Are well-intended Buddhist practices an under-appreciated threat to global aquatic biodiversity?

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Abstract
1. The inherently pro-conservation and humane Buddhist practice of ‘live release’, entailing the release into the wild of creatures destined for slaughter, poses potentially significant conservation consequences if inappropriate, invasive species are procured for release.
2. This article collates evidence, citing one legal case and other examples, about the risks of the live release of potentially invasive aquatic species that may result in serious, possibly irreversible, conservation threats to aquatic biodiversity and natural ecosystems, with ensuing adverse ecological and human consequences.
3. It is essential that practitioners are aware of these risks if their actions are not to work diametrically against the pro-conservation and humane intents of the practice.
4. Ensuring that live release occurs safely necessitates raising awareness, with guidance informed by science, to ensure that good intentions do not result in perverse, environmentally destructive outcomes.
5. We propose four simple principles to achieve this, for dissemination to the global adherents of these otherwise entirely laudable practices.

KEYWORDS
conservation, fish, humane, invasive species, live release, mercy release

1 INTRODUCTION

Biotic homogenization – declining biological diversity resulting from environmental changes favouring a subset of species – is a pervasive global problem (McKinney & Lockwood, 1999), reaching substantial levels in some regions of the Palaearctic and Nearctic realms (Villéger, Blanchet, Beauchard, Oberdorff, & Brosse, 2011). Scott and Helfman (2001) observed that fish species are prone to biotic homogenization owing to the pressures of habitat destruction, favouring a few tolerant species, as well as purposeful introductions that may also lead to extinctions of native species. Across other taxonomic groups, potentially invasive species introduced beyond their native ranges are a significant factor driving environmental change, with extinctions of formerly locally representative species increasing the tendency towards genetic, taxonomic, or functional similarity between locations, with broader consequences for ecological and evolutionary processes (Olden, Poff, Douglas, Douglas, & Fausch, 2004). Liu, Comte, and Olden (2017) have provided a review of life-history traits of the world’s freshwater fishes as predictors of invasion and extinction risk, in order to support management decisions without needing to refer to individual species ecology.

The Buddhist practice of ‘live release’, also known by many alternative names, including ‘fang sheng’, ‘mercy release’, and ‘prayer animal release’, entails the release into the wild of captive animals and particularly those destined for slaughter. The practice is founded on the good intention of protection of living organisms; however, it also represents a potential pathway for the introduction of non-native and potentially invasive species, which may have perverse outcomes for...
the conservation of the ecosystems into which they are released. The primary aim of this article is to provide initial evidence for raising awareness of a potential emerging yet poorly researched threat to aquatic conservation. This aim is approached from an ecological perspective, without being critical of the human value dimensions that underpin these otherwise laudable actions.

2 | CAUSES AND CONSERVATION IMPACTS OF ALIEN FRESHWATER FISH INTRODUCTIONS

Ricciardi and Rasmussen (1998) recognized 11 factors predisposing aquatic organisms to becoming invasive (Table 1). Assessment of the suitability of fish species for aquaculture tends to address factors such as growth rate and hardiness (for example, see Ali et al., 2016), generally omitting consideration of native provenance or the potential for invasion of the regions in which the fish are produced. Aquaculture is consequently widely observed to be a source of alien invasive species posing conservation threats to invaded ecosystems, with freshwater fish homogenization driven by a few widespread non-native species globally (Toussaint, Beauchard, Oberdorff, Brosse, & Villéger, 2016). Numerous examples range from temperate system non-native salmonid invasions associated with declines of native fishes (Arismendi et al., 2009) to widespread tropical invasions by the Nile tilapia, Oreochromis niloticus (Linnaeus, 1758) (Schofield, Peterson, Lowe, Brown-Peterson, & Slack, 2011). Table 1 records the high coherence between the suitability of a species for aquaculture and the predisposition for that species to become invasive. Vilà and Hulme (2017) addressed multiple direct and indirect consequences of biological invasions on ecosystem services, including those of farmed fishes. The ornamental fish trade is also a significant vector for invasive fishes (for example, Costa-Pierce, 2003; Gozlan, Britton, Cownx, & Copp, 2010; Raghavan, Prasad, Anvar-Ali, & Pereira, 2008). So too is fish stocking, both legal and illegal, in support of recreational angling (Davis & Darling, 2017), as well as accidental releases, such as bait releases, aquaculture escapes, or ballast water transport (Gupta & Everard, 2010; Raghavan, Prasad, Anvar-Ali, & Pereira, 2008).

