Using underwater video to observe aquaculture gear in Long Island Sound- A Citizen Science Guide

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Funding for this work provided by the NOAA Office of Aquaculture, NOAA Northeast Fisheries Science Center and The Nature Conservancy

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March 29, 2022

Executive Summary

This Citizen Science Guide, prepared by NOAA Fisheries Milford Laboratory, describes methods for recording video that can be used by shellfish growers, field biologists and anyone who is curious to observe and document activity of fish and other animals in and around aquaculture gear. Step-by-step instructions and photographs explain how to program and deploy action cameras on or adjacent to oyster cages and other types of aquaculture gear. Methods include updating camera firmware, optimizing settings, using off the shelf equipment and accessories, and strategies for troubleshooting. We also show options for attaching cameras on or adjacent to aquaculture gear during field deployments.

Sections on data management, video analysis, editing, and storage options offer guidance on processing and archiving video. We address using multiple camera perspectives to optimize field of view during video recording. Though we use GoPro Hero 3+/4 silver cameras, we also provide details on camera settings and readily available accessories for newer GoPro models 5/6/7, as used by our research partners at Northeastern University and The Nature Conservancy. Links to useful websites and suggested reading material offer additional resources about Milford Lab's GoPro work and other related projects that also use action cameras to record fish near aquaculture gear and in other settings. Video collected by citizen scientists can provide a window into the underwater world of shellfish farms and enhance our understanding of how fish interact with aquaculture gear.

Introduction

Our project team studies interactions between oyster aquaculture gear and the environment. We are using video from action cameras to investigate whether oyster aquaculture cages provide habitat for fish similar to that of natural structured habitat. Anecdotal observations from shellfish growers suggest that fish may use oyster cages as a food source, for shelter, refuge from current flow or protection from predators. Shellfish farms with many cages add structure to the seafloor and may serve as an artificial reef, attracting greater numbers of fish than found on bare bottom. We have collected data quantifying fish interactions with oyster cages and fish activity adjacent to natural structure on a rock reef (see Mercaldo-Allen et al. 2021, Aquaculture Environment Interactions; https://doi.org/10.3354/aei00408 and https://www.fisheries.noaa.gov/aquaculture-habitat-NE). After talking with interested students, growers, and members of the public, we created this guide for anyone interested in deploying their own action cameras to observe life on shellfish farms.

To collect video, we chose action cameras (GoPro Hero 3+ silver) because they are:

- small,
- inexpensive,
- easy to use,
- provide good quality video, and
- can support high speed and capacity memory media (e.g., SDHC or SDXC cards based on current technology).

To observe fish activity, we mounted two cameras to each oyster cage, providing top and side views of the cage structure. To collect video over a full tidal cycle and all daylight hours, we used a timer compatible with the cameras that allowed us to conduct underwater recording at eight-minute intervals every hour for 13 hours. We also developed a "t-platform" stand system for mounting cameras that enabled video collection among natural habitats, such as boulders, while minimizing addition of new structure to the local environment (to avoid potentially biasing the data). Our collaborators at Northeastern University have successfully used a more recent camera model (Hero 7) and relied on time lapse photography instead of video, since a compatible timer is not yet available.

Our study has demonstrated the utility of action cameras as a tool for observing aquaculture gear in Long Island Sound, and related projects by colleagues in the northeast and northwest have also demonstrated applicability to other coastal environments. This guide, which builds on our experiences, describes how to capture, edit and view underwater video images and is intended for those familiar with digital cameras. Our top and side view camera mounting system is effective for collecting video on both shelf and bag and tray style oyster aquaculture cages. This document has been updated to include newer camera models and methods used by our collaborators at Northeastern University and The Nature Conservancy in Massachusetts, as well as provide information on optimizing camera placement in the field. A list of supplies and brands we tested are included in this document. NOAA and the Northeast Fisheries Science Center do not endorse GoPro® or other branded products described here.

Cameras

GoPro Hero 3+ and Hero 4: GoPro Hero 3+ and Hero 4 cameras can be used underwater by adding a waterproof dive case (choose 40 or 60-meter depth). Cameras require a battery, data or SD card and access to the internet for programming. The Hero 3+ and 4 are no longer being produced, but refurbished models are available online through third party sellers. GoPro is no longer providing new firmware updates for these models. The final firmware update was released in 2016 and can be accessed through the GoPro website.

Photo below shows a Hero 3+ Silver camera in a 40 m dive case

Updating firmware: The process for updating camera firmware is similar for all camera models and is accomplished at the GoPro Website.

The first five steps apply to all camera models:

1. Go to the GoPro Website and create a free GoPro account
2. From the GoPro home page, click 'Support' on the top navigation bar on the right side. This is depicted as the headset option next to the search icon.
3. Click on 'Update Page', located on the side panel or in the gray box under the search banner.
4. Select the 'Product updates' box
5. Click 'Product updates' on left navigation bar
6. Select 'Hero 3+' or your correct camera

The following instructions are specific to the 'Hero 3+' and steps for other models may be different:

7. Select 'Update manually'
8. Enter GoPro serial number (located in the battery area of the camera), enter email address and click next
9. Select update type and click next step
10. It is best to set up WiFi and Firmware the first time you update cameras. Setting up WiFi information makes it easier to use the GoPro App and tell multiple cameras apart
11. Follow directions for entering a camera name and password for WiFi set up. Select Next Step
12. Follow the prompts to continue
13. Wait for the 'Download' button to become blue and click to download
14. Open your "downloads" folder. Unzip folder by right clicking on the file folder and selecting 'Extract All' and designating where you would like to save it
15. Insert a microSD card from the camera to the computer via a microSD card reader/writer. We used the Vivitar Ultra Slim SDHC Card Reader/Writer.
16. Move the extracted folder to the USB drive and eject drive once transfer is complete
17. Put SD card in camera
18. Turn camera on and the update will automatically begin
19. The camera will flash 'Updating' before it turns off. As long as you do not see a 'Camera Update Failed' message, the update was successful. If you are unsure the version number will show on the camera as you turn it on.

