

APPENDIX A. SUPPLEMENTAL TABLES AND FIGURES

(Arranged based on the sequence when citations appear in the main text)

This supporting information presents detailed results from our analysis of Hangzhou-West Lake landscape evolution in the five broad historical periods specified in the main text, as well as evidence supporting our syntheses of cultural and political ecology characteristics. In the study, we have drawn on a broad range of evidence focusing on a variety of different topics, consistent with the breadth of ecosystem services involved over nearly two millennia. We have ordered this presentation of supplemental material to be consistent with the organization of the main body of the paper.

First, information on West Lake area geology describes an important component of the natural environment. Formations in the West Lake area are primarily Paleozoic Era, spanning Silurian to Permian periods (Figure S1), though a more fine-grained evaluation than depicted in the geologic map indicates formations dating to later periods (Mesozoic and Cenozoic, as noted in Table S1 below). Much of the geology is carboniferous or sandstone, both consistent with the coastal location of the lake and adjoining mountains. As described in the main text, much of the soil around the lake and to its east is silt, derived relatively recently from both marine and terrestrial origins. The nature of the sediment that is perpetually deposited in the lake in part reflects the geology of the mountains to the west and southwest. Determinants of the siltation patterns involve several characteristics—topography, soil type and soil (and rock) friability, precipitation patterns, and land use and land cover. Although we lack data to explore lake

siltation beyond the physical presence of sediment that displaces water, the parent material of these sediments clearly can affect water chemistry and, ultimately, the aquatic ecology of West Lake.

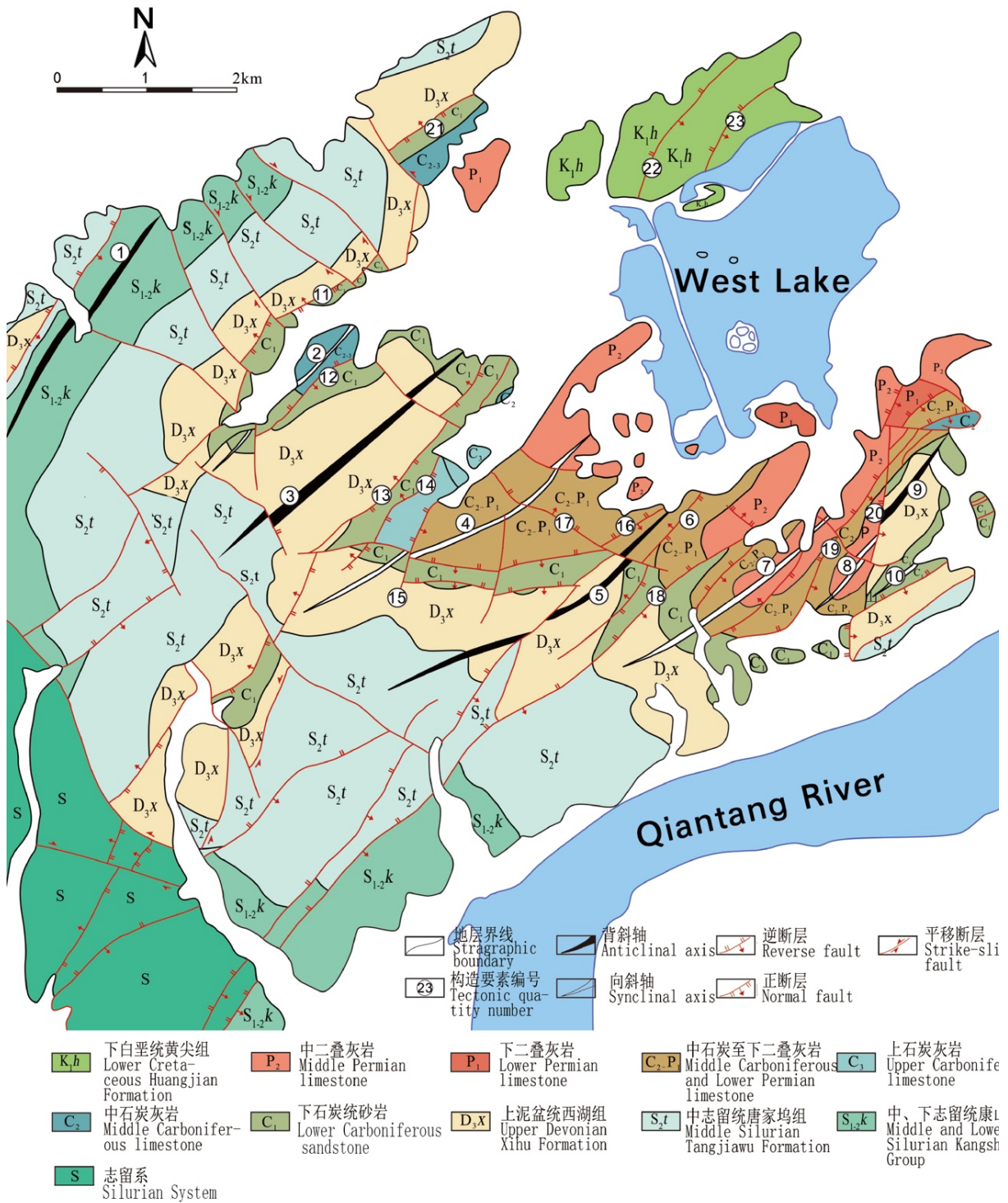


Fig. S1: Geology of the West Lake area (adapted from Fu 2020).

