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ARTICLE

Religious Spaces and Biodiversity in Contemporary Myanmar

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Drawing together methodologies and analytical frameworks from religious studies and environmental science and related fields, this paper discusses the possible role of Buddhist sacred spaces in conserving biodiversity in Myanmar. Faculty and students worked together to analyze relationships between sacred spaces, religious practice, and biodiversity. We explored whether there was any evidence for an emergent or present Buddhist eco-ethic in Myanmar that fused religious spaces and places with environmental protection, and if so, how it might resonate with Buddhist environmentalism in other areas of the world, such as in Thailand, in the Tibetan regions of China, and elsewhere.[1]

Keywords: Buddhism; religion; environmental science; ecology; biodiversity; conservation; sacred places/spaces

[1] Research for this article was first conducted in January 2017 by a team consisting of Cheryl Swift, Professor, Biology; Jason A. Carbine, Associate Professor, Religious Studies; Rosemary P. Carbine, Associate Professor, Religious Studies; San Dar Nyunt Wai, EC Member, Myanmar Bird and Nature Society and Member, Biodiversity and Nature Conversation Association; Christina Mecklenburg, Biology; Marissa Ochoa, Biology; Anders Blomso, Religious Studies; Julia Davis, Religious Studies. A second trip to Myanmar in January 2019 led by Cheryl Swift, Jason A. Carbine, and San Dar Nyunt Wai (now with 360ed) with thirteen students furnished additional data and reference points. We are extremely grateful for the research team work with San Dar; for all of the contacts enabled in Myanmar by Hla Hla Win and Yan Ming Aung, 360ed, that made this research possible; for the generous dedication of Mr. Michael and Mr. Oo, our guides, and of Mr. Moe and his team in general, Myanmar Travel Expert, Myanmar Birding Agent, for making our trips successful in every way, especially for the access they provided to key sites; for the generosity given to us especially by Kyauk ka lat Sayadaw and Thamanya Sayadaw when we visited their monasteries; for the presentation by U Thein Aung, Assistant Director, Shwe Set Taw, and for the discussion with the Staff Officer and other members of their team there; for the permissions granted by Mr. Win Naing Thaw, Director, Nature and Wildlife Conservation Division, Forest Department, Ministry of Natural Resources and Environmental Conservation, Nay Pyi Taw, and Mr. Ohn Lwin, Administrator, Head of the team, Shwe Set Taw Wildlife Sanctuary; for feedback on our research at the "Southeast Asian Natures: Defining Environmentalism and the Anthropocene in Southeast Asia Conference," UC Riverside (2018); for editorial suggestions made by John Swift; and, for feedback during the review process. This research project has been generously funded by the Henry Luce Foundation's Initiative on Asian Studies and the Environment.

I. Introduction: The Setting of This Study

As scholars, activists, and others have long explored, some religious traditions contain conceptual, ritual, and spatial resources that approach nature not as an instrumental commodity but as having intrinsic value and agency. Even religious traditions viewing nature as subordinate to humanity are now responding to the Earth's degradation by emphasizing stewardship and sustainability. Buddhist environmentalism, more specifically, sometimes combines foundational religious beliefs (e.g., the Four Noble Truths, Nirvana, suffering, Noble Eightfold Path, compassion), ethical and ritual practices (e.g., ritual consecrations), and spaces (e.g., forests, mountains, and water) to promote sustainability as well as the intrinsic value of nature and environmental protection. For example, some Buddhist ecological ethics may be founded on and flow from the Noble Eightfold Path. As summarized by Stephanie Kaza, right or ethical conduct on the path is based on the principle of non-harming or not killing, which creates an ecological frame for interpreting other Buddhist ethical principles and praxis. Taken together, green Buddhism emphasizes a non-dualistic worldview, or the inextricable interrelatedness and interdependence of all life, and consequently upholds all life's intrinsic value. As elaborated by Kaza:

> The first precept [of nonharming] applies to environmental conflicts around food production, land use, pesticides, and pollution. The second precept, "not stealing," engages global trade ethics and corporate exploitation of resources. "Not lying," the third precept, brings up issues and advertising that promote consumerism. "Not engaging in abusive relations," interpreted through an environmental lens, can cover many examples of cruelty and disrespect for non-human beings. Nonharming extends to *all* beings—not merely to those who are useful or irritating to humans. This central teaching of nonharming is congruent with many schools of eco-philosophy which respect the intrinsic value and capacity for experience of each being. (Kaza 2006, 191)

Exemplifying this application of Buddhist ideas and ideals to environmental protection, some Thai Buddhist monks have expanded their religious leadership into

eco-social activism. These monks adapted traditional monastic ordination rituals to sacralize and defend national parks and forest preserves threatened by rapid modernization and development through international trade and infrastructure projects. Together with lay people (including political leaders, NGO representatives, and local villagers), they performed highly profiled eco-rituals of tree ordination in the early 1990s to raise environmental awareness, to resist deforestation, and to protect watersheds through this symbolic act of religious solidarity with the trees (Darlington 2012, 2014).[2]

Likewise, as shown in the documentary film *Pad Yatra: A Green Odyssey* (Lee et al. 2013), eco-pilgrimages or *pad yatra*s in the Himalayas hold religious and ecological significance for Buddhists in Tibet and its border regions. On *pad yatra*s, pilgrims exercise selfless or bodhisattva-like compassion for–and environmental protection of–all life, including mountains and water. The documentary chronicles a 2009 Buddhist-inspired pilgrimage spanning nearly 450 miles across the Himalayas, taken by His Holiness the Gyalwang Drukpa, the Drukpa Kung Fu nuns, and nearly 700 other trekkers. This pilgrimage fused spiritual compassion and environmental justice to clean up nearly half a ton of trash, especially plastic waste, to encounter and preserve indigenous and Drukpa cultures amid increasing climate crises in the Himalayan region. They also educated local villages about environmental protection, sustainability, and responsible disposal or reuse of non-biodegradable materials. The trekkers demonstrated Buddhist reverence for mountains and caves as sacred sites for meditation. They showed loving-kindness and compassion for animals and insects by providing injured donkeys and mules with healthcare, and by blowing insects out of their path to avoid unnecessary

