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Using Videography To Monitor Coral Reefs

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U.S. Department of the Interior
U.S. Geological Survey
Florida Caribbean Science Center

U.S. Department of the Interior
National Park Service
Virgin Islands National Park
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U.S. Department of the Interior
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USING VIDEOTAPE TO SAMPLE CORAL REEFS

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I. Before Getting Started

Four of the components needed for this protocol can be most efficiently transferred to other users electronically. They will be available on a disk, on a web site, or by e-mail to those wishing to use them. They have been scanned for viruses. To receive them, please contact the authors.

- Randomplot.xls: A Microsoft Excel worksheet containing a macro that generates random points.
- Video Methods.atn: A file containing a set of automatic scripted actions to be loaded into Adobe Photoshop.
- Lola.wbt: A script written for the software program WinBatch for Windows to automates the dotting process.
- Dataentry.xls: A Microsoft Excel worksheet that automatically groups, tabulates, and summarizes video dot analysis data.

This protocol is designed for use on IBM-type computers. Those needing information regarding a Macintosh-based version of this protocol should contact the authors.

Disclaimer

This protocol provides details for each aspect of monitoring coral reefs using videotape. The methods and materials described in this protocol are not the only means to accomplish this monitoring. Other cameras, housings, software, and techniques may be substituted to meet the needs of a particular situation. The use of brand names such as Sony, Adobe Photoshop, Light and Motion, WinBatch, and AquaMap is not meant to be nor should it be taken as an endorsement or recommendation of a product, software or service. The authors believe the inclusion of explicit and detailed instructions for specific equipment will be valuable for those using the same or similar products.

Protocol Overview

Given the constraints of scuba diving, photography provides the most practical means of sampling large areas underwater. While still photographs offer better resolution than video images, the high-resolution video technology now available is adequate for monitoring benthic cover on coral reefs, the objective of this protocol, and videotaping is easier and faster than still photography. A diver needs to be adept at buoyancy control to produce quality video images, but a proficient videographer can cover a far greater area per unit sampling effort than does a still photographer. In addition, video exposures can be automatic, continuous, and do not require developing.

In this method, the diver uses a high-resolution digital video camera fitted with a wide-angle lens and an underwater housing. The diver videotapes while swimming slowly (~30 seconds per meter) along the transect holding the camera perpendicular to the substratum from a height of ~40 cm, producing a “swath” or belt transect that is ~ 40 cm wide.

Back in the office, the videotape is viewed to make sure that the clarity and resolution are satisfactory, then catalogued to archive the raw footage. A computer is connected to either the camera or a separate videotape player and the tape is played to "capture" adjacent, non-overlapping frames as still images. In this way, each transect is depicted by a number of unique frames, or

video “quadrats," which are converted to photo files and saved in a computer folder. Random dots are placed on each frame during a process that uses Microsoft Excel and Adobe Photoshop and is automated by WinBatch for Windows, a batch-processing program. After the images have been processed, an analyst identifies the benthic components under the random dots while viewing the frames in Adobe Photoshop. These data can be used to calculate percent cover of substratum categories.

Throughout this protocol, these icons are used:

 Activities generally done on dry land, usually requiring a computer.

 Activities done at the study site, mostly underwater.

➢ A specific step in carrying out the protocol.

Tips to keep you on track.

 Precautions to help protect your life, your equipment, or your data.

Time Requirements

- Videotaping requires ~5 minutes of bottom time per 10-meter transect, plus the time needed for transect location and set-up. Ten 10-meter transects can be filmed during a typical dive (60 to 75 minutes bottom time) using one battery and videotape (digital tapes and batteries last approximately 60 minutes). However, if you are using AquaMap™ to locate sample points, you will probably complete no more than five transects per dive.
- The dotting process requires ~20 minutes per 100 frames, but it is automatic and can be run after hours or at other times when the computer workstation is not in use.
- For image analysis (identification of substrate under random points) and data entry, ~45 to 60 minutes are needed per 10-meter transect.

The time invested in this process, and the cataloging and archiving of the data and tapes, can provide statistically significant comparative data that will be useful for many years.

Materials and Equipment

This section describes preparation of the necessary equipment, not including standard dive equipment. It is meant to augment, not replace, the manufacturer's instructions.

- Camera and accessories
  - Video camera, mounted on a camera tray
  - Mini digital video cassette tapes for camera
  - Video batteries (charged)
  - Sony AC-V515 AC power adapter/battery charger
  - Zoom-macro diopter
  - Sony DCR-VX1000 digital vi
  - Dry bag to store items
- Housing and Accessories
  - StingRay (Light & Motion brand) underwater camera housing
  - Distance aiming wand (~70 cm)
  - Straps fastened around housing to hold distance aiming wand
  - Lens cap

  - Silicone grease
  - Cotton Q-tip swabs
  - Supplies and equipment for using AquaMap (see AquaMap protocol)
- Miscellaneous underwater equipment
  - Video slate (Magnadoodle type), with pen/pencil attached
  - 25-50m fiberglass survey tapes (as needed, depending on the site) on a plastic reel with metric units shown on at least one side

  - Optional: clipboards, mylar, pencils, rubberbands
- Computer hardware
  - Minimum requirement: 400 MHz processor with 128MB RAM and 2 partitioned hard drive
  - Video capture board (we use Sony DVBK-2000; Sony boards are the only ones we know of that can capture still images rather than video segments and have other needed software features)
- Computer software
  - Adobe Photoshop (5.0 or higher)
  - MS Excel
  - WinBatch for Windows (download from a WinBatch CD or from the Internet at www.winbatch.com)
  - Windows 95 or 98 (Unfortunately, as of 2001 the driver for the Sony capture board has not been updated to work with later versions of Windows)

II. Video Equipment Preparation and Handling

(See the StingRay instruction manual for more details)

The sealing system for the video housing uses 6 o-rings: 2 rear plate o-rings (red) for use during storage; 2 rear plate active-use o-rings (black); and 2 active-use o-rings under the front optic port (black). The storage o-rings allow partial sealing at atmospheric pressure.

The storage o-rings should never be used when the housing is submerged. However, if the active-use o-rings for the rear plate are used during storage for more than a month, they may become flattened and are more likely to fail when submerged.

1. Charge the batteries.

The day before the dive, charge the video batteries. Even if you charged the batteries after the last use, it's a good idea to "top" them off. If the batteries have sat for awhile since they were last charged, they may discharge more quickly during use. For example, while batteries and mini-cassettes both last ~60 minutes, a charged battery that has sat for several days may provide power for only 45 to 50 minutes. According to information provided with the batteries, topping off a partially charged battery does not affect its life or memory. Batteries with a green tab exposed are fully charged.

The camera uses a lithium battery which should last about three years. Change this battery every other year to ensure consistent operation of the camera. If the battery happens to fail in the field, the camera will not work. When battery is replaced, you must reset the clock so that the camera to record the proper time code.

2. Prepare the video housing.

- Remove the back plate from the video housing by rotating the black cam mechanism counter-clockwise.
- Use your fingers or a blunt wooden object (never a sharp or pointed object) to remove the two red storage o-rings from the grooves in the back housing plate.
- Use cotton swabs to clean the grooves of the back housing plate and the o-ring sealing surface that is located at the very back of the camera housing.
- Clean the two black active-use o-rings. Inspect the o-rings for any nicks or signs of wear. Replace with new o-rings, if necessary.
- Apply a dab of silicone grease on your thumb and index finger and rub it onto the active-use o-rings. Use enough silicone to make the o-rings shiny, but not so much that gobs of silicone that will catch debris.
- Inspect the o-rings again for any imperfections or any dirt, lint or hair that may adhere to them. The silicone is not intended to prevent water from getting past the o-ring; it just maintains the o-ring's flexibility so it can change shape in the groove, creating a barrier to the water.
- The two o-rings on the front optic are less subject to wear and tear than those on the rear plate, but they also need to be inspected periodically and cleaned if necessary, i.e., after approximately every 10 uses. See the following section for basic instructions or refer to the video housing instructions for more details.

Inspecting and Cleaning the Front Housing

There are three places in the front housing to inspect and clean: the o-rings, the grooves into which the o-rings fit, and the sealing surface.

1) Position the housing vertically so that the "*Light & Motion*" logo is at the bottom (6:00) as you look into the front port.
2) Place your thumb on the black slider mechanism, to the left (at 9:00) of the optic, and move it left.
3) Rotate the optic clockwise until it stops (~90 degrees).
4) Pull the optic out from the housing.
5) Hold the housing so that you may focus your attention on the front view port.
6) Inspect the black active use o-rings and the sealing surface on the front of the housing for wear or any foreign matter. If necessary, remove and clean the o-rings, o-ring grooves, and sealing surface, and lubricate it with silicone. You can apply pressure with your fingers to cause a bubble or bend in the o-ring, and then slip it out of its groove.

 **Never use a sharp or pointed object to remove an o-ring.**

7) When the cleaning and lubricating is completed, replace the o-rings into their grooves.
8) This is a good time to clean the inside of the front view port and the red filter if necessary (see page 10 for details on the red flip filter). Use a soft, clean, dry cloth, taking care not to rub any silicone onto the lens or filter. Spots on these surfaces may cause the camera to focus on the dirty lens.
9) Apply a thin film of silicone to the o-ring surface area and the sealing surface on the front of the housing. This will allow the black view port to slide more easily when re-installing.
10) Place the optic into the opening on the housing until it seats into place. There are three orientations for the optic, all of which permit it to be installed correctly. This is best observed by rotating the optic until it partially "drops" into the front plate.
11) Once the optic is seated, push it into the housing to fully seal it and allow it to turn. This may require some force because you are engaging a bayonet-type bore seal on the optic.
12) With the optic flush against the housing, rotate the optic counter-clockwise until you hear a click (~90 degrees). The black slider should move out to the left as the optic is rotated and snap back to the right when the optic is in place. Do not move the black slider with your finger when installing optics. When the optic is correctly installed, it should not be possible to rotate the optic or pull it out.

- If you are using an aiming rod to keep a constant distance from the substrate, place the straps that hold the rod around the housing, checking to make sure that you can access the camera switches without interference from the straps. Slide the aiming rod under the straps and gently tighten them so that the end of the rod is 40 cm from the front of the lens optic of the housing.

3. Prepare the camera.

- Install a battery in the back of the video camera near the bottom left. The battery compartment door will pop open when you press the release button. Align the battery and slide it into the battery compartment. The battery is held in by the release clip on the back, left side of the battery compartment. The compartment door will click shut when closed properly.

  The battery is spring loaded. It will pop out of the compartment when you press and slide the release clip in the direction of the arrow.

- Clean and press the Zoom-Macro diopter onto the front of the camera. This is used to get the full optical properties from the camera. (See the housing instructions for more details.)

- The tray that attaches the camera to the housing also transfers the camera switch features to the housing switches. Connect the three wires from the camera tray to the video camera:

  — The remote/lanc cord is a thin black wire with a plastic probe that travels under the battery compartment door, between the bottom of the camera and the camera tray. It connects to the back upper right hole, labeled "lanc" that has a light blue ring around the fitting. (Remove the semi-triangle-shaped plastic cover if necessary.)

  — *The video-out cord* is a thicker, gray cord with a heavy RCA-type male connector. It runs under the battery compartment door, along the right side of the camera, under the hand strap, and into the yellow RCA fitting on the upper right front of the camera. (Remove the gray plastic cover if necessary.)

  — *The DC-in cord* is a thick black wire with a heavy black plastic connector that has a modified "T" 4-pin probe. It runs along with the video out cord, under the hand strap, to the upper right front of the camera, into the black rectangular connection. You can see the female mate of the modified "T" with 4 pins connection.

  All cables should be snug to the camera so that the camera can slide easily into the housing. They should not obstruct the sliding track guide that is located on the sides of the camera tray. You don't need to remove the cables and tray when the camera is not in use.