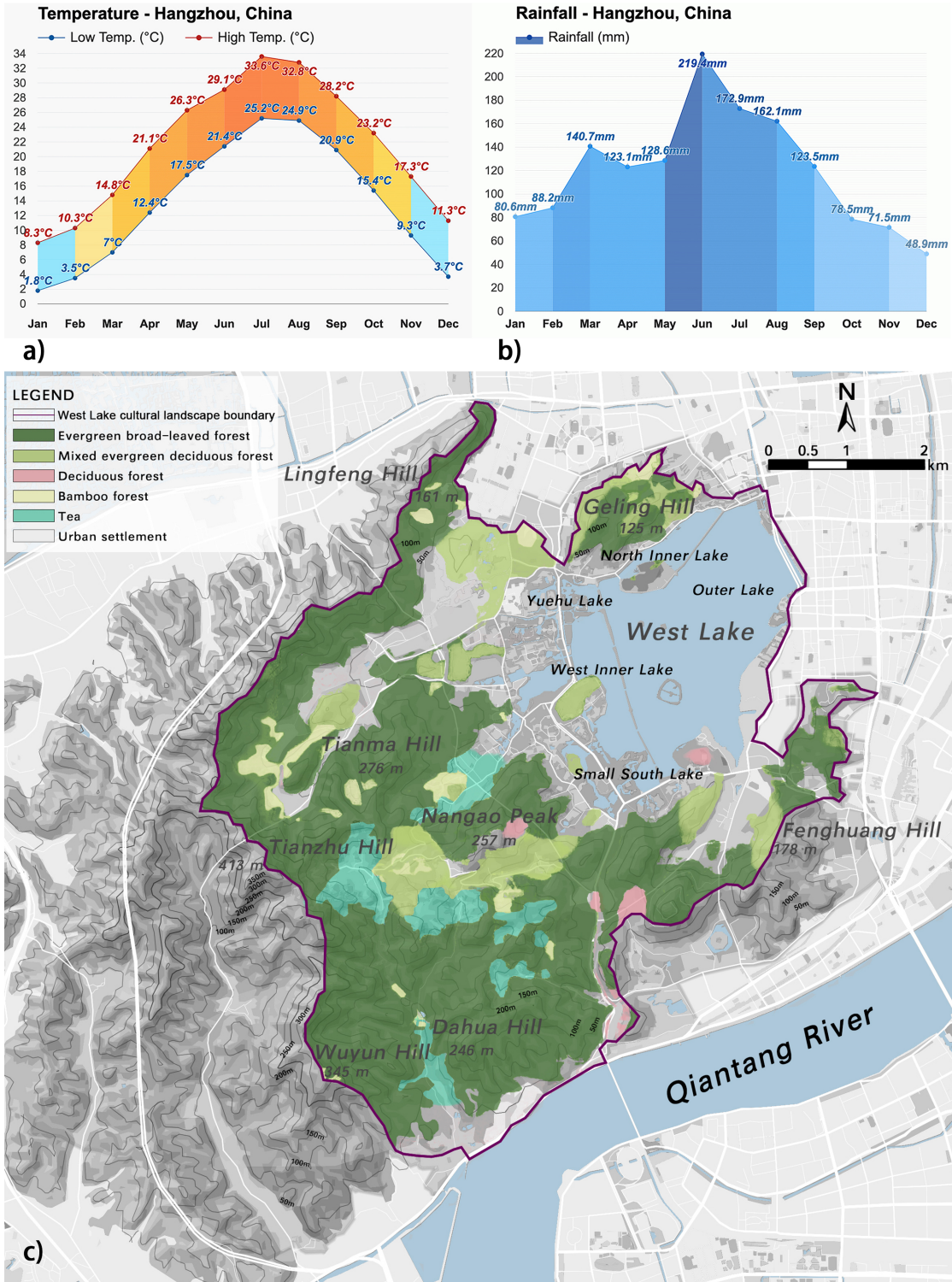


Fig. S2: Temperature (a) and rainfall (b) of Hangzhou, and vegetation types (c) of the West Lake area (Sources: a/b - Hangzhou temperature and rainfall data from <https://www.weather-atlas.com/en/china/hangzhou>; c - Hangzhou West Lake Scenic and Historic Area Management Committee 2002).

The climate of Hangzhou, generally representative of the West Lake area, consists of cool, moderately dry winters and warm, wet summers, the latter particularly characterizing June, July, and August (Figures S2a, S2b). Fall and spring climate generally represent transitions between winter and summer in terms of both temperature and precipitation. Unfortunately, these generalized data do not reveal the possible variability during important periods of the growing season, when reduced precipitation greatly hampers crop production. Such variability, coupled with varying water requirements for different crops, can introduce considerable risk to agriculture, a risk mitigated through the introduction of irrigation. Irrigation also extends growing seasons into drier periods of the year, which is important to meet the subsistence needs of increasing populations such as those of Hangzhou.

Much of the landcover within the West Lake Cultural Landscape is forested, primarily evergreen broad-leafed and mixed evergreen and deciduous forests (Figure S2c). Smaller areas of bamboo forest also occur, along with limited patches of deciduous forest. The cultural landscape also includes human land uses, notably human settlement and tea plantations. Tea occupies a special place in Chinese culture and in the West Lake area, explaining the large amount of land dedicated to producing this crop to the exclusion of others within the cultural landscape. Given the length and intensity of occupation of the West Lake area, the vast majority if not all vegetation in the cultural landscape is successional, though many trees in the forests are several centuries old (State Administration of Cultural Heritage of People's Republic of China 2008).

Table S1 provides additional information on the natural environment of the West Lake Cultural Landscape, in particular placing culturally important localities in their natural environmental contexts. This table divides the landscape components into natural and created

ones, in both aquatic and terrestrial contexts. It also presents poetically named places that involve natural and human-made localities, including the ten poetically named scenic places. Also included are human-made places, many of them representative of religions, important periods in history, and even economic activities (e.g., tea culture). Finally, Table S1 lists vegetation important to the West Lake Cultural Landscape, all of it planned and installed by people but centuries-old and integral parts of this iconic landscape that involves land formations, built infrastructure, and purposefully arranged plants.

Table S1: Critical Elements of the West Lake Cultural Landscape (Source: State Administration of Cultural Heritage of People’s Republic of China 2008).

Type	Components	Year	Geological Age/ Historical Period	Location	Area (m ²)
Natural Components					
Water bodies	Main Lake, West Inner Lake, Small South Lake, Yuehu Lake, North Inner Lake, and Maojiabu	~2600 years ago	Late Holocene Cenozoic Era	Between the southern and northern hills, to the west of Hangzhou	6 500
Southern hills	Wushan Hill, Ziyang Hill, Fenghuang Hill, Jiangtai Hill, Yuhuang Hill, Jiuyao Hill, Nanping Hill, Xizhao Hill, Qinglong Hill, Daci Hill, Dahua Hill, Wuyun Hill, Lion Hill, Tianzhu Hill, Qipan Hill, Nangao Peak, Dingjia Hill, etc.	~250 million years ago	End of the Mesozoic Triassic Era	Hills to the south and southwest of West Lake	—
Northern hills	Gushan Hill, Geling Ridge, Jiangjun Hill, Lingfeng Hill, Beigao Peak, Meiren Peak, Longmen Hill, Feilai Peak, Yuegui Peak, Tianma Hill, etc.			Hills to the west and north of West Lake	—
General Layout (Artificial landscape created from dredging silt)					
Two Causeways	Bai Causeway	822- 824	2 nd - 4 th year of Changqing in Tang Dynasty when BAI Juyi took office in Hangzhou	In the west of West Lake	26 100
	Su Causeway	1090	5 th year of Yuanyou in the Northern Song Dynasty when SU Shi took office as Governor of Hangzhou	In the north of West Lake	96 600

Three Isles	Lesser Yingzhou Isle	936-944	Tianfu period of Later Jin during the Five Dynasties	In the southwest of the Main Lake	76 700
	Mid-lake Pavilion Isle	1090	5 th year of Yuanyou in the Northern Song Dynasty	In the center of the Main Lake	5 200
	Ruangongdun Isle	1809	14 th year of Jiaqing in the Qing Dynasty	In the center of the Main Lake	6 125