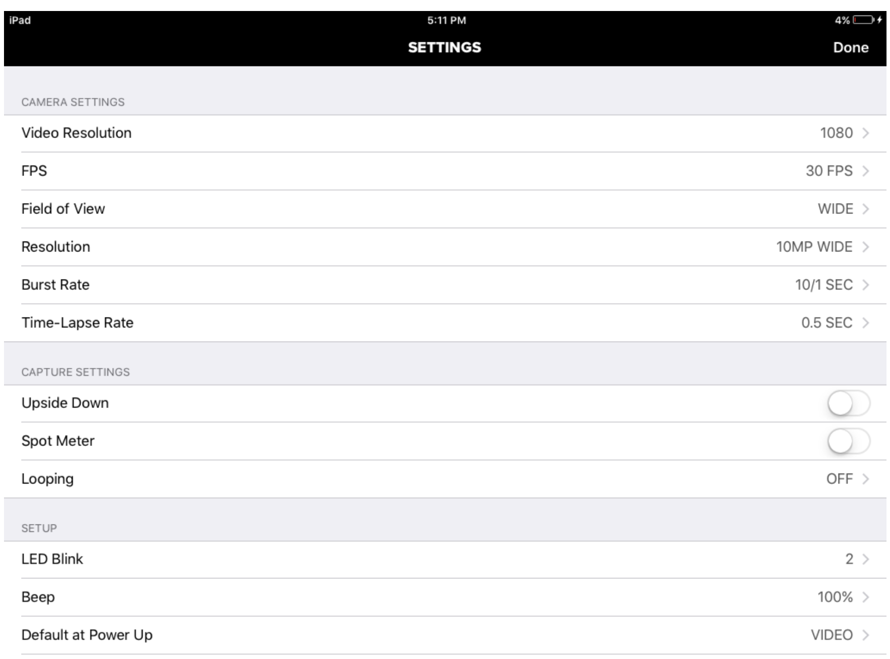
Free app to control cameras: GoPro offers a mobile/tablet app for managing and programming cameras and for basic video editing.

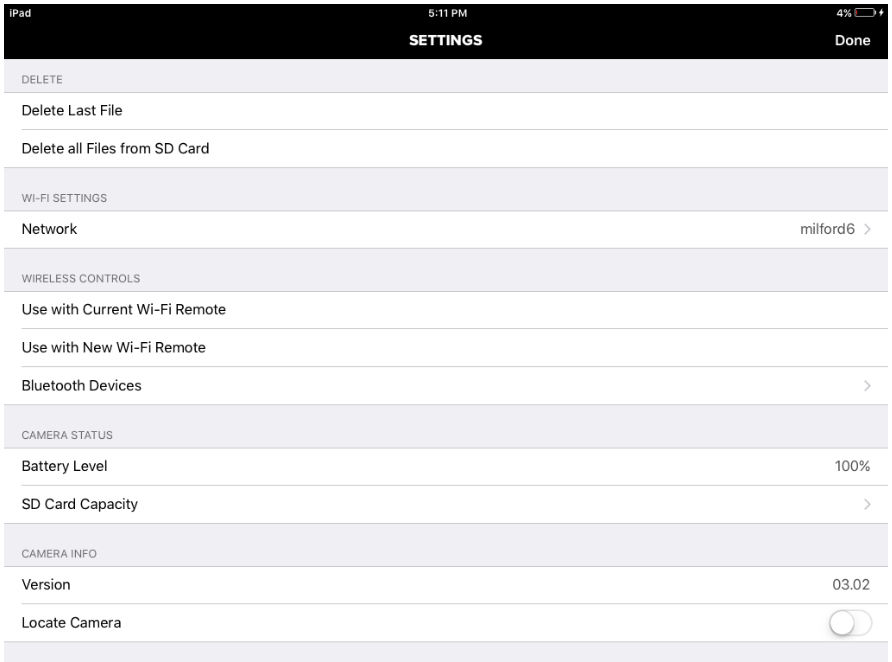
GoPro "QUIK" Mobile/Tablet app:
This app can be used with a smartphone or tablet. Additional capabilities included in the '**Video Analysis and Editing'** section at the end of this document. Both Apple and Android versions are available. We found this app useful for checking camera settings, syncing times, ensuring WiFi is on/off, monitoring battery level, and clearing SD cards. Before connecting the camera to this app, update the camera firmware and enable custom WiFi settings, especially if using more than one camera (see step-by-step directions above under "Updating Firmware"). Additionally, you can update your firmware through the mobile app when the camera is connected to the internet. Steps

for this are not included in this document. There are also additional video editing features within this app that can be used to create and share video clips and can post directly to social media. We have not utilized this feature to date.

To connect camera to the app:

1. Download and open the GoPro App on device
2. Enter your GoPro App username and password. If you have updated the firmware on your camera (see step-by-step directions above under "Updating Firmware"), the login you created is also used in the mobile/tablet app.
3. Click "Connect to Camera"
4. Select "Add New"
5. Select Camera Type and follow prompts
6. Turn on Camera
7. Turn on WiFi, wait to connect. If camera and WiFi doesn't immediately pair or prompt you for the camera password, then press continue. This will take you to the device WiFi page to connect directly
8. Once connected, return to the GoPro app, this should automatically take you to the camera view. On this page you can take pictures or videos using the app, look at media on the camera or change camera settings.
9. To change settings, click on the wrench icon
10. Use the Time and Date setting if you have multiple cameras to ensure that all cameras are synced to the same time
11. Once you connect cameras to the app on WiFi, you can use the app in the field via WiFi or cellular connection





Our camera settings: Camera settings can be easily changed using the GoPro mobile app for smartphones and tablets.

