Why Fish Don't See Your Lures!

How Fish Vision Affects Intelligent Fishing Tackle Color Selection

Lake Fishing, River Fishing, Sea Fishing

Dr Greg Vinall

Vinall's Lure Fishing

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Why Most People Suck At Choosing Lures.....

Did you know that some fish species can see different colors than other species can, and some fish can even see colors that humans can't?

Did you know that that the colors fish can see change depending on how deep they dive?

Have you ever wondered why fish sometimes charge at your lure, then turn away at the last second without striking?

Would you like the confidence to choose the best lure colors for any fishing scenario?

For the majority of lure enthusiasts, choosing which colored lure to tie on their line is nothing more than a game of chance – but it doesn't have to be. Knowing how to pick the right colored lure requires an understanding of how fish see objects and how light and color behave in the fish's world.

I'm fortunate to have spent the majority of my working life in a career that allows me to improve my knowledge of how fish behave, and these days I put a lot of thought into lure color selection. I make my lure choices based on the intimate understanding of lakes, rivers and oceans that my profession as an aquatic scientist has provided as well as my past experience with a fishing rod.

With all that knowledge, I'd love to say that I've always made intelligent decisions about what lures to buy or use for a particular situation.

Unfortunately, I can't say that.

Like so many others, my approach to lure color selection for many years was little more than a lottery. I caught fish by switching lures a hundred times until I found one that worked, and very often I wasted a lot of valuable fishing time before I started catching fish. The trouble with this approach is that the next time you go to wet a line the conditions have changed and you have to start over and waste time all over again.

I'm glad to say that many years ago I stopped playing the lottery and started to put serious thought into how I could make intelligent lure choices, and since then I haven't looked back.

I'm not going to tell you that I have the secret formula for knowing which lure style or color of lure the fish are going to be smashing on any given day, because that would be ridiculous. Conditions constantly change and fish, like humans, can change their minds, defy logic and rewrite the rules any time they wish.

But what I can do is offer you an understanding of the many interrelated factors that affect the appearance of your lures to the fish and how that might attract fish (or not). In my experience this knowledge is invaluable for increasing your chances of catching a fish. In this eBook I take some very complex scientific concepts and simplify them, giving you a starting point for eliminating the least likely lures and going straight to the top few that are most likely to work on the day. After that, it's up to you to go through the daily process of trial and error that all lure fishermen must go through.

Take The Lure Moron Test

Before we kick off on this journey, I'd like you to take my "Lure Moron Test".

There is no need to feel anxious. No one will ever know your results except you, so be honest. When I first responded to the questions, I was an ‘ultimate moron’ so don’t worry! The purpose is to be aware of whether you make intelligent decisions about lure color selection.

Here is how it works: I’ll give you 5 statements that I often hear fishermen make and I’d like you to count how many of them you’ve actually said yourself, simple as that. Each statement shows how not putting any great thought into the color of your lure may keeping you from catching some great fish.

Let’s get started!

Statement 1: “I always do well with red lures”

Interpretation: “I can’t be bothered thinking about what color to use!”

Usually the person using this statement (whether the color choice is red or any other color) will go on to explain that they haven’t had to use another color for weeks. I guarantee that red lure will stay on the end of their line until they stop catching fish (who changes lures while they’re catching fish?). It will be the first lure they tie on next weekend, too. If you use a red lure 90% of the time it’s likely you’ll catch a lot of your fish on red lures!

Statement 2: “The bloke at the tackle shop reckons they’re taking green lures this week!”

Interpretation: “I took advice from the guy who was selling old stock to make room for new seasons lures!”

OK, please don’t send me hate mail. I know you can get a lot of good advice from reputable tackle store owners, but the person making this statement may not have given any actual thought to what lure style or color are suited to conditions on the day. Green may be useless if there has been a recent flood, for example.

Statement 3: “Bright colors for bright days, dark colors for dull days”

Interpretation: “I read this somewhere and it seems to work”

Actually, this isn’t a bad rule – but it’s just too simplistic. Which bright colors work when? What if there are times when a dark lure works best even on a bright day?

Statement 4: “I switched from a blue crank to a yellow lipless crank and caught a fish next cast”

Interpretation: "I'm ignoring all the other things I changed and assuming that yellow is the magic color of the day"

The color change may have had something to do with it, but the diving depth probably changed too. Lipless cranks make a different vibration to other cranks and have a different body shape, plus lipless cranks are often noisier. Are you sure color was the reason?

Statement 5: "Perch seem to like pink lures"

Interpretation: "Every time I fish for perch I use a pink lure, so I always use pink for perch!"

It may well be that the color pink is highly visible and perch love it. But like every color, pink can just look grey under some conditions. So once again, are you sure it's the lure color that is working for you?

How Did You Score?

I could easily give another 100 examples of similar statements.

Personally, I'd give myself score of 5/5! I've made all of these statements at some stage or other (and many others like them), so don't feel too bad if you've heard yourself making similar declarations.

In fact, you should feel excited if you are one of those who regularly make these kinds of statements, because you're about to vastly improve your understanding of how fish really see your lures, and from now on you'll be able to make smart choices about what lure color to use. Really smart!

What We'll Cover In This eBook

Intelligent lure color selection is complex and is influenced by a whole bunch of factors like the optical properties of water and the physiology of a fish's eyes. Getting a full understanding is daunting, so many of us are looking for a "cheat sheet" - a simplified version that gives us enough knowledge to choose lures properly, right?

Look no further!

Here is what we'll cover in the next 45 or so pages:

- What colors fish can physically see in bright and dim light, clear and dirty water

- What colors key species are adapted to see

- How fish use vision for hunting and how you can help them find your lure
- What lure colors are most visible at the water surface, mid water and down deep
- Which lure colors to use when you are fishing in clear, dirty, colored or algae rich waters
- Other factors that combine with color to attract fish and cause them to strike.

About Fish Vision

Water is a great medium for the transmission of sound and vibration. Both of these travel long distances in water and both are extremely important to fish for hunting, evading predators and so on. In fact, this is the very reason fish have such well-developed organs for detecting and interpreting sound and vibration (the lateral line).

Sound and vibration are transmitted by “mechanical waves”, meaning that they are caused by the vibration of particles. Water molecules are closer together than gas molecules, so sound travels much more freely through water than air. It’s just one reason why an anchor banged against an aluminium hull can send fish for miles around scurrying for cover.

Unlike sound and vibration, light is not transmitted so well in water. Rather than the vibration of particles, light is caused by electromagnetic radiation, which travels more easily when the medium has few particles and gets blocked by denser materials like liquids and solids. So light travels easily through outer space where there are virtually no particles, but has more difficulty once it strikes the earth’s atmosphere because gas molecules, water vapor and other particles tend to block electromagnetic waves. That’s why on a cloudy day we experience less light at the earth’s surface than on a clear day – water vapor in the atmosphere is absorbing light.

So if water vapor can reduce the passage of light to that extent, just how much light does a liquid water body, such as a lake, river or ocean block out? The behaviour of light in water is a really important aspect of how fish perceive color, so we’ll explore it in a lot more detail in the next section.

The important message is that while terrestrial animals can often see for several miles, and humans can sometimes see more than 12 miles (20 km), fish can rarely see beyond 150 feet (45 metres), even under exceptional circumstances. In muddy, algified or turbulent water, the penetration of light into the water can reduce visibility to mere centimetres [1].

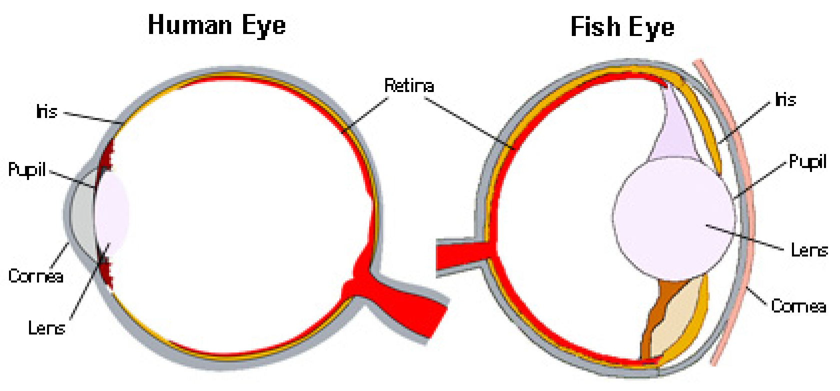
How a fish's eyes work

While it's not possible to fully appreciate what images might reach a fish's brain, a lot has been learned by physical or chemical examination of fish eyes and by exposing fish to stimuli in laboratory experiments. That being said, generalising about fish vision is of limited value, since different species are believed to have different vision capabilities and laboratory experiments are often poor representations of real world conditions.

Physical and anatomical studies of the eyes and retinas of fish indicate that most species can obtain a clearly focused image, detect motion, and have good contrast-detection ability.

In terms of overall structure, a fish's eye is not unlike a mammalian eye [(2)]. Both have:

- A light sensitive layer of tissue at the back of the eyeball called the "retina".
- A thin, circular structure called the "iris" that controls the amount light that reaches the retina. Light passes through a hole in the center of the iris called the "pupil".
- A "lens" between the iris and the retina focuses the light
- A clear cover called the "cornea" protects the iris and lens, but also refracts light and helps focus
- An optic nerve transmits the information from the retina to the brain for interpretation.



Within the retina of both people and fish are two kinds of light sensitive cells: Rods and Cones. Rods handle vision in low light conditions but can't distinguish colors, while cones are the cells that sense color and detail. Because rods are around 100 times more light-sensitive than cones, they are the part of the eye that provides vision during low light periods, such as dawn, dusk and the hours of darkness [(3)]. But in aquatic environments, low light periods can occur at any time of the day. Dirty water, algal blooms, turbulence, overhanging trees or dissolved organic material can all stop the penetration of light, particularly deep beneath the water surface.

Since the rod cells don't distinguish color, a fish's vision under these circumstances becomes increasingly greyscale and they are unable to distinguish between colors, especially similar hues. On the other hand, the super sensitivity of rod cells to low levels of light makes them very useful for detecting contrast. So in low light conditions fish are able to see objects that have contrasting colors or whose colors contrast with the background, such as dark colors over a sandy bottom, but they may not always be able to see colors. Human vision is much the same: Our eyes struggle to distinguish between colors if there is not a lot of light for us to work with, such as twilight periods.

In bright light, the rod cells are withdrawn into the retina to prevent damage and the cone cells take over, giving the fish color perception and the ability to discern greater detail as a result. Deep sea fish that live in low light environments may have a rod to cone ratio of several hundred to one. Conversely, fish living on coral reefs may have a rod to cone ratio of ten to one. It stands to reason that a fish that lives in an environment where both light and color are abundant will benefit more from an abundance of cone cells in order to utilise the available color spectrum[4].

There are three main differences between a fish's eye and a human eye:

1. The pupils in a fish's eye are of fixed diameter and are not adjusted by the iris to regulate the amount of light that reaches the retina[3].

2. The lens in a fish eye is spherical, compared with a human lens, which is elliptical. In humans, special muscles change the shape of the lens to allow us to focus on objects. In fish, this focusing is done by moving the lens inwards or outwards[5].

3. Fish eyes are (generally) on opposite sides of their head, while human eyes are forward facing. This gives humans better perception of distance than fish.

As a result of the anatomical design of their eyes, most fish tend to be nearsighted (myopic) with few species able to focus well on objects more than 15 feet (5m) away[6]. However, Because 95 percent or more of the light is filtered out in the first 25 feet (6m) even in clear water, limited distance vision is not problematic for most species. In murky lakes or streams this can be shortened to just a foot or two (30-60cm). This attenuation of light by water is a big part of the reason that the iris in fish doesn't need to adjust the pupil size: the amount of light that can enter the retina is already limited by the surrounding environment.

