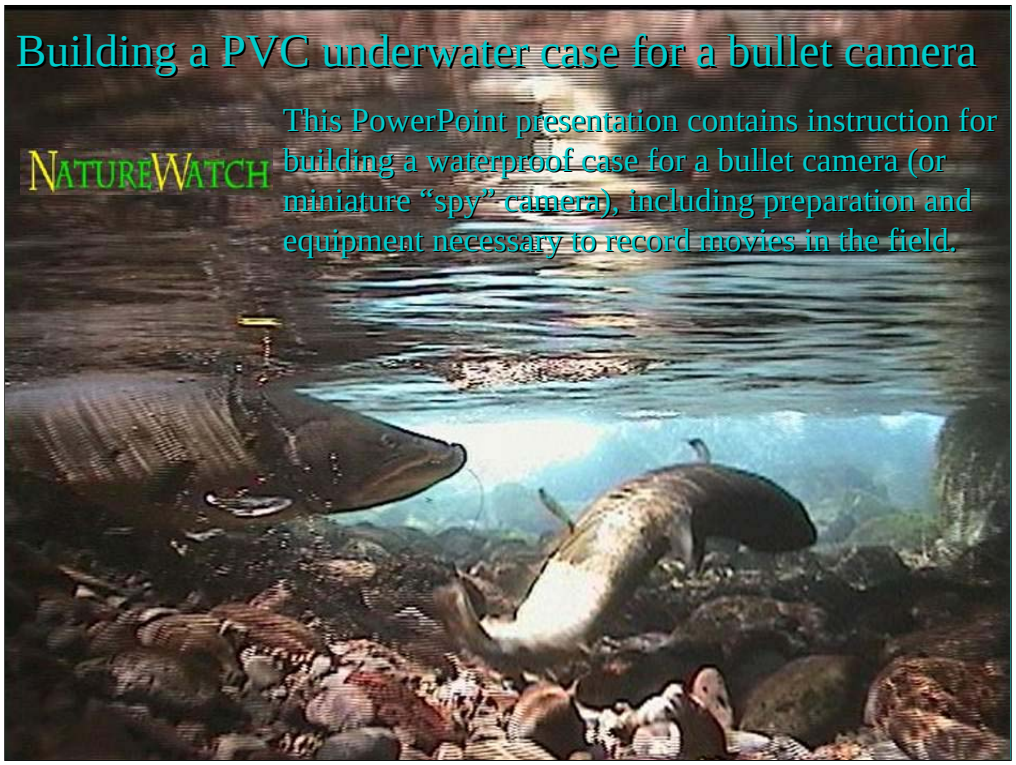
View actual FISH VIDEOS



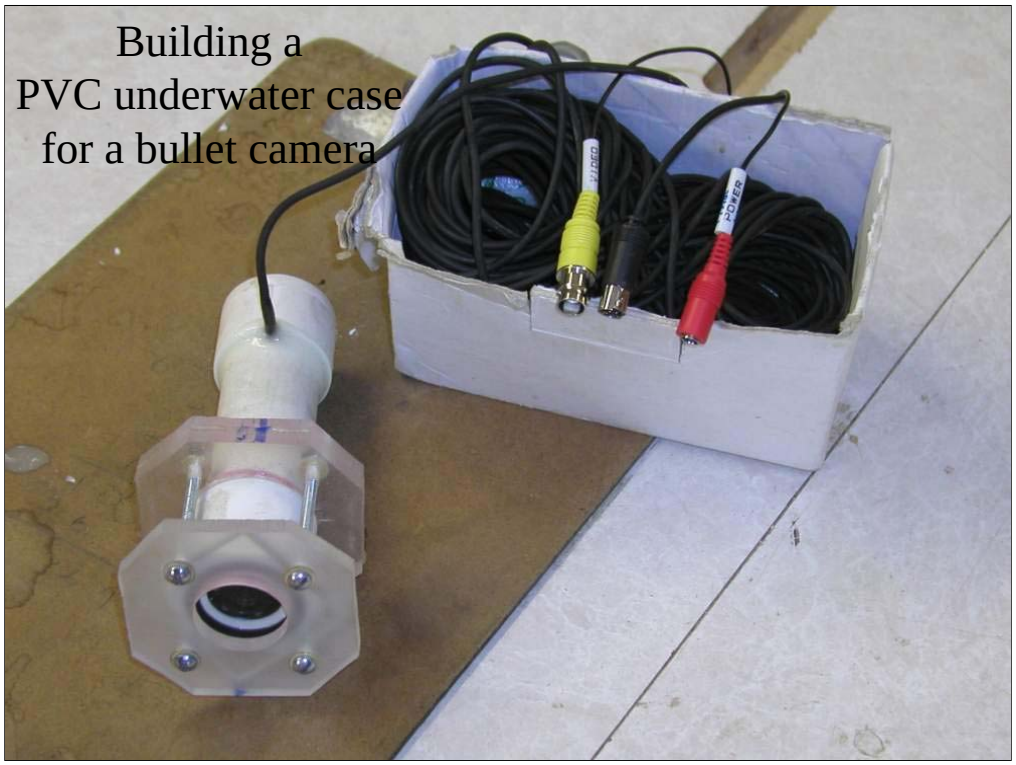
The advantages of this system are high resolution images and equipment portability. Equipment necessary for digital recording observations of aquatic animals can fit in a camera bag or day pack.