Resolution refers to the pixel dimensions within the video captured by the camera. Higher resolution yields better video quality, but also creates large video files. We used 1080, 10MP WIDE for the video resolution in our project.

Field of View refers to the portion of the camera sensor that is used to capture video. The larger the field of view, the more of the scene in front of the camera is captured. We used the Wide setting. Other settings may result in distortion, and it's best to test your camera to optimize this setting prior to deployment.

FPS or Frames per Second refers to the number of frames captured each second by the camera. Higher frame rates produce better quality than slow motion video. We have found that slowing video playback can be useful when identifying fish in suboptimal light conditions however, higher frame rates also increase file sizes. We used 30 FPS in our project.

Camera orientation: Camera orientation will matter for the final product. This setting can be controlled in the app. The "upside down" function in the settings menu can flip the camera to enable an upside-down recording view. If rotating 90 degrees the field of view is reduced, as seen in the figure below. For this reason, we recommend mounting cameras to capture the desired view rather than altering the video file afterward.

Photo below shows the optimal orientation of an oyster cage

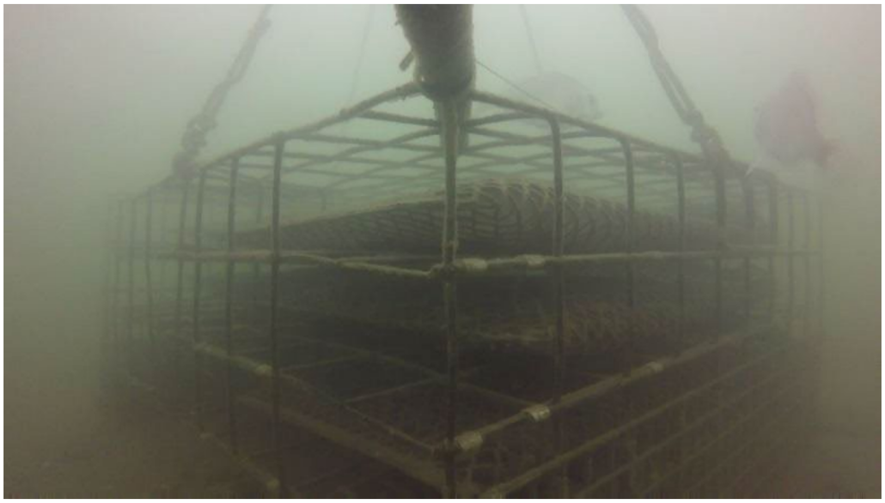


Photo below shows the cage has been rotated 90 degrees after capture and much of the view is lost.

Additional note: We also turned off the "LED Blink" and "Beep" to eliminate noise and the blinking red light while recording (sound or light could serve to attract or repel fish). In order to do this on the GoPro App click "LED Blink" and select "Off to turn the light off. To turn off noise, select "Beep" and select "Off"

Tips for putting a camera underwater: WiFi will not work once the camera is underwater so all camera setup should be done prior to deployment!

Dive cases: Two case options are currently available for this camera model; both are waterproof to either 40 or 60 meters. When purchasing accessories, it is important to note which case style you purchase to ensure compatibility.

Photo below shows front view of dive case rated to 40 m (left) and 60 m (right)

Photo below shows the top view of dive case rated to 40m (left) and 60 m (right)

Lubricant provides additional waterproofing and camera protection:
Use silicone or synthetic lubricant to protect metal parts, seawater is very corrosive. Add a small amount of lubricant to dive case O-rings to ensure a tighter seal and protect cameras from water damage. Add a small amount of lubricant to any metal fittings exposed to seawater (i.e., GoPro thumb screws) to prevent seizing of the metal, and prevent rusting. This simple step will protect your cameras and extend the life of your equipment.

Photo below shows view of open dive case with inner white O-ring

Camera troubleshooting and other helpful tips:

Check to see if a firmware update is available: Check that you are using the most recent camera firmware. Older cameras are less likely to be updated but should be checked periodically. If you are running into issues such as camera turning off, not recording or changing settings then re-download the firmware and update.

Battery troubleshooting: Ensure battery is fully charged and not damaged. Batteries will have reduced recording capacity underwater when water temperatures are colder.

SD card: SD cards must be formatted to be compatible with the camera. Newer camera models with higher resolutions may work better with a MicroSDXC instead of a MicroSD card as the memory writing capacities are different. The SD card that comes with the camera will already be formatted. If you are running into recording problems, you may need to reset the SD card. Back up any files from the SD card first. Insert card into the camera. Open the GoPro Mobile app, connect it to WiFi, then select “Delete all SD Files”. The app will ask: “Format SD card” which will correctly set up the card for new GoPro files.

Camera Waterproofing tips:

1. Check that O-ring seals are present and intact as this keeps the case waterproof. Grease O-ring seals with silicone lubricant to aid in secure sealing of the case.
2. Check for cracks in cases. Check that the clip holding the case together is tight fitting and not cracked or otherwise broken.
3. Ensure a tight fit: Camera should not move around in the case. Change the backing if necessary.
4. Test a case without a camera in a bucket of water to confirm a proper seal. Although this does not simulate the increased pressure experienced at depth, it is a good place to start.
5. If cameras are deployed in the intertidal zone, the sudden temperature changes that occur when the tide comes in and submerges the case/camera may cause leakage. Proper lubrication of O-rings is especially important in these situations.
6. Silica gel packs placed with cameras during storage can help absorb moisture and prevent water damage.

Camera Accessories

Magenta Filter: Used to balance the color and reduce greenish tones or cast in video and/or photos, reducing the need for post-processing. We used the PolarPro GoPro Magenta Filter – Hero4, which is compatible with Hero 3, 3+, and 4 cameras. Separate filters are sold for the 40 vs. 60 m dive case.

