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- Everard, M., Pinder, A.C., Raghavan, R. and Kataria, G. (2019). Viewpoint: Are well-intended Buddhist practices an under-appreciated threat to global aquatic biodiversity? *Aquatic Conservation: Marine and Freshwater Ecosystems*, pp.1–6. <https://doi.org/10.1002/aqc.2997>.

Viewpoint:

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 release into the wild of creatures destined for slaughter, poses potentially significant conservation consequences if inappropriate, invasive species are procured for release.
2. We collate evidence, citing one legal case and other examples, about the risks of 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 awareness-raising and guidance informed by science to ensure that good intentions do not result in perverse, environmentally destructive outcomes.

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35 5. We propose four simple principles to achieve this, for dissemination to the global
36 adherents of these otherwise entirely laudable practices.

37

38 **Keywords**

39 Live release; mercy release; invasive species; humane; conservation; fish

40

41 **1. Introduction**

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

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

67

68 **2. Causes and conservation impacts of alien freshwater fish introductions**

69 Riccardi & Rasmussen (1998) recognise eleven factors predisposing aquatic organisms
70 to becoming invasive (see Table 1). Assessment of the suitability of fish species for
71 aquaculture tends to address factors such as growth rate and hardiness (for example Ali
72 *et al.*, 2016), generally omitting consideration of native provenance or potential for
73 invasion of the regions in which the fish are produced. Aquaculture is consequently
74 widely observed to be a source of alien invasive species posing conservation threats to
75 invaded ecosystems, with freshwater fish homogenisation driven by a few widespread

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76 non-native species globally (Toussaint, Beauchard, Oberdorff, Brosse, & Villéger,
 77 2016). Numerous examples range from temperate system non-native salmonid
 78 invasions associated with declines of native fishes (Arismendi *et al.*, 2009) to
 79 widespread tropical invasions by Nile tilapia, *Oreochromis niloticus* (Linnaeus 1758)
 80 (Schofield, Peterson, Lowe, Brown-Peterson, & Slack, 2011). Table 1 records the high
 81 coherence between species suitability for aquaculture and predisposition to become
 82 invasive. Vilà & Hulme (2017) address multiple direct and indirect consequences of
 83 biological invasions on ecosystem services, including those of farmed fishes. The
 84 ornamental fish trade is also a significant vector for invasive fishes (for example Costa-
 85 Pierce, 2003; Gozlan, Britton, Cowx, & Copp, 2010; Raghavan, Prasad, Anvar-Ali, &
 86 Pereira, 2008). So too is fish stocking, both legal and illegal, in support of recreational
 87 angling (Davis, & Darling, 2017), as well as accident releases such as through bait
 88 releases, aquaculture escapes or ballast water transport (Lintermans, 2004; Gupta, &
 89 Everard, 2017). Notwithstanding individual species life history traits favouring population
 90 establishment, propagule pressure (i.e. the combination of numbers of introduced
 91 individuals, the number of introductions and temporal introduction rate) has also been
 92 demonstrated to be crucially important and a potentially overriding factor in determining
 93 invasion success and impact (Simberloff, 2009).

94 *Table 1: Attributes of aquatic organisms predisposed to become invasive and also*
 95 *suitability for aquaculture*

Attributes of aquatic organisms predisposed to become invasive (Riccardi & Rasmussen, 1998)	Suitability for aquaculture with suggested reason	Suitability for aquarist use with suggested reason
1. Abundant and widely distributed in their original range		
2. Wide environmental tolerance	Hardy in crowded rearing conditions	Hardy in crowded aquarist conditions
3. High genetic variability		
4. Short generation time	Highly fecund with short generation time for rapid production	Easy to breed for ornamental fish trade
5. Rapid growth	Grows rapidly suiting production in aquaculture conditions	Rapid growth for ornamental fish trade
6. Early sexual maturity	Highly fecund with short generation time for rapid production	Rapid growth to maturity and breeding for ornamental fish trade
7. High reproductive capacity	Highly fecund with short generation time for rapid production	Fecund, for rapid production and profitability in aquarist trade
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

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10. Possessing natural mechanisms of rapid dispersal		
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

96

97

98 **3. The Buddhist practice of ‘live release’**

99 The Buddhist practice of ‘live release’ is founded on good intentions relating to the
100 protection of living organisms. However, perverse outcomes may ensue if uninformed
101 releases of potentially invasive organisms impact native biodiversity.

