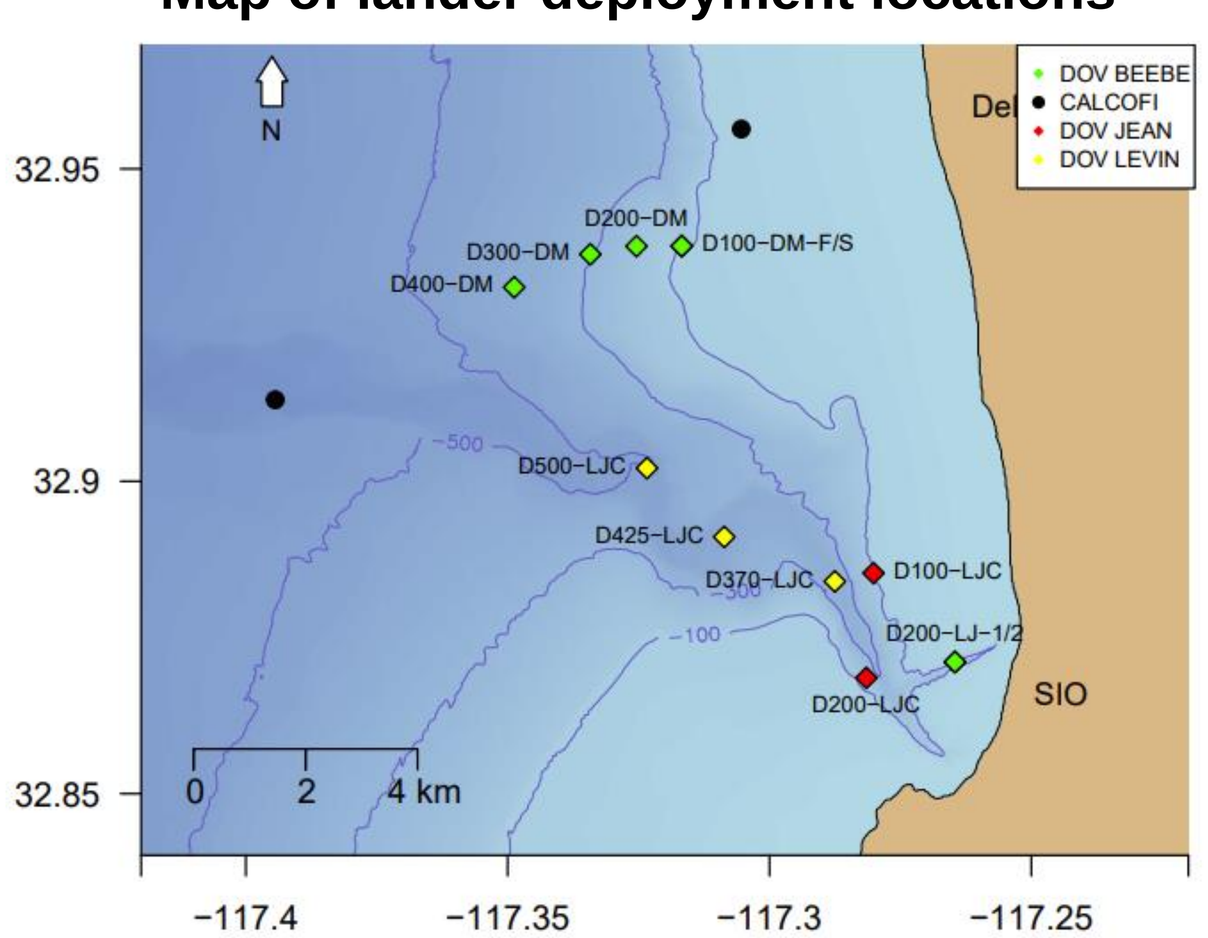
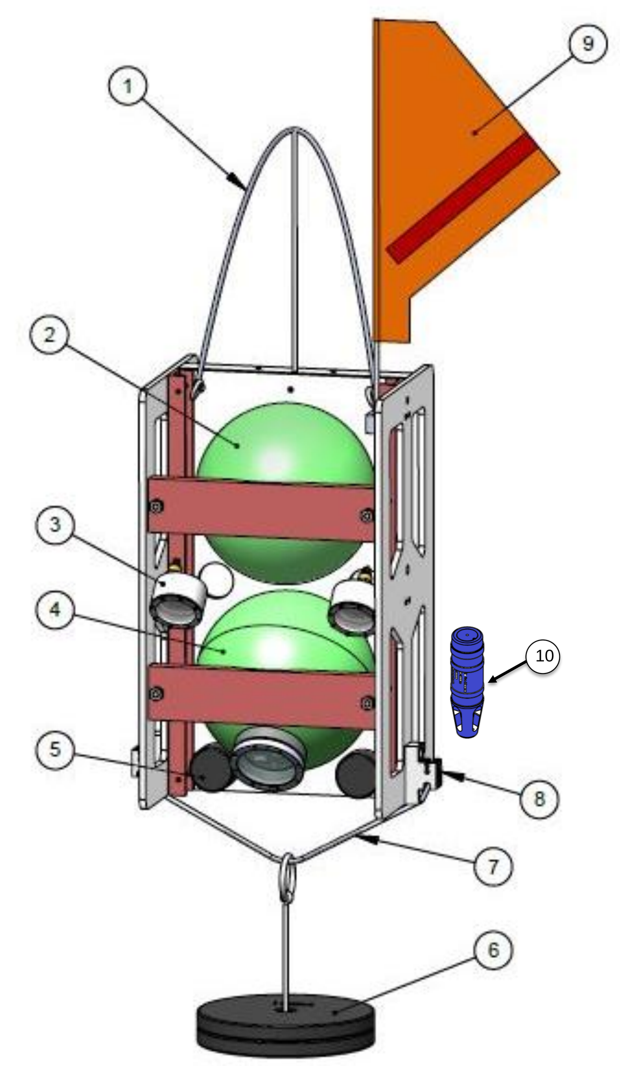



