Using HydroMoth to Make Underwater Recordings

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HydroMoth is a variant of the standard AudioMoth designed specifically for making underwater recordings with the AudioMoth underwater case.

1 HydroMoth Hardware

The HydroMoth hardware is directly compatible with all AudioMoth firmware and uses the same audio front-end and microphone as the standard AudioMoth 1.2.0 and AudioMoth Dev boards. It is specifically designed for use within the underwater case with (i) repositioned LEDs for improved visibility, (ii) a more accurate 32.768 kHz MEMS oscillator to reduce clock drift during long deployments, and (iii) the same magnetic reed switch used within the AudioMoth GPS board to enable recordings to be started and stopped in wet conditions without opening the case.

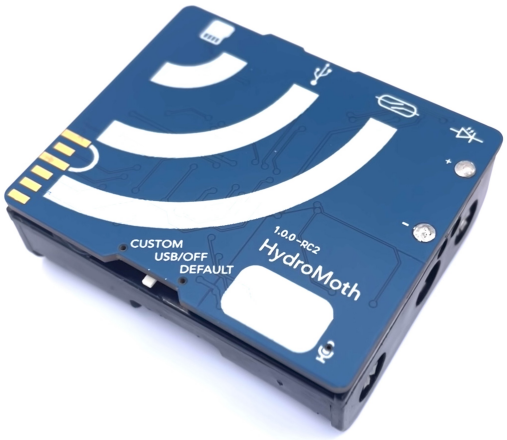

Figure 1: *HydroMoth variant specifically designed for use within the underwater case.*

2 Underwater Case

The AudioMoth underwater case is a clear injection-moulded polycarbonate housing that allows both AudioMoth and HydroMoth devices to be used underwater. It is based on the standard IPX7 case without the use of an acoustic vent. The case is fully submersible and has been tested at 30 metres depth for deployments of over 2 months.

Figure 2: *HydroMoth variant inside the underwater case.*

3 Deploying HydroMoth

HydroMoth is compatible with all the standard AudioMoth firmware and desktop utilities. The inbuilt magnetic reed switch is used by the standard firmware (from version 1.7.0 onwards) to support delayed start. This can be enabled by checking the *Enable magnetic switch for delayed start* option in the AudioMoth Configuration App (see Figure 4).

3.1 Delayed start

When enabled, switching to CUSTOM will put the HydroMoth into a delayed start mode, flashing the green LED once every four seconds, rather than the normal two seconds when in CUSTOM mode waiting to start a recording. In this state the HydroMoth uses very little power and will wait until activated by a magnetic key (see Figure 3) held near the magnetic switch icon on the front face. Once activated, the HydroMoth will rapidly flash the green LED ten times, before switching fully

Figure 3: *Magnetic key used to trigger the HydroMoth magnetic switch.*

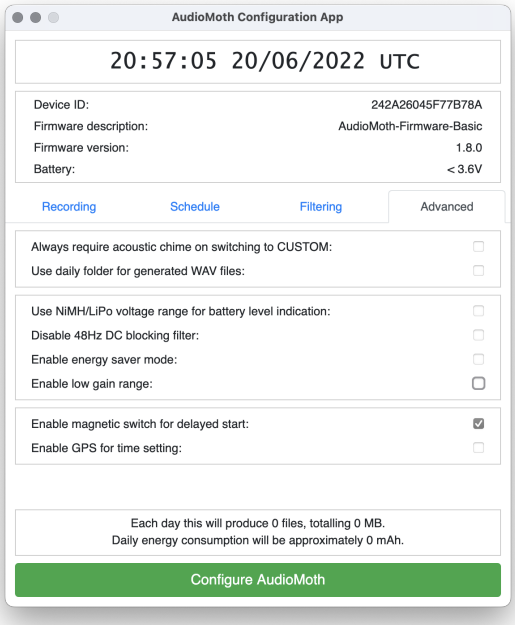

Figure 4: *AudioMoth Configuration App showing 'Advanced' tab with options to 'Enable magnetic switch for delayed start' and 'Enable low-gain range' options.*

to CUSTOM mode and starting to make recordings as per the configured schedule. This allows a configured HydroMoth to be placed inside the underwater case, with its batteries and SD card installed and the switch set to CUSTOM, prior to transport to the deployment site, where it can then be fully switched into CUSTOM mode from outside the case with a magnet. This avoids the need to open the underwater case in wet conditions that might be found in a typical deployment (e.g. when deploying from a small boat).

The magnetic switch can also be used to stop recordings and to return to delayed start mode at any time. The HydroMoth will indicate that it is stopping a recording by rapidly flashing the red LED ten times, and will report this in the WAV file header comments if a recording has been cut short in doing so.

