



OCEANS AWAY FROM HOME:

THE SUFFERING OF FISH IN CAPTIVITY

SUMMER 2023



TABLE OF CONTENTS

INTRODUCTION.....	3
REPORT SUMMARY.....	4
UNIVERSAL RESEARCH BIAS NEGLECTS FISH	5
THE PRIVATE TRADE IN FISH.....	7
FISH WELFARE	9
(UN)SUSTAINABILITY PRACTICES IN ZOOS	11
WELFARE (SUB)STANDARDS IN ZOOS.....	12
RANGING BEHAVIORS AND ACTIVITY BUDGET IN THE WILD.....	13
TOUCH TANKS.....	15
FISH PROTECTION LEGISLATION – OR LACK THEREOF	19
WILD POPULATION DEPLETION – CITES AND ESA REGULATIONS	22
CONCLUSION	24
REFERENCES	25

INTRODUCTION



Angela Grimes
Chief Executive Officer

At Born Free USA, we value all animals' individual lived experiences; from large, land-roaming elephants to some of the smallest fish in the sea. We know that every life counts, no matter how different from us or misunderstood a species may be.

We always hold compassionate conservation at the core of our work, and our latest report, *Oceans Away from Home: The Suffering of Fish in Captivity*, reinforces this guiding principle. All wild animals, including fish, deserve the right to live freely and without the suffering or extensive wild population depletion caused by large-scale captive industries, primarily including the ornamental fish trade, zoos, and aquariums.

This report places a spotlight on the universal research bias that neglects fish, causing a massive knowledge deficit in fish welfare, biology, and conservation status; the unregulated and unethical taking of fish from the wild to supply the ornamental fish trade; the inability of zoos to safeguard fish welfare or conservation in captivity; and the failure of United States legislation to adequately protect fish from abuse, cruelty, or neglect in captivity.

This report gives a voice to sentient beings who are often misunderstood and viewed as “lesser” animals, yet they deserve the same respect and protections as more familiar ones.

Therefore, as animal advocates, we must speak up for fish in the same ways that we so fervently advocate for other “warm-blooded” animals, starting with halting the wild capture of fish for zoos and aquariums, phasing out touch tanks from aquariums, as they do not contribute to any genuine conservation efforts and directly negatively impact the welfare of the animals and humans involved, and including fish in the definition of “animals” in both state and federal animal cruelty legislation to better protect their health and welfare and appropriately extend compassionate conservation to all deserving beings.

REPORT SUMMARY

Fish represent some of the most overlooked and neglected species in terms of basic animal husbandry and welfare yet remain some of the most popular animals held captive in the world. In the United States, despite being blindly collected and imported in mass numbers to supply the ever-increasing demand from captive industries like zoos and privately owned ornamental aquariums, fish are not protected by law other than exceptions made for species involved in aquaculture and those listed on the Endangered Species Act. Fish also are not even considered to fall under the category of “animals” in many circumstances. Almost all captive facilities that keep fish completely ignore that these animals are individuals, are sentient, possess naturally evolved biological needs, and require the opportunity to engage in species-specific behaviors, which are essential to living a healthy, meaningful, and gratifying life for any living creature.

This report summarizes the reasoning behind this disproportionate lack of value associated with fish compared to other animals; overviews the harmful effects of wild fish population depletion to supply the demand for the private fish trade; analyzes the gross shortcomings of zoos in protecting fish welfare and conservation; confirms fish sentience by providing evidence for complex social and neurological processes similar to mammals, and therefore a similar capacity to experience suffering and pain; and argues for a more compassionate and comprehensive protection of the tens of thousands of unmonitored fish species that fall victim to the exploitation-driven private fish trade every day.

To prevent irreversible wild population depletion and end the cycle of unnecessary suffering for fish in captivity, we urge zoos to immediately halt the wild capture of fish from their natural habitats to stock collections, thereby decreasing the use of harmful harvest practices like cyanide fishing. We implore zoos to ban touch tanks from aquariums, as they do not contribute to any genuine conservation efforts and directly negatively impact the welfare of the animals and humans involved. Lastly, we advocate that fish are included in the definition of “animals” in both state and federal animal cruelty legislation based on the scientific evidence summarized in the following report.

UNIVERSAL RESEARCH BIAS NEGLECTS FISH

Like our lack in knowledge of the great blue depths that comprise the world's oceans, our understanding of the numerous fish species living in these waters remains just as limited and understudied. According to the National Oceanic and Atmospheric Administration (NOAA), in 2023, more than 80% of this vast underwater world remains

unexplored. Just 10% of the global ocean has been mapped with modern sonar technology, despite oceans covering over 70% of Earth's surface (NOAA 1, 2023). Only about 35% of the ocean and coastal waters of the U.S. has been mapped using modern methods.

In contrast, a broad, land-based research bias has disproportionately affected focuses of

scientific research around the world. Historically, most animal welfare research has targeted larger charismatic land mammals, primarily including primates, big cats, bears, and elephants. For example, in a literature review of research conducted by the British and Irish Association of Zoos and Aquariums (BIAZA) facilities from 1998-2009, projects most frequently focused on primates, followed by carnivores, hoofstock, birds, reptiles, amphibians, and, least frequently, fish (Melfi, 2009).

The same bias holds true for North American Association of Zoo and Aquarium (AZA) facilities: over two-thirds of all AZA member research has focused on mammals, featuring chimpanzees, elephants, western lowland gorillas, and orangutans most frequently.

For the remaining research, 68% of all projects were dedicated to other mammals; 12% to birds; 8% to reptiles; 5% to fishes; 3% to amphibians; 3% to invertebrates; and less than 1% to flora (Che-Castaldo et al., 2018). The lack of research dedicated to fish may be attributed to the decreased



THE LACK OF RESEARCH DEDICATED TO FISH MAY BE ATTRIBUTED TO THE DECREASED VALUE MANY HUMANS ASSOCIATE WITH FISH COMPARED TO MAMMALIAN SPECIES WHOSE LIFESTYLES AND APPEARANCES BEAR GREATER RESEMBLANCE TO OUR OWN.

value many humans associate with fish compared to mammalian species whose lifestyles and appearances bear greater resemblance to our own. As a result, most fish species remain undesirable focal animals for research so long as they seem unfamiliar, uninteresting, and useless.

This research discrepancy exists even between fish species. The term “fish” includes animals of many different taxonomic statuses, from teleosts (a class of bony fish, like zebrafish) to cartilaginous fish (like sharks and rays) living in fresh, brackish, and marine waters (Biasetti et al., 2020). Representing the largest and most diverse group of vertebrates on the planet, teleosts comprise approximately 98% of all ray-finned fish species (*Actinopterygii*) and include nearly 30,000 total

species (Ravi & Venkatesh, 2018). In a study that compared research published in zoo journals conducted on *Chondrichthyes* (sharks and rays) and *Osteichthyes* (bony fishes) separately, bony fishes were underrepresented at a much greater level than *Chondrichthyes* (Oldfield & Bonano, 2022).

These are surprising statistics, given that more species of teleost fish exist than all other vertebrates combined (Toni et al., 2019). Concerningly, despite an admittedly large knowledge deficit concerning fish species biology, behaviors, and how to adequately address their needs in captivity, the statistics outlined above confirm that zoos have both historically and continuously put the least amount

of funding into research efforts to learn about and improve fish welfare in captive environments.

THE TERM "FISH" INCLUDES ANIMALS OF MANY DIFFERENT TAXONOMIC STATUSES, FROM TELEOSTS (A CLASS OF BONY FISH, LIKE ZEBRAFISH) TO CARTILAGINOUS FISH (LIKE SHARKS AND RAYS) LIVING IN FRESH, BRACKISH, AND MARINE WATERS.




THE PRIVATE TRADE IN FISH

Although these pronounced research gaps in the understanding of fish biology, welfare, and conservation status remain prevalent, fish are some of the most popular animals kept in captivity. Estimates of fish imported and exported by zoos and traveling exhibitions remain almost impossible to quantify, however, as these numbers are not regulated or reported publicly like other species involved in captive breeding programs monitored by zoos, i.e., the Species Survival Program (which uses studbooks to document every animal's life event in captivity including births, transfers, and deaths). Additionally, most legislation currently in place does not require fish owners, breeders, or distributors to register them or document any of their life details. Some statistics exist, however, to provide insight into the private pet trade of fish. Therefore, any estimates provided in this report regarding the financial impact and number of fish harvested from the wild are likely gross underestimates and require future investigation into zoos to

analyze the true conservation impact on these understudied and unregulated (yet widely used) fish species.

While 95% of freshwater fish are bred in captivity, 95-99% of marine (or saltwater) fish in the aquarium trade are taken from the wild. Globally, it is estimated that more than 1 billion ornamental fish (freshwater and marine) from some 5,400 species are traded annually for the aquarium industry.

This does not include the invertebrates, crustaceans, live rock, corals, and plants that are also part of the ornamental fish trade. The U.S. is one of the top importers of ornamental fish. Mortality rates from stress, injury, disease, or mistreatment during transport for the private trade have been documented to exceed 80% (AWI, 2015).



GLOBALLY, IT IS ESTIMATED THAT MORE THAN 1 BILLION ORNAMENTAL FISH (FRESHWATER AND MARINE) FROM SOME 5,400 SPECIES ARE TRADED ANNUALLY FOR THE AQUARIUM INDUSTRY.

Fish are the most numerous pets in Western countries (including Australasia, Europe, and the Americas), kept domestically by over 10% of Western households in numbers that far exceed dogs or cats (Australian Companion Animal Council 2010). In 2012, 151.1 million fish were owned as pets in the U.S., compared to 78.2 million dogs and 86.4 million cats (APPA 2011-2012) (Sullivan, 2014). Although the number of fish owned has slightly decreased since 2012, fish remain the most numerous pets in the U.S. at the time of this report publication. In 2023, 139.3 million freshwater fish were reported to be kept as pets, compared to 89.7 million dogs and 94.2 million cats (Spots, 2023), and 11.1 million households reported keeping fish, compared to dogs (65.1 million households) and cats (46.5 million households) (Bedford, 2023).

The annual retail value of fish and other aquatic species is estimated to be worth between US\$3 billion and \$4.5 billion (O'Sullivan et al., 2008). The total international sales value of the ornamental fish industry, including fish, food, and accessories, is estimated to be valued at US\$15 billion per year (Ploeg 2007). This value has increased consistently since 1985, at an annual rate of about 14% (Bartley 2000). This upward trend can also be observed in

the expansion rate of the international fish trade, which has grown from 28 countries exporting fish in 1976 to 146 countries in 2004 (Ploeg 2007).