The spherical lens of fish eyes is far denser than the lens of mammalian eyes, which gives it a higher refractive index. This has the same effect as humans experience when we wear goggles: a much sharper picture of the underwater world. However, the round shape of the lens results in light coming from in front of the fish having a shorter path with greater diffraction, while light from the side has a longer path with reduced diffraction. This gives the fish better close vision in front, which assists with hunting, feeding and navigation. On the other hand, distance focus is better from the side, allowing the fish to detect predators better.

The round lens of a fish has the added advantage that it protrudes through the iris and further exaggerates the natural protrusion of the eye from the fish's head. Humans and most other mammals have a blind spot behind them and must turn their head to see to either side or behind. However, the protruding eyes of fish combine with the natural side to side motion of their head during swimming virtually eliminates blind spots and allows fish to see well in all directions simultaneously(6).

The Fish's Color Spectrum

The ability for a fish (or any animal) to discern color is the result of the cone cells in the retina producing specific chemicals in response to exposure to a particular wavelength of light. Those chemicals stimulate the optic nerve, causing electrical impulses that are deciphered by the brain. Think of each cone cell as being a pixel in a digital image and you'll be on the right track.

The range of colors that any animal can discern is called the "spectral range", and is determined by the ability of the cone cells to detect different wavelengths and produce a chemical response.

Deer hunters provide a great example. Hunters who stalk deer often wear bright, flame orange colored clothing so they are highly visible to other hunters rather than risk accidental shooting. Human eyes contain cone cells that detect orange wavelengths and send a strong signal to our brains, so flame orange is a color that stands out like a beacon to us. Deer cone cells, on the other hand, do not respond to orange wavelengths. Because flame orange is not part of their spectral range it is indistinguishable from other colors and the hunter does not stand out from the background.

Why deer cone cells have evolved not to detect the color orange is a question that's not easily answered, however it's fair to say that orange hues are not a part of their natural environment. Until hunters started wearing flame orange clothing deer probably had no need to be able to distinguish that color!

Fish eyes have also evolved differently between species, with the mechanisms for determining color tending to reflect the colors available in their natural environment. For example, inshore reef fish have good color vision with a wide spectral range, because their environment is well lit and contains a wide range of colors. Offshore pelagic fish live in an environment where blue or green colors dominate and other colors tend to be scarce. The cone cells of these species are believed to be more sensitive to blue and green hues and can detect black and white, but are poorly adapted for distinguishing other colors.

Nocturnal species and those that are adapted to dirty water or low light rely largely on rod cells for vision and often only see in black and white. Whilst they may not discern colors, these species often have large eyes and large pupils, plus a higher density of rod cells in the retina, all of which allow them to perceive a clear black and white image with only a little light.

Predatory fish often have larger eyes that are adapted to low light conditions, which assist them in hunting baitfish during the low light periods of dawn and dusk.

Like offshore zones, freshwater lakes and rivers also present a limited range of colors, even when the water is quite clear. As a general rule, the eyes of fish species that live in relatively clear water tend to distinguish a wider range of colors than those that live in dirty or tannin stained water. Fish that are adapted to the latter conditions don't get exposure to blue and violet wavelengths and tend to be adapted to the spectral ranges of red-orange and yellow-green[8].

It is considered likely that some fish may see colors that are outside of the visible spectrum for humans, in much the same way as dogs can hear ultrasonic noise that is beyond the human audible range. Examples of this adaptation include species that see colors in the ultraviolet range. In some cases this adaptation allows them to see food particles like zooplankton, which are more visible in UV. In other cases, such as salmonids, the juvenile fish are thought to be able to discern UV in order to find zooplankton but adult fish are believed to lose this ability as they no longer hunt UV active prey[9, 10]. In other cases the fish may have UV pigment on their skin that allows them to distinguish themselves from other species[11].

The sensitivity peaks for some common fish species are provided below:

- Rainbow trout have one of the widest color spectrums among fish and are particularly sensitive to wavelengths in the 600nm (red), 535nm (green), 440nm (blue) and 355nm (ultra-violet) ranges

- Large and smallmouth bass, perch, bluegill, crappie and walleye are most sensitive to wavelengths in the 590-650nm range (orange-red), but are also sensitive to colors in the 510-570nm range (green-yellow)[12]

• Billfish have two types of cone cells that are sensitive to different wavelengths, giving them overall sensitivity to 420-490nm wavelengths (blue-green)[13]

To be clear, adaptation to a particular spectral range doesn't necessarily mean that colors outside of that range are not visible at all. It is possible, in fact quite likely, that other colors are still visible, but the fish is unable to discern subtle changes in hue. For example, billfish are spectrally adapted to the blue-green wavelengths and are thought to be able to discern between shades of these colors. So a billfish is easily able to distinguish between a red lure and a blue one, for example, and may well be able to distinguish several different hues in a lure that is painted only in shades of blue, but may be unable to do so if the lure was painted only in shades of red. It simply sees blues better than reds.

Likewise, bass tend to be spectrally attuned to red-orange and yellow-green wavelengths, and probably see more detail in an orange lure with red stripes than they would a blue lure with dark blue stripes.

I don't want to give the impression that because bass, for instance, are particularly sensitive to red-orange and yellow-green that these are the colors to automatically gravitate to every time you are chasing bass. No! Imagine a scenario where you are fishing for bass in a lake that has a lot of planktonic algal growth, which gives the water a greenish tinge. Under these conditions all wavelengths other than green are filtered from the water column, so everything beneath the water surface has a greenish appearance. A green lure is essentially camouflaged under these conditions and may be harder for a fish to see than a black or dark blue one.

Try looking at a green object through green cellophane, then look at a blue object through the same piece of cellophane and you'll see what I mean.

Fish Vision And Feeding Efficiency

Most human beings rely heavily on vision as the primary sense, because we are fortunate to have exceptionally well developed sight and under normal circumstances our surroundings allow us to use that gift to great effect. But take a look at what happens if you put on a blindfold for a short while: Almost immediately you'll find yourself straining to hear more of what's happening around you, feeling your way using your hands and feet, sniffing the air for clues about where you are or what's going on. Indeed, people who are permanently blind become very adept at using these other senses in their day to day life.

As most humans are so dependent on sight, it's only natural that we might assume that other animals are also highly dependent on vision.

Now take the example of some other mammals. Any deer hunter will tell stories of deer that flee before they've even seen any sign of danger. They are constantly on the alert for smells and sounds that provide a hint that they need to take action. Even your domestic dog prefers to sniff a scent trail rather than look for visual clues. In marine environments, sharks and other large predators are the obvious examples, relying heavily of olfactory senses (smell) to follow a scent trail for many miles to a food item that is way beyond the limits of underwater vision. Even once within visual range, sensory organs on the snout of the shark called Ampullae of Lorenzini detect minute electric fields emitted by baitfish and probably play at least as big a role in helping them home in on their food as vision [14].

There is no doubt that eyesight plays an important role in assisting fish in navigation, avoidance of predators and of course in finding food items. But when we analyse the way fish's eyes actually do their job and the environmental factors that influence how effectively fish can see, it becomes apparent that in many cases other sensory processes play a much larger role.

For fish, visual stimulation can only really occur when the water clarity and the proximity of an object allow it. For ocean dwelling pelagic fish this might be a large proportion of the time, because their watery home tends to be characterised by clear water and good light penetration. The large eyes and response to teaser lures of billfish, tuna and other pelagic predators is a good example[15]. Likewise, predatory fish that reside on shallow coral reefs where water is clear, sunlight is plentiful and color abounds tend to be very visual.

But for deep sea fish, nocturnal feeders and fish living in less clear water, the other senses play a much larger role. Under these circumstances smell, electro and magneto fields, sound and "feel" may be the primary way in which fish find food items, with vision relegated to a secondary sense and color vision all but non-existent.

Even when fish are primarily visually hunting, color often plays less of a role than we might imagine. For example, a large proportion of fishermen will agree that "hot bites" are often experienced for short periods around dawn and dusk. But we have already noted that the rod cells that the fish's eyes are dependent on in low light are not color sensitive, and we'll shortly examine the behaviour of light in water, which will further confirm that color doesn't play too much of a role under these conditions. That doesn't mean the fish aren't visual predators, just that factors other than color are more important.

To give another example, many fish retire to shady areas during the brightest part of the day, preferring to lie in wait under a big log, a bridge, lily pads or other overhead structure rather than stay in brightly lit water where their eyes are better equipped to discern color. If color was an important factor to these fish they would stay where colors are visible.

So why is it that predatory fish often feed more actively in low light conditions? The answer may lie in their ability to adjust to changing light levels, rather than to discern colors. For example, research into largemouth bass suggests that it may take 20 minutes or more for them to adjust to changing light at dawn or dusk, while the eyes of smaller baitfish species can take even longer. This may give predatory fish an advantage as their eyesight is temporarily better than that of their prey(16). Predatory fish can therefore expend less energy by feeding in marginal light; the short duration of the dawn and dusk period adding urgency and purpose, resulting in more aggressive feeding at dawn and dusk(3).

Most often it is a combination of senses that allow a fish to locate and catch prey. How much of a role vision plays in this process depends on the fish species and conditions, but often it is but a small part. The role of color as a stimulus to entice a fish to attack an object is even smaller again, with other visual stimuli favoured both by the nature of the fish's eyes and by the surrounding environment.

Color And Light In The Fish's World

I get into all sorts of arguments whenever I enter into the topic of light behaviour in water, so let me begin this chapter with a statement:

"Everything you are about to read in this chapter is 100% scientifically proven – and is far more important than how a fish's eye works or what colors it is capable of seeing".

What we are about to discuss has nothing to do with how a fish sees, and has everything to do with what is actually there for the fish to see in the first place. In fact, if you believe you can prove anything contrary to what I say in this chapter then I strongly urge you to document it and publish it in a scientific journal, because you my friend have discovered something that thousands of physicists, opticians, scientists and Nobel prize winners have missed! You will have made one of the most remarkable discoveries in modern times!

OK, I think I've made my point pretty strongly there, so let's get on with finding out what we need to know.

And as I so often do, I'll slot in an analogy to help me to explain.

Picture in your head a person standing in the room in front of you. Let's say for the sake of this example that he/she is wearing a bright red shirt. Get a really good mental image of the shirt and particularly the brightness and hue of the red shirt.

Now imagine for a moment that somebody turns out the light.

What color is the shirt now?

The answer of course is…….Red! But you can't see that it's red because there isn't enough light – everything looks black. You just know its red because you saw it in the light.

Now imagine that another two people enter the room. What color shirts are they wearing? You have no idea, do you? The room is still dark, so everything looks black.

Suddenly, the emergency lighting switches on and the room is lit by those dim red lights. The original red shirt looks red, of course! But now you can see that one of the other two people is also wearing a red shirt and the other a grey one.

Finally, the power is restored and the room is fully lit again. Standing in front of you is:

- One red shirt
- One white shirt (that appeared red in the emergency lights)
- One green shirt (that appeared grey in the emergency lights)

What just happened?

None of the shirts was physically changed in any way, yet to our eyes they all appeared different under different light.

You see, color is just a perception. Color is our brains interpretation of the information it gets from our eyes. And if our eyes only get part of the information, then our brain can only partially interpret what we see.

What does any of this have to do with fish and how they see color?

In the human world we are fortunate that more often than not we enjoy viewing objects under white light, so we get to see the full range of colors at full intensity. But when we darken the room by reducing light all of the colors we see are reduced in intensity. When we remove some wavelengths and let others through (like the red emergency lights) we can see objects of some colors, but objects of other colors may appear dull or grey.