Photo below shows 40 m dive case with no filter (left) and with PolarPro magenta filter for GoPro Hero 4

Although effectively correcting for green water coloration, filters considerably reduce the amount of light entering the camera. Therefore, magenta filters are most effective at shallow water depths (<20 feet in Long Island Sound). Lower light levels at greater depths or locations with high turbidity may require use of video post-processing rather than camera filter correction.

Post-processing refers to manual editing of video using software (see above section on software available from GoPro) and can include balancing video color by adding red back into the video to reduce green coloration. This process requires creation of multiple copies of the same video file, which increases storage requirements. Additionally, manually converting and editing video files is very time consuming.

Similar filters can be found for newer camera models on third-party sites such as Amazon by searching for magenta filter + your camera model. Options may also include red filters although we used magenta filters exclusively for our field trials.

Photo below shows image taken without filter (left) and with magenta filter added to camera (right)

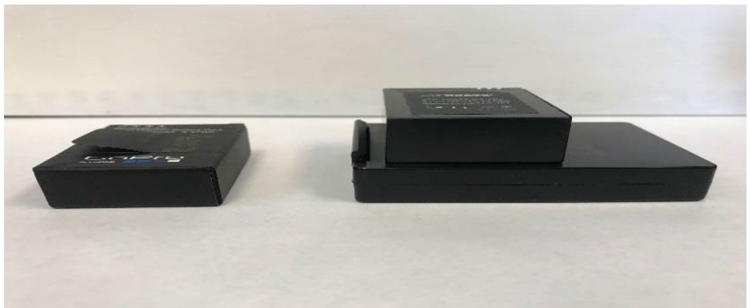
Extended backdoor attachment for the GoPro underwater case: BacPac for GoPro is an extension of the GoPro dive case, which allows space for other camera accessories that should be kept waterproof. We used the Vicdozia Waterproof BacPac Back Door Case that is compatible with the GoPro Hero 4/3+ Standard Housing Case. Similar cases can be found for newer camera models through third party sellers.

Photos below shows a top down view of the standard dive case (left) and with addition of the BacPac (right)

Photo below shows a side view of the standard dive case (left) and with addition of BacPac (right)

Extending battery life through use of a double battery: If length of video recording is limited by battery life and not memory card capacity, the addition of a double battery can increase recording time. Using a double battery underwater requires adding the extended backdoor attachment to the standard dive case (see above). Water temperature greatly affects battery life, colder temperatures shorten battery life and reduce recording time. Important note: when a battery is removed, the time and date is reset on the GoPro! Keep in mind if using multiple synced cameras in your project!

Photo below shows a single battery (left) and double battery (right)



Blink Timers: Blink® by CamDo is a programmable timer that can be used with some GoPro camera models to automatically record for set intervals of time after deployment. The Blink attaches directly to the back of the GoPro camera, uses the GoPro battery to operate and is programmed using a cellular- and WiFi-enabled device. Use of a Blink requires the addition of an extended backdoor attachment on the GoPro dive case (see above). Once removed from the camera, the Blink must be reset. Blinks turn the camera on and off at preset times. We have used Blinks for two primary functions in our project:

1) To delay the onset of recording to allow fish communities time to recover from the disturbance of camera deployments, typically 18-24 hours; and

2) To extend the battery life by recording short video intervals over a much longer time period than would be possible by continuous video recording. Our project records 8 minute videos over 13 hours, in order to capture video from most daylight hours and over a full tidal cycle.

All setup and troubleshooting documents are available for download on the CamDo website. Step by step instructions are provided on the website, including pictures of the set-up process.

We do recommend updating the software to the latest version upon purchase of the Blink and checking frequently for updates. Because setup of the Blink timers is accomplished through a WiFi connection, programming of the device on a cellular network will allow for easier configuration.

If the Blink software is updated after use, then select “Clear All” the next time you use it. If not, the Blink may fail to record all intervals. Make sure you have a note or copy of the set up screen as you will need to input it again following an update.

The extended backdoor attachment that we used (BacPac, see above) provides enough space for either a second battery or a Blink, but not both!

Blinks have been updated to the BlinkX for use with Hero 5 – Hero 8 models but require hardwiring into the camera and may need an external battery source depending on the model. Additional information can be found on the Cam-Do website listed above. Due to these limitations this product cannot be used in conjunction with off the shelf accessories to function underwater. Custom built aluminum housings are currently recommended if time lapse is important to your individual project needs, however, this option can be expensive.

GoPro Smart Remote: The remote can turn cameras on remotely when connected via WiFi. You can turn on and start recording using multiple cameras simultaneously if previously paired with the remote. This can be useful for remote deployment (within WiFi range) or syncing the start of video. When pairing the remote, the WiFi may need to be specified between GoPro App and the remote. If you need to adjust the camera settings but plan to start recording with your remote, then you will need to change the WiFi settings back to remote once settings are complete. Reminder that having WiFi enabled will shorten battery life during the deployment. Instructions detailing this process are included with the remote or from the GoPro website.

Photo below shows the GoPro Smart Remote

Desiccants: Cameras used in underwater studies, especially the earlier non-waterproof cameras, are continually exposed to moisture. Storing the cameras in a Tupperware that seals along with a desiccant can ensure cameras dry out and prevents damage. If there are large differences in temperature during camera deployment (for example in intertidal environments) GoPro makes anti-fog inserts that can be used to prevent lens fog. Desiccants are generally reusable and inexpensive and may extend the life of your cameras, especially ones that may be exposed to water.

Fisheye Lens: We tested the Inon® UFL-G140 SD Underwater Semi-Fisheye Conversion Lens attachment available from Backscatter to increase the field of view captured by the GoPro cameras. Specifically, we used the lens to look down at the top horizontal surface of our oyster cages. The semi-fisheye lens provided a wider field of view than the standard GoPro lens but the curved lens wasn't compatible with the flat magenta filter we used to remove the green color from video (see above). The lens was also quite heavy, requiring construction of a PVC frame to support its attachment to the buoy lines. The video captured by the lens was also somewhat distorted at the edges. For these reasons, we ultimately did not use this accessory in our project.