**Figure 1**. Map of Nanolander *DOV BEEBE* and Picolanders *DOV JEAN* and *DOV LEVIN* deployments shown in relation to the La Jolla Canyon. Green diamonds indicate the *DOV BEEBE* deployments, red diamonds indicate *DOV JEAN* deployments, yellow diamonds indicate *DOV LEVIN* deployments, and black circles indicate local California Cooperative Oceanic Fisheries Investigations (CalCOFI) stations that are sampled quarterly. Also shown are isobaths at 100, 300, and 500 m depth. Note that green diamonds labelled as D200-LJ-1/2 and D100-DM-F/S represent two deployments each, but points overlap due to proximity.

## Small autonomous lander design and schematics

**Figure 2:** A diagram of the Picolander *DOV JEAN.* 1) Spectra lifting bale; 2) ~25cm polyamide control sphere containing the timed-release system; 3) oil-filled LED lights; 4) ~25cm polyamide camera sphere containing a GoPro Hero 4, CamDo timelapse controller, V50 Voltaic Systems battery,16mAh LiPo battery, and battery management system; 5) 1.5lb counterweights x2 sides; 6) 25lbs expendable iron anchor; 7) chain connecting weights to the burnwires; 8) burnwire release and mount x2 sides; 9) surface recovery flag; 10) ZebraTech Moana pressure and temperature sensor (fastened to the interior of the frame.



