REPORT

Historical and contemporary cultural ecosystem service values in the rapidly urbanizing city state of Singapore

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Abstract Cultural ecosystem services are a function of people and place, so may change as a location transitions from rural to urban. Singapore has undergone rapid urbanization after its independence in 1965, with a concomitant decline in natural habitat extent and accessibility. Using coastal mangrove forests as a case study habitat, changing cultural values were explored with a novel array of techniques, including qualitative archival analysis (photographs, oral histories), current sources (publically uploaded social media photographs), and surveys of (a) the general public and (b) visitors to publically accessible mangroves. Cultural value changed through time, with a significant transition from intrinsic, intrapersonal values (spiritual, cultural heritage) to instrumental, interpersonal values (recreation, education). Additionally, cultural value varied between different mangroves depending on their public accessibility, and the evolving degree of human interaction with the ecosystem as urban development occurred. Cultural values change as development transitions, though mangroves still play an important cultural role in a heavily urbanized environment.

Keywords Coastal · Ecosystem services · Mangrove · Recreation · Singapore · Urbanization

INTRODUCTION

Ecosystem services are an important framework for assessing and conserving threatened habitats. Ecosystem services are generally categorized within the broad groups of provisioning, regulating, supporting, and cultural services

(MEA 2005). Cultural ecosystem services describe the predominantly non-material benefits that people gain from nature, such as recreation, education, spiritual enrichment, inspiration, cultural heritage, and aesthetic experiences (MEA 2005; Hernández-Morcillo et al. 2013). The value of cultural ecosystem services can be substantial, particularly in urbanized landscapes where the importance of recreation and well-being may outweigh other ecosystem services, such as local food or natural resource production (Bolund and Hunhammar 1999). Despite their importance, cultural ecosystem services remain poorly understood as they are commonly intangible and subjective, making them difficult to analyze and quantitatively value alongside biophysical or economic metrics (Hernández-Morcillo et al. 2013; Satz et al. 2013; Pleasant et al. 2014). The often intangible nature of cultural ecosystem services also makes it difficult to quantify how their values may change through time, compared to tangible provisioning and regulating ecosystem services (e.g., Ray et al. 2011).

We may better understand cultural ecosystem services by studying the actions and perceptions of local people (Bryan et al. 2010; Plieninger et al. 2013; Pleasant et al. 2014). Cultural ecosystem services have typically been analyzed using focused surveys over short time periods (Bryan et al. 2010; Plieninger et al. 2013), but it is likely that cultural values are not static. Instead, people are likely to experience and use habitats differently as they are converted and degraded (Selim et al. 2014). To explain patterns in the present distribution of cultural ecosystem service delivery and predict the impacts of future habitat conversion, it is critical to understand how past changes in habitat conditions have affected the cultural values that societies place on habitats.

The cultural values that a society attaches to a habitat depend on interactions between the environment and the people (Hernández-Morcillo et al. 2013). Habitat

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conversion often coincides with major changes in demographics and societal culture, perhaps most obviously in the case of urbanization, which can precede changes in lifestyle and social structure (Ives and Kendal 2014). Thus, a change from rural to urban may lead to a shift in the way that habitats are used culturally over time. People who live in urban areas are generally physically further from natural habitats, and are therefore likely to visit them less frequently (Willits and Luloff 1995). Fragments of natural habitats that remain in urban landscapes are likely to come under increasing pressure to deliver cultural ecosystem services, as the area of available habitat decreases and the human population increases. Urbanization may cause a shift from intrinsic to instrumental cultural use, such as usage for education (Willits and Luloff 1995) and recreation (Bolund and Hunhammar 1999; Thompson 2002).

Singapore provides a valuable case study in which to investigate changing cultural values during the transition from rural to urban, as many other cities in Southeast Asia and the tropics more generally are expected to follow similar development trajectories in the near future (Sodhi et al. 2004). The island city-state has experienced rapid growth since independence in 1965, with the population growing from just over 2 million in 1970 to 5.4 million in 2013 (Singapore Department of Statistics 2013), and potentially 6.9 million by 2030 (NPTD 2013). There has been a corresponding rapid increase in urbanized area, with now only 56 % of Singapore's land surface classified as vegetated (Yee et al. 2011). Large-scale land reclamation programs have also been implemented to increase the area available for building space; Singapore's land area increased by 33.5 % from 581 to 775.5 km² between 1957 and 2007 (De Koninck et al. 2008). Urbanization has resulted in the loss of natural and semi-natural habitats, particularly in coastal areas that have been affected by reclamation.