Poetically Named Scenic Places
(Combined natural and human-made landscape)

Ten Poetically Named Scenic Places of West Lake Landscape	Su Causeway in the Morning of Spring	1253-1258	Took shape in the Baoyou Period during the Southern Song Dynasty;	At and around Su Causeway	96 600		
	Breeze-ruffled Lotus at Winding Garden			To the west of the northern end of Su Causeway	614		
	Autumn Moon Over the Calm Lake			By lakeside in the southeast corner of Gushan Hill	1 600		
	Lingering Snow on Broken Bridge			At and around the Duanqiao Bridge at the east end of Bai Causeway	26 100		
	Viewing Fish at Flowery Pond			To the west of the south end of Su Causeway	2 500		
	Orioles Singing in the Willows			By lakeside to the north of King Qian's Temple on the east shore of West Lake	5 400		
	Three Pools Mirroring the Moon			1699-1751	matured in the Kangxi and Qianlong Reigns of the Qing Dynasty	The Lesser Yinzhou Isle in the southeast of the Main Lake, and the water area to the south of the Isle	76 700
	Twin Peaks Piercing the Cloud					The two highest peaks in the south and north among the hills west of the lake, and the viewpoint by Hongchun Bridge at the northwest corner of West Lake	—
	Leifeng Pagoda in Evening Glow					At and around Xizhao Hill on the southern shore of West Lake	131 900
	Evening Bell Ringing at Nanping Hill					At and around Nanping Hill on the southern shore of West Lake	39 100

Historical and cultural sites <i>Human-made monuments and sites</i>						
Representative sites of Buddhist Culture	Baochu Pagoda	976	Wuyue Kingdom of Five dynasties	1 st year of Taiping Xingguo period in the Northern Song Dynasty	On the Baoshi Hill on the northern shore of West Lake	800
	The site of Leifeng pagoda	977		2 nd year of Taiping Xingguo period in the Northern Song Dynasty	On the Xizhao Hill on the south bank of West Lake	1 400
	Liuhe Pagoda	970		3 rd year of Kaibao period in the Northern Song Dynasty	On the Yuelun Hill to the north of Qiantang River	12 622
	Jingci Temple	954		1 st year of Xiande in the Late Zhou Dynasty	On the south bank of West Lake	39 100
	Feilailong Peak	951		1 st year of Xianhe period of the Eastern Jin Dynasty	On the south slope of Beigao Hill to the west of West Lake	63 000
	Lingyin Temple	326		1 st year of Guangshun period of Later Zhao	On the south slope of Beigao Hill to the west of West Lake	63 000
Representative sites of Confucian Culture	Yue Fei's Tomb (and Temple)	1221	14 th year of Jiading in the Southern Song Dynasty	On the south slope of Qixia Ridge on the northern shore of the West Lake	288 725	
	Wenlan Pavilion	1782	46 th year of Qianlong's reign of the Qing Dynasty	On the south slope of Gushan Hill	15 842	
Representative sites of Taoist culture	Baopu Monastery	317-420	Eastern Jin Dynasty	On the Geling Hill on the northern bank of West Lake	7 390	
Representative Sites of Historic events	Site of Qiantang Gate	1148	18 th year of Shaoxing in the Southern Song Dynasty	In the north of the eastern shore of West Lake	2 000	
	Site of Temporary Palaces of Qing Dynasty	1705	44 th year of Kangxi's reign of the Qing Dynasty	On the south slope of Gushan Hill	15 700	

Representative Sites of Personages	Stele of Wu-He-Fu Lin Bu's Tomb	1696 1028	35 th year of Kangxi in the Qing Dynasty	On the south slope of Gushan Hill	410
Representative sites of Modern Time	Building Complex of Xiling Engravers Society	1904	30 th year of Guangxu in the Qing Dynasty	The southwest end of Gushan Hill to the north of West Lake	5 758
Representative Sites of Tea Culture	Longjing	220-265	The Three Kingdoms Period	Fenghuang Ridge to the southwest of West Lake	2 000
Characteristic natural flora of West Lake					
Special flowers of the four seasons	Peach in Spring Lotus in Summer Osmanthus in Autumn Plum blossom in Winter	13 th century	Started from Southern Song Dynasty at the latest	Around and on the surface of West Lake	—
Intercropping Peaches and Willows	Su and Bai Causeways and lake shoreline	11 th century	Northern Song Dynasty during SU Shi's time	On the shores of West Lake	—
Longjing Tea Plantation	Longjing, Manjuelong, Jiuxi, Wengjiashan, Yangmeiling, Shuangfeng, Lingyin, and Maojiabu villages	317-420	Eastern Jin Dynasty	Fenghuang Ridge to the southwest of West Lake	2 400 000

Although we discuss West Lake in the main body of the paper as a single entity, culturally and hydrologically it comprises five smaller lakes (Table S2). The locations of these lakes appear above in Figure S2c.

Table S2: Area, volume, and average depths of the five smaller lakes of West Lake (Source: State Administration of Cultural Heritage of People's Republic of China 2008).

Name of smaller lake	Area (m²)	Volume (m³)	Average Depth (m)
Outer Lake	4 399 225	9 066 289	2.06
West Inner Lake	726 350	1 239 148	
North Inner Lake	314 050	490 048	1.56
Yuehu Lake	64 125	70 535	1.10
Small South Lake	89 275	89 275	1.50
Total	5 593 025	133 538	1.97

We examined historic management of West Lake, revealing details on the ecosystem services involved as well as complexities of the challenges underlying decision-making associated with the lake, by examining a broad collection of historical documents (Table S3). Spanning about 1300 years, these documents involve both actions specifically focused on West Lake—for example, dredging and other forms of maintenance—as well as elements indirectly associated with West Lake, such as economic and demographic characteristics of Hangzhou and information on irrigation canals connected to the lake.

Table S3: Historical Documents reviewed.