[2] Welcoming the forest into the Sangha by wrapping trees with Buddhist monastic robes aligns with the historical origins of Buddhism or "home culture of the dharma," which "take[s] the wilderness itself as [its] teacher, not simply to conform to the ways of nature—for nature is samsara itself—but to break through to truths that would transcend them entirely…. Learning the lessons of the wilderness involved more than just mastering the skills of physical survival" (Thanissaro Bhikkhu 2014, 101, 103). According to these Buddhist wilderness or forest monks, the Buddha is purported to have been born, achieved enlightenment, preached his first sermon, and died in a forest.

harm. Echoing the bodhisattva vow of selfless service and compassion for all—or what some Buddhist environmental advocates have called the ecosattva vow (Kaza 2006, 194)—the Gyalwang Drukpa continually preached during the trek about the links between a clean, kind, selfless mind and living an ecofriendly way of life. Recycling trash to preserve local cultures and water security was intimately connected with self-recycling, a recycling of the self through environmental education and protection, one footstep at a time.[3]

Thus, religious spaces and their associated practices can play crucial roles in protecting and conserving the environment, and especially biodiversity.[4] Salick et al. (2007) found that while diversity was similar in adjacent sacred spaces and forests in the Eastern Himalayas, tree cover and tree diameter were significantly higher in sacred sites. Moreover, there was exchange between sacred spaces and the surrounding landscapes, which argues for conservation of not just sacred spaces, but also the surrounding ecosystems. For example, Bhagwat et al. (2005) suggest that the diversity of forests surrounding sacred forests in the Western Ghats may be crucial to the diversity of those sacred forests. With these ideas in mind, we considered religious spaces and practices in Myanmar, which is part of the Indo-Burma Biodiversity

[3] Similarly, numerous studies of Tibetan sacred mountains have concluded that such spaces offer great conservation opportunities, and that the designation of forbidden areas at times enforced by monasteries, NGOs, and others protects ecosystems' and species' diversity (Luo et. al 2009; Shen et. al 2012; Shen et. al 2015; Coggins with Gesang Zeren, 2014; Marcuse and Shi 2014). Also, karmic teachings and religiosity around monasteries have proven invaluable in protecting routes of snow leopard migration through the Himalayas (Li et. al 2013).

[4] See Schmithausen (1997) for an important discussion of the relation between early Buddhism (explored primarily through Pali sources) and contemporary ecological ethics. Schmithausen criticizes contemporary ecological ethicists who weave early Buddhism into their ecological viewpoints and highlights the world-transcending aspects of the tradition, which he argues "negate nature... [and] all mundane existence, nature as well as civilization" (33). Schmithausen does offer some constructive arguments toward the end of the essay, drawing on notions of non-violence, compassion, and loving kindness. In this article, we are not so much concerned with the early textual tradition and with critiquing various viewpoints regarding green Buddhisms. We are more interested in that while green Buddhisms are evident in some places in other parts of the world, they are not strongly evident in Myanmar in the contexts we researched. Other aspects of conservation and attempts at conservation in Myanmar have been discussed elsewhere (e.g., Sovacool 2012, Thaung 2007).

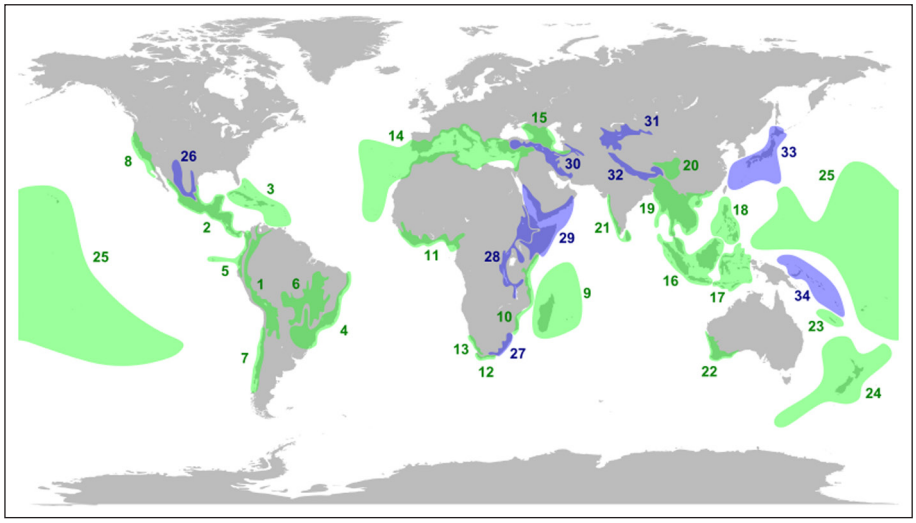

Figure 1: The earth's biodiversity hot spots (Wikipedia Commons).

Hotspot (**Figure 1**) and a predominantly Buddhist country. As a biodiversity hotspot, Myanmar harbors many endemic species that are limited in distribution to this area, yet many important habitats remain outside of protected areas (Tordoff et al. 2012). Sacred spaces have the potential to function as protected areas for these habitats (Bhagwat et al. 2005, Singh et al. 2013). This combination of biodiversity and a heavy socio-cultural and socio-political emphasis on Buddhism, seen against the background of certain kinds of Buddhist ecological ethics mentioned above, has intrigued us and has generated an interest in conducting an interdisciplinary field research project that critically examines the intersections of religion and ecology/conservation, particularly in this region.

This interdisciplinary study combined religious studies and ecological perspectives during two short field-research trips to Buddhist spaces in Myanmar to analyze their practices, protection of biodiversity, and the emergence of an eco-ethic.[5] Recent political changes in Myanmar have resulted in increased international engagement in the form of trade, and this has catastrophic potential for the protection

[5] We recognize that Myanmar has many pressing issues that warrant ethical consideration. It is not our goal in this paper to address those issues.

of biodiversity, particularly as agriculture and forestry expand (Webb et al. 2014). Rao et al. (2013) identify habitat loss (as a result of logging and overexploitation of species) as two important threats to Myanmar's biodiversity. A Buddhist eco-ethic might work to counteract the overexploitation of natural resources, and be an important tool to protect biodiversity (Hakkenberg 2008).