- Check the camera settings.

  — **Focus:** For filming video transects, we've found it best to use auto focus (the camera selects what to focus on) rather than manual (the operator selects the focus point). You can change from auto to manual focus and vice versa after you're in the water using a switch on the camera housing.

  — **Focal distance:** Set to full wide angle.

  — **Exposure:** We've found it best to use automatic, which allows the camera to select the shutter speed and iris (lens opening). For information about other options, see the camera manual.

  — **Power switch:** Move from OFF to CAMERA.

  — **Option switch:** Move to STANDBY.

4. Put the camera in the housing

- Before putting the camera and tray in the housing, make sure the camera settings have been adjusted as specified above, a tape is in the camera, and the battery is fully charged.
- Loading the camera: The camera tray is contoured at the front to ease loading. Place the front of the tray into the housing and push on the back of the camera until it docks to the front housing. You can tell when it is properly docked because you will not be able to push it any farther, nor will you be able to pull it out, for the small latch at the bottom left of the tray will be engaged.
- Installing the rear plate: You can install the plate with the housing resting horizontally on a table, but you may find it easier to stand the housing on the end containing the front optic, first checking to make sure that the red lens cap is in place and the o-rings are lubricated and clean.
  - Place the housing in the desired position and align the pins from the back plate with the holes in the camera tray.
  - Make sure the latches are rotated to expose the tracks on their underside. Simultaneously, rotate both latches in toward you a full 270° or until you hear a "snap". This signals that the plate is fully seated. Both o-rings should be inside the tube and the latches should be parallel to the length of the tube. Engaging the latches together ensures a snug fit and decreases the chance the rear plate gets cocked to one side.
  - Inspect around the entire rear plate to ensure the o-rings are properly sealed.

5. Using the camera settings and functions.

For this protocol, we use the camera primarily in the "point-and-shoot" mode. That way, instead of manipulating camera functions the diver can concentrate on camera orientation, buoyancy control, and swimming along the transect at a consistent speed, air, depth, and bottom time, etc. Camera operators should be familiar with the housing switches as they are described in the manual and below. To protect the lens from scratches or other damage, leave the housing's lens cap in place (on the front of the housing) until you are ready to film the slate, then replace it after completing the transect swim-back.

Once the camera is in the housing, all functions are controlled by four switches that can be pushed to the right or left. Depending on what you are trying to do, the switch may need to be held in place for several seconds and then released, or toggled back and forth.

- **Power and record/standby**
  - **PWR:** To turn on the camera, hold this switch at the PWR position until the camera powers up. This may take 2-5 seconds. It will take another 5 seconds before the camera responds to any commands.

    To turn the camera off, hold the switch at PWR for ~5 seconds before releasing. The camera will then begin its power down routine, which may take a few seconds.
  - **REC/STBY:** To start recording after the power is on, toggle the switch, i.e., slide it to the REC/STBY position and release it. You can tell the camera is in recording mode by the red dot and the "REC" in the viewfinder.

To stop recording and return to standby mode, toggle the switch again. You can toggle between “record” and "standby” at any time.

As a battery saving feature, the camera turns itself off after it's been in standby mode for three minutes. Check in the viewfinder to make sure you're in the right mode.

- Zoom

  This feature is not needed for purposes of videotaping benthic transects, where you are trying to maintain a constant focal distance from the substrate. But the camera housing does permit you to zoom in on a subject (telephoto) by holding this switch in the “T” position or zoom out (wide angle) by holding it at “W”. As soon as you release the switch, the camera will stop zooming. Remember, the camera needs to be set to full wide angle during perpendicular transect filming.

- **Auto focus and white balance**

  - **AF:** If the camera has been set on manual focus, you can hold this switch in the "AF" position to put the camera in “momentary” auto focus. When you release the switch, the camera will return to manual focus. To put the camera into "full-time" auto focus, toggle the PWR switch. (If you hold the PWR switch in place, the camera will shut off.)
  - **WB:** By sliding this switch to the "WB" position and releasing it, you can toggle through the various white balance settings, which are used to normalize the color of light reaching the lens after striking a surface. Due to the light absorption qualities of water (and since this protocol does not include the use of lights), the white balance should be left on automatic. If no icon is visible in the upper-left corner of the viewfinder, you are in auto mode.

- **Focus**

  The focus switch works in the same manner as the zoom switch, but it controls the focus of the camera lens. If the camera is in auto focus, sliding this switch in either direction ("N" for near or "F" for far) will automatically change the camera to manual focus mode. To get back to auto focus, toggle the PWR switch.

  If using the auto focus setting while pointing the camera at an object more than 3 to 4 meters away, the camera may try to focus on the particles in the water. To prevent this, either get closer to the subject, point the camera at a closer subject, or use manual focus.

- **Red flip filter**

  The deeper you go in the water, the greater the loss of perceptible color, with the red wavelengths lost first. At some point below about six meters, you may find that using the camera’s internal red filter restores red tones to a more “natural” level relative to blue tones. The filter is attached to a knob on the outside of the housing in the front plate. Rotating the knob up moves the filter in front of the optic; rotating the knob down moves it out of position. To determine if the filter is necessary, look through the viewfinder with and without the filter, and decide which looks more natural. If you're going to use the filter, make a note on the underwater slate before you start filming the transect to record that the coloration was altered.

III. Field Activities

This protocol assumes that you've already determined which transects you are going to videotape and are using AquaMap (as described in the AquaMap protocol) or some other method to locate the transects. After marking the first transect at the site with a survey tape, you start by filming an underwater slate that identifies the transect, then film the transect itself with the camera oriented 40 cm from and perpendicular to the bottom. At the end of the transect, the filming continues at an oblique view as you swim back to the starting point.

Do not make a force-full entry (e.g., back-roll or giant stride entry) into the water while holding the video housing, which may force water past. the o-rings. Instead, have the housing handed to you or reach into the boat to retrieve it after you are in the water.

Using Laminated Photos to Relocate a Transect

Depending on the objectives of your monitoring program, you may want to re-film the same transects over time. (See "Tracking changes on a reef in the US Virgin Islands with video-graphy and SONAR: a new approach" by Rogers *et al.* for a discussion of re-sampling the same transects versus selecting new transects each monitoring period.) Photo captures from the initial filming that have been laminated for use underwater can be helpful in relocating a transect on subsequent dives and accurately lay the transect in the same position even if the transect has been fixed using survey pins or monument structures. For an explanation of the photo capture and lamination process, see Appendix C.

Marking the Transect

To mark the transect, you will need a fiberglass survey tape with a string leader attached to the free end so that you can secure it to the substrate. After locating the start of the transect:

- Use the string to attach the free end of the tape to a non-living bottom feature as close as possible to the start of the transect so that you can begin filming at the 0 meter point. Take care to avoid injury to any living organisms.
- Run the tape along the designated bearing for the selected transect distance, i.e., 10 meters. However, you may need to extend the tape beyond this distance to find suitable substrate for securing or tying off the tape. There may be gaps where the tape is not flat against the bottom because of bottom contours, but make sure the tape is straight and taut (not moving in the surge/current), and as close to the bottom as possible. It should not entangle, bend, or abrade gorgonians, sponges or other living creatures. It will make your work easier if the tape is metric side up, but this is not necessary.

  Re-swim the transect to assure the tape is aligned properly. Time spent carefully laying the tape will pay off later in better video images and easier analysis.

- It's essential to mark the end point of the transect (i.e., the 10m point on the transect line), so that it can be easily identified in the videotape, especially if you have tied off the tape beyond the end of the transect. To indicate the end of the transect, use a marker to blacken that point on the survey tape (a 2-5cm section, so that it will show up on the videotape) or tie a *small* piece of flagging tape at that point. (A large piece of flagging tape may obscure benthic components when the videotape is analyzed.)

Filming the Transect

Assuming that you've entered the water with a video slate and a loaded and fully-charged video camera in its housing with active use o-rings in place, the aiming rod attached, and the lens cap removed, you are ready to begin filming. If you plan to use captured photos from the videotape to help relocate the transect on future dives, take special care to film the transect origin and terminus and to include identifying features.

- To identify the transect, write the following information on the slate in large letters.
  - date
  - site name
  - transect number
  - if a red filter is being used
  - depth
  - videographer name or initials

  
  Filming legible data on the slate is vital. When the tape is reviewed in the lab, the analyst must be able to determine which transect it is and the circumstances under which it was filmed.

- Hold the slate in front of the camera aiming rod and film it for ~5 seconds. Make sure that the camera is recording by looking in the viewfinder for the red indicator light.
- You can toggle the REC/STBY switch to pause the camera, or continue filming and immediately move to the beginning of the transect tape.
- Hold the camera so that the 40-cm rod is just off the substrate and the camera is perpendicular to the bottom. It must also be oriented so that the long axis of the video image is perpendicular to the transect tape (use the handles of the video housing for a guide). Be careful not to tilt the camera either back-front, or side-side. Make certain that the camera is recording by checking again for the red dot in the viewfinder.
- It should take ~5 minutes to film a 10m transect. To monitor the time, you can put a watch on the video housing. After some experience with filming transects, this pace will become second nature to you.
- At the end of the transect, keep filming as you slowly move the camera to a more horizontal view. Then turn around 180°, aiming slightly back down toward the transect. While swimming ~3-6 feet from the bottom, continue filming as you return along the tape at a comfortable pace. (On a 10m transect, this should take about 1 to 1½ minutes.) It's often difficult to get an overall perspective of the reef from images taken 40 cm away, and this swim back along the tape will provide a “wide-angle,” oblique view of the reef /transect.
- When back at the beginning of the transect, toggle the REC/STBY switch to stop recording.
- Move on to the next selected transect and, after changing the information written on the slate as needed, repeat the steps above.

Post-Dive Tasks

- Rinse off the equipment. The handle of the fiberglass survey tape will begin to rust immediately, so wash them thoroughly after each use and spray monthly with WD-40 to prolong tape life.

- Rewind the tape to protect it from premature oxidation.
- Remove the tape cassette from the camera, label it, and apply a record-protect tab.
- Store the camera and housing. Put the housing's lens cap on to protect the optic during storage and transport.
- Recharge the batteries.

IV. Viewing and Cataloging the Videotapes

You *must* view the videotapes promptly after filming to make sure that the quality is sufficient to meet your monitoring objectives.

If you simply assume that everything worked properly, you may find out later that the tapes are unusable because of something that happened or failed to happen. The tapes should be evaluated for qualities required to produce good quality, captured images, e.g., focus, steadiness, rate of filming, and proper transect documentation. This checking should not be done in the field (e.g., in an open boat) or in such a manner as to expose the camera to water. However, it should be done as soon as possible after you have returned to the office. If a videotape is deemed unusable, the transect will need to be re-filmed.

The videotapes must also be catalogued in such a way that each transect at a site may be located at a later date with relative ease through a database or spreadsheet. This can be done when viewing the tapes for usable quality. This log will provide a valuable archive of qualitative data, and provide information for quality assurance and quality control issues.

- Open the program that contains your video log (MS Excel, Access, or other database program).
- Find the last entry, if any. If all previous tapes have been entered, give this tape the next sequential number. Any previous tapes that have not yet been logged in should be assigned numbers first and entered into the log as soon as possible. Label each case and the cassette itself with the tape's number in large letters.
- Put the video cassette in the player or select the VTR function on the video camera. The camera back will display the time code in "H" (hours), "M" (minutes), "S" (seconds), and "F" (frames). If you're using a cassette player, you may have to select this display type (refer to the manual).
- Enter the appropriate data in the columns of the spreadsheet, referring to the information filmed on the video slate as needed.
  - Tape number: as already logged in.
  - Date: the date of filming.
  - Site: this may include the island, territory, area in that site, as well as transect number. For example: "STX, Buck Island, Back Reef #4 transect."
  - Location: this is the detailed portion of the site. It might include an action or some item of special interest. For example, "0m – 10m," "swim back along Pin 2," or "black band disease on CN, brain coral."

