

## Using drones to improve the estimation of the dolphin abundance in the eastern tropical Pacific Ocean

The Inter-American Tropical Tuna Commission (IATTC – [www.iattc.org](http://www.iattc.org)), in coordination with the *Comision Nacional de Acuacultura y Pesca* (CONAPESCA) of the Government of Mexico and with the support of the *Instituto Nacional de Pesca y Acuacultura* of Mexico (INAPESCA), the Mexican tuna industry, and the Center for Research into Ecological and Environmental Modelling (CREEM - [www.creem.st-andrews.ac.uk](http://www.creem.st-andrews.ac.uk)) at the University of St Andrews (USTAN), is undertaking a ship-based survey to estimate the abundance of dolphin populations in the eastern tropical Pacific Ocean (EPO) and improve management of those populations and the EPO ecosystem. The ecology of this region is a very unusual due to the association between tunas and dolphins, which come together to form dynamic aggregations, a result of special oceanographic conditions. This association allows purse-seine fishermen to locate tunas by searching for schools of dolphins at the sea surface, particularly schools of spotted, eastern spinner and common dolphins ([Figure 1](#)). The first phase of the survey, which has been recently completed, lasted 14 days during which research was carried out with the use of drones operated from an oceanographic vessel. This unprecedented experiment will make it possible to establish the appropriate technology and methods to be used in the next phase of the project.