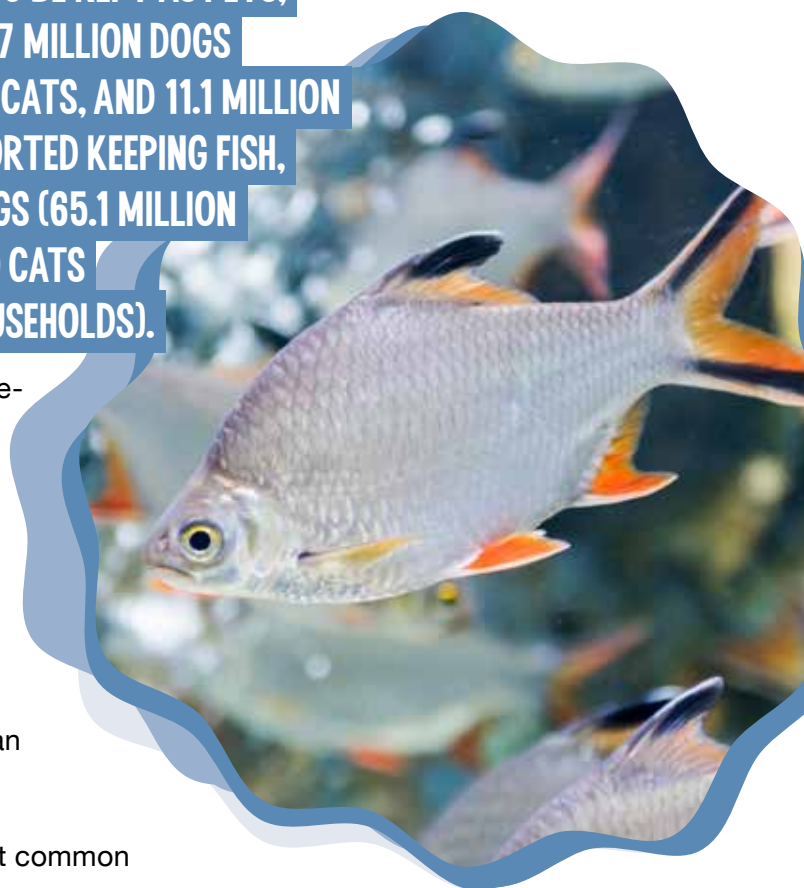
Overall, trade in ornamental fish is dominated by tropical and cold-water freshwater species. Ornamental fish species include more than 2,000 freshwater finfish species, almost 1,500 marine finfish species, and up to 1,000 invertebrate species. Freshwater species of ornamental fish are predominantly bred in aquaculture facilities, while marine species are typically caught in the wild (O'Sullivan et al., 2008). Over 90% of fish

Characidae (tetras); *Cyprininae* (barbs and goldfish); *Callichthyidae* (mostly *Corydoras* species); *Loricaridae* (*Plecostomus* and *Ancistrus*); *Poeciliidae* (live-bearers, i.e., guppies, sword-tails, platys, mollies); *Cichlidae* (cichlids, mouth-brooders, and egg-layers); and *Anabantidae* (labyrinthfish such as bettas and gouramis) (Bassleer, 1994). In the U.S., Chapman et al. (1997) reported that 32 species accounted for 58% of all fish imports. Two species, guppies (*Poecilia reticulata*) and neon tetras (*Paracheirodon innesi*), accounted for 37% of all U.S. imports in 1992.

IN 2023, 139.3 MILLION FRESHWATER FISH WERE REPORTED TO BE KEPT AS PETS, COMPARED TO 89.7 MILLION DOGS AND 94.2 MILLION CATS, AND 11.1 MILLION HOUSEHOLDS REPORTED KEEPING FISH, COMPARED TO DOGS (65.1 MILLION HOUSEHOLDS) AND CATS (46.5 MILLION HOUSEHOLDS).

traded are captive-bred freshwater species (Bartley 2000; O'Sullivan et al. 200; UNEP 2007), with sales primarily from as few as 30 key species (O'Sullivan et al. 2008).

Some of the most common taxa and species in the ornamental trade include



FISH WELFARE

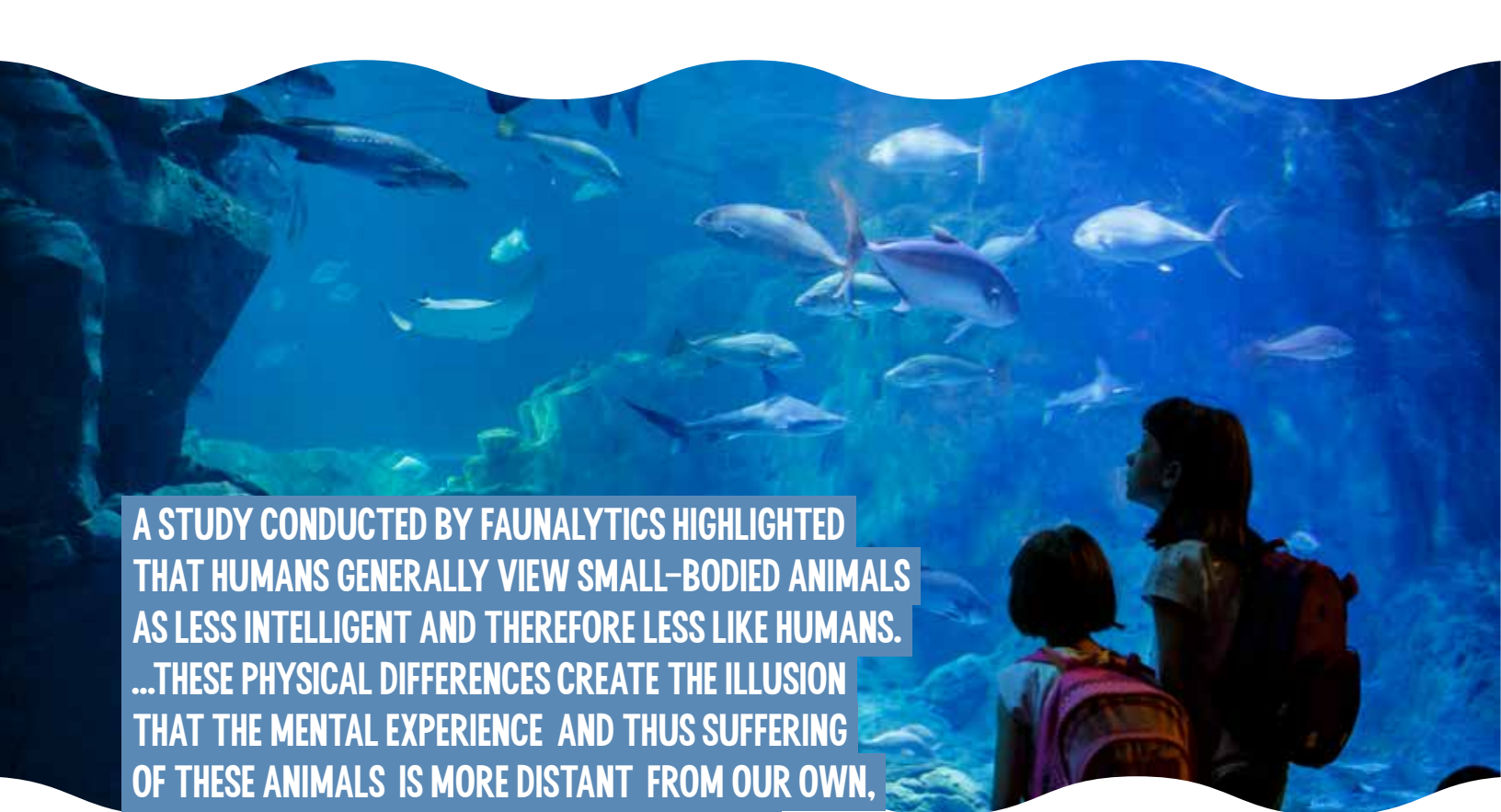
The absence of fish in scientific literature suggests that knowledge pertaining to their care and species-specific needs may also be lacking. The animal welfare field has increasingly recognized the importance of positive welfare (i.e., mental and physical states beyond the bare minimum needed for immediate survival, like appropriate diet, shelter, and comfort level) and accordingly introduced indicators of positive welfare beyond neutral states for use of life quality assessment in agriculture, laboratories, and zoos/aquariums (Fife-Cook & Franks, 2019). Of the limited fish welfare literature available, the most prominent welfare concerns studied in captive fish include stress, boredom, and frustration—all classic behavioral responses to an unstimulating environment that can become harmful when experienced at chronic levels. Other dominant focuses have included minimizing suffering during slaughter and controlling disease in farming situations (Gonzalez, 2022), although the latter is arguably to prevent loss of fish stock, and therefore profits, rather than from concern over fish welfare.

Beyond providing the basics an animal would need simply to survive in captivity, positive experiences help improve psychological and physical states and protect animals from experiencing boredom, helplessness, and emotional distress, which can result in adverse health conditions including physical injury, disease, developmental delays, metabolic issues, and mental illness when endured long-term. Positive emotions have been demonstrated to strengthen well-being and linked to improved cardiovascular health. Similar patterns have been identified across a wide range of species, with the same mechanisms likely functioning in fish as well (Fife-Cook & Franks, 2019).

Many have argued that ignoring fish from the larger welfare discussion can be attributed to humans failing to find commonalities with them due to the seemingly irreconcilable differences observed between their appearance, environment, and lifestyle and our own. A study conducted by Faunalytics highlighted that humans generally view small-bodied animals as less intelligent and therefore less like humans. For example, most fish lay eggs and breathe

underwater. These physical differences create the illusion that the mental experience and thus suffering of these animals is more distant from our own, making us less empathetic and concerned for their wellbeing (Gonzalez, 2022). This reasoning is highly flawed, however, as research has more recently confirmed that fish are much more like humans than previously thought. It is important to note that similarity to humans, however, should not be a benchmark used to assign value to animals. Animals each possess their own inherent value to live, free to express natural behaviors, regardless of their resemblance or perceived proximity to humans.

