Fluorescence Photography:

Exploring New Photographic Options

by Steve Taylor and Kerry Enns

Hermit Crab by Steve Taylor

Fluorescence photography, also know as fluoro or fluo photography, seems to have been growing in popularity in the last few years and it certainly adds some unique challenges. We, Steve and Kerry, have put our heads together to try and sort out some of the information out there and make it relevant for cold water divers. We are not experts, by any stretch. Just a couple of hobbyists who love to learn. Hopefully, this article will spur others to take on the challenge and share their discoveries.

Steve's interest in underwater fluorescence photography began a couple of years ago when he came across some spectacular fluoro images taken in tropical and semi-tropical regions, particularly the images by Kevin Deacon published in X-Ray Magazine (2013, vol. 55, pp. 84-91). At the time, he had not seen any underwater fluoro shots from the PNW, so he made some inquiries. A local underwater camera distributor advised him that fluoro photography in the PNW was "challenging." Undeterred, he experimented with various types of fluoro gear and learned the true meaning of "challenging", but persisted in exploring various solutions. Underwater fluorescence in the PNW tends to be subtle, as compared to the bright fluorescence in the tropics, but nevertheless, can be quite beautiful.

Kerry's interest in this type of photography was also piqued by some of the terrific images that came from the tropics. She did not pursue it at the time due to cost, however. Recently, while learning about underwater infrared (IR) photography for the Winter edition of PNW Diver, she began to understand better the concepts of wavelengths within the light spectrum and their relevance to underwater photography. With a basic understanding of IR under her belt, she decided to explore the other end of the spectrum. At the same time, Steve began posting his fluoro images online. In hopes of coming up with an inexpensive, DYI version, Kerry began researching and collaborating with Steve and another PNW Diver, Eli Wolpin, to better understand this new medium.

What is Fluorescence?

Fluorescence is different from bioluminescence. Fluorescence requires a blue or ultraviolet light source to excite the proteins of an organism or a mineral. Once excited, the proteins give off light of a particular colour, with common fluorescent colours being green, red, yellow, and purple. Althoug UV light does excite fluorensence, it tends to be dim. For more on that see Lynn Miner's White paper available here. To see fluorescence under a blue light you use a yellow filter, fitted over your mask and your camera lens. It filters out the blue or ultraviolet light, allowing fluorescent light to pass through the filter enabling you to see or photograph fluorescence. Please note that UV light does not require a yellow filter, but the risk of UV exposure to YOUR eyes and the eyes of the critter, it's best to stick with blue.

In comparison to fluorescence, to see bioluminescence on a night dive, you turn off all sources of light so as to see the algae, etc. glowing. In Howe Sound, Opalescent Squid look beautiful and may glow at night, but they do not fluoresce; they exhibit bioluminescence.

Fluorescence diving is typically done at night because fluorescent light tends to be weak. Daylight typically washes out fluorescence, making it difficult to see. So, you switch on your flashlight with its blue filter, place the yellow filter over your mask, and take a giant stride off into the inky blackness on your PNW night dive. What do you see? Mostly nothing, because not many things fluoresce in the PNW. Because your source of illumination is a blue light and you are wearing a yellow filter, you will not be able to see anything that doesn't fluoresce. It is usually a good idea to bring a regular flashlight (and a backup light) when you are fluoro diving so that you can navigate underwater, illuminate camera controls when necessary, and perform other safety tasks that require full illumination.

Fluorescence photos are often dramatic, beautiful, and other-worldly. However, is fluorescence photography simply a gimmick for creating weird photos? The short answer is no. The long answer is: Fluorescence reveals something about the underwater world that we do not usually see. Some marine organisms do not see full spectrum light as we do because longer wavelength light (red light, etc.) is filtered out at depth. The visual experience of these organisms might be more akin to seeing as we see with fluorescence filters. So, fluorescence photography provides insight into what it might be like to see like a crab or shrimp. In some cases, it is conceivable that fluorescence might serve some sort of signaling or warning function, just like the bright colours on poisonous fish serve to warn off predators. But in other cases fluorescence might simply be an incidental effect of the organisms proteins with no apparent survival value. Nevertheless, when we shine our (full spectrum) flashlights on marine creatures on night dives it is erroneous to assume that we're seeing the underwater world for how it really is; we're introducing light wavelengths (colours) that do not appear at depth. Fluorescence diving and fluoro photography remind us that we can broaden our perspectives by considering other ways of viewing the world.