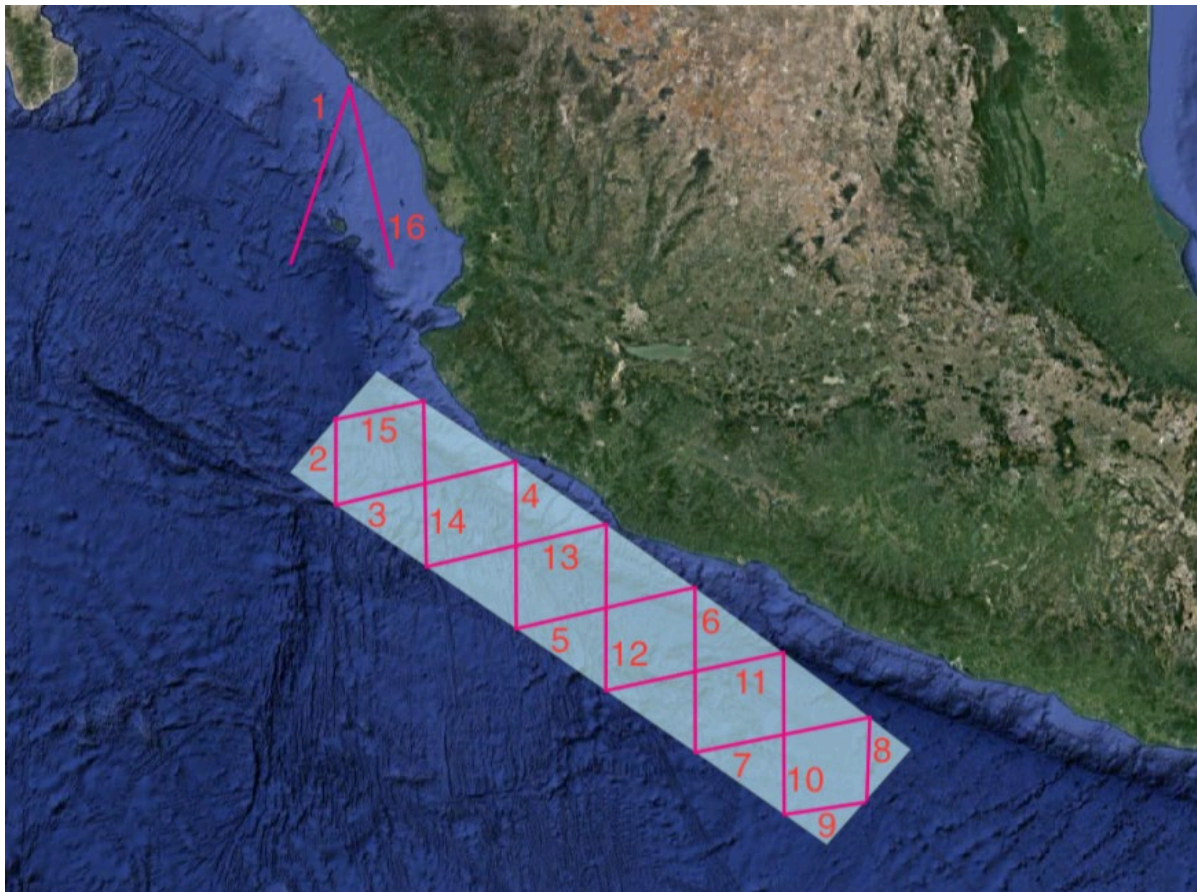
### A novel research plan using drones

Armed with a [novel research plan](#) developed by researchers at CREEM 37, on the morning of 17 November 2019, an international research team sailed out from Mazatlán, Mexico, aboard the R/V Dr Jorge Carranza Fraser of the INAPESCA for the 14-day research trip. The team was led by Dr Cornelia Oedekoven of USTAN and Dr Cleridy Lennert-Cody of IATTC, and composed of scientists, drone pilots and mechanics from four different countries (Mexico, USA, Germany and Chinese Taipei).

The team headed out into a small study area between Mazatlán and Acapulco where they expected to find high numbers of spotted and spinner dolphins ([Figure 2](#)). The project had two goals: 1) test whether drones can ‘see’ dolphin schools directly ahead of the survey vessel that might be missed by ship-based marine mammal observers, and 2) test whether drones can be used to collect data on dolphin school size and species composition, data essential for calibrating estimates made by the ship-based observers. To achieve these goals, the research vessel had to be outfitted with a special observation platform on the level above the bridge, called the ‘flying bridge,’ that included four sets of high-powered binoculars mounted on pedestals, a data recorder station, a wind dam and a canopy for sun protection ([Figure 3](#)). The vessel was also outfitted with a special platform on the stern for launching and landing the drone ([Figure 4](#)).



**Figure 1.** Eastern spinner dolphins (top left), spotted dolphin (top right) and common dolphins (bottom left) encountered during the ETP trial survey. Photo credits: Paula Olson, courtesy IATTC & USTAN.