We wondered—especially given Myanmar's long-term closure under military rule and subsequent recent opening in its shift to more democratic rule—if there was any evidence for an emergent or present Buddhist eco-ethic in Myanmar that fused religious spaces and places with environmental protection. If there was any evidence, how might it resonate (or not) with Buddhist environmentalism in other areas of the world, such as Thailand, the Tibetan regions of China discussed above, and elsewhere.[6]

At methodological and analytical levels, this study fused approaches from both religious studies and biology. We focused the study on a couple of vectors of analysis. We asked specifically: (1) how biodiversity was represented in selected sacred spaces in rural and urban areas in Myanmar, and (2) how bird and plant diversity varied between those same urban and rural religious spaces. We coupled spatial-structural and bird-and-plant diversity analysis with impromptu conversations with abbots and others at sacred places (those who were willing to talk with us about environmental concerns), and with observations of various practices at the sites. As research unfolded over the course of the two short-term study-abroad trips in January 2017 and January 2019, we also developed a series of additional guiding questions, such as: How is nature depicted at the sacred places? Do the sacred spaces function to preserve biodiversity? Do the sacred spaces function to replace lost biodiversity? How are the symbols at the sites representative of/connected with the natural world? Do the temples represent or distill patterns found in nature? Where do we see religious symbols, practices, spaces in Myanmar used explicitly for an ecological ethic? To restate this last question, is there any evidence of a dynamic, religious-based

[6] Myanmar also has a large variety of natural resources, such as jade, coal, timber, tin, copper, marble, limestone, petroleum, and others.

environmental ethic in the religious spaces of Myanmar? That is, do these religious spaces in Myanmar play any active role in preserving the country's biodiversity?[7]

Our aim was to understand the relationship between religious spaces and biodiversity in both urban and rural settings in Myanmar. There were three interlocking procedures to move toward the goal of understanding the relationship between religious space and biodiversity. First, we analyzed the relationship of religious symbols, spaces, and practices to matters of conserving biodiversity—we studied certain Buddhist and other understandings, including various realms and notions of rebirth. Second, we compared species diversity within and around these spaces to quantify the biodiversity of said spaces, and we compared representations of biodiversity within said spaces. Third, we collected narratives from various informants—monks and lay people—about their sacred spaces and about the environment.

On the January 2017 trip, members of the research team visited nine Buddhist sites, three in urban settings and six in rural settings ranging from Yangon to Mandalay, as specified in **Map 1** and **Table 1** below. We categorized the sites as rural or urban spaces based on surrounding location and population size. Rural spaces were located in forests and farmlands with low human populations. Urban spaces were located within cities with high human populations. Religious spaces ranged from the Shwedagon Phaya, the most important national shrine in Myanmar, to Mount Popa, the center of *nat* (spirit-lord) worship, and to old Bagan, the center of an empire that at its zenith in the 12th century once covered most of what is now modern-day Myanmar. On the second trip in January 2019 we repeated visits to several of these sites, and added visits to other sites as well; only the most relevant sites are listed in **Map 2** and **Table 2** below. For this second trip we added some places that were

[7] We had certain limitations for what we collected as evidence. We did not attempt to compare diversity between sacred spaces and other spaces. We did not regularize the conversations we had with various people in terms of formalized questionnaires and the like, preferring to let discussion move in an improvisational manner. We did not attempt to try to assess the impact of temple restoration projects, at Bagan for instance (e.g., Hudson 2008), on our data points. We also did not spend extended periods of time over several days or weeks at each of the sites we visited. That said, the evidence we collected has led us to some conclusions, as presented and discussed in this article.

specifically protected areas, namely at Alaung Daw Kassapa (alternatively spelled Alaungdaw Kathapa) and Shwe Set Daw (in its protected forest zone).

The remainder of this article summarizes our approach and findings, and then comments on the absence of, but yet potential for, an emergent Buddhist eco-ethic or "land ethic" in Myanmar that may help assist with addressing the many problems of the Anthropocene.

Map 1: Location of Sites Visited, 2017.

Table 1: Religious Sites Visited, 2017.

Setting	Location	Notes
Urban		
Shwedagon Phaya	Yangon	Urban pagoda; national shrine, believed to hold relics of Gautama Buddha as well as the three Buddhas preceding him.
Sambuddhe Phaya	Myae Nae near Monywa	Built in the early 20th century, the Sambuddhe Phaya bears protection verses from the Angulimala Sutta along the exterior in a series of friezes.
Kaung Hmu Daw Phaya	Sagaing	Kaung Hmu Daw Phaya was originally built in imitation of a Sri Lankan stupa but has since been redecorated to more closely resemble Burmese styles.
Laykyun Sakya	Monywa	The Laykyun Sakya is an enormous, hollow standing Buddha in which one can walk up, ascending through the levels of rebirth. The site is also home to an enormous grove of Bodhi Trees under which sit statues of the Buddha.
Rural		
Akuak Taung	On Irrawaddy River, near Pyay	The Akauk Taung images are said to have been left originally by traders who stopped near there at a toll station on the river.
Mount Popa	Central Myanmar, southeast of Bagan	Mt. Popa is the center of *nat* worship in the country. Capped by a monastery, it is still very popular as a pilgrimage destination to worship *nats*.
Shwe Set Daw	Chin Hills	Shwe Set Daw holds two Buddha footprints, and is the site of a regional pilgrimage that welcomes tens of thousands of pilgrims during the dry months of February and March. A wildlife/deer park is maintained there.

(Contd.)

Setting	Location	Notes
Mount Phoe Win Taung	Northwest Central Myanmar	A Buddhist cave complex. The Phoe Win Taung images are said to have been carved between the 14th and 18th centuries and remain an important site of devotional activity.
Old Bagan	Bagan	At its zenith, the Bagan empire spanned most of modern Myanmar; Bagan's vast "plain of merit" contains thousands of religious structures; we looked at some in Old Bagan.

II. Religious Spaces in Myanmar: Narrative, Image, Practice, Nature

In terms of methodology, the religious studies members of the research team sought to record and catalog the range of religious and other symbolisms at religious spaces. We identified how, if at all, they touched on matters related to nature, the natural world, and biodiversity, whether explicitly or implicitly. Data collection was irregular, in part because of the vast array of narrative symbolism at the different sites, in part because the level of access to informants at different sites varied, and in part because of the amount of time spent at the sites. Thus, our comments and findings constitute preliminary conclusions.

