

WHAT A FISH KNOWS
© Jonathan Balcombe, PhD

transcript of illustrated (PowerPoint) lecture

- 1 Title slide
- 2 When I was eight I climbed into an aluminum rowboat with the elderly director of a summer camp north of Toronto. He rowed us out ¼ mile into the bay and we spent the next 2 hours fishing.
- 3 I caught sixteen fish that day. Some were released. Several larger ones were kept for breakfast the next day. Mr Nelson did all the dirty work, baiting the hooks with squirming earthworms, twisting the wire from the fishes' mouths, and plunging his knife into the skulls of the "keeper" fishes.
- 4 As a sensitive boy with a soft spot for animals, a lot of what went on in that rowboat disturbed me. I fretted privately about the worms, I wondered if the fishes felt pain as the hooks pierced their faces, and I worried that some of the keepers had survived the knife and were slowly dying in the basket that hung from the boat side.
- 5 I never took a shine to fishing. I soon lost interest when it came time to bait my own hooks and remove them from fish.
- 6 I just couldn't help seeing things from the fishes' perspective.
- 7 That was 50 years ago. Today, we continue to show a curious indifference to fishes. Their primary place in popular culture is as objects of food...
- 8 ... or a source of recreation and pleasure.
- 9 Fishing is perceived as so benign and beloved that it has become a sentimental symbol of all that's good about life.
- 10 Today I want to encourage you to consider fishes through a different lens.
- 11 I've spent many years swimming with ...
- 12 ... and researching and writing about fishes ...
- 13 ... culminating in a popular science book that advocates for fishes.
- 14 Fishes are incredibly **successful** and **diverse**.

- 15 There are more fish species on Earth today than all other vertebrates—birds, reptiles, mammals, and amphibians—combined. We are living in an age of fishes.
- 16 They range in size from this tiny goby of Philippine lakes, which measure 1/3 inch, and of which 300 weigh less than one US penny ...
- 17 ... to the giant ocean sunfish, which can grow 60 million times from egg to century-old adult, and can weigh 1.5 tons
- 18 It was recently discovered that some Greenland sharks live up to 400 years or more, making them the longest-lived of any known vertebrate.
- 19 Another reflection of their diversity is the colorful names that creative biologists have given them. Here we have the aptly named clown triggerfish.
- 20 For the most outrageous fish name, I nominate the sarcastic fringehead.
- 21 For least flattering: the hairy-jawed sack-mouth.
- 22 The prize for longest fish name surely goes to the Hawaiian triggerfish, known to the locals as the humuhumunukunukuapua'a (the fish who sews with a needle and grunts like a pig).
- 24 My favorite fish name is this one: diagonal-banded sweetlips. When I see those luscious lips I just want to kiss them!
- 25 Fishes have some bizarre life-history traits. Flatfishes like this flounder must suffer the indignity of having one eye migrate from one side of the face to the other. It is a useful adaptation for a lie-in-wait predator of the sandy bottom, but it makes for an awkward adolescence.
- 26 Not all fishes have the characteristic fish fins. Toadfishes, for example, of which there are 40 or so species, walk on legs and feet.
- 27 Few fishes can outdo the deep-sea anglerfishes for the audacity of their sexual habits. It is hard to find mates in the permanent darkness of the deep ocean—the world's largest habitat. That may be why a male, on finding a female of his species, bites her and holds on. Eventually, his face becomes absorbed into her flesh. He stays there for life, inseminating her intravenously.
- 28 As the first vertebrates on Earth, fishes probably invented most of the sensory systems familiar to us, and they appear to have invented color vision.
- 29 They also use some sensory systems that we don't have. The lateral line, a row of specialized scales along their sides, allows fishes to detect subtle changes in water pressure, water flow, and the presence of objects in the dark.

30 Blind cave fishes quickly learn the locations of stones and other solid objects in their habitats, using their lateral line and making a mental map.

31 Some fishes, including sharks, can detect electrical fields in the water. It is useful for finding prey, such as a small animal hiding in the sand whose heartbeat may give them away.

32 The elephantfishes of Africa and South American knifefishes use electrical pulses for **communication**. Individuals have their own signature, which they may adjust to avoid jamming with another, or switch off so as not to offend a territory-holder.

33 We look at a little shoal of Ambon damselfishes and might wonder if they **recognize** each other as individuals.

34 Not only do they, but they have a covert face recognition system that works in the ultraviolet light spectrum invisible to most fishes. So damselfishes recognize each other without compromising their camouflage against predators.

35 Studies in which archerfishes are trained to squirt water at overhead targets show that they recognize familiar human faces.