- Tape counter: record the start time and end time displayed that corresponds to what you entered for Site and Location. This may be broken down for significant findings, animals, disease, etc. You do not need to include the frame number.
- Filmed by: the name or initials of the person who filmed the video.
- Camera: the model of the camera that was used for the filming.
- Exposure: generally automatic; note if other setting was used.
- Lens: generally wide angle; note if other setting was used.
- Focus: auto or manual (or A/M if you used both)
- Shutter speed: generally automatic; note if other setting was used.
- Light: note if the red filter was on or off, and if artificial lights were used.
- Comments: any other information that may be useful to someone looking at the tape months or years from now (e.g., poor visibility or surge present).

V. Capturing the Video Images

You can capture ~23 to 27 unique frames from a 10m transect (46 to 55 frames from a 20m transect). The process used to select non-overlapping frames from the video transect and save them to your computer's hard drive depends on the type of capture board installed in your computer. Capture boards often have both manual and automatic capture features.

Manual versus Automatic Capture

To obtain the best possible results, we recommend using the manual capture feature on the Sony DVBK 2000 Still Image Capture Board. With manual capture, you must concentrate completely on the video playback, watching for each unique frame to be displayed so that you can make the "capture." With automatic capture, you program the capture card so that frames are selected at a designated time interval, eliminating the need for you to watch the video during the capture process.

Automatic capture is a feasible option only if the entire transect was filmed at a uniform speed, e.g., 1 meter every 30 seconds. Surge and reefs with large vertical features tend to alter the pace of filming, making steady filming difficult if not impossible. If the transect was filmed at a variable speed, using automatic capture will cause under-sampling in areas that were filmed more quickly, creating gaps in the video record, and over-sampling in more slowly filmed areas, resulting in over-lapping frames. Therefore, although it requires more of your concentration, we believe that using the manual capture method is superior to the automatic capture.

Storing the Captured Video Images

- **File folders:** For a single site, you may have 250 frames (i.e., ten 10m transects with 25 frames per transect). As they are captured, all of these frame files should be stored in one folder. (We use D:/Images/Source.)
- **File format:** Some capture programs allow you to select the format in which the image will be saved. The Sony capture board application creates image files in their proprietary "dvf" format, but they can be converted to another format so you can open them in Adobe Photoshop. We recommend that the files be saved or "exported" as JPEG files (*.jpg). The JPEG file

format is compressed, which results in the loss of some data, but not enough to significantly decrease image resolution.

You can convert the *.dvf files to *.bmp files in order to retain all of the image data, but the large size of BMP files (~900 KB per image compared to ~130 KB for JPEG files) slows the automated dotting process and may cause the script to crash. If you want to save the images as BMP files, we recommend that you also save them as JPEG files for dotting and use the BMP files for backup or archival storage.

- **File name:** By assigning a unique name to each captured frame, you can indicate its transect number, where and when the transect was filmed, and the location of the frame within the transect. We use a 10-character format because the WinBatch script is designed to look for a 10-character code in the described format to create a subfolder for each transect's frames.
  - The first two characters are the transect number. If the transect number is a single digit, it should be preceded by a zero.
  - The second two characters indicate the transect location. For example, the fourth transect at Newfound Bay would be 04NF.
  - The next four digits indicate the month and year the video was filmed. For example, November 2000 would be represented by 1100.
  - The last two digits are automatically assigned sequentially by the Sony Capture Board program, starting with "00" for the video frame showing the slate.
- **Slate image:** The first frame to be captured for each transect should be that of the slate that shows the location and transect number of the site. This redundancy provides another record to link all the frames from a particular transect.
- **Readme file:** This protocol produces many video transects with thousands of frames. To record notes, comments, or other metadata regarding any step of the image logging, capture, dotting or analysis process, you need to create a "Readme" file that will be kept in the same folder as the image analysis data sheets. This will provide a record for yourself and others to track the progress of analysis at a particular study site. This metadata file records additional information, e.g., transects were recorded or when changes were made during the analysis

  Open a new document (e.g., in MS Word) to begin a metadata file that will be saved in a *.doc or *.txt format. In chronological order, keep a record of who did what and when. For example, “11/02/99: Jeff Miller filmed the 8 transects at Bob’s Reef. They are numbered 01-08. The video tape was logged in on the video log master list, and recorded as tape number 4.” Or, “11/30/99: Ellen Link analyzed transects 01-03.”

Starting the Capture Process

The videotape images are captured by the computer using a “firewire” cable connected to a still image capture board. Plug one end of the fire wire into the capture board at the back of the computer and the other end into the DV in/out port on either the player or, if you don’t have a player, on the back of the camera. Using a larger image will make it easier for you to observe reef details during the capture process, so if possible connect your playback device to a television screen through an RCA-type cable (i.e., video out of playback device to video in of TV).

- Go to START PROGRAM SONY DV APPLICATION. This launches the capture program, displaying a small screen with button controls, as on the camera. The video screen will be displayed both on the playback device and on your computer, and you can play and stop the tape using either piece of equipment. However, because the CAPTURE button must be clicked on the computer screen, we find it easier to do all the videotape manipulation on the computer.
- To create a folder where each transect or other subset of captured images will be temporarily stored until they are exported as JPEG files, go to FILE NEW ALBUM and create a folder called "Capture." We use the "Album" feature instead of "Library" because when new images are captured from within a new album, the capture details are displayed on the screen (i.e., time, date of capture and filming).
- Go to VIEW NORMAL. This will provide data on the images you are capturing, e.g., time code and frame numbers.

Then proceed with either the automatic or manual capture method, depending on which you have chosen to use.

Using the Manual Capture Method

- Play the videotape from the beginning until you can clearly read the site details on the slate. Then pause the tape and click on the CAPTURE button. (You can capture a frame without pausing the tape, but you may want to stop it to make sure that the slate is in clear view.) You should see the image added to your Capture folder. This first file in each transect will be assigned a default name ending in "00" until you rename it, as explained in the "Renaming and Exporting the Image Files" section that follows.
- Play the tape until you reach the beginning of the transect or forward to the tape counter number that you identified in your video log. This may take some time, as there will be non-transect tape covering the period after the slate has come into view and before the aiming wand settles at the beginning of the transect tape.
- Pause the tape and click on CAPTURE when the starting point of the transect is at the bottom of the screen.
- Look at the top of the screen to identify a feature, e.g., a sea fan or sand channel.
- After the first transect frame has been captured, follow the feature that was observed as it tracks to the bottom. When it is at the bottom, click on CAPTURE again.
- Repeat this process, capturing abutting, non-overlapping frames as they appear until the end of the transect. You should have ~25 frames per 10 meter transect. The last captured frame should have the flagging tape or other end of transect marker at or near the top of the frame. Click on the square button on your computer screen display (or press the button on your camera) to stop the tape.

Using Auto-Capture

If you maintained a consistent speed while videotaping the transect, filming about one meter every 30 seconds for the entire transect, you may wish to use the Auto-Capture feature to capture the video frames. (See "Manual vs. Automatic Capture" on page 15.)

- With the Sony DV Application launched and your Capture folder open, go to file preferences capture. In this window, you need to indicate the number of frames to be captured, how frequently they are to be captured, and the prefix by which they will be identified.
  - STOP WHEN: For a 10-meter transect, enter "27." This may be more than you need, but it is better to have the program run out of videotape from which to capture frames than to have it stop too soon.
  - TIMING: A conversion factor is used to establish how frequently the frames will be captured. From your video log, determine how long it took to do the transect. If you met the goal of one meter every 30 seconds, this would be 300 seconds for a 10-m transect, or 600 seconds for a 20-m transect. Multiply this number of seconds by 1.2 for a 10-m transect, and 0.6 for a 20-m transect. Enter this number in the box as a numerator divided by 30.
  - PREFIX: Enter the number of the transect followed by the two letter site code. If it is one of the first nine transects, enter a zero first (i.e., 01YZ, 02NF, 05HW, 10TE, 11MB). Space is provided for only four characters.
- When the above information is correctly entered, click on OK.
- Play the tape until the slate showing the site details is in clear view. Then pause the tape and click on the CAPTURE button. You should see the image added to your Capture folder. This first file in each transect will be assigned a default name ending in "00" until you rename it using the 10-character method.
- Play the tape until you reach the beginning of the transect or forward to the tape counter number that you identified in your video log.
- When you are at the beginning of the transect, click on AUTO.
- Watch the videotape to make sure that abutting, non-overlapping frames are being captured. You should be in "normal" view to see the details on the captured frames.
- When the last frame has been captured, you should be at the end of the transect, with the last frame showing the flagging tape or other end of transect marker at or near the top of the frame. Click on the square button on your computer screen display (or press the button on your camera) to stop the tape.

Renaming and Exporting the Image Files

The Sony capture board application creates images files using their proprietary "*.dvf " format. With a few mouse clicks, all of these *.dvf files can be renamed and converted to *.jpg files so that they can be opened in Adobe Photoshop. If you catalog all of the images in one folder, they will be automatically sorted into folders named for each transect.

- To create the folder where images files will be stored after exporting, go to START and right click to get to EXPLORER. Select the location for the folder that you are making. We recommend "D:\Images" so that the files are on a different partition of the drive than the operating system in case of a system crash. Go to the FILE drop-down menu and choose SELECT NEW FOLDER. We call the folder "Source."
- To select all the images captured for this transect, go to the Sony Capture Board icon display and choose ALL. (Or choose SELECT ALL on the SELECTION drop-down menu.)
- Go to the IMAGES drop down menu and choose RENAME IMAGES. At this point, assign the file name as explained above: the two-digit numeric prefix that corresponds to the transect number; then the two-character site code, then the four-month/year of the filming, with no spaces between characters.
- Go to the IMAGES drop-down menu and choose EXPORT. Select JPG as the file format and HIGHEST as the option for graphic quality. (The *.jpg files created in this way will generally be from 100 to 160 KB in size.) Click on OK. This will automatically export the images and convert them to *.jpg files in the Capture folder that you created, but the process may take a few minutes. When it is completed, you can close the Capture folder while the Capture Board program remains open on your taskbar.

> **Saving Images as BMP Files**
> To archive the images as BMP files, follow the preceding steps, except choose BMP as the file format. Save the BMP image files to a separate folder on your hard-drive for later placement on a CD. You do not want to dot BMP files as their large size slows the automated process and will cause the dotting script to crash. When you've completed saving the images as BMP files, repeat the procedure to create JPEG files for dotting.

- Go to START and right click to get to EXPLORER. In the Capture folder you created in the Sony DV Application directory, you'll see a *.dvf file of each image in addition to the *.jpg files.
- To sort the file types alphabetically so that you can easily select all the *.jpg files, go to the VIEW drop-down menu and choose ARRANGE ICONS BY TYPE.
- Select all the *.jpg files (select the first *.jpg file, then hold down the shift key while clicking on the last *.jpg file) and move them to your Source folder.
- After you've checked to make sure that the *.jpg files have all been moved to your Source folder, you can delete the *.dvf files.

Next transect: If you video images from another transect to capture, play the tape forward and pause or stop it when you reach the introductory slate. Double-click on the Capture folder you created, which should now be empty again. Repeat the steps for the manual or auto-capture method.

VI. Using Adobe Photoshop

The three tasks explained in this section (setting the scratch disk, modifying the *.ini file, and loading the actions file) only have to be done one time per computer; the settings do not need to be changed during any subsequent use of Adobe Photoshop.

Setting the Scratch Disk

Adobe Photoshop will first try to process images using your computer's RAM. If it can't find enough space there, it will create a temporary file in the location that has been designated as the "scratch" disk. Usually the C: \drive or setup file is the default location. To use Adobe Photoshop in processing video frames, you must make sure you have sufficient space on your computer and select the drive with the most available space for the scratch disk.