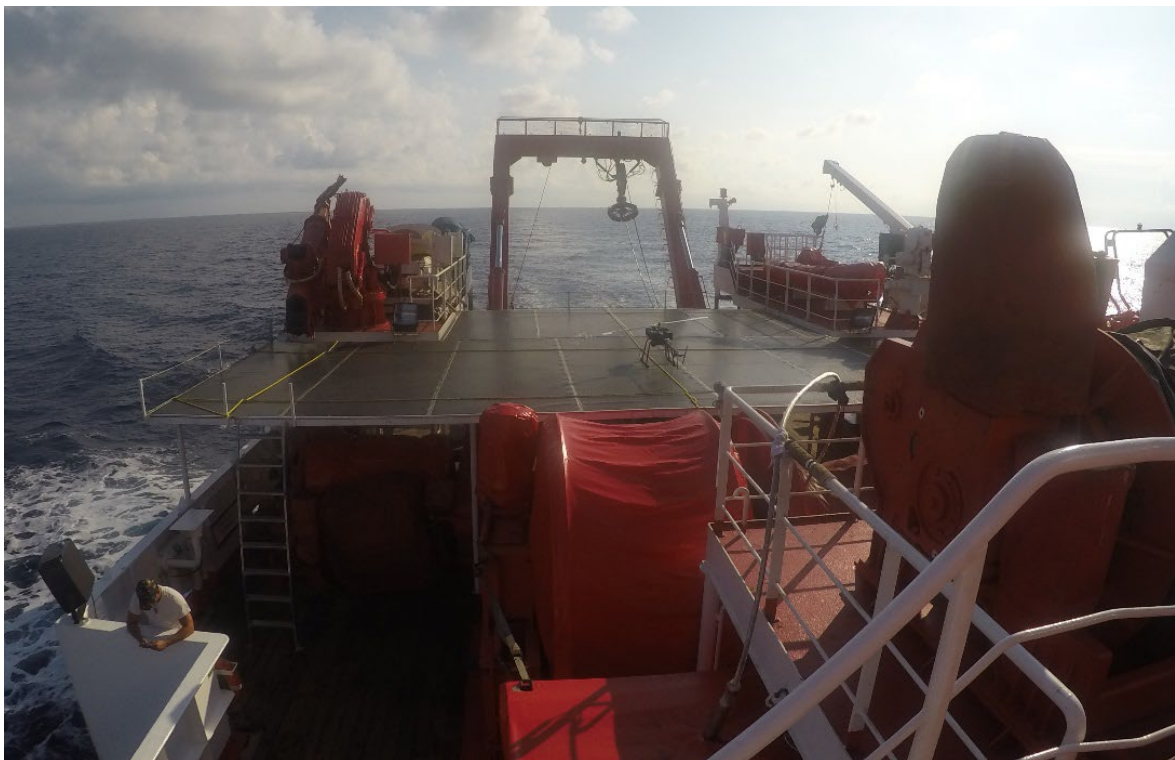


**Figure 2.** Study area (shaded area) and transect lines for the trial survey. Transects 1 and 16 were designed to lead in and out of Mazatlán, while transects 2-15 are in an area where high numbers of spotted and spinner dolphins were expected.





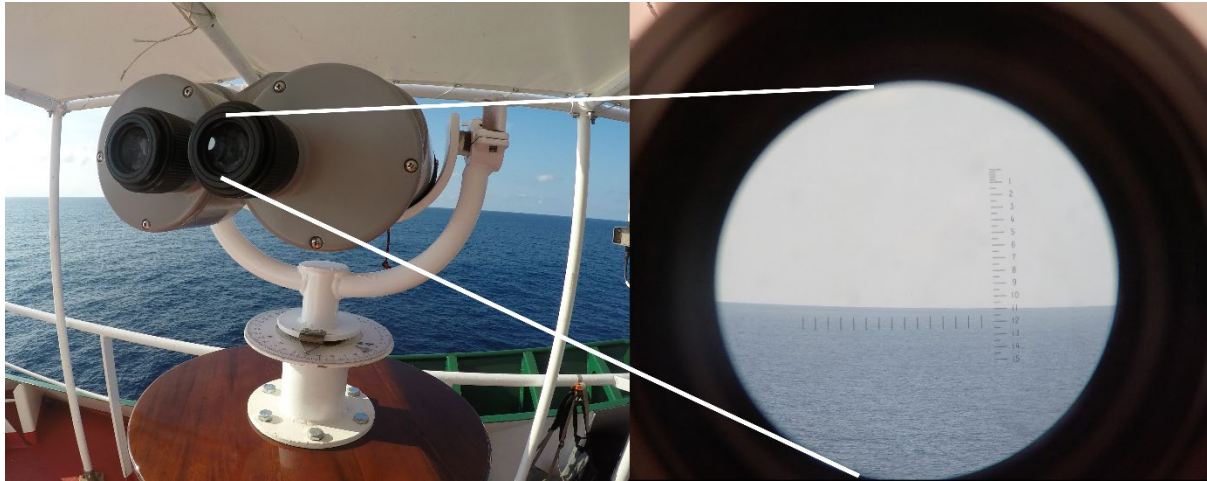
**Figure 3.** Observers on the flying bridge: three main observers, Suzanne Yin, Ernesto Vazquez and Andrea Bendlin scan the forward 180° with bigeyes binoculars and naked eye. Tracker Braulio Bernal on the right focuses on the central areas within 15° on either side of the ship.



**Figure 4.** Platform for launching and landing drones on the back deck of the R/V Dr Jorge Carranza Fraser with a Seahawk S drone operated by pilots from GttNetCorp ready for take-off.