102 The release of captive animals for religious purposes has historically been a traditional
103 practice in many religions of Asian origin, including both Buddhism and Taoism, and is
104 especially prevalent in the Buddhist doctrine (Agoramoorthy & Hsu, 2007). Live
105 release, also known as ‘mercy release’ or Tsethar in the Tibetan tradition, is the
106 Buddhist practice of saving the lives of beings destined for slaughter and is part of all
107 schools of Buddhism: Theravada, Mahayana and Vajrayana. By buying and releasing
108 animals destined to be killed, live release puts the ideal of compassion into practical
109 action, in part as compensation for the inevitable collateral killing of organisms as
110 humans walk, breathe and conduct their lives. Whilst live release may be initiated
111 spontaneously to save an endangered life, it can also be planned in the form of
112 purchasing animals directly from slaughterhouses, fishermen or other sources,
113 frequently planned around auspicious days in the Buddhist calendar to amplify the merit
114 of the act. The Humane Society International (2012), in a report from a conference co-
115 hosted with The American Buddhist Confederation, record that problems stem from the
116 fact that “...mercy release has become an industry built on the capture and supply of
117 wild animals, for whom there are devastating consequences of injury, illness or death”.

118 The ancient origins of this practice may have meant that animals were released into
119 their native environments. However, live release of animals in an increasingly
120 internationalised society has the potential to generate negative environmental impacts.
121 For example, some animals are captured for the explicit purpose of being released, or
122 are released into environments where they are unable to survive (Humane Society
123 International, 2009). A gross example is the bird market in Mong Kok, Hong Kong, a
124 major tourist attraction, where captive-bred budgerigars (*Melopsittacus undulatus*), Java
125 sparrows (*Lonchura oryzivora*) and various finch species are made available for
126 purchase by the pious for freeing under ‘fang sheng’ (“giving life”) rituals that tend to
127 result in the early deaths of organisms not adapted to wild or local conditions (Wordie,
128 2017). However, a more problematic potential outcome is that live release provides an
129 as yet unquantified pathway for introduction of invasive species into non-native
130 environments, with the potentially perverse outcome of substantial ecological harm
131 including the progressive loss of local biodiversity (Shiu & Stokes, 2008).

132 Despite the best of intentions, some examples of live releases have been associated
133 with conservation concerns and sometimes legal consequences (Severinghaus & Chi,

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134 1999; Agoramoorthy & Hsu, 2007; Liu, McGarrity, & Li, 2012). As one example, Tsethar
135 practices are arising as a significant concern in Bhutan, an exceptional region for
136 freshwater fish biodiversity, where African Catfish (*Clarias gariepinus*) are imported live
137 from Bangladesh via Kolkata and sold for release by religiously inclined Bhutanese
138 people (Gurung, 2012). Whilst *Clarias gariepinus* is itself of Least Concern on the IUCN
139 Red List (Freyhof, FishBase team RMCA, & Geelhand, 2016), it is also listed as having
140 a wide tropical distribution beyond its native range where it has been listed as a
141 'Potential Pest' (Froese, & Pauly, 2018) and has been associated with significant
142 ecosystem disruption (for example Cambray, 2003; Weyl, Dagall, Ellender, & Vitule,
143 2016). If awareness and education about the ecological consequences of such
144 practices is not provided to local communities, this may serve as a major avenue for the
145 introduction of alien species into the freshwaters of Bhutan (Gurung, Dorji, Tshering, &
146 Wangyal, 2013). In the Yunnan province of China, Jiang, Qin, Wang, Zhao, Shu, *et al.*
147 (2016) concluded that the introduction since 2009 of two species of non-native
148 weatherfishes (*Misgurnus anguillicaudatus* and *Paramisgurnus dabryanus*) through the
149 practice of 'prayer animal release' and their subsequent increasing populations was
150 putting at risk the threatened native freshwater fish *Ptychobarbus chungtienensis* in
151 Shangri-La region. In considering 'Deliberate release for cultural reasons', constituting
152 one of twelve pathways of human-assisted dispersal of freshwater fishes in Australia,
153 Lintermans (2004) noted that the 2001 Census recorded that 1.9% of the Australian
154 population were Buddhists and reported anecdotal evidence suggesting that purchase
155 and release of aquarium species for live release was not uncommon albeit entirely
156 unquantified