This presentation is best viewed in the *Notes Page* view, found on the upper left menu bar of PowerPoint, under the *View* menu tab.

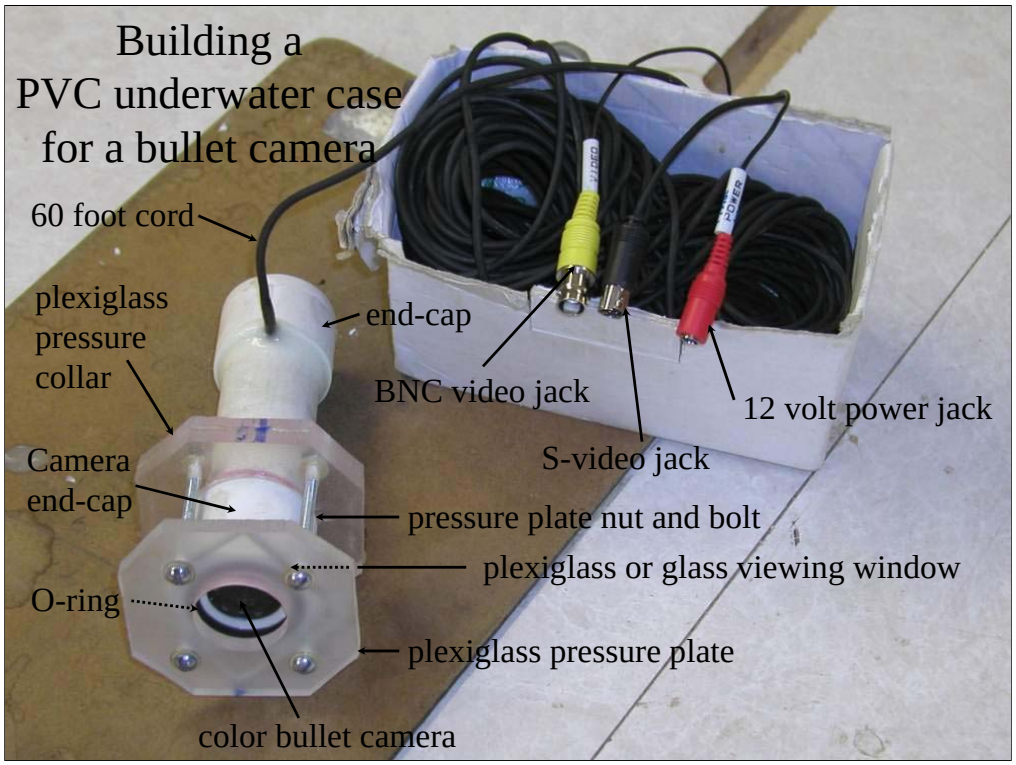
Additional details to better assist you in construction of a PVC underwater case are included in the *Notes Page* view.

If you'd like a magnified view of an image, switch to *Slide Show* or *View:Zoom* image.

Using the *Notes Pages View* will provide additional details important in construction of the PVC housing and uses of the waterproofed camera.



The waterproof case for a bullet camera is built of parts available at hardware and electronic parts stores. This simple design will take about one day to construct.



When we built this system, there were no good quality color bullet cameras with truly waterproof housings (the definition of weatherproof is often extended to include waterproof, particularly among imported cameras). We expect there to be future demand for such a product, but until then we found this case to provide reliable protection for a color bullet camera. Basically, the PVC housing for the bullet camera consists of a short length of PVC pipe, two end-caps and sealant. To provide a viewing window with a waterproof seal, an O-ring is placed under pressure between the viewing window and camera end-cap. This diagram provides a reference to part names we use.