Not unexpectedly, religious sites in Myanmar, at the level of narrative and image, are often deeply interconnected with their surrounding natural environs, in an often-instrumental way (i.e., in terms of a religious path to liberation associated with the Buddha as exemplar). Reliefs and images at the religious places we visited depict humans interacting with nature. At these places, we often saw the Buddha reigning over human nature as well as the nature of the natural world (both assumed to be driven by desire or craving). Such narrative motifs underpinned all the Buddhist sites we visited. Also, depictions of the diversity of the natural world (e.g., food, plants, and animals) are evident at these sites, as illustrated forcefully at the urban

Map 2: Religious Sites Visited, 2019.[8]

Sambuddhe Phaya and implicitly at places like Akauk Taung cliff and other sites. Sambuddhe Phaya is a beautifully decorated temple near Monywa. The exterior of the temple offers a repository of natural images: tigers, snarling leopards, elephants, lions, snakes, cranes, bees, frogs, dogs, monkeys, and horses. Plants abound too: twining flowers climb up pillars, and fruits such as bananas and durians sit on top of the pillars and in niches.[9] At the Akauk Taung cliff (**Figure 2**) there are abundant

[8] Please note: Maps 1 and 2 were produced at different times during the research; they were completed by different team members using different mapping methods, hence the variation in presentation here. Map 2 was made using Google maps.

[9] Interestingly, whereas the exteriors depict an enormous amount of human, animal, plant, and narrative diversity, the interior consisted entirely of Buddha images. Some were enormous; others were very small and set into the thousands of niches that line the walls, columns, ceiling, and skylights. There were no observable images of *nats*, animals, or any other kind of creature on the inside.

Table 2: Religious Sites Visited, 2019.

Place	Location	Notes
Shwedagon (1)	Yangon	Also see 2017. Urban pagoda; national shrine, believed to hold relics of Gautama Buddha as well as the three Buddhas preceding him.
Bayannyi Cave (2)	Hpa-an	Sprawling monastic and temple complex, with a cave that runs for about 100 meters, ending in a small relic chamber; hot springs for male and female travelers.
Kyauk ka lat Monastery (3)	Hpa-an	Picturesque monastic setting situated at the base of a limestone towering rock formation, surrounded by a human-made lake.
Lumbini Garden (4)	Hpa-an	Garden grove with 1000+ Buddha images.
Thamanya Monastery and Temple complex (5)	Near Hpa-an	A famous monastery on a hill, surrounded by lay quarters, buildings, etc. The land around this monastery is designated a place where vegetarianism is practiced.
Win Sein Taw Ya (6)	Mawlamyine	A huge complex with a nearly completed massive reclining Buddha, housing images of the cosmos and the life of the Buddha; stalled construction of another reclining Buddha. The abbot recently died, and energies have been diverted to his mausoleum.
Nwar la boat (7)	Mon State	Considered to pre-date the better known Kaik Hti Yoe, the pagoda is said to house hair relics of the Buddha inside the middle of three stacked rocks that form a ritual and devotional center of the site. Around the temple grounds some trees are marked with sashes that indicate protection by the mountain nat.

(Contd.)

Place	Location	Notes
Kaik Hti Yoe (8)	Mon State	The famed Golden Rock Pagoda atop a mountain. A major pilgrimage site, especially around Myanmar's Independence Day and other holidays. Construction and various sites range across the hilltop region.
Sri Ksetra (9)	Pyay	An old archaeological site associated by many people with the ancient Pyu people and civilization.
Shwe Set Daw Preserve and Temple complex (10)	Chin Hills	See site info also under Religious Sites Visited, 2017; an area that includes a park station, a deer park, an upper and lower footprint temple, and a forest preserve; on this trip we were granted access to restricted areas of the forest.
Bagan (11)	Bagan	See site info also under Religious Sites Visited, 2017; visits were to Ananda Phaya, Mi Ma Laung Kyaun, Shwezigon Phaya, an unnamed temple (#744), Sulamani, Manuha, Nan Phaya, Gu Pyauk Gyi and environs.
Mount Phoe Win Taung (12)	Northwest Central Myanmar	See also 2017. A Buddhist cave complex. The Phoe Win Taung images are said to have been carved between the 14th and 18th centuries and remain an important site of devotional activity.
Alaung Daw Kassapa National Park (13)	Sagaing Division	A national park with a temple and a devotional area in a lower deep grotto for Alaung Daw Kassapa, or embryo Kassapa. The devotional area in the grotto is home to an expression of rock in the shape of a meditating monk, said to be Alaung Daw Kassapa inside the rock itself.

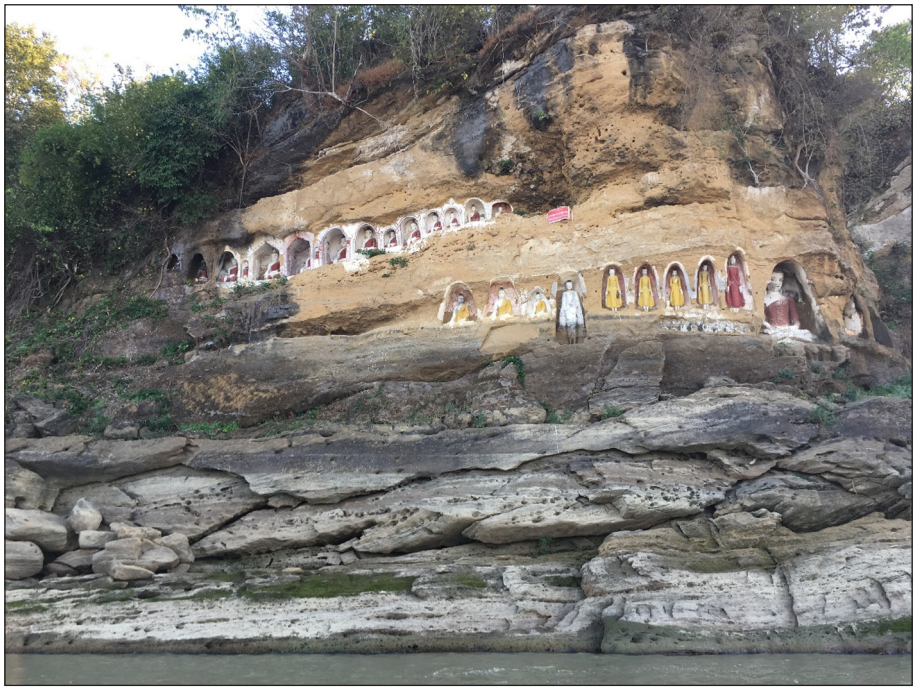

Figure 2: A view of some of the carved images at Akauk Taung. Photograph courtesy Jason A. Carbine.

images of the Buddha touching the earth to call upon the Earth Goddess to bear witness to his enlightenment. Moreover, sculptures of the Buddha meditating in the coiling girth of the serpent King Mucalinda can be seen at many sites. Buddhism in Myanmar, at the level of narrative and imagery, is deeply grounded in conceptions of the natural, non-human world.