Steve took the following images during fluorescence night dives at Kelvin Grove in Howe Sound. The camera details and photo specifications were as follows: Nikon D810 in a

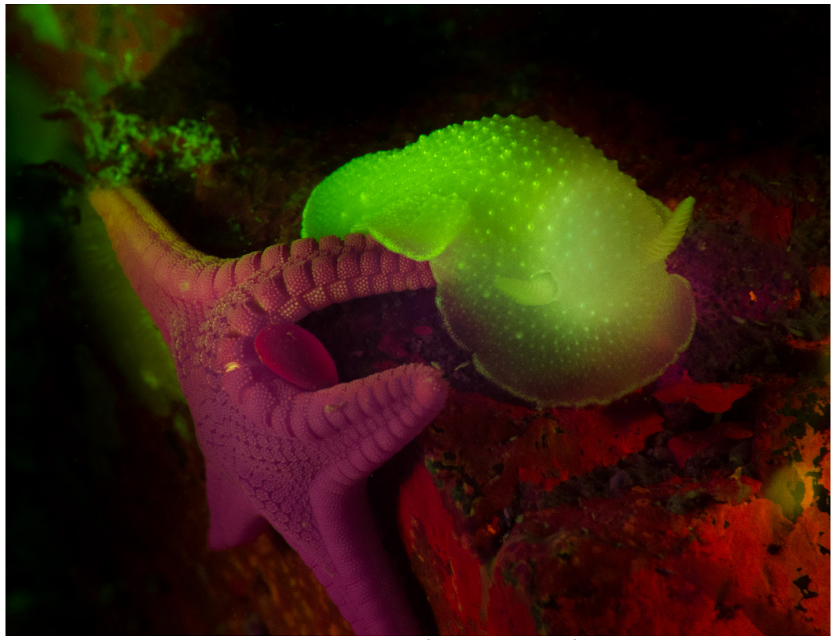
Anemone by Steve Taylor

Spot Prawn by Steve Taylor

Image by Steve Taylor

Nauticam housing, Nikkor 60mm lens, dual Sea & Sea YS-D1 strobes with Fire Dive Gear (FDG) blue filters, Nightsea and Galaxy Blue focus lights, FDG yellow lens filter, ISO 400, 1/60, f11, and a combination of auto and manual focus. He used a wide aperture to provide sufficient light for focusing. As a result, the depth of field was shallow.

We mentioned that fluoro photography is typically done at night, but in the PNW there are conditions in which it can be done during the day. Daytime fluoro photography in the PNW is best done during overcast conditions in which there is an intense plankton bloom in the top layer (e.g., top 20 feet) of water. In these circumstances it is sufficiently dark in, say, 60 ft of water, to make it possible to see fluorescence. The following image is an example of daytime fluorescence photography, taken by Steve at Bowyer Island in Howe Sound. The image consists of