36 Fishes of various species “fall for” the same optical illusions as we do. These two orange spots are the same size, but fishes by being rewarded when pressing their nose against the larger of two spots will choose the one on the right.

39 With their keen senses and alert perceptions, fishes also show **intelligence**.

40 Despite not having grasping limbs, they still use tools. This black-spot tuskfish used water as a tool to remove sand, uncovering a clam. The fish has carried the unfortunate mollusk to a nearby rock, which is used as an anvil with a series of well-timed head-flicks and releases.

41 Archerfishes also use water as a tool, squirting at flying insects. They use different techniques—including turn-and-shoot, and predictive tracking—depending on the size, distance, and speed of the prey. Inexperienced fishes, like the smaller pair on the left, learn these skills by watching others.

42 We rightly marvel at the spatial memory of a chimpanzee that far exceeds our own.

43 But we should reserve some admiration for the memory of the frill-fin goby, a 5-inch denizen of the inter-tidal zone.

44 They can jump accurately from one tide pool to another. How do they know how far and in which direction to jump without making a leap of faith and ending up

stranded on the rocks? Captive experiments showed that they do it by swimming in the tide-pool area at high tide, and making a mental map for later reference. They can memorize the zone in one day and remember it 40 days later.

45 It's a useful skill when an octopus or a heron comes lurking.

46 Being able to feel is as useful to a fish as is being able to think.

47 On the inside, fishes show all the features of being able to feel.

48 Careful scientific experiments done by Victoria Braithwaite and others have shown that fishes can feel **pain**.

49 Studies with anesthetized trout show that fishes have the same types of nociceptors that we have for detecting different sources of pain: mechanical (example cutting), heat (burning), and chemical (burning).

51 Fish physiologist Lynne Sneddon designed a clever experiment showing that fishes will pay a cost to relieve pain. When a painkiller was dissolved in a barren, brightly-lit section of their tank that the zebrafishes usually avoided, individuals injected with painful acid began to swim in that chamber of the tank, while those injected with a non-painful saline remained in the preferred, dimly-lit tank chamber with rocks and shelter..

52 We may debate where to draw the line on animal sentience, but the evidence is quite clear that all vertebrates fall above that line (and probably some invertebrates, too).

53 At the University of Lisbon, a study of stressed surgeonfishes found that they prefer a moving to a stationary wand. After being placed in a small bucket of water for 30 minutes, the stressed fishes sought caresses from the moving wands, and their blood cortisol went down. Stationary wands were ignored because they could not provide stress-relieving strokes.

54 A Norwegian study of farmed salmon documented high mortality from constant stress. Many young fishes failed to cope with the stresses of crowding, aggression, and disease; these so-called "drop-outs" become listless, float to surface, and die. Conclusion: they are suffering from "severe depression."

55 Fishes respond to human drugs in similar ways to us. Valium acts as an anti-anxiety medication, and Prozac an anti-depressant.

56 Fish **society** is rich and complex.

58. Fishes can become bored and will play with buoyant objects for entertainment.

59 A 9-year-old pet pufferfish named Mango comes excitedly to the glass when his human guardian comes home from work.

60 Herrings are highly gregarious, and they have an unusual way of communicating by releasing gas from their anuses. Scientists playfully called these Frequent Repetitive Ticks, or more briefly: FRTs. They appear to be used for consensus decision-making.

61 I was inspired to make this little cartoon.

62 But most fish communication doesn't involve anuses. Rabbitfishes show the **virtue** of consideration for others. They pair up and take turns feeding in the vulnerable head-down position while the other plays look-out. Then they switch places.

63 Groupers use a head-shake or body-shimmy **gesture** to invite moray eels to go hunting with them. When they work together their per-capita success rate is higher than when they hunt alone. Groupers will also point at hidden prey for over 20 minutes, using a head-stand pose to beckon an eel to come over and help.

64 Here, a male barred hamlet courts a female by swimming in caressing loops around her. Tomorrow, he may turn into a female, for hamlets are among many fishes that can change sex, and they don't need to pay for expensive surgery to do it.

65 Some male fishes resort to artwork to impress females. These 2 meter wide "crop-circles" in the sand were discovered by a Japanese diver in 2012 at a depth of 25 meters off the southern coast of Japan.

66 Unaware of who made the patterns, he set up a camera and soon discovered that they were made by a previously undescribed species of pufferfish.

