STANDARD OPERATING PROCEDURES (SOP)

Collection of Radiometric Data for Calculation of *In Situ* Extinction Coefficients for PRIMENet Research

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PROCEDURAL SECTION

1.0 SCOPE AND APPLICATION

This SOP provides guidance for the collection of depth-specific radiometric data (broad waveband solar radiation: UV-B; 280 to 320 nm, UV-A; 320 to 400 nm, and visible; 400 to 700 nm) suitable for the calculation of three, waveband-specific, *in situ* extinction coefficients.

2.0 SUMMARY OF METHOD

This PRIMENet radiometric data collection SOP involves the measurement of solar radiation intensity at no less than 5 depths, plus a surface measurement, of three specific wavebands of radiation; the UV-B, UV-A, and visible. These instructions are specific to the MACAM UV-203 ip67 radiometer, although the principles can be applied to other radiometric equipment.

2.0.1 Brief background - *in situ* extinction data are plotted as the natural log of intensity (generally in watts, or μwatts per cm^{-2}, or m^{-2}) versus depth. The slope of this line is the extinction coefficient and represents the rate at which light is filtered by the overlying water column (primarily by dissolved organic carbon, but also by particulates, algae, etc.). This value is the most accurate estimate of how intense sunlight will be at any depth in the measured wetland and provides a means to characterize expected sunlight doses, and compare them among wetlands (Arts et al. 2000, Whitehead et al. 2000).

3.0 PERSONNEL QUALIFICATIONS

Field crews will have completed first aid/CPR training and read all appropriate PRIMENet SOPs prior to starting field work. Measurement procedures will be checked by an experienced staff member (e.g. subproject lead) prior to sending novice technicians into field sites.

4.0 MATERIALS AND PROCEDURES

4.1 Apparatus and supplies - See attached checklist (Table 1).

4.2 Measurement conditions - whenever possible, extinction data should be collected within two hr of local solar noon (the midpoint between sunrise and sunset times),

generally between about 10 am and 2 p.m., and during times of full sunlight. When these conditions are not available measurements should be taken during other times of the day, but in full sunlight. Extinction data collected during variable sunlight conditions cannot be used, as differences in light intensity among measurement depths cannot be attributed solely to the effect of depth, but may result from variable shading by clouds, haze, etc.

4.3 Locating sites on maps – NPS personnel will identify measurement sites (where identifiable) on maps provided by the NPS. Definitive site location will be accomplished using GPS as described elsewhere (PRIMENet Wetland Amphibian Surveys and Habitat Assessment SOP). Sites will be identified using unique codes for each park and location, as indicated on approved data sheets.

4.4 Determining measurement location - given the extensive variability among the sites to be measured, only general guidance can be provided. Field workers will be required to use best judgement in selecting measurement locations, based on the following criteria:

4.4.1 Areas of dense aquatic or overhanging vegetation will be avoided;

4.4.2 Measurements should be made as far from shore as practicable.

4.4.3 Great care will be taken to avoid disturbing bottom sediments and flocculent material. Where this cannot be avoided, the integrating disc should be slowly moved to adjacent locations to avoid the attenuating effect of disturbed materials. The effect of the stirred materials can be seen as a predictable loss of intensity at the target depth. It should be remembered that many substances that can be disturbed may not be readily visible, yet can have a significant attenuating effect on solar radiation.

4.5 Field sheets - Measurement locations will be marked on sketched maps on standard field data sheets. Measurement information including date, time of measurement, field crew I.D., and reference to map will be recorded on standard field data sheets.

4.6 The following steps will be followed to collect extinction data:

4.6.1 The meter will be zeroed by placing the sensor head (specifically, its top surface where the Teflon discs are visible) in a dark location. This can be

accomplished by placing a completely light-dense object over the top surface (e.g. several layers of dark plastic, a wader, etc.) or against the body. An ideal method is to place the sensor top surface against the back of the thigh, near the knee, and then squatting to squeeze the sensor between the thigh and the calf muscle.

4.6.2 The wetland will be approached from the north side in an area where the water surface is not shaded.

4.6.3 If possible, a location that provides for bracing handle against a solid object (a rock, log, etc.) will be used. While not essential, bracing will maximize the accuracy and consistency of depth measurement.

4.6.4 If it is necessary to enter the wetland to take measurements, an attempt will be made to stir up as little sediment as possible. It may be necessary to "migrate" away from stirred-up sediments as measurements are taken. In all cases, measurements will be made as far as possible from the area of stirred of sediment. The critical point is that even slightly disturbed sediments will dramatically affect readings. Experimentation by the purposeful disturbance of sediments and observation of their effect on measurements should be undertaken by field workers.