Photo below shows Inon® UFL-G140 SD Underwater Semi-Fisheye conversion lens (left) for GoPro Hero silver 3+ camera (right)

A PVC bridle with 1-inch mesh was used to mount the GoPro camera with attached semi-fisheye lens situated above the oyster cage with a view looking down.

Photo above shows PVC bridle to support camera with semi-fisheye lens

Camera Field Deployment

Altering video orientation using GoPro software: *Upside down* is a camera setting that allows you to capture video in the opposite orientation of your field of view. This option reduces the need to fix camera positioning through post-processing, which is time consuming and can result in large video files.

Changing height and direction: Pivot arms can change the height and direction of cameras:

Photo above shows pivot arms for mounting GoPro cameras

A variety of mounting pieces are offered by GoPro and other aftermarket producers. Some pieces are available in both aluminum and plastic. Some pieces are curved. Some attach by clips or thumb screws or both. Combining these accessories with the pivot arms allow adjustment of camera angle and direction to obtain the desired view. Most of the mounting parts and pieces are interchangeable among camera models.

Photo above shows mounting accessories for GoPro cameras

Thumb screw tool: The thumb screw tool for tightening screws is a useful accessory for camera deployment. These, in combination with the 1-inch or longer thumb screws, make it easier to attach and secure cameras to a mount that is fixed on an object such as an oyster cage.

Attaching cameras to gear: We used materials that are readily accessible from local hardware stores whenever possible. Some examples include the following:

Photo above shows flexible hose mount for GoPro camera

Photo above shows camera mounted to the corner of the oyster cage using flex marine wet exhaust water hose

The above picture shows the mount we used to attach a camera to a corner of the oyster cage. The mount is constructed from ½ inch PVC pipe covered by ⅞ inch marine wet exhaust and water hose, secured with hose clamps. A GoPro quick release flat surface adapter buckle base is attached to a piece of PVC cut in half at the end to allow for mounting the base. The marine reinforced water hose has some flexibility, allowing the camera to hang down from the top of the cage and provide a view of two sides and also the cage-seafloor interface. This view of the cage-seafloor interface has been effective in capturing fish activity in our videos.

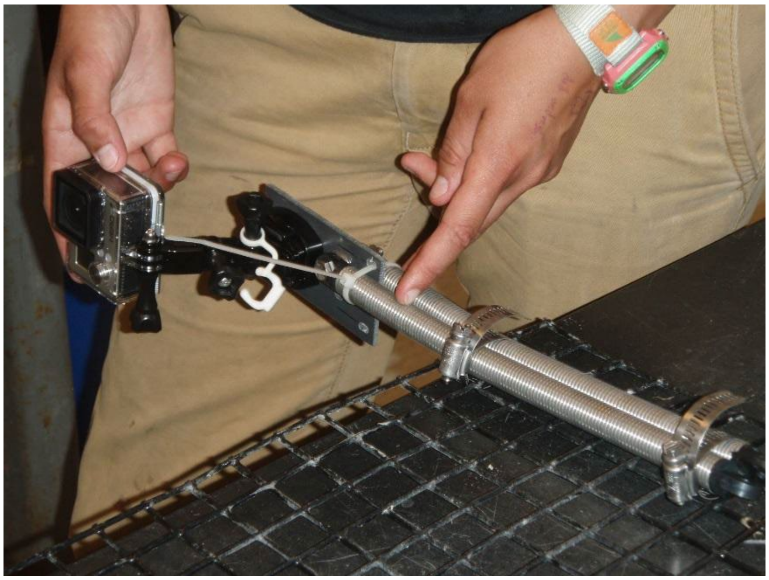


Photo above shows prototype spring mount for GoPro camera

The above picture shows an early prototype mount that we tested but ultimately did not use. This spring attachment placed at a corner of the cage provided more flexibility than the marine reinforced water hose, but unfortunately resulted in too much camera motion during deployments.

Photo above shows the periscope style mount used to view across top of oyster cages

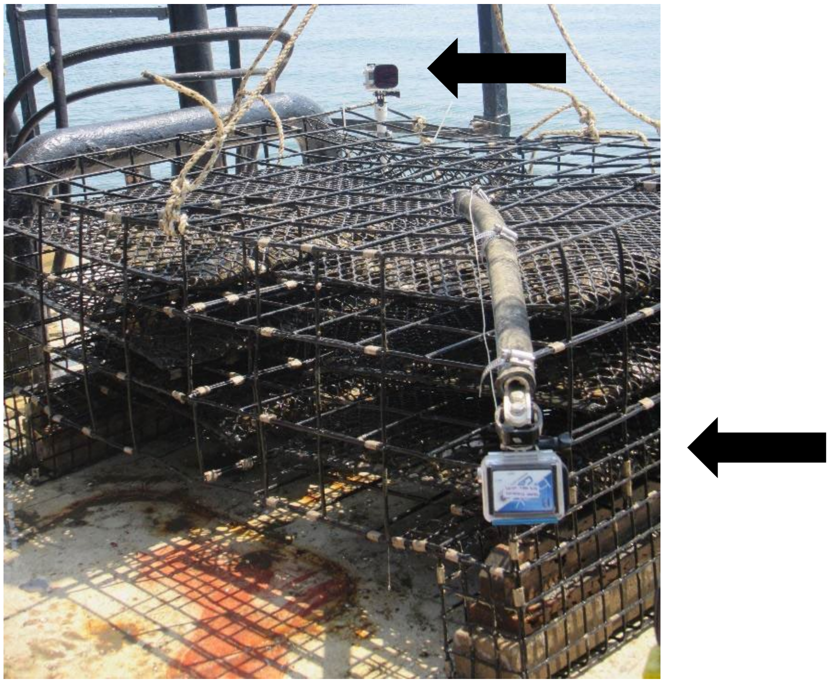


Photo above shows placement of both cameras on the oyster cage

We cut ½ inch PVC pipe to the height of the cage. We used a PVC 90-degree elbow to obtain the proper camera orientation. A GoPro quick release flat surface adapter buckle base was attached to a piece of PVC cut in half at the end to allow for mounting of the base.