In addition to such images and narratives, we observed a number of religious practices related to nature or the natural world more broadly. For instance, *dana*, or giving, is a common practice in Myanmar. At many places we visited, *dana* was extended to non-human members of the community: e.g., the feeding of monkeys at Mount Popa and of birds and fish at other temples. Animal catch-and-release practices at Kaung Mhu Taw Phaya are another example of species-specific actions. In these practices, fish and birds are caught for the karmic edification of devotees, who pay to have them released (only to be caught and released again and again, in a somewhat samsaric cycle).

The rhythms of nature were often manifested at several of the temples we visited in terms of the Burmese zodiac. The zodiac appears at temples in the form of planetary posts, associated with a day of the week. With roots in Hindu and Vedic astrology, the zodiac governs, among other things, the naming of individuals per their birth day in the week, as well as the sounds in the Burmese alphabet associated with each day of the week. Indeed, the zodiac links cardinal directions, planets, animals, and sounds, and the planetary posts at temples like the Shwedagon Phaya receive much devotional attention.

Based on our observations, we note that within the context of the Buddhist and local temple cultural frameworks, nature or the natural environment is present in at least five ways:

- There are depictions of the world system as a whole (e.g., the 31 planes of existence, the existence of diverse types of beings in the universe); nature or the natural world are assumed to be part of this system.
- There are depictions and ritual uses of the zodiac. The relation of the zodiac to the flow of life here on earth is crucial, wherein directions, planets, certain animals, and certain sounds are interconnected in terms of how people understand their lives.
- There are depictions of the natural world, filled with suffering, which must be triumphed over to achieve liberation.
- There are depictions of the dangers of the natural world (e.g., raging water buffaloes and elephants). Hence, we find protective verses, etc., incised at certain places at temples.
- There are depictions of various kinds of life, viz., human, divine, semi-divine, ghosts, demons, animals, birds and plants. Animals such as lions, *naga* (the serpent), and elephants among others are frequently depicted in pagodas as guardians. Bodhi Trees and lotus flowers are used to represent the Buddha himself and enlightenment.

Significantly, none of the sites we visited at the level of religious narrative, imagery, or practice were associated in any way with an ethic of protecting or conserving biodiversity.

In terms of perspectives derived from impromptu conversations with various informants, some interesting points emerged during both trips. We encountered one monk at the Shwedagon who linked the control of consumption with protecting the environment, which resembles Kaza's eco-interpretation of the eightfold path. The commentary by the monk was strikingly similar to a lecture that members of the team attended the previous year by Yan Min Aung, a National Land Policy Consultant, who also explored environmental protection from the perspective of decreasing consumption. Additionally, at Kyauk ka lat monastery, the abbot situated the conversation about the environment in relation to two themes. First, he drew attention to the idea that the safe, harmonious environment of the monastery and its immediate surroundings was made possible by the ethos of mental cultivation, kindness, and compassion exemplified by people there, especially by, but not limited to, himself. In this way, an idealized natural environment of non-harm was connected to mental cultivation. He seemed to draw on root images in the Buddhist tradition regarding the capacity for mental culture to transform the natural world, as similarly demonstrated in the Himalayan *pad yatras* explored earlier in this article. Another abbot at a nearby monastery (Thamanya monastery) invoked similar ideas. Second, in contrast to what others said to us, the abbot at Kyauk ka lat also related the harmony of the space there to the Rohingya conflict, implying that the spaces and places where the violence was happening did not have the kind of mental culture needed for peace. For him, the environment—whether natural or political—was seen through a lens of mental cultivation and progress on the Buddhist path, something widely depicted throughout the Buddhist sacred spaces we visited.

While nature-based forms are extensively represented in the Buddhist sites' artwork and architecture which we investigated in this small-scale study, no explicit environmental ethic was evidenced or practiced thus far. This study thus emphasizes the potential for Theravada Buddhism in Myanmar to promote such an ethic. The data collected thus far for this ongoing study about religion and ecology in Myanmar contrasts with other well-renowned cases of green Buddhism (in Thailand and Tibet) discussed in the introduction to this article. As in other regions, more religious and environmental actors are needed in Myanmar to enact or activate Buddhist

environmental worldviews found in Buddhist teachings, sites, art, and architecture. These could be harnessed to explicitly support such environmental preservation or protection projects. Some nascent examples of this complex process of interaction between worldviews and ecologically oriented projects include both the abbot's and Yan Min Aung's perspectives as noted above.

III. Conserving Biodiversity

Nature reserves, national parks, and other protected areas act as a means of conserving natural habitats and minimizing degradation. These protected areas cover approximately 5% of the total land area of the Earth's surface (Paul and Arunachalam 2005). Ecotourism also has the potential to conserve biodiversity by educating the world's population about the causes of recent species extinctions and the need to preserve and conserve the natural habitats of endangered animals and plants (Sridhar 2006). Since the primary cause of biodiversity loss is habitat fragmentation and degradation, religious spaces may also be important sites to stem the loss of biodiversity (Dudley et al. 2009). Recently, Jackson and Ormsby (2017) observed that more research on biodiversity in urban sacred spaces needs to be done to document the role these spaces play in preserving natural capital. Our small-scale study takes an innovative step in the direction of such research.