157 Unregulated mercy releases have also resulted in the red-eared slider turtles
158 (*Trachemys scripta elegans*) native to central America, but which are widely invasive
159 (van Dijk, Harding, & Hammerson, 2011) yet readily procured from pet shops in the US,
160 dominating and outcompeting native terrapin species in New York's Central Park
161 (Selleck, 2015). Indicative of the potential scale of the problem, mindful of the large
162 number of ceremonial animal release events occurring globally in accordance with the
163 traditions of Buddhism and other Asian religions, Liu, McGarrity, Bai, Ke, & Li (2013)
164 evaluated the release of two highly invasive species (American bullfrogs *Lithobates*
165 *catesbeianus* and red-eared slider turtles *Trachemys scripta elegans*) by 123 Buddhist
166 temples surveyed across four provinces in China correlated with intensive field surveys
167 of release sites, finding that both bullfrogs and sliders were present at the majority of
168 sites where release of these species was reported. Given the large numbers of such
169 temples in this region and the pervasion of religious observants across the world, the
170 scale at which live release could potentially be happening is substantial. Gong, Chow,
171 Fong, & Shi (2009) record that China is the largest consumer of turtles in the world
172 serving markets for two main types of local and international trade: for food and
173 traditional Chinese medicine; and for release by Buddhists. Liu *et al.* (2012) tabulate
174 evidence from a search of literature and news reports for the global occurrence of
175 religious wildlife release, though the literature on aquatic species and particularly their
176 impacts are largely addressed in this summary highlighting the scale of the knowledge
177 gap.

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178 West (1997) reports that a small congregation of seven Buddhist adherents led by a
179 monk procured 2,500 goldfish from a storefront temple in New York's Chinatown and
180 transported them for ritual release in Westons Mill Pond, a reservoir for the city of New
181 Brunswick as an act of compassion but which was perceived by scientists and wildlife
182 experts as introducing competition to and potentially outbreeding native species of
183 perch, sunfish, catfish and of aquatic fauna. The same report recorded conservation
184 concerns likely to arise from freeing caged birds that are more likely to die than thrive in
185 their new environments, and that release by Buddhists of turtles into ponds in Brooklyn's
186 Prospect Park and Central Park also had the potential to perturb local aquatic
187 ecosystems directly and through the introduction of diseases as well as genetic
188 dilution. As a general principle, relevant to some instances of live release but also wider
189 conservation matters, introductions of even conspecific species may perturb
190 ecosystems posing a threat to conservation though genetic homogenisation including
191 the introduction of non-native genes and the loss of local adaptation (Champagnon,
192 Elmberg, Guillemain, Gauthier-Clerc, & Lebreton, 2012).

193 Fish invasions are known to have significant knock-on effects on the conservation of
194 freshwater ecosystems, their functions and associated biota. Whilst not inferring that it
195 was consequent from live release, radical degradation of both aquatic and avian
196 biodiversity has followed the introduction of alien common carp (*Cyprinus carpio*) to
197 Medina and Zoñar Lakes in South Western Spain. Driven by the destruction of
198 submerged macrophyte beds via mechanical disturbance and elevated turbidity, the
199 invasion of *C. carpio* and other non-native fishes throughout the fresh waters of the
200 Mediterranean region is now recognised as a major threat to water birds, including
201 globally threatened taxa such as white-headed duck (*Oxyura leucocephala*), listed as
202 Endangered on the IUCN Red List (BirdLife International, 2017) (Maceda-Veiga, López,
203 & Green, 2017). Similarly, tilapia, *Oreochromis* spp. and *C. gariepinus* have invaded
204 and now totally dominate Jal Mahal, the water palace lake in Jaipur (Rajasthan state,
205 India), with knock-on consequences for avian biodiversity, further extending the
206 negative socioeconomic implications for bird-watching based ecotourism (H. Vardhan,
207 pers. com. & author observations). (Invasion of Jal Mahal by *Clarias gariepinus* and
208 *Oreochromis* spp. has yet to feature in the peer-reviewed literature but is well-known
209 locally, observed by the authors and other local biologists, and there are many
210 YouTube.com clips of the two species in vast numbers and also sometimes turning up
211 dead as the lake goes anoxic.)