3.2 Low gain range

When making underwater recordings in noisy environments (such as when recording boat noise) it may be necessary to reduce the gain to prevent the audio signal saturating. When necessary, an additional low gain range can be enabled by checking the *Enable low gain range* option in the AudioMoth Configuration App (see Figure 4). Table 1 shows the gain applied at each setting when low gain and normal ranges are selected.

	Low Gain	Normal
Low	0.33	4.33
Low-Medium	0.55	7.00
Medium	1.00	15.00
Medium-High	1.67	25.05
High	2.00	30.00

Table 1: *Gain applied at each setting when low gain or normal range is selected.*

3.3 Applications

HydroMoth can be used to record both continuous audio, as well as triggered recordings based on amplitude threshold or frequency response. At its lowest sampling rates, HydroMoth can record continuously for over three weeks on a standard set of AA batteries. Deployments can be extended by duty cycling recordings.

The underwater case can be attached to many underwater structures or to weighted lines. For short deployments the velcro strap makes it easy to attach and remove the device. For longer deployments the velcro straps can be removed and the device can be de-

Figure 5: *HydroMoth cable-tied to a weighted line prior to deployment from a small boat.*

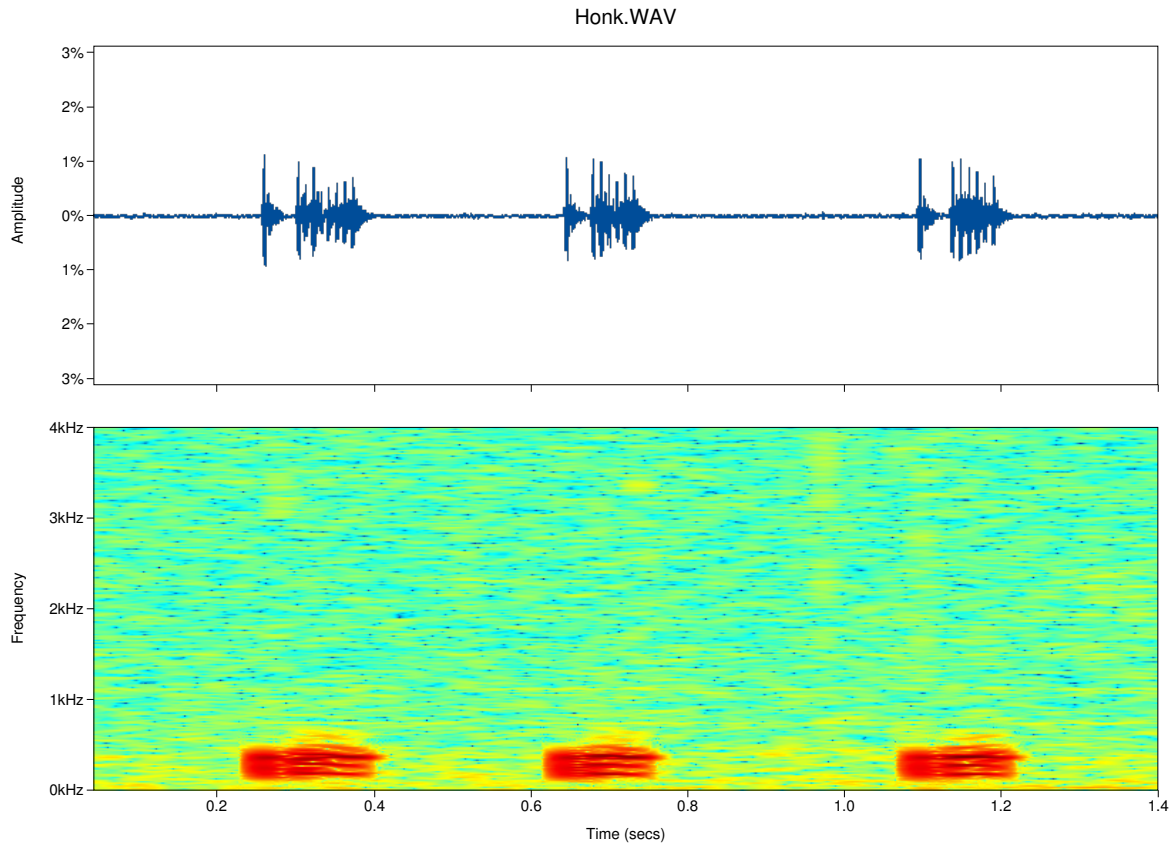

Figure 6: *Underwater recording, provided by Lamont et al., 2022, showing the unusual sound made by an unknown fish. Downsampled from 48kHz to 8kHz using the AudioMoth Filter Playground.*

