Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for hemispherical digital photography field **surveys** conducted as part of a temperature Total Maximum Daily Load (TMDL) or Forests and Fish Unit technical study

Version 2.0

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Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
10/16/06	1	Wrote to SOP from scratch	1,2,3,4,5,6,7	D. Bilhimer
11/10/06	2	Updated Safety info and references	8,9,10	D. Bilhimer
3/16/07	1.2	Minor changes and added lens plate specifications	5,6,8	D. Bilhimer
11/14/07	1.3	Minor changes to definitions and added text about taking photos under canopy. Incorporated James Kardouni's comments	1,3,6,	A. Stohr
3/1/08	1.4	Formatting. Draft incorporation of Forests and fish protocols.	all	A. Stohr
5/08/08	2.0	Extensive changes to incorporate Forests and Fish protocols and James/Jacks comments	all	A. Stohr

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1.0 Purpose and Scope

1.1 One way to characterize forest canopy is via photography. Hemispherical digital photographs are taken looking upwards from beneath the plant canopy, using a 180° fish-eye lens and digital camera. Though the photo strategy varies by objective, to support stream temperature analysis, such images are generally taken in the riparian zone or mid-channel (Figure 1) to estimate such details as visible sky or solar radiation load at particular locations. After accounting for glare and other image problems, shade and radiation values can be calculated from the photographs using software applications such as HemiView©.

1.2 This procedure only covers the field acquisition of digital images; the computer analysis is covered in another document, Ecology SOP #EAP046.

Figure 1: An example hemispherical photograph.

1.3 The Nikon coolpix camera is used in conjunction with a tripod (A) outfitted with a ball head (B) and a lens mounting plate (C) to take these pictures (Figure 2).

Figure 2: Hemispherical photography tripod and lens mount system.

2.0 Applicability

2.1 This SOP procedure will be followed during the process of collecting field data for a temperature TMDL or Forests and Fish unit project.

3.0 Definitions

3.1 **Effective Shade:** fraction of total possible solar radiation above the vegetation and topography that is blocked from reaching the surface of the stream and summed over a full day. The effective shade at a particular location (the location of the hemispherical photo) can be calculated, using HemiView©, for any day of the year. Because the solar path across the sky changes each day, the solar exposure a particular location receives will also change each day. Note: To date, studies have covered deciduous "leaf on" portions of the year. For winter analysis, it would not be appropriate to run a winter "leaf off" date with a summer deciduous canopy photo.

3.2 **Canopy Cover:** The percentage of the sky that is blocked by vegetation or topography. Unlike effective shade, this is a largely static quantity (assuming no wind) between full leaf expansion and leaf drop. This value can be measured by a densiometer. The 1-VisSky value calculated by the HemiView©software is the canopy cover.

3.3 **Hemispherical photo**: a hemispherical digital picture. A hemispherical photo is a permanent record of canopy condition.

3.4 **HemiView©:** a proprietary computer software package for the analysis of hemispherical digital images. This software can be found at: http://www.dynamax.com/hemiview.htm

3.5 **Lens mounting plate**: the plate that holds the fisheye lens and connects with the tripod mount. We have designed our own lens mounting plate to suit our field needs. Other lens mounting plates (such as the Delta-T Hemiview system) can be purchased from Dynamax at: http://www.dynamax.com/

3.6 **QAPP:** Quality Assurance Project Plan

3.7 **Riparian vegetation:** Vegetation occurring along stream corridors.

3.8 **Thermistor**: a temperature data logger

3.9 **TMDL**: Total Maximum Daily Load

4.0. Personnel Qualifications/Responsibilities

4.1 Persons involved in the field data collection and analysis must have experience and training in the natural, environmental or physical sciences.

4.2 Typical Job Class performing SOP: Natural Resource Scientist 1/2/3, Environmental Engineer 1/2/3, Environmental Specialist 1/2/3/4/5, Hydrogeologist 1/2/3/4, Administrative Intern 1/2/3.