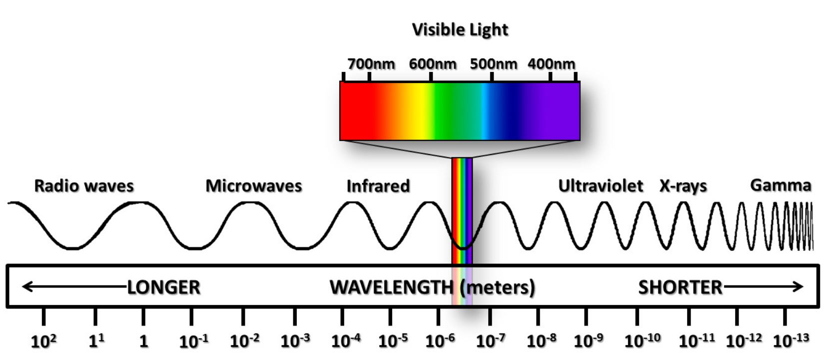


Daytime Image by Steve Taylor

a blend of ambient light and fluorescence. Here it can be seen that the dorid is fluorescing green and the algae on the rock is fluorescing red. This photo was taken using a Sony RX100 compact camera in a Nauticam housing, using Sea & Sea YS-01 strobes with Nightsea blue filters and a Nightsea focus light.

The Science Behind Fluorescence

The visible light spectrum, ranges between 350nm to about 750nm (see Figure below). When taking IR images, the filter on the camera blocks out light in the red range, that is, longer than 720nm. For our viewing pleasure, converting that very red image into black and white, gives a pleasing result (see Kerry's recent article in the Winter 2016 edition of PNW Diver on IR photography). In fluoro photography the camera blocks all visible light in the opposite direction; that is, in the blue range: 450 - 480nm. The strobes and focus lights are the blue spectrum, which causes marine organisms to fluoresce, but as mentioned earlier this blue light is filtered to better see the fluorescence. Lynn Miner, a physicist with Fire Dive Gear, has been researching this extensively, and a detailed White Paper is linked here and below.



http://www.ces.fau.edu/nasa/module-2/radiation-sun.php

Here is a short list of things that display fluorescence in Steve's dives in Howe Sound: Some organisms fluoresce brilliant green, as if electrically illuminated from the inside. These include some types of anemones and feather duster worms. Most other organisms fluoresce less intensely but still beautifully. Kelp fluoresces in rich reds and oranges. The algae growing on the shells of hermit crabs fluoresce in shades of red and yellow. The hairs on the legs of the crabs fluoresce green. The effects tend to be subtle and so bright focus lights (with blue filters) are necessary for both manual and autofocus, along with bright strobes. Try not to stare at the bright blue light because it can be damaging to the eyes.

What We are Learning about Equipment

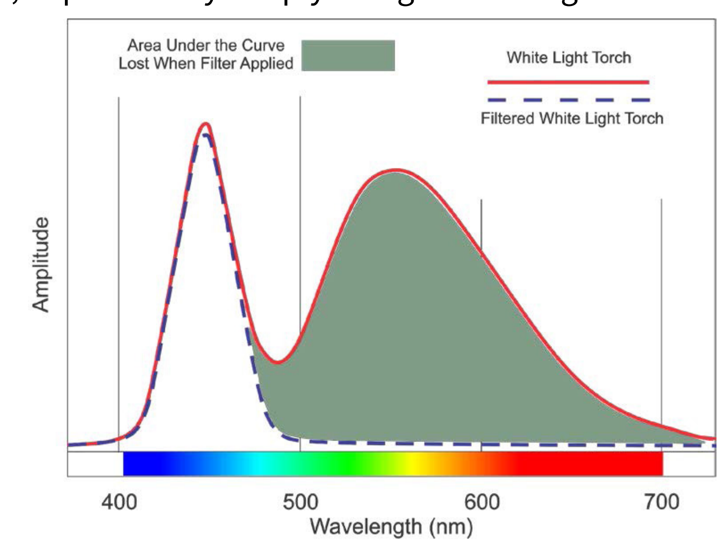
All you really need to take fluoro images are a blue light and a yellow filter. It seems simple enough, but in searching for the right blue light, we've learned a great deal. These are short commentaries of what is necessary.

A Camera Sensitive to Light

The better the sensor quality, the better images, especially in fluoro photography. Because light is at a premium, the ISO needs to be quite high. Different cameras handle the graininess that high ISO gives. Steve's full frame camera means he can take successful images at only 400 ISO and f11 with strobes. Kerry however, on a cropped frame DSLR, needed the ISO much higher and the aperture at f4.5 without the use of strobes. GoPro cameras will be at a disadvantage here, according to Lynn Miner at Fire Dive Gear.