### TABLE 1 Attributes of aquatic organisms that are predisposed to become invasive and their suitability for aquaculture

<table>
<thead>
<tr>
<th>Attributes of aquatic organisms predisposed to become invasive (Ricciardi &amp; Rasmussen, 1998)</th>
<th>Suitability for aquaculture, with suggested reason</th>
<th>Suitability for aquarist use, with suggested reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abundant and widely distributed in their original range</td>
<td>Hardy in crowded rearing conditions</td>
<td>Hardy in crowded aquarist conditions</td>
</tr>
<tr>
<td>2. Wide environmental tolerance</td>
<td>Highly fecund, with short generation time for rapid production</td>
<td>Easy to breed for ornamental fish trade</td>
</tr>
<tr>
<td>3. High genetic variability</td>
<td>Grows rapidly, suiting production in aquaculture conditions</td>
<td>Rapid growth for ornamental fish trade</td>
</tr>
<tr>
<td>4. Short generation time</td>
<td>Highly fecund, with short generation time for rapid production</td>
<td>Rapid growth to maturity and breeding for ornamental fish trade</td>
</tr>
<tr>
<td>5. Rapid growth</td>
<td>Acceptance of diverse diets in rearing conditions</td>
<td>Acceptance of diverse diets in aquarist conditions</td>
</tr>
<tr>
<td>6. Early sexual maturity</td>
<td>High reproductive capacity</td>
<td>Acceptance of diverse diets in aquaculture conditions</td>
</tr>
</tbody>
</table>
| 7. Reproductive capacity | Highly fecund, with short generation time for rapid production | Ecological 
| 8. Broad diet (opportunistic feeding) | Acceptance of diverse diets in rearing conditions | Acceptance of diverse diets in aquarist conditions |
| 9. Gregariousness | Tolerant of crowded rearing conditions | Tolerant of crowded fish-keeping conditions |
| 10. Possessing natural mechanisms of rapid dispersal | Suited to aquaculture, with brood stock readily transported | Suited to aquarist conditions with ready transport for trade |
| 11. Commensal with human activity (e.g. transport in ship ballast water or trade of ornamental species for aquarists) | Suited to aquaculture, with brood stock readily transported | Suited to aquarist conditions with ready transport for trade |

3 | THE BUDDHIST PRACTICE OF ‘LIVE RELEASE’

The Buddhist practice of ‘live release’ is founded on good intentions relating to the protection of living organisms; however, perverse outcomes may ensue if uninformed releases of potentially invasive organisms have impacts on native biodiversity. The release of captive animals for religious purposes has historically been a traditional practice in many religions of Asian origin, including both Buddhism and Taoism, and is especially prevalent in the Buddhist doctrine (Agoramoorthy & Hsu, 2007). Live release, also known as ‘mercy release’ or ‘Tsethar’ in the Tibetan tradition, is the Buddhist practice of saving the lives of beings destined for slaughter, and is part of all schools of Buddhism: Theravada, Mahayana, and Vajrayana. By buying and releasing animals destined to be killed, live release puts the ideal of compassion into practical action, in part as compensation for the inevitable collateral killing of organisms as humans walk, breathe, and conduct their lives. Although live release may be initiated spontaneously to save an endangered life, it can also be planned in the form of purchasing animals directly from slaughterhouses, fishermen, or other sources, frequently planned around auspicious days in the Buddhist calendar to amplify the merit of the act. In a report from a conference co-hosted with The American Buddhist Confederation, the Humane Society International (2012) records that
problems stem from the fact that ‘... mercy release has become an industry built on the capture and supply of wild animals, for whom there are devastating consequences of injury, illness or death’.