- To determine the available space on your hard drives:
  - Double click on the MY COMPUTER icon on your desktop.
  - Click once on (C:) to select the C drive. Go to FILE PROPERTIES. Write down the amount of free space on your C:\drive. Close this window.
  - Repeat the previous step for your D drive and any other hard drive on your computer.
- To designate the drive for the scratch disk:
  - Open Adobe Photoshop (5.0 or higher).
  - Go to FILE PREFERENCES PLUG-INS & SCRATCH DISKS.
  - As the first choice, select the drive with the most space available, usually D.
  - As the second choice, choose the drive with the next most available space or the option "NONE".
  - Choose OK.

*Modifying the *.ini File*

To ensure that Adobe Photoshop will operate smoothly with the dotting process, we recommend that you modify your system's "*.ini" file. If you don't do this and get an error message that the "PASTE command is not available" when you press F8 in Adobe Photoshop, you'll know you're in trouble.

- Go to START FIND FILES OR FOLDERS. Search for "photo*.ini" in the directory where Photoshop is located. (If you don't know this, start at the root of C, then try D or another drive.) If you have Photoshop 5.0, it will be the "photo50.ini" file and probably be found in C:\Program Files\Adobe\ Photoshop 5.0\ Adobe Photoshop Settings.
- Open the *.ini file. Add the exact line of text below as the last line of the *.ini file. The first letter of each word must be in upper case, with no spaces in the text and no other formatting or punctuation:

  AlwaysImportClip=1
- Save and close the file.

Unless this *.ini file is modified again, in the future Adobe Photoshop will import what is stored on your system clipboard, which is what you need to happen.

Loading the Actions File

- To load VIDEO METHODS, open Adobe Photoshop, go to the WINDOW drop-down menu and choose SHOW ACTIONS.
- Click on the black triangle in the upper right corner of the Actions palette.
- From the menu which appears, choose LOAD ACTIONS. Each action will be associated with a specific function key on your computer, as listed on page 19 and 27.
- Browse to locate and select the "Video Methods.atn" file. Click on LOAD.
- To hide the Actions palette, click on the X at the top right corner.

VII. Random Dot Processing Set Up

To randomly sample areas on the video frames for benthic identification, MS Excel is used to create a unique plot of 10 random dots per image. This plot is "cut and pasted" (superimposed) onto a video frame in an image file that has been opened using Adobe Photoshop. After some manipulations, you will have 10 randomly located hollow red squares outlined in yellow superimposed on the video frame.

Three computer files have been set up to enable you to create these randomly sampled frames.

- A set of actions, or function key commands, called "Video Methods.atn" which is loaded into Adobe Photoshop.
- An MS Excel spreadsheet called "Randomplot.xls" with a macro embedded within it to create the random plot of points.
- The WinBatch script file called "Lola.wbt" which is run in the program WinBatch for Windows.

In summary, you will paste the plot of points generated by the Randomplot macro onto the video frame displayed in Photoshop, and adjust the plot's size and position so that it matches the frame exactly. Although you must initially determine the plot's correct size and position by trial and error, you can then make the adjustment permanent by editing the code in the macro in Excel and the Actions file in Photoshop. Once these edits have been made and saved, LOLA will automatically replicate the necessary size and positioning of the plot for each video frame.

This is the only point at which you can alter the instruction codes for the dotting process, and you can modify them only as described below. Alterations to any other part of the Photoshop Actions file or the Excel macro may jeopardize the performance of the WinBatch script.

1. Launch Randomplot.

The macro in Randomplot is used to produce the plot of random points, label the points A-J (1-10) and make them into red hollow squares so that they are easier to find.

- In MS Excel, open and maximize the Randomplot spreadsheet. If you get a box prompting you to either "enable" or "disable" macros, choose ENABLE**.**
- Run the macro by simultaneously pressing CTRL + SHIFT + P. It will take 2 to 4 seconds. Do this two or three times to make sure it runs smoothly. The final step in the macro "cuts" the plot to your computer clipboard. Consequently, you will not see the final plot until it is pasted in Adobe Photoshop unless you view the clipboard.

2. Evaluate the plot size and position.

The F8 command in Adobe Photoshop ("Paste, clear and move") pastes the graph generated by the macro onto the JPEG image as a second layer, makes the layer transparent, and moves the graph in an attempt to align the X and Y axes of the plot with the edges of the video frame. However, to ensure that the entire area of the frame is covered by the plot and that any point within the frame may be selected as a sampling point, the size and position of the plot and the frame must match up *exactly*. The extent of adjustment, if any, that must be made to the size and position of the plot to get it to match the frame varies between computers.

Using the Function Keys in Photoshop

F2: brightness adjust
Shift+F2: undo brightness adjust
F3: contrast adjust
Shift+F3: undo contrast adjust
F4: unsharp mask
Shift+F4: find edges
F5: open JPEG file
F6: open BMP file
F7: open TIFF file
F8: paste, clear and move
F9: flatten, purge and close
F11: close, no changes
F12: delete layer

The first six keys listed above may be used during the image analysis process.

To check the size and movement settings:

- In Photoshop, open a JPEG file from your Source folder. If the Photoshop toolbar or any other Photoshop option box is displayed, remove it by pressing the TAB key twice, or go to the WINDOW drop-down menu and choose HIDE TOOLS.
- In Excel, open and maximize Randomplot. (If Excel is already open and you previously ran the Randomplot macro, you will notice that the spreadsheet is scrolled down to approximately row #26. You need not change this or any other feature within this sheet to run the macro.)
- Run the Randomplot macro by simultaneously pressing CTRL + SHIFT + P.
- Click on Photoshop in the task bar to display the JPEG file that you opened before.
- Press F8 to paste the plot as a layer on top of the video frame.
- You will need to use your computer keys rather than your mouse to move the top layer (the plot layer) up and to the right to be able to see the X and Y-axis unit labels. You may have to move the plot in order to even see the X and Y-axes.

  CTRL + [or] = small move right [or left]
  CTRL + SHIFT + [or] = large move right [or left]
  CTRL + [or] = small move right [or left]
  CTRL + SHIFT + [or] = large move right [or left]

- Check the Y-axis by moving the plot layer to the right so that you can see the unit labels. If the tick mark for "0" is at the bottom edge of the video frame and the tick mark for "100" is at the top, the plot is the correct height. If not, you will need to adjust it as described in the next section.
- Using the computer keys, move the plot back to the left so that the Y-axis aligns with the left edge of the video frame.
- Check the X-axis by moving the plot layer. Unless the tick mark for "0" is at the left edge of the video frame and the tick mark for "100" is at the right, you will need to adjust the plot width as described in the next section.
- Press F12 to delete the plot layer.

3. Adjust the size of the plot.

To adjust the size of the plot, you will need to edit the spreadsheet macro.

- Click on Excel on the taskbar to return to Randomplot and maximize if necessary.
- Press ALT + F11 to open the Visual Basic Editor window.
- If the Project Explorer window does not also open, go to the VIEW drop-down menu and select PROJECT EXPLORER.
- In the Project Explorer window, look in "VBAProject (randomplot)" for the Modules folder. Double-click on module 1. This will display the macro code.

You must follow these instructions exactly so that you do not make any inadvertent changes to the Visual Basic script. If you hit keys that change the script in ways other than that specified below, go to the EDIT drop-down menu, and select UNDO TYPING.

- Go to the EDIT drop-down menu and select FIND. In the FIND WHAT box, type "width" and click on FIND NEXT. This should take you to line 150, reading:

  "Selection.ShapeRange.ScaleWidth 2.08, msoFalse, msoScaleFromTopLeft"

- It is the number after "ScaleWidth" (2.08) that sets the width of the plot. Increase or decrease this number as necessary, starting out by trying a small change (~0.5 units). If you use 2.00, Visual Basic writes it as "2#".
- It may take more steps, but we've found it saves time in the long run if you adjust the size of only one axis at a time. After you've entered a different width to try, go to the FILE drop-down menu, close this file of coded instructions, return to Randomplot and run the macro again: CTRL + SHIFT + P.
- Click on Adobe Photoshop in the task bar to display the video frame again. Press F8 to paste the resized plot on top of it. Check the new width by moving the plot layer with the CTRL (+ SHIFT) + [or]. Return to the Visual Basic Editor window to try a larger or smaller width until it is the same as that of the video frame: the tick mark for "0" on the X axis is at the left edge of the frame, and the tick mark for "100" is at the far right.
- When the width is correct, follow the same procedure to adjust the plot height until the tick mark for "0" on the Y axis is at the bottom edge of the frame, and the tick mark for "100" is at the top. The code for the height can be found by going to the EDIT drop-down menu, selecting FIND, typing "height" in the FIND WHAT box, and clicking on FIND NEXT. Line 152 will read:

  "Selection.ShapeRange.ScaleHeight 3#, msoFalse, msoScaleFromTopLeft"

- When you have set the correct width and height, open Randomplot and run the macro: CTRL + SHIFT + P.
- Go the FILE SAVE, or click on the disk icon ( ) on your toolbar.
- We also recommend writing these width and height values in a place where you can easily find them, so that you don't have to repeat the sizing process.

4. Adjust the position of the plot.

The default setting in the Photoshop Actions file attempts to position the axes of the plot layer along the edges of the video frame. Depending upon your computer system, this positioning may have to be adjusted. You can use your computer keys to move the plot layer into the correct position, but to make the positioning automatic each time the plot is pasted onto a video frame, you'll need to keep track of which key strokes and how many you use to position the plot and modify the Actions file accordingly.

- With the correctly-sized plot layer showing on a video frame as described in the previous section, move the plot so that the Y-axis lines up with the left edge of the frame. Write down the number, direction and size of key commands you are using, e.g., "shift Y-axis to the left with two large moves and one small move."

  CTRL + [or] = small move left [or right]

  CTRL + SHIFT + [or] = large move left [or right]

- Next, line up the X axis with the bottom edge of the video frame, and record keep the number, direction and size of key commands that you make:

  CTRL + [or] = small move up [or down]

  CTRL + SHIFT + [or] = large move up [or down]

- Repeat this process until you're certain you've accurately recorded the number, size, and directions of key commands needed to position the plot correctly.
- To record the number, size and direction of key commands in the action sequence, you need to have a JPEG file open. Run the Randomplot macro to create a plot layer, click on Photoshop on the taskbar, and press F8 to paste the plot on the frame.
- To turn on the Photoshop Action Recorder, go to the WINDOW drop-down menu and select SHOW ACTIONS.
- In the Actions palette, click on the triangle left of PASTE, CLEAR AND MOVE. This opens that action sequence so that you can see the individual instructions.
- Select PASTE with your mouse cursor (which is probably in the shape of a finger pointing). This should result in the PASTE command line being blue.
- At the bottom of the Actions palette, click on the round button. It should turn red, indicating the recorder is turned on. From this point until you turn off the recorder, all key commands will be recorded under the PASTE command line, in the PASTE, CLEAR AND MOVE action sequence.
- Move the plot layer using the number, direction and size of key commands that you have determined necessary for its correct placement on the video frame.
- When the plot layer is correctly positioned, click on the square button at the bottom of the Actions palette (left of the round record button) to stop the action recorder.
- Click on the triangle left of PASTE, CLEAR AND MOVE to close the action sequence.
- To hide the Actions palette, click on the X at the top right corner.

5. Confirm plot size and position.

Run the macro again and place a plot layer on a video frame to make sure that it is correctly placed and sized.

- In Adobe Photoshop, open a JPEG file from your Source folder, or press F12 to delete any layer from the previously opened frame.
- Minimize Photoshop.
- With Randomplot.xls open and maximized, run the macro by simultaneously pressing CTRL + SHIFT + P.
- Click on Adobe Photoshop in the task bar to display the video frame that you opened previously.
- Press F8 to paste the plot generated by the Randomplot macro as a layer on top of the video frame.
- At this point, the plot layer should be properly sized and placed on the video frame. Check this by repeating the sequence of steps under "Evaluate the size and position of the plot" on page 19.