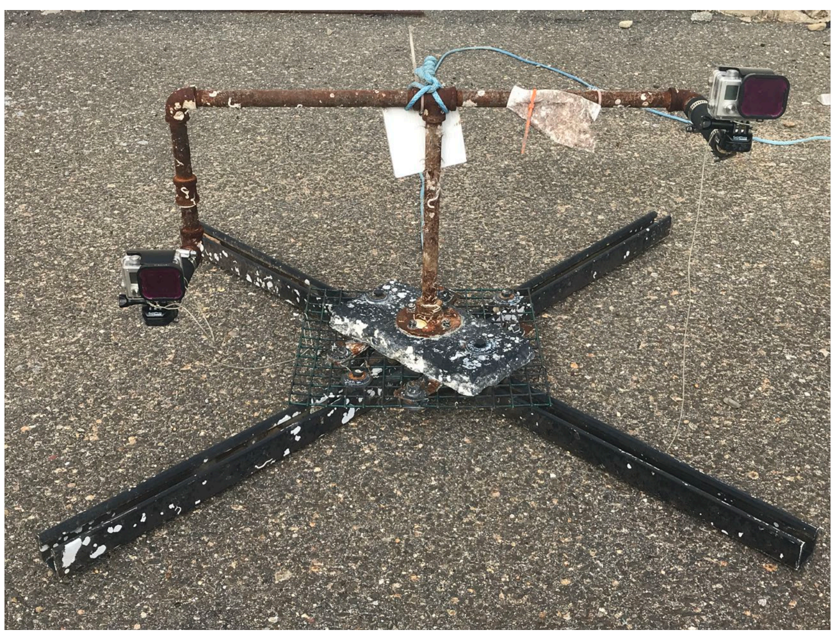


Photo above shows T-platform base for mounting cameras adjacent to boulders on the seafloor

In the photo above, the X base was constructed using 1 5/8 inch Aickinstrut fiberglass channel with 90 degree brackets. One-inch vinyl coated mesh was bolted to the top of the strut, and a 5x10 zinc plate was bolted to the top of the mesh to provide ballast. A ½ inch floor flange was attached to the top of the zinc plate. Interchangeable ½ inch threaded black pipe was used to create custom heights based on the dimensions of each replicate boulder. The base was painted black to better blend in with the seafloor.

A few simple tips for optimizing video collection in the field:

Water depth: Areas in shallower water will yield better video due to higher light availability.
We found that depths < 20 feet depth (mean high water) produced the best quality video in Long Island Sound.

Tidal cycle: Lower tide will allow for better light penetration. Slack tide may be a time of low current speed and higher quality imaging

Weather: Sunny conditions result in higher light availability. Days immediately following large rain events can have turbid/cloudy water, which reduces video quality.

More Recent Camera Models

GoPro Hero 7 Black: This model, used by our collaborators at Northeastern University and The Nature Conservancy, is currently available for purchase through GoPro and supported with firmware updates. This camera style is waterproof without an external housing to 10m unless specified by the manufacturer. Other Hero 7 and newer models are similar but the location of the charging ports on the camera vary, which may affect compatibility of products like extended batteries or housings. The intervalometer Blink timer used with Hero 3+ and 4 cameras is not compatible with the Hero 7, however the Blink X (Time Lapse and Motion Detector Controller) can be used with GoPro 5/6/7 cameras. In place of recording intermittent video segments, time lapse recording can also be used to document fish activity at intervals and extend battery life.

Hero 7 Black Setup:

C*amera settings:* used for these field trials:

- Timelapse video
    - 1 second recorded every 3 seconds
    - The frequency of time capture can be changed to record one second every 0.5-10 seconds. Here it is up to the user to determine the best settings for your individual project needs. The more frequent the recording intervals the more battery life consumed.
- 2.7k resolution
- **Wide** Field of View

Settings used here were applied at field sites in Cape Cod, Massachusetts, both in intertidal and subtidal environments. We considered similar optimization when selecting frequency of data collection, battery life, lack of delayed recording time and water clarity.

Hero 7 Accessories:

- Power bank was used to extend the battery life during recording.
- Dive case can be used in conjunction with the power bank above.

To increase waterproofing, the power bank can be wrapped in plastic and O-rings treated with silicone to improve seal strength underwater.

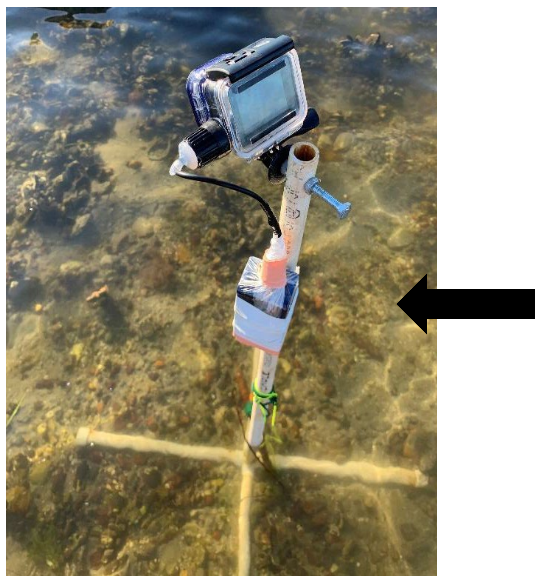


Photo above shows a power bank wrapped in a plastic bag and taped to increase waterproofing.

Mounting system:

Our colleagues at the NWFSC used a tripod mount to attach a GoPro through ½ inch PVC using ¼ inch nuts and 2-inch screw (below).