For example, on a neurological level, the subcortical neural networks that fish share with other vertebrates contain neural marks of qualitative feeling, which are neurochemically the same as the terrestrial mammals we traditionally associate with complex cognitive function, emotion, and importantly, pain (Gonzalez, 2022). According to Dr. Culum Brown of Australia's Macquarie University, a leading specialist in fish social behavior: "Fish perception and cognitive abilities often match or exceed



A STUDY CONDUCTED BY FAUNALYTICS HIGHLIGHTED THAT HUMANS GENERALLY VIEW SMALL-BODIED ANIMALS AS LESS INTELLIGENT AND THEREFORE LESS LIKE HUMANS. ...THESE PHYSICAL DIFFERENCES CREATE THE ILLUSION THAT THE MENTAL EXPERIENCE AND THUS SUFFERING OF THESE ANIMALS IS MORE DISTANT FROM OUR OWN, MAKING US LESS EMPATHETIC AND CONCERNED FOR THEIR WELLBEING.

other vertebrates... the extensive evidence of fish behavioral and cognitive sophistication and pain perception suggests that best practice would be to lend fish the same level of protection as any other vertebrate” (AWI, 2015). The American Veterinary Medical Association (AVMA) also supports the notion that fish feel pain and can suffer. The 2013 Guidelines for the Euthanasia of Animals states that “The preponderance of accumulated evidence supports the position that finfish should be accorded the same considerations as terrestrial vertebrates in regard to relief from pain” (AVMA, 2013).

Additionally, studies have confirmed that fish regularly partic-

ipate in complex behaviors, including recognizing conspecifics as individuals, exhibiting paternal care, engaging in pro-social behaviors like allogrooming, and constructing complicated social groups. For example, some species of cichlids form monogamous pairs and have helpers, which altogether construct a social group of both sexes who participate in defending the territory and offspring. Studies on zebrafish (*Danio rerio*) have indicated that proximity to a conspecific has rewarding properties; even just visual contact with a conspecific can be used to reinforce behavior in an associative learning task. Further, some species of fish have demonstrated that tactile stimulation can decrease stress levels

and facilitate future pro-social interactions (Fife-Cook & Franks, 2019). Another study demonstrated that fish can sense fear in other fish and also become afraid. The ability is regulated by oxytocin, the brain chemical that underlies the capacity for empathy in humans (Akinrinade, 2023). Impressively, fish will choose certain environmental elements that reinforce species-specific behaviors and improve overall welfare, even when accessing these environmental elements is difficult and requires more energy to obtain. In motivational assessment studies, goldfish will swim against a current to access plants, and a species of cichlid, Mozambique tilapia (*Oreochromis mossambicus*), will push against a door to access social partners (Fife-Cook & Franks, 2019).

(UN)SUSTAINABILITY PRACTICES IN ZOOS

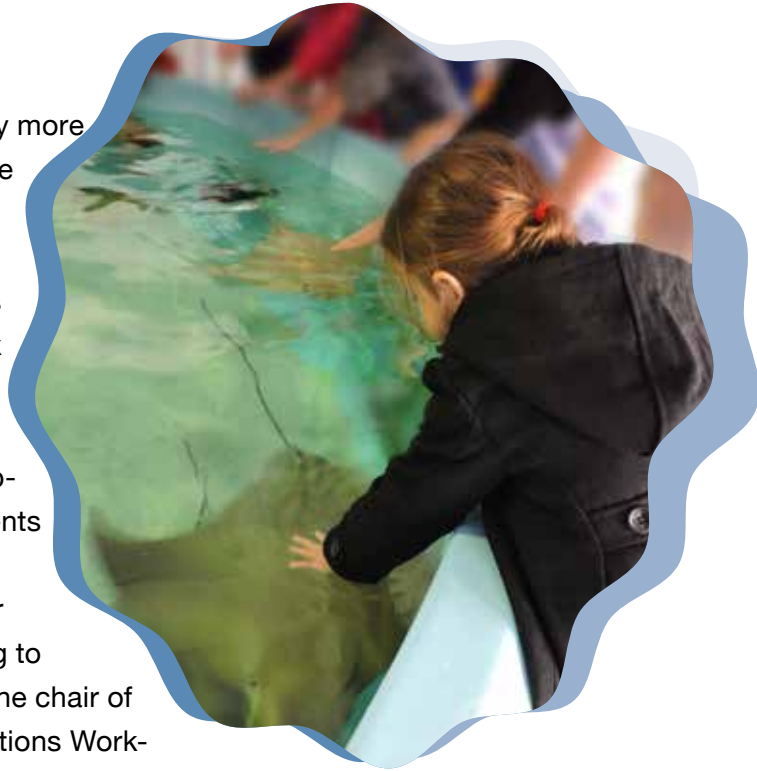
In a survey of 130 AZA-accredited facilities, 101 respondents (76.5%) stated that they have aquatic animals within their care. Despite most AZA facilities keeping aquatic animals, the import, captive breeding practices, transfer process, and enclosure standards of fish in zoos are largely unregulated and undocumented. Further, no requirements established or enforced by the AZA currently exist to ensure that facilities source their fish ethically or sustainably.

The AZA cannot confirm whether the fish they import from the wild were exposed to cyanide, which would indicate that they were caught via cyanide fishing; a destructive method of wild capture involving spraying a mixture of sodium cyanide directly into the fishes' habitats, rendering them incapacitated to facilitate easy capture. Several aquariums and universities are studying the effects of cyanide fishing on fish genes and enzymes, in the hopes that a future test could detect cyanide exposure in fish with the goal of eventually outlawing this unethical practice (Richard 2, 2021).

This lack of controls and checks is, according to the AZA website, a work in progress that

needs substantially more attention to achieve full transparency and reliability. The AZA attributes this failure to “complex supply chains,” which are controlled by local suppliers or governments and rarely forthcoming about their policies. According to George Parsons, the chair of the Ethical Acquisitions Working Group and the senior curator of fishes at the John G. Shedd Aquarium in Chicago: “The first step is to really understand the current acquisition model and its procedures. What does our collection footprint look like?” Troublingly, the zoo industry's impact on wild fish populations, especially those considered Endangered or Data Deficient by the International Union for the Conservation of Nature (IUCN) remains largely unknown, even by those in senior level positions (Richard 2, 2021).

While habitat loss is considered the main threat driving most freshwater fish species towards extinction, for many species, the aquarium trade is the most lethal (Shiffman, 2023).



Despite recent plans to create an Aquatic Collections Sustainability Committee (ACSC) (Richard 2, 2021), even AZA facilities, which claim to be the top tier of all zoos and distinguish themselves as leaders in conservation (Che-Castaldo et al., 2018), have no system in place to monitor the depletion of wild populations caused by stocking their captive collections, nor do they have any knowledge or control over the harvesting process or its ethical implications for other wild species and surrounding environment. And yet, despite their potentially devastating impact on wild fish populations, all AZA institutions include conservation as a priority in their mission statements (Che-Castaldo et al., 2018).

WELFARE (SUB)STANDARDS IN ZOOS

As of 2023, no complete or in-progress animal care manual exists for any fish species on the AZA website (AZA 1, 2023). The only category of aquatic animals specifically outlined in the 2023 AZA Accreditation Standards & Related Policies are for cetaceans, which include whales, dolphins, and porpoises (AZA 2, 2023). Therefore, these facilities have zero minimum standard requirements for enclosure size relating to tank dimensions, depths, or volumes, environmental substrates or features, social groupings, diet, or enrichment provision for fish.

The only fish-specific guidelines that exist in the AZA care manuals include those pertaining to monitoring water quality; fishes housed indoors without sunlight exposure having access to ultraviolet wavelengths of light; and tanks having a warning mechanism to alert staff about critical life support failures (including adequate water flow, oxygen, temperature, and gas saturation). The manual highlights that shallow, warm

water, and high biological loaded enclosures, such as stingray touch tanks, are especially vulnerable to these complications (AZA 2, 2023).

According to a user on the website ZooChat, a public forum used mainly by zookeepers and other zoo staff members and supporters to discuss captivity-related topics: “Fish tend to be some of the worst signed animals in public zoos and aquariums. In some tanks,

ACCURATE INFORMATION ABOUT THE SPECIES EXHIBITED MUST BE AVAILABLE. GENERALLY, THIS SHOULD INCLUDE, AS A MINIMUM, THE SPECIES NAME (BOTH SCIENTIFIC AND COMMON), ITS NATURAL HABITAT AND SOME OF ITS BIOLOGICAL CHARACTERISTICS AND DETAILS OF ITS CONSERVATION STATUS.

fewer than half of all species are labeled, and due to the fact that many species die easily or get moved to other tanks (water parameters, aggression by tankmates, etc.) turnover can be high, leading to outdated signage and maybe even the sign department not bothering to make signs at all. I often have to rely on encyclopedias, data-

bases, and Facebook ID groups to get unsigned fish identified, with mixed results” (ZooChat, 2023).

Most accredited zoos have a minimum educational requirement pertaining to informing visitors about the species held in their collections. For example, in the UK Secretary of State’s Standards of Modern Zoo Practice, which specifies the minimum standards that zoos in England are expected

to meet, one of the sections reads: “Accurate information about the species exhibited must be available. Generally, this should include, as a minimum, the species name (both scientific and common), its natural habitat and some of its biological

characteristics and details of its conservation status.” While this requirement may not be directly enforceable, it is very much expected of many zoos and can impact their licensing process (DEFRA, 2012).

RANGING BEHAVIORS AND ACTIVITY BUDGET IN THE WILD

Home range size is defined as the total area used by an animal to carry out normal activities (Kramer & Chapman, 1999). Home range size generally increases with animal body size but can also be influenced by water body size and shape (e.g., lakes and rivers) (Woolnaugh et al., 2009), animal taxa, life-history stages, temperature, flow conditions, habitat, heterogeneity, channel size, and location within a watershed (Crook, 2004).