If the plot is correctly sized and positioned, the unit labels for the X and Y axes (located outside the graph) will not be visible on your screen.

VIII. Automating the Dotting Process

Automating the random dot process is not essential to carrying out this protocol, but it can save hours of time and is strongly recommended. We use WinBatch for Windows, a proprietary programming language, to automate the task of activating MS Excel, creating the random plots, merging each random plot with a video frame in Adobe Photoshop (JEPG file format), and saving it to a designated directory, leaving the original image file unaltered. It also serves to catalog the images in a file system. Running the WinBatch script when the computer is not otherwise occupied enables you to automatically dot up to 1,000 frames in one series, at a rate of ~100 frames every 25 minutes on a Pentium Pro machine with 450 MHz processor and 128 MB RAM.

The WinBatch Script

A script has been developed to automate the dotting process for this protocol. You will need to install WinBatch on your computer from a WinBatch CD or by downloading it from the Internet. Do not modify this script (Lola.wbt) in any way. If you have questions or problems regarding this script, contact the authors of this protocol.

Downloading WinBatch from the Internet

Go to http://www.winbatch.com and click on DOWNLOAD OUR SOFTWARE. To start the download, choose any of the ftp or http addresses under "WinBatch." The file is ~3MB in size. You receive a free 21-day trial, after which, if you want to purchase it, the cost is $99 plus shipping/ handling.

File Management

During the automated dotting process, WinBatch uses a three-directory file management system.

- **The source directory:** This is the same as your Source folder, where the original "un-dotted" video frames are stored as JPEG files. They should not be put into subfolders within

this directory, and no other documents or items besides the images should be put in this directory. The dotting process will “dot” whatever is in this directory.

- **The destination directory:** This is where the WinBatch program moves the video frames after the plot layer of random dots has been added. We recommend "D:\destination" so that the files are on a different partition of the drive than the operating system in case of a system crash. Within this directory, WinBatch will create a folder for each transect that is named using the first eight characters of the file names for the video frames in that transect.
- **The working directory:** WinBatch automatically creates a temporary directory (C:\working) and saves each frame in it during the dotting process until it is moved to the destination directory. (Only one frame at a time is put in the working directory.) You won’t see this directory on your computer because WinBatch automatically deletes it when the dotting process is complete.

For example, assume you have filmed twenty 10m transects and captured 26 frames (25 from the transect plus 1 for the slate) for each transect and saved them as JPEG files. You now have a total of 520 files. You have stored these 520 JPEG files in your Source folder.

If you use the suggested 10-character naming format explained on page 13, WinBatch will take the images from your Source folder and put them in individual transect folders that are named according to the first 8 characters of the image name. Each folder contains the 26 JPEG files for that transect. By using a name that identifies the image date and location (e.g., the slate frame of the first transect named 01CR029800), you can avoid confusing similarly numbered transects filmed at different locations or on different dates.

What WinBatch Does Automatically

- After you specify the directories, the Randomplot macro starts, generating random points three times to assure proper synchronization. Adobe Photoshop also becomes active, and the ChopChop window opens.
- The Randomplot macro runs again and copies an un-dotted video frame from the source directory you specified to the temporary working directory.
- Within Photoshop, the image from the temporary working directory is opened, dots are pasted on the video frame as a second layer; and the two layers are compressed into one image and saved as such in the temporary working directory.
- The image is then moved to the appropriate subfolder that was automatically created by the WinBatch script in the destination directory you designated.
- The Randomplot macro runs again, repeating the process for the next frame, and continuing until 100 images or all the images in the source directory have been processed, whichever comes first.
- The WinBatch script closes Adobe Photoshop and then MS Excel, which takes ~1 minute. WinBatch will then re-open MS Excel and Adobe Photoshop, and continue to repeat the process in batches of 100 until all the frames have been dotted.

Dotting a Batch of Captured Images

- Launch the WinBatch script by double-clicking on "Lola.wbt".
- You will be prompted by four dialog boxes to specify:
  - **Image type:** Select the same file format that you used when you saved the captured video frames. (Only one file format can be used per batch.) We use JPEG, which is the default.
  - **Source directory**: Browse to indicate the Source folder where your un-dotted image files are located.
  - **Destination directory:** Browse to indicate where you want the dotted frames to be saved.
  - **Randomplot.xls**: Browse to indicate where this spreadsheet is located.
- After responding to the dialog prompts, you must let your computer run the applications without interruption. You cannot use the computer for any other purpose while the Win-Batch script is running. You can monitor the progress by checking the counter, which indicates which frame out of how many total frames is currently being processed. It takes ~20 minutes to process 100 frames on a computer with 450 MHz processor.
- When all the images in the source directory have been dotted and saved to the destination directory, WinBatch will close all applications and open a dialog box indicating the elapsed time for the processing of all frames.
- WinBatch will create one Notepad file for each batch of 100 JPEG files, listing them in the order in which the frames were dotted (Logfile_1, Logfile_2, etc.) You can open these files by double-clicking on the Logfile icon on your computer desktop. Check the number of dotted frames to make sure that it is the same as the number of un-dotted image files in the source directory. If it is not, check to see which files are missing. Depending on the number of missing files, you can either dot the frames individually or copy them from your source directory to a separate folder and run WinBatch again, using this new folder as your source directory.
- Save the Logfiles in the same directory as the JPEG files and the data entry worksheet.

The script is set up to close the applications after 100 frames because WinBatch may fail if the large temporary files that created during the processing are not removed. They will automatically be deleted when the WinBatch script closes Adobe Photoshop.

Backup and Long-Term Data Storage

The efficacy of this protocol relies heavily upon the collection and safe storage of digital data that is easily corruptible and can be permanently lost by a drive failure or virus infection. (Other methods of coral reef monitoring such as chain transects also involve data entry, but they are backed up by hand-written data in data log books.) Although your specific procedures regarding the frequency and method for back-up and long-term storage may depend on the policies of your employer or work unit, the eventual fate of the videotapes, images, and analysis data you produce in the course of your monitoring needs careful consideration, and frequent backing-up of computer drives is advised. To help protect the data, we recommend that you:

- **Partition your hard drive.** Store all images and data on a hard drive partition that does not contain the operating system. That way, when you experience an operating system

failure and need to re-format that drive to re-install the operating system, the data will probably be safe.

- **Write data to CD often.** For each site, create a library of CDs for images (captured BMPs, un-dotted and dotted JPEGs). The images can also remain on your hard drive until space or operational efficiency is compromised. A site may be associated with as much as 210 MB of data, including archive, source, and destination files for captured images from twenty 10-m transects; completed data entry sheet; map of the site and sample points derived from AquaMap; various AquaMap operational files; and a metadata record file. A CD can hold 650 MB. If you leave the CD session "open" when transferring the images to the CD, the data sheet and metadata for the site can be added later.

  For example, suppose you've completed twenty 10-meter transects at Chalupa's Reef, captured the images and converted them to BMPs, and JPEGs, and run the dotting script, but you don't have time to analyze the dotted images right away. You can copy the three files of images for the site onto a CD, leaving the session open. (If applicable, the configuration, waypoint, and metadata files associated with the use of AquaMap at this site can also be put onto the CD.) When the image analysis is performed, keep the data sheet and Readme file on your hard drive until the analysis for all transects is complete, then copy the data sheet and metadata file to the CD and store.

- **Clearly and accurately label the CDs and videotapes**, making sure that the tapes are fully rewound.

- **Store the CDs and videotapes safely** in a cool, dry, place away from magnets, preferably with climate and humidity control. If building damage from hurricanes or flooding may occur, precautions such as creating off-site or off-island backup copies should be taken.

- **File any associated printed materials.** Data summaries for the site and by transect should be printed and filed along with the metadata and any site sampling maps.

IX. Substrate Identification and Data Entry

Using MS Excel

The data for each site is entered on a separate worksheet in MS Excel, using the worksheet that has been set up for this protocol, "Dataentry.xls". The tabs at the bottom of the sheet are labeled 01TRAN to 20TRAN, one for each transect. This file also contains a data table spreadsheet for the intermediate storage of the compiled data, and a print table that tabulates data in a printable format. An extra transect sheet is provided in case the site has more than 20 transects, but it is not linked to the print or data tables.

> Before entering data in the worksheet, you must make sure the "AutoComplete" editing feature has been disabled, or errors will result.

For example, if you enter "MACA" for "macroalgae" and later enter "MA" for "*Montastraea annularis,*" the AutoComplete feature will automatically change your "MA" entry to "MACA," and since both are valid entries, the checking process that has been built into worksheet will not notice the error. To disable AutoComplete:

- Go to the TOOLS drop-down menu and choose OPTIONS EDIT SETTINGS.

- Go to the bottom of the list of entries and "un-check" the box for "Enable AutoComplete for cell values". Then choose OK.

Setting Up the Data Entry Worksheet

- Open and maximize Dataentry.xls from D:\DATA ENTRY or wherever it is stored.
- To begin data entry, select the tab that represents the number of the transect you are analyzing. Enter the metadata in cells B1-B8.
  - **B1: Location.** Give general location, e.g., the name of the reef study site, "Newfound", or "Yawzi."
  - **B2: Transect number.** This corresponds to the tab number. Make certain it corresponds to the transect that you are viewing.
  - **B3: Videotape number.** This is the number used to identify the tape in the video log. It should also be written on the cassette and on the white liner of the cassette case.
  - **B4: Date.** The date that the transect was videotaped. It can be found in the video log sheet or in the information filmed on the underwater slate for the transect.
  - **B5: Length of transect.** The length of the transect as measured in meters.
  - **B6: Number of data points**. Do not enter anything in this cell; the number of data points will be automatically calculated as you enter the data. It is derived from the number of frames that were captured along the transect and the number of random dots applied per frame for analysis. Generally, each frame will be analyzed with 10 random points; therefore, if 25 frames were captured for transect, the number of data points will be 250.
  - **B7: Analysis by.** Enter your name.
  - **B8: Date of analysis.** Enter the date of the analysis.
- After the B1-B8 cells have been completed, minimize the Dataentry worksheet.

Opening Files in Adobe Photoshop

You will record the identification of each sampled point on the Dataentry worksheet by keeping a small portion of it open while viewing the video frame at 100% image size in Adobe Photoshop. This process goes more quickly if you open as many frames within each transect as possible at the same time. Photoshop and your computer have memory/ resource allocations that determine how many files can be open at once. For example, on a computer with 128 MB of RAM, this maximum is generally about 20 to 30 JPEG files.

Photoshop will open the files sequentially so that the first frame you request ends up at the bottom of the "stack." Because you want to enter the data for the frames in the order in which they appear in the transect, with #01 first, you will need to open the files in reverse order. For example, assume you have a transect folder with 28 frames, but your computer can only have 20 open at time. You would open the first 20 frames in reverse order, starting with #20 and ending with #01. After you have entered the data for a frame, press F11 to close it. When you are finished with the first 20 frames, open the remaining eight frames #21 to #28 in reverse order, starting with #28.

- Open and maximize Adobe Photoshop to the size of your desktop. If the Photoshop toolbar or any other Photoshop option box is displayed, remove it by pressing the TAB key, or go to the WINDOW drop-down menu and choose HIDE TOOLS.

- Determine the maximum number of JPEG files you can have open by experimenting on your computer.
- Go to the FILE drop-down menu and open the maximum possible number of files (or the number of files you need to do, if fewer) in reverse order, so that the file with the lowest number appears on top of the stack. Instead of opening the files one at a time, it's generally faster to click first on the file with the highest number in the sequential set you will be analyzing, and then hold down the shift key while clicking on the file with the lowest number.
  - You may find that this file opening process works better if you reverse the order in which the files are listed. (If the file details are not displayed, click on the DETAILS icon near the upper right corner of the OPEN dialog box; then click on the NAME bar to list the files in descending order, from the highest number to the lowest. If you have used the suggested naming format, it is the last two digits before the extension that change sequentially.)
  - However, if you open a series of files simultaneously, you must check to make sure the files have been stacked in the correct sequence before you start entering data. You may find that Adobe Photoshop has opened the first and/or last file out of sequence, and you will have to rearrange them.
- Adjust the Photoshop window so that it is small as possible while still enabling you to view the image at 100%, and can see the entire video frame and dots without having to scroll up/down or over the frame.

