

# Measuring Visibility in Moving Waters: Constructing a Horizontal Viewing Disc

Horizontal viewing discs are simple devices for measuring underwater visibility in shallow streams, fast-flowing rivers, or in other areas where traditional, vertical Secchi discs are impractical. Even though a viewing disc's measurement of water clarity is an approximate evaluation of the transparency of water, it is used primarily for its simplicity and because it can be constructed with a minimum of materials. Measuring the clarity of water—which can be affected by soil erosion, runoff from urban and agricultural areas, wastewater and stormwater inputs, algae and plant materials, and abundant bottom feeders stirring up sediment—is important in the evaluation, maintenance, and restoration of habitat for aquatic organisms. Researchers at the University of Washington's Center for Streamside Studies have developed instructions for building a horizontal viewing disc.

There are two types of horizontal viewing disc: the horizontal black disc developed by Robert Davies-Colley<sup>1</sup> in New Zealand and the horizontal Secchi disc.

The horizontal black disc consists of a black disc on a stick, and a periscope sealed with thick, clear plastic on one end. The disc and the covered end of the periscope are placed close together underwater, then pulled apart until the disc is no longer visible through the periscope. The distance at which the disc disappears is recorded as the measure of visibility. Because the black disc does not reflect light (ideally), this measure of visibility allows one to estimate the beam attenuation coefficient, an inherent property of light.

The horizontal Secchi disc is identical to the horizontal black disc except that the disc is painted with alternating black and white quadrants. The target is pulled away from the viewing window of the periscope until it is no longer visible, pulled away a bit further, and then gradually brought toward the periscope until it is just visible again. The measure of water clarity for the horizontal Secchi disc is recorded as the average of the distance at which the disc disappears and reappears. Like a traditional Secchi disc, the horizontal Secchi disc measures an apparent optical property of water.

Theoretical advantages to the black disc are outlined by Davies-Colley<sup>1</sup>. He suggests using four different sizes of black disc to maintain a relatively constant viewing angle at all levels of water clarity. However, some observers find the horizontal Secchi disc easier to use because the border between the black and white paint can be followed in the viewing window more easily than the edges of the black disc. In a comparative study<sup>2</sup>, measurements from the two types of disc were nearly identical ( $R^2 = 0.98$ ) (Figure 1).

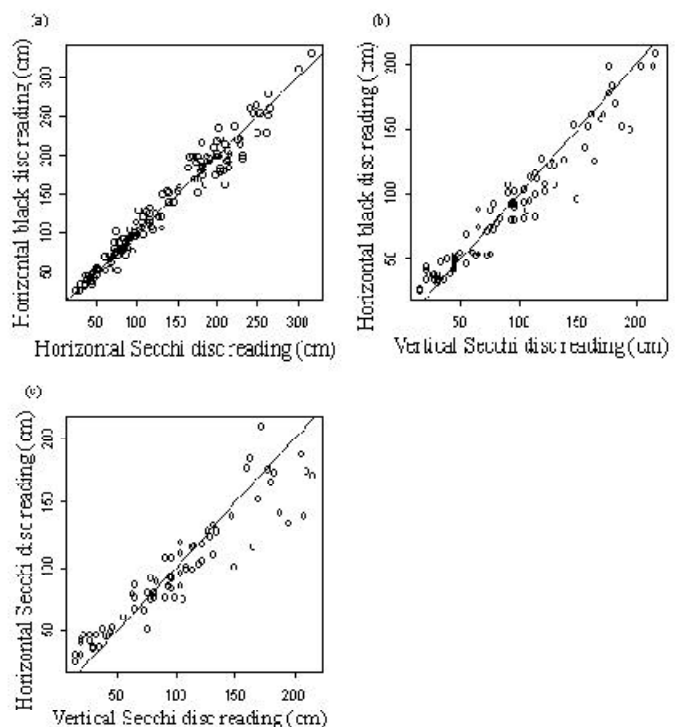


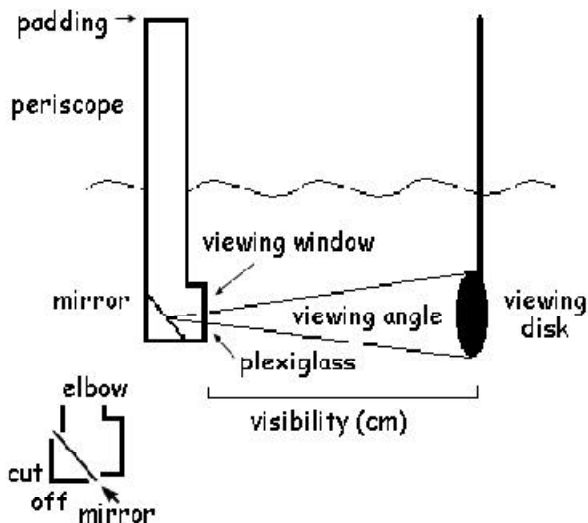
Figure 1. Comparison of the vertical and horizontal discs (both black and Secchi). The lines represent a 1:1 relationship (Steel 1999).