V-1255-B-BNC

Color High Resolution Weatherproof Bullet-size Camera

- 1/3 inch CCD color camera
- Built-in LED's allow camera to see in complete darkness
- 9.0V - 14.0VDC, 1.95W or less
- Has both NTSC and S-Video output
- Comes with 60ft cable attached

The **V-1255** is a new state-of-the-art bullet color camera. Using current Digital Signal Processing, this camera offers 450 TV lines and measures only 2.93 inches long and 1.15 inches diameter. Its built-in LED's allow it to see up to 10ft in total darkness making this an ideal camera for any surveillance application where lighting is less than ideal. Camera comes complete with stand and universal hinge for installation in any direction. Camera also comes with a 60 foot cable with BNC and S-Video connectors attached.

Part No.	Resolution	Pick-up Device	Scanning System	Light Sensitivity	Lens	S/N Ratio	Iris	Power
V-1255-B-BNC	450 TV Lines	1/3" CCD	525 Lines	3 Lux	3.6mm	>45dB	Auto Iris	9-14VDC, 110mA

http://www.mars-cam.com

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A large variety of bullet cameras are currently available. Most companies carrying them specialize in surveillance equipment and feature websites describing their products. A search of *bullet camera*, *lipstick tube camera*, or *spy camera* on the web will yield many responses. We chose a camera sold by Marshall Electronics due to its compact size, high resolution color capability, and S-video and BNC video connection. We expect there will be improvements in the quality of image captured by surveillance cameras in the future, so options should get even better.

Tools

- drill press
- hole saws (1 1/8 inch, 1 3/16 inch, 1 3/8 inch)
- 5/32 inch drill bit
- band saw
- hack saw
- medium and fine sandpaper
- masking tape
- pocket or x-acto knife
- multi-meter
- screwdriver
- box, socket, or crescent wrench

Materials

Equipment	Part	Part Number (Vendor)	Quantity	Cost/unit	Subtotal
PVC Waterproof Housing for Bullet Camera	High Resolution Color Bullet Camera	V-1255-B-BNC (Marshall Electronics, Inc.)	1	$359.99	$359.99
	Class 200 1 inch PVC pipe (10 feet)		1	$0.99	$0.99
	1 inch PVC threaded male adapter		1	$0.29	$0.29
	1 inch PVC end-cap		1	$0.29	$0.29
	Aquaseal (sealant for waders/drysuits)		1 oz.	$5.95	$5.95
	O-ring (1-1/8 inch inside diameter)	N70-217 (hardware store)	1	$0.48	$0.48
	Silicon lubricant		1 tube	$3.99	$3.99
	8-32 x 2 1/2 inch machine screws		4	$0.15	$0.60
	8-32 stop nuts (w/ nylon insert)		4	$0.18	$0.72
	# 8s flat washers		8	$0.10	$0.80
	polycarbonate plexiglass 1/4 inch thick (clear)		remnants	$0.50	$0.50
	polycarbonate plexiglass 1/8 inch thick (clear)		remnants	$0.50	$0.50
	Telescopic Bream Pole		1	$24.99	$24.99
	Duct tape		1 roll	$1.99	$1.99
				Total Cost	$402.08
Bullet Camera Portable Power Supply	12 volt rechargable battery (5 Ah)	230-0289 (Radio Shack)	1	$24.99	$24.99
	Class 2 transformer (battery charger) output 12 VDC 500 mA.		1	$9.99	$9.99
	Adaptaplug Cord (6 feet)	273-1641 (Radio Shack)	1	$3.49	$3.49
	Adaptaplug "M"	273-1716 (Radio Shack)	1	$4.99	$4.99
	1/4 inch female terminal (18-22 gauge)		2	$0.25	$0.50
				Total Cost	$43.96
Battery Powered Television/VCR Combo	RF Adapter (BNC to RCA)	278-303B (Radio Shack)	1	$4.99	$4.99
	Phono Plug Adapter	274-863 (Radio Shack)	1	$3.99	$3.99
	13 inch TV/VCR combination		1	$99.00	$99.00
	400 watt DC to AC inverter		1	$40.00	$40.00
	12 volt marine battery (105 Ah)		1	$59.00	$59.00
	Deep cell battery charger		1	$50.00	$50.00
				Total Cost	$256.98
Digital Recording and Editing	miniDV Camcorder with S-video in/out			$580.00	$580.00
	Digital Movie Editing Software (including video card and firewire link)		1	$99.00	$99.00
				Total Cost	$679.00
				Total Cost All Options	$1,382.02

A system setup for streamside interpretation (camera, housing, extension pole, TV/VCR combo and power supplies) costs about $700.00.