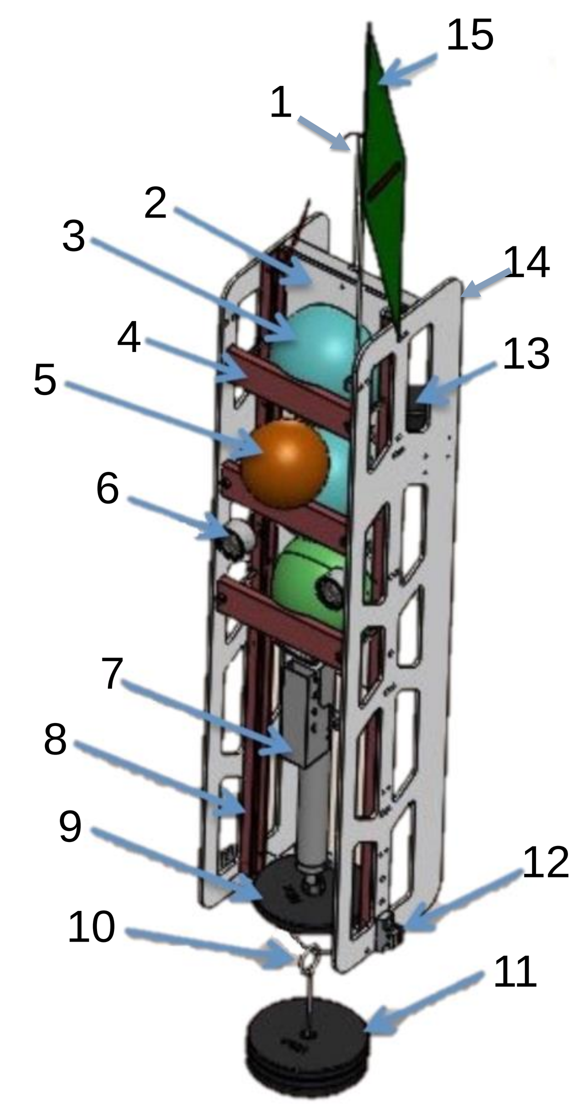
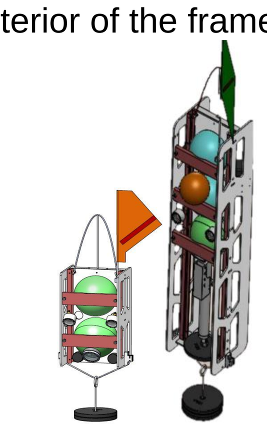




**Figure 3**: A detailed diagram of the Nanolander *DOV BEEBE* components from Gallo et al. (2020): 1) Spectra Lifting bale; 2) HDPE centerplate; 3) ~25 cm polyamide spheres stacked top, middle and bottom, top is the command sphere, middle has 32mAh LiPo battery, and bottom is the camera; 4) sphere retainer; 5) auxiliary ~18 cm flotation sphere; 6) oil-filled LED lights; 7) Seabird MicroCAT-ODO in the lower payload bay; 8) central fiberglass frame; 9) stabilizing counterweight; 10) anchor slip ring; 11) 40lbs expendable iron anchor; 12) burnwire release and mount x2 sides; 13) Edgetech hydrophone for acoustic command and tracking; 14) HDPE side panels; and 15) surface recovery flag. Not shown: drop arm on front.