5.0 Equipment, Reagents, and Supplies

5.1 Design specifications for the hemispherical lens mounting plate are included in Appendix A. This lens mounting plate was designed and manufactured "in-house" to meet the field needs for temperature TMDLs. It is designed specifically to fit the Nikon FC-E8 converter fisheye lens. The field equipment needed for this SOP are as follows:

5.1.1 Nikon Coolpix 995, 990, or 4500 digital camera
5.1.2 Nikon FC-E8 Fisheye converter lens 0.21x
5.1.3 Battery charger for camera batteries
5.1.4 Charged batteries
5.1.5 Compact Flash memory card
5.1.6 Lens mounting plate
5.1.7 Rugged tripod with a Manfrotto joystick tripod head
5.1.8 Lens cleaner and cloth
5.1.9 GPS receiver
5.1.10 Field notebook

6.0 Summary of Procedure

6.1 Photography locations can be distributed along the channel in various ways so users are referred to their specific study plans for final guidance. Here are two common distributions:

6.1.1 TMDL: Photographs are taken at all in-stream temperature monitoring locations. The photographs are typically taken directly at the thermograph location or immediately upstream if that area has a more typical canopy for the stream reach. Two additional hemispherical photos are taken under the riparian canopy, one in the left riparian zone and one in the right riparian zone. The riparian photos are taken along a transect that is perpendicular to the stream and that includes the location of the instream photo. The riparian zone photos allow calculation of canopy density produced by different vegetation types. Calculation of both current and future riparian shade conditions require inputs of vegetation height and density in the riparian zone.

Other hemispherical photo locations usually coincide with the channel surveys or vegetation surveys (a channel survey SOP and a vegetation survey SOP are under development). If the hemispherical photos will be used as a field measure of average effective shade over the stream's thermal survey reach), then either several additional stream center pictures under typical canopy conditions need to be taken, or a procedure similar to the one outlined in the Forests and Fish section should be used. Often, the more easily moved solar pathfinder equipment is used for estimation of reach average effective shade.

6.1.2 Forests and Fish: small channels high in the watershed can warm and cool quickly. Small channel canopy can also vary greatly. Thus, canopy photographs are distributed evenly from confluence to headwall to estimate average canopy and identify sections of channel where canopy may be low. To do this, measure the full channel length with a string box such as a Hip Chain. Then select a random number between 1 and 50. This becomes the point of the first photo. Subtract this number from the total channel length, then divide by 10. This sets the distance between photos. If the project has a pre-harvest vs. post-harvest overstory aspect, hardwire these distances into the data sheet for each basin. Post-harvest photos can then be taken at the same location.

6.1.3 The pictures can be taken at the same time as the channel surveys or they can be taken independently. Photos that will be used to evaluate summer stream temperatures need to be taken before deciduous trees/shrubs begin losing their leaves in autumn. For best between year comparisons, photos should be taken at about the same time each year. Forests and fish projects target June to early July to optimize the chance of consistent results.

6.1.4 Always make sure you start the day with a fully charged camera battery, a back-up battery and enough space on the memory card. Also confirm that the correct image resolution is selected and used consistently. Refer to your project lead or photo analyst for guidance.

6.1.5 For best comparison, all photographs should be taken at approximately the same height above the channel. Forests and Fish projects, for example, generally adjust the tripod so that the top of the platform is roughly 1.3 m.

6.1.6 The weather will also affect the quality of the image. The best hemispherical photos are taken during overcast sky conditions because the contrast between the sky and shading vegetation is best. However, due to tightly planned field schedules you may not have a choice of sky conditions in which to take the hemispherical photos. Corrections necessary because of the solar disc appearing in the image or poor contrast between sky and vegetation can be performed using digital image processing software such as Adobe Photoshop Elements©. Hemispherical photo correction techniques and analysis using Hemi-view© are covered in the Hemispherical Image Analysis SOP EAP046 (Stohr, 2008).

6.1.7 Each photograph must be oriented to magnetic north but its possible to either adjust for declination at the site or at the analysis stage. Typically, TMDL staff adjust for magnetic declination during the photo analysis stage and Forests and Fish staff adjust for magnetic declination in the field. Either way, use your method consistently and note how declination was handled on the data sheet. Otherwise, this correction could be applied twice, introducing error in the solar load calculations.

6.1.7.1 To adjust for declination at the site, estimate the latitude and longitude of your photography points via a GIS program such as ArcMapr or some other method. As declination does not vary greatly across the state (eg, a few degrees), high precision is not needed. Two decimal places is probably adequate. Then pick one of the free declination calculators on the web (there are many) and punch in latitude and longitude of the target site. If study sites are scattered widely, repeating this effort for other sites to find out how they vary. Alternatively, a map of declination for the state can be made using the 1:100,000k or larger topographic grid and putting declination values into each cell. If the project is wide-ranging, such as for Forests and Fish, the result can be printed and given to the field crew.