This study also indicated that measures of water clarity taken with both types of horizontal viewing disc correlate well with more traditional measures of water clarity or turbidity, the vertical Secchi disc and the electronic nephelometer, and may be more precise than electronic nephelometers<sup>2</sup>.

## Building Instructions

**Equipment:** jigsaw, drill, caulking gun, glass-cutter, and glass pliers

**Materials:** These materials will make one complete horizontal viewing disc (either black or Secchi). Other materials can often be substituted. A 2-3 m measuring device is also necessary. If the disc will be used from a boat, a cloth tape



**Figure 2.** Schematic of a horizontal viewing disc. The box to the left is a blow up of the elbow and mirror in the diagram above.

measure can be taped to the side of the boat. If the disc will be used at the edge of a river, a length of PVC pipe marked in 10 cm intervals works well.

*Materials for Periscope*

- 4-5' of 4" diameter PVC or ABS pipe
- 90 degree 4" diameter PVC or ABS elbow
- small sheet Plexiglas (at least 4" square)
- mirror (at least 6" square)
- grease pensilicone glue and ABS glue
- rubber tubing or foam padding (about 12")
- duct tape
- several feet of webbing or other material for a strap/handles

*Materials for Viewing disk*

- 4-5' thin copper pipe
- 5 gallon paint bucket lid or 2'x2' sheet of stiff black plastic
- 2 copper pipe ends
- 2 pipe brackets
- 4 small nuts and bolts
- black spray paint (matte)

**Instructions:**

**Step 1:** Cut the corner off the periscope elbow at a 45 degree angle (retain cut-off corner). Trace around cut-out onto mirror with grease pen. Cut out oval-shaped mirror using glass-cutter and pliers.

**Step 2:** Trace original round end of elbow onto Plexiglas. Cut out circle of Plexiglas.

**Step 3:** Clean mirror and Plexiglas.

**Step 4:** Attach elbow to long pipe with ABS glue.

**Step 5:** Attach mirror to back of elbow with silicone glue. Let dry.

**Step 6:** Attach Plexiglas to outside of viewing window and the cut-off corner of elbow to the back of mirror with silicone. Be careful to make a complete seal between the Plexiglas and the elbow but try to keep the Plexiglas window free of silicone.

**Step 7:** Cut the rubber tubing down the center and fit over the top end of the periscope (or use foam padding). Fix the tubing or padding in place with duct tape. This padding provides protection for your face as you peer through the periscope. The padding should not obscure the view.

**Step 8:** Drill holes in sides of periscope toward the top (for most comfortable use, one hole should be facing toward the viewing window and the other hole should be directly opposite). Thread the webbing through each hole and knot in place. Knots should be small so as not to obscure the view. Do not thread webbing through both holes so that the webbing passes through the center of the pipe. (Or attach handles to sides of pipe).

**Step 9:** For horizontal Secchi disc, paint the bucket lid with alternating black quadrants (scuffing the surface with 100 grit sandpaper first will help paint to adhere). For horizontal black disc, cut out four sizes of black circles (20 mm – for very turbid waters, less than 0.5 m visibility, 60 mm – 0.5 to 1.5 m visibility, 200 mm – 1.5 to 5 m visibility, and 600 mm – 5 to 15 m visibility).

**Step 10:** Attach target to copper pipe using pipe brackets, nuts, and bolts. For the horizontal black disc, you may simply want to silicone the small disc to the top end of the copper pipe then spray with black matte paint. Attach pipe ends.

<sup>1</sup>Davies-Colley, R.J. 1988. Measuring water clarity with a black disc. *Limnology and Oceanography* 33 (4, part 1): 616-623.

<sup>2</sup>Steel, E.A. 1999. In-stream factors affecting juvenile Chinook Salmon Migration. Ph.D. Dissertation, UW, Seattle, WA.

**Contact:** Center for Streamside Studies  
 University of Washington, Box 352100  
 Seattle, WA 98195-2100  
 (206) 543-6820; Fax (206) 543-3254  
 cssuw@u.washington.edu