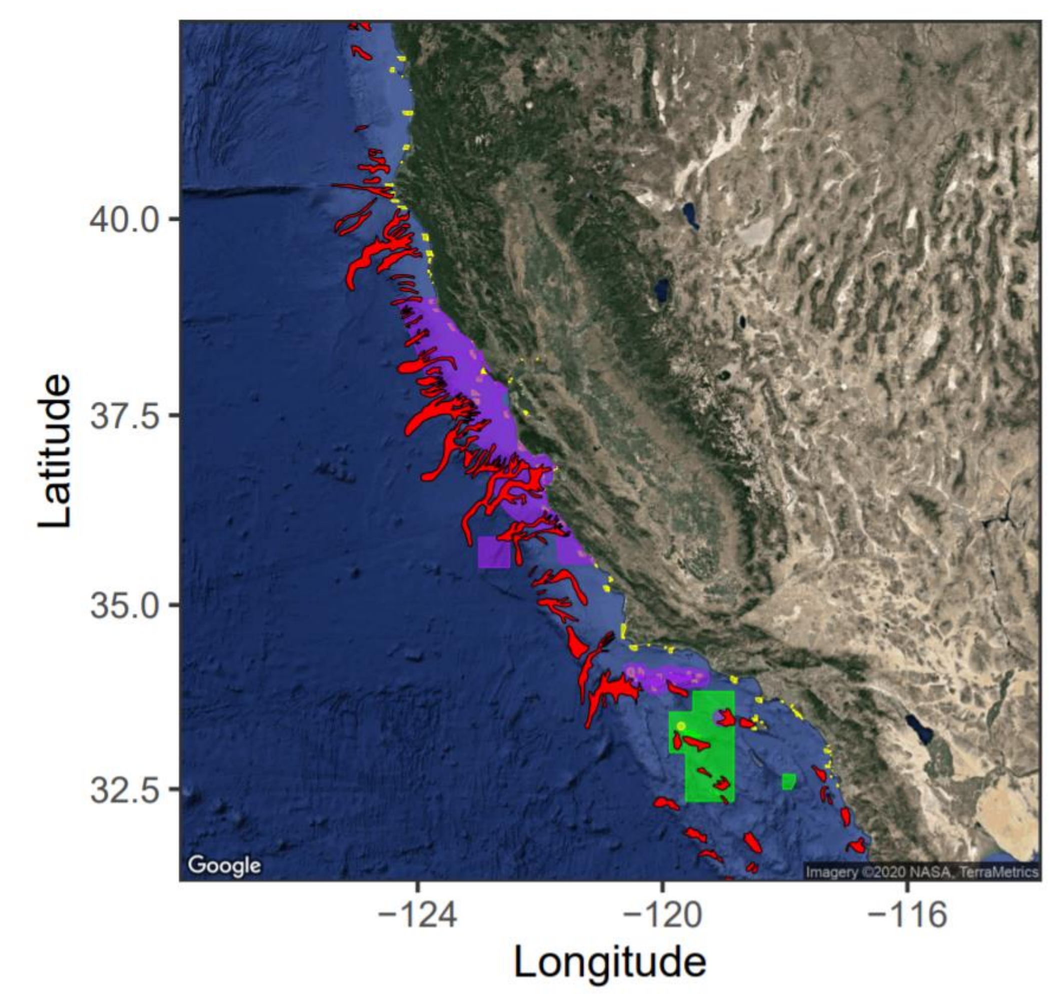
Picolander *DOV JEAN*

0.64m tall, 0.36m wide, 0.36m deep

Nanolander *DOV BEEBE*

1.6m tall, 0.36m wide, and 0.36m deep

## Map of large submarine canyons and protected areas on the coast of California




- In this study, we found that 27% of large submarine canyons off the coast of California by area are protected by government agencies. However, this number does not include the smaller nearshore canyons which tend to be unprotected.
- We defined nearshore submarine canyons as features within 5 km of shore that are deeper than 200 m and incised at least 100 m into the slope.
  - By applying this definition we identified 32 nearshore submarine canyons in the Southern California Bight alone.

**Figure 4**: A map of the coast of California with large submarine canyons as defined by Harris and Whiteway (2011) shown in red, Marine Protected Areas shown in yellow, National Marine Sanctuaries shown in purple, and Cowcod Conservation Areas shown in Green. This data was used to calculate the percent overlap between large submarine canyons and government protection areas on the coast of California.

## Conclusions

Nearshore submarine canyons play an important role in connecting nearshore and deep-sea ecosystems, however, they are hard to access with traditional deep-sea techniques. Small autonomous landers offer a robust and cost-effective way to study these features. Because landers can collect physical, biogeochemical, and biological data (Fig. 5) they can be used to inform management decisions surrounding these unique systems. As sensor and battery technology continue to improve, landers can also become smaller while retaining similar sampling abilities. Thus, increasing their ease of use and decreasing the cost associated with studying the deep sea.