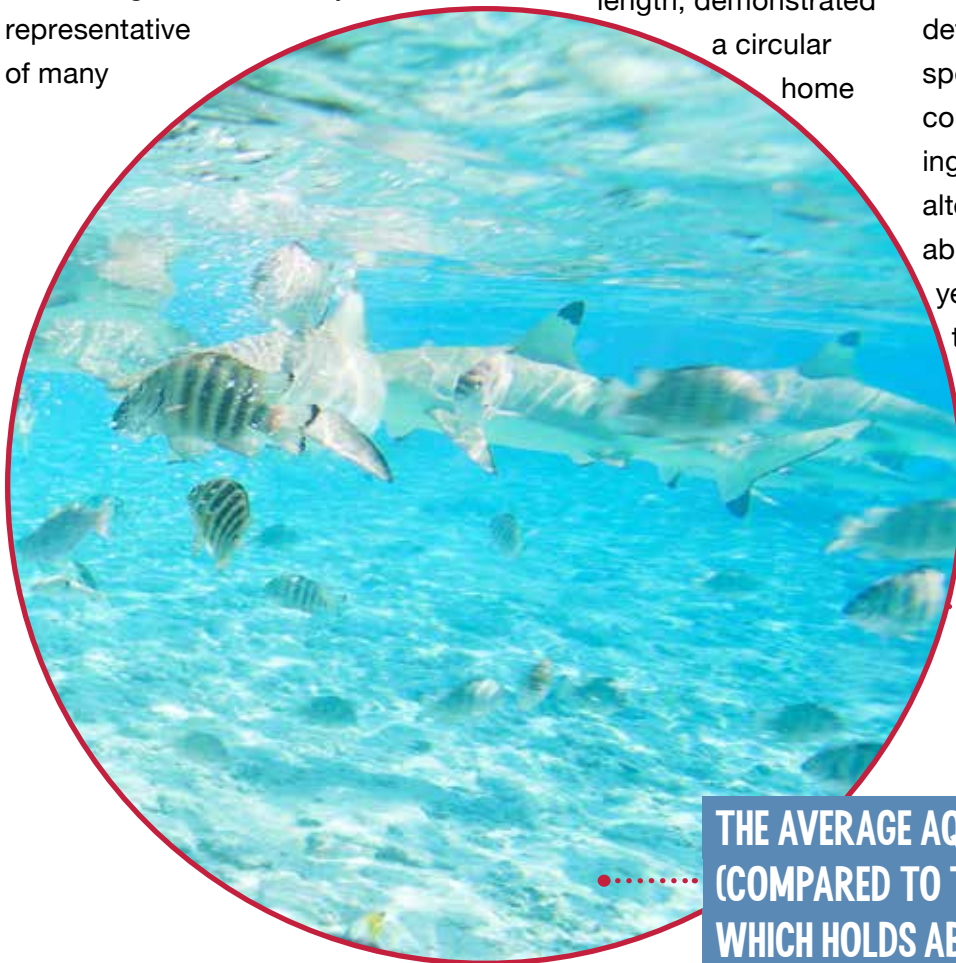
On the smaller end of the fish home range scale, a study representative of many

small-bodied, sedentary coastal species inhabiting reefs and other coastal climates monitored the movement of several pearly razorfish (*Xyrichtys novacula*) for 20 days to determine their home range size. The authors concluded that their small circular home range encompassed a radius of 476 feet (or about three times the size of an Olympic swimming pool). Another small species similar in size, the Mediterranean rainbow wrasse (*Coris julis*), which can reach up to six inches in

length, demonstrated a circular home

range radius size of 748 feet (Alós et al., 2016). In Southeast Asia, adult red morwong (*Cheilodactylus fuscus*), who can grow up to 26 inches long, have demonstrated a mean home range size of 20,075 ft² during the day. At nighttime, they demonstrated a significantly greater home range size of 39,170 ft² (or about 70% of the length of a football field) (Lowry & Suthers, 1998).

Like home range size, migration distances often increase with animal body mass. Migration is defined as the movement of a species between regions where conditions for behaviors including foraging and breeding are alternately favorable or unfavorable depending on the time of year, and it is more beneficial to an animal's fitness to move between favorable environ-



THE HOMERANGE SIZE FOR THE PEARLY RAZORFISH IS 476 FEET (OR ABOUT THREE TIMES THE SIZE OF AN OLYMPIC SWIMMING POOL).

THE AVERAGE AQUARIUM SIZE IS 72 INCHES (COMPARED TO THE AVERAGE BATHTUB, WHICH HOLDS ABOUT 42 GALLONS OF WATER).



THUS, MANY FISH DEVELOP ABNORMAL BEHAVIORS AND SWIMMING PATTERNS IN CAPTIVITY TO COPE WITH THESE EXTREME SPATIAL RESTRICTIONS.

ments than to stay in one place. For example, species of highly mobile carp (*Cyprinidae*) have been documented to make frequent upstream and downstream movements of more than 62 miles per month (Crook, 2004). Similarly, in a study that demonstrated the great migratory capacity of Jucá (*Prochilodus marginatus*), the authors tagged 1,012 fish at the Sobradinho dam in Brazil. After 85 days, one of the fish was recaptured 497 miles upriver. After 186 days, another was found 684 miles upriver (Zaniboni-Fihlo & Schulz, 2003). Bluefin tuna (*Thunnus thunnus*), who can reach a whopping body mass size of 529 pounds, have demonstrated the maximum migration distance ever recorded for the largest fish species (excluding sharks) at 5,903 miles (equal to about two times the distance of Los Angeles to New York) (Hays & Scott, 2013).

In terms of activity budgets, or the amount of time an animal spends engaging in

species-specific behaviors throughout the course of a 24-hour period, Valenciennes (*Ophioblennius atlanticus*), a species of diurnal tropical blennioid fish, spend about 60% of their time resting, 15% swimming, and 8.5% feeding. They use territory exponentially, with up to 50% of their time spent in about 15% of the territory. They occur at a density of approximately two individuals per 11 ft² (Nursall, 1981). As diurnal tropical fish who can grow up to four inches long, Valenciennes function as a good model for many fish kept in aquariums. Their active use of territory and relatively sparse distribution behaviors observed in the wild contrast how most of these fish species are kept in captivity, with far less space allocated per individual for essential daily activities.

As indicated by the substantial home range sizes observed by relatively small, sedentary fish to the vast migratory distances of wide-ranging, large-bodied

species, constrictive captive environments cannot come close to allowing even the smallest of these animals to meet their most basic species-specific needs. Many of the largest aquarium tanks range from just 36 x 18 x 19 inches to 72 x 24 x 25 inches, containing 50 to 180 gallons of water (compared to the average bathtub, which holds about 42 gallons of water) (Home Stratosphere, 2023). In the pet industry, however, a 30-inch, 20-gallon tank is commonly recommended as the minimum tank size for goldfish, who can grow up to eight inches in length. These dimensions give the goldfish about 30 inches to swim back and forth, and just 12 inches to turn around (Aquarium Co-op, 2023). Goldfish are close relatives of carp, who, as previously stated, can range distances upwards of dozens of miles per month. Thus, many fish develop abnormal behaviors and swimming patterns in captivity to cope with these extreme spatial restrictions.

TOUCH TANKS



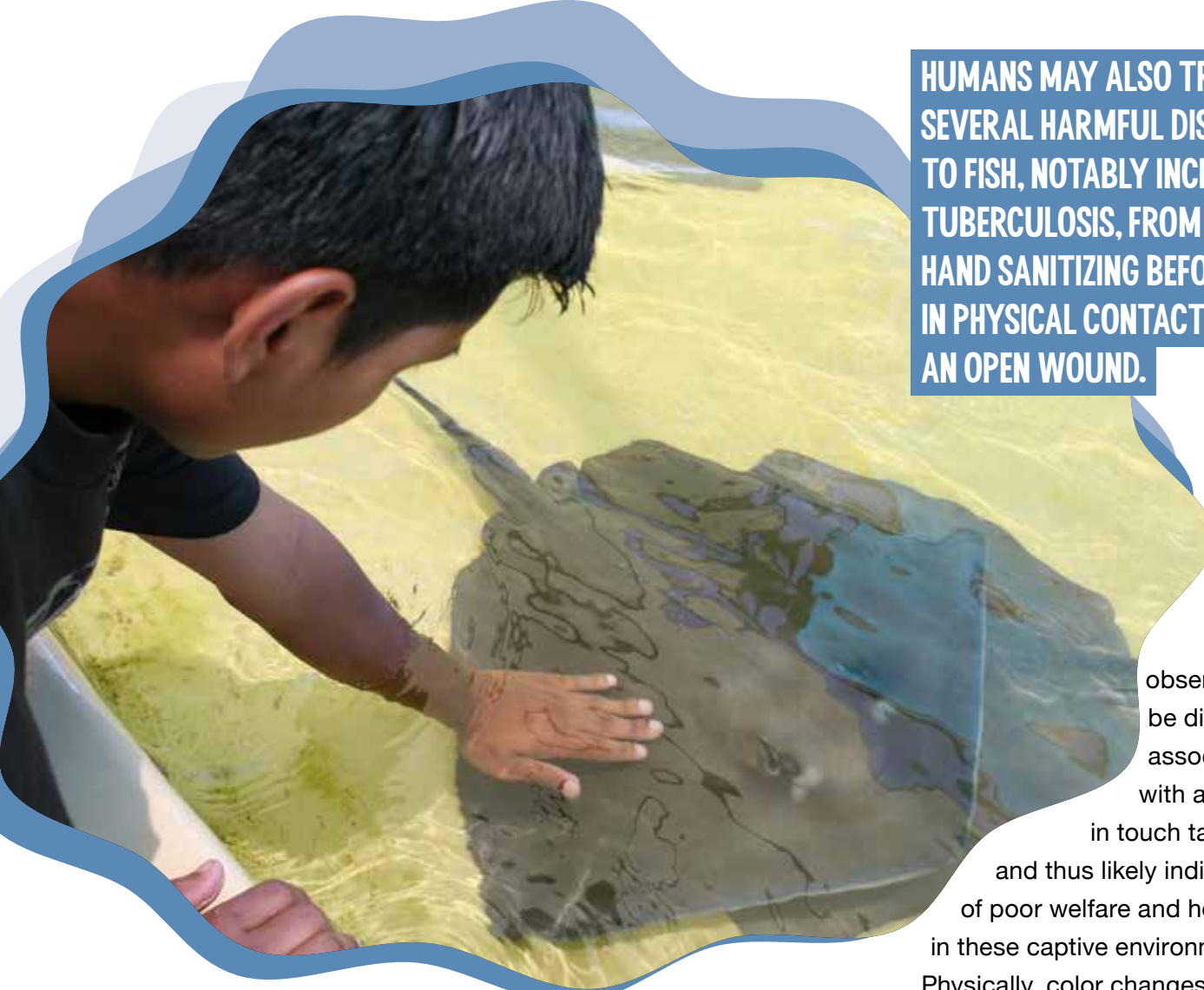
PRACTICES DIFFER WIDELY BETWEEN AQUARIUMS, INCLUDING SPECIES INVOLVED IN TOUCH TANKS, AMOUNT OF TIME ANIMALS ARE EXPOSED TO DIRECT HUMAN CONTACT, HOW HUMAN CONTACT IS MONITORED AND/OR DIRECTED, BACTERIAL CONCERNS FROM PATHOGENS INTRODUCED FROM OUTSIDE OF THE FISHES' HABITAT, AND ANY MEASURES TAKEN TO REDUCE STRESS OR INJURIES EXPERIENCED BY THE ANIMALS INVOLVED.

As with any other animal species, the environment occupied by fish drastically affects their welfare. In captivity, where enclosures and tank sizes are often many orders of magnitude smaller than an animal's natural range size in the wild, numerous environmental factors can affect their welfare, including the temperature, pH level, water salinity, light exposure, noise, and environmental complexity. Even color may play a role, as research suggests that the presence of blue may reduce aggression in some animals (Toni et al., 2019).