From the perspective of biodiversity conservation, depictions of nature in a religious space can serve at least three functions: (1) to enhance or emphasize the appearance of actual biodiversity within and around the temple grounds, (2) to replace or compensate for the lack of actual biodiversity within or around the temple grounds, or (3) to represent the importance of biodiversity to religious practice. Previous studies suggest that religious spaces located within rural areas function to enhance the already existing biodiversity; sacred groves are one example (Jamir and Pandey 2003; Bhagwat et al. 2005; Salick et al. 2007). On the other hand, religious spaces located within urban areas may recreate or mimic native habitats by protecting or planting trees with specific uses (Ishii et al. 2010; Divya et al. 2018). Alternatively, representations of plants and animals in religious spaces may substitute for the lack of biodiversity surrounding temples and shrines.

IV. Biodiversity: Observations, Photographic Surveys, and Transects

To address these functions of religious spaces for possible biodiversity conservation, members of our biology research team in 2017 counted representations of plants and animals in temple spaces using photographic surveys and on-site observations. On-site observations included making notes of plant and animal images, supplemented by photographic surveys analyzed post-visit. For the purposes of this survey, multiple images of a single species (for example a lion) or species type (repeated images of a single flower type) were counted as one type of representation of nature, not separate representations.

Sampling Plants and Birds

For collection of plant-species data, two randomly placed, non-overlapping 30 meter transects were sampled at each of the temple sites, except for Shwedagon, where no transects were sampled, and Mount Popa, where only one transect was sampled. The number of individuals of each plant species was totaled for each transect. Species diversity for each transect was calculated using the Shannon-Weaver diversity index (**Table 3**), which takes into consideration the relative abundance of each species in addition to the total number of species. Area 1 and Area 2 each had four species and a total of eight individuals (**Table 3**); however, Area 1 had greater species diversity because there were an equal number of individuals of each species (**Table 3**).

$$\text{Shannon} - \text{Weaver Diveristy index } H = -\sum_{i=1}^{s} p_i \ln p_i$$

Table 3: Species Diversity Example.

	Area 1				Area 2			
Species	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Individuals	2	2	2	2	5	1	1	1
Proportion p	0.25	0.25	0.25	0.25	0.625	0.125	0.125	0.125
$\ln p$	−1.38	−1.38	−1.38	−1.38	−0.47	−2.08	−2.08	−2.08
$p \ln p$	−0.35	−0.35	−0.35	−0.35	−0.29	−0.25	−0.25	−0.25
H	1.40				1.04			

In addition to the transects, we also recorded all species of plants observed; each site was characterized by a diversity index and a total species number. Bird diversity was determined by recording each individual observed, and then totaling the number of individuals of each species observed. A Shannon-Weaver diversity index was then calculated for birds. As for plants, each site was characterized by a Shannon-Weaver diversity index and species total for birds.

Mean values for rural and urban plant diversity indexes and bird and plant species numbers were compared using a *t*-test, a statistical test that compares mean values by calculating the variation within and among two groups.

Mount Phoe Win Taung supported the highest number of plant species within the temple grounds; the highest number of bird species was recorded at Old Bagan, and Old Bagan ranked highest in total number of species (plants and birds combined, **Figure 3**). Mount Popa supported the lowest total number of species, plant and bird species combined (**Figure 3**). Shwe Set Daw had the highest Shannon-Weaver

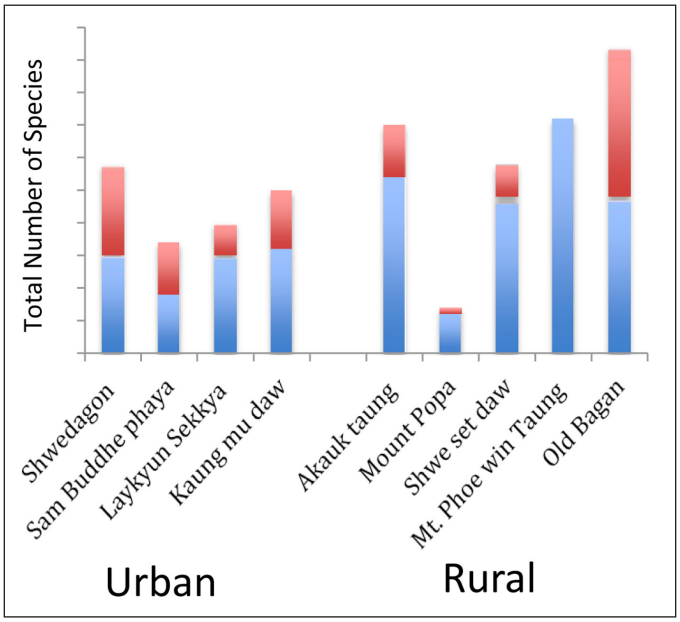

Figure 3: Total Number of Species. This figure illustrates the overall total species with plant and bird species shown as stacked bars for each temple site. Birds are in red, and plants are in blue.

Table 4: Averaged Diversity Index. The index is given for each temple site, displayed by using the Shannon-Weaver diversity index, based on transect data only.

Rural Sites	Shannon Weaver Diversity Index	Urban Sites	Shannon Weaver Diversity Index
Mount Phoe Win Taung	1.91	Sambuddhe Phaya	1.47
Akauk Taung	2.05	Kaung Hmu Daw	1.88
Shwe Set Daw	2.11	Shwedagon	N/A
Mount Popa	1.47	Laykyun Sekkya	1.63
Old Bagan	1.68		
Mean (se)	**1.84 (0.11)**		**1.66 (0.15)**

diversity index, and Sambuddhe Phaya had the lowest overall biodiversity based on the Shannon-Weaver diversity index calculated from the temple site transect data (**Table 4**). No significant differences were observed between the urban and rural temple sites, although rural sites had higher mean numbers of plant and animal species and had higher mean Shannon-Weaver diversity indices.

Depictions of Biodiversity

We collected extensive observations and photographic surveys of the depictions of nature at each temple site. About 4,000 photographs were examined to count the depictions of animals and plants observed at each temple site and to calculate an approximate number of nature depictions for each temple site. Depictions were quantified as follows: 1) we identified the number of unique species on each surface, 2) we multiplied that number by the number of unique surfaces. These surfaces included pillars, archways, shrines, walls, façades, pedestals, columns, paintings, etc. Unequal variance *t*-tests were used to compare means between rural and urban spaces. Two scatter plots were used to compare data gathered from the live-plant and bird surveys, resulting in: (1) the total number of depictions versus total species, and (2) the total number of depictions versus biodiversity.