Entering the Data

Manipulating Images in Photoshop

Pressing the "+" key while holding down the CTRL key in Photoshop will make the image larger; pressing "–" with CTRL will make the image smaller. The function keys can also be used to manipulate images:

F2: Brightness adjust
Shift+F2: undo brightness adjust
F3: Contrast adjust
Shift+F3: undo contrast adjust
F4: Unship mask
Shift+F4: Find edges

- Open the Dataentry.xls worksheet and adjust its size so that it fits on the screen with the first frame you will be analyzing. The worksheet area will be small; only about the first 10 lines that are available to enter data will be visible. Make sure that it is the active window and that the substrate identifications are not being made in some other window.
- The characters A-J in column B indicate which space corresponds to which data point. Starting with dot A, enter in cell A11 the identification code for the benthic group/species found directly under that dot on the video frame. (See the "Guide to Substrate Identification" on page 32 for instructions and Appendix A for the codes.) Continuing sequentially through "dot" J, enter the codes vertically in cells A11 through A20. When you have completed entering data for the first frame, the gray shading indicates that 10 lines of data have been entered, corresponding to the 10 dots on the video frame.

Do not copy and paste data into cells. For example, even if all 10 dots are on DCA, avoid the temptation to copy the first "DCA" and paste it into the next nine cells. Also, if you make a mistake in data entry, do not delete the entire line or "cut and paste." Delete only the errant letters and re-enter the correct code in the cell.

- Column C is used to enter miscellaneous notes regarding a point and certain codes. Only these codes will be automatically quantified by the spreadsheet:
  - BL = Bleaching
  - BBD = Black Band Disease
  - WBD = White Band Disease
  - PLA = Plague Type II
  - YBD = Referred to as "Yellow Blotch Disease"
- Each time you have completed the data entry for a frame, go to the FILE drop-down menu in Excel and click on SAVE.
- Repeat the process for each frame in numerical order in the transect.

Check to make sure that the frame number you are looking at matches the rows in which you are entering data on the worksheet. For example: frame #1 will be entered in cells A11-A20; frame #2 will begin with A21 and end in A30; frame #9 will begin in cell A91 and go to A100; frame #20 will begin with A201 and end in cell A210.

Checking the Data

- After you've completed the data entry for a transect, enlarge the dataentry.xls worksheet so that you can see all of it and check the validity of your data entries. The worksheet will automatically count the number of cells containing raw data (column A), compare the spelling of the raw data entries against a master list of possible data entry codes, and compare the results of the two counts.
- Check to see whether yes or no is displayed in cell **G6**.
  - YES means that all of the data codes match those in the master list. Make sure you have saved the worksheet, then proceed to step #4.
  - NO means that the worksheet detects an error, or doesn't recognize a data entry.
- If NO is displayed in cell **G6**, check column E, beginning with cell E11 and scrolling down. If the worksheet recognizes the identification code in column A, the same code appears in the corresponding cell in column E. If the code in column A is not recognized, "#N/A" appears in column E.

Data entries must consist only of characters, with no blank spaces before, within, or after the codes.

- When you find a mistake, correct the code in column A. (You may need to re-open the JPEG file to confirm which identification code should be used.) After you have checked all of the cells in column E, save the worksheet.
- Check the question at line **F6** to see that the answer is YES. If it is not, repeat the above procedure or check to see that the correct number of data points has been entered into cell **B6**.

- When the answer in cell **G6** is YES, click on SAVE. Make sure the file is in the appropriate folder corresponding to the transect location and date. Then open the next set of frames in Adobe Photoshop and repeat the data entry process.

X. Data Summary and Analysis

Individual Transect Data

Each of the first 20 sheets in the Dataentry.xls worksheet corresponds to a transect.

- Individual species and other major categories (see "Guide to Substrate Identification" on page 32) are displayed in cells **F11** through **F114**.
- The number of points and their relative percentages are found in corresponding cells **G** and **H**.
- Embedded within each sheet at cell **F124** is a table for coral condition and disease calculations.
- The Shannon-Weaver Diversity Index calculations performed for each transect are displayed in cells B17 to U17 (for 20 transects)Embedded within each sheet at cell **F136** is a chart that summarizes category abundance (points and percentages) for the transect; numbers of points and relative percentages of diseases, bleaching, and the Shannon-Weaver Diversity Index. This summary table is linked to the data tables and print tables sheets within this Dataentry worksheet.

  The Shannon-Weaver Diversity Index is calculated for each transect and for the entire site using: $H' = -\Sigma p_i \ln p_i$, where $p_i = n_i / N$,in which N= total number of point (individuals) of all species, and n_i the number of points of species 'i'. Dots identified as "CORAL" (not identified to species) are *excluded* from this calculation.

Site Data

The Data Tables worksheet contains two tables that are composites of the individual transect summary chart. The values for these tables (and the metadata in rows 1 to 3) are automatically computed and updated as you enter data on the worksheet.

- Percent cover by benthic groups per transect is found in the top table **(rows 6 to 29)**.
- Data on bleaching, and/or disease cover (percent cover relative to transect cover, and percent cover relative to coral cover) is summarized within this table in **rows 19 to 28**.
- The Shannon-Weaver Diversity Index for each transect is displayed in **row 30**.
- The number of points of each benthic group and bleaching or disease type per transect is found in the bottom table **(rows 35 to 57)**.

Similar to the Data Tables, in the Print Table worksheet, the cumulative sums of number of points for major categories are displayed in a separate chart. However:

- A different font and font size is used to provide a better print-out, and the bleaching/ disease data have been removed.
- The mean and standard deviation are calculated using individual transect percent cover values of each major category, and are displayed in cells V5–V16 (mean), W5–W16 (standard deviation).

- The Shannon-Weaver Diversity Index is calculated for each transect and displayed in cells from B17 to U17 (for 20 transects).

The Shannon-Weaver Diversity Index is also calculated for the entire site by summing the number of points of a coral species for all transects. This coding is found in the Print Table worksheet beginning with row AA-AG. The overall site H' value is found in cell AG23. (This value is also found in the percent cover table, cell V17.) To allow for a comparison of the H' between years when *Monatastaea annularis* was not broken into its complex species, another calculation of H' is provided in cell AG30 and copied to cell V18. A comparison is made of the number of points identified to coral species versus category "CORAL" in cells AF23 and AF27.

Documenting Transect Analysis and File Locations

It is recommended that you label the name and storage location of the Print Table so that when you have a print copy, you can link it back to the computer file where it is stored and locate the data from which the results were obtained. You can do this by simply writing on the printed copy or by using a function of WinBatch to automatically copy the path and file name to a cell.

- Open Explorer. .
- Select the data entry file in which you are working.
- Click the right mouse button and select CLIPBOARD TRICKS.
- Select PATH AND FILE NAME(S) TO CLIPBOARD. The path and file name will be displayed momentarily and copied to the clipboard.
- Return to the data entry sheet in which you are working, select a cell (approximately cell A36) and go to EDIT PASTE to paste the path and file name into that cell.
- It is also recommended that you type or write the date you last saved this file.

In addition, in the Metadata/Readme file, record what you have done, the transects that have been analyzed, and the names/locations of the files that have been saved. Then save the Metadata/ Readme file.

What, no database?

Data summaries per site are produced as the data are entered into the spreadsheet. A database will eventually be created to store information, but it is not ready at this time.

A. *Printing Transect Data and Results Table*

When you have finished entering and checking data for the last transect for the site or station, you may want to print the results table and individual transect data.

To produce the optimum print-out of the results table:

- Click on the PRINT TABLE tab.
- Delete the columns for transect numbers that were not in this site. For example, if you have 10 transects, delete the columns for transects 11-20. This will allow the mean and standard deviation to be calculated.
- Go to FILE PRINT PREVIEW to see how many pages will be required to print all of the columns in a given font and paper orientation. Using the default font (8 point Arial) and landscape orientation, 10 transects will fit on one page. The Shannon Weaver Diversity Index calculations will fit on a separate page.

- Select the pages that you wish to print and click on PRINT.

To print the data for a specific transect:

- Click on the tab for the appropriate transect number.
- Go to the TOOLS menu and choose PROTECTION UNPROTECT SHEET.
- Go to cell H9, the Percent category, and click on the down arrow. This will give you options from which to filter the analyzed data set. Choose CUSTOM and select NOT EQUAL TO and 0. This will reveal all the species that were present on the transect.
- Select the three rows from F1 to H1 down to the bottom of the summary chart and the total values.
- Go to FILE PRINT AREA. This sets the area to print what you have selected.
- Go to FILE PRINT PREVIEW to make sure the columns fit on one page and then click on PRINT. You should check to see that the transect date, and label ("Metadata") are at the top of the printed page.
- Make sure that you do not accidentally save the data sheet in this form, with the "zero" values removed. To restore them:
  - Go to FILE PRINT AREA CLEAR PRINT AREA.
  - Go to the Percent box and click on the down arrow. Choose ALL to get all the data back.
- Go to TOOLS PROTECTION PROTECT SHEET. Make sure that there is a check mark next to contents; objects and scenarios, then click on OK.

To print another transect, select the tab that corresponds to the transect and repeat the process above.

Statistical Analyses

Results from this method are tabulated in the data entry sheet, data tables or print table. The number of dots and percent cover for each benthic category, plus the Shannon-Weaver diversity index (H') are tabulated per transect. Additionally, an overall mean and standard deviation are calculated for each category for the site using all transects. A Shannon-Weaver diversity index is also calculated for the site in two ways: first, by transect and, second, by pooling all coral species points for all transects.

This protocol recommends the use of permanent randomly selected transects; that is, the same transects are re-visited each year as opposed to randomly selecting a new set of transects each sample period (year). The random selection assures unbiased, independent sampling of the defined area. Revisiting those samples each year allows for application of more powerful statistical tests. (e.g.: t-test for paired data vs. Student's t-test for unpaired data. See Rogers *et al.*, in press, and attached to this document for more details on statistical analysis.)

Initial data analysis should begin by testing data for normality, and incorporating a transformation (e.g.: arcsine) as necessary. If data are normally distributed, parametric tests can be used; otherwise non-parametric analysis is advised. When comparing cover of substrate categories for the same sample points (e.g. transects) between two years the parametric test would be a paired t-test, while for non-parametric data, the Wilcoxon matched-pairs signed-ranks test is used. If different transects were sampled and the mean percent cover by substrate categories are being

compared between two years, a Students T-test is used for parametric data, and the Mann-Whitney *U* test is used for non-parametric data.

When comparing categories for more than two years for data that are normally distributed, a repeated measures Analysis of Variance (ANOVA) can be used for dependent samples (repeating sample locations), while a Standard ANOVA is used when comparing independent samples. If this data are not normally distributed, a Friedman 2-way ANOVA by ranks is used for dependent samples, and the Kruskal-Wallis one-way ANOVA by ranks is used for independent samples.

When comparing greater then five or six time periods, the ANOVA will give way to a trends or time series analysis, however the details of that analysis have not been completed at this time.

XI. Guide to Substrate Identification

This guide is intended to provide assistance in identifying benthic components on videotaped frames; generally, frames that are being randomly sampled through the use of hollow dots that have been applied using WinBatch software. It assumes that the identifications are being made by an analyst who has been trained in the data collection process and is knowledgeable in identification of coral and other marine invertebrates. Identification of reef components on video images should be made with confidence and certainty. Diving experience in the area where the filming was done is an advantage when making identifications, but is not essential.