This study focuses on the cultural ecosystem services provided by mangroves in Singapore, in part because of the recent rapid decline of these habitats. Mangroves are also of interest because they are known to provide a range of cultural services (e.g., James et al. 2013). The potential for mangroves to deliver a range of cultural services suggests that there is scope for societies to prioritize different aspects of mangroves over time, as environmental and societal conditions change. It is also possible that different mangrove areas currently provide different cultural ecosystem services, depending on their location in the landscape and their corresponding histories of development. The first objective of this study investigated how the cultural value placed on mangrove habitats in Singapore has changed over time, by comparing archival photographs, audiovisual recordings and transcripts of historical interviews to modern-day photographs, and responses from semi-structured interviews conducted with

members of the public. The second objective investigated how the development history and current use of different mangrove sites have affected the values that people place on them, achieved through a second set of focused surveys of visitors to accessible mangrove sites.

MATERIALS AND METHODS

Study locations

Singapore is located in a region with the largest mangrove extent and the highest mangrove species diversity globally (Polidoro et al. 2010). Mangrove covered much of Singapore's coast historically, though has experienced a severe decline in areal extent due to a number of anthropogenic stressors. Singapore is a small, densely populated island, so land reclamation to allow increasing urban development has been a leading cause of mangrove decline since Singapore's independence (Lai et al. 2015; Fig. 1). Mangrove loss was especially high in southwest Singapore, where shallow sloping mangrove intertidal areas were reclaimed for harbor developments. This reclaimed land has become the economic engine of Singapore, with the nation home to one of the world's busiest ports and marine bunkering centers. A further cause of mangrove decline is related to Singapore's increasing freshwater demand. Classed as a 'High Water Stress Country,' Singapore has constructed 17 reservoirs for water storage, 12 of which are coastal (Ziegler et al. 2014). The coastal reservoirs were constructed by the damming of small mangrove-fringed estuaries, causing mangrove loss and conversion to freshwater habitats. Due to these stressors, the area of Singapore's mangrove habitat declined from 63.4 km² in 1953 (Hilton and Manning 1995) to just 6.6 km² today (Yee et al. 2010) (Fig. 2).

Historical associations with mangroves in Singapore

Historically, human interaction with mangroves in Singapore occurred mainly around local settlements, or "kampongs" [Malay = village] that were located inside, or immediately behind the mangrove forest. Such villages were in existence in Singapore before the British Colonial period in 1819, with the estuaries of Singapore inhabited by the Orang Laut. Few kampongs remain in Singapore today, though the association of historical kampongs with mangroves can be seen through their names on maps, for example, Kampong Lalang (lalang = a coastal grass); Kampong Tumbok Opih (tumbok = to pound, opih = a type of limpet); or their locations on islands associated with mangroves, such as Pulau Bakau (Pulau = island, Bakau = mangrove). Despite rapid urbanization, this relationship existed in Singapore until relatively

Fig. 1 Mangrove loss and land reclamation gains in Singapore from 1820 to the present day, and the dates when key accessible mangroves areas were opened to the public. Sources for land reclamation area: Chia and Chou (1991); Singapore Department of Statistics. Sources for mangrove area: Corlett (1992); Hilton and Manning (1995); Yee et al. (2010); Lai et al. (2015); Tan and Friess, *unpublished data*

Fig. 2 Locations of mangrove sites in Singapore that are discussed in this study. Current mangrove sites used in this study are indicated by *black circles*, and the historical settlement Kampong Lorong Fatimah is indicated by a *white circle*

recently; for example, Kampong Lorong Fatimah was located in a mangrove forest on the north coast of Singapore (Fig. 2) until the communities were relocated to public housing in the late 1980s (Friess et al. 2012). Relocation was part of a bigger plan to transform Singapore into a modern city-state, and has been attested to aims of changing “squatters” into Singaporeans while tightening the government’s control on the island’s legislative politics (Loh 2009).