A system setup for movie making adds a digital camera and editing software/hardware, bringing the cost of all materials and equipment to about $1400.00.

Preparing the camera end-cap

- Using a band saw or hack saw, cut the male threads from a 1 inch PVC threaded male adapter, as close to the thread base as possible.
- Avoid scoring the base with the saw blade.

The camera end-cap is the end of the PVC case the camera will look out through a viewing window. It is important to have an even, smooth face on the outside of the camera end-cap, which is where the O-ring will seat. The O-ring will provide a waterproof seal against total immersion of the case, so make sure no saw blade scratches are present on the outside surface.

Preparing the camera end-cap

• Sand the thread base of the camera end-cap using medium, then fine sand paper. Remove all saw blade scratches.

The PVC camera end-cap sands easily and you will find it smoothes quickly. It is better to do this stage by hand rather than using a sander as the PVC is soft. Sand the thread base until it is completely smooth.

Preparing the camera end-cap

- Using a 1 1/8 inch hole saw and drill press, center the camera end-cap in a vice.
- The objective of this stage is to cut a slight recess on the inside of the end-cap to accommodate the bullet camera.

The bullet camera outside diameter is slightly smaller than the inside diameter of the PVC housing. To accommodate the lens end of the bullet camera, a slight recess (3/16 to 1/4 inch) must be cut from the inside of the camera end-cap. Do not cut all the way through the end-cap. Leaving a narrow rim will retain the bullet camera in the housing.

Preparing the camera end-cap

- Once the camera end-cap is centered, cut 3/16 inch away from the inside with the hole saw.
- Do not cut through the end-cap.

Cut away small quantities from the inside of the camera end-cap at a time, slowly approaching the 3/16 inch recess. This stage is the most difficult as it requires that you precisely center the end-cap in the vise prior to cutting, and then cut only a slight recess. Purchasing an extra 1 inch male threaded end-cap or two ($0.29 ea.) may save you an extra trip to the hardware store if you're unsuccessful on the first try.

Preparing the camera end-cap

- Trim away remnant PVC chaff with a pocket or x-acto knife.
- Smooth the inside recess with the knife to ready it for the bullet camera.

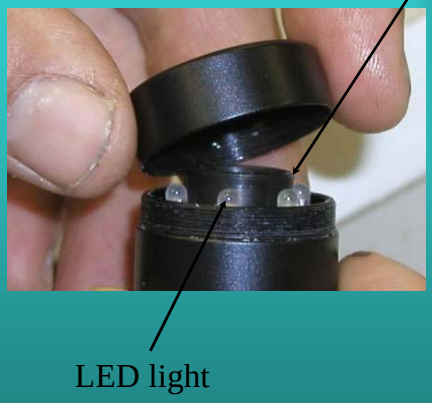
Preparing the camera end-cap

- Remove the lens cover from the bullet camera.

Remove the lens cover provided by the manufacturer as it is not necessary in this underwater housing. The configuration inside the PVC housing will place the bullet camera lens directly against the inside of a small plexiglass plate (viewing window). The viewing window that the bullet camera looks through will be sealed from water by pressing against an O-ring.

Preparing the camera end-cap

- Note the rubber lens shield and six LED lights arranged around the outside of the shield.
- The rubber lens shield must extend beyond the camera end-cap (next slide).



The rubber lens shield, if seated properly against the inside of the viewing window, will prevent light emitted by any of six LED lights from interfering with image quality. It is important to ensure the lens shield extends an adequate distance beyond the camera end-cap as described in the next slide. If it does not, return to the drill press step of *Preparing the camera end-cap* and remove more of the inside of the end-cap.

Preparing the camera end-cap

- Test the clearance of the lens shield with the outside of the camera end-cap by placing the bullet camera in the recess.
- The lens shield should extend about 1/8 inch beyond the surface of the end-cap.

The lens shield will serve the same purpose in the underwater housing as it did in the case that came from the manufacturer - that is to shield the camera from the LED lights.

Preparing the camera end-cap

- To prepare a seat for an O-ring, center the end-cap in a vice on the drill press.
- Make a slight score using a 1 3/8 inch hole saw.
- Sand with medium, then fine sandpaper.