The ancient origins of this practice may have meant that animals were released into their native environments; however, the live release of animals in an increasingly internationalized society has the potential to generate adverse environmental impacts. For example, some animals are captured for the explicit purpose of being released or are released into environments where they are unable to survive (Humane Society International, 2009). A gross example is the bird market in Mong Kok, Hong Kong, a major tourist attraction where captive-bred Melopsittacus undulatus (Shaw, 1805) (budgerigars), Lonchura oryzivora (Linnaeus, 1758) (Java sparrows), and various finch species are made available for purchase by the pious for freeing under ‘fang sheng’ (‘giving life’) rituals that tend to result in the early deaths of organisms not adapted to wild or local conditions (Wordie, 2017). A more problematic potential outcome, however, is that live release provides an as yet unquantified pathway for introducing invasive species into non-native environments, with the potentially perverse outcome of substantial ecological harm, including the progressive loss of local biodiversity (Shiu & Stokes, 2008).

Despite the best of intentions, some examples of live releases have been associated with conservation concerns and sometimes legal consequences (Agoramourthy & Hsu, 2007; Liu, McGarrity, & Li, 2012; Severinghaus & Chi, 1999). As one example, Tsetar practices are arising as a significant concern in Bhutan, an exceptional region for freshwater fish biodiversity, where Clarias gariepinus Burchell, 1822 (African sharp-toothed catfish) are imported live from Bangladesh via Kolkata and sold for release by religiously inclined Bhutanese people (Gurung, 2012). Although Clarias gariepinus is itself of Least Concern on the International Union for Conservation of Nature (IUCN) Red List (Freyhof, FishBase team RMCA, & Geelhand, 2016), it is also listed as having a wide tropical distribution beyond its native range, where it has been listed as a ‘Potential Pest’ (Froese & Pauly, 2018) and has been associated with significant ecosystem disruption (Cambray, 2003; Weyl, Dagall, Ellender, & Vitule, 2016). If awareness and education about the ecological consequences of such practices is not provided to local communities, this may serve as a major avenue for the introduction of alien species into the fresh waters of Bhutan (Gurung, Dorji, Tsherig, & Wangyal, 2013). In the Yunnan province of China, Jiang et al. (2016) concluded that the introduction since 2009 of two species of non-native weatherfishes (Misgurnus anguillicaudatus (Cantor, 1842) and Paramisgurnus dabryanus Dabry de Thiersant, 1872), through the practice of ‘prayer animal release’, and their subsequent increasing populations was putting the threatened native freshwater fish Ptychobarbus chungtienensis (Tsao, 1964) at risk in the Shangri-La region. In considering ‘Deliberate release for cultural reasons’, constituting one of 12 pathways of human-assisted dispersal of freshwater fishes in Australia, Lintermans (2004) noted that the 2001 Census recorded that 1.9% of the Australian population were Buddhists, and reported anecdotal evidence suggesting that the purchase and release of aquarium species for live release was not uncommon, albeit entirely unquantified.

Unregulated mercy releases have also resulted in Trachemys scripta elegans (Wied-Neuwied, 1839) (the red-eared slider turtle), native to central America, but widely invasive (Van Dijk, Harding, & Hammerson, 2011) yet readily procured from pet shops in the USA, dominating and outcompeting native terrapin species in New York’s Central Park (Selleck, 2015). Prayer releases have also resulted in red-eared slider turtles becoming widespread in Hong Kong (Tricarico, Junqueira, & Dudgeon, 2016). Indicative of the potential scale of the problem, Liu, McGarrity, Bai, Ke, and Li (2013) evaluated the release of two highly invasive species – Lithobates catesbeianus (Shaw, 1802) (American bullfrogs) and red-eared slider turtles – by 123 Buddhist temples surveyed across four provinces in China, together with intensive field surveys of release sites. They found that both bullfrogs and sliders were present at the majority of sites where the release of these species was reported. Given the large numbers of such temples in this region and the pervasion of religious observers across the world, the scale at which live release could potentially be happening is substantial. According to Gong, Chow, Fong, and Shi (2009), China is the largest consumer of turtles in the world, serving markets for two main types of local and international trade: for food and traditional Chinese medicine; and for release by Buddhists. Liu et al. (2012) have tabulated evidence resulting from a search of the literature and news reports on the global occurrence of religious wildlife release; however, the literature on aquatic species, and particularly their impacts, is largely addressed by this summary, thereby highlighting the scale of the knowledge gap.