Present-day study sites

Currently, much of Singapore’s mangrove is military or State land. Public interaction with mangroves is restricted predominantly to four sites that are administered by the National Parks Board; Sungei Buloh Wetland Reserve in the northwest, Berlayer Creek, part of Labrador Park Nature Reserve in the south, Pasir Ris Park in the northeast,

Table 1 Characteristics of the four present-day mangrove sites used in this study

Site	Protected status	Accessibility	Visitor facilities	Previous history	Surrounding land use
Berlayer Creek, Labrador Park Nature Reserve	Nature Reserve ^a	MRT station at entrance	World War II Memorial Plaque, Adventure Playground, Jogging Path, Fitness corner, Food and beverage area	Maritime and war past	Dense commercial, residential
Chek Jawa, Pulau Ubin	Open space	Boat ride from Changi Ferry Point Terminal to Pulau Ubin. Chek Jawa is accessible by foot, bicycle, or van	Information kiosk, boardwalk, viewing tower, viewing jetty, and a visitor center	Granite quarries, prawn farming	Reserve site and open space
Pasir Ris Park	Park ^b	500 m from MRT station	Children's Playground, Fitness Corner, Basketball court, Pony rides, Mangrove BoardWalk, Bicycle and Skate Rental, Water sports, Food and Beverages outlets	Either kampong or beach	Residential and commercial
Sungei Buloh Wetland Reserve	Nature Reserve ^a	Public bus, Taxi, Shuttle service, Car	Wi-Fi-services, Viewing tower, Shelters, Pond, Nature trail, Look-out points, Food & beverage area, Bird sanctuary	Aquaculture	Agriculture, light industry

^a "Nature Reserve" is the highest legally protected status in Singapore

^b Public Parks have a lower protected status than a Nature Reserve

and Chek Jawa on the island Pulau Ubin, off the northeast coast (Fig. 2; Table 1). Sungei Buloh and Chek Jawa are located outside of the main urban areas, in agricultural and semi-natural areas, respectively. Pasir Ris is adjacent to a high-density residential neighborhood, which was primarily developed between 1983 and 1997. Berlayer Creek has the longest history of urbanization, being adjacent to a reclaimed harbour and a residential area that has been occupied since the 1820s (Teo and Savage 1985).

Analysis of past and present-day cultural ecosystem services

Past cultural ecosystem services: Archival analysis

The National Archives of Singapore provide records from the period of rapid urbanization, and particularly photographs and oral history interviews, which relate to life in mangrove Kampongs before their demolition. The archives were searched for photographs, records of oral history interviews, and audiovisual and sound recordings, using the term "Mangroves." 181 photographs, 11 oral history interviews, and 2 audiovisual or sound recordings were returned through this search. The content of the photographs was classified into one of seven categories of cultural services along a gradient of intrinsic to instrumental value; spiritual/religious, recreational, aesthetic, inspirational, educational, sense of place, and cultural heritage (Table 2; Fig. 3). The seven categories of cultural ecosystem services were based largely on categories presented in the Millennium Ecosystem Assessment

(2005), and no more than 2 categories were assigned to each photograph. The content of the oral history records and audiovisual recordings was considered qualitatively to provide context, such as quotes, to the photographic data.

Present-day cultural ecosystem services: Photographic records from Flickr

Recent photographic records of mangroves were obtained by searching the image-sharing website Flickr (www.flickr.com) for the names of four mangrove sites in Singapore: "Sungei Buloh," "Chek Jawa," "Berlayer Creek," and "Pasir Ris mangrove." The volume of photographs as a proxy of visitation rates has previously been used as an indicator of cultural ecosystem service values generally (Wood et al. 2013; Casalegno et al. 2013), though recent studies have begun to use Flickr to determine types of cultural ecosystem services that are valued by the user (Richards and Friess 2015). In this study the cultural ecosystem services that were represented by each photograph were inferred, using the same method and seven categories used by the archival photographs above ("Analysis of past and present-day cultural ecosystem services" section; Table 2; Fig. 3). We analyzed no more than the first 51 photographs returned by each search term (161 in total).

The proportional occurrence of each ecosystem service in the sources was compared between the historical sources and modern photographs. For each ecosystem service, a two-sample test for equality of proportions was applied using the statistical software R (R Core Team 2012).

Table 2 Definitions of different cultural ecosystem services used in this study

Cultural ecosystem service	Definition (modified from MEA 2005)
Spiritual/religious	Sacred, religious, or other forms of spiritual inspiration derived from ecosystems
Recreation and tourism	Characteristics of natural or cultivated landscapes that allow recreation and tourism
Aesthetic	Appreciation of scenic or other beauty in natural and cultivated landscapes
Inspirational	The use of natural motives or artifacts in arts, folklore, etc.
Educational	Ecosystem attributes that facilitate formal and informal educational opportunities
Cultural identity/sense of place	Current cultural linkages between humans and their environment
Cultural heritage	“Memories” in the landscape from past cultural ties

Fig. 3 Examples of archival and modern photographs displaying the seven cultural ecosystem services identified in this study