Fold a small piece of sandpaper into a narrow roll to smooth the O-ring slot. Finish with a fine-grade sandpaper. All scratches should be removed to ensure a watertight seal.

Preparing the PVC housing

- Using a band saw or hack saw, cut a 5-inch long piece of 1 inch diameter PVC pipe.
- Sand the outside and inside surfaces with a medium grit sandpaper.

The 1 inch diameter PVC pipe will serve as the bullet camera housing. A length of 5 inches will allow some extra airspace within the housing to place a desiccant pack. The desiccant will absorb any residual moisture to avoid condensation inside the housing. It is recommended to construct and seal the housing in low humidity conditions. Light sanding the PVC will allow better adhesion with the Aquaseal sealant.

Preparing the PVC housing

- Place the non-camera end-cap on the housing.
- Mark a hole large enough to accommodate the camera cable, just beyond the end cap.

Refer to slide #4 to view the finished housing and see how the camera cable exits the PVC pipe.

Preparing the PVC housing

- Mark a slot just wide enough to slide in the camera cable.

The camera cable will slip into the slot before the end-cap is placed.

Preparing the PVC housing

- Using a vice and hack saw, cut the cable slot in the PVC housing.

Make the slot as close to the width of the cable as you can. We intentionally make the slot slightly smaller, then use sandpaper to achieve the final width.

Preparing the PVC housing

- Sand the edges of the slot to remove sharp edges.
- Test the width of slot by sliding the bullet camera into the housing and cable into the slot.

Be careful to remove sharp edges of the slot with sandpaper prior to placing the cable - the edges can be sharp enough to cut the cable insulation.

Preparing the pressure collar and pressure plate

• Cut two 2.75 x 2.75 inch square pieces of 1/4 inch thick polycarbonate plexiglass.
• Trim the corners off.

The polycarbonate plexiglass is much stronger and flexible than standard plexiglass, allowing a single thickness of 1/4 inch to serve as the pressure collar.

[If you use 1/4 inch thick standard plexiglass, cut an extra 2.75 inch square piece to make a double thickness pressure collar, then glue the two standard plexiglass collars together with Aquaseal, as in Slide #4 diagram.]

Preparing the pressure collar and pressure plate

- Drill the pressure collar using the 1 3/8 inch hole drill.
- Drill the pressure plate using the 1 3/16 inch hole drill.
- Drill four 5/32 inch holes for bolts.

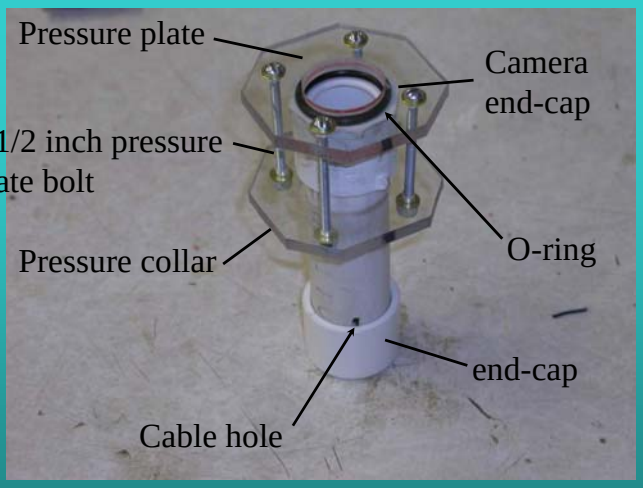
Marking an outside edge of the pressure collar and pressure plate with permanent marker will allow you to reorient the two pieces once they have been assembled on the housing. Proper alignment of drill holes will give a better fit of pressure plate nuts and bolts. Once you have completed fabrication, we recommend a dry assembly of all parts prior to sealing (as shown in slide #26).

Cutting a viewing window

- Cut a viewing window, through which the bullet camera will look, of polycarbonate plexiglass measuring 1.75 x 1.75 inches.
- The viewing window should be 1/8 inch or less in thickness.

Thinner polycarbonate plexiglass is recommended over thicker material for viewing windows. Thicker material may reflect light emitted by LED lights into the camera view. Plexiglass is more likely to be scratched than glass, but it is inexpensive if bought as scrap remnants at a plexiglass supplier, and is easily replaced on the PVC housing. If you decide to use a glass viewing window, do not use material less than 3/16 inch thick as it will break under the stress of the pressure plate against the O-ring. Thicker glass also reflects light into the camera view.