Photos above show tripod mounting system

To view oyster bottom cages, ½ inch PVC was used to construct the mounting stands. The height of the upright PVC piece was 30 inches. A 5-way PVC cross base was used to connect the upright and legs for the stand. Each leg was made from 1-foot sections of PVC and rebar. The rebar provided weight and stability and caps placed on the ends of the legs kept the rebar in place.

Photo above shows PVC mounting stands for cameras placed adjacent to oyster trays.

The picture below is a side mount created using the same materials as described above but in a different configuration for floating cages. The arm with the GoPro extends 2 feet, with 1-foot anchor points and a 0.5-foot leg extending to the middle of the cage.

Photo above shows camera mount for floating cage

Data Management

Increase speed of file transfer: It is more efficient to use the same SD card reader used to transfer files onto a computer rather than using the USB cord provided with the camera.

Create a logical folder system to organize and store videos on your computer: Create a system for storing videos to document when and where they were recorded. This will make it easier to find specific videos later. Start this process early before you have large numbers of videos or it may become confusing. DO NOT RELY on the "date modified" associated with a file to record when video was taken, because depending on the way a computer folder is set up, clicking or editing a file could change the date modified.

Video files are large – be prepared! How much computer or network storage you need depends on the quantity of video and at what quality you record. As you increase video quality, the files produced will be larger. Video quality is controlled by the camera settings (see camera section of this document). Increasing frames per second and resolution will result in larger file sizes. The camera settings we describe in this document produce a 900 mb (0.9 gigabyte) file for each 8-minute interval of video recorded. Newer camera models and higher resolution defaults will require additional memory storage. However, the prices of large external storage systems are decreasing.

Continuous video recording: If you record a continuous video file, the GoPro camera separates those videos into multiple video files for management. The length varies based on resolution settings as there is a maximum single file size. The camera settings we describe in this document generate file lengths of approximately 20 minutes. Shorter files can be helpful for downloading and playback of videos.

If possible, it is a good idea to store your video in two places in the event of a technology mishap: External hard drives can be used to back up video separately from your primary computer. Cloud services like GoPro Plus offer an option for storing raw video files either in complement or as a primary backup option. We use rugged external hard drives as we occasionally need to bring storage into the field.

Video Analysis and Editing

What to do with the video you create? Video clips can be a great public outreach tool, can be used for analysis or to just enjoy the views!

Basic analysis: Using common computer applications such as Microsoft Excel you can keep track of the fish observed in videos.

GoPro Quik desktop program:
Allows you to take clips and capture still photos from your video. You can also rotate videos in this app. Rotations applied within the app are saved but this process may alter the size of the video. This program does not enable changes to color or other features within the video. The software also includes additional features such as compile burst, time lapse photos, cloud uploads, and can be used to update some models of cameras.

GoPro offers additional desktop apps that are outside of the scope of this document and the cameras mentioned in this document. Software and application updates can happen often so checking the camera website for historical applications or new applications may differ from what is described in this document.

There are also other options for image/video software, such as Adobe Photoshop or Adobe Premiere. Some features that have been useful include:

- color balancing and contrast,
- volume or soundtrack addition,
- playback speed adjustment,
- clipping
- and creating highlight reels or short films.

We have not explored these alternatives, but note that these software options may require additional cost, storage and/or knowledge.

Free software exists to help you track and record what you observe in your videos: Behavioral Observation Research Interactive Software (BORIS) is a free downloadable behavior analysis software that allows you to set up your own video analysis framework specific to your study. There is an instruction and user guide available online. You can use it to keep records of fish abundance of multiple individual species that you observe in your videos. You can also create variables for each individual species, and record activities such as feeding, moving in and out of the oyster cage, etc. This software will require a time investment to set up a project and learn the program.

