Drones for Whale Research: SnotBot, EarBot & FLIRBot

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In 2012 we started exploring alternative tools to collect biological data from whales. Our first efforts were directed towards SnotBot, a drone which collects respiratory samples from whales. As the program developed, and we spent more time working with drones, it became apparent just how powerful a tool today's drones can be for marine mammal research, able to collect a wide variety of high quality data streams. This has led Ocean Alliance to develop multiple bots, with plans for many more in the pipeline. Here we present information on our first three bots.

EarBot

Introduction: EarBot is a waterproof drone which lands in the water close to a group of whales. EarBot is fixed with a hydrophone and a transmitter which transmits the acoustic signal back to the boat.

Potential applications: Ocean Alliance's founder and president, Dr. Roger Payne, has always maintained the importance of the acoustic realm when studying whales. EarBot presents an array of new acoustic recoding opportunities to the researcher.

Advantages:
- Non-invasive
- Mobile, not fixed
- Deployed away from boat/launch platform
- Affordable

Disadvantages:
- Current limitation controlling the depth of hydrophone
- Some interference of signal with drone electronics

Data and Results:
Beta-testing took place in Goose Cove Reservoir, MA, with field tests being carried out in Frederick Sound, Alaska, recording humpback whale feeding vocalizations.

Objective 1: To land EarBot in the water and transmit acoustic signal back to researchers.
Objective 2: After making a successful recording, re-deploy drone to new location with same group of whales.

Both objectives were met.

The Gear: Urban Drones Splashdrone

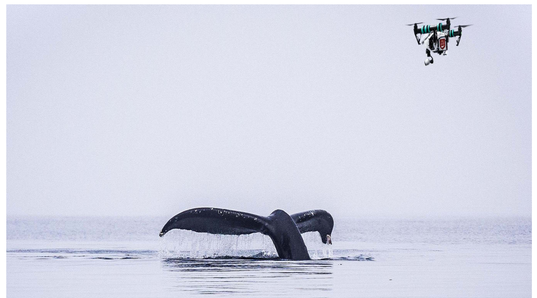
Advantages: Waterproof, practical, affordable.

Specifications/capabilities:
- flight time 19 min;
- payload release system (dropping hydrophones);
- GoPro/action camera attachment;
- weight 2.3 kg;
- speed 21m/s

SnotBot

Introduction: SnotBot is a drone which flies above a whale to collect the blow, or exhaled breath condensate(EBC).

- Ocean Alliance is committed to the idea that to get a robust understanding of a whale's health, and the impacts of anthropogenic or natural stressors on its health, researchers must collect physical, biological samples.
- Current methods of collecting such samples can be expensive, subject to low sampling rates and invasive towards the animals.
- SnotBot can collect physical samples at a high sampling rate without the whale even knowing we are there.



The Gear
Drone: DJI Inspire 1 V 2

Advantages:
- Affordable
- Reliable
- Adjustable parameters

Disadvantages
- None to date

Key specifications:
- Flight time 22 mins
- Weight 2.9kg
- Speed 22m/s

Collection Device:
- 1 6-inch petri dish
- 2 4-inch petri dishes (see picture)

SnotBot Statistics	
Number of flights	258
Samples collected	124
Species sampled	4
Most flights in one day	26
Most samples in one day	15
Largest sample size	1.9 mL
Average flight duration	06:55
Longest flight duration	23:17

- We believe that drones such as SnotBot will open up a new paradigm in marine mammal science and conservation.
- Modern consumer drones are practical, increasingly user-friendly, highly adaptable and able to collect a wide variety of data: including EBC, photo-ID, photogrammetry, behavioural data, bio-acoustics, lowlight/night-time footage etc.
- The list of potential future applications is expansive.
- Moreover, the fact that these drones are relatively inexpensive, means that far more researchers globally can be using them to collect all this data.
- SnotBot itself offers many advantages over conventional methods of collecting biological samples from whales. It is far faster than any vessel a sample could be collected from and thus can achieve a far higher sampling rate than other methods. It is also far less invasive.