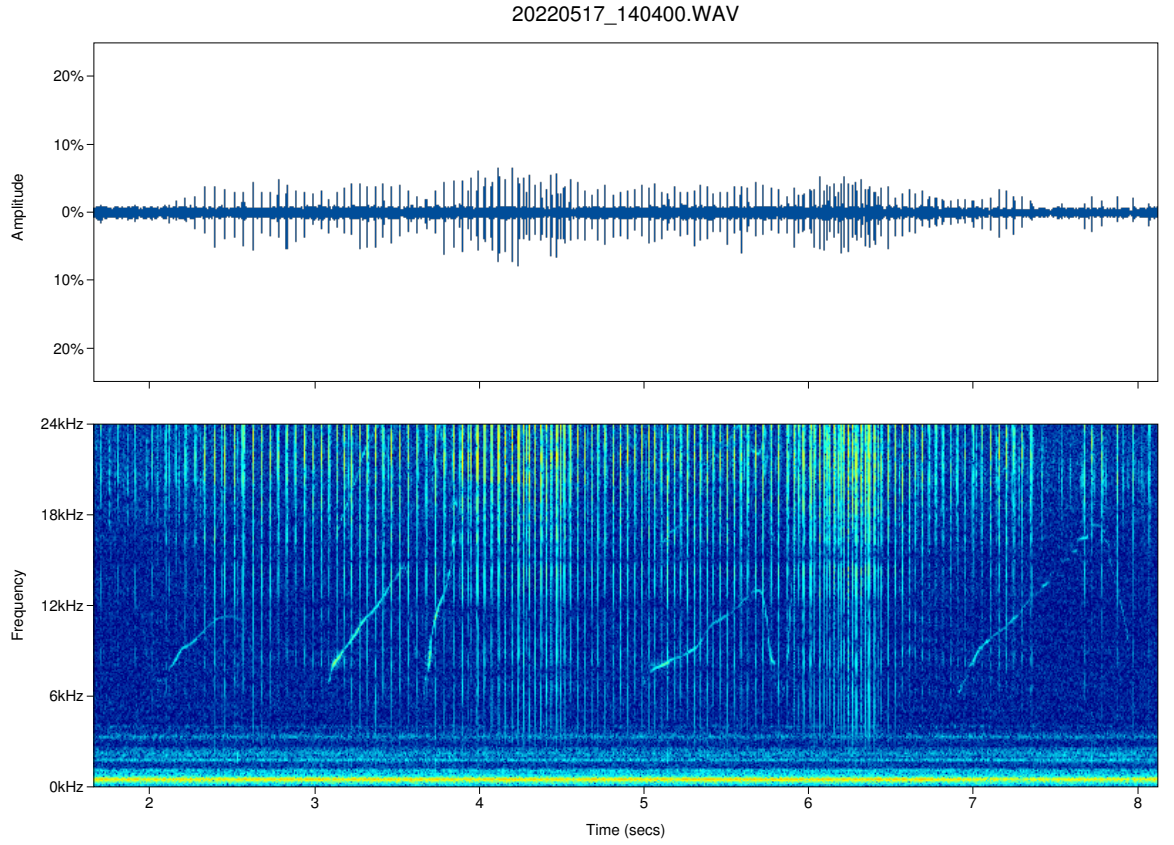

Figure 7: *Underwater recording, provided by Dr. David March of the University of Valencia, showing clicks and whistles of delphinids in the Strait of Gibraltar. Downsampled from 384kHz to 48kHz using the AudioMoth Filter Playground.*

ployed using cable ties for added security. For example, Figure 5 shows a HydroMoth cable-tied to a weighted line prior to deployment from a small boat.

In freshwater, HydroMoth has been used to record sounds from underwater insects, plants and amphibians in ponds, rivers or lakes (Abrahams, Desjonquères, and Greenhalgh, 2021). For this application the device can be deployed and retrieved on a short line. In the ocean, HydroMoth has been trialled along the South African Cape Coast and the Norwegian Sea to record dolphin whistles and whale song, and in French Polynesia to record sounds from coral reefs (Lamont et al., 2022). Here, it has been attached to a buoy and cable tied to a weighted line 20 meters below the water surface. Figure 7 shows recordings of the clicks and whistles of delphinids in the Strait of Gibraltar provided by Dr. David March of the University of Valencia. Low frequency boat noise, and occasional high frequency echo-sounder pings, are also present.

In the case of recording from coral reefs, HydroMoth has been deployed on stakes embedded in the sea floor close to the reef. The resulting audio has been used directly as part of emerging efforts to collect libraries of underwater biological sounds (Parsons et al., 2022). For example, Figure 6 shows a *honk* from an unknown fish recorded on fringing reefs, 500m off Tema'e beach, Mo'orea, French Polynesia by Lamont et al., 2022. In addition, recordings from coral reefs have also been used to calculate various acoustic indices which have been shown to correlate well with broad measures of coral health (Williams et al., 2022).

References

Abrahams, Carlos, Camille Desjonquères, and Jack Greenhalgh (2021). "Pond Acoustic Sampling Scheme: A draft protocol for rapid acoustic data collection in small waterbodies". In: *Ecology and Evolution* 11.12, pp. 7532–7543.

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