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

217

218 **4. Conclusions and recommendation**

219 At present, there appears to be little awareness about potential perverse, unintended
220 outcomes from live release practices for aquatic and other wildlife, a lack of
221 quantification of conservation impacts, and consequently no effective, proactive

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222 interventions to avert them. Nor is there a great deal of scientific study to back up
 223 management advice. Table 2 documents the outcomes of searches on the University of
 224 the West of England’s online library resources (dated 20th April 2018) using the filter of
 225 ‘Scholarly and peer reviewed’ sources. Although many pertain to the intent of doing no
 226 harm, only a small number of sources relate directly to the problem of unintended alien
 227 species invasions affecting aquatic conservation.

228 *Table 2: Searches of the online libraries for ‘scholarly and peer reviewed’ documents*
 229 *relevant to alien species invasions from live release affecting aquatic nature*
 230 *conservation*

Search terms	Number of hits	Number of relevant hits
(live release) AND (buddhist) AND (invasion)	657	3, assessed from top 100 beyond which relevance declined substantially (Agoramoorthy & Hsu, 2007; Shiu & Stokes, 2008; Gong, Chow, Fong, & Shi, 2009; Liu, McGarrity, Bai, Ke, & Li, 2013)
(live release) AND (buddhist) AND (fish)	680	4, assessed from top 100 beyond which relevance declined substantially (Agoramoorthy & Hsu, 2007; Shiu & Stokes, 2008; Gong, Chow, Fong, & Shi, 2009; Liu, McGarrity, Bai, Ke, & Li, 2013)
(live release) AND (buddhist) AND (conservation)	346	5, assessed from top 100 beyond which relevance declined substantially (West, 1997; Agoramoorthy & Hsu, 2007; Shiu & Stokes, 2008; Gong, Chow, Fong, & Shi, 2009; Liu, McGarrity, Bai, Ke, & Li, 2013)

231

232 It is not the intent of the authors to denigrate or deter any pro-conservation or pro-
 233 environmental intent. The authors have not received any external funding or influence
 234 to research and publish this paper, simply acting on their own volition and concern to
 235 raise the profile of an emergent and material concern in support of improving the safety
 236 and the intended outcome of the practice of live release. However, this analysis of
 237 potential and still largely unquantified risks of perverse outcomes for nature
 238 conservation and dependent human livelihood needs arising from a traditional practice
 239 is highlighted as an issue requiring more research and precautionary action. In
 240 particular, we invoke the Precautionary Principle, a strategy to cope with possible risks
 241 from human activities that may lead to morally unacceptable harm that is scientifically
 242 plausible but uncertain (EC, 2000). The Humane Society International (2012), in
 243 collaboration with The American Buddhist Confederation, announced an intention to
 244 “...support animal welfare instead of the ritual of releasing animals, such as birds, fish
 245 and turtles, into the wild”, a useful contribution to modernisation of the inherently
 246 virtuous intent to Buddhist practices but falling short of addressing conservation risks
 247 and particularly across the wider world.

248 The Theravada, Mahayana and Vajrayana schools of Buddhism are common in Tibet,
 249 Nepal, Mongolia, Inner Mongolia, Tibet, China, Myanmar, Laos, Thailand, Cambodia,
 250 Vietnam, Korea, Japan and Sri Lanka, also spreading into adjacent nations and more
 251 remotely in pockets. Consequently, although published evidence is lacking, it can be

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252 assumed that ecological risks associated with uninformed live releases are potentially
253 globally pervasive. Further research is needed to establish the level of risk, and so to
254 inform the most appropriate responses.