NO.	Dynasty/ Time	Historical documents		Author
		Chinese	English	
HD1	Tang	《钱塘湖石记》	Stone Record of Qiantang Lake	BAI Juyi
HD2	Song	《杭州乞度牒开西湖状》	Hangzhou Application Document for Dudie to Dredge West Lake	SU Shi
HD3	Song	《申三省起请开湖六条状》	Proposal for Six Rules of Dredging West Lake to Three Provinces	SU Shi
HD4	Song	《乞子圭师号状》	Application Document for Shihao to Zigui	SU Shi
HD5	Song	《淳祐临安志》	Chunyou Lin'an Chronicle	SHI E
HD6	Song	《咸淳临安志》	Xianchun Lin'an Chronicle	QIAN Shuoyou
HD7	Song	《梦梁录》	Menglianglu	WU Zimu
HD8	Yuan	《宋史·河渠志》	River and Canal Records — Song Dynasty History	TUO Tuo et al.
HD9	Ming	《西湖游览志余》	Sequel of West Lake Sightseeing Records	TIAN Rucheng
HD10	Ming	《万历杭州府志》	Wanli Hangzhou Chronicle	CHEN Shan et al.
HD11	Qing	《康熙钱塘县志》	Kangxi Qiantang County Chronicle	WEI Xiu et al.
HD12	Qing	《乾隆杭州府志》	Qianlong Hangzhou Chronicle	ZHENG Yunxiu
HD13	Qing	《西湖志》	West Lake Chronicle	LI Wei
HD14	Qing	《重浚杭城水利记》	Hangzhou Hydraulic Engineering Re-dredging Record	RUAN Yuan
HD15	Qing	《西湖岁修章程全案》	Comprehensive Regulations for West Lake Annual Repair	—
HD16	ROC	《民国杭州府志》	Hangzhou Chronicle in the Republic of China	GONG Jiajun et al.

West Lake rose to modern prominence for its place in Chinese culture, with many features influencing the nation for many centuries, often through their presence in important literature, art, or both. We provide a detailed listing of important named cultural components by period of creation (Table S4). These dozens of localities began attracting large numbers of tourists to West Lake centuries ago. Many form the foundation of modern tourism to West Lake, which we discuss in the main body of the paper, representing the main cultural service of the lake in the twenty-first century.

Table S4: List of poetically named places (Source: State Administration of Cultural Heritage of People’s Republic of China 2008).

Dynasty	Chinese	English
Song (~1239) [10]	苏堤春晓	Spring Dawn at Su Causeway
	曲院风荷	Breeze-ruffled Lotus at Winding Courtyard
	平湖秋月	Autumn Moon over the Calm Lake
	断桥残雪	Lingering Snow on Broken Bridge
	花港观鱼	Viewing Fish at Flowery Pond
	柳浪闻莺	Orioles Singing in the Willows
	三潭印月	Three Pools Mirroring the Moon
	双峰插云	Twin Peaks Piercing the Clouds
	雷峰夕照	Leifeng Pagoda in the Evening Glow
Qing (1722-1735) [Yongzheng Reign, a total of 18]	南屏晚钟	Evening Bell Ringing at Nanping Hill
	功德崇坊	Lofty Archway of Merits and Virtues
	海霞西爽	Xishuang Pavilion West of Gushan Hill and West Lake
	鱼沼秋蓉	Cotton Roses around the Pond in the Autumn
	莲池松舍	Lotus Pond Nunnery
Qing (1722-1735)/ (1736-1796) [13 overlapped between Yongzheng/ Qianlong]	亭湾骑射	Horse Archery by the Pavilion at the Bay
	蕉石鸣琴	Qin Music from Plantain-shaped Rocks
	玉泉鱼跃	Fish at Yuquan Temple
	凤岭松涛	Soughing Pines on Fengling Ridge
	湖心平眺	Level View from Huxin Pavilion
	吴山大观	Terrace on Wushan Hill with a Bird’s View
	天竺香市	Pilgrimage at Tianzhu Temples
云栖梵径	Foot Path Lined by Bamboo Woods	

	韬光观海	Viewing Tides at Taoguang Temple
	西溪探梅	Plum Flowers along Xixi Brook
	湖山春社	Temple of the God of Lake and Hills
	玉带晴虹	Rainbow over Yudai Bridge
	梅林归鹤	Cranes Returning to Plum Wood
	宝石凤亭	Phoenix Pavilion on Baoshi Hill
Qing (1736-1796) [Qianlong Reign, a total of 24]	六和塔	Liuhe Pagoda
	黄龙积翠	Yellow Dragon in Lush Green
	小有天园	Xiaoyoutian Garden
	漪园湖亭	Pavilion on the Pond in Yiyuan Garden
	留余山居	Liuyu Mountain Villa
	篁岭卷阿	Winding Ridge on Fenghuang Hill
	吟香别业	Villa of Lotus Fragrance
	瑞石古洞	Ancient Cave in Ruishi Hill
	香台普观	Fragrance Terrace in Manao Temple
	澄观台	Chengguan Terrace
	述古堂	Shugu Hall
PRC (1985) [10]	云栖竹径	Bamboo-lined Path at Yunqi
	满陇桂雨	Osmanthus Fragrans at Manjuelong Village
	虎跑梦泉	Hupao Temple and Spring
	龙井问茶	Drinking Tea at Longjing Temple
	九溪烟树	Nine Creeks in Misty Forest
	吴山天风	Heavenly Wind over Wu Hill
	阮墩环碧	Ruangong Islet Submerged in Greenery
	黄龙吐翠	Yellow Dragon in Lush Green
	玉皇飞云	Clouds Scurrying over Yuhuang Hill
	宝石流霞	Baoshi Hill Floating in Rosy Clouds
PRC (2007) [10]	灵隐禅踪	Lingyin Temple
	六和听涛	Liuhe Pagoda
	岳墓栖霞	Colorful Clouds Resting over General Yue's Mausoleum
	湖滨晴雨	Sunny and Rainy Sceneries at the Lakeside
	钱祠表忠	Qianliu Temple of Loyalty Memorial
	万松书院	Wansong Academy
	杨堤景行	Moving Scenery along Yang Causeway
	三台云水	Misty Waters around Santai Hill
	梅坞春早	Early Spring in Meijiawu Tea Village
	北街梦寻	Reminiscing History and Culture in Beishan Street

As a source of ecosystem services, West Lake is of particular interest in part due to its creation largely by human actions and in part due to its reliance on consistent maintenance. Much of the latter involves dredging to remove sediment that natural processes continually wash into the lake from the mountains to the west and southwest. Both the frequency and magnitude of dredging are noteworthy, as documented in detail in Table S5. This table also lists other activities associated with maintaining West Lake, as well as policies that guided various actions to sustain the body of water. Ultimately, what West Lake *was* (and *is*) and how it functioned relied on human intervention that was guided by leaders at varying levels of government as well as processes of negotiating among various competing factions. These decisions, and the actions that followed, had enormous implications for the economy and the culture of the West Lake area.

Table S5: Details of large-scale dredging projects, associated costs, and major management policies over time (Sources: Zheng 2010; also see historical documents HD1-HD6, HD8, HD10-HD16 in Table S3).

Notes: * “Guan (贯)”/“Min (缗)” was equivalent to 1 000 copper coins in Song Dynasty; † “Dudie (度牒)” was a state-issued certification issued to those who had been lawfully recognized as monks and nuns; it was employed by the Song government as a special currency tool to address fiscal deficit.