Present-day cultural ecosystem services: Semi-structured interviews

To evaluate the wider context of present-day mangrove use, 55 semi-structured interviews were conducted with members of the public. Combined with analysis of archival and present-day photographic records, semi-structured interviews allows this study to interrogate the meanings that cultural ecosystem services of mangroves hold for a diverse group of Singaporeans. Interviews were conducted in public places such as parks and food courts, and open-ended questions were used to query participants about their perceptions of cultural value of mangroves in Singapore. These transcribed interviews were analyzed for

keywords and quotes relating to the previously mentioned ecosystem service categories. Content analysis, where the mention of specific words was counted (in addition to extracting relevant quotes for qualitative analyses) was used to provide a neutral and objective quantitative description of interview content (Marshall and Rossman 2006).

Between-mangrove variation in present-day cultural ecosystem service provision: Questionnaire

Present cultural value was investigated using a questionnaire survey. The questionnaire was employed to find out the cultural ecosystem services that draw contemporary

visitors to different mangrove sites around Singapore. Two hours were spent at each mangrove site across two weekends (22–23 February and 1–2 March 2014). The study sites were visited in the late morning or evening, taking into account the opening hours of mangrove sites such as Sungei Buloh and Chek Jawa, as visitors were leaving the sites at these times. For mangroves with a fixed entrance/exit such as Sungei Buloh, surveys were conducted at the entrance/exit; in the case of the remaining three mangroves which have various entry/exit points, participants were approached along the boardwalk in order to obtain a more representative sample of visitors. Opportunity sampling was conducted, whereby participants were recruited as they exited the mangrove, or as they walked along the boardwalk. Surveys were limited to only one person per group. Participants were chosen with the aim of being representative in terms of their age and gender. The on-site surveys of mangrove visitors received 67 participants; 12 each at Berlayer Creek and Chek Jawa, 18 at Pasir Ris mangrove, and 25 at Sungei Buloh. There were a total of 36 female (53.7 %) and 31 male (46.3 %) respondents, with the average age of respondents being 35. Participants were asked to state motivations which had driven them to visit the mangrove on that particular day, and gave responses by selecting from nine pre-defined motivations; outdoor recreation, tourism, education, local history, to enjoy time with family and friends, to gain a sense of familiarity, to gain a sense of peace and tranquility, to connect with nature, and to enjoy the cityscape. The nine categories describing the motivations for visits to the mangrove were modeled on MEA (2005), though adapted for (a) Singapore's urban context and (b) to make them more accessible to the general public. Given the low significance of spiritual/religious cultural ecosystem service change from past to present, this cultural ecosystem service was adapted, and the term 'sense of peace' was used to describe the 'spiritual connection' that people have with nature (*sensu* Chiesura 2004). 'Sense of peace' comes in the form of natural restorative environments that add to one's 'sense of well-being and peacefulness' (Chiesura and de Groot 2003; Hansen-Ketchum et al. 2011). 'Enjoy the cityscape' was used to represent the aesthetic cultural ecosystem service, 'sense of familiarity' was used to explain 'sense of place,' 'connect with nature' was used to represent the inspirational cultural ecosystem service value, and 'local history' was used to denote cultural heritage value. Social relations or 'enjoy time with family' as a cultural ecosystem service was added to the list as suggested by other studies (Raymond et al. 2009; Gee and Burkhard 2010). This was represented in the study by 'enjoy time with family.' Finally, education, outdoor recreation, and tourism were based on the original definitions by MEA (2005).

Potential study limitations

Archival records are an unobtrusive research tool that allow for data observation and collection without the potentially erroneous introduction of bias that could affect the outcome of the study (Marshall and Rossman 2006). However, archival records are data previously collected by another party (in this study, a number of archival records were from newspaper holdings), and may be subject to inherent biases during data collection. Despite this limitation, archival records confer an invaluable historical perspective crucial to this study.

Similar biases may exist with the present-day photographs sourced from the publically available platform Flickr. Although the use of social media is an opportunity to obtain a great variety of participants, this is not necessarily representative of a larger group (Murphy et al. 2014). For instance, this study is unable to assess the collection of photographs from non-Flickr users or Flickr users who set their privacy settings to private. Flickr may also attract a certain type of user, such as amateur nature photographers. Due to time constraints and the selection of a large number of sites, our sample size for on-site surveys may be considered a limitation; while in total we had 67 surveys across sites, the number of surveys per site was lower or similar to the average sample size of 28–31, calculated from 560 qualitative research studies (Mason 2010). However, a mixed methods approach—as employed in this study—may require fewer survey participants (Mason 2010).