Major Categories

The substrate found at most of the reefs we study falls into one of the following major categories:

- living invertebrates (coral, sponges, gorgonians, zoanthids)
- dead coral with algae/turf algae
- macroalgae
- sand
- rubble
- pavement

Although the quality of video images filmed underwater varies, we can usually make accurate identifications of most hard corals to a species or genus level, and some macroalgae to a genus level. Some adjustments, e.g., brightness and contrast, can be made while viewing the image in Adobe Photoshop to assist with identification (see page 19). Identification of the other substrate components has proven to be more challenging.

If there is any doubt regarding identification, the more general or "conservative" category should be selected. For example, a dot that is "probably over *Montastraea cavernosa*" should be entered as "coral"; what "might be *Dictyota*" should be identified as "macroalgae". However, if you cannot determine the major category (i.e., phylum) for a selected point, such as whether a component is a sponge, tunicate, dead coral with algae/turf or macroalgae, the "Unknown" category is the appropriate choice.

Distinguishing Between Dead Coral with Algae/Turf and Macroalgae

Distinguishing between dead coral with algae/turf and macroalgae in images captured from a videotaped transect may be difficult, but is worth taking the time to try to do accurately. The pre-

dominance of either category of substrate can be an important ecological indicator. Greater macroalgae levels may reflect elevated nutrient levels, and low fish or urchin grazing (and possibly over-fishing), whereas increased DCA/turf may indicate recent coral disease or high levels of grazing by fish/urchins. In the field, we use height (~<2-3 cm) and the absence of identifiable an identifiable macroalgal species to identify DCA. Macroalgae generally attain a height/thickness >2-3cm, and they are fleshy rather than filamentous, often with conspicuous branches or blades.

When deciding whether a dot is on DCA or macroalgae, you will need to evaluate other areas in the image for comparison. As with the hard corals, you should identify the seaweed to the most descriptive level possible, ideally genus. If this is not possible, but the alga appear fleshy and to have a thickness >2cm thick, it should be identified as "macroalgae." As this video method provides only a two-dimensional view of the reef, the component's "height" can be difficult to ascertain. Looking around the image, at substrate both similar and different than the area in question, may enable you to interpret features (colors, shading, textures etc.), that resolve the image in a third dimension. DCA would be the more conservative category, as explained on page 35.

Finding the Center of the Dot

It is also sometimes difficult to determine which benthic component occupies the exact center of the square, hollow sampling "dot." When a dot falls on the edge of two components, you may find it helpful to use the "rectangular marquee tool" from the tool menu in Adobe Photoshop. This produces a small "+" which can be used to help find the center of the dot.

An experienced analyst can train a new analyst by reviewing the same images and making independent identifications. When differences of opinion arise, the two analysts compare how they reached a decision. This training will help the new observer to use consistent criteria when making identifications, so that in time, he or she will be able to work independently.

Category Definitions

Category identifications are entered in column A of the Dataentry worksheet, where they are automatically quantified and grouped by species and major category. See Appendix A for the complete list of codes. The codes must be entered exactly with no extra letters or spaces. See "Entering the Data" on page 27 for more details.

- **CORAL = Hard coral: living hard coral**

  Identify hard corals to the most specific taxonomic level possible and enter the applicable code from Appendix A. In many cases this will be the code for the exact species. However, if you know the genus but are uncertain of the species, use the code for the genus (e.g., AGPS for *Agaricia* species). If you cannot be certain of even the genus, use the generic "CORAL" code. Do not use the code for "unknown" (UNK) unless you have decided the component is not any species of coral.

  NOTE: The appropriate code should be entered if you can confidently identify whether the species is *M. annularis* (MA), *M. faveolata* (MFAV), or *M. franksi* (MFRA). If you believe it is one of these three species, but are uncertain which one, enter the code for "*Montastraea annularis* complex," MACX. (In addition to quantifying the number of MACX entries you've made, the spreadsheet will also tally the number of entries made for MA, MFAV, MFRA plus MACX in case you need this number for comparison with previous data sets that used MA for all three species. If you can identify the genus as *Montastraea*, but you cannot identify the species, use the generic *Montastraea* code, MSPP.

If a dot is on coral that is alive but bleached or pale and this identification is made with knowledge of present or possible bleaching at the time the coral was videotaped, identify the coral in column A, and enter BL in the Notes column (C). It's important to note the bleaching so that it will be quantified.

BL = Bleached

Coral bleaching is usually correlated with warmer sea water temperatures and is therefore usually observed in summer and early fall. This may help differentiate coral bleaching from some coral diseases.

- **CORJU = Coral juvenile**

This code is used for coral recruits usually <4 cm in size. If you can identify the species, enter the species code in column A. However, if you cannot identify the species (which is usually the case at this small size), use the CORJU code instead.

- **DCOR = Diseased coral**

This category is used when the dot is on a diseased portion of a coral colony (e.g., the dark ring in black band disease), or on bare coral skeleton that has apparently been recently killed by a disease (i.e., without filamentous algae overgrowth). Be careful in differentiating bare, recently dead skeleton from bleached coral (see above, "BL = Bleached"). Additional information should be put in the Notes column:

BBD = black band disease
WBD = white band disease
PLA = plague Type II (a.k.a., White Plague, Type II)
YBD = "yellow blotch disease"

Other comments about the coral may be made in the Notes column, but only these four codes plus the BL code for bleaching will be included in the automatic quantification.

Be careful not to interpret color variations as a definitive indications of disease. Most coral diseases are difficult to distinguish in the field, much less from an image. There is at present no consensus on definitive identification of coral diseases, so keep abreast of new findings documented in the literature.

- **GO = Gorgonians**

Use the generic code GO for any gorgonian unless one of these more specific codes that indicates form or species applies:

ENGO = Encrusting gorgonian
FAN = Sea Fan
PLUME = Plume
ROD = Rod
WHIP = Whip
BRIA = *Briareum asbestinum*
ERYTH = *Erythropodium caribaeorum*

- **SPO = Sponges**

  The generic code SPO can be used for sponges, which come in all shapes, sizes, colors, and textures. Depending on your taxonomic skill, you may use instead a more specific code that indicates the form or species:

  BALL= Ball
  BASP = Barrel/Vase
  BOSP = Boring
  ENSP = Encrusting
  ROPE= Rope
  TUBE= Tube
  CLIO = *Clionia delitrix*

- **ZO = Zoanthids**

  Use the generic code ZO for both solitary and colonial cnidarians unless one of these species codes applies:

  PALY = *Palythoa caribaeorum*
  ZOSO = *Zoanthus sociatus*

- **ANEM = Anemones**

- **CMOR = Corallimorpharians**

- **MACA = Macroalgae**

  Macroalgae are usually larger plants (>3 cm) that, compared to DCA, are fleshy rather than filamentous, and often have conspicuous blades or branches. If you can determine that the component is a thick, tall, non-filamentous plant, but you cannot identify the genus, enter MACA in Column A. If you can identify it as one of the following genera, use the applicable genus code instead.

  AMPH = Amphiroa spp.
  CLAD = Cladophora spp.
  DICT = Dictyota spp.
  HALI = Halimeda spp.
  MICRO = Microdictyon spp.
  LIAG = Liagora spp.
  LOBO = Lobophora spp.
  SARG = Sargassum spp.
  SCHIZ = Schizothrix spp. (actually cyanobacteria, “blue-green” algae)

- **DCA = Dead Coral with Turf Algae**

  This category is characterized by a relatively short (<2-3cm) layer of filamentous algae. The algae lack conspicuous branches or blades and may require laboratory analysis for genus or species identification. It's difficult if not impossible to determine whether the coral under the algae is definitively dead. This category includes substrate that varies from being recently dead/recently overgrown, to long-dead/long-overgrown. The algae may appear as thin and sparse; whitish, washed-out, or covered with a thin layer of sand. Compared to macroalgae, turf algae are both smaller in size (<2-3 cm) and lack identifiable "fleshy" or calcareous blades or branches. If the DCA is visible through a thin sand layer, or if a dusting of sand that covers the DCA is estimated at <1cm deep, the component is identified as DCA; if more sand is present, it is identified as sand.

- **CALG = Coralline Algae**

  Corraline algae can be difficult to distinguish from DCA, but color (often pink or purple) and texture (sometimes "crusty") may be the best clues.

- **B = Boulder**

- **S = Sand/Sediment**

  In the field, sand is usually identified by measuring to >1cm in depth, or probing with the tip of a pencil, but it can be difficult to distinguish in a video frame. If there is only a dusting or thin (<1cm) layer of sand, the underlying component should be identified. Watch for texture changes that may help define this feature, and look around the dot and throughout the image for clues such as sand ripples to help identify sand.

- **R = Rubble**

  Rubble is generated by the mechanical breakage of coral from storms, surge, anchoring, or even bio-erosion. It can be difficult to distinguish in a video frame. If filamentous turf algae are growing on the substrate, use the DCA code. Pieces of coral (i.e., recently killed coral fragments) that do not appear to have algal growth should be coded "R".

- **P = Pavement:**

  This is bare, hard substrate without a layer of sand or algal growth, unlike recently killed coral, which will have turf algae. Algae have not overgrown this substrate. This differs from recently killed coral (DCA).

- **TAPE = Tape**

  This is used when the dot falls on the transect tape, the tape reel, handle, or transect pin.

- **WAND = Wand**

  This is used when the dot falls on the aiming wand (the rod attached to the video housing to guide filming 40 cm from substrate).

- **O = Other**

  This code is used for any component for which we don't have a specific category, e.g., a fish, urchin, worm, bivalve, tunicate, hand, finger, bottle, dive gear. The spreadsheet will only recognize "O", not "Other." Describe the feature in Column C.

- **SHADOW = Shadow**

  This code is used when the dot is on a dark spot or deep in a crevice. You can use the F2 and F3 key to adjust the brightness and contrast, but sometimes you still cannot make a certain identification. If you cannot confidently identify what is under the dot because it is in a dark place or shadow, use the SHADOW code. Quantifying the extent of shadow may make it possible to determine if using supplemental light may be helpful.

- **UNK = Unknown**

  This is the code to use when you cannot make a confident identification in any of the above categories. For example, if you find yourself debating between identifying a component as a sponge or macroalgae (i.e., different kingdoms!), use this designation. Unlike shadow, in which a component cannot be identified because of its dark location, in this case the component is unknown because of one or more reasons such as insufficient focus or too many benthic features clumped together.