Dynasty	Date	Official	Actions	Policies	Dredging Time/Labor/Monetary Costs
Tang (618-907)	766-779	LI Mi	Dug six well-reservoirs to draw West Lake water to the city	—	—
	~822	BAI Juyi	1. Repaired six well-reservoirs 2. Built Bai Causeway to increase water storage 3. Built sluice gates to regulate water level	1. Specified detailed plan for irrigation water release 2. Allowed residents to apply for water release during droughts 3. Regulated inspection of water infrastructure 4. Lawbreakers required to plant trees or remove <i>Zinania latifolia</i> fields around West Lake	—
FDTK (907-979)	927	QIAN Liu	Established a lake-dredging team with ~1 000 soldiers	—	Annual dredging for 51 years with ~1000 soldiers
	932	QIAN Yuanguan	1. Dredged Yongjin Pond to connect the Grand Canal 2. Drew lake water into the city for water transportation	—	—

Song (960-1279)	1007	WANG Ji	1. Dredged the lake 2. Built sluice gate for flood control 3. Carved BAI Juyi's poem <i>Qiantanghushiji</i> on the stone beside West Lake	Followed BAI Juyi's policies	—
	1020	WANG Qinruo	—	Fishing and hunting were prohibited	—
	1042	ZHENG Ji	Dredged the lake	—	>10 000 people from surrounding counties
	1060	SHEN Gou	Dug Shengong Well in the south to increase drinking water supply	Fishing and hunting were prohibited	—
	~1073	CHEN Xiang	Repaired six well-reservoirs and Shengong Well; replaced bamboo water pipes with brick ones	—	—
	1089-1090	SU Shi	1. Dredged the lake 2. Built Su Causeway with the silt from the <i>Zinania latifolia</i> fields 3. Cleared <i>Zinania latifolia</i> fields for water transportation 4. Repaired six well-reservoirs 5. Connected West Lake and Yanqiao canal to support water transportation	1. Employed people who lost jobs instead of outright grant 2. Prohibited renting of West Lake water bodies for planting; however, areas where <i>Zinania latifolia</i> grew can be rented for <i>Trapa incisa</i> planting to encourage <i>Zinania latifolia</i> removal 3. Used taxes from <i>Trapa incisa</i> fields to pay for dredging every year 4. Established a bureau for regular lake management (<i>Kaihusi</i>)	Six months ~200 000 person-time 10 000 <i>Min</i> *, 760 tons of rice and 100 <i>Dudie</i> [†]
	1139	ZHANG Cheng	Had a lake-dredging team with 200 soldiers	Punished people who occupied the lakeshore for farming	—
	1149	TANG Pengju	Dredged the lake and repaired six well-reservoirs; added sluice gate to control water level	Punished people who occupied the lakeshore with <i>Zinania latifolia</i> and <i>Trapa incisa</i> plantings	Regular dredging with ~200 soldiers
	1165-1173	ZHOU Cong	1. Dredged the lake 2. Repaired six well-reservoirs, following SU Shi's method	1. Prohibited activities that pollute the lake (e.g., bathing horses, laundering clothes) 2. Punished people who occupied the lakeshore with <i>Zinania latifolia</i> and <i>Trapa incisa</i> plantings	Regular dredging with ~100 soldiers
	1173	SHEN Du	People planted <i>Zinania latifolia</i> around <i>Nelumbo nucifera</i> fields, and the government removed the <i>Zinania latifolia</i> plantings	Planting <i>Zinania latifolia</i> was prohibited	—
1185-1189	ZHANG Biao	1. Repaired six well-reservoirs and three sluice gates, following ZHOU Cong's method	—	—	

			2. Punished an official who occupied part of the lake and built pavilions		
	1247	ZHAO Yugui	1. Dredged the lake and removed all the <i>Trapa incisa</i> and <i>Nelumbo nucifera</i> fields to clean up the well-reservoirs inlet 2. Drew water from Tianmu Mountain to West Lake when the lake dried up	Boats were prohibited from entering the water inlet area to prevent pollution	30 000 Guan*
	1270	QIAN Shuoyou	1. Dredged the lake 2. Built the Chengshui sluice gates to prevent trash/debris from entering West Lake 3. Replaced brick water pipes with stone ones	—	—
	1265-1274	BAO Du	Punished officials for illegal occupation and polluting the lake while bathing horses	—	—
Yuan (1271-1368)	Due to groundwater becoming potable and increasing reliance on underground wells for drinking water, the six well-reservoirs and Shengong well became less important, without any records of their repairment.				
	No records of dredging could be found in Yuan Dynasty. Powerful people occupied the lakeshore and planted <i>Zinania latifolia</i> and <i>Nelumbo nucifera</i> . The western part of the lake became a wetland.				
Ming (1368-1644)	(Early Ming Dynasty) Citizens and temples occupied the lake; area to the west of Su Causeway and west and south banks of the inner lake became pools, farmland, and mulberry stands. Lack of water threatened fishermen's livelihood. (1370) City government started to collect high taxes from people who occupied the lake, which turned out ineffective in reducing illegal occupation. (1426-1449) Suggestions to dredge the West Lake were shelved, and powerful people hindered dredging.				
	1456	SUN Yuanzhen	After a prolonged period when privileged classes hindered dredging for their own benefits, SUN suggested to the central government to repair the two sluice gates for water storage, restart dredging, and prohibit powerful people from occupying the lake	—	—
	1474	HU Jun	Small-scale dredging in outer lake	—	—
	1475	LIYI,NING Liang,YANG Xuan	1. Built watergate to draw lake water to the city 2. Built flashboard at outer bridge to increase water storage and prevent flooding	—	—
	1481	LIU Zhang,YANG Zongji,LIANG Wanzhong	Reclaimed illegally occupied lake area	—	—
	1483	LIU Fu	Reclaimed illegally occupied lake area	—	—
	1499	WU Yiguan	Built stone weir for water level control	—	—
	1508	YANG Mengyin	1. Dredged the lake within 180 days 2. Removed ~2.27 km ² of farmland within/around lake 3. Cleared ~9 500 000 m of <i>Zinania latifolia</i> fields	1. Inventoried and legalized farmlands for continued operation 2. Inventoried all illegally occupied land	152 days 6 700 000 person-time