In touch tanks, the balance of these factors becomes signifi-

cantly more difficult (or impossible) to manage in a way that does not negatively affect the animals involved. Particularly problematic, there are no standards by which touch tanks are required to be operated. Therefore, practices differ widely between aquariums, including species involved in touch tanks, amount of time animals are exposed to direct human contact, how human contact is monitored and/or directed, bacterial concerns from pathogens introduced from outside of the fishes' habitat, and any measures taken to reduce stress

or injuries experienced by the animals involved. For example, many aquariums have opted to remove fish from touch tanks altogether and replace them with anemones, starfish, and other invertebrates, as these animals cannot escape and are therefore caught and touched by visitors with ease. Using invertebrates instead of fish



HUMANS MAY ALSO TRANSFER SEVERAL HARMFUL DISEASES TO FISH, NOTABLY INCLUDING TUBERCULOSIS, FROM IMPROPER HAND SANITIZING BEFORE ENGAGING IN PHYSICAL CONTACT OR THROUGH AN OPEN WOUND.

observed to be directly associated with animals

in touch tanks and thus likely indicative of poor welfare and health in these captive environments. Physically, color changes and bitten fins can indicate that a fish is suffering. Behaviorally, aggression and changes to swimming patterns similarly offer clues into a fish's negative mental state (Toni et al., 2019). Rays lifting the upper front of their body above the surface of water, or surface breaking behavior, may indicate a stereotypy, or abnormal repetitive behavior induced by chronic stress, trauma, or boredom, or a reaction to the shallow depth of the pools compared to their natural habitat (Grossman 2005; Ashley 2007). Animals contained in touch pools have also been observed to frequently

presents less perceivable welfare concerns to the general public compared to more obviously mobile, overstimulated, stressed, avoidant, and potentially injured fish (Pers. Comm. Jack Wootten, 2023).

Facilities that have touch tanks employ several strategies aimed at reducing pain, distress, and accidental injuries among the animals. These include promoting visitors to use the “two-fingers” policy to avoid aggressive grabbing or picking up of the animals; periodically closing touch tank exhibits during the day to allow the animals some time to rest; weekly or monthly

rotation of animals used; and building wide touch pools with a relative water depth to allow the animals to disperse on the surface and in the water column, or not even be reached if desired (Biasseti et al., 2020D). The implementation of these measures clearly demonstrates that zoos recognize the stress and harm caused by touch pools yet allow them to continue to satisfy visitors at the expense of animal welfare.

Despite the lack of touch tank monitoring enforced by aquariums, some consistent psychological behaviors and physical impairments have been

display evasive behavior triggered by stress accumulation, e.g., “tail-wagging” in dogfish, where they attempt to escape the exhibit by walking on their tails and jumping out of the tank (Biasetti et al., 2020).

Zoonoses, or diseases that may be transferred from animals to humans, also pose a major health concern. Zoonotic diseases, primarily bacterial infections, can be passed from food, bait, ornamental fish, tropical fish, and shellfish to humans mainly via direct physical contact with fish, exposure to contaminated water, and touching a tank and/or its components inside. The most common zoonoses transferable from fish to humans include *Mycobacterium*, *Erysipelothrix*, *Campylobacter*, *Aeromonas*, *Vibrio*, *Edwardsiella*, *Escherichia*, *Salmonella*, *Klebsiella*, and *Streptococcus iniae*. These infections are often asymptomatic in fish but can cause serious illness in humans. People with medical conditions including chronic illness, immunodeficiency, and pregnancy may be at higher risk of developing disease or complications from interactions with fish in touch tanks. Humans may also transfer several harmful diseases to fish, notably including *Tuberculosis*, from improper hand sanitizing before engaging in physical contact or through an open wound (Washington State University, 2023).

CASE STUDIES

The diseases that can pass between humans and fish can, in some cases, be fatal. In 2021, investigators at the Centers for Disease Control and Prevention (CDC) discovered that a young girl from Texas and two other people infected by a rare tropical disease potentially contracted the disease via contact with contaminated fish tanks. When the four-year-old first got sick, doctors diagnosed her with a rare bacterial infection called *Melioidosis*. *Melioidosis*, or Whitmore’s disease, is an infectious disease caused by bacteria called *Burkholderia pseudomallei*, commonly found in tropical climates like northern Australia and Southeast Asia. Because the bacteria only occur naturally in specific environments, doctors found themselves perplexed when several people fell ill without traveling internationally. The other two cases of bacteria contraction occurred in Kansas and Minnesota. In August 2021, the CDC reported that two of the people who contracted the disease died. A report released later by public health officials, however, offered a clue when they connected a similar Maryland case from 2019 back to the woman’s freshwater aquarium in her home. The report stated that the woman got *Melioidosis* despite never having travelled internationally. Investigators tested samples

from the woman’s home and found three positive genetic match samples from her freshwater home aquarium, which contained imported tropical fish. Health officials then launched a review into the pet store from which she had purchased the imported fish. Investigators highlighted in the report that “because these vendors might distribute freshwater animals and aquatic plants to pet store retailers throughout the United States, identifying possible source[s] of introduction with *B. pseudomallei* in the supply chain is essential to public health” (Berlin, 2021).

Clearly, touch tanks not only harm the welfare of fish but also can adversely affect human welfare and safety. For example, in 2022, a 12-year-old girl was bitten by a shark while feeding stingrays in a touch tank at the Turtle Back Zoo in New Jersey. The type of shark involved in this incident was not specified in the accident report, but Epaulette sharks were present inside the 1,600-gallon tank along with the stingrays. Epaulette sharks are native to the coasts of New Guinea and Australia and typically grow to be 27-35 inches long. The zoo made no modifications to their touch tank exhibit or interaction practices following the incident (Rogers, 2022).

Many aquariums make unnatural modifications to the animals in touch tanks to make them

less dangerous to the public, including clipping stingrays' barb tissue every two weeks, which can lead to a greater risk for infection or injury. Despite these inhumane adjustments, at least 30 people were injured by animals at SeaQuest's Colorado location between 2018 and 2019, including from shark bites and a stingray barb that pierced and got stuck in one visitor's hand. Three of the reported injuries were from puffer fish, whose bite may transfer a dangerous neurotoxin that can cause numbness and difficulty breathing. These symptoms were experienced by at least one visitor (ABC News, 2019; PETA, 2023).

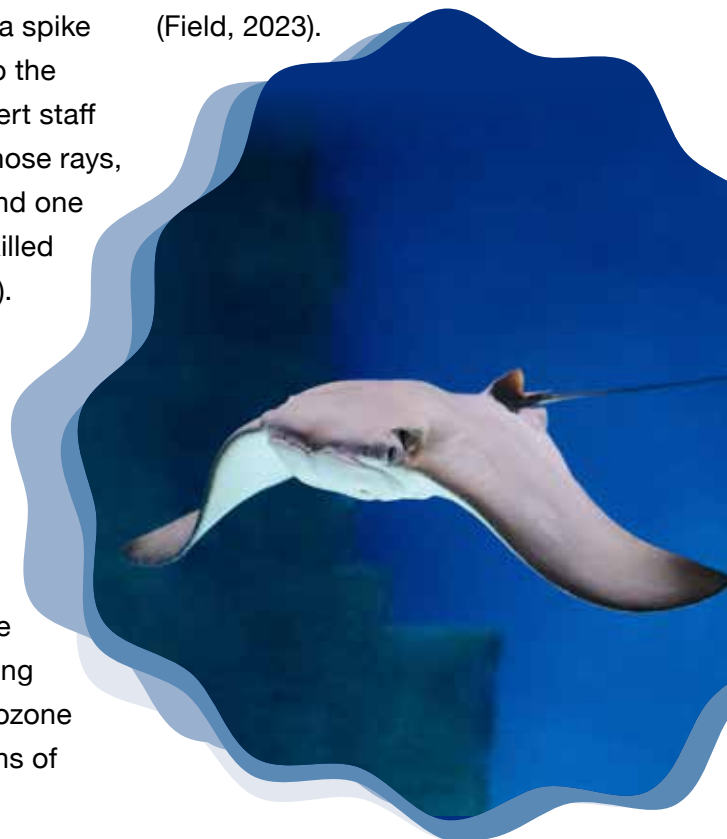
The design of touch tanks also poses serious security and health risks for the animals inside. In July of 2018, thieves stole a horn shark named Miss Helen from the San Antonio Aquarium by removing the 16-inch animal from an uncovered touch tank with their own net and placing her in a baby carriage. They made it all the way back to their residence before local police were able to locate them. Luckily, Miss Helen survived the theft (Johnson & Silva, 2018).

In 2008 at the Calgary Zoo in Canada, 41 out of 43 cownosed stingrays died due to a dangerously low level of oxygen in the water just three months after the new touch tank exhibit opened

(CBC News, 2009). At the Fresno Chaffee Zoo in California in 2007, 18 of 19 total rays died in a series of accidents including a power outage that led to a water quality failure and a stingray pup getting caught in a water cleaning device (Lee, 2007; Mullen, 2008). Similarly, in 2015, 54 stingrays (including four southern stingrays and 50 cownosed rays) died at the Brookfield Zoo in Illinois after a malfunction caused oxygen levels in their habitat to suddenly drop (ABC News, 2015). In 2022, eight more stingrays died in the touch tank at the National Mississippi River Museum & Aquarium in Dubuque, Iowa, when the exhibit appeared to have experienced a "supersaturation event" following a malfunction in the life support system, causing gas embolisms, or gas bubble disease, in the animals. The exhibit's monitoring system showed a spike in oxygen levels prior to the incident but failed to alert staff as expected. Five cownose rays, two yellow stingrays, and one Atlantic stingray were killed as a result (Cook, 2022).

At another SeaQuest aquarium located inside the Trumbull mall in Connecticut, according to a State Department of Agriculture (DOA) report on the incident, a malfunctioning filtration system led to ozone poisoning-related deaths of

numerous animals in the stingray tank. DOA officials had received a complaint from People for the Ethical Treatment of Animals (PETA) claiming that an anonymous former employee reported a "mass tank failure" and "mass die off" in the main stingray tank. As a result of this mechanical failure, 18 smaller fish died, but no sharks or stingrays were killed. Because the state animal control and agricultural division do not regulate most marine animals, including fish, and therefore have such limited experience with these species and the inhumane conditions in which these animals are often kept, these cases are rarely classified as animal cruelty or neglect. They typically warrant no further charges or changes made to current exhibits; even in the cases involving dozens of animals losing their lives at once (Field, 2023).