255 Liu *et al.* (2013) found that ecological knowledge of invasive species reduced the
256 probability of release at the Chinese temples they were studying, but that conversely
257 market availability increased the probability of release. Targeted public education about
258 invasive species could therefore be an effective strategy for preventing religious release
259 of invasive species on a global scale. Drawing from the eleven attributes of aquatic
260 organisms predisposed to become invasive (Riccardi & Rasmussen, 1998), we
261 therefore recommend that Buddhist adherents undertaking the traditional practice of live
262 release should observe the precautionary considerations in Table 3. This form of
263 precautionary approach is already inherently included in some national legislation
264 relating to import of alien fishes, for example under the UK's *Import of Live Fish*
265 *(England and Wales) Act 1980* (HM Government, 1980). ILFA (as the Act is known)
266 specifically schedules a number of known problematic invasive fish species, but also
267 applies more generally to all fish species that have the potential to escape and form
268 self-perpetuating populations.

269 *Table 3: Precautionary principles for ecologically safe Buddhist 'live release'*

Precautionary principles for ecologically safe 'live release' include that aquatic species should be:

- Native to the geographical range in which they are to be released;
- Of local genetic provenance, so as 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 mobilisation.

270

271 Chong (2012) calls upon conservationists to recognise the powerful role of religion in
272 Burmese society and to engage its potential in support of sustainable development.
273 Gong, Hamer, Meng, Meng, Feng, & Xue (2012) recognise that Buddhist leaders can
274 play significant roles in environmental protection in Myanmar and potentially other Asian
275 countries, whilst also acknowledging that this may be hampered by lack of ecological
276 understanding citing particularly uninformed practice of 'prayer animal release' and the
277 captive animal trade associated with it. The aim of the paper is to assist conservation
278 and religious organisations and other institutions with influence on live release
279 practitioners and communities to raise awareness and offer practical guidance about the
280 holistic animal welfare issues associated with fang sheng. We recognize the need to
281 assist Buddhist practitioners and their advisers about what constitutes a non-native
282 species, for which we suggest the definition "A species introduced by humans – either

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283 intentionally or accidentally – outside of its natural past or present distribution”, adapted
284 from a definition provided by IUCN (2018). Science-based professional societies,
285 conservation organisations and NGO networks may also have roles to play in helping
286 disseminate key messages, as the Humane Society International has already
287 demonstrated in its collaboration with The American Buddhist Confederation.

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

299

300 5. References

301 Agoramoorthy, G., & Hsu, M. (2007). Ritual releasing of wild animals threatens island
302 ecology. *Human Ecology* 35: 251–254.

303 Ali, H., Haque, M.M., Murshed-e-Jahan, K., Rahi, M.K L., Ali, M.M. Al-Masud, M., &
304 Faruque, G. (2016). Suitability of different fish species for cultivation in integrated
305 floating cage aquageoponics system (IFCAS) in Bangladesh. *Aquaculture Reports* 4:
306 93-100.

307 Arismendi, I., Soto, D., Penaluna, B., Jara, C., Leal, C., & León-Muñoz, J. (2009).
308 Aquaculture, non-native salmonid invasions and associated declines of native fishes in
309 Northern Patagonian lakes. *Freshwater Biology* 54: 1135-1147.

310 BirdLife International. (2017). *Oxyura leucocephala*. The IUCN Red List of Threatened
311 Species 2017: e.T22679814A119403602. (<http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22679814A119403602.en>, accessed 23rd July 2018.)

313 Cambray, J.J. (2003). The need for research and monitoring on the impacts of
314 translocated sharptooth catfish, *Clarias gariepinus*, in South Africa. *African Journal of*
315 *Aquatic Science* 28:191-195.

316 Champagnon, J., Elmberg, J., Guillemain, M., Gauthier-Clerc, M., & Lebreton, J-D.
317 (2012). Conspecifics can be aliens too: A review of effects of restocking practices in
318 vertebrates. *Journal for Nature Conservation* 20: 231-241.

319 Chong, K.Y. (2012). Religiously Protecting Myanmar's Environment. *Science* 337: 1604-
320 1605.

321 Costa-Pierce, B.A. (2003). Rapid evolution of an established feral tilapia (*Oreochromis*

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322 spp.): the need to incorporate invasion science into regulatory structures. *Marine*
323 *Bioinvasions: Patterns, Processes and Perspectives* 5: 71-84.