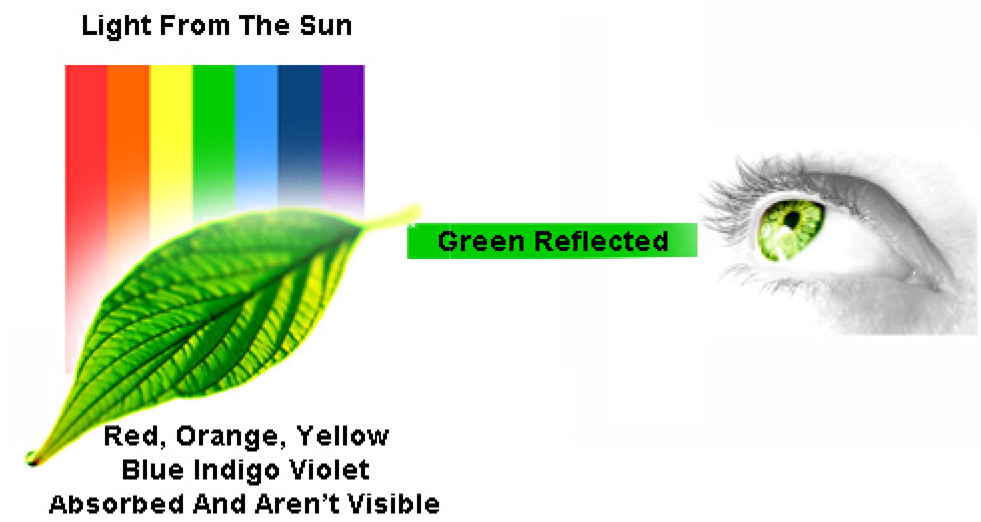
In the fishes world things are a little different. Fish almost never experience the intensity of white light that we enjoy, and very often some wavelengths are removed by the water, changing the appearance of colors.

Color In Water Compared With Air

Most of us are aware that white light is made up of many different wavelengths combined. When white light strikes an object, some wavelengths are absorbed and others are reflected. It is those wavelengths that are reflected from the object that reach our eyes and are interpreted by our brain as color.

Objects that reflect all of the wavelengths in the human visible spectrum will appear to our eyes to be white, as shown below. Objects that absorb all wavelengths of light are interpreted by our brain as being black.

Most objects absorb some wavelengths and reflect others and it is the combination of reflected wavelengths that we perceive as color. For example, when white light strikes a leaf, most of the red, orange, yellow, blue, indigo and violet wavelengths get absorbed, but green wavelengths are reflected and are detected by our eyes, as shown below.



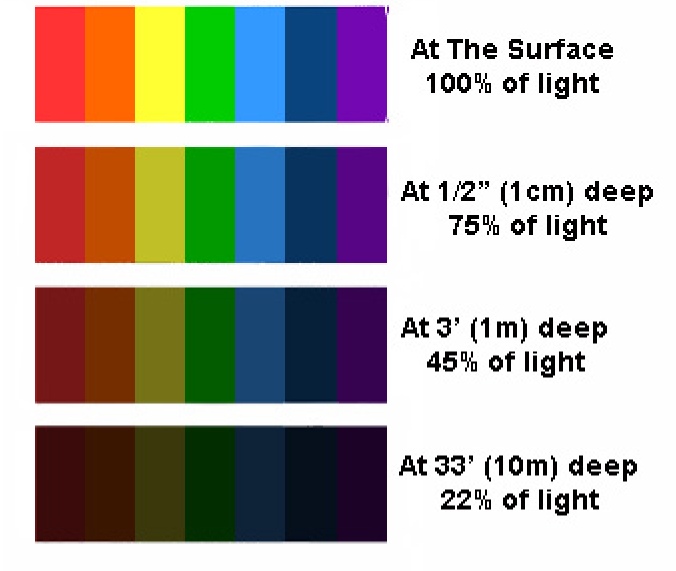
No matter how pure or clean water might be, light in water behaves very differently to light passing in air.

Water molecules allow some light to pass through, but some light is lost to absorption as well as scattering. In fact, 25% of light is lost by the time you reach a depth of ……. ½" (12mm). That's not a typo……. ½" deep, 25% of light lost. And remember, this is a scientific fact and has been measured thousands of times by thousands of people all over the world using underwater irradiameters, myself included.

To help visualize what this means, imagine removing a 100 watt light globe in your living room and replacing it with a 75 watt globe. Does that make things look a little drab? You bet!

By the time you reach 3ft (1m), 55% of the light that hit the water surface has been scattered or absorbed, so take that 75 watt globe out and replace it with a 45 watt version and see how much that reduces the vibrancy of the colors in the room.

Only 22% of the light that strikes the water surface gets down to 33 feet (10m), and as you go deeper this steadily starts to disappear too[3].



And please keep in mind that what I'm showing you is the best case scenario. For light to penetrate this well requires a cloudless day with the sun high overhead, no wind and ultra-clear water. Start throwing a little cloudiness into the water, or some algae, or wind ripple, turbulence…….even less light gets down to where the fish are.

Water Changes Color Perception

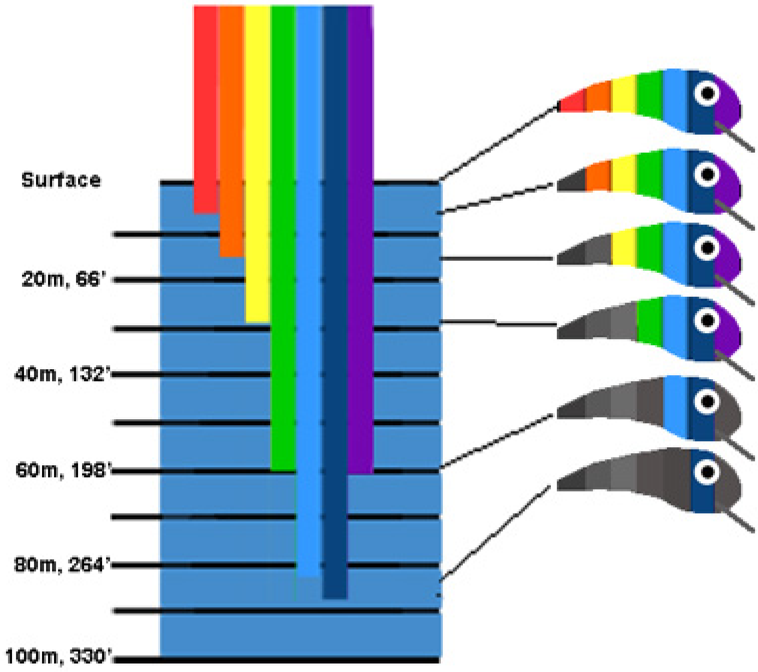
The color puzzle gets even more complex when we consider that some of the wavelengths that make up white light are more susceptible to being scattered or absorbed, while others can penetrate a little deeper into the water.

Generally, when the water is clear the longer wavelengths (near infra-red, red and orange) are the ones most readily absorbed by the water molecules while the shorter ones (blues and violets) penetrate deeper into the water.

Let's think about what it's like deeper in the water and go back to my previous analogy of the room that was lit by emergency lighting. Only in this case it's not red light, because we now know that red light gets quickly absorbed, it's blue light. So how would your chosen lure look if it was lit only by a dull blue light? If it was any color other than blue it would probably appear as a shade of grey!

So if a lure were to start at the surface of a crystal clear lake and dive ever deeper, the first color to become invisible would be red, then orange, yellow, green, violet and finally blue.

Unfortunately, things get a little hazy when we try to work out at what depth each color fades away, because so many factors change the optical properties of the water, but below is an example of how changes in depth can impact on the visual appearance of color in very clear water.



Water Clarity And Color Affect Lure Color

There are two very good reasons why light penetrates deeper into oceanic waters than it does most freshwater lakes, for example: low turbidity and low color.

Turbidity refers to anything that makes the water cloudy, such as silt, algae and so on. Microscopic particles of silt or sediment create turbidity that causes light to scatter and reduces the penetration of all wavelengths, but especially the longer ones (reds and oranges).

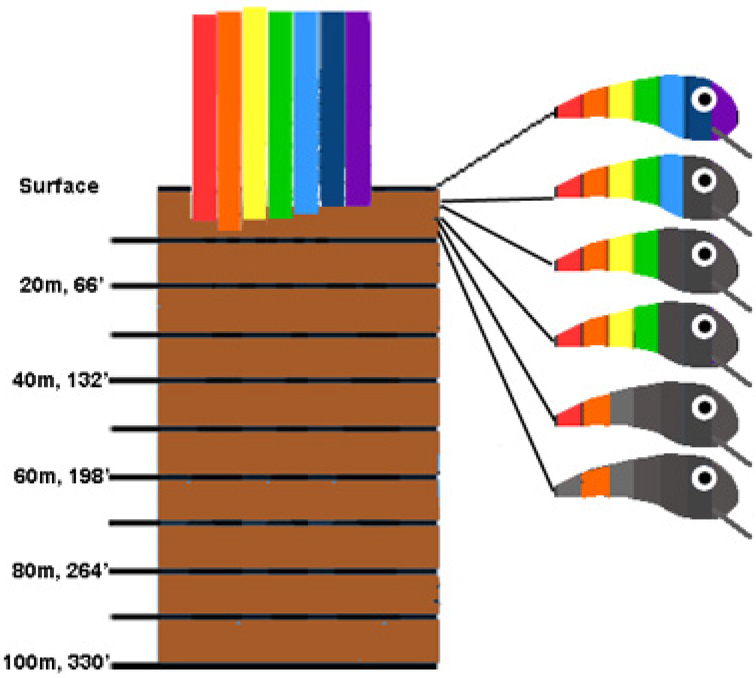
In open oceans this is less problematic because the water is generally free from alga or sediment and is very clear, but the story is very different in coastal and inland waters, where pollution, erosion and algal growth reduce clarity. Sometimes, coastal and inland waters can look reasonably clear to the naked eye but the microscopic particles significantly reduce light penetration. The main thing you need to know is that light, generally speaking, doesn't penetrate anywhere near so deep in the coastal and inland waters where 95% of fishermen spend their time.

Water that is made turbid by silt or sediment particles (eg following heavy rains) has different optical properties than water that has been made turbid by an algal bloom. Sediments tend to absorb the shorter wavelengths, from yellows and greens through to violet and ultraviolet, allowing only the reds and oranges to penetrate. Algae, on the other hand, tend to absorb most wavelengths other than green, making everything in the water appear greenish.

Water color is caused by dissolved materials and is very different to turbidity. A cup of black tea is a good example of water that has low turbidity and lots of color. Add milk and it has both turbidity and color.

Color is more common in freshwater and estuarine waters than in marine and coastal areas. It is usually caused by dissolved organic chemicals like humins and tannins that might come from decaying terrestrial or aquatic vegetation. These substances reduce light penetration in the water column by absorbing some wavelengths more than others. Highly colored water is not that unusual and doesn't necessarily mean that a water body is unhealthy – it is quite often a natural phenomenon.

Highly colored water caused the absorption of all wavelengths, but it's the blue and green wavelengths that are most affected. Scientists refer to these systems as "red window" lakes, because all but the red and orange wavelengths tend to be filtered out within the first inch (25mm) or so. Everything in these highly colored systems has a red hue, whilst all other colors appear greyscale, as shown in the diagram below.



Just how deep the red and orange wavelengths can penetrate depends on a lot of factors, such as the amount of color in the water, the intensity of the sunlight and the angle of the sun in the sky. Essentially though, highly colored waters are pretty dark, colorless places for fish to live.