Assessing value provided by multiple camera perspectives

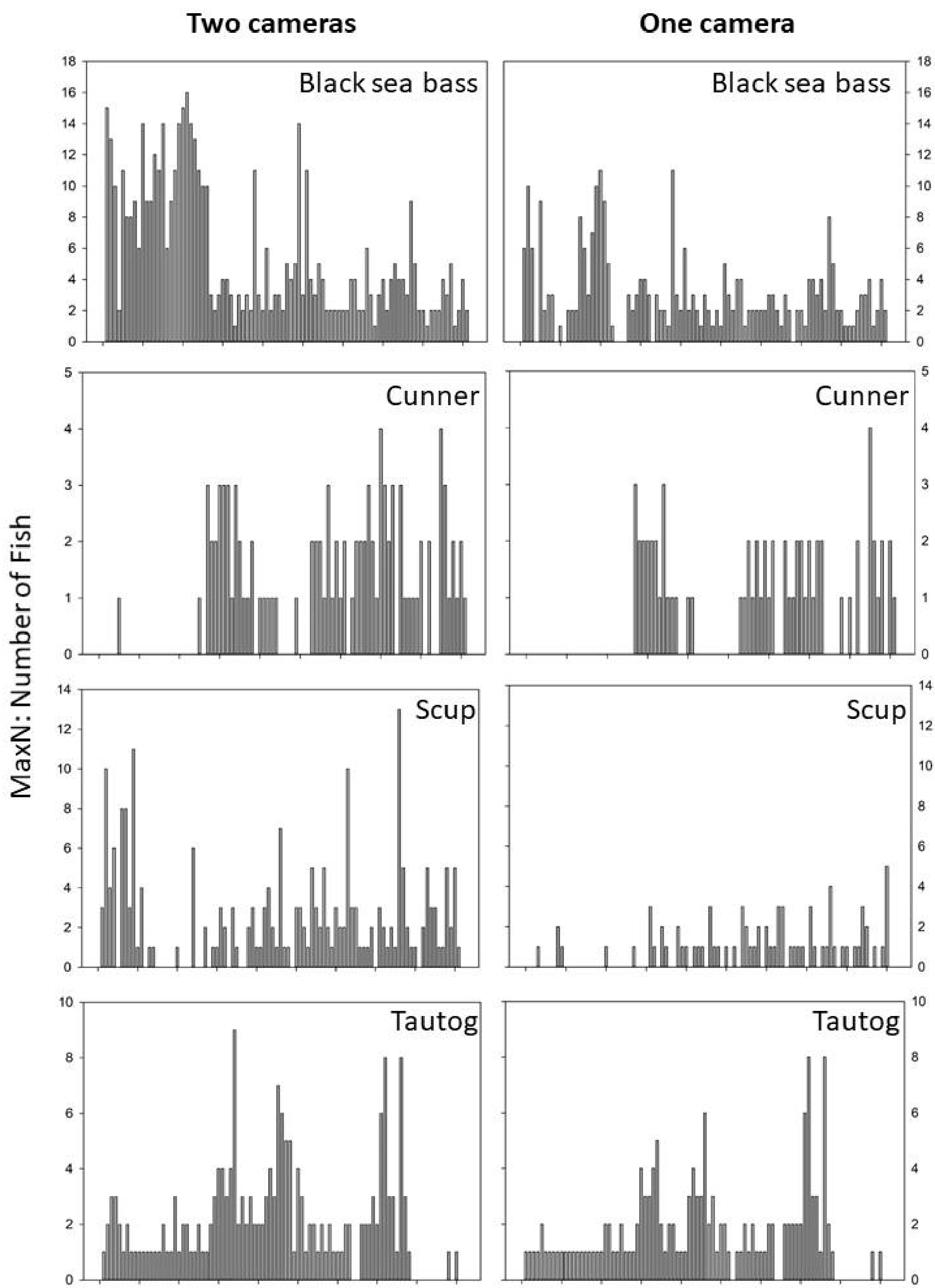
Increasing the number of cameras used to record activity around an individual oyster cage increases the proportion of that gear in view, and could provide a more thorough assessment of fish and other wildlife interactions with aquaculture gear. However, the number of cameras may be limited by factors such as funding for equipment and digital storage, or labor available to collect, process, and view video. These constraints limited our project to two cameras per cage, and we recognize that some teams may be further constrained to a single camera per piece of aquaculture gear. Recognizing this potential limitation, we have compared estimates of fish abundance using the field of view provided by one (side view only) versus two cameras (top and side view) from some of our videos, to help inform reader decisions about camera number and placement. We chose the side view as the preferred single-camera placement since this perspective captures two of the four cage sides as well as the cage-seafloor interface, which we have observed as an area of high fish activity.

Video was collected as part of our 2017 field study from three oyster cages on three dates at a shellfish farm in Milford, CT (Mercaldo-Allen et al. 2021). On each date, video was collected in eight minute intervals, once per hour for 13 hours, yielding 117 total videos. Only video pairs where at least one camera recorded occurrence of an individual fish species were included in the assessment; i.e., joint absences were excluded. We used a conservative estimate of abundance called MaxN, which is calculated as the maximum number of fish of each species observed in a single frame within each video interval. MaxN is commonly used to estimate abundance on underwater structures, because it prevents double-counting of fish that move in and out of the camera view as they swim around the structure. MaxN may underestimate the total number of fish associated with a cage if not all individuals are visible at the same time.

During the three dates of video collection, four species were observed in the single-camera and two-camera placements (black sea bass, cunner, scup, and tautog). These species were observed frequently, and were associated with all three cages on all three dates. The two camera configuration yielded three additional species (banded rudderfish, butterfish, and yellow jack) not observed by the side camera, for seven total species observed. These three additional species were only observed rarely; out of 117 total videos, the banded rudderfish was recorded in a single video, butterfish in two videos, and yellow jack in five videos.

The figures below compare abundance of the four species observed in both the single and two-camera configurations. All figures on the left are taken using the 2-camera configuration, and can be directly compared to the figures on the right taken using the single camera placement. Each bar within a figure represents the abundance of a species within a single 8-minute video. While the addition of a second camera increased the overall estimates of abundance for all four species, the size and frequency of that increase varied by species. Determining fish abundance using one versus two cameras underestimated black sea bass abundance 63% of the time, cunner 52%, scup 74%, and tautog 31%. On average, the addition of a second camera increased black sea bass abundance estimates by 2.5 individuals, 0.6 for cunner, 2.0 for scup, and 0.5 for tautog.

To summarize, the addition of the second camera in our study substantially increased our observations of both fish abundance and diversity. However, the single camera successfully recorded all of the common species associated with the cages. For species such as black sea bass and scup, the addition of the second camera had a bigger impact on abundance estimates than was observed for cunner and tautog. If resources and infrastructure are limited, and restrict deployments to a single camera for monitoring oyster cages, we observed that the side mount offered the most expansive view of fish activity by capturing two cage sides and the area where the cage and seafloor meet, but the top mount did a better job of recording rare species interactions with oyster cages.


Two cameras
One camera
Black sea bass
Black sea bass
Cunner
Cunner
Scup
Scup
Tautog
Tautog
MaxN: Number of Fish

Sharing video

The East Coast Shellfish Growers Association hosts a webpage where folks can submit interesting videos of marine life associated with aquaculture gear. To have your video considered for posting on their cool videos page, please contact Ann Rheault at https://ecsga.org/contact/.

Useful links

Capturing Life on Shellfish Farms: Two NOAA-funded projects are documenting how shellfish farms interact with the environment

Milford Lab's GoPro Aquaculture Project Page: Using GoPro Cameras to Understand Interactions Between Shellfish Aquaculture Gear and the Environment.

Northeastern-Nature Conservancy Partnership: collaborating with oyster farmers to study how growing oysters can benefit people and nature

Rutgers project investigating fish and invertebrate interactions with oyster aquaculture gear and natural habitats using GoPro cameras in New Jersey.

Suggested Reading

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