West (1997) reported that a small congregation of seven Buddhist adherents led by a monk procured 2500 goldfish from a storefront temple in New York’s Chinatown and transported them for ritual release in Westons Mill Pond, a reservoir for the city of New Brunswick, as an act of compassion. This was perceived by scientists and wildlife experts as introducing competition with, and potentially out-breeding, native species of perch, sunfish, catfish, and other aquatic fauna. The same report described the conservation concerns that are likely to arise from freeing caged birds, which are more likely to die than to thrive in their new environments, and that the release of turtles into ponds in Brooklyn’s Prospect Park and New York’s Central Park by Buddhists also had the potential to perturb local aquatic ecosystems directly, as well as through the introduction of diseases and by genetic dilution. As a general principle, relevant to some instances of live release but also to wider conservation matters, even introductions of conspecific species may perturb ecosystems, posing a threat to conservation though genetic homogenization, including the introduction of non-native genes and the loss of local adaptation (Champagnon, Elmberg, Guillemain, Gauthier-Clerc, & Lebreton, 2012).

Fish invasions are known to have significant knock-on effects on the conservation of freshwater ecosystems, their functions, and their associated biota. Although not inferring that it was caused by live release, a radical degradation of both aquatic and avian biodiversity has followed the introduction of the alien species Cyprinus carpio Linnaeus, 1758 (the common carp) to Medina and Zoñar lakes in south-western Spain. Driven by the destruction of submerged macrophyte beds via mechanical disturbance and elevated turbidity, the invasion of Cyprinus carpio and other non-native fishes throughout the fresh waters of the Mediterranean region is now recognized as a major threat to waterbirds, including globally threatened taxa such as...
Oxyura leucocephala (Scopoli, 1769) (the white-headed duck), which is listed as Endangered on the IUCN Red List (BirdLife International, 2017) (Maceda-Veiga, López, & Green, 2017). Similarly, tilapia, Oreochromis spp., and Clarias gariepinus have invaded and now totally dominate Jal Mahal, the Water Palace Lake in Jaipur (Rajasthan State, India), with further consequences for avian biodiversity, thus extending the adverse socio-economic implications for bird watching-based ecotourism (H. Vardhan, pers. comm., and author observations). (The invasion of Jal Mahal by Clarias gariepinus and Oreochromis spp. has yet to feature in the peer-reviewed literature, but is well known locally, and has been observed by the authors and by other local biologists. There are many YouTube clips of the two species in vast numbers and also sometimes found dead, as the lake becomes anoxic.)

There is limited case law at present relating to the potential ramifications of live release; however, in the UK, two Buddhists performing a live-release ritual were convicted, fined, and ordered to pay compensation in September 2017 for offences under the Wildlife and Countryside Act 1981 in releasing non-native lobsters into the sea, potentially causing ‘untold damage’ to marine life (Sherwood, 2017).

4 CONCLUSIONS AND RECOMMENDATION

At present, there appears to be little awareness about the potential perversity, unintended outcomes from live-release practices for aquatic and other wildlife, and a lack of quantification of conservation impacts. Consequently, no effective proactive interventions have been implemented so far, and there is not a great deal of scientific study to back up any management advice. Table 2 documents the outcomes of searches of the online library resources of the University of the West of England (searched on 20 April 2018) using the filter of ‘Scholarly and peer reviewed’ sources. Although many pertain to the intent of doing no harm, only a small number of sources relate directly to the problem of unintended alien species invasions affecting aquatic conservation.

It is not the intent of the authors to denigrate or deter any pro-conservation or pro-environmental intent. The authors have not received any external funding or influence to research and publish this article. They have simply acted on their own volition and concern to raise the profile of this emerging activity, and to improve the safety and the intended outcome of the practice of live release. However, this analysis of the potential and still largely unquantified risks of perverse outcomes for nature conservation and dependent human livelihoods highlights the need for more research and precautionary action. In particular, we invoke the Precautionary Principle, a strategy to cope with possible risks from human activities that may lead to morally unacceptable harm that is scientifically plausible but uncertain (European Commission, 2000). The Humane Society International (2012), in collaboration with The American Buddhist Confederation, announced an intention to ‘...support animal welfare instead of the ritual of releasing animals, such as birds, fish and turtles, into the wild; a useful contribution to modernizing the inherently virtuous intention of Buddhist practices but falling short of addressing conservation risks, particularly across the wider world.