Seasonal Color Cycles Experienced By Fish

The penetration of light (and thus the colors that are visible to fish) in most lakes and oceans actually has a seasonal cycle that is linked to physical and biological processes. This can differ a little between tropical and temperate zones, northern and southern hemispheres. Let's take a look at a typical example for a reasonably deep freshwater lake in a temperate or sub-tropical area.

Over the summer months, longer days tend to encourage the growth of planktonic algae, which may or may not be visible to the eye, depending on how dense the growth is. Algae scatter all wavelengths of light and absorb all but the green wavelengths. Green will be the most visible color, but other colors will still be visible near the water surface. Everything in the lake will have a greenish hue and most other colors will look greyscale deeper in the water.

As summer moves into fall, the growth of algae tends to peak, which further reduces light penetration and makes colors other than green even less visible to fish. The days grow shorter and the angle of the sun further reduces light penetration (we'll talk about this a little more shortly).

By the time winter arrives, the days are shorter, so the growth of algae tends to die back, leaving the water very clear and allowing light to penetrate much deeper than in summer and fall (assuming that flood waters don't bring dirty water into the system). On the other hand, the sun is lower in the sky and can conspire with greater cloud cover to reduce the amount of light available, so even though light penetration is often good in winter, the underwater world may still be a little dull and gloomy. However, on a clear and sunny winter's day it's not unusual for colors to be more visible to fish.

With the spring comes warming of the water surface and increasing day lengths, which begin to stimulate algal growth and the cycle starts once again.

Of course, the scenario can be a little different in the tropics or in cold climates where lakes freeze over. It can also be affected by things like turbid inflows, changes in water level, an influx of tannins and so on. But you get the idea that the underwater light climate is constantly changing and is certainly influenced by seasonal factors.

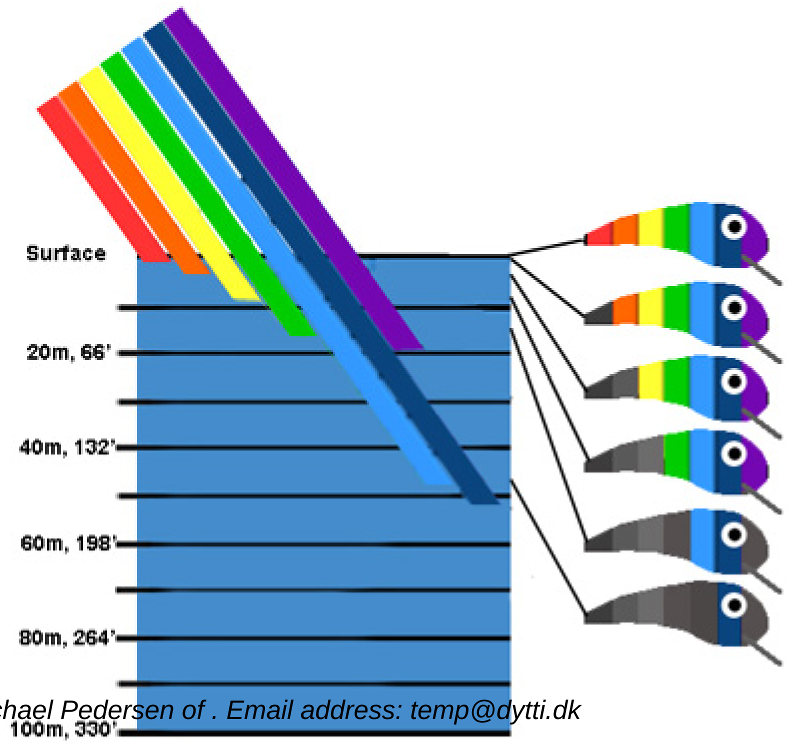
Angle Of The Sun And Color Visibility

One of the biggest influences on how much light actually makes it into the water and how much is scattered away at the surface is the angle of the sun on the water. When the sun is directly overhead, light strikes the water at right angles and scattering is minimal, so the maximum amount of light enters the water. Conversely, when the sun is low in the sky the light strikes the water at an angle, which causes a large proportion of the light to be bounced off.

Try throwing a stone vertically at the water and it penetrates the surface and sinks. Throw it horizontally and it will bounce off the water and “skip”. Light is the same, the lower the sun is in the sky, the more light is bounced away rather than penetrating into the water column. Less light means less color.

The wavelengths of light that reach as far as the water surface also change during the dawn and dusk periods. On a clear day with the sun overhead the light has a short path through the atmosphere, so there are fewer gas molecules and airborne particles to scatter the short (blue) wavelengths. Towards dusk the path of the light through the atmosphere lengthens, so there is a lot more opportunity for blue wavelengths to get scattered. Red and orange wavelengths eventually give way to indigos and violets giving us a spectacular sunset. Have you ever noticed that the most spectacular sunsets often occur when there is a smoke haze? That’s because the smoke particles filter out the blue and green wavelengths earlier in the evening, while the sun is still strong.

The aquatic environment not only emulates what happens above the waterline, but magnifies the effect. So the loss of blue wavelengths at each end of the day is much greater underwater and starts earlier in the day than it does above water. Remember that these are the ones that penetrate deepest, so the period over which colors are visible deep in the water are much shorter than they are at the surface.



The figure above shows how light penetration is affected by the angle of the sun above the water. Note that all the wavelengths penetrate the water to the same extent, but as the light comes in at an angle, not all wavelengths will reach the same depth.

During winter, this effect is even more pronounced, because the sun is always lower in the sky than in summer, so there is a constantly changing light climate from season to season.

Surface Activity And Color Visibility

Are you starting to realize that there are a lot of factors that affect the colors that fish can see? But there is still more.

Wind disturbs the water surface and causes light to diffract and scatter more so than a flat surface, much like rippled glass on a bathroom window confuses the light and softens it. When wind is present, some of the light penetrates the water, but much of it is reflected, scattered or absorbed, resulting in a reduction in the penetration of all wavelengths.

Essentially, a windy day with lots of surface chop dulls colors below the water surface and makes them less vibrant. The stronger the wind or the more disturbed the water surface, the more this effect will be felt.

Very windy and rough conditions with breaking waves and foamy water near the surface can literally shade the water below, making colors generally dull and the light stippled. This can make color visibility very poor indeed.

Fish Color Perception From A Distance

Some folk find this final concept a little hard to get their heads around, but it's an important one to grasp so I'll make it as simple as I can. Here it is:

The distance that light travels through the water varies according to all of the variables we have discussed: turbidity, color, seasonal factors, wind ripple and so on. But at any point in time, the distance that light can travel horizontally beneath the water surface is the same as the distance it can travel vertically.

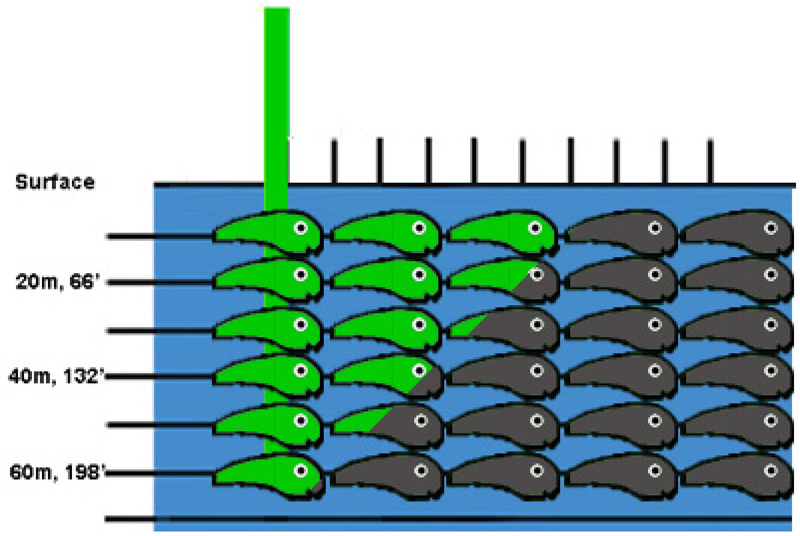
Let's imagine a flashlight that is equal in intensity to the sunlight at the water surface. Now put the flashlight beneath the water and shine it horizontally. Now let's say that on this particular day, blue wavelengths from sunlight are able to penetrate to a depth of 20 feet (6.5m). If that's the case, the blue wavelengths from the flashlight would travel 20 feet in whichever direction you aimed it.

As we know, for a fish to perceive a blue color, some of those blue wavelengths must bounce off an object and reach the fish's eye. Now let's say the blue object that the fish is looking at is at a depth of 15 feet (5m). Since the blue wavelengths are only travelling 20 feet (6.5m) the fish would need to be within 5 feet (1.5m) to have any chance of recognising the object as being blue in color (actually, some of the blue wavelengths are scattered and absorbed by the object so the distance would be slightly less, but let's keep things simple).

If the object was moved up to 10 feet (3m) below the water surface, then there is a reasonable chance of a fish perceiving the color of the object as being blue if it is within 10 feet of the object.

But remember, blue is the deepest penetrating light, so when we start looking at wavelengths that are absorbed or scattered at shallower depths this becomes more of a problem. For example, in real-world conditions red wavelengths often only penetrate to a depth of 3-6 feet (1-2m). So for a fish to see the color red on an object that is 3 feet below the surface it often needs to be within 3 feet or less of the object. Once the object is down at a depth of 5-6 feet (1.5-2m) the fish would need to be within a few inches for red to be visible.

The diagram below illustrates what I'm saying. In essence, the deeper the fish is below the water surface the closer it needs to be to the lure in order to see the color.



Other Visual Stimuli For Fish

As you are well aware, this eBook is principally about what colors are visible to fish and how to use that information to make intelligent lure choices. But there are a number of additional factors that affect the visibility of your lures to fish. These aren't to do with color *per se*, but are nonetheless related to how light behaves beneath the water surface and how your lure or bait is perceived by the fish. So I've decided to include them!

Fluorescence And Luminescence

Fluorescence occurs when light of one wavelength strikes an object and is reflected off at a different wavelength, usually a longer one. For example, a lure that is painted fluorescent green will reflect the green wavelengths from sunlight as normal. However, a proportion of the blue wavelengths that strike the lure will be reflected off as longer (green) wavelengths. As a result the green wavelengths are intensified and the blue ones are missing, so the lure will look ultra bright green to our eyes.

In a more practical sense, fluorescent colors allow us to present colors to fish that are deeper in the water. To use our fluorescent green lure as an example once again, let's say it's a deep diving lure. Now, at the surface our lure may look very unnatural, as fluorescence as a rule is uncommon in aquatic environments. But as the lure dives deeper the intensity of the color is reduced, and eventually it will reach a depth at which the green wavelengths from sunlight are unable to penetrate. At this point a normal green lure would appear grey to a fish, but a fluorescent green lure will continue to convert blue wavelengths into green. So fish can effectively see a green lure where everything else around them appears blue!

This effect is even more pronounced when lures are painted fluorescent yellow, orange or red. These colors are associated with long wavelength light that doesn't normally extend too far below the surface. But even though these long wavelengths may have been filtered out, the conversion of shorter wavelengths can suddenly make red, orange and yellow visible to fish at depths where these colors couldn't otherwise be seen.

Fluorescent colors create an interesting conundrum. Although they may look unnatural at the water surface, at greater depth the brightness is lost and the resulting colors can look much more natural. However, a lure that is yellow when everything else around it is blue may still look out of place.

My personal theory on the matter is that fish don't make the connection. If they are feeding on bait that are, say, orange in color (eg crawdads) then I suspect they would take a fluorescent orange lure fished at a depth where everything else appears blue-green or greyscale. My experience is that they associate that color with a food item and will engulf it despite the lack of background color.