FISH PROTECTION LEGISLATION – OR LACK THEREOF

All U.S. federal legislation relating to fish in captivity in 2023 pertains to fisheries, including fish raised in aquaculture or those caught from the wild within the parameters of U.S. federal waters. These laws focus primarily on preventing disease and parasite transmission and ensuring that wild population stocks remain sustainable. Sadly, any mention of fish welfare in current U.S. legislation stems from measures enacted to protect these human-based concerns (NSGLC, 2018). Therefore, as of 2023, no federal legislation exists in the U.S. that protects fish kept in private possession in terms

of animal cruelty, neglect, or abuse. Sadly, most federal and state legislation does not even consider fish to fall under the category of an “animal” at all regarding captive conditions for pets or exhibition animals used in zoos or circuses.

As a result, the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS), which together work to enforce the Animal Welfare Act (AWA) of 1966, do not require individuals to register for an exhibitor’s license to own fish, even for large-scale operations like zoos. This means that the health,

welfare, and conditions of captive fish are never investigated, and multitudes of fish suffering occurs regularly, completely unseen. The AWA regulates the minimum standards of care for “warm-blooded” animals, and excludes protection for rats, mice, farmed animals, some species of birds, and “cold-blooded” animals including reptiles, amphibians, and fish (ALDF, 2023; APHIS, 2023). In addition to being excluded from the AWA, fish are also omitted from the Humane Methods of Slaughter Act and the Preventing Animal Cruelty and Torture Act (In Defense of Animals, 2021).



On a state level, animal cruelty laws vary widely. In addition to the other “cold-blooded,” farmed, and exotic animals outlined above, fish are often excluded from state and county animal cruelty laws. Ten states explicitly exclude fish from their statutory definitions of “animals” (Pallotta, 2019).

On the federal legislation front, the Magnuson–Stevens Fishery Conservation and Management Act (MSA), first passed in 1976, is the primary law that governs marine fisheries management in the U.S. The law applies to waters within 200 nautical miles of the U.S. shore. The primary objectives of the MSA include preventing overfishing, rebuilding overfished populations, increasing long-term economic and social benefits, ensuring a safe and sustainable supply of seafood, and protecting fish habitat (NOAA 2, 2023).

The MSA Reauthorization Act of 2007, in addition to strengthening the existing policies, established further accountability measures like annual catch limits; strengthened the role of science through peer review; and enhanced international cooperation by addressing illegal, unregulated, and unreported fishing and bycatch (NOAA 2, 2023).

The Sustainable Fisheries Act of 1996 enacted additional mandates to better protect fish

habitat needed for survival and reproduction to mitigate the growing demand of commercial and recreational fisheries. This act added three new national standards to address fishing vessel safety, fishing communities, and bycatch and established new requirements for fishery management councils to identify Essential Fish Habitat (EFH). A 2002 update allowed fishery management councils to designate Habitat Areas of Particular Concern (specific areas that have become especially vulnerable to environmental degradation) and established a federal consultation process that advises federal agencies how to offset adverse effects on EFH (NOAA 2, 2023).

Thus, while domestic laws seek to manage fish health issues that could impact humans (e.g., disease and parasites) or practices that would harm the survivability of popularly farmed or fished fish species, they fail to require even the most basic standards of humane treatment (NSGLC, 2018). Although no federal law related to farmed fish welfare currently exists in the U.S., other countries have implemented national legislation and guidelines that regulate the humane treatment of farmed fish (mostly during the transport and slaughter processes).

When these measures fail, the private sector often intervenes by creating industry-regulated

codes of practice aimed at protecting fish welfare, though in these instances, many of these schemes were likely created based on financial interest to minimize deaths (NSGLC, 2018). Even to the average reader without a background in animal protection legislation, it may become obvious that legislation pertaining to the protection of fish, as it currently stands, is almost entirely based upon viewing them as mass groups, not conscious individuals. New legislation must consider fish as individuals, with “attention given to their qualitative experience at every stage of life in captivity,” perhaps beginning with informing and thus changing how the public sees fish as conscious, singular beings altogether (Gonzalez, 2022).

CASE STUDIES

In 2019, a man in North Carolina abandoned his one-year-old Oscar fish at his home after he was evicted. He was subsequently arrested and charged with four animal cruelty misdemeanors, including one count of animal abandonment and three counts of cruelty to animals, for failing to provide his fish with food and fresh water. According to accounts from the rescue, the fish was found severely malnourished, in a filthy tank, and languishing with a parasitic disease upon the arrival of local authorities. Authorities seized the fish and took him to

a retail pet store, where employees rehabilitated him with medication and food (Pallotta, 2019). The following week, all charges were dropped, as North Carolina animal cruelty laws do not include fish in their definition of “animals.” Like many other states, North Carolina’s animal cruelty statute defines animals

MANY ANIMALS, HOWEVER, ARE NOT GRANTED EVEN THE MOST BASIC PROTECTION UNDER THE LAW TO DISTINGUISH THEM FROM LIFELESS, INSENTIENT PROPERTY, AND ARE CONSEQUENTLY LEGALLY PERMITTED TO SUFFER IN WHAT ARE VERY CLEAR CASES OF ANIMAL CRUELTY.

as “every living vertebrate in the classes Amphibia, Reptilia, Aves, and Mammalia except human beings” (NC General Statutes). Fish are not included in these categories and thus the only vertebrate class ignored by the law. Animal cruelty laws are one of the few legal protections that distinguish animals from other types of property. Many animals, however, are not granted even the most basic protection under the law to distinguish them from lifeless, insentient property, and are consequently legally permitted to suffer in what are very clear cases of animal cruelty. Troublingly, similar cases likely occur frequently around the country, remaining

completely unnoticed, as long as the legislation views fish as property over living, feeling animals (Pallotta, 2019).

At Simmons Farm Raised Catfish, one of the largest catfish farms investigated by the USDA located in central Mississippi, Animal Equality conducted an undercover investigation into the

facility over five weeks in 2020 (Animal Equality, 2022). The investigator documented fish dumped onto a conveyor belt and left to suffocate for more than 30 minutes, with no water, when workers

would take breaks. The investigator also shot video footage of turtles and discarded fish abandoned in buckets without water for long periods of time before being cut up alive in an industrial machine. According to Sean Thomas, the international director of investigations for Animal Equality: “If one pig were killed in this manner, the slaughterhouse would be shut down.” According to legal experts, the state laws in Mississippi do not explicitly exclude fish. The state law refers to “any living creature” except dogs or cats, who are covered under separate statutes. Therefore, the state law covers animals like fish and turtles. Despite this legislation,

getting a prosecutor to argue for upholding animal cruelty laws against alleged fish abuse, however, proved near impossible. When Animal Equality reached out to a Yazoo County prosecutor named John Donaldson to inquire about a criminal investigation into the catfish farm, he finally wrote back, “I’m not interested in any of this.” Bill James, a consultant for the Catfish Farmers of America, an industry group, who also speaks on behalf of Simmons (the farm owner), dismissed the investigation as “silly and misguided.” Catfish farms are inspected by the Agriculture Department, but the inspections focus only on whether the animals are prepared and processed in sanitary conditions, not the state of animal welfare.

Although extremely rare, prosecutors have brought criminal charges stemming from similar allegations of fish abuse in the past. In March 2020, an Ohio fishery was charged by the state Department of Natural Resources Wildlife Division with illegally removing and abusing fish, including a native species called gar and a trophy-size muskellunge from Lake Erie. The Szuch Fishery pleaded not guilty to one count of causing intentional injury to a noncommercial fish species, among other charges. The case remains ongoing (Schapiro, 2021).

WILD POPULATION DEPLETION – CITES AND ESA REGULATIONS

The knowledge deficit of fish population status in the wild and resulting minimal regulations enacted to protect them has led to the near depletion of some species, most notably including yellow tang, hermit crabs, feather duster worms, Achilles tang, Goldring tang, Potter’s angelfish, and Moorish idols in Hawaiian waters. Removing these populations harms local ecosystems, as many of these fish regulate algae growth.

In response to these unprecedented population decreases, in 2022, a U.S. Supreme Court ruling banned all collection of marine fish across

Hawaii until further notice. The ruling originated from a legal case in 2012, where plaintiffs sued the State Department of Land and Natural Resources over non-compliance with Hawaii’s Environmental Policy Act regarding the undertaking of environmental reviews before issuing collecting permits. The ruling of the court will require analysis of the commercial aquarium industry’s impact on marine ecosystems before any future collection permits will be issued. Without such permits, no collection can occur.

The impacts of years of unregulated fish harvest from the waters of Hawaii can be observed at the individual level as well, as one plaintiff in the case, experienced diver Rene Umberger, went on the record stating that since she began diving in 1983 (totaling 10,000+ dives), she noticed that “fish species that are prized by the aquarium trade have abruptly disappeared from a lot of dive sites” (Practical Fishkeeping, 2023).

The Convention on the International Trade of Endangered Species (CITES) and the Endangered Species Act (ESA) attempt to regulate the trade of species potentially threatened with extinction to maintain sustainable populations in the wild. CITES is an international treaty, of which the U.S. became a signatory in 1975. CITES regulates the international and domestic trade of wildlife among participating nations. Approximately 5,800 species of animals and 30,000 species of plants are covered by the treaty. The ESA is a federal law in the U.S. that protects fish, mammals, birds, and plants listed as Threatened or Endangered (ALDF, 2023).

To determine the current level of regulation of CITES-listed species via imports into the U.S. of popular aquarium fish species, we searched all fish classes separately in the CITES database (CITES, 2023). The taxonomic fish species listed by CITES include those under the classes *Elasmobranchii*, *Actinopteri*, *Coelacanthi*, and *Dipneusti* (excluding the genus *Hippocampus*) (Eschmeyer & Frick, 2015).



Our search criteria remained constant for each fish class we searched in the database, including the following: all imports from 2012 to 2022; all exporting countries; imported only into the U.S.; all sources including captive-bred/artificially propagated, born in captivity, pre-convention, source unknown, wild, and specimens taken in the marine environment not under the jurisdiction of any state; for circus, travelling exhibition, or zoo purposes; and live.

We discovered that just four of the 14 recognized classes and subclasses of all fish (Weitzman, 2023) are listed by CITES. According to the CITES spreadsheets returned for each class search, only two of the classes covered by CITES returned import/export data from 2012-2022: *Actinopteri* (Appendix II) and *Elasmobranchii* (Appendix II and III).

According to the CITES results, 150 individuals of the *Actinopteri* class, or ray-finned fishes, were imported into the U.S. between 2012 and 2022. Sixty-seven percent of all imported individuals (n=100) went to zoos, and 33% (n=50) went to circuses and traveling exhibitions. Sixty-one percent of all individuals were captive bred (n=92), 33% were first generation captive born (n=50), and 5% were wild caught (n=8). Sixty-seven percent (n=100) of these individuals were exported from Australia. The remaining 33% (n=50) were exported from Canada.