			4. Repaired SU Causeway and planted willows 5. Built Yanggong Causeway and planted willows	for reclamation by the government 3. Compensated people who returned their occupied land 4. Punished anyone who hindered the reclamation of illegally occupied land	23 000 taels of silver (1 tael = 50 grams) Source of funds: Central Government
	1539	FU Fengxiang	Reclaimed illegally occupied lake area	—	—
	1565	PANG Shangpeng	Carved management regulations on steles at the three gates of the city	Prohibited occupation of West Lake	—
	1607	NIE Xintang	1. Dredged the lake 2. Followed SU Shi's method and used the silt from dredging to build an islet in the middle of the lake	Designated West Lake as a "Free Life Pond"	—
Qing (1644-1912)	1654	ZHANG Ruxiu	1. Reclaimed illegally occupied lake area 2. Removed ~ 0.053 km ² of <i>Zinania latifolia</i> fields	Requested occupied land to be returned to the government	—
	1724	LI Wei, WANG Jun	Developed detailed construction plans to: 1. Dredged 2.08 km ² of hardened sandy areas and <i>Zinania latifolia</i> fields 2. Raised and repaired the Su Causeway with dredging silt	1. Waived taxes from farmers whose occupied lands were reclaimed by the government 2. Allowed people with economic trees (e.g., mulberries and Chinese tallow) to choose transplant locations as they wished 3. Ensured an extensive and functional irrigation system from Hangzhou to Haining County 60km away to the northeast 4. Encouraged farmers to assist dredging the silted irrigation canals with compensation in wintertime 5. Budgeted 42 742 taels of silver for dredging; used unspent fund (5 113 taels of silver) for farmland acquisition; designated resultant rent and taxes as annual dredging funds	1 year and 11 months >10 000 personnel 37 629 taels of silver; Source of funds: WANG Jun's donation
	1727	—	1. Built four sluice gates and a rolling dam in Jinshagang; designated two rolling-dam operators 2. Raised grass carp to control <i>Zinania latifolia</i> growth	Kept fish farming in the inner lake where fishing was forbidden; permitted fishing in the outer lake	—
	1757	YANG Tingzhang	1. Surveyed the West Lake 2. Reclaimed land obstructing water flows 3. Dredged silted areas only	Collected rents from occupied lands exempted from reclamation as funds for annual dredging	—

			4. Carved “no illegal occupation” rules on steles at four banks		
	1774-1775	SAN Bao	Dredged the lake	Budgeted 11 000 taels of silver for dredging; designated unspent fund (1 440 taels of silver) for annual dredging later	7 months 9 561 taels of silver
	1804-1805	RUAN Yuan	1. Dredged the lake 2. Installed sluice gate for water level control 3. Followed SU Shi’s method and used silt from dredging to build a small islet in the lake for boats to dock	Required dredging to occur annually in November	10 months 4 800 taels of silver; Source of funds: donations from RUAN Yuan, other officials, gentries, and merchants
	1815	YAN Jian	Appointed officials familiar with water conservation projects to construction	Employ people who lost jobs instead of outright grant	3 months >1000 low-income residents 40 000 taels of silver; Source of funds: donations from gentries and interests of loans from merchants
	1829-1843	LIU Binshi	1. Dredged West Lake every year. 2. (1837) Raised grass carp to control <i>Zinania latifolia</i> growth 3. Repaired two dams and Bai Causeway	1. Established West Lake dredging bureau 2. Formed government-resident cooperation in dredging projects 3. (1837) Prohibited farming around Su Causeway and grazing around West Lake 4. Kept fish farming in the inner lake; its revenue paid to ~200 fishermen families 5. Assessing dredging salary by boatloads of dredged silt	14 years (1837) ~5000 personnel 45 000 taels of silver; Source of funds: donation from former governor SHUAI Xianzhou and interests
	1864	XUE Shiyu, LI Guoxian	Dredged the lake	—	—
	1865	JIANG Yili	Dredged the lake	—	—
	1867	LI Hanzhang	Dredged the lake	—	—
	1876	YANG Changjun, LIU Dongsheng	Dredged the lake	—	1 year
ROC (1912-1949)	1917	Hangzhou engineering bureau	Dredged the lake	—	—
	1928	Hangzhou municipal engineering bureau	Dredged the lake	—	30 workers
	1938	Dredging team	Dredged the lake	—	1 boat

	1945-1949	Hangzhou municipal engineering bureau	Dredged the lake	—	10 workers and 30 boats (all designated for dredging)
PRC (1949-present)	1952-1958	Hangzhou government	1. Dredged 7.19 million m ³ of silt; average lake depth reached 1.81 m, and water storage reached 10.27 million m ³ 2. Large-scale afforestation.	Employed people who lost jobs instead of outright grant	6 years (1952) 800-person dredging team; (1956) 7000 volunteers, 40 000 person-time in total 4.38 million RMB; Source of funds: Central Government
	1978-1982	Hangzhou government	Cleared 188 400 m ³ of silt	—	5 years Machines 2 million RMB; Source of funds: Central Government
	1985-1986	Hangzhou government	Drew 120 million m ³ of water annually from Qiantang River to the West Lake to improve water quality	—	20 months 11.69 million RMB
	1999-2003	Hangzhou government	Cleared 3 469 000 m ³ of silt; lake depth increased from 1.65 m to 2.27 m; water capacity increased from 9.34 to 14.29 million m ³	Part of a nationwide 200-billion-RMB urban infrastructure plan by the Central Government to expand domestic demand	4 years Machines 235 million RMB

The cultural ecology of and associated economic activities around West Lake changed over time, depending in part on management of the aquatic resources and in part on broader political and economic interests. We list crops grown in the vicinity of West Lake—around the lakeshore and in nearby hills to the west and southwest of the lake—from Pre-Sui times to the present (Table S6). Although certain consistency occurs over time for most periods, crops produced do vary, presumably in response to local demand as well as broader economic patterns (such as the changing role of Hangzhou as a center of silk production, influencing the level of mulberry production). We also list information on fish species present in West Lake, based on two surveys in the twentieth century (1930-1931 and 1983; Table S7). Detailed information on fish species present was unavailable for earlier periods. We lack data to specify species

documented in the surveys that were economically important at the time of those data collection efforts, though many would have been used for food. As a final more detailed look at lake resources, we list policies and management activities during the Republic of China (ROC) and the People’s Republic of China (PRC) periods (Table S8). Available data reveal dramatically different management strategies, including fish farming, and similarly dramatic contrasts in the amounts of fish harvested. The information in Table S8 demonstrates the wide-ranging potential of West Lake as a source of protein, with reasonably large amounts possible when managed for that purpose.

Table S6: Crops historically grown in Hangzhou (Sources: Zhou 1997a and 1997b; also see historical documents HDs 6, 10, 12, and 16, Table S3)

Note: Mulberries were grown primarily around the lake and at the foot of the hills, rice in Renhe County to the north and Haining County to the northeast. Other crops, including beans, other grains, and vegetables) were primarily grown outside of the east city wall.