Bagan, Laykyun Sekkya, and Akauk Taung showed the lowest depictions of biodiversity, while Kaung Hmu Daw, Sambuddhe Phaya, and the Shwedagon revealed the highest occurrences, supporting our hypothesis. Phoe Win Taung, Mount Popa, and Shwe Set Daw fell in the middle (**Figure 4**). Plants were more heavily depicted

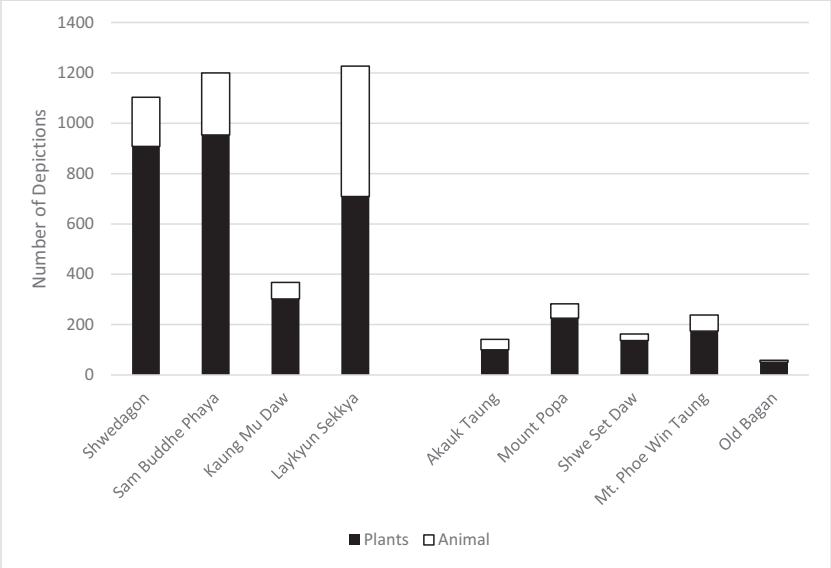

Figure 4: Total Number of Depictions of Plants and Animals.

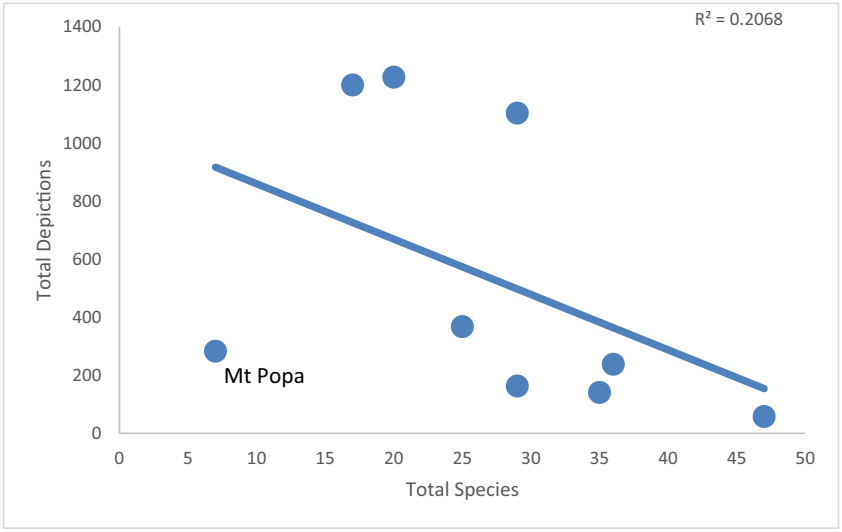

Figure 5: Number of Depictions as a Function of Total Species Present.

than animals at all the sites, but there was no significant difference between depictions of plants and birds (**Figure 4**). The scatter plots displayed negative trends (**Figures 5** [11] and **6** [12]); as the number of live plants and birds decrease, there was

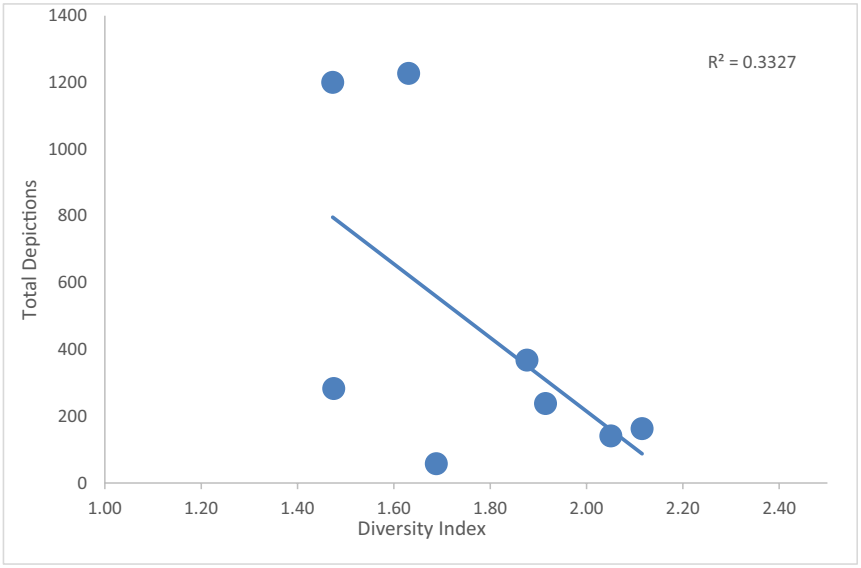

Figure 6: Number of depictions as a function of Shannon-Weaver diversity index.

an increase in biodiversity depictions. However, the species diversity only explains about 33% of the variation in the number of depictions, and the number of species only explains about 20% of the variation in the number of depictions.