6.1.8 The following procedure would apply to any hemispherical photo acquisition regardless of location.

6.1.9 Attach camera to lens and mounting plate securely. The threaded lens ring on the camera is a soft metal and it is very easy to cross-thread and strip out the threads. Use caution to prevent this from happening; replacing the ring requires sending the camera to an authorized repair facility.

6.1.10 Attach the lens mounting plate to the tripod mount.

6.1.11 Extend the tripod legs so that when the camera and tripod are placed at the hemispherical photo location at the center of the stream the camera and lens will not get wet. Place the tripod at stream center along a stream transect that intersects the stream thermistor, or at another specified transect. Large rivers may require a boat. Photographs may be taken from the boat using the tripod as a camera stand as previously mentioned. When taking canopy photos from a boat remain still because movement may disrupt the orientation and level of the camera platform.

6.1.12 Turn on the camera, if not already on, and adjust the zoom so it is at the camera's widest angle. The full circular image should be seen in the camera LCD, if not then keep zooming out.

6.1.12.1 Alternatively, users can select the hemispherical or Fisheye lens setting programmed into the CoolPix 900 and similar camera. This fixes many settings for consistency between images. Using these settings, images are clear and of consistent pixel size.

6.1.13 Squeeze the tripod mount trigger and maneuver the lens mounting plate so that both the bubble level bubble is in the center of the bulls-eye and the compass needle is aligned

with north (if you will be adjusting for declination during analysis). If you are adjusting for declination on site (see 6.1.7.1), the compass needle should point toward the appropriate declination value. Aligning the photograph with the compass will ensure that the North and South fixed markers (red and white reflective tape) on the top surface of the lens mounting plate will show in the correct location on the photo.

6.1.14 Duck below the lens mounting plate so that you are not in the picture frame, and make sure that any other field personnel are also out of the picture.

6.1.15 Push the shutter release button on the camera. The camera will normally beep and the camera LCD will show the image being saved to the memory card. The Nikon Coolpix cameras also have a shutter timer feature that can also be used.

6.1.16 Write down the following information on your field notes: the picture location, station id, date, time, field crew names, the picture number (this is not 1 or 2 of "x" number of pictures, but the actual filename like 0011.jpg, see camera instructions for help), and note which of the markers (red or white) points north on the lens mounting plate, and the latitude and longitude (NAD83) if the location is not associated with a monitoring station.

6.1.17 As an added precaution to maintaining photo order, Forest and Fish crews take an ID photo prior to the canopy photo. This is useful because photo order is maintained on the photo card. Thus, each canopy photo is paired with an ID photo. The crew is supplied with a small erasable board and an erasable marker, on which should be noted date, basin and stream id, photo location, and assigned photo ID. Forest and Fish uses a compound ID system based on basin name, survey year, and unique numeric photo ID.

7.0 Records Management

7.1 Field information to document hemispherical photos can be written on the vegetation survey maps (see Riparian Vegetation Survey SOP), in the comments section of another form being used at the time, or on blank, waterproof, field notebook sheets. Each picture must have all the documentation information provided in section 6.1.16. The north marker color can be written down once during the survey since this will not change unless a different lens mounting plate is used.

7.2 Field notes must be retained for use in the computer analysis.

8.0 Quality Control and Quality Assurance Section

8.1 View each picture in the camera LCD before moving on to the next location. Pictures should be retaken if the following apply:

8.1.1 The solar disk obscures too much of the image.

8.1.2 Field personnel are in the picture and obstruct a clear view of the riparian canopy.

8.1.3 Incorrect compass orientation.

8.1.4 Camera platform not level.

9.0 Safety

9.1 Proper fieldwork safety procedures outlined in the EA Program Safety Manual for working in rivers and streams, working near traffic and from bridges .

10.0 References

10.1 Environmental Assessment Program, 2006. Environmental Assessment Program Safety Manual.

10.2 Rich, Paul M., et al. 1999. Hemiview User Manual. Delta-T Devices, Ltd. http://www.delta-t.co.uk/products.html?product2005092818855

10.3 Stohr, A. 2008. Standard Operating Procedure for the computer analysis of hemispherical digital images collected as part of a temperature Total Maximum Daily Load (TMDL) or Forests and fish Unit technical study. EAP046. Environmental Assessment Program, WA Department of Ecology.