Dynasty	Crops	References
Pre-Sui	Rice (<i>Oryza sativa</i> Linn.)	Zhou 1997a
	Mulberry (<i>Morus alba</i> L.)	
	Ramie [<i>Boehmeria nivea</i> (L.) Gaudich.]	
Tang	Rice (<i>Oryza sativa</i> Linn.)	Zhou 1997b
	Mulberry (<i>Morus alba</i> L.)	
	Ramie [<i>Boehmeria nivea</i> (L.) Gaudich.]	
	Tea [<i>Camellia sinensis</i> (L.) O. Ktze.]	
Song	Rice (of various cultivars) (<i>Oryza sativa</i> Linn.)	HD6, Table S3
	Wheat (<i>Triticum aestivum</i> L.)	
	Sesame (<i>Sesamum indicum</i> Linn.)	
	Beans (of various cultivars) (<i>Leguminosae</i>)	
	Millet [<i>Setaria italica</i> (L.) Beauv.]	
	Mulberry (<i>Morus alba</i> L.)	
	Ramie [<i>Boehmeria nivea</i> (L.) Gaudich.]	
	Tea [<i>Camellia sinensis</i> (L.) O. Ktze.]	
Vegetables (of various cultivars)		
Yuan	—	—
Ming	Rice (of various cultivars) (<i>Oryza sativa</i> Linn.)	HD10, Table S3
	Millet [<i>Setaria italica</i> (L.) Beauv.]	
	Wheat (<i>Triticum aestivum</i> L.)	

	Sesame (<i>Sesamum indicum</i> Linn.)	
	Soybean [<i>Glycine max</i> (Linn.) Merr.]	
	Mulberry (<i>Morus alba</i> L.)	
	Tea [<i>Camellia sinensis</i> (L.) O. Ktze.]	
	Vegetables (of various cultivars)	
Qing	Rice (of various cultivars) (<i>Oryza sativa</i> Linn.)	HD12, Table S3
	Wheat (<i>Triticum aestivum</i> L.)	
	Millet [<i>Setaria italica</i> (L.) Beauv.]	
	Beans (of various cultivars) (<i>Leguminosae</i>)	
	Sesame (<i>Sesamum indicum</i> Linn.)	
	Mulberry (<i>Morus alba</i> L.)	
	Tea [<i>Camellia sinensis</i> (L.) O. Ktze.]	
ROC	Rice (of various cultivars) (<i>Oryza sativa</i> Linn.)	HD16, Table S3
	Millet [<i>Setaria italica</i> (L.) Beauv.]	
	Wheat (<i>Triticum aestivum</i> L.)	
	Beans (of various cultivars) (<i>Leguminosae</i>)	
	Mulberry (<i>Morus alba</i> L.)	
	Tea [<i>Camellia sinensis</i> (L.) O. Ktze.]	
	Vegetables (of various cultivars)	

Table S7: Fish surveys in ROC (1930-1931) and 1983 (Sources: Zhu 1932; Hangzhou West Lake Scenic and Historic Area Management Committee 2002).

#	Family	Genus	Scientific Name	1932	1983
Cypriniformes					
1	Cyprinidae	<i>Mylopharyngodon</i>	<i>Mylopharyngodon piceus</i>	Yes	Yes
2		<i>Ctenopharyngodon</i>	<i>Ctenopharyngodon idella</i>	Yes	Yes
3		<i>Opsariichthys</i>	<i>Opsariichthys bidens</i>	Yes	Yes
4		<i>Elopichthys</i>	<i>Elopichthys bambusa</i>	No	Yes
5		<i>Phoxinus</i>	<i>Phoxinus lagowskii variegatus</i>	Yes	No
6		<i>Aphyocypris</i>	<i>Aphyocypris chinensis</i>	Yes	Yes
7		<i>Xenocypris</i>	<i>Xenocypris argentea</i>	Yes	No
8		<i>Xenocypris</i>	<i>Xenocypris davidi</i>	No	Yes
9		<i>Xenocypris</i>	<i>Xenocypris microlepis</i>	No	Yes
10		<i>Distoechodon</i>	<i>Distoechodon tumirostris</i>	Yes	Yes
11		<i>Pseudobrama</i>	<i>Pseudobrama simoni</i>	No	Yes
12		<i>Abbottina</i>	<i>Abbottina rivularis</i>	Yes	Yes
13		<i>Pseudorasbora</i>	<i>Pseudorasbora parva</i>	Yes	Yes
14		<i>Squalidus</i>	<i>Squalidus nitens</i>	Yes	Yes
15		<i>Parabramis</i>	<i>Parabramis terminalis</i>	Yes	Yes
16		<i>Parabramis</i>	<i>Parabramis pekinensis</i>	No	Yes

17		Megalobrama	<i>Megalobrama amblycephala</i>	No	Yes
18		Chanodichthys	<i>Chanodichthys erythropterus</i>	Yes	Yes
19		Chanodichthys	<i>Chanodichthys dabryi</i>	No	Yes
20		Chanodichthys	<i>Chanodichthys mongolicus</i>	No	Yes
21		Hemiculter	<i>Hemiculter leucisculus</i>	Yes	Yes
22		Toxabramis	<i>Toxabramis swinhonis</i>	Yes	Yes
23		Rhodeus	<i>Rhodeus sinensis</i>	No	Yes
24		Rhodeus	<i>Rhodeus ocellatus</i>	Yes	Yes
25		Acheilognathus	<i>Acanthorhodeus chankaensis</i>	Yes	Yes
26		Cyprinus	<i>Cyprinus carpio</i>	Yes	Yes
27		Carassius	<i>Carassius auratus</i>	Yes	Yes
28		Carassius	<i>Carassius cuvieri</i>	No	Yes
29		Carassius	<i>Carassius gibelio</i>	No	Yes
30		Hypophthalmichthys	<i>Hypophthalmichthys molitrix</i>	Yes	Yes
31		Aristichthys	<i>Hypophthalmichthys nobilis</i>	Yes	Yes
32	Cobitidae	Misgurnus	<i>Misgurunus anguillicaudatus</i>	Yes	Yes
Siluriformes					
33	Siluridae	Silurus	<i>Silurus asotus</i>	Yes	Yes
34	Bagridae	Pelteobagrus	<i>Pelteobagrus fulvidraco</i>	Yes	Yes
35	Ariidae	Cryptarius	<i>Cryptarius truncatus</i>	No	Yes
Gobiiformes					
36	Oxudercidae	Rhinogobius	<i>Rhinogobius giurinus</i>	Yes	Yes
37	Eleotridae	Micropercops	<i>Micropercops swinhonis</i>	Yes	Yes
38		Odontobutis	<i>Odontobutis obscura</i>	Yes	No
Beloniformes					
39	Adrianichthyidae	Oryzias	<i>Oryzias sinensis</i>	Yes	Yes
40	Hemiramphidae	Hyporhamphus	<i>Hyporhamphus sajori</i>	No	Yes
Synbranchiformes					
41	Mastacembelidae	Macrognathus	<i>Mastacembelus aculeatus</i>	Yes	Yes
42	Synbranchidae	Monopterus	<i>Monopterus albus</i>	Yes	Yes
Anguilliformes					
43	Anguillidae	Anguilla	<i>Anguilla japonica</i>	Yes	Yes
44			<i>Anguilla marmorata</i>	No	Yes
Anabantiformes					
45	Channidae	Channa	<i>Ophicephalus argus</i>	Yes	Yes
46	Osphronemidae	Macropodus	<i>Macropodus chinensis</i>	Yes	Yes
Clupeiformes					
47	Engraulidae	Coilia	<i>Coilia nasus</i>	No	Yes
Total number of species				32	44

Table S8: Management of plant and animal resources in ROC and PRC (Sources: Hangzhou Garden Administration of Zhejiang Province 1974; Shi 1995; Hangzhou West Lake Scenic and Historic Area Management Committee 2002; Wang 2004a; Xu et al. 2013).