Of the *Elasmobranchii* class, including sharks and rays, five individuals (two of the *Sphyrna lewini* taxon and three of *Potamotrygon* spp.) were imported into the U.S. One hundred percent (n=5) of all individuals went to zoos. Forty percent (n=2) were wild caught,

60% were pre-convention (n=3). Forty percent (n=2) were exported from Australia; 60% (n=3) were exported from Canada.

In total, our CITES searches returned results for just 155 individuals imported into the U.S. over a ten-year period. These results dwarf the likely tens of thousands of individual fish imported into the U.S. each year, as thousands of species remain unregulated and thus traded without a trace. Altogether, we have confirmed that CITES provides documentation for and lists a very small fraction of the fish species involved in the aquarium trade, completely excluding the most numerous species involved in the commercial and private trade of ornamental fish. The species not listed by CITES are some of the most frequently harvested and traded fish around the world, many of whose population statuses remain largely Unknown.



CONCLUSION

In this report, we overview comprehensive findings confirming that many species of fish suffer in captivity due to the inability of most captive environments to meet their needs. We also confirm the glaring failure of zoos and prominent animal regulating bodies to protect fish conservation by participating in the unsustainable and unmonitored wild harvest of countless fish for the ornamental fish trade.

To properly protect future populations of fish and guarantee the stability of underwater ecosystems in the years to come, we recommend the following:

- Determine the wild population status of the most frequently imported ornamental fish species.
- Petition to add these species to the CITES appendices listings and ESA as needed to begin monitoring the extent to which these species are imported for aquarium purposes and protect them from further irreversible population depletion.
- Halt the wild capture of fish for zoos and aquariums.
- Phase out touch tanks from aquariums. They do not contribute to any genuine conservation efforts and directly negatively impact the welfare of the animals and humans involved.
- Include fish in the definition of “animals” in both state and federal animal cruelty legislation.

By 2023, most animal welfare research on fish is in resounding agreement: these individuals are sentient, intelligent, social, and highly capable of suffering and feeling pain. They do not belong in tiny glass tanks devoid of any other meaningful environmental elements, except for pairs of intimidating, foreign eyes peering in at them and the occasional disruptive jolt of a finger loudly tapping on the glass. They deserve the freedom to swim in a space that affords more than just tight, repetitive circles, no bigger than the length of their bodies. They deserve freedom, no matter how much smaller or different they seem compared to the rest of the animal kingdom.

In the same way that a solitary elephant in a small zoo enclosure would suffer without the presence of her family members or enough space to roam, the similar experience of a fish suffering cannot be minimized; theirs is largely the same, torturous existence in captivity. Therefore, we must afford fish the same protection from mental and physical harm that we provide for almost all other animal species. To achieve this more quickly, we implore communities to say “no” to visiting aquariums, especially those that have active touch tank exhibits, to help us keep more fish where they belong: in the wild.

REFERENCES

ABC News. (2019). Reports of injuries pile up at SeaQuest Interactive Aquarium, State confirms ongoing investigation. *ABC News*. Available at: <https://www.denver7.com/news/front-range/littleton/reports-of-injuries-pile-up-at-seaquest-interactive-aquarium-state-confirms-ongoing-investigation>.

ABC News. (2015). 54 Rays Die After Malfunction at Illinois Zoo. *ABC News*. Available at: <https://abc7news.com/brookfield-zoo-rays-die-stingrays/845900/>.

Akrinrinade, B., Kareklas, K., Teles, M.C., Reis, T.K., Gliksberg, M., Petri, G., Levkowitz, G., Oliveira, R.F. (2023). Evolutionarily conserved role of oxytocin in social fear contagion in zebrafish. *Science*, 379(6638), 1232-1237. Available at: <https://www.science.org/doi/10.1126/science.abq5158>.

ALDF. (2023). Captive Animals. *Animal Legal Defense Fund*. Available at: https://aldf.org/focus_area/captive-animals/.

Alós, J., Palmer, M., Balle, S., Arlinghaus, R. (2016). Bayesian State-Space Modelling of Conventional Acoustic Tracking Provides Accurate Descriptors of Home Range Behavior in a Small-Bodied Coastal Fish Species. *PLoS ONE* 11(4): e0154089. <https://doi.org/10.1371/journal.pone.0154089>. Available at: <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154089>.

Animal Equality. (2022). Investigation: Killed While Conscious at Catfish Slaughterhouse. *Animal Equality*. Available at: <https://animalequality.org/news/investigation-animals-killed-while-conscious-at-u-s-catfish-slaughterhouse/>.

APHIS. (2023). AWA Standards for Birds. *Animal and Plant Health Inspection Service*. Available at: <https://www.aphis.usda.gov/aphis/ourfocus/animalwelfare/new-bird-rule/awa-standards-for-birds>.

APPA. (2011-2012). Industry Statistics and Trends. *American Pet Products Association*. Available at: http://www.americanpetproducts.org/press_industrytrends.asp.

Aquarium Co-op. (2023). How Many Fish Can I Put in a Fish Tank? *Aquarium Co-op*. Available at: <https://www.aquariumcoop.com/blogs/aquarium/how-many-fish>.

AVMA. (2013). AVMA Guidelines for the Euthanasia of Animals: 2013 Edition. *American Veterinary Medical Association*, 13. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.in.gov/boah/files/AVMA_Euthanasia_Guidelines.pdf.

AWI. (2015). Ethical and Ecological Implications of Keeping Fish in Captivity. *Animal Welfare Institute*. Available at: <https://awionline.org/awi-quarterly/2015-fall/ethical-and-ecological-implications-keeping-fish-captivity>.

AZA 1. (2023). Animal Care Manuals. *Association of Zoos & Aquariums*. Available at: <https://www.aza.org/ANIMAL-CARE-MANUALS>.

AZA 2. (2023). The Accreditation Standards and Related Policies. *Associated of Zoos & Aquariums*. Available at: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://assets.speakcdn.com/ASSETS/2332/AZA-ACCREDITATION-STANDARDS.PDF>.

Bartley, D. (2000). Responsible Ornamental Fisheries. *FAO Aquaculture Newsletter*, 24, 10-14.

Bassleer, G. (1994). The International Trade in Aquarium/Ornamental Fish. *Infofish International*, 5(94), 15-17.

Bedford, E. (2023). Number of Pet Owning Households in the United States in 2023, by Species. *Statista*. Available at: <https://www.statista.com/statistics/198095/pets-in-the-united-states-by-type-in-2008/>.

Berlin, S. (2021). Young Girl who Suffered from Brain Damage from Infection may have Caught it from Fish Tank. *Newsweek*. Available at: <https://www.newsweek.com/young-girl-who-suffered-brain-damage-rare-infection-may-have-caught-it-fish-tank-1636339>.

Biasseti, P., Florio, D., Gili, C., de Mori, B. (2020). The Ethical Assessment of Touch Pools in Aquariums by Means of the Ethical Matrix. *Journal of Agricultural and Environmental Ethics*, 33, 337-353.

Available at: https://www.researchgate.net/publication/339856330_The_Ethical_Assessment_of_Touch_Pools_in_Aquariums_by_Means_of_the_Ethical_Matrix.

Boyle, S.A., Berry, N., Cayton, J., Ferguson, S., Gilgan, A., Khan, A., Lam, H., Leavelle, S., Mulder, I., Myers, R., et al. (2020). Widespread Behavioral Responses by Mammals and Fish to Zoo Visitors Highlight Differences between Individual Animals. *Animals*, 10, 2108.

CBC News. (2009). Lack of Oxygen Killed Stingrays, Calgary Zoo Admits. CBC News. Available at: <https://www.cbc.ca/news/canada/calgary/lack-of-oxygen-killed-stingrays-calgary-zoo-admits-1.797898>.

CITES. (2023). Full CITES Trade Database Download Available (Version 2022.1). *CITES Trade Database*. Available at: <https://trade.cites.org/>.

Chapman, F.A., Fitz-Coy, S.A., Thunberg, E.M., Adams, C.M. (1997). United States of America Trade in Ornamental Fish. *Journal of the World Aquaculture Society*, 28(1), 1-10.

Che-Castaldo, J.P., Shelly, A.G., Faust, L.J. (2018). Evaluating the Contribution of North American Zoos and Aquariums to Endangered Species Recovery. *Scientific Reports*, 8(9789), 1-9. Available at: <https://www.nature.com/articles/s41598-018-27806-2.pdf>.

Congressional Research Service. (2021). Federal Statutes Protecting Domesticated and Captive Animals. *Congressional Research Service*, R46672. Available at: <https://crsreports.congress.gov/product/pdf/R/R46672>.

Cook, L. (2022). 8 Stingrays Die, Iowa River Museum Stops Touch-Tank Experience. *Our Quad Cities*. Available at: <https://www.ourquadcities.com/news/local-news/8-stingrays-die-iowa-river-museum-stops-touch-tank-experience/>.

Crook, D. (2004). Is the Home Range Concept Compatible with the Movements of Two Species of Lowland River Fish? *Journal of Animal Ecology*, 73, 353–366. Available at: <chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://besjournals.onlinelibrary.wiley.com/doi/pdfdirect/10.1111/j.0021-8790.2004.00802.x>.

DEFRA. (2012). Secretary of State's Standards of Modern Zoo Practice. *Department for Environment Food and Rural Affairs*, 15. Available at: chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69596/standards-of-zoo-practice.pdf.

Eshmeyer, W.N., & Frick, R. (2015). Taxonomic Checklist of Fish Species. *CoP17*. Available at: <https://cites.org/sites/default/files/eng/cop/17/WorkingDocs/E-CoP17-81-01-A6.pdf>.

Evers, H-G, Pinnegar, J.K., Taylor, M.I. (2019). Where are They All From? – Sources and Sustainability in the Ornamental Freshwater Fish Trade. *Journal of Fish Biology*, 94, 909– 916. Available at: <https://onlinelibrary.wiley.com/doi/epdf/10.1111/jfb.13930>.

Field, A.T. (2023). Trumbull SeaQuest fish die-off caused by faulty tank, report shows. *CT Post*. Available at: <https://www.ctpost.com/news/article/trumbull-seaquest-fish-deaths-caused-faulty-tank-17856523.php>.

Fife-Cook, I. & Franks, B. (2019). Positive Welfare for Fishes: Rationale and Areas for Future Study. *Fishes*, 4(2), 31.