Discussion

The results of the above-collected data suggest that there is some relationship between depictions of nature and surrounding species diversity, which indicates the potential for sacred spaces to compensate for the loss of biodiversity. Having said that, the depictions were largely ornamental and did not necessarily replicate the surrounding biodiversity. Our results suggest that while nature is used as an ornamentation, that alone is not an attempt to recreate a loss of biodiversity. We had anticipated that urban sacred spaces might have lower overall diversity, however if those urban sacred spaces were important to preserving biodiversity, then they should share a pattern similar to rural spaces. Indeed, there was a great deal of overlap in species diversity indices between rural and urban areas which suggests that sacred spaces could function as a repository of biodiversity even in unprotected areas (Singh et al. 2013; Skórka et al. 2018). And, overall bird diversity was similar in

both rural and urban areas. Skórka et al. (2018) documented higher bird diversity in church areas as compared to surrounding farmland and attributed this in part to the increased structural diversity churches provide. Overall diversity indices in a protected area were somewhat lower than those measured for mixed deciduous forest; Sein et al (2015) measured a diversity index of 2.32 in similar types of forests in Aluangdaw Kathapa National Park. Our rural sacred sites, while somewhat more diverse than urban sites, were less diverse than protected areas, arguing against the idea that these sites function as "sacred groves" (Bagwhat et al. 2005; Dudley et al. 2009; Salick et al. 2007).

V. Conclusion

Taking the religious studies and biological methods and data all together, the evidence explored in this article does not show a direct link between sacred spaces and conserving biological diversity in Myanmar. Similar to Himalayan and wider green Buddhist ecological beliefs and practices, narrative discourses about mental cultivation emphasize the transformation of nature or surrounding environment as part of the religious quest. Yet, in Myanmar this Buddhist worldview is not yet ecologically oriented to species conservation.

Promising Buddhist ecological imagery in Myanmar is rooted in the Buddhist precept of not killing, the practice of relationships of reciprocity (e.g., *dana*), and the enforcement of rules and restrictions in and around these sacred spaces (which our data highlighted at some sites). All of this could play a crucial role in protecting the biodiversity of these rural and urban areas. The ubiquitous presence of nature as ornamentation in Buddhist temples argues that nature plays an important role in Buddhist religious traditions. Buddhist sacred spaces could use their agency and influence to establish more widespread respect of nature, involving local communities and government institutions to protect and enhance the biodiversity of these global regions. In this case study of selected sites in Myanmar, the preservation of biodiversity seems incidental rather than intentional given the range of diversity indexes between rural and urban spaces, the lower overall diversity indexes when compared to a protected area (Sein et al. 2015), and the range of observational and qualitative evidence gathered.

Plants and animals are essential parts of temple imagery; they form a backbone of Buddhist representations of their traditions and its various facets. Although this is more so the case for urban temples than for rural temples (at least in their present-day usage and upkeep), our preliminary analysis suggests that both kinds of places can serve to protect bird and plant biodiversity. However, significant litter pollution at rural temple sites, sometimes associated with food sold for monkeys, complicates the relationship of temples to the preservation of biodiversity. Nevertheless, thinking about our observations of the religious sites in Myanmar against the backdrop of Buddhist environmentalism elsewhere, we find it useful to re-engage the idea of an eco-ethic, via the promising notion of a (Buddhist) "land ethic" that Aldo Leopold espoused many decades ago (Leopold 1949), This could fuse the protection of biodiversity with Myanmar's religious places, and could be an important strategy to reduce human environmental impacts that characterize the Anthropocene.

Anticipating the most expansive eco-ethical perspectives of today, Leopold explained the idea of a land ethic as "enlarging the boundaries of the community to include soils, waters, plants, and animals, or collectively the land" (Leopold 1949, 239). A land ethic promotes conservation of not just a single species or of individuals, but rather ecosystems defined as plants and animals interacting with each other and the physical environment. He pointed out that many ecosystems and species have no economic value but are key to ecosystem functions such as nutrient cycling and energy flow. Leopold defined a land ethic as reflecting an "ecological conscience" that confers "individual responsibility" for the integrity of the ecosystem, or as he phrases it, "the health of the land" (Leopold 1949, 258). At the close of the essay, he lays the blame for the lack of a land ethic on the separation of people from the ecosystems on which they depend. His land ethic is not grounded in plant-based diets or the ethical treatment of animals; instead, he defines land use as "right" when it preserves the integrity of the ecosystem.

Leopold's insight highlights the problem of religious spaces serving as refuges for biodiversity. Buddhists such as Thich Nhat Hanh see the importance of connections between humans and the services provided by ecosystems (Gregory and Sabra 2008). Kraft's (1997) term "eco-karma" might describe one's ecological footprint. Thai monks

practice tree ordination to protect the forest ecosystem (Darlington 2012, 2014, as highlighted in the introduction to this article). Buddhism must distinguish between saving individual animals and a land ethic that extends to preserving species to protect ecosystem function.

At present, we see no evidence of such a "Buddhist land ethic" in the religious sites we visited in Myanmar. Although Buddhism certainly offers the potential for a strong land ethic, given the religion's concern for the well-being of sentient beings, this potential has yet to be realized.[10] Indeed, attitudes toward animals are more indicative of interspecies or individual interactions that occur without awareness of the interactions' ecological context. This is in direct contrast to a land ethic which accounts for important ecological processes and does not value one species before the health of the biosphere as a whole. For example, while providing food for monkeys or returning fish to a pond increases merit, saving such individuals may not be consistent with a land ethic if the action harms other species or leads to environmental degradation.[11] At these religious spaces, Buddhists respect prohibitions against killing, and strive to act compassionately. However, species-specific interactions can be short-sighted and detrimental to the surrounding environment.[12] An awareness of the ecological impact of individual, species-specific interactions needs to be developed if the vast biodiversity of Myanmar is to be preserved.

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[10] We are aware that ecologically oriented approaches are emergent in other areas of Myanmar's cultural and political life, including contemporary visual and media arts not connected with the sacred spaces at the center of this study. Further exploration of these areas will be included in our subsequent studies.

[11] While the fish-release practices in places like Kaung Hmu Taw had a negligible environmental impact since the fish were released into a closed pool, members of Myanmar's Bird and Nature Society expressed concern about the negative impact that catching and releasing species could have on the environment. They were concerned about the long-term impact of catch-and-release practices on animal welfare, as animals are often caught by poachers, sold to Buddhists to be released, and then are again caught and sold in a repeating cycle. Research elsewhere has indicated that such rituals are detrimental to the environment because these practices may introduce invasive species (Agoramoorthy et. al 2007).

[12] The various ethnic conflicts in Myanmar lie beyond the present scope of the paper, but attention to such conflicts may shape the way we approach our next round of data collection in Myanmar on this topic.

Competing Interests

The authors have no competing interests to declare.

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