### **‘Seeing’ all dolphin schools on the survey transect lines**

During previous surveys, conventional distance sampling methods have been used to estimate abundance of dolphins. During such surveys, the ship travels sequentially along each transect line placed in the study area (such as those shown in [Figure 2](#)), and trained marine mammal observers record the location of cetacean schools using measurements of the radial distance to the dolphin schools from the transect line and angle in relation to the ship’s heading ([Figure 5](#)), as well as the size and species composition.



**Figure 5.** Bigeye binoculars (25 x 150): the angle ring and the reticule scale in the right ocular allow determining the angle and radial distance of the detection in relation to the ship.

This methodology allows for observers missing dolphin schools that pass the beam of the ship at greater distances, however, it assumes that observers detect all schools directly on the transect line. If schools on the transect line pass undetected, the abundance estimates will be too low. Because the dive intervals of the dolphin species of interest are relatively short, it has generally been assumed that all schools on the transect lines are detected, regardless of weather conditions. However, a recent analysis of previous survey data provided evidence that this may not be the case, and that the probability of missing schools on the transect line increases when wind speeds increase and viewing conditions deteriorate.

During the 14-day trip, scientists tested if the drones can be used to estimate transect line detection probability. For this purpose, the drone flew in a zigzag pattern across the transect line 4nm ahead of the ship and sent video footage back to the ship in real-time. Observers on the ship monitored the drone footage, recording dolphin schools and their locations ([Figure 6](#)). These detections were then compared with those made by the marine mammal observers on the flying bridge. To supplement this real-time video analysis, further analyses of the drone footage will be done in the coming months using sophisticated computer algorithms designed to find schools of dolphins. If these analyses determine that the flying bridge observers saw all detections that the drone ‘saw’, then we may have evidence that the flying bridge observers have perfect detection on the transect line. If they missed some of the drone detections, we may have evidence that observers have less than perfect detection on the transect line and a correction factor should be applied.



**Figure 6.** Drone observers Dr Cleridy Lennert-Cody and Juan Carlos Salinas monitor the drone video footage transmitted back to the ship in real-time. Drone engineer Lin Jia-Huei (Jason) of GttNetCorp, on the left, ensures that video footage and GPS data are recorded.

### **Calibrating dolphin school size estimates**

Estimating the number of individuals in a school of dolphins accurately poses another challenge for estimating dolphin abundance. Dolphin schools vary in size from a few dolphins to several hundred animals. For observers who are tasked with estimating school size, it is unknown how many animals are below the surface at any given time, making it difficult to obtain accurate estimates of school size. Marine mammal observers that participate in surveys in the EPO are calibrated by comparing their estimates against the true number of dolphins. This true number can be obtained by taking high resolution imagery (video or photo) of the school from above. On previous surveys, photos of calibration schools were taken from helicopters or small aircraft. During the present study, suitable video footage was taken with the drone that will allow us to determine the true number of dolphins in the calibration schools ([Figure 7](#)). Two views of dolphin schools were required: imagery from a relatively high altitude that allowed the whole dolphin school to be observed for some time, and imagery using a zoom lens to obtain species identifications. Because the Seahawk S drone is highly manoeuvrable, it was able to hover over and follow dolphin schools for extended periods of time. Once observer estimates have been calibrated using the imagery, their estimates of school size for all dolphin schools can be used in abundance estimation analyses. We will still rely on observers making school size estimates for all schools as it is not practical to use the drone to get true counts for all schools.





**Figure 7.** Aerial view of part of a school of Risso's dolphins encountered during the study. Photo: courtesy IATTC & USTAN.

### **What's next**

During this first phase of the survey, high-resolution imagery was collected with the drone on almost 90 flights and over 200 cetacean schools were recorded by the ship-based marine mammal observers. These data represent a wealth of information that will be carefully analysed in the coming months to evaluate the benefits of using drones for improving estimates of dolphin abundance. The analytical tools that will be developed for these analyses and the results of these analyses will benefit scientists all over the world working on estimation of abundance of marine mammals. Following the analyses of first phase of the project, the planning and development of the second phase of this project will continue. The second phase of the project will include a 120 sea-day survey of the entire EPO, scheduled for the second half of 2020, with the objective to estimate dolphin population abundance, which will improve the conservation and management of dolphin populations in the EPO.