A Blue Light

This is where it gets interesting. Steve uses two dedicated blue lights: a Sola Nightsea and a Fire Dive Gear Galaxy, shown here. Kerry tried using the Fluoro Kit by BigBlue on her BigBlue VL2800 white light with little success. Steve even tried a blue filter on his Sola 8000 lumen light, with very dim results. Lynn Miner's White paper, referenced below, explains why simply using a white light with a blue



http://firedivegear.com/science/excitation-filters/

filter tends to be inadequate for viewing fluorescence. A white light produces a large amount of light, mostly in the middle wavelengths. The blue filter blocks 80% of the output, only allowing a fraction of light (i.e., the blue light) to exit the filter. The graph below illustrates this.

Perhaps if the visibility was clear, as in the tropics, light loss might not be as significant. However, in our waters where visibility is often only between 10-20', we tend to require much brighter lights.

This brings us to strobe filters. Although the blue filters will block 80% of the power of the strobe, powerful strobes like the YS-D1 will still give a significant output. Steve uses the filter made by FDG shown here.

A Yellow Filter for Both Camera and Mask

As mentioned earlier, the blue light washes the area with the color blue. The yellow filter removes the blue so that we can process better what we see. This can be a simple yellow mask that covers the primary mask, a custom made mask filter (FDG make them custom), or a yellow acrylic clipped onto the rigging as shown in the image below from Reefphoto.

The camera also needs the filters, whether directly on the lens inside the housing, or on the exterior. Cheaper point and shoot cameras or GoPros will need an exterior filter.

Backup white lights

This is just a good idea when night diving. You'll need to use white lights for signaling your buddy, for navigation, for seeing your gauges, and more. If you are using a dedicated blue light, then two white lights are probably wise in case one fails. Safety first, please!

Areas to Explore

There are several areas that might be worthwhile exploring yet. The most obvious will be comparing the different types of dedicated blue lights available. As mentioned already, Steve has the Sola Nightsea and the FDG Galaxy. He has noticed some difference in the colors these lights cause to fluoresce. Fantasea has a new light, Radiant Pro 2500 that boasts of dedicated UV and blue light modes as well as white and red. We wonder at the strength of these modes and the subtle color differences? Does BigBlue plan on making a dedicated light to go with their ever increasing array of lights? All FDG blue lights have the same characteristics

No doubt there are different colors of yellow filters. As in the blue lights, how these yellow filters compensate color would be an interesting area to explore. Kerry has the BigBlue yellow barrier filter, but there is no color number on it for comparison. When she compared her image to her buddy's image using the same subject and same blue light, their images were different, one having a more pink cast and the other an orange cast. A Google search shows lots of choices from various manufacturers.

It also seems that there are different manufacturers of strobe filters. Reef Photo sells a generic strobe filter that appears to be a plain blue acrylic. How does that differ from those with a dichroic film on it? Kerry bought a sheet of blue acrylic #2424, 3mm thick to try to create a strobe filter. She has not been able to test it yet but suspected that it won't work as well without the dechroic coating. Miner confirmed this and goes into detail in his White Paper available by clicking here.

It would also be interesting to test fluoro photography using popular point-and-shoot cameras such as the Canon G-series or the Olympus TG-4, with and without strobes.

Concluding Remarks

Viewing fluorescence in our water is amazing, but capturing images of it are even more challenging. Winter seems to be the best time to get out and experiment. We need to research available gear. Perhaps this article will encourage others to try it out and share their experiences. There is an open group for sharing and learning on Facebook called 'Fluorescence Diving / Underwater Fluorescence'. Consider sharing there or directly on PNW Diver's Facebook page.

References

Miner, Lynn. January 2015. *White Paper - Why a Dedicated Blue Source is better than a White Source with Excitation Filters for Fluo Diving* (click here for pdf)

http://firedivegear.com/

Tube-dwelling Anemone at Whytecliff, BC - image by Kerry Enns