Gonzalez, T. (2022). The Welfare of Captive Fishes. *The IAABC Foundation Journal*, 23, doi: 10.55736/iaabcfj23.8. Available at: <https://iaabcjournal.org/the-welfare-of-captive-fish/>.

Hays, G. C. & Scott, R. (2013). Global Patterns for Upper Ceilings on Migration Distance in Sea Turtles and Comparisons with Fish, Birds and Mammals. *Functional Ecology*, 27, 748–756. Available at: <chrome-extension://efaidnbmnnnibpcajpcgclefindmkaj/https://besjournals.onlinelibrary.wiley.com/doi/pdfdirect/10.1111/1365-2435.12073>.

Home Stratosphere. (2023). Fish Tank Sizes (Charts & Tables). *Home Stratosphere*. Available at: <https://www.homestratosphere.com/fish-tank-sizes/>.

In Defense of Animals. (2021). Respect for Fish Day: Planet's Most Abused Animals Can't Run Or Scream. *One Green Planet*. Available at: <https://www.onegreenplanet.org/animals/respect-for-fish-day-planets-most-abused-animals-cant-run-or-scream/>.

Johnson, A. & Silva, D. (2018). Thieves snatch shark from San Antonio Aquarium, wheel it out in a baby carriage. *NBC News*. Available at: <https://www.nbcnews.com/news/us-news/thieves-snatch-shark-san-antonio-aquarium-wheel-it-out-baby-n895956>.

Kramer, D.L. & Chapman, M. R. (1999). Implications of Fish Home Range Size and Relocation for Marine Reserve Function. *Environmental Biology of Fishes*, 55, 65-79. Available at: <https://link.springer.com/article/10.1023/A:1007481206399>.

- Lee, C. (2007). Stingray Dies at Fresno Chaffee Zoo. *Fox 26 News*. Available at: <https://kmpf.com/archive/sting-rays-die-at-fresno-chaffee-zoo>.
- Lowry, M.B. & Suthers, I.M. (1998). Home Range, Activity, and Distribution Patterns of a Temperate Rocky-Reef Fish, *Cheilodactylus fuscus*. *Marine Biology*, 132, 569-578. Available at: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/http://www.famer.unsw.edu.au/publications/Lowry1998.pdf>.
- Melfi, V.A. (2009). There Are Big Gaps in Our Knowledge, and Thus Approach, to Zoo Animal Welfare: A Case for Evidence-Based Zoo Animal Management. *Zoo Biology*, 28, 574–588.
- Mullen, W. (2008). Brookfield Not Alone in Ray Deaths. *Chicago Tribune*. Available at: <https://www.chicagotribune.com/news/ct-xpm-2008-07-18-0807170882-story.html>.
- NC General Statutes. (2023). North Carolina General Assembly, Chapter 14, Article 47. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ncleg.net/EnactedLegislation/Statutes/PDF/ByArticle/Chapter_14/Article_47.pdf.
- NOAA, 1. (2023). How Much of the Ocean Have we Explored? *National Oceanic and Atmospheric Administration*. Available at: <https://oceanservice.noaa.gov/facts/exploration.html#:~:text=Currently%2C%20less%20than%20ten%20percent,been%20mapped%20with%20modern%20methods>.
- NOAA, 2. (2023). Laws & Policies. *NOAA Fisheries*. Available at: <https://www.fisheries.noaa.gov/topic/laws-policies>.
- NSGLC. (2018). Standards for Farmed Fish Welfare: A Domestic and International View. *University of Mississippi*. Available at: <https://nsglc.olemiss.edu/blog/archive/2018/oct/5/index.html>.
- Nursall, J.R. (1981). The Activity Budget and Use of Territory by a Tropical Blennioid Fish. *Zoological Journal of the Linnean Society*, 72(1), 69–92. Available at: <https://academic.oup.com/zoolinnean/article-abstract/72/1/69/2658792>.
- Oldfield, R.G. & Bonano, P.E. (2022). Psychological and Social Well-being of Bony Fishes in Zoos and Aquariums. *Zoo Biology*, 1-9.
- O’Sullivan, D., Clark, E., Morison, J. (2008). The Australian Ornamental Fish Industry in 2006/07. *Dosaqua Pty Ltd*, 1-216. Available at: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.frdc.com.au/sites/default/files/products/2007-238-DLD.PDF>.
- Pallotta, N. (2019). Animal Welfare Charges Dropped Because Fish are not “Animals” Under North Carolina Law. *ALDF*. Available at: <https://aldf.org/article/animal-cruelty-charges-dropped-because-fish-are-not-animals-under-north-carolina-law/>.
- Personal Communication via email with Jack Wootten (2023).
- PETA. (2023). Everything Wrong with Touch Tanks. *PETA*. Available at: <https://www.peta.org/features/touch-tanks-deaths-exploitation-marine-animals/>.
- Ploeg, A. (2007). The Volume of the Ornamental Fish Trade. *Ornamental Fish International*. Available at: <http://www.ofish.org/files/files/volume-of-thetrade.pdf>.
- Practical Fishkeeping. (2023). Fish Collection in Hawaii Halted. *Fishkeeping News*. Available at: <https://www.practicalfishkeeping.co.uk/fishkeeping-news/fish-collection-in-hawaii-halted/>.
- Ravi, R. & Venkatesh, B. (2018). The Divergent Genomes of Teleosts. *Annual Review of Animal Biosciences*, 6, 47-68. Available at: [https://pubmed.ncbi.nlm.nih.gov/29447475/#:~:text=Boasting%20nearly%2030%2C000%20species%2C%20teleosts,finned%20fish%20species%20\(Actinopterygii\)](https://pubmed.ncbi.nlm.nih.gov/29447475/#:~:text=Boasting%20nearly%2030%2C000%20species%2C%20teleosts,finned%20fish%20species%20(Actinopterygii)).
- Richard 1, H. (2021). Welfare and Ethics in Aquatic Collections. *Association of Zoos and Aquariums*. Available at: <https://www.aza.org/connect-stories/stories/animal-welfare-in-aquariums?locale=en>.
- Richard 2, H. (2021). Improving Supply Chains for Aquatic Collections. *Association of Zoos and Aquariums*. Available at: <https://www.aza.org/connect-stories/stories/improving-aquarium-supply-chain?locale=en>.
- Rose, N.A., Hancock Snusz, G., Brown, D.M., Parsons, E.C.M. (2017). Improving Captive Marine Mammal Welfare in the United States: Science-Based Recommendations for Improved Regulatory Requirements for Captive Marine Mammal Care. *Journal of International Wildlife Law and Policy*, 20(1). Available at: <https://www.tandfonline.com/doi/full/10.1080/13880292.2017.1309858>.
- Rogers, J. (2022). Girl, 12, Bitten by Shark While she was Feeding Stingrays in Touch Tank at a Zoo. *The U.S. Sun*. Available at: <https://www.the-sun.com/news/5136738/shark-bites-girl-feeding-stingrays-zoo/>.

RSPCA. (2023). Keeping Freshwater Fish as Pets. RSPCA. Available at: <https://www.rspca.org.uk/ADVICEANDWELFARE/PETS/FISH>.

Sánchez-Suárez, W., Franks, B., Torgerson-White, L. (2020). From Land to Water: Taking Fish Welfare Seriously. *Animals*, 10, 1585.

Schapiro, R. (2021). Is a catfish farm abusing its fish? An animal rights group says yes. *NBC News*. Available at: <https://www.nbcnews.com/news/us-news/catfish-farm-abusing-its-fish-animal-rights-group-says-yes-n1276823>.

Shiffman, D. (2023). Amazon Freshwater Stingrays Gain Much-Needed Protection—Will it be Enough? *The Revelator*. Available at: <https://therevelator.org/amazon-freshwater-stingrays/>.

Spots. (2023). Pet Ownership Statistics. *Spots.com*. Available at: <https://spots.com/pet-ownership-statistics/#:~:text=Pet%20Population%20Statistics&text=393.3%20million%20pets%20live%20in%20the%20United%20States.,dogs%20are%20kept%20as%20pets>.

Sullivan, M. (2014). Fishing for Answers: Improving Welfare for Aquarium Fish. *The University of Western Australia*. Available at: https://www.researchgate.net/publication/294050418_Fishing_for_answers_improving_welfare_for_aquarium_fish.

Toni, M., Manciocco, A., Angiulli, E., Alleva, E., Cioni, C., Malvasi, S. (2020). Review: Assessing Fish Welfare in Research and Aquaculture, with a Focus on European Directives. *Animal*, 13(1), 161-170. Available at: <https://www.sciencedirect.com/science/article/pii/S1751731118000940>.

UNEP. (2007). International Trade in Aquatic Ornamental Species. United Nations Environment Programme & World Conservation Monitoring Centre, SRG 42/8/a Available at: <http://www.ornamental-fishint.org/uploads/JT/ix/JTixi221VIVRdUsCoeXclg/UNEP-WCMC.pdf>.

Washington State University. (2023). Zoonoses Associated with Fish. *Institutional Animal Care and Use Committee*. Available at: <https://iacuc.wsu.edu/zoonoses-associated-with-fish/>.

Weitzman, S.H. (2023). Teleost Fish. *Britannica*. Available at: <https://www.britannica.com/animal/Bombay-duck>.

Woolnaugh, D.A., Downing, J.A., Newton, T.J. (2009). Fish Movement and Habitat Use Depends on Water Body Size and Shape. *Ecology of Freshwater Fish*, 18, 83–91. Available at: <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=f8b54fe46b82d4fb4040915e8d694a1aec66f588>.

Zaniboni-Filho, E. & Schulz, U.H. (2003). Migratory Fishes of the Uruguay River. In: *Migratory Fishes of South America Biology, Social Importance and Conservation Status*. Victoria, British Columbia, 157-194. Available at: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.researchgate.net/profile/U-Schulz/publication/312455850_Migratory_fishes_of_the_Uruguay_river_pp_157-194/links/5aa962e2a6fdccd3b9b96f4a/Migratory-fishes-of-the-Uruguay-river-pp-157-194.pdf.

ZooChat. (2023). Why Aren't Fish More Popular? *ZooChat*. Available at: <https://www.zoochat.com/community/threads/why-arent-fish-more-popular.486825/>.



8737 Colesville Road, Suite 715, Silver Spring, MD 20910
301-448-1407 • info@bornfreeusa.org • www.bornfreeusa.org

BORN FREE USA • KEEP WILDLIFE IN THE WILD® • [f](https://www.facebook.com/bornfreeusa) [t](https://twitter.com/bornfreeusa) @bornfreeusa [i](https://www.instagram.com/bornfreeusaorg) [t](https://www.tiktok.com/@bornfreeusaorg) @bornfreeusaorg