67 The 10 cm male spends many hours making the pattern and adorning it with bits of shells.

68 If he is successful, he mates with a female, who lays her eggs in the middle of the arena.

69 **Parental care** occurs in a quarter of fish species. And mouthbrooding, shown here, has been documented in at least nine fish families. It's an effective way to protect one's babies!

70 **Pleasure** is rarely considered in animals, but it plays an important role in motivating useful behaviors (as it does for us).

71 The **mutualism** between cleanerfishes and their "clients" is one of the most sophisticated social systems in the animal world. Here, two blue-striped cleaner-

wrasses minister to a six-barred angelfish. Cleaners remove parasites, algae and other unwanted things from the clients. In exchange for a client spa treatment, the cleaners get fed.

72 The relationship is built on **trust** between known cleaners and clients who return to the same cleaning station. Clients invite cleaners by opening their mouths and gill covers and the cleaners swim inside. Clients have not been seen eating their cleaners...it just isn't good business to eat your colleague. Cleaners sometimes cheat by nipping off mucus from the client's body. They are less likely to do this if they are being watched by other potential clients, who rate cleaner quality by keeping an accumulated "image-score." It is like e-bay seller ratings. (I am not making this up!)

73 We know it involves the pleasure of touch. Cleaners will pause from cleaning to caress their clients with rapid movements of their pectoral fins. Perhaps no wonder, then, that fishes like this Nassau grouper will approach trusted divers to get stroked, even though there is no parasite removal service.

74, 75 A veterinary student in Kansas sent me these photos of her and her father interacting with another grouper.

76 Note the open gill covers, allowing the bubbles to flow through the gills.

77 Divers like Cristina Zenato send sharks into a state of "tonic immobility" (hyper-relaxation) by rubbing their faces and bellies. In this way, they are able to remove large fishing hooks buried in the sharks' faces.

78 These sharks know the divers who help them and return again and again to be helped.

79 After divers removed this hook, this adult blue shark swam among them for many minutes. Could these animals be showing gratitude, as whales do when cut free from fishing nets?

80 These positive shark-human interactions contradict the stereotyped image of shark attacks on humans. About a dozen humans die from misdirected shark bites each year, compared to 75-100 million sharks killed by us.

81 It is self-evident is that fishes are **sentient**—they feel—and sentience is the bedrock of ethics. The basis of moral systems is that others have lives that matter to them.

82 The human relationship to fishes is a deeply troubling one. We catch and kill a trillion or more fishes every year.

83 Our **fishing** methods are cruel and notoriously wasteful. Here, a shrimping net near Mozambique contains mostly unwanted fishes that will be discarded either dead or dying.

84 We toss away about 100 million kilos of so-called “**bycatch**” every day.

85 Fishes and other marine life aren’t the only ones to suffer. **Forced labor and enslavement** are widespread problems in the commercial fishing industry, especially in Asia.

86 **Fish farms** now produce nearly a half of all fish meat worldwide. Problems include: overcrowding, rampant diseases and parasites, pesticides, concentrated wastes, ocean pollution, genetic dilution of wild population, and fish suffering.

87 Campaigns to stop the **shark-finning** by stopping demand are helping, but the problem is still serious, and horribly cruel.

88 A joint study of the World Wildlife Fund and the Royal Zoological Society estimates that there is only about half as much marine life today as there was in 1970, due to human activities.

89 In addition to overfishing, other problems facing the oceans are **climate change, acidification, coral bleaching,** and **pollution** with plastics and discarded fishing gear, of which about 680,000 tons are left in the seas each year.

90 The oceans produce more than half the world’s oxygen.

91 Even though $\frac{3}{4}$ of the Earth’s surface is covered by water, the total mass of water on our planet is relatively small. We harm it at our own peril.

92 We are adept at arbitrarily compartmentalizing animals into different categories by convenience. These two creatures are equivalent, yet depending on where you live, one is cherished and the other cruelly killed for food.

93 Maybe it’s because they don’t blink or scream that we are so dismissive of fishes. But their lives tell us otherwise...that there is a feeling being living behind that glassy stare.

94 Let me finish with the story of Jasper, a discus fish who lived for 9 years in an aquarium. When his human guardian returned from work, Jasper would play games of chase with her from behind the glass. Then, whenever she would cup her hands together and lower them into the water, Jasper would swim onto his side and nestle his little body inside the cup, where Karen would stroke him gently with her thumbs. She grieved his loss as we would a family member.

95 The words of noted oceanographer Sylvia Earle express the sort of relationship we can have with fishes and their homes. We have a long way to go but we have to succeed if we want a sustainable, compassionate future.

96 They deserve our advocacy, not our appetites.

97 [author's/speaker's contact information]

- END -