

## Can Fish See Above the Water? By Mark Fisher

We've all spooked fish by letting them see us, but just how much can they see above the water? Is there anything we can do to avoid being seen?

The answer lies in a phenomenon known as Snell's Window, named for the mathematician Willebrord van Roijen Snell who first described it in 1621. Snell's Window is a round portal from which the surface world is visible from underwater. The window is formed by the refraction of light as it enters the water, causing a 180° view of the world to be condensed into 97.2°. This is because light that enters or leaves the water within the "critical angle" of 48.6° will be refracted and can be seen underwater; outside of the critical angle, it will be reflected away. A fish can see anything within the 97.2° (twice the critical angle) sight window, known as Snell's Window, but objects near the edge of the window will be severely distorted and out of focus. The greater the angle, the greater the distortion. Objects directly above the fish will appear almost completely undistorted

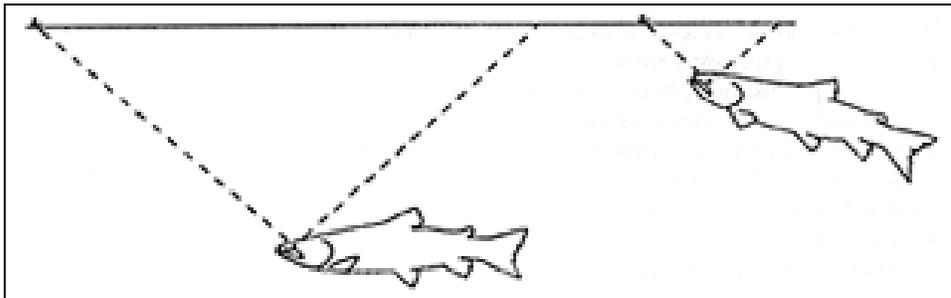


Figure 1 (from <http://www.greatoutdoors.com/published/fishing-snells-window>) depicts Snell's Window. The deeper a fish is, the larger the diameter Snell's Window becomes, although the 97.2° angle remains constant. The diameter is 2.26 times the water depth of the fish. Outside Snell's Window the surface of the water appears as a mirror, reflecting the bottom. If the surface is choppy, the mirror effect is reduced.

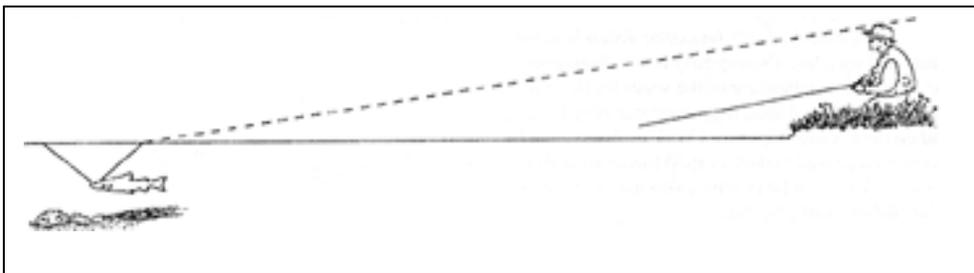


Figure 2 (from <http://www.greatoutdoors.com/published/fishing-snells-window>) shows the best defense we have against being spotted by a fish—stay low! If you can stay below about 20 degrees above the horizon, you'll be distorted and difficult to see. Avoid bright colored clothing and try to limit your movement. One of my favorite brown trout pools had to be slowly approached on my hands and knees; otherwise, I'd be spotted and they wouldn't take anything I offered.

Surface flies must land within Snell's Window for the fish to see it. Outside the window is a "mirror" that reflects the bottom, and a fly floating outside the Window can't be seen. We all know what happens when our fly lines land within Snell's Window!

The next time you are in a swimming pool, go underwater and look up. You can see Snell's Window for yourself!

In summary:

- Fish can see above water via Snell's Window.
- The refraction of light in water condenses the 180° horizon into a 97.2° window
- Stay low if you do not want to be seen. Objects at a low angle will be severely distorted and difficult to see.
- A waving 9' fly rod will be visible to fish, even if you are low. A side-arm cast would be less noticeable than an overhead cast.