Preparing the PVC housing



- Dry assemble the housing before applying Aquaseal sealant.

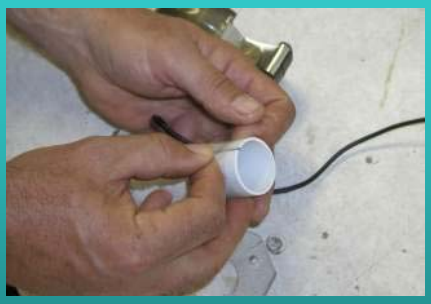
A test assembly will ensure parts are properly aligned. Not shown in this photo is the 1/8 inch thick viewing window. Test it by inserting between the O-ring and pressure plate to be sure it fits. To ensure better adhesion of Aquaseal sealant, rough PVC surfaces to be sealed with medium sandpaper (inside of end-caps, inside and outside of housing, etc.)

Waterproofing the PVC housing

- Apply Aquaseal to the camera end-cap, slide on and let cure.
- Slide on the plexiglass pressure collar.
- Slide the bullet camera into the housing and cord into the slot.

It is important to do these three steps in order. The pressure collar must be slid on the tube before the bullet camera is sealed in the housing. Do not apply excess sealant to the inside of the camera end-cap as it may accumulate in the bullet camera recess. Cure time for Aquaseal with accelerant is about 1-2 hours.

Waterproofing the PVC housing



- Place scotch or masking tape on the outside of the housing cable slot.

The objective of this step is to seal the cable slot with Aquaseal, prior to placing the end-cap. This step requires sealing the cable slot from inside the housing.

Waterproofing the PVC housing

- Fill the cable slot with Aquaseal from the inside of the housing.
- Apply small quantities of Aquaseal at a time and let cure before subsequent applications.
- Use of Aquaseal accelerant will shorten the cure time to about 1 hour.

Sealing the cable slot is done with the bullet camera slid forward as far as possible. To avoid getting Aquaseal on the bullet camera, put a slight tilt on the housing so that the fluid sealant does not flow toward the camera. Placing a piece of tape on the open end of the housing will create a dam and tiny reservoir to hold curing sealant. Applying sealant mixed with accelerant in two or three steps will ensure sealant does not flow far in its fluid state.

Waterproofing the PVC housing

- Secure the pressure collar to the back of the camera end-cap with Aquaseal.
- Let cure.

In this step, the pressure collar is glued to the back edge of the camera end-cap.

Waterproofing the PVC housing

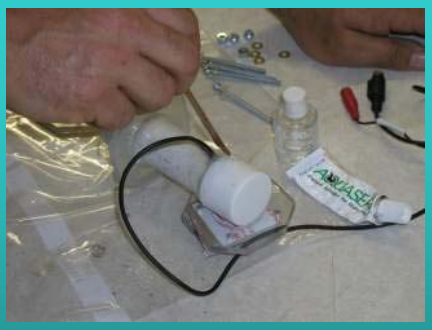
- Once the Aquaseal sealing the cable slot has cured, remove the masking tape and place a desiccant pouch inside the housing air-space.

Placing desiccant in extra air-space within the housing is intended to remove potential sources of condensation on the inside lens, once the housing is sealed. Construction of the PVC housing should be done in low humidity conditions. We made our desiccant pouch from a larger commercial desiccant (clay granules) by filling a fabric pouch with dry desiccant, then sewing it closed. Using silica desiccant packets that come with new electronics should work too. Do not use chemical dehumidifier granules as they are caustic and would harm electronics.

Waterproofing the PVC housing

- Apply Aquaseal to the end-cap and seal the housing.
- Let cure.

Waterproofing the PVC housing

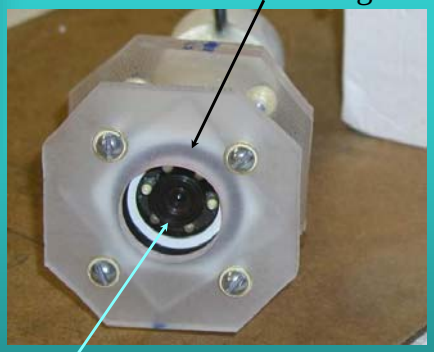


- Build several layers of Aquaseal around the cable entry point into the PVC housing.
- Let cure.

Waterproofing the PVC housing

• Once cured, the viewing window, pressure plate, O-ring and nuts may be placed on the viewing end of the housing.