324 Davis, A.J.S., & Darling, J.A. (2017). Recreational freshwater fishing drives non-native
325 aquatic species richness patterns at a continental scale. *Diversity and Distributions* 23:
326 692-702.

327 EC. (2000). *Communication from the Commission on the precautionary principle,*
328 *2.2.2000, COM(2000) 1 final.* Commission of the European Communities, Brussels.
329 (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2000:0001:FIN:EN:PDF>,
330 accessed 20th April 2018.)

331 Freyhof, J., FishBase team RMCA, & Geelhand, D. (2016). *Clarias gariepinus*. The
332 IUCN Red List of Threatened Species 2016: e.T166023A84198891.
333 (<http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T166023A84198891.en>, accessed
334 23rd July 2018.)

335 Froese, R., & Pauly, D. (2018). *Clarias gariepinus* (Burchell, 1822) North African catfish.
336 [online.] (<http://www.fishbase.org/summary/Clarias-gariepinus.html>, accessed 20th April
337 2018.)

338 Gong, B., Hamer, R., Meng, X., Meng, Q., Feng, J., & Xue, D. (2012). Limits to
339 Religious Conservation Efforts. *Science* 338: pp.740.

340 Gong, S-P., Chow, A.T., Fong, J.J., & Shi, H.T. (2009). The chelonian trade in the
341 largest pet market in China: scale, scope and impact on turtle conservation. *Oryx* 43:
342 213-216.

343 Gozlan, R. E., Britton, J. R., Cowx, I., & Copp, G. H. (2010). Current knowledge on non-
344 native freshwater fish introductions. *Journal of Fish Biology* 76: 751-786.

345 Gupta, N., & Everard, M. (2017). Non-native fishes in the Indian Himalaya: an emerging
346 concern for freshwater scientists. *International Journal of River Basin Management*,
347 DOI: <https://doi.org/10.1080/15715124.2017.1411929>.

348 Gurung, D.B. (2012). Introduction of African Catfish, *Clarias gariepinus* in Bhutan. *MIN,*
349 *The Newsletter of the IUCN-SSC/WI Freshwater Fish Specialist Group - South Asia &*
350 *the Freshwater Fish Conservation Network of South Asia* 1: 26.

351 Gurung, D.B., Dorji, S., Tshering, U., & Wangyal, J.T. (2013). An annotated checklist of
352 fishes from Bhutan. *Journal of Threatened Taxa* 5: 4880–4886.

353 HM Government. (1980). *Import of Live Fish (England and Wales) Act 1980*. HM
354 Government, London.
355 (https://www.legislation.gov.uk/ukpga/1980/27/pdfs/ukpga_19800027_en.pdf, accessed
356 11th July 2018.)

357 Humane Society International. (2009). *Mercy release: kind intentions, cruel*
358 *consequences*. Humane Society International, Washington.
359 (http://www.hsi.org/assets/pdfs/mercyrelease_flyer_english.pdf, accessed 20th April
360 2018.)

FULL TEXT:

- Everard, M., Pinder, A.C., Raghavan, R. and Kataria, G. (2019). Viewpoint: Are well-intended Buddhist practices an under-appreciated threat to global aquatic biodiversity? *Aquatic Conservation: Marine and Freshwater Ecosystems*, pp.1–6. <https://doi.org/10.1002/aqc.2997>.
- 361 Humane Society International. (2012). *HSI and The American Buddhist Confederation*
362 *Discourage Harmful Animal Release Rituals*. Humane Society International,
363 Washington.
364 ([http://www.hsi.org/news/press_releases/2012/05/mercy_release_2012_statement_051](http://www.hsi.org/news/press_releases/2012/05/mercy_release_2012_statement_051612.html?referrer=https://www.google.com/)
365 [612.html?referrer=https://www.google.com/](http://www.hsi.org/news/press_releases/2012/05/mercy_release_2012_statement_051612.html?referrer=https://www.google.com/), accessed 11th July 2018.
- 366 IUCN Red List. (2018). *Invasive species*. IUCN, Gland. [Online.]
367 (<https://www.iucn.org/theme/species/our-work/invasive-species>, accessed 20th April
368 2018.)
- 369 Jiang, W-S., Qin, T., Wang, W-Y., Zhao, Y-P., Shu, S-S., Song, W-H., Chen, X-Y., and
370 Yang, J-X. (2016). What is the destiny of a threatened fish, *Ptychobarbus*
371 *chungtienensis*, now that non-native weatherfishes have been introduced into Bitu Lake,
372 Shangri-La? *Zoological Research* 37: 275-280.
- 373 Lintermans, M. (2004). Human-assisted dispersal of freshwater in Australia. *New*
374 *Zealand Journal of Marine and Freshwater Research* 38: 481-501.
- 375 Liu, C., Comte, L., & Olden, J.D. (2017). Heads you win, tails you lose: Life-history traits
376 predict invasion and extinction risk of the world's freshwater fishes. *Aquatic*
377 *Conservation: Marine and Freshwater Ecosystems* 27: 773-779.
- 378 Liu, X., McGarrity, M.E., & Li, Y. (2012). The influence of traditional Buddhist wildlife
379 release on biological invasions. *Conservation Letters* 5: 107-114.
- 380 Liu, X., McGarrity, M.E., Bai, C., Ke, Z., & Li, Y. (2013). Ecological knowledge reduces
381 religious release of invasive species. *Ecosphere* 4: 1-12.
- 382 Maceda-Veiga, A., López, R., & Green, A.J. (2017). Dramatic impact of alien carp
383 *Cyprinus carpio* on globally threatened diving ducks and other waterbirds in
384 Mediterranean shallow lakes. *Biological Conservation* 212: 74-85.
- 385 McKinney, M.L., & Lockwood, J.L. (1999). Biotic homogenization: a few winners
386 replacing many losers in the next mass extinction. *Trends in Ecology and Evolution* 14:
387 450-453.
- 388 Olden, J.D., Poff, N.L., Douglas, M.R., Douglas, M.E., & Fausch, K.D. (2004).
389 Ecological and evolutionary consequences of biotic homogenization. *Trends in Ecology*
390 *& Evolution* 19: 18-24.
- 391 Raghavan, R., Prasad, G., Anvar-Ali, P.H., & Pereira, B. (2008). Exotic fish species in a
392 biodiversity hotspot: observations from River Chalakudy part of Western Ghats, Kerala,
393 India. *Biological Invasions* 10: 37-40.
- 394 Riccardi, A., & Rasmussen, J.B. (1998). Predicting the identity and impact of future
395 biological invaders: a priority for aquatic resource management. *Canadian Journal of*
396 *Fisheries and Aquatic Sciences* 55: 1759-1765.
- 397 Schofield, P.J., Peterson, M.S., Lowe, M.R., Brown-Peterson, N.J., & Slack, W.T.
398 (2011). Survival, growth and reproduction of non-indigenous Nile tilapia, *Oreochromis*
399 *niloticus* (Linnaeus 1758). I. Physiological capabilities in various temperatures and

FULL TEXT:

- Everard, M., Pinder, A.C., Raghavan, R. and Kataria, G. (2019). Viewpoint: Are well-intended Buddhist practices an under-appreciated threat to global aquatic biodiversity? *Aquatic Conservation: Marine and Freshwater Ecosystems*, pp.1–6. <https://doi.org/10.1002/aqc.2997>.

400 salinities. *Marine and Freshwater Research* 62: 439-449.

401 Scott, M.C., & Helfman, G.S. (2001). Native invasions, homogenization, and the
402 mismeasure of integrity of fish assemblages. *Fisheries* 26: 6-15.

403 Selleck, V.M. (2015). Mercy release: the compromise between Buddhism and
404 conservation. *Elephant Journal*, 25th November 2015.
405 ([https://www.elephantjournal.com/2015/11/the-compromise-not-conflict-between-](https://www.elephantjournal.com/2015/11/the-compromise-not-conflict-between-buddhism-conservation/)
406 [buddhism-conservation/](https://www.elephantjournal.com/2015/11/the-compromise-not-conflict-between-buddhism-conservation/), accessed 20th April 2018.)