RESULTS

Differences in cultural ecosystem service values between the 1980s and 2014

The cultural ecosystem services that were most commonly identified in historical archival sources were intrinsic values such as sense of place and cultural heritage, and to a lesser extent recreation, while the services identified in the modern photographs were primarily aesthetic value, and instrumental values such as recreation and education (Fig. 4). The proportion of sources related to recreation, aesthetic value, and inspirational value increased significantly between the archive and present-day samples, while the proportional occurrence of spiritual or religious values, inspiration, sense of place, and cultural heritage, decreased significantly over this period (Fig. 4).

The archival oral histories focused predominantly on the description of intrinsic values; in particular, there was evidence that the mangroves instilled a sense of place and had an aesthetic value, and that there was a strong cultural and spiritual heritage associated with the communities that lived

Fig. 4 Proportion of sources that related to each of seven cultural ecosystem services. *Open bars* indicate the proportions of the historical archive sources, and *gray-shaded bars* indicate modern photographs. *Error bars* indicate 95 % binomial confidence intervals. *Asterisks* indicate the level of significance of the difference in proportional occurrence between the historic and modern sources (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$)

adjacent to the mangroves. Archival oral histories included descriptions of experiences with spirits in the mangrove (*spiritual and religious value*), the opportunity for peaceful reflection and inspiration while living in the mangrove Kampong, and the explicit use of mangroves in place identification. Few of the oral histories discussed instrumental cultural values, such as education and tourism. A video from the Singapore Tourism Promotion Board (STPB) in 1980 featured mangroves, though the focus of this portion of the clip was as an introduction to Singapore; thus, the use of mangroves in this context was more for intrinsic national branding, as opposed to selling mangroves as an explicit destination for tourists visiting Singapore. More detailed quotes from the interviews are included in the [Discussion](#) section. Quantitatively, the cultural ecosystem services that were found most frequently in the archival records (e.g., photographs) were inspirational value, sense of place, and cultural history (Fig. 4).

In the present day, mangroves are considered to provide mainly instrumental cultural ecosystem services. Interviews with local residents indicated that the most popularly perceived cultural values of mangroves in Singapore were recreation, ecotourism, and education. Respondents directly mentioned the word “education” most commonly (32 times), and mentioned “learn” four times, “tourism” five times and “recreation” 11 times. Intrinsic cultural ecosystem services were not mentioned by interview participants. More detailed quotes from the interviews are included in the [Discussion](#) section.

Variation in cultural ecosystem service values between different mangroves in the present day

The four mangrove sites that were surveyed provided different suites of cultural ecosystem services (Table 3). Berlayer Creek, which is located close to both residential

and commercial areas, was valued by the largest number of respondents for outdoor recreation and opportunities to have contact with nature. Chek Jawa, the most remote mangrove, was valued most highly as a place to connect with nature and enjoy outdoor recreation. Pasir Ris, the mangrove located near a residential area, was most highly valued for its peace and tranquility. Sungei Buloh, has been most developed as a nature reserve center and international tourist attraction. It was most valued as a place to connect with nature, but was also valued for outdoor recreation and education.

DISCUSSION

Evolving human interaction with nature: Differences in cultural ecosystem service values between the 1980s and 2014

Historically, with lower urbanization and when people were physically closer to nature, mangroves were valued intrinsically. In oral histories, Singaporeans deemed that their mangroves had a high intrinsic value, as they often used evaluative attitudes (Sandler 2012) to make reference to their personal, spiritual, and intangible feelings when discussing the mangrove landscape and the general natural habitat around them.

The inhabitants of historical villages such as Kampong Lorong Fatimah lived in close proximity to mangrove habitats, and consequently interacted with the ocean and mangrove forests on a daily basis. This daily connection comes across strongly in the archival interviews; one interviewee stated that “Maybe the water was only about one feet from the big house” (Mr. Sajimon, interviewed in 1989), and two agreed that “during their free time most

Table 3 Percentage of visitors to mangroves in Singapore who stated that their motivation for visiting came under one of nine categories. Percentages are given by site. *Italic values represent the two most popular motivations for each site*