Luminescence is very different to fluorescence and occurs when an object that has been illuminated by sunlight or by an artificial light source continues to glow for a while after the light source has been removed. Usually the paints that cause luminescence are pale green in daylight or under artificial lights and have a peculiar green glow when they are then moved to low light.

The idea of luminescent lures may seem a little odd at first, but consider that the color and glow of luminescent paint is quite similar to that glow and color of the phosphorescent algae that often light up in green sparkles when a baitfish swims through. It's also similar to the glow of the tiny lights that some deep sea fish use to lure and trap prey.

Annecdotally, there is plenty to suggest that luminescence has a place in helping fish to find your lure. However, it seems that to be effective, luminescence must be used sparingly and that low intensity glow works better than a lure that glows like a beacon. Lures that have eyes, occasional spots or other subtle markings painted with luminescent paints that glows dimly seem to be far more effective than those that have a large proportion of their body coated in the glowing stuff[17].

Flash: The Beacon That Attracts Predators!

Have you ever noticed a flash of light as a distant boat bobs in the swell or motors along? Did it catch your attention and did your eyes keep going back to that spot on the horizon where you last saw it? Or maybe you've noticed a flash of light on the beach and gone over to check whether it was a shiny coin or just a piece of tin foil or plastic?

Shiny surfaces can reflect light at 10 times or more the intensity required for us to be able to see it, so we can see a flash of light from a very long way off, well before we can see the color of the object that caused it. Because a flash of light happens very quickly, our iris doesn't have to constrict the pupil and keep the light down to a level that the light sensitive rod cells can handle. The result is that a flash can actually be painful and leaves "spots" in our eyes, because the rod and cone cells are temporarily disabled by the overwhelming brightness.

When this happens repeatedly within a short space of time, our brain becomes tuned in to the annoyance that keeps causing us pain and lost vision, and that's why you find yourself looking at the spot where the last flash occurred and trying to work out what caused it.

During daylight hours, predatory fish can home in on flashes of light even faster than humans because it is part of their survival strategy. In the underwater world the most common reason for a flash of light is sunlight reflecting off scales. How many times have you watched a documentary when a school of baitfish turns in unison, with a massive flash of silver off their collective sides? And how much more frequent is the flashing when that school of fish is being pursued by a predator and is ducking and weaving in all directions?

For us, a bright flash makes us curious and holds our attention, but for animals whose very survival depends on finding and hunting baitfish, a bright flash is a dinner bell! They are instinctively attuned to detect flash and will almost always go to investigate the source. Maybe there is a feeding frenzy going on and they want their share!

Offshore game fishermen have long understood the value of flash, and usually troll large mirrored teaser lures behind their boat to mimic the flash of bait schools.

Lures finished with holographic, metallic, chrome, flake and similar bright, shiny finishes can create flash that will attract a fish from a long way off – much further in fact than they can see color. For lures that are painted in non-metallic colors the clear coat plays an important role in giving the lure a reflective surface that creates flash. The latter is more subtle than a mirror-like chrome surface, but is still a very important fish attractant.

Contrast – The Secret To Getting More Strikes!

If there is one thing that is certain to make objects more visible to fish it would have to be contrast.

Contrast refers to the difference in color and brightness between different parts of a scene that allow those parts to be distinguished from each other or from a background. Maximum contrast occurs when black and white are placed side by side, but anywhere a dark and light color are put together (or light and dark hues of the same color), you will get good contrast.

To go back to our knowledge of how a fish's eyes actually work, the rod cells in the retina that are extremely good at sensing changes in light are far more prevalent than the cone cells that sense color. What that means in practice, is that fishes eyes (and ours, too) are very good at detecting contrast.

In a fishing context there are two types of contrast: Contrast between your lure and the background against which the fish is viewing it, and contrast between the colors within your lure.

Good examples of lure colors that contrast against their background include:

- Dark colored lures against a light colored, sandy bottom
- White lures against dark brown backgrounds of logs or rocks
- Bright yellow or chartreuse lures against the blue background of the open ocean
- Pink lures against a green backdrop of aquatic vegetation

Examples of contrast within a lure include:

- A dark back with a lighter belly (common in nature)
- Dark spots, blotches or bands on the back or sides of a light colored lure
- A white eye pupil on a dark colored lure body
- Alternating light and dark bands

Using contrast effectively may not always mean choosing the brightest and most visible color under a particular set of circumstances. Quite often the natural food items on which fish are feeding are similar in color to their background – they use camouflage to avoid being eaten. If fish are selectively feeding on green baitfish amongst aquatic vegetation a bright pink lure might be ignored because it looks unnatural, even though it might be easier to see. Other times a pink lure might bring a reaction strike, so there are never any hard and fast rules for color selection.

Ultra-realistic Paint Jobs

It's worth making mention here of one of the trends that has emerged in the lure making industry over quite a few years now – exquisite paint jobs that give lures an ultra realistic appearance. Many commercial lures today have amazingly detailed painted finishes. Eyes, gill plates, fins, tails, scales, you name it. Unfortunately, you can't always judge the quality of the lure from the quality of the paint job, and I've been sucked in before by some great looking lures that were dismal performers.

And that brings me exactly to my point: Super detailed paint jobs are extremely important………. to lure makers. Not fish, lure makers!

Why?

Because people will buy a product that looks professional. People love detail and realism, and they can't see the lure working (or not working, as the case may be) on the tackle shop shelves. They get mesmerized by a glitzy looking lure.

In practice, we now know that fish often can't see the color of your lure and that they have limited ability to focus their eyesight. Add to the equation that your lure is moving, often quite erratically, and it becomes pretty much impossible for a fish to examine a lure closely enough to be mesmerized. Fish must make a decision: if your lure is the right size and shape, has a natural action, makes a vibration like a food item and is the right color (assuming color is visible) then they'll inhale it. They don't count the number of spots or scales on the caudal peduncle before they make that decision – and you shouldn't either!

And don't blame the lure makers, either. They are in the business to make a buck, and even the most effective fishing lure on the planet won't get a second glance from most anglers if it looks as though it was painted by a preschooler. Think about it, would you buy strawberry icecream that was brown in color?

If they want to stay in business they have no option but to produce lures that look as good as their competitors. So unfortunately an enormous amount of effort is expended on developing high tech painting systems and making lures the spitting image of real baitfish – and we pay for it in the lure prices! As a lure maker and author I do the same thing, expending enormous time and effort to paint lures professionally just so my customers and readers are convinced that I'm professional. Lure I make for my own use don't need to look so slick, but they'll catch just as many fish!

Hunger Versus Reaction Strikes

A hunger strike is what happens when fish are actively hunting and feeding - in other words they hit your lure because they are hungry. Usually hunger has been stimulated by conditions or some kind of event, such as bait migration, warming water or pre-spawn conditioning. Often a hunger strike will occur when your lure closely resembles the food that fish are actively feeding on.

A reaction strike is what happens when a fish hits a lure more out of aggression, annoyance, self defence or territorialism rather than hunger. In my opinion, we probably underestimate the proportion of our strikes that are actually reaction strikes.

Generally, when fish are actively hunting, they are attuned to a particular food item, so getting a hook up means selecting a lure that is the right size, shape and (sometimes) color to imitate the natural food source. Then it's a case of getting it in front of the fish and imparting the right kind of action.

At times fish will react aggressively to almost any lure that swims past, particularly if they are being territorial. At other times fish will be shut down and have to be annoyed into striking your lure. Bright, gaudy colors are one way of annoying fish into striking, and a lot of fishermen focus on this approach. But because we now know that those bright colors might not always be visible to fish, we need to consider other ways to get their attention. Flash, movement, vibration, contrast, lure size/shape and noise might be much more successful in waking up a lazy fish at those times when colors are not so visible.

Things You <u>Must</u> Get Right Before Choosing A Color…..

The following guide has been put together to assist you in choosing effective lure colors. However, the main rule of choosing lure colors is that the fish make the rules. I have provided information based on facts about the transmission of light in water and on the current understanding of how fish see and interpret colors, but just because the color you choose might be visible to a fish doesn't mean that a fish will automatically take it.

As I've mentioned before, my personal view is that the diving depth, size, shape and vibration of a lure are generally far more important than color. I'd wager that most times when we are struggling to entice a fish to a lure it will be because we have one or more of these four factors wrong rather than the wrong color.

<u>Diving Depth</u>

How deep will you be working your lure?

This is perhaps one of the most critical things you need to get your head around, because unless you are getting your lure into "the zone", the fish are not going to see it and you'll be wasting your time dragging lures through fishless water.

What is 'the zone"?

It's that area on the fish's radar where a lure is close enough that it will be noticed and, hopefully, will spark enough interest to make the fish come for a closer look. The zone is completely independent of light penetration and color: quite often the colors of a lure that is in the zone won't be visible to a fish unless it comes to take a closer look. But movement, silhouette, contrast, noise or vibration do their thing and excite the fish enough to come and inspect the lure, after which color may or may not play a role.

Like everything in fishing, there are very few hard and fast rules about how close a lure must be to the fish before it has entered the zone. Active, aggressive fish in warm water can move a long way to hit a lure, while passive, shut-down fish in cold water may ignore anything that is more than a foot or two away. Some species are fast swimmers and will travel great distances to chase down a baitfish while others prefer to lie in wait until one comes within striking distance. Knowing something about the habits of your target species will greatly increase your chances of catching fish.

One thing that almost always holds true though is that fish will rarely move downwards to strike at a lure that is swimming deeper in the water column, but they will often travel a long way upwards. Personally, I find that in freshwater there is a “sweet spot” around 2-6 feet (1-2m) above the fish that generally seems to be the optimum distance to work my lures. But this is a generality, sometimes fish will travel further and other times my lure almost has to hit them on the head.

For ocean game fish, this distance is often much greater, and it’s not unusual for fish to travel 35 feet (10m) from bottom structure to nail a lure near the surface.

Knowing what depth fish are holding at is easiest if you are boat fishing and have a good fish finder, and particularly when fish are suspending in mid water. If you are shore fishing, casting from a kayak or don’t have a fish finder, then knowing the depth to work your lure takes a little more experimentation. In that situation it is best to start with shallow running lures and work your way down from the top of the water by changing to progressively deeper running lures until you start either hooking fish or striking the bottom or whatever structure might be around. Alternatively, you could use a sinking lure and count down so that your lure is worked progressively deeper with each cast.

Getting your lure into the zone is one of the greatest skills in lure fishing and requires an excellent knowledge of your quarry, the lures you are using and the nature of the water you are fishing. There is no substitute for experience when it comes to perfecting this skill.

Noise and Vibration

Sound travels five times faster in water than it does in air, so it stands to reason that fish are highly tuned in to noise for self preservation, hunting and also for navigation. Evidence indicates that some fish species are better adapted to hear sound than others. However, most can not only distinguish specific sounds above a background noise such as breaking waves or the hum of a diesel engine, but that they are also able to determine the direction and distance of the source[(18)].

Unlike light, sound is not affected by water color, time of day, depth and so on, and that makes it important to predatory fish because it is a very reliable sense.

To fish, sound and vibration are two very closely related sensations. As most anglers would be aware, fish have an external sensory organ known as the “lateral line” that is visible and runs from just behind the operculum (gill covers) to the caudal peduncle (tail wrist). The lateral line is a very sensitive organ that detects the tiniest changes in water pressure, vibrations and so on. It assists the specialized organs that are used for hearing and are located in the fish's head[(19)].