### Time series of Oxygen, Temperature, and Fish Observances

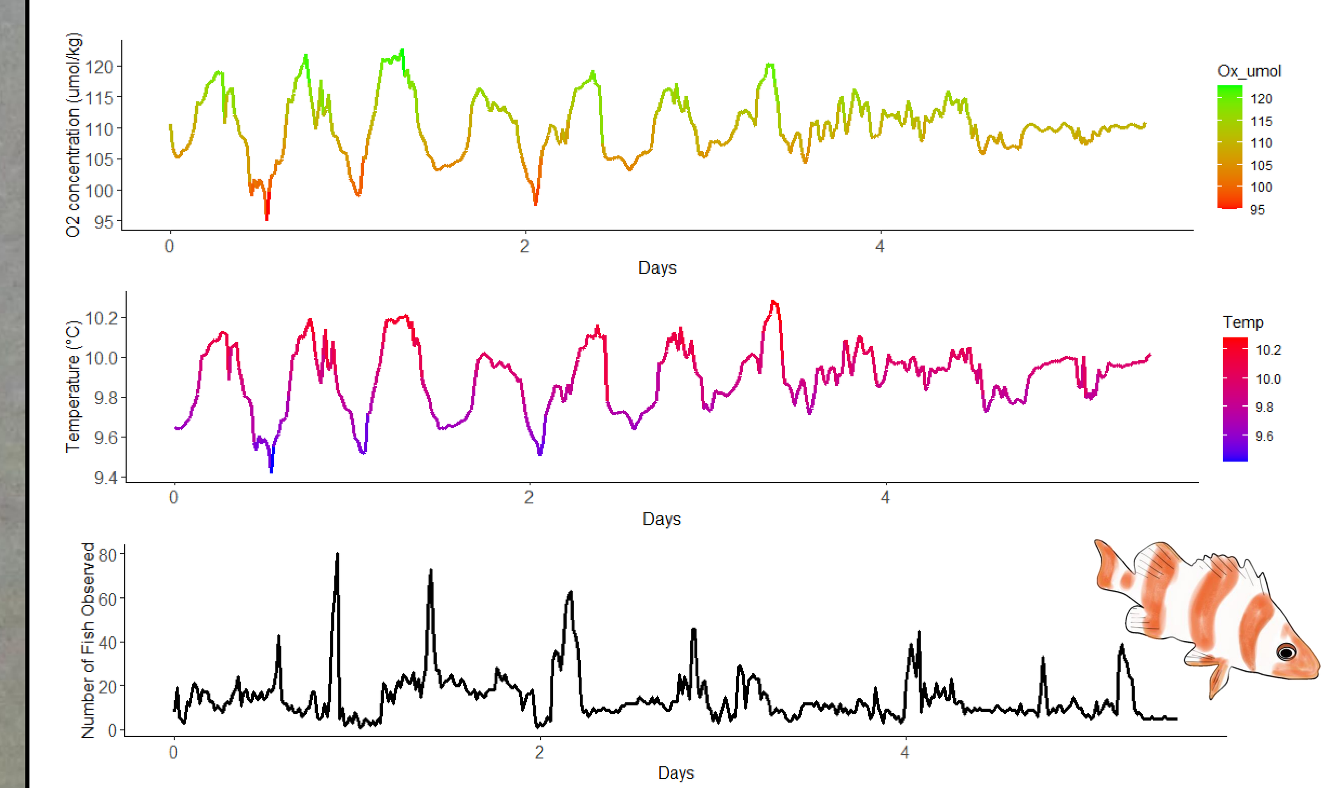



**Figure 5**: A time series showing oxygen concentration in μmol $kg^{-1}$, temperature in Celsius, and fish observations over 5 days during a 100 m deployment at Del Mar Steeples Reef with Nanolander *DOV BEEBE* (D100-DM-S).

## Literature cited

Harris, P. T., & Whiteway, T. (2011). Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. *Marine Geology, 285*(1-4), 69-86. doi:10.1016/j.margeo.2011.05.008

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