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To: Scott Allen, National Fresh Water Fishing Hall of Fame

From: Douglas Arnold, Director
Institute for Mathematics and its Applications, University of Minnesota

Date: December 1, 2005

Subject: Determining fish size from photo

I am writing with regard to the photo you sent displaying an angler, Louis Spray, with a most impressive muskie. The photo is reproduced on the following page. You ask if it is possible to accurately estimate the length of the muskie based on the photo and the fact that we know that the fisherman is 6' tall.

The answer to your question is that it is *not* possible to estimate the size of the fish from the photo. Mathematically speaking the difficulty comes from projective geometry, which tells us how an arrangement of objects will project onto the film in a camera, depending on the size and positions of the objects *and the position of the camera*. Without knowing the position of the camera, we can only give an upper bound on the size of the fish. Even if we could be certain of the distance of the fish in front of the fisherman, different size fish could produce exactly the same photo if the camera were placed differently.

This is best explained by a diagram. In the first diagram in Fig. 1 you see a sketch of an angler holding a suspended fish, and the views from two different cameras. The second figure shows the image that would be captured by the blue camera, and the last, the image captured by the green camera, which is nearer. As you can see, the fish appears much larger when photographed by the nearer camera.
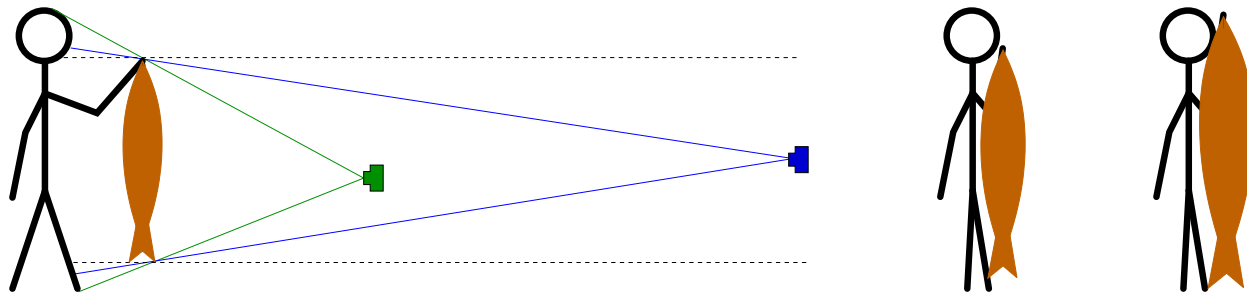

Fig. 1. The relative size of the photographed images of the angler and the fish depend on the placement of the camera, as shown in the diagram on the right. The green camera's image, shown in the rightmost diagram, results in a much larger image of the fish than the blue camera's image shown in the middle.

In fact, by bringing the camera close enough to the fish, you could make it appear as large as you want relative to the fisherman behind it, if you had a sufficiently wide-angle lens. On the other hand, no matter how far away the camera is placed, the captured image will show the fish as no smaller than indicated by the parallel dotted lines in the first figure. This can be calculated from the photo by measuring the image of the fish and the image of the man and using simple proportion, without any projective geometry. In view of the known height of the man, in your image this comes to approximately 63" as the maximal possible length of the fish (from tip of lower jaw to tip of caudal fin). *Thus the only conclusion that we can draw with certainty is that the fish is shorter than 63", perhaps considerably so.*

The second and third photos below illustrate this effect. They show me holding a 48" board in place of a fish. I am 5'10" with shoes and hair. Simple proportion applied to the front view would suggest that the board is about 60" inches. The side view gives a more accurate impression, although the board is appears a little shortened compared to me, since it is slightly further from the camera.

Thanks for bringing this interesting question to my attention. I am sorry that mathematics cannot give you the answer you seek, but I hope you agree that it does clarify the situation.

Fig. 2. Left: supplied photograph of Louis Spray (6') with his muskie. Center and right: a similar pose with a 48" board held by a 5'10" man, photographed from front and left side.

High resolution versions of the diagrams and photos can be downloaded from
http://www.ima.umn.edu/~arnold/muskie/