The lateral line is incredibly sensitive to vibration and movement near the fish, even in very turbulent water. For tightly schooling baitfish, the lateral line is a navigation tool and is the reason that an entire school of baitfish can change direction simultaneously. Fish can sense the size and shape of your lure based on the vibration it creates and can get a good sense of the proximity of your lure.

All fishing lures make some noise and vibration by virtue of the clatter of steel hooks and rings against other lure parts. But of course many lures are also fitted with internal rattles that are specifically intended to create maximum underwater commotion. The pitch of the noise depends on a few factors such as the material the lure body is made from, whether the rattle chambers are glass or plastic and whether the rattles are steel, tungsten, plastic or glass beads.

Because noise is conducted so well by water it can significantly extend "the zone" and make fish aware of your lure and its location, even when the visibility is exceptionally poor. It's worth trying noisy lures when the water is cloudy, is tinged with algae, is turbulent or foamy or when there is a lot of background noise such as boats, wave action and so on. Of course, noisy lures also come into their own when the water is tannin stained or if you are fishing during low light periods and can sometimes create a reaction strike if fish are sluggish due to cooler water or other circumstances.

Conversely, noisy lures can actually scare fish if they are used in skinny, shallow water that is naturally very quiet. Anecdotally, the explosion in the fishing lure market of rattlebaits and noisy crankbaits has resulted in the fish in some more heavily fished waters becoming cautious about taking noisy lures.

A common strategy when fishing for shut down fish that remain close to heavy cover is to deliberately smash lures into the snags to make as much noise as possible. This is particularly effective using a variety of soft plastic lures and crankbaits, particularly the square-billed variety. Once again, the noise and commotion can attract a fish long before there is any chance it will have seen the color of your offering.

Size and body shape of lures

The size and shape of your fishing lure bodies play two important roles in convincing fish that they are something worth going to investigate: 1. They provide an outline or silhouette that hopefully resembles the food items that your target is familiar with and 2. They determine the nature of the vibration that your lure will emit.

Remember, the lateral line of most game fish species is extremely sensitive and can detect minute vibrations and changes in water pressure. A spinning blade on a spinnerbait, the gentle fizzing of a propbait or the side to side wobble of a crankbait all emit very different vibrations and, you guessed it, these vibrations can be easily detected by fish even when the lure color cannot.

When using hard bodied lures I like to match the body shape to the primary food items that I suspect the fish are feeding on. If it's minnow, hardyhead or smelt then a slender crankbait emits a vibration that is similar to those species. If it's bony bream, shad or herring then a lipless crank has a tighter shimmy and the deeper body shape moves more water with each wobble, much like the real fish. If crawfish are the primary food source then a stocky, thick bodied crank with a strong, rhythmic beating action is a good match for the powerful tail beats of the craw.

Matching the size and shape of your lures to the primary food source of your quarry takes a little knowledge about baitfish species in your area and about what baitfish the fish are likely to be targeting and when. But it's worth going to some effort to acquire this knowledge as it will significantly improve your results.

Take the scenario that you are fishing after dark and the fish are feeding on herring, which are deep bodied, flat sided fish that swim with a tight shimmy. Because its dark and the fish can't see, they'll be relying on the lateral line to detect unlucky herring and the fish will be focussed on the particular high frequency vibration that herring emit. If you tie on a jerkbait that is long and slender or a spinnerbait with a Colorado blade you'll be creating a completely different vibration. If fish are fixated on herring then they may ignore your offering. Then again, maybe it will make your lure stand out and could work to your advantage. In my experience it will get ignored nine times out of ten, but now and then if things aren't working it is worth switching to something different just to see if you can get the fish's attention!

<u>Contrasting colors</u>

We've already discussed contrast to some extent in the previous chapter, so I won't say too much more on the subject except that it's probably a more important visual stimulus to game fish than color itself.

Choosing lures that contrast with the background, or ones that have bold bands, stripes or spots in contrasty colors can improve the visibility of your lure to fish even when the colors themselves are not visible. Keep in mind that fish very often strike from below, so colors that contrast with the sky are often a very good choice.

Intelligent Color Selection

So now we get to where this eBook has been leading – choosing lure colors that will improve your chances of catching fish on any particular day. To refresh our memories, let's recap the key elements discussed so far:

- Fish have limited distance vision and can only focus on objects that are close-by
- Color vision in fish tends to be adapted to their preferred habitat
- Fish see well in low light, but only in greyscale
- Fish are particularly good at visually detecting contrast and movement
- Fish rarely hunt exclusively using visual means. Smell, taste, feel or other senses usually assist and may play a larger role than sight.
- Light is dulled by water, so all colors are less bright to fish than they appear to us above water
- Some wavelengths of light don't penetrate far into water, so reds, yellows and oranges are often less visible than blues and greens
- The visibility of colors under water is influenced by water clarity, water color, time of day, time of year, surface conditions and so on. It's constantly changing hourly, daily and seasonally.
- Just because a color might be visible doesn't mean it is the best color to use on a given day!

- Fish often feed best in environments where color visibility is low, eg dawn and dusk, shady spots, deeper water, turbulent conditions or cloudy water.

Now, the above are just the scientifically measurable and provable variables. They don't take into account the whims of the fish in any way whatsoever. Whether fish are feeding aggressively or are "shut down"; whether they are targeting a particular prey item or feeding opportunistically on anything that swims by; whether they are alert and skittish or are relaxed and casual; migrating or territorial. So many other factors affect what fish will and won't eat that everything we've learned so far can only serve us as a starting point for selecting the right lure.

But we have to start somewhere, don't we?

If you are confident that you are fishing at the right depth, are using the right size and shape of lure and have considered your needs in terms of noise and contrast, then read on and I'll provide you with a color selection guide that will help with the final missing piece to the puzzle! I'll go through a variety of fishing scenarios and help you identify the colors that are visible to fish and those that aren't, and at the end of each scenario I'll give you a summary table as a quick reference guide.

To use this section you'll need to understand a couple of terms, which will help you to understand how the summary tables work.

Light Climate

This term refers to the amount of available light and is broken into 4 categories:

Vivid refers to periods when the light is extremely intense. A very bright, still, cloudless day between the hours of 10am to 4pm (summer) or 11am to 3pm (winter) would be an example of vivid conditions. The kind of light where you don't want to be caught without a good pair of polarised sunglasses!

Bright refers to periods when the light is not maximum intensity but is still quite strong, such as early morning, late afternoon, when there is a little wind or maybe some light and patchy cloud cover. You would still want sunglasses in bright light, but could manage without them if you had to.

Dull refers to periods around dawn and dusk when the light is very dim. It also applies to days when there is fairly heavy cloud cover, strong wind, or those days when there is significant wind ripple. The sort of days where a lot of the time it feels like twilight all day long – sunglasses are optional and might actually be too dark. The other time you'll experience dull conditions is when you are tossing lures into shadowy areas like under trees, bridges or undercut banks where the light is subdued, even if the day is still relatively bright.

Dark is pretty self explanatory: all of the hours between dusk and dawn. If the day is dull it also applies to those shadowy spots under bridges, undercuts and so on.

Water Depth

I've broken this up into 5 categories:

Surface: refers to lures that are being worked on or in the surface film, or down to a depth of 1 foot (30cm). Fish will always be taking these lures from beneath.

Shallow: refers to lures worked from 1 to 6 feet (0.3 to 2m) below the surface.

Medium: lures that are worked from 6 to 15 feet (2-5m).

Deep: lures that are worked from 15 to 30 feet (5-10m)

Very Deep: lures that are being worked deeper than 30 feet (10m), such as super deep diving crankbaits, or lures worked on leadlines, paravanes of downriggers.

Scenario 1: Clear Water Lakes, Rivers And Estuaries

Clear waters offer the best light transmission, and hence a greater range of colors are visible to a greater depth. The chance that fish will be hunting visually is relatively high, so assuming that all other factors have been properly considered during lure selection, the choice of color has high potential to influence catch rates.

Although many freshwater game fish are capable of seeing most colors in the human visible spectrum, most are particularly sensitive to colors in the red-orange and yellow-green wavelengths, so they'll see better contrast in these ranges.

Flash can be transmitted a long way when the water is clear and may attract predatory fish from a long way off. Most freshwater baitfish don't have the same sheen as their silvery saltwater cousins, so the use of chrome or metallic lures generally needs to be curbed, or at least properly thought through. If very silvery bait are encountered, or where fish are not feeding out of hunger these styles of lure may still work particularly well.

The most visible colors in clear rivers, lakes, estuaries and bays are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	All colors, esp dark ones	All colors, esp dark ones	Dark colors	Black, dark colors	Dark colors create silhoutte against the background sky
Shallow	All colors, esp red-orange or yellow-green	All colors, esp red-orange or yellow-green	All colors, esp yellow-green and fluor red/orange	Black, dark colors	Fish attuned to red-orange and yellow-green, which are visible in clear, shallow water
Medium	All colors, esp yellow-green	All colors, esp yellow-green and fluoro red-orange	All colors, esp fluoro yellow-green, chartreuse	Black, dark colors	Fluoro colors may extend working depth on dull days
Deep	Green, black, dark colors, fluoro red/green/yellow/orange	Dark colors, fluoro green	Black, dark colors, fluoro green	Black, dark colors	Loss of red-orange except on vivid days. Fluoro colors extend working depth of yellow-green
Very deep	Dark colors, fluoro green	Dark colors, esp black	Dark colors, esp black	Black, dark colors	Loss of most colors, use dark colors for contrast
	Most colors visible. Red, orange, yellow, green esp. good	Most colors visible. Red-orange may be less visible at medium or greater depth	Red-orange lost at relatively shallow depth. Yellow-green better visibility	Lure color not critical, dark colors give contrast	

Scenario 2: Mildly Turbid Lakes, Rivers And Estuaries

Mild cloudiness of the water (turbidity) is generally caused by microscopic particles of mineral material such as suspended soil, silt, sediment or clay. Technically, it can also be caused by a bloom of microscopic planktonic algae, but since algae have a different effect on lure colors than suspended sediments we'll look at that later (Scenario 4).

For the purposes of choosing lure colors, lets define mild turbidity as being a brown, reddish, whitish or yellow colored (i.e. not green) cloudiness that is visible to the naked eye, but is mild enough that you can see the bottom in at least 3 feet (1m) of water or more. Any more turbid than that and the impact on color visibility will be quite severe, so we'll look at that next in Scenario 3.

Some very productive lake, river and estuarine systems have some degree of turbidity all year around, while others might be seasonally affected by an influx of silt during the wetter months.

Shallow systems can become temporarily turbid as a result of wind action that whips up waves and stirs up the bottom sediments.

Whatever the reason for a system being turbid, the cloudiness in the water changes the light available to fish, so it strongly influences the colors that are visible.

Mild turbidity has the effect of absorbing most wavelengths of light, but red and orange wavelengths seem to be the least affected in most cases where soil or sediment has caused the cloudiness. You'll recall from our discussion on fish vision that many freshwater fish are adapted to be sensitive to colors in the red-orange and yellow-green wavelengths than others in the visible spectrum. This means that they can get better contrast and see those colors more clearly. This adaptation does not necessarily mean that they will take red-orange colored lures in preference to other colors, but it does allow them to find objects that are colored red-orange that might otherwise blend into the background. Other colors may appear more greyscale in the turbid environment but may still attract fish if they create contrast against the background.

Fluorescent colors can be useful in mildly turbid systems, particularly at medium depths or when the light is poor. Fluorescent reds and oranges, and to a lesser degree yellows and greens, can extend the depth to which these colors are visible. The loss of light intensity beneath the water surface makes these colors look more natural than they do above water, and they may stand out to fish as relatively bright objects against a duller red background.