Motivation	Original definition (Table 2)	Chek Jawa (<i>n</i> = 12)	Sungei Buloh (<i>n</i> = 25)	Pasir Ris (<i>n</i> = 18)	Berlayer Creek (<i>n</i> = 12)
Sense of peace	Spiritual/religious	8.3	0	38.8	8.3
Recreation	Recreation and tourism	33.3	24	16.6	58.3
Tourism	Recreation and tourism	8.3	4	0	0
Enjoy the cityscape	Aesthetic	8.3	4	5.5	0
Connect with nature	Inspirational	25	44	16.6	25
Educational	Educational	8.3	20	0	8.3
Sense of familiarity	Cultural identity/sense of place	0	0	5.5	0
Local history	Cultural heritage	0	0	0	0
Enjoy time with family	New category	8.3	4	16.6	0

went to the sea” (Mr. Sajimon, interviewed in 1989; Mr. Lai, interviewed in 2008). The mangrove Kampong villagers in Singapore have now all been moved to apartments on the mainland, and these residents, along with much of the urban Singapore population are physically distant from natural habitats, so rarely visit them (*sensu* Willits and Luloff 1995). The economic growth experienced in Singapore since the 1970s has propelled its rapid urbanization, and with a large proportion of the land surface now urbanized (Yee et al. 2011), the degree of contact that Singaporeans have with nature has decreased over time, and has been funneled into a smaller number of designated recreational areas, such as parks, that are strictly managed (Henderson 2013).

Historically, the residents of mangrove villages valued the surrounding coastal habitats for their intrinsic cultural benefits. Archival photographs focused strongly on abstract values such as sense of place, aesthetic value, and cultural heritage (Fig. 4), and these values were also prevalent in the oral history interviews; respondents valued the shared cultural knowledge that was passed on by the resident Malay fishermen (Mr. Lai, interviewed in 2008), and landmarks such as shipwrecks and large expanses of mangrove were imprinted in the interviewees’ memories (Mr. Lee, interviewed in 1999; Mr. Lai, interviewed in 2008) and were even used in street naming (“Grove Road,” running from the center of Singapore to Katong road; Mr. Lee, interviewed in 1999). Mangrove wildlife was used in cultural activities such as fish fighting (Mr. Lee, interviewed in 1981), and had a lasting impact on local news and community history; one interviewee made reference to an inhabitant who was eaten by a crocodile (Mr. Lai, interviewed in 2008). The intrinsic values attached to Singapore’s mangroves in the past suggest that this habitat largely had an innate worth. The existence of the ecosystem and the role that it played

in people’s day-to-day lives was sufficient enough to attribute a cultural value to it.

A strong sense of intrinsic value is in contrast to present-day Singapore, where the cultural values that people place on the local mangroves are more instrumental in nature, with contemporary social media photographs focusing on extrinsic values such as recreation and education (though nature photography also contributed to an increase in intrinsic aesthetic value). Interviewees commonly mentioned activities such as education: “I see that the mangroves are more conserved solely for educational purposes,” and recreation: “Mangroves for eco-tourism or recreation.” These cultural values are contingent on the presence of visitors, and many interviewees recognized this by referring to third parties; “These mangroves are for visiting by tourists both local and foreign.” The instrumental cultural values now attached to Singapore’s mangroves are therefore seen as benefits which are accrued by clear user groups (which may or may not include the interviewees), instead of being considered inherently valuable by the interviewees.

Urbanization has made mangrove habitat rare in Singapore (Fig. 1), and this increasingly rare and difficult to access resource is under pressure from a far larger population than in the past (Singapore Department of Statistics 2013). The reduced interaction between the general public and mangroves may have led to them being less strongly associated with cultural heritage and sense of place, as most people do not visit them often. Singaporeans now associate urban architecture, roadway trees, and parks with their national and cultural heritage, as they are likely to experience these more frequently, and due to the modern construct of Singapore as the “City in a Garden”; a government development vision that began in the 1960s, aiming to create a clean (and largely managed) natural environment that improved quality of life by mitigating the “harsh concrete urban environment” (Ng 2008). It is likely

that modern Singaporeans have less direct and daily interaction with natural habitats such as mangroves, so visiting them is likely to be seen as an occasion that is undertaken for a particular purpose; the novelty of the mangrove habitat may be exciting for recreation, or may provide an opportunity for stimulating education. The change in cultural ecosystem services provided by Singapore's mangroves has therefore changed for two reasons that are two sides of the same coin: people have less contact with mangroves so no longer appreciate them intrinsically, and conversely the rarity of mangrove experiences has increased their value for instrumental uses such as recreation and education.