407 Severinghaus, L.L., & Chi, L. (1999). Prayer animal release in Taiwan. *Biological*
408 *Conservation* 89: 301–304.

409 Sherwood, H. (2017). Why Buddhist ‘fangsheng’ mercy release rituals can be more
410 cruel than kind. *The Guardian*, Monday 25 September 2017.
411 ([https://www.theguardian.com/world/shortcuts/2017/sep/25/buddhist-fangsheng-mercy-](https://www.theguardian.com/world/shortcuts/2017/sep/25/buddhist-fangsheng-mercy-release-cruel-wild-animals)
412 [release-cruel-wild-animals](https://www.theguardian.com/world/shortcuts/2017/sep/25/buddhist-fangsheng-mercy-release-cruel-wild-animals), accessed 20th April 2018.)

413 Shiu, H., & Stokes, L. (2008). Buddhist animal release practices: historic,
414 environmental, public health and economic concerns. *Contemporary Buddhism* 9: 181-
415 196.

416 Simberloff, D. (2009). The role of propagule pressure in biological invasions. *Annual*
417 *Review of Ecology, Evolution, and Systematics* 40: 81-102.

418 Toussaint, A., Beauchard, O., Oberdorff, T., Brosse, S., & Villéger, S. (2016). Worldwide
419 freshwater fish homogenization is driven by a few widespread non-native species.
420 *Biological Invasions* 18: 1295–1304.

421 van Dijk, P.P., Harding, J., & Hammerson, G.A. (2011). *Trachemys scripta* (errata
422 version published in 2016). The IUCN Red List of Threatened Species 2011:
423 e.T22028A97429935. ([http://dx.doi.org/10.2305/IUCN.UK.2011-](http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T22028A9347395.en)
424 [1.RLTS.T22028A9347395.en](http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T22028A9347395.en), accessed 23rd July 2018.)

425 Vilà, M., & Hulme, P.E. (Eds) (2017). *Impact of biological invasions on ecosystem*
426 *services (invading nature – Springer Series in Invasion Ecology)*. Springer: London.

427 Villéger, S., Blanchet, S., Beauchard, O., Oberdorff, T., & Brosse, S. (2011).
428 Homogenization patterns of the world’s freshwater fish faunas. *PNAS* 108: 18003-
429 18008.
430 <https://doi.org/10.1073/pnas.1107614108>[http://www.pnas.org/content/108/44/18003/tab-](http://www.pnas.org/content/108/44/18003/tab-article-info)
431 [-article-info](http://www.pnas.org/content/108/44/18003/tab-article-info), accessed 20th April 2018.)

432 Wordie, J. (2017). Why Buddhist ritual of ‘saving lives’ is a death sentence for animals.
433 *Post Magazine*, 20th January 2017. ([http://www.scmp.com/magazines/post-](http://www.scmp.com/magazines/post-magazine/short-reads/article/2063558/why-buddhist-ritual-saving-lives-death-sentence)
434 [magazine/short-reads/article/2063558/why-buddhist-ritual-saving-lives-death-sentence](http://www.scmp.com/magazines/post-magazine/short-reads/article/2063558/why-buddhist-ritual-saving-lives-death-sentence),
435 accessed 20th April 2018.)

436 West, D. (1997). Buddhists Release Animals, Dismaying Wildlife Experts. *New York*
437 *Times*, 11th January 1997. ([https://www.nytimes.com/1997/01/11/nyregion/buddhists-](https://www.nytimes.com/1997/01/11/nyregion/buddhists-release-animals-dismaying-wildlife-experts.html)
438 [release-animals-dismaying-wildlife-experts.html](https://www.nytimes.com/1997/01/11/nyregion/buddhists-release-animals-dismaying-wildlife-experts.html), accessed 20th April 2018.)

FULL TEXT:

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439
440
441

Weyl, O.L.F., Dagall, V.S., Ellender, B.R., & Vitule, J.R.S. (2016). A review of *Clarias gariepinus* invasions in Brazil and South Africa. *Journal of Fish Biology* 89: 386–402.