Year	Resource type/species	Amount	Policy/Management	Source
ROC	Fish	~20 tons	—	Hangzhou Garden Administration of Zhejiang Province 1974
1949		—	National policy encouraged productive landscapes; License required for harvesting fish or plant (<i>Nelumbo nucifera</i> , <i>Brasenia schreberi</i>) resources	Wang 2004a
1959	Fish	—	West Lake fish farm established in 1959; Dredged lake in 1954-1958 to facilitate fish farming; Stopped applying fertilizer and feed after one year due to water quality concerns	Wang 2004a
1965	Beijing white duck	250	Stopped planting <i>Brasenia schreberi</i> later because of management difficulties	Wang 2004a
	<i>Nelumbo nucifera</i> , <i>Trapa incisa</i> , <i>Brasenia schreberi</i>	Planted 0.2 km ² in total area; ~500kg annual yield of <i>Brasenia schreberi</i> ; ~200kg annual production of lotus root starch		
1959-1972	Fish	A total of 6 130 tons (i.e., >400 tons average annual yield)	Explored fish farming methods to balance scenic protection (esp. <i>Nelumbo nucifera</i> sceneries)	Wang 2004a
1980	<i>Bellamya quadrata</i>	Bred in large numbers	Started to control fish amount, change species structure, and implement scientific methods of fish farming	Wang 2004a
	<i>Nelumbo nucifera</i>	Planted 3.3 km ² in total area		
1981	Snail (<i>Sinotia quadrata</i>)	>20 tons	All raised to improve water quality	Wang 2004a
	Mussel (<i>Unionidae</i>)	10 tons		
	Ricefield eel (<i>Monopterus albus</i>)	0.245 tons		
	water grass (<i>Vallisneria natans</i>)	25 tons		
1984	Fish		Regulation by Hangzhou municipal administration of landscape and cultural relics: annual fish harvest cannot exceed 300 tons	Shi 1995
1959-1988	Fish	~311 tons (average annual yield)		Shi 1995

2002	Fish	~300 tons annually		Hangzhou West Lake Scenic and Historic Area Management Committee 2002
2013	Fish	~250 tons annually		Xu et al. 2013

Finally, we present data on the magnitude of tourism for West Lake and Hangzhou between 1999 and 2019 (Figure S3). Data show impressive though reasonably steady tourist figures for West Lake during this period. They also reveal enormous growth in Hangzhou tourism over the same two decades, along with tourism revenue. Even if the lake itself is not visited, the main attraction for Hangzhou tourists appears to be West Lake. Seen as a cultural ecosystem service, based largely on the significant contributions of West Lake and surrounding localities to Chinese culture, the draw of enormous numbers of people has transplanted the contributions of all other ecosystem services in assessing the importance of this human-made, heavily managed aquatic resource.

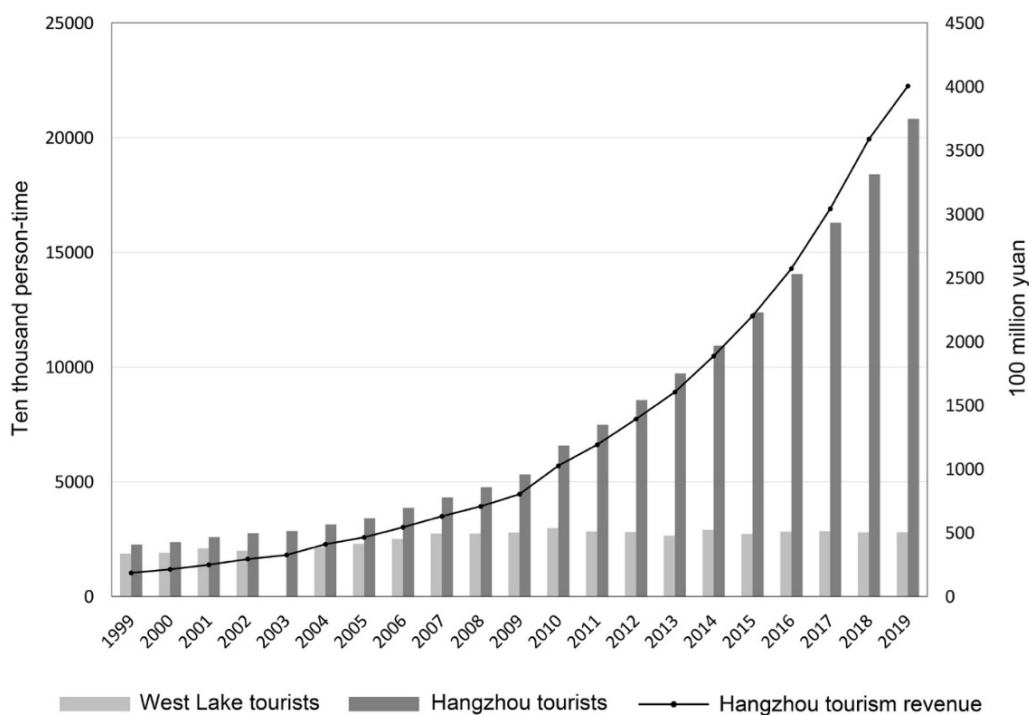


Fig. S3: Tourist visitations to West Lake and Hangzhou (1999-2019) (Source: Local Chronicle Office of Hangzhou Municipal Government n.d.)

Note: West Lake tourists data in 2003 was unavailable. 1 Yuan = 0.16 US Dollar (Dec. 2021).

References for Apx. A:

- 1 . Fu, *On the geological landscapes heritages and their significances of West Lake and its surrounding area in Hangzhou*, 2020, 66(02): 475-484.
- 2 . Hangzhou Garden Administration of Zhejiang Province, *Overview of West Lake fish farming*, 1974, 4:2-4.
- 3 . Hangzhou West Lake Scenic and Historic Area Management Committee, *2