Few previous studies have compared how cultural ecosystem services and values have changed in response to a substantial landscape modification such as urbanization. Previous studies have focused on the changing monetary values of instrumental services due to land cover change at coarse resolutions (Zhao et al. 2004; Tianhong et al. 2010; Su et al. 2012). Other studies have investigated qualitative changes in single cultural ecosystem services, such as a perceived reduction in aesthetic values in response to the construction of offshore windfarms (e.g., Gee and Burkhard 2010). However, these studies have investigated single cultural ecosystem services and not how the *types* of cultural ecosystem service provided have changed in response to landscape modification.

Despite a dearth of studies, we may expect the pattern of change from intrinsic to instrumental values with urbanization and reduced access to apply to other regions and ecosystems, not just mangroves in Singapore, as urban populations become disconnected from nature and access is restricted to designated and managed recreational zones such as parks. An increase in instrumental recreation values may also be driven by broader international increases in interest in outdoor recreation in recent decades (Bengston 1994), reflected in the Singapore context by the more recent publication of reports such as the 2001 URA Parks and Waterbodies Plans, and the first island-wide Leisure Plan in 2008 (Henderson 2013).

Variation in cultural ecosystem service values between different mangroves in the present day

Mangrove patches in Singapore have their own distinct history. One's memories are derived less from "direct personal experiences" but also from the sum of shared memories (Lewicka 2008). As such, derived knowledge of a mangrove is likely to affect its perceptions and usages. Habitat patch location and advertising also determines its accessibility, i.e., the less people know [of the mangroves], the less likely they are to visit it (Wang et al. 2013). The development history and current use of each mangrove site

thus play an important role in the type of values that people place on them.

Berlayer Creek is an elevated mangrove boardwalk trail that is part of the larger Labrador Nature Reserve. Its current use as a nature area in the midst of a dense commercial and residential area has led to it being valued mainly for outdoor recreation and the opportunity to have contact with nature. Berlayer creek has been marketed by the National Parks Board as a key link in the Southern Ridges recreational trail, linking several other terrestrial parks and green spaces along a 10-km stretch. The main focus of the Southern Ridge is to offer recreational, play and event opportunities (Henderson 2013) for "walking enthusiasts, history buffs, shutterbugs, nature lovers, bird watchers, and families looking for a different kind of family outing" (National Parks Board 2015). Particularly for people living in urban environments, such outdoor recreation is a way for them to reap direct benefits of ecosystem services because interactions with natural ecosystems are usually limited (Daniel et al. 2012).

The mangroves at *Chek Jawa* make up one of six unique habitats on an island off the shores of Singapore, Pulau Ubin. Similar to Berlayer Creek, this site is valued mainly for its outdoor recreation and opportunity to connect with nature. Chek Jawa is a well-known nature area that was recommended for reclamation by the government in 2001. However, the government deferred plans for reclamation following public protest. The saving of Chek Jawa is often described as an important milestone in the development of Singapore environmental community. This highlights that Chek Jawa is an important nature area in the hearts of Singaporeans. In addition, it is significant to note that a variety of outdoor activities are held at Pulau Ubin, such as guided nature walks by the National Parks Board and other organizations. Pulau Ubin also offers opportunities for mountain biking and dining. The availability of these recreational facilities may have influenced the types of visitors to Chek Jawa, as people visiting the island for recreational purposes are likely to consider the mangrove as an additional recreational opportunity.

Pasir Ris Mangrove is a 6-ha mangrove forest within the larger Pasir Ris Park, located near residences. Uniquely among the study mangroves, it is valued for the more intrinsic benefits of peace and tranquility, and enjoying time with family. Urban green spaces can attenuate sounds generated outside their area (Irvine et al. 2009), and wooded areas can restore a sense of peace, comfort, and mental and spiritual balance (Hansen-Ketchum et al. 2011). The proximity of the Pasir Ris Mangrove to residences may allow locals to visit more frequently, and therefore to appreciate the more intrinsic benefits that it can provide. Family time, tranquility, and peace may confer a greater sense of place and cultural attachment; it is interesting that

this was the only site where any respondents recorded a sense of place.

Sungei Buloh Wetland Reserve is the only designated wetland nature reserve in Singapore. Its status as a nature reserve is likely to have resulted in greater knowledge among visitors and led them to value it for the opportunity to connect to nature. In addition, increased exposure of Sungei Buloh's status as a nature reserve may have increased the number of visitors visiting it for educational purposes, more so than for the other mangroves. Thus, the knowledge that visitors have about a mangrove plays an important role in determining the value they place on mangroves.