The Theravada, Mahayana, and Vajrayana schools of Buddhism are common in Tibet, Nepal, Mongolia, Inner Mongolia, Tibet, China, Myanmar, Laos, Thailand, Cambodia, Vietnam, Korea, Japan, and Sri Lanka, and also spreading into adjacent nations and found more remotely in other geographically scattered areas. Consequently, although published evidence is lacking, it can be assumed that ecological risks associated with uninformed live releases are potentially globally pervasive. Further research is needed to establish the level of risk, and so to inform the most appropriate responses.

Liu et al. (2013) found that ecological knowledge of invasive species reduced the probability of release at the Chinese temples that they were studying, but that conversely the market availability increased the probability of release. Targeted public education about invasive species could therefore be an effective strategy for preventing the religious release of such species on a global scale. Drawing from the 11 attributes of aquatic organisms predisposed to become invasive (Ricciardi & Rasmussen, 1998), we therefore recommend that Buddhist adherents undertaking the traditional practice of live release should observe the precautionary considerations presented in Table 3. This form of precautionary approach is already inherently included in some national legislation relating to the import of alien fishes: for example, under the UK’s Import of Live Fish (England and Wales) Act 1980 (HM Government, 1980). ILFA, as the Act is known, specifically schedules a number of known problematic

<table>
<thead>
<tr>
<th>Search terms</th>
<th>Number of hits</th>
<th>Number of relevant hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>(live release) AND (buddhist) AND (invasion)</td>
<td>657</td>
<td>Three. Assessed from top 100, beyond which the relevance declined substantially (Agoramoorthy &amp; Hsu, 2007; Gong et al., 2009; Liu et al., 2013; Shiu &amp; Stokes, 2008)</td>
</tr>
<tr>
<td>(live release) AND (buddhist) AND (fish)</td>
<td>680</td>
<td>Four. Assessed from top 100, beyond which the relevance declined substantially (Agoramoorthy &amp; Hsu, 2007; Gong et al., 2009; Liu et al., 2013; Shiu &amp; Stokes, 2008)</td>
</tr>
<tr>
<td>(live release) AND (buddhist) AND (conservation)</td>
<td>346</td>
<td>Five. Assessed from top 100, beyond which relevance declined substantially (Agoramoorthy &amp; Hsu, 2007; Gong et al., 2009; Liu et al., 2013; Shiu &amp; Stokes, 2008; West, 1997)</td>
</tr>
</tbody>
</table>

Aquatic species should be:

- native to the geographical range in which they are to be released;
- of local genetic provenance, to avoid dilution of locally adapted strains;
- released only in numbers that will not dominate the ecosystems into which they are placed; and
- unlikely to change ecosystem balance (for example, by significantly increasing predation or sediment mobilization).
invasive fish species, but also applies more generally to all fish species that have the potential to escape and form self-perpetuating populations.

Chong (2012) calls upon conservationists to recognize the powerful role of religion in Burmese society and to engage its potential in support of sustainable development. Gong et al. (2012) recognized that Buddhist leaders can play significant roles in environmental protection in Myanmar, and potentially in other Asian countries, while also acknowledging that this may be hampered by a lack of ecological understanding, citing in particular the uninformed practice of ‘prayer animal release’ and the captive animal trade associated with it. The aim of this article is to assist conservation and religious organizations, and other institutions with influence on live-release practitioners and communities, to raise awareness and offer practical guidance about the holistic animal welfare issues associated with fang sheng. We recognize the need to assist Buddhist practitioners and their advisers about what constitutes a non-native species, and we suggest the following definition: ‘A species introduced by humans – either intentionally or accidentally – outside of its natural past or present distribution’, adapted from a definition provided by the IUCN Red List (2018). Science-based professional societies, conservation organizations and non-governmental organization (NGO) networks may also have roles to play in helping disseminate key messages, as the Humane Society International has already demonstrated in its collaboration with The American Buddhist Confederation.

As a significant, unquantified, number of releases of aquatic organisms occur in developing countries, where data about biological baselines as well as widespread knowledge of risks to ecology and ecosystem services is lacking, these risks will generally be proportionately under-recognized. In the longer term, further research linked to local capacity building, with associated education, can shape a more precautionary approach to be taken by local communities. A more direct route for the uptake of these precautionary principles in the interim, however, is their onward communication by influential people and institutions in the global Buddhist community, to ensure that practical outcomes are consistent with the pro-conservation and humane intent of live release, thereby averting perverse, unintended negative consequences for nature conservation and human livelihoods.

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