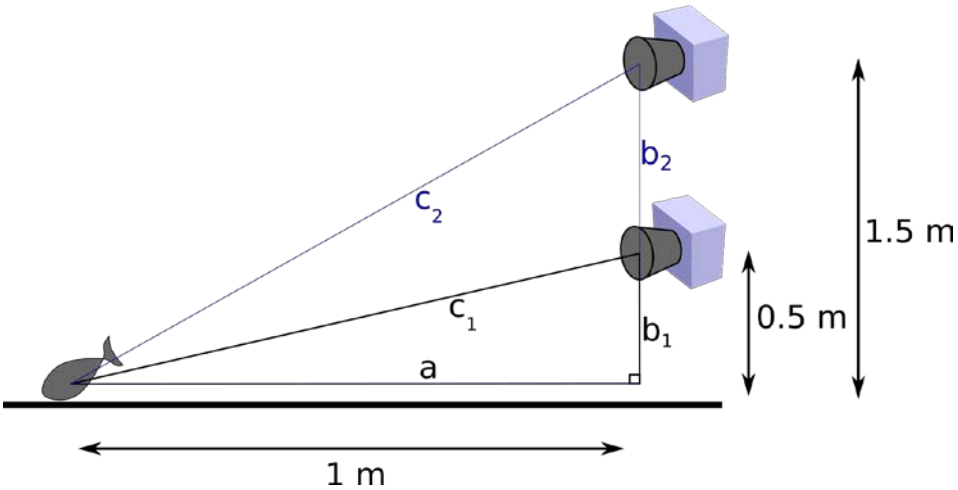
Supplementary material 3:

How altitude could have affected measurements?

Three main points are being discussed here because they are potentially impacting our results, with first the effect of altitude on measured distance from the camera to the specimen, second the effect of such distance on image resolution of specimens recorded and lastly the effect of altitude on possible missed specimens due to the field of view.

1. Effect of altitude on distance measurements

We use the Pythagorean Theorem to calculate the theoretical difference in distance from a fish to a camera system placed at two different altitudes.



If *a* is the distance between the fish and the vertical projection of the camera on the ground, *b* the altitude and *c* the distance between the fish and the camera system.

$$c^2 = a^2 + b^2$$

When the camera is at 0.5m altitude:

$$c_1 = \sqrt{1^2 + 0.5^2} = \mathbf{1.12\ m}$$

When the camera is at 1.5 m altitude

$$c_2 = \sqrt{1^2 + 1.5^2} = \mathbf{1.80\ m}$$

The difference between distances depending on the altitude is:

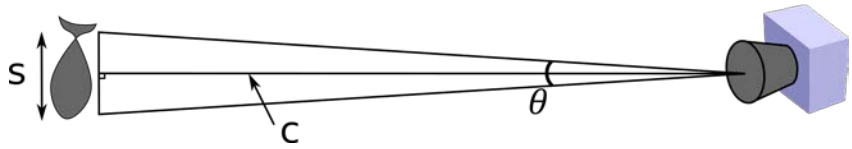
$$\Delta c = 1.80 - 1.12 = 0.68\ m$$

Therefore the difference in distance measured by two video systems placed at two altitudes (0.5 and 1.5 m) would be around 70 cm which is in the range observed between methods in the present study.

2. Effect of camera-specimen distance due to altitude variation on fish resolution

Admitting that the fish measured at 1 m in front of the camera has a 4 cm fork length, what would be his size in pixels on a full HD video?

Using trigonometry, lets first measure the angular size (θ) of the fish.



If *s* is the length of the fish (4 cm), *c* the distance between the fish and the camera and θ is the angular length of the fish

$$\tan(\theta/2) = \frac{s/2}{c} \rightarrow \theta = 2 \times tan^{-1}\left(\frac{s/2}{c}\right)$$

A fish being at **1.12 m** (c_1) from the camera will have an angular size of:

$$\theta_1 = 2.04°$$

A fish being at **1.80 m** (c_2) from the camera will have an angular size of:

$$\theta_2 = 1.27°$$

Now in order to transform these angles in pixels numbers from a Gopro recording in medium field of view (127° horizontal) and in full HD (1920 pixel horizontal), lets scale the full field of view to the angular size of the fish based on horizontal numbers of pixels. We also need to consider water diffraction effect and because there is a flat lens on the housing, field of view underwater is roughly reduced to **84°**.

Therefore the size in pixels for a 4 cm fish at **1.12 m** is:

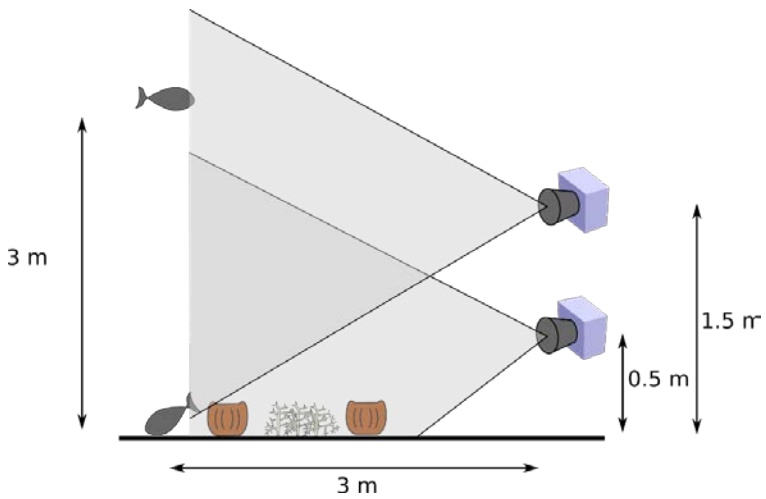
$$pix_1 = \frac{1920}{84} \times \theta_1 = 47\ pixels$$

And when the same fish is placed at **1.80 m** from the camera, his size will be:

$$pix_2 = \frac{1920}{84} \times \theta_2 = 29\ pixels$$

So a cryptic fish would appear nearly twice smaller if the camera is 1 m higher, probably enough to miss some small cryptic species.

3. Effect of altitude on fishes being out of the field of view



The stereo system we used in this work had a field of view approximating 5 m wide and 3 m high when objects were positioned 3 m ahead of the video system. For the sake of argumentation let say, a large fish is passing 3 m in front of the camera system. In what condition could it be seen by a camera system recording at 1.5 m from the ground and not be seen by a camera system passing at 0.5 m from the ground?

That fish would have to pass at an altitude between 3 and 4 m high. If the same argument is being made at 5 m from the system, that fish would have to pass between 5 and 6 m from the ground. Although such fact is possible with fishes that are pelagic or that swim great distances, it is unlikely with benthic species.

Another possibility is when habitat is complex with numerous hides, a higher camera could spot a fish in a crevasse that a lower camera could not because hidden by the habitat.

4. Conclusion

Altitude could affect measurements in mainly two ways:

- Benthic species appear 70 cm further and nearly twice smaller on video
- Species hidden behind benthic features or swimming high from the substrate might be more easily spotted by higher cameras than the lower one.

As a result altitude difference could influence measurement of assemblages mainly via detectability of small benthic species and highly mobile ones. These groups of species are generally the source of variability among methodology but cannot account for all the variation measured in the present study.

In conclusion, small benthic species will better be quantified when recording occur close to the substrate and large pelagic species better quantified when the recording occurs furthest from the substrate. In our study altitude difference between Semi-Autonomous Underwater Vehicle and Diver Operated Video was small (1 m at maximum), therefore such fish assemblage variation should remain small.