On the whole, outdoor recreation and connecting with nature have been valued most highly by visitors to the four mangroves. Recreation is one of the most highly valued ecosystem services in urban areas, as natural areas within them provide space and opportunities for recreation and physical exercise for unwinding (Breuste et al. 2013; Gómez-Baggethun and Barton 2013). Additionally, green spaces such as mangroves are seen to 'provide form in the human-nature relations for the urban Singaporean' (Yuen 1996); this can be seen from the valued opportunity to connect with nature.

Cultural ecosystem services in a future Singapore

Despite (or because of) rapid urbanization and increasing population density, green spaces have always been important in the urban planning of Singapore. The role of green spaces as the "lungs" of Singapore was acknowledged by the British Colonial Administration in the 1920s (Kong and Yeoh 1996), and there has been a particular planning focus on the provision of parks and manicured streetscapes post-independence. A need to increase the livability of Singapore through the provision of cultural services increased the national Park Provision Ratio from 0.13 ha per 1000 people in 1971 to 0.75 ha per 1000 people in 2010 (Tan et al. 2013). This has had an important impact on local perceptions of the environment and their cultural value: parks and greenery were deemed by Singapore residents to be one of the top 5 most important elements to their quality of life, while 91 % of respondents felt that greenery contributes to Singapore's identity (URA 2010).

Nonetheless, Singapore continues to develop rapidly. Recent national land-use plans (e.g., URA 2013) require the additional reclamation of 5600 ha (Fig. 1), in line with an increase in population from 5.47 million today to potentially 6.90 million by 2030. If realized, this scale of land reclamation may result in the loss of another 33 % of Singapore's current mangrove area (Lai et al. 2015), further limiting public access to just a few designated parks, where interpersonal cultural ecosystem services such as recreation will dominate. Sites in this study such as Chek

Jawa have been slated for reclamation previously and continue to face the risk of reclamation over the medium term (URA 2013). It is clear from this study that Singaporeans value habitats such as Chek Jawa and other accessible mangroves. A better understanding of non-monetary ecosystem services such as cultural and recreational value may help to incorporate natural habitats more strongly into the extensive Singapore planning process, alongside other types of manufactured green space.

As Singapore develops its population sustainably toward becoming a 'City in a Garden' (NPTD 2013), it is important that it creates opportunities for its people to engage with nature in their day-to-day life. Engaging with nature through such outdoor everyday experiences also helps to raise both human and environmental health, and can be achieved through increased access to restorative outdoor places in neighborhoods (Hansen-Ketchum et al. 2011). However, Singapore's green space strategy is focused predominantly on the provision of managed and manicured parks, green spaces, and streetscapes. Mangroves provide an opportunity to engage with a more natural type of green space that in this study has been shown to be valued for multiple cultural ecosystem services. As such, mangroves could play an important role as Singapore further develops into the 'City in a Garden.'

CONCLUSIONS

As Singapore develops, there has been a growing distance between visitors and the mangrove environment and thus a shift from intrinsic to instrumental cultural values. This growing distance between urban residents and the environment has been recognized in other settings, though cultural ecosystem services often provide a connection between green spaces and human well-being in an urban context (Andersson et al. 2014). The intrinsic and instrumental cultural services of mangroves investigated in this study may precisely be the values critical for ecological management, which can no longer progress solely with biophysical knowledge only (Ives and Kendal 2014). In addition, the fact that different mangroves are being valued differently reveals insights into how locals relate to these mangroves. Each mangrove is unique to its visitors, and it is therefore important for ecological managers to recognize the inherent differences of each mangrove, and see each mangrove as a place in itself. This involves understanding the meanings and history associated with each site, and possibly using them as a way of (re)constructing an identity for each mangrove, which may help to rebuild that connection between urban residents and their environment, and thus enhance their well-being.

While the cultural services of mangroves in Singapore have been well regarded through time, be it intrinsic or

instrumental, national- or site-specific, it might be of some concern that the cultural services of mangroves today are predominantly and narrowly perceived as recreation, eco-tourism, and education. While these three cultural services are able to motivate mangrove conservation efforts, they are more instrumental in nature and contingent on the actions of others. This could proliferate the misconception that these three are the only existent cultural values. Creating a deeper understanding of past values through the archival analysis of photographs and oral histories would not only give researchers crucial background information but could also interest people in their local mangrove conservation issues, and thus acts as a conservation tool (Pesch and Garber 2001). Therefore, for more effective protection and conservation activities, the significance of the cultural values of mangroves needs to be highlighted, with a particular emphasis on intrinsic values such as sense of place, inspiration, and cultural heritage.

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