The distance to which flash is transmitted is also reduced by turbidity, although the intensity of a flash of light means it is still visible to fish from much further away than a plain color. In fact, the turbidity diffuses the light reflected from a shiny surface and makes it less directional. To help visualize this, compare in your mind the difference between forked lightning and sheet lightning. If you're not looking in the right direction you might miss a bolt of forked lightning. Sheet lightning is less intense, but it momentarily lights the entire sky and catches your attention no matter which direction you were looking. A hungry predatory fish will be alerted by a flash and vibration before the lure is close enough for it to see color, so the use of metallic and chrome lures is not a bad plan when you are fishing in mildly turbid waters.

The other (non-color) consideration is that of noise. As visibility is reduced, increasing the volume of your lures using rattles or stronger action is often an effective strategy for helping fish find them in dim light.

The most visible colors in mildly turbid rivers, lakes, estuaries and bays are shown in the table below.

Water Depth	Light climate: Vivid	Bright	Dull	Dark	
Surface	All colors, esp dark ones	All colors, esp dark ones	Dark colors	Black, dark colors	Dark colors create silhoutte against sky backbground
Shallow	All colors, but esp red-orange	Red-orange, yellow-green, dark colors	Fluoro red-orange, fluoro yellow-green, dark colors	Black, dark colors	Reasonable color visibility on bright days, fades quickly if light is dim
Medium	Red-orange, fluoro red/orange, fluoro yellow/green, dark colors	Red-orange, fluoro red-orange, dark colors	Fluoro yellow/green, dark colors	Black, dark colors	At medium depths contrasty lure patterns improve visibility to fish. Yellow-green not visible unless fluoro
Deep	Fluoro red-orange, fluoro yellow-green, dark colors	Dark colors, esp black, brown and purple	Fluoro yellow/green, dark colors	Black, dark colors	Red-orange not visible, but fluro red-orange may be if turbidity is mild.
Very deep	Dark colors, esp black, brown and purple	Dark colors, esp black, brown and purple	Dark colors, esp black	Black, dark colors	Loss of most colors, contrasty color patterns and dark colors effective
	Silt turbidity gives everything a red hue in bright light. Intense light lets some other wavelengths penetrate	Red and orange may penetrate to normal depth, other colors disappear early. Fluoro colours worth a try.	Mild turbidity decimates color in dull light. Contrasty lures with dark bands/ stripes/spots work best.	Lure color not critical, dark colors give contrast	

Scenario 3: Strongly Turbid Rivers, Lakes And Estuaries

By strongly turbid conditions I'm referring to those systems where the water is too cloudy to be able to see the bottom in 3 feet (1m) of water or less. Once again we are talking about cloudiness caused by particles of silt, clay or sediment, not algae, so if the water has a green tinge then move on to Scenario 4.

Sometimes highly turbid water is a natural seasonal event, whereas other times it's caused by an unusually large flood, a landslip or some kind of erosion event either natural or man-made. If turbid inflows are a regular or seasonal event then it is likely that the fish will have adapted to this aspect of their environment and will continue to feed, perhaps even more aggressively than they might in clear water. If the turbidity is unusual, then it may shut the fish down until the water clears again.

Many fishermen are put off by very turbid water or are concerned that fish won't be able to find their lures. But as we now know, sight is just one sense that fish used to home in on prey, and they have plenty more hunting tools to call on.

In my younger days I fished regularly for brown trout during the winter floods in southern Australia (there was no closed season in those days). During the flood periods the water came down the river systems like a flowing torrent of mud and a hand placed beneath the water surface couldn't be seen beyond 1 inch (25mm) deep. I had some very productive sessions catching trophy fish on a regular basis from some very fast flowing, turbulent riffles in filthy water, in the middle of the night using a small black streamer fly that was no more than 1.5 inches (35mm) in length. Such is the sensitivity of the brown trouts sensory systems that they could easily find a small, silent black lure in highly turbulent, zero visibility conditions!

Heavy turbidity takes a significant toll on the visibility of almost all colors because very little light can actually penetrate deep enough to illuminate objects. That's why submerged aquatic plants won't be found in systems that are constantly turbid - there isn't enough light for photosynthesis to occur.

Even if you are fishing the shallows around a lake margin, very little color will be visible to the fish. Fluorescent colors can be worth a try in shallow waters, particularly reds, oranges and perhaps yellows. However, better results tend to come from using very contrasty patterns, irrespective of what colors are used. Bold bars, stripes, spots and so on have the maximum visual effect as they send a signal to the rod cells on which the fish eyes are relying in low light conditions.

For me, solid black or solid white lures have always been the most effective in really dirty water because they contrast strongly with the dimly lit and dull colored background. Browns, dark blue and purple are also a good choice.

The distance to which flash is transmitted is also reduced by turbidity, although the intensity of a flash of light means it is still visible to fish from much further away than a plain color. However, flash is much less effective in highly turbid waters than in those systems that are only mildly turbid, because there is not enough light penetrating beneath the surface to take advantage of a shiny lure. However, if fish are within reasonably close proximity to a flashy surface or shallow running lure, then you might get some benefit.

Once again, noise and vibration are very often effective strategies for helping fish find lures in dim light, so choosing lures with rattles, blades or very strong, pulsating swimming actions will make a difference.

The most visible colors in very turbid rivers, lakes, estuaries and bays are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	All colors, esp dark ones	Dark colors, chrome, metallic	Dark colors	Black	Dark colors create silhoutte against sky backbground
Shallow	Dark colors, fluoro red-orange, chromes and metallics	Dark colors, fluoro red-orange, chromes and metallics	Black, blue, purple, brown, white	Black	Very poor color visibility even on bright days. Fluoro colors and flash beneficial
Medium	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black	Very poor color visibility, contrast more important than color
Deep	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black	Very poor color visibility, contrast more important than color
Very deep	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black, blue, purple, brown, white	Black	Very poor color visibility, contrast more important than color
	Even close to surface color is very limited. Contrast important	Even close to surface color is very limited. Contrast important	Lure color not critical, dark colors give contrast	Lure color not critical, dark colors give contrast	

Scenario 4: Green (Algae) In Lakes

The type of algae that affects what lure colors we choose is the microscopic, planktonic variety that aren't normally visible to the naked eye, but give the water a greenish coloration. The growth of planktonic algae is a natural cycle and is important for the function of most lakes.

Heavy algal blooms sometimes occur where lakes are polluted with nutrients that stimulate their growth, and can sometimes become visible to the naked eye or even produce a scum on the water surface. The species responsible are frequently toxic, so I don't recommend fishing when these conditions occur. Therefore I won't be providing guidance on lure colors for heavy algal growth.

Microscopic algae require reasonably still conditions, so they don't often bloom in river systems unless they are very slow flowing. I'm going to focus on lake systems, but the same principles would apply for choosing lures for fishing a slow flowing, algae influenced river system.

The reason a lake that has a significant algal growth develops a greenish tinge is that algae absorb most wavelengths other than the green ones. As you'd imagine, any object that is illuminated with a green light will have a greenish appearance, so many of the other colors are not visible in a lake with an algal bloom. The longer wavelength colors in particular (such as red, orange and yellow) will appear as greyscale.

How much color visibility is affected by algal growth depends on the intensity of the algal bloom. As a general rule, the greener the water appears, the greater the reduction in color, even in the shallow surface waters.

Sometimes when algal growth is reasonably heavy, the algal cells can move up close to the water surface to get maximum exposure to sunlight. When this happens it is almost as though a big blanket has been thrown over the surface of the lake and is shading everything beneath. Within a foot or two (30-60 cm) all colors other than green disappear and soon afterwards even green light is scarce.

Because freshwater fish have a high sensitivity to light in the yellow-green spectrum, they are able to make out more detail on a green lure than some other colors and fish are therefore able to distinguish it from the green tinged background fairly easily. With only green wavelengths to illuminate your lure, a monochromatic pattern in green or a green and white pattern are relatively visible. Other colors appear greyscale, so bold colors that create contrast make the lure more visible to fish, even if the color itself appears grey. Of course, fluorescent yellows and greens take advantage of the limited blue wavelengths present to add vibrancy to their color and become more visible to fish.

If the algal growth is not too dense and isn't all at the water surface, then flash can again catch a fish's attention from a long way off, so chrome and metallic finishes are worth trying as well.

The most visible colors in green lakes are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	All colors, esp dark ones	All colors, esp dark ones	Dark colors	Black, dark colors	Dark colors create silhoutte against sky backbground
Shallow	All colors, but esp yellow-green, white	Yellow-green, red-orange, fluoro red-orange, white, dark colors	Fluoro yellow-green, fluoro red-orange, white, dark colors	Black, dark colors	Wavelengths except greens absorbed by algae. Other colors visible on bright days
Medium	Yellow-green, fluoro yellow-green, fluoro red/orange, dark colors	Yellow-green, fluoro yellow-green, dark colors	Fluoro yellow/green, white, dark colors	Black, dark colors	Little color left except greens. Fluoro colors help. Dark colors contrast and are easier to see
Deep	Fluoro yellow-green, dark colors	White, dark colors	Dark colors, esp black, brown, purple	Black, dark colors	Contrast the most important feature
Very deep	Dark colors, esp black, brown and purple	Dark colors, esp black, brown and purple	Dark colors, esp black	Black, dark colors	Very poor color visibility
	Algae reduce light intensity, colors dull, green wavelengths go deepest	Colors become more dull as light dims. Contrast increasingly important	Most colors not visible except fluoro yellow-green close to surface. Contrast more important than color	Lure color not critical, dark colors give contrast	

Scenario 5: Tea-Colored Rivers, Lakes And Estuaries

As we discussed in an earlier chapter, many natural waterways are highly colored by tannins, humins and other natural organic compounds. These waters are not cloudy but, like a cup of tea, they have a dark appearance as a result of dissolved materials.

I’ve worked and fished on some natural waterways that have been at least as dark as a strong cup of tea and from measurements I’ve taken more than 95% of light is blocked out in the first 2 feet (60cm). Those particular lakes are almost as dark as the underground cave lakes where blind fish live! This is certainly an extreme, but even mildly stained water has a surprising effect on underwater light and on the color of objects in the water.

In tea colored water, red wavelengths are allowed to penetrate through the upper layers, but most other wavelengths are quickly absorbed, so the entire environment has an eerie red appearance. Because freshwater game fish are often adapted to be sensitive to the red-orange spectrum, they are able to make out red and orange lures from the dark, red background. However, that doesn’t necessarily mean that red and orange lures are the most visible in tea colored water. Dark colors like black, dark blue and purple provide a strong contrast that fish can home in on, and white lures take on a lighter red appearance that also contrasts with the dark red background.

The surprise package when it comes to tea colored lake systems are the fluorescent colors, particularly orange and yellow, but also green to a lesser extent. Each of these colors absorbs the long wavelengths (red) and emits the shorter wavelength (oranges and yellows). In heavily stained systems this isn't much of an advantage because the shorter wavelengths that are emitted get absorbed before they get far from the lure, but in light to moderately stained systems they can be visible from a little further away. To a fish that has lived all of its life in a dark, red tinged environment an orange, yellow or green lure must stand out like a sore thumb! And whilst it can't look natural to the fish, my own experience and anecdotal feedback from others suggests that fluorescent colors are sometimes a good choice.

Depending on how heavily stained the water is, flash can also be a useful fish attractant in these environments. Unlike turbid waters, colored water doesn't make the bright momentary flash of light omnidirectional, it simply reduces the intensity. So in heavily colored water a bright shiny, metallic or chrome lure doesn't offer much advantage because the flash of light doesn't penetrate the gloom.