APPENDIX A: Identification Codes for Benthic Components

Categories in Column A

I) Coral Species and Genus Codes			
Acropora cervicorni	AC	*Montastraea annularis complex*	MACX
Acropora palmata	AP	*Montastraea cavernosa*	MC
Acropora prolifera	APR	*Montastraea faveolata*	MFAV
Agaricia agaricites	AA	*Montastraea franksi*	MFRA
Agaricia fragilis	AF	*Montastraea* spp.	MSPP
Agaricia grahamae	AG	*Mussa angulosa*	MAN
Agaricia humilis	AH	*Mycetophyllia aliciae*	MAL
Agaricia lamarcki	AL	*Mycetophyllia danaana*	MDA
Agaricia tenuifolia	AT	*Mycetophyllia lamarckiana*	ML
Agaricia undata	AU	*Mycetophyllia ferox*	MF
Agaricia spp.	AGSP	*Mycetophyllia* spp.	MYSP
Colpophyllia natans	CN	*Oculina diffusa*	OD
Dendrogyra cylindrus	DCY	*Porites astreoides*	PA
Diploria clivosa	DC	*Porites branneri*	PB
Diploria labyrinthiformis	DL	*Porites divaricata*	PD
Diploria strigosa	DS	*Porites furcata*	PF
Dichocoenia stokesii	DSO	*Porites porites*	PP
Eusmilia fastigiata	EF	*Porites branching* spp.	PBSP
Favia fragum	FF	*Scolymia cubensis*	SC
Isophyllia sinuosa	IS	*Scolymia lacera*	SL
Isopyhyllastrea rigida	IR	*Scolymia* spp.	SCSP
Leptoseris cucullata	LC	*Siderastrea radians*	SR
Manicina areolata	MAR	*Siderastrea siderea*	SS
Madracis decactis	MD	*Siderastrea* spp.	SSPP
Madracis formosa	MAFO	*Solenastrea bournoni*	SB
Madracis mirabilis	MM	*Solenastrea hyades*	SH
Meandrina meandrites	MME	*Stephanocoenia michelinii*	SM
Montastraea annularis	MA	*Tubastraea aurea*	TA
Other Coral Codes			
Millepora alcicornis	MILA	Unknown coral juvenile spp.	CORJU
Millepora complanata	MILC	Unknown adult coral spp.	CORAL
Millepora squarrosa	MILS		

Gorgonian Species and Forms			
Briareum asbestinum	BRIA	Plume form	PLUME
Erythropodium caribaeorum	ERYTH	Rod form	ROD
Encrusting gorgonian	ENGO	Whip form	WHIP
Sea fan	FAN	All other and unknown gorgonians	GO

Sponge Species and Forms			
Clionia delitrix	CLIO	Encrusting sponge	ENSP
Ball sponge	BALL	Rope sponge	ROPE
Barrel/vase sponge	BASP	Tube sponge	TUBE
Boring sponge	BOSP	All other and unknown sponges	SPO

Zoanthid Species and Generic Codes			
Palythoa caribaeorum	PALY	Other zoanthids	ZO
Zoanthus sociatus	ZOSO		

Macroalgal Species, Genus, and Generic Codes			
Amphiroa spp.	AMPH	*Liagora* spp.	LIAG
Cladophora spp.	CLAD	*Lobophora variegata*	LOBO
Dictyota spp.	DICT	*Sargassum* spp.	SARG
Halimeda spp.	HALI	*Schizothrix* spp.	SCHIZ
Microdictyon spp.	MICRO	Other macroalgae	MACA

Other Categories			
Coralline algae	CALG	Other live organisms:	
Dead coral with turf algae	DCA	• Anemones	ANEM
Diseased coral	DCOR	• Corallimorpharians	CMOR
Inorganic substrate components:		Non-substrate entities:	
• Boulder	B	• Tape	TAPE
• Sand/Sediment	S	• Wand	WAND
• Rubble	R	• Shadow	SHADOW
• Pavement	P		
Other identifiable entities	O	Unknown entities	UNK

Codes for Column C *(will be automatically quantified)*

II) Coral Bleaching and Diseases			
Bleached coral point	BL	Plague, Type II	PLA
Black band disease	BBD	Yellow blotch disease	YBD
White band disease	WBD		

APPENDIX B: Glossary of Terms

Actions: Adobe Photoshop lets you automate tasks by grouping a sequence of commands into a single action. For example, you can create an action that applies a series of filters to reproduce a favorite effect or combine commands to prepare images for online publishing. Actions can be grouped into sets for easier organization. As in the previous example, you could create a set of actions in which each action applies to a different series of filters. You can use an action on a single file or on a batch (multiple files in the same folder). You use the Actions palette to record, play, edit, and delete actions. It also lets you save, load, and replace action sets. It is located under the Adobe Photoshop Windows drop-down menu (See "Show Actions").

Active use o-rings: The o-rings to be used when the unit or device is submerged or subjected to greater than atmospheric pressure.

Adobe Action Package: A folder called "Video Methods" that contains the Action commands for all the components of the video protocol.

Adobe Photoshop: Computer program used as the image platform. Photoshop displays the image during the dotting process, and data analysis components.

Aiming rod: A stick ~1 cm in diameter that is attached to the video camera housing to enable the diver to accurately guide the camera 40 cm from the substrate; also known as an "aiming wand."

Batch: A group of up to 1,000 images located in a folder, ready to be "dotted."

Brightness Adjust: This Adobe Photoshop feature manipulates the image light levels. A brightness adjustment has been pre-programmed to the F2 Function key through the action palette.

Camera tray: A metal plate containing electrical circuitry that attaches to the bottom of the video camera for inserting the camera into the housing.

Capture – Automatic: Feature of some capture cards that automatically selects and saves video image frames, usually based on a time interval.

Capture – Manual: Operator controlled process of selecting and saving video image frames.

Capture board: A computer card installed within the PC case that conducts the video image capture options. This protocol uses the Sony DVBK-2000/2000E capture board.

Capture album: The computer folder where captured still images are stored.

ChopChop: Temporary name that is automatically given to Adobe Photoshop during the dotting process. It is canceled when the process is complete or when the program (Adobe Photoshop or "chopchop") is closed. It will not affect or harm any other images or applications on your computer that utilize Adobe Photoshop.

Contrast: This Adobe Photoshop feature manipulates the image light levels. A contrast adjustment has been pre-programmed to the F3 Function key through the action palette.

Destination: This term is used with the WinBatch script to define the user-selected location of the images after they have gone through the dotting process.

Drop-down menu: This are located above the icon bar on a PC to access features within a program.

Dotted: An image that has gone through the dotting process and now has "dots" (i.e., hollow red squares) placed upon it.

Exposure: The video camera setting that controls the opening of the lens aperture. Auto-exposure is recommended.

File types:

***.bmp** (bitmap)

***.dvf** The digital video file format used by the Sony Capture board when a still image is captured.

***.jpg** (JPEG: named for the Joint Photographic Experts Group, the committee that developed this image compression mechanism) JPEG is a useful format for compact storage and transmission of images, but there is some image degradation each time a JPEG file is recompressed, i.e., each time it is edited or otherwise manipulated and re-saved as a file.

***.tif** (tagged image file format)

***.wbt** Files created by the WinBatch script in WinBatch Studio

***.xls** Spreadsheet format for Microsoft Excel.

Fire wire: This wire connects the video tape player or video camera, to the capture board communicating digital information from the tape to the computer.

Flatten: This Adobe Photoshop process merges multiple layers into one. For our purposes, it is an action contained within the Adobe Action Package that melds the layer containing the random dots to the video image layer.

Focus – Auto: This video camera setting allows the camera to pick the dominant object or plane on which to focus.

Focus – Manual: This video camera setting requires the operator to pick the dominant object or plane on which to focus.

Focus – Momentary Auto-Focus: Toggling the focus switch to AF will set the manual focus at the subject distance.

Housing view port optic: The shaped glass contained in the view port for the video camera lens. The Stingray housing uses a "bayonet" mounted, Zoom-Macro system.

Macro: A series of commands written in Visual Basic Programming language contained within a Microsoft Excel Worksheet. A series of key commands activates this "program".

Metadata: As used in this protocol, metadata refers to details about the data collection dive and may include depth, time, divers, dive conditions, etc.

Randomplot: This is the name of the Microsoft Excel worksheet that contains the macro responsible for creating the random points.

Readme file: This computer file is created in a word processing application in order to enter metadata.

Red flip filter: This red plastic lens can be manually rotated into position in front of the video camera lens, inside the camera housing.

Script: This is a sequence of steps written in windows interface language and used by the WinBatch program to run the dotting process. Similar to macro.

Show Actions: This command can be selected in an Adobe Photoshop drop-down menu to display the Action Palette.

Shutter speed: This video camera setting affects the video image exposure. It can be set by the operator (manual) or automatically by the camera.

Storage o-rings: These are used in devices while they are not being submerged or under greater than atmospheric pressure.

Sony DV Application (APP): This is the application that works the Sony capture board to create the image libraries, saves the image types, etc.

Source: The WinBatch script uses this term to identify the location of the un-dotted images just prior to the dotting process.

Time code: This is a string of data "written/recorded" on the digital video tape that reflects the time, (hours, minutes, and seconds) since the tape started.

Toggle: A rapid motion to activate a switch on the video camera housing that involves moving the switch, then releasing the switch to its normal (neutral) position.

Un-dotted: Images without dots are usually located in the source directory prior to the dotting process.

Unsharp Mask: This filter is used in Adobe Photoshop to improve the focus of an image (sharpen the edges) by increasing the contrast between adjacent pixels. An unsharp mask adjustment has been pre-programmed to the F4 Function key through the action palette

Video slate: This device used to record data relevant and just prior to the recording of a transect. We have found the magnetic type work very well for this purpose.

White balance: This video camera setting attempts to normalize the color of light reaching the lens after striking a surface. Due to the light absorption qualities of water (and since this protocol does not include the use of lights), the white balance should be left on automatic.

WinBatch: This is the program from which the dotting process script is run; it instructs Adobe Photoshop and Microsoft Excel to perform the necessary functions to carry out the dotting process.

WinBatch – Studio: This is the application within WinBatch from which the user can launch the WinBatch Script.

Working directory: This directory is automatically created by WinBatch during the dotting process for the manipulation of the un-dotted image into the dotted image. It is also deleted automatically, so there will be no evidence of it on your computer system.

Zoom-Macro Diopter: This lens, usually encased in rubber, is fitted onto the camera lens, allowing the video housing system to operate from wide angle to zoom.

APPENDIX C: Creating Laminated Photos for Transect Relocation

If your monitoring program is designed to include repeated monitoring of the same site, you will need to be able to lay the transect so that it is in the exact same position as it was when you collected your baseline data. Even if you are using the AquaMap tracking system (see separate protocol), which can put you within approximately one meter of the original transect origin, this can be difficult. However, we've been able to precisely relocate transects by using laminated photo captures of the video transect in combination with AquaMap. The photos provide helpful information regarding, for example, placement of the transect placement with respect to a sea fan or large coral colony. Depending on the goals of your program, you may decide to install pins in the substrate to mark the origin and terminus of the transects. (copper covered steel survey markers from Forestry Suppliers, Inc. work well), but the installation and maintenance of survey pins inevitably results in some degradation to the environment

> If you plan to use captured video images to help relocate a transect, keep this in mind while you are doing the initial filming, and take special care to film the transect origin and terminus, and to include identifying features.

To create the laminated photos:

1) Use the Sony Capture program to capture, convert to JPEGs, and save images from the videotape that show the placement of the transect (see page 13 for more details). These are the images to look for:

   - The best view of the transect placement is generally filmed during the "swim back" portion of the video, so try to capture three of four images that show this long view, preferably including monument-type corals or other identifying features. For example, if you filmed a 10-meter transect, you would look for the best images taken above the 10m point and at about 8m-6m, at 5m-3m, and at 2m to the transect origin.
   - A photo of the transect origin that provides as much detail as possible about the transect tie-off point in relation to the surrounding reef.
   - A photo of the terminal end of the transect.
   - You may also want to capture an image of the slate at the beginning of the videotape that identifies the transect.

   Convert these images to JPEGs, selecting "Highest" as the option for graphic quality, and save the images to a file on your hard drive. (The *.dvf files created by the Sony Capture Program can then be deleted.)

2) Use a software program to size the photos (we use MS Publisher) so that each transect can be arranged on a 8½" x 11" page. Depending on the type of laminator you have, you may need to leave a margin of about one-half inch around the edge of the paper. (Ordinary 8½" x 11" paper can be used with some laminators, while others require trimming about a half inch off the edge of the paper in order to ensure watertight sealing.) We lay out the "swim back" photos along the left margin, starting with the 0-2m photo capture at the top.

3) Use the "print preview" to make sure that the photos are large enough to provide the necessary detail.

4) After printing out the page, use a dark marker to make any notes needed to identify the photos or circle critical points, such as the place where the transect tape was tied off. If an image of the slate was not captured, write the transect number, site name, and data on the photo page. It's much easier to write on the photo sheet *before* it has been laminated.

5) You can put the photo pages back-to-back to reduce the number of laminations required. The laminated sheets can then be placed on a clipboard and secured with rubber bands for use while diving.