Waterproofing the PVC housing



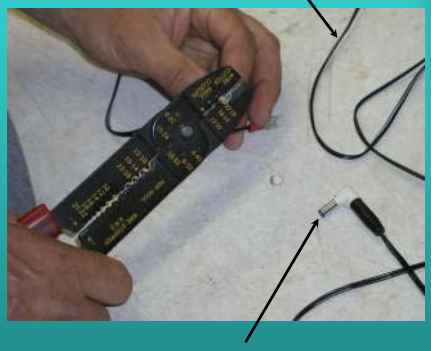
- Grease the O-ring with silicon grease.
- Place the plexiglass viewing window between the pressure plate and O-ring.
- Tighten the pressure plate nuts evenly.
- The O-ring will visibly flatten indicating a good seal.

It is important to tighten the nuts at an even rate to get a proper seal on the O-ring. Counting turns of the wrench/screwdriver on each bolt will help you achieve a proper seal. Also keep an eye on the O-ring from above and edge-on to help ensure you are applying even pressure.

The rubber lens shield should be making contact with the inside of the viewing window, effectively screening the camera imager from the LED lights. If you do not see the lens shield making contact with the viewing window, try adjusting the pressure plate with the pressure plate nuts.

Making a portable power supply

- From the Radio Shack power cord 273-1641, cut the male end away.
- Attach an Adaptaplug “M” adapter to the female end, with the posts oriented to “center positive”.
- Crimp on two 1/4 inch female terminals (18-22 gauge).



Specifications for the Marshall Electronics bullet camera require a 9-14 volt power supply, with a *center positive* power connection. We chose a 12 volt rechargeable battery (w/ 5 amp hours) that provides sufficient power for a full day of running the camera.

Making a portable power supply

- Determine the polarity of the Adaptaplug by hooking the female terminals to a 12 volt battery.
- Switch the posts if necessary to get a positive value on the center of the Adaptaplug.

To avoid damaging the bullet camera, you must determine the polarity of the Adaptaplug power connection prior to connecting to the camera. Use a multimeter to determine which posts need to be hooked to positive and negative.

Making a portable power supply

- Use a permanent marker to paint the negative connector black.

Once you have determined the Adaptaplug will be “center positive”, you’ll be ready to provide power to the bullet camera. Permanently marking the negative post with black will allow you to properly connect to the battery in the future. Use a piece of electrician’s tape at the base of the Adaptaplug to maintain the connection and help avoid accidental disconnection.

Application - Digital Recording

• Attach the bullet camera to a telescoping rod.

We use a 16 foot telescoping *bream* or *crappie pole* to extend our camera into the water. Duct taping the camera near the end of the pole allows quick setup in the field.

Application - Digital Recording

• With camera power on and connected to the digital video recorder, the system is ready to submerge and record.

If viewing organisms near the bottom of a stream, leave a bit of excess pole below the camera mount to help stabilize the extension. If viewing organisms in the middle of the water column, attach higher on the extension. You will find higher velocity water will vibrate the camera (example *feeding rainbow.mpeg*), so finding a sturdier extension system will be necessary. We found we could approach fish to within 6 inches and remain in focus (with an auto focus camera). We have not yet tried recording at night, but suspect the low amount of light emitted by the LED lights will require being rather close to the subject, or will require an auxiliary light source.

Application - Digital Recording

• Stealth and concealment allow observation of organisms and behavior.

We've found the bullet camera does not apparently interfere with behavior if stealth is used in approaching a stream channel. We've also observed that if fish are spooked by the initial approach and camera placement, they soon resume their position and activity if you remain concealed on the bank.

Application - Digital Recording

• Monitor the bullet camera view on the camcorder LCD screen.

The camera view is monitored by watching the digital camcorder's screen. If you plan to record in the field, it is important to find a camcorder with alternate video inputs. In our example, we sought a camcorder with S-video input, allowing us to connect and record directly from our bullet camera. Our digital video recorder is Sony's DCR-TRV17 (no longer made). Current comparable models are available from Sony and other manufacturers. Before you purchase a camcorder, a test of your bullet camera on various models (at a retailer) would provide you with a comparison of features.

Application - Field Interpretation

• An ideal setup to conduct streamside interpretation consists of waterproof camera, TV and battery/inverter.

A less portable system consisting of waterproof camera and TV/VCR combination powered by a marine battery and inverter, allows quick setup at easy access sites. This is an ideal configuration to conduct streamside interpretation of habitat and organisms for school groups. This setup requires two adults; one to operate the camera and one to interpret images/direct the camera (students have operated the camera too, when a second adult is not available).