Once again, the best weapon for attracting fish in strongly colored waters is a strong vibration and lots of rattles to create as much noise and movement as possible for fish to home in on.

The most visible color choices for moderately tea colored waters are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	Dark colors, esp black	Dark colors, esp black	Dark colors, esp black	Black	Dark colors create silhoutte against sky background
Shallow	Black, red-orange, brown, white, fluoro orange, fluoro yellow, fluoro green	Black, red-orange, brown, white, fluoro orange, fluoro yellow, fluoro green	Black, blue, purple, brown, white, fluoro orange	Black	Very poor color visibility even on bright days. Fluoro colors and flash beneficial
Medium	Black, blue, purple, brown, white	Black, blue, purple, brown	Black, blue, purple, brown	Black	Dark colors for contrast, bold bands or bars can help
Deep	Black, blue, purple, brown	Black, blue, purple, brown	Black, blue, purple, brown	Black	Dark colors for contrast, bold bands or bars can help
Very deep	Black, blue, purple, brown	Black, blue, purple, brown	Black, blue, purple, brown	Black	Very poor color visibility, contrast more important than color
	Color is very limited. Contrast important. Fluoro orange, yellow green good near surface	Very little color even and/or light	Essentially a dark environment except near very surface	Lure color not critical, dark colors give contrast	

Scenario 6: Clear Water Coastal And Oceanic Locations

As in freshwater systems, clear waters in coastal and oceanic environments offer the best light transmission and greater visibility of all colors. In areas where the water is consistently clear, such as coral reefs and offshore waters, fish are likely to be hunting using all senses, including sight.

Many reef species have better than average color perception because they live in a colourful and well lit environment and their eye have adapted to this. However, offshore predators live in a world of blues and greens and whilst they can see other colors they are more attuned to the blues.

Flash is a very important feeding cue for many marine predators, so chrome and metallic finishes on lures can be particularly effective, and even a good quality high gloss finish can help attract attention. Lots of noise doesn't hurt, either, whether it be in the form of lots of rattles, surface commotion or just a very strong actioned lure.

Contrast can be a very powerful attractant in marine environments, but particularly in open ocean waters, where dark stripes, bands or spots on a metallic blue lure body can be a deadly combination in clear waters.

The most visible color choices for clear marine waters are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	All colors, esp dark ones	All colors, esp dark ones	Dark colors	Black, dark colors	Dark colors create silhoutte against the background sky
Shallow	All colors, esp red-orange or yellow-green	All colors, esp red-orange or yellow-green	All colors, esp yellow-green and fluor red/orange	Black, dark colors	Fish attuned to red-orange and yellow-green, which are visible in clear, shallow water
Medium	All colors, esp yellow-green	All colors, esp yellow-green and fluoro red-orange	All colors, esp fluoro yellow-green, chartreuse	Black, dark colors	Fluoro colors may extend working depth on dull days
Deep	Green, black, dark colors, fluoro red/green/yellow/orange	Dark colors, fluoro green	Black, dark colors, fluoro green	Black, dark colors	Loss of red-orange except on vivid days. Fluoro colors extend working depth of yellow-green
Very deep	Dark colors, fluoro green	Dark colors, esp black	Dark colors, esp black	Black, dark colors	Loss of most colors, use dark colors for contrast
	Most colors visible. Red, orange, yellow, green esp. good	Most colors visible. Red-orange may be less visible at medium or greater depth	Red-orange lost at relatively shallow depth. Yellow-green better visibility	Lure color not critical, dark colors give contrast	

Scenario 7: Mildly Turbid Coastal Waters

It is quite rare for deep oceanic waters to become cloudy because they are well away from terrestrial sources of silt and sediment and because the water is generally too deep for bottom sediments to be disturbed by wind or wave action.

On the other hand, coastal locations are frequently turbid, being influenced by silt discharged by rivers in flood and of course pollution. Then there is the effect of wave action, which can stir up bottom sediments and create cloudiness in the water. Usually, these effects are short-lived and the water clears after a few days or weeks.

Sometimes when there is a significant flow event, sediment laden fresh water can sit on top of the more dense seawater without mixing, resulting in a layer of dirty water above a layer of clear, clean seawater.

Turbidity in marine coastal environments can absorb different wavelengths depending on the nature and origin of the material. Organic rich sediments brought to the site by river discharge will absorb most wavelengths in the visible spectrum other than the red-orange colors, causing an effect similar to mild turbidity in freshwater environments.

Turbidity of marine origins (ie from the seabed) is often lighter in color and less organic and can have a whitish appearance that turns clear blue seawater into a pale green soup. This type of turbidity shades the water below from all wavelengths, but particularly the short wavelengths associated with the color blue.

We know that many coral reef fish enjoy good color perception across a broad spectrum of wavelengths, so those species are probably able to discern lures in the yellow-green wavelengths that are able to penetrate at least a little way into mildly turbid waters. However, the deeper water predators that sometimes visit coastal zones are more attuned to blue wavelengths and may not have their normal ability to detect contrast when the water is turbid. For these species the use of lures that contrast boldly with the background (eg dark colors) seems to work well, as do fluorescent blue colors that absorb yellow and green wavelengths and emit them as blue wavelengths.

Flash is a very important feeding cue for many marine predators, so chrome and metallic finishes on lures can be particularly effective, and even a good quality high gloss finish can help attract attention. As in freshwater systems that are affected by turbidity, the unidirectional nature of a flash of light is lost to a more broadscale flash when the water is cloudy. Whilst flash doesn't attract a fish's attention from the same distances under turbid conditions as clear, it is still far more visible than color. Research has certainly shown that marine fish in turbid water are readily able to find food that is well outside of their visual range, suggesting other senses play a large role[20].

Once again, lures that create a strong vibration or a lot of noise are not a bad choice under these conditions.

The most visible color choices for moderately turbid marine waters are shown in the table below.

Light climate

Water Depth	Vivid	Bright	Dull	Dark	
Surface	All colors, esp chromes and metallics	All colors, esp chromes and metallics	All colors, esp chromes and metallics	Black and other dark colors	Dark colors create silhoutte, chrome and metallic creates flash
Shallow	All colors, esp blue, green, white, chromes and metallics	Fluoro blue, green, white, chromes and metallics	Fluoro blue, yellow, green, white, chromes and metallics.	Black and other dark colors	Blue color penetrates surface layers, contrast helps with visibility
Medium	All colors, esp green, white, fluoro blue, chromes and metallics	Fluoresecent green, chromes and metallics, dark colors	Green, blue, purple, white, fluoro green, fluoro blue	Black and other dark colors	Fluoro colors extend visible depth range
Deep	Fluoresecent green, chromes and metallics, dark colors	Dark colors, green, blue, purple, white	Dark colors, green, blue, purple, white	Black and other dark colors	Loss of most colors due to shading, dark colors and contrast work best
Very deep	Dark colors best	Dark colors best	Dark colors best	Dark colors best	Loss of most colors, blues penetrate deepest, fluoro blue extends working depth
	Blue visible near surface but disppears earlier than in clear waters. Fluoro colors and greens most visible	Blue colors progressively disappear as light fades. Fluoro, contrast and flash help with lure visbility	Darker colors create contrast and are increasingly effective as the light fades	Lure color not critical, dark colors give contrast	

The final word

If you've read everything to this point then I'd like to congratulate you. Very few people put any serious thought into lure color selection; most will instead prefer to follow the flock, play the random color game or take the advice of the guy in the tackle store without further consideration.

By now you might be starting to realize why that is the case – understanding exactly what fish can see and what colors are visible is a complex business. There are so many factors to consider, and many of them change constantly.

If you are feeling a little overwhelmed then I'd like you to relax and remember something I said earlier on in this eBook:

Color is a small piece of the puzzle and is rarely as important as most anglers think. If you're not sure what color to use, be sure to get diving depth, size and shape and lure action right and then the color you choose will more often than not be irrelevant!

And even when color is a big part of the picture, by using your newfound understanding of how fish see color, you can narrow the range of likely colors down quickly and be catching fish sooner!

Further Reading

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Other Publications From the Author

Luremaking Publications

Greg Vinall's Complete Wooden Lure System

The most comprehensive wooden lure making system available anywhere! These amazing resources are available online to premium members of Greg's "Wooden Lures Inner Circle" membership site. For more information please visit www.makewoodenlures.com

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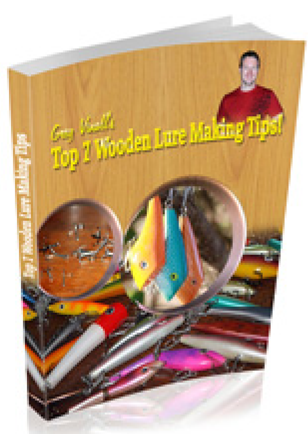
Greg Vinall's Top 7 Wooden Lure Making Tips



A free wooden luremaking resource that can be downloaded from Greg's website at www.makewoodenlures.com

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Make Your Own Fishing Lures: Wooden Lures

Greg's handbook for hand making professional quality wooden crankbaits using a minimum of tools.

Available for purchase and download at www.woodenlureworkshop.com

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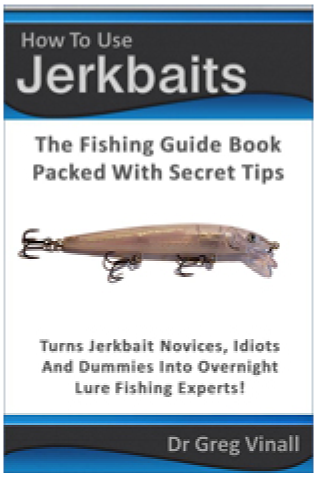
Make Your Own Fishing Lures: Plastic Lures

Greg's handbook for small scale production of plastic hard bodies lures. Available for purchase and download at www.makebetterfishinglures.com.

Lure Fishing Publications

How To Use Jerkbaits (Kindle Edition)



The ultimate resource for anyone wanting to learn the finer points to getting the most out of jerkbaits. Greg explains how jerkbaits can be fished effectively all year round, even to shut-down fish. Available at Amazon via this link

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Greg's Online Lure Making Resources

Make Wooden Lures

Wooden Lure Making Blog

The Wooden Lure Workshop

Hard Plastic Lure Making

About The Author

Greg Vinall is an incredibly passionate fisherman who has been using all kinds of lures since he was a small child and has been designing and making fishing lures for more than 30 years.

Not content with fishing only on weekends, Greg studied Aquatic Science and in 2001 was awarded a PhD for his research on the management of algae in freshwater lake systems. Greg has continued to work as a professional aquatic scientist and built his own speciality consultancy that helped large companies manage their impacts on freshwater lakes and rivers. But in 2011 Greg decided to pursue his true passion – lure making and lure fishing – through his writings on blogs, in eBooks and on websites. He sold his business, but continues to work as an aquatic scientist while he writes fishing articles.

Greg is a prolific author on the subject of lure making and is one of very few experts in this field that is willing to share the secret tips and tricks that can turn the novice home lure maker into a one-man factory that turns out professional quality lures!

He is skilled at turning technical aquatic science concepts into easy to understand fishing rules that can help anyone who is willing to apply thought to their lure making and/or lure fishing. Greg aims to heighten the understanding of every day fishermen to help them make intelligent lure selections and then fish those lures in a way that fish can't resist.

If you're serious about lure making and/or lure fishing, then jump aboard and share in the wealth of knowledge that is now being built and shared through Greg's eBooks, websites and blog. Or drop him a line on email, Facebook or Google+, his details are just below:

Email Greg at support@makewoodenlures.com

Facebook: www.facebook.com/WoodenLureMaking

Twitter: www.twitter.com/makelures

YouTube: www.youtube.com/user/Makelures