4.6.5 Take a surface reading with the sensor held as close to the water surface as possible without submersing it.

4.6.6 Lower the sensor until the intensity reaches about 5% of the surface value; this is the depth at which the lowest measurement should be taken. In some cases, this depth will not be reached because the water will be too shallow. In this case, take readings as deeply as possible without stirring up sediments. Also note that the 5% depth will vary with wavelength range; it will be shallowest for UV-B and deepest for visible light, with UV-A intermediate, so that different depth series will be used for each of these wavebands..

4.6.7 Divide the surface to 5% depth into segments so that 5 or 6 submersed measurements can be made.

4.6.8 The measurement sequence will involve three separate attenuation "data sets" for each waveband. This is achieved by starting at the surface, then measuring at an approximate 2-cm depth (the minimum depth at which the

sensor can be maintained barely submersed), and then moving downward through the depth measurements. At the greatest depth, two readings will be taken with the second representing the starting point for the second series. Measurements are then taken in order from deepest to the surface. Two above-surface measurements will be taken with the second representing the starting point for the third series. This process will be repeated for each waveband.

4.6.9 Actual measurements will be taken using the averaging function. This is done as follows:

4.6.9.1 set the radiometer to the wavelength range to be measured

4.6.9.2 press the MODE button once; the “average” light should come on and the readings will hold at zero

4.6.9.3 position sensor head and then press HOLD/RUN; the radiometer will start averaging readings. Wait 5 seconds, and then press hold/run again; this will “freeze” the average value on the screen. Record this value and the depth

4.6.9.4 press FUNCTION/RESET, move the sensor to the next depth and press HOLD/RUN. Wait 5 seconds, and then press hold/run again; this will “freeze” the average value on the screen. Record this value and the depth

4.6.9.5 repeat this process until all depth measurements have been made

4.7 Health and safety warnings

All measurement will be conducted in pairs (or more). Sites will not be entered if unsafe conditions are apparent, including thunderstorm activity, the presence of grizzly bears, etc. All National Park Service standard safety procedures for field work in bear habitat and the back country in general will be followed.

5.0 DATA ACQUISITION, CALCULATIONS, AND DATA REDUCTION

See separate SOP for description of data calculation and reduction.

5.1. Control of field data - all field data sheets will be reviewed at each measurement location by a member of the field crew not directly involved in the collection of those specific data (e.g. review of water sample data sheets could be reviewed by a member of the amphibian survey crew). Upon return to National Park Service facilities all Field Data Sheets will be photocopied in triplicate. One copy will be retained by the P.I., another will be stored at that facility, and the third will be stored at a separate, secure site.

6.0 QUALITY CONTROL AND QUALITY ASSURANCE SECTION

6.1 As no means will be available for field crews to calibrate instruments (they are calibrated by the manufacturer), assessment of data quality will depend on replicate extinction data. It is essential that detailed, specific notes be recorded regarding changing sunlight condition, e.g. whether intermittent clouds extended measurement intervals beyond the typical range, or if haze or filamentous clouds could not be avoided.

6.2 Interference

6.2.1 Weather, presence of bears, and other unforeseen unsafe conditions will necessitate repeat visits to selected sites. Decisions regarding revisiting sites will necessarily be made on a day-to-day basis and will be contingent upon other field crew goals and logistics.

6.2.2 Cloudy weather - extinction data should not be collected in cloudy weather (i.e. conditions in which full sunlight never occurs).

7.0 REFERENCES

Arts, M. T., Robarts, R.D., Kasai, F., Waiser, M.J., Tumber, V.P., Plante, A.J., Rai, H., de Lange, H.J. 2000. The attenuation of ultraviolet radiation in high dissolved organic carbon waters of wetlands and lakes on the northern Great Plains. Limnol. Oceanogr. 45:292-299.

Whitehead, R.F., de Mora, S., Demers, S., Gosselin, M., Monfort, P., and Mostajir, B. 2000. Interactions of ultraviolet-B radiation, mixing, and biological activity on photobleaching of natural chromophoric dissolved organic matter: A mesocosm study. Limnol. Oceanogr. 45:278-291.

Table 1. Water quality measurement supplies/equipment checklist

Supplies/equipment	Packed
Pair of hip boots (one per person)	
Pair of chest waders (if needed; one per person)	
Field data sheet(s)[1]	
Pens (NOT water-soluble)	
Pencils or waterproof pens	
Maps to field sites	
Radiometer (Macam UV 203 ip-67)	