Application - Field Interpretation

• A VHS tape can be placed in the TV/VCR and a recording made during field interpretation.

The streamside interpretation setup is ready to go quickly. Attach the bullet camera to the end of the telescoping pole. Connect the power supply to the camera. Connect the camera video out to the TV video in. Attach the inverter to the battery. Connect the TV/VCR powercord to the inverter.

A VHS tape can be placed in the TV/VCR and a recording made during field interpretation. We have not yet found a compatible microphone to connect to the TV's audio-in and record the audio portion of field interpretation - *please let us know if you find a suitable microphone!*

Not visible in this image is the camera operator, out of view to the right. The interpreter directs the camera operator and describes habitat elements (in this case, aquatic insects and habitat). As the video portion of this interpretation nears completion, an aquatic insect sample was collected (students view the underwater kick sample as it was collected), then students separate and identify aquatic insects, while learning of life history and habitat needs. Most students enjoy the real time underwater view and relate the video images to the collected sample.

Application - Digital Video Editing

• Manipulating digital film segments with editing software allows high quality video presentations to be produced.

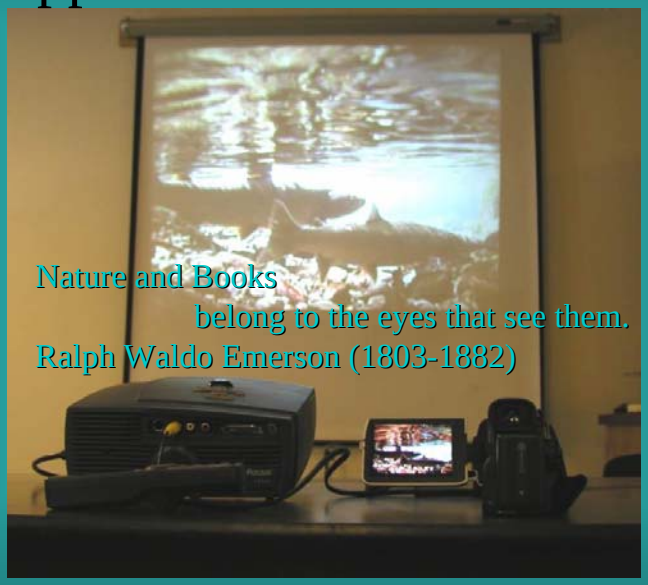
Loading recordings onto a personal computer and manipulating files with editing software will allow high quality video presentations to be produced. We use Pinnacle System's *Studio DV*, an inexpensive digital movie editor. The software comes with video card and high-speed cable connection (IEEE-1394 cable). Special effects, two layers of audio, text, still images, etc. may be added to the digital video. The file may be saved as .MPEG or other formats, or saved back to mDV tape for playback from the digital recorder. No loss of image quality occurs as film segments are transferred from digital recorder to PC, edited, then transferred back to digital recorder. Loss of image quality does occur when film segments are saved as .MPEG files. Examples of .MPEG video clips made using this system are located in the file folder: *Fish Videos.*

Application - Presentation

• A superior quality image is produced with no loss in quality when playing directly through a computer projector from video recorder.

Film segments edited on the PC or raw digital video may be plugged in and played directly through most computer projectors. In this case, the digital video recorder connects directly to the projector via an RCA connection. A superior quality image is produced with no loss in quality when playing directly from video recorder.

Application - Presentation



Among the greatest benefits to consider of video in your presentation is communication of resource values - we've found moving images often capture the imagination of students and adults alike, and aids in the conveyance of that message.

In addition to the applications described in this presentation, we have used variations of this system for:

- Underwater inspection of a downstream migrant trap (gasket seals) and fish screens.
- Location and recovery of a sunken Hydrolab data recorder.
- Spawning migration of bull trout adults (enumeration using time-lapse VCR).

View actual FISH VIDEOS

Prepared by FishWatchers on the McKenzie River Ranger District
Ray Rivera, Mike Cobb, Dave Bickford

Send questions to: dbickford@fs.fed.us

Please copy and share this presentation/mpegs with others who might be interested. We would also like to continue improving on our own underwater video methods and would like to hear of your problems, successes, see your mpegs, and how you've used this or your own system. Thanks!

Our mailing address is:

McKenzie River Ranger District
57600 McKenzie Hwy
McKenzie Bridge, OR 97413