Data and Results: Our initial goals were:

- Prove that respiratory samples could be collected from a whale using a drone.
- Increase the "snot" sample size and sampling rate of the program.
- Develop the technology and methodology for collecting samples.

Thus far we have sampled four different species of whales in four different locations:
- Southern right whale, *Eubalaena australis,* in Patagonia, Argentina
- Gray whale, *Eschrichtius robutus,* on the Pacific coast of Baja California
- Blue and humpback whales, *Balaenoptera musculus* and *Megaptera novangliae,* in the Sea of Cortez
- Humpback whale in Frederick Sound, Alaska).

The next steps will be to continue developing the best collection, storing and curating protocols while working closely with scientific partners to analyse the samples for a variety of physiological compounds.

FLIRBot

Introduction: FLIRBot is a DJI drone carrying an FLIR Vue Pro InfraRed camera on a custom gyro.

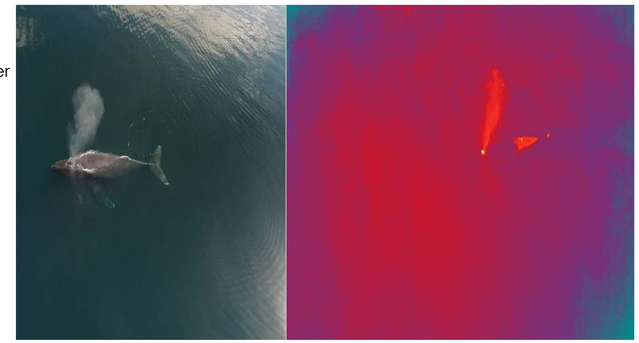
Research questions: Can we collect behavioural data at night?

- There are a multitude of reasons which make whales difficult animals to study, primarily related to their habitat, their range and their diving capabilities.
- Studying them at night presents even more challenges. The reality is we know too little about what these animals do during half of their lives (i.e. at night).
- There are also streams of data FLIRBot could collect during daylight hours, such as looking at heat patterns on whale's backs and looking at potential wounds/scarring.

Data and Results:
To date we have completed beta-testing.

- 10 flights completed in Frederick Sound, Alaska, over humpback whales.
- The FLIR struggled to effectively focus on the water surface unless some of the horizon was in the shot.

The Gear: **Drone**: DJI Inspire 1
Advantages: Very practical, easy to use, reliable affordable,
Key specifications: flight time 22mins; weight 2.9kg; speed 22m/s
Camera: FLIR VUE Pro – Designed for drone use
Camera mount – Custom Gyro



Drone suggestions for other researchers

Introduction: We believe that inexpensive consumer drones, such as those we are using, will facilitate significant advances in marine mammal science and conservation over the coming decades. One of the, if not THE, primary objective of this program is to encourage and accelerate this process. Below is some advice for researchers exploring the idea of using drones in their own research.

Choosing a drone

Key Words: User friendly, field friendly, affordable.

- Stick with the drones from the top manufacturers, with DJI being, in our experience, top of the pile.
- Ease of use and reliability in the field are key. The greatest advantage of the top manufacturers is the remarkable usability, stability and reliability of their drones.
- Practice, practice, practice (flying). The new drones are very easy to fly; we are concerned that this can lead to overconfidence which could be disastrous in the field.
- Flight Time: Flight time is a crucial factor in any study. The DJI Mavic and the new DJI Inspire 2 have 27-minute maximum flight times.
- Waterproof, yes or no? We recommend non-waterproof drones over waterproof drones. In our experience the advantages of waterproof drones are outweighed by the disadvantages: namely usability (they are more difficult to operate) and weight (reducing flight time). Our primary DJI Inspire has flown through +50 blows and still operates with no issues. During +400 flights over water we have had just two drones land in the water and both were pilot error.

In the future, we plan to release more in-depth data and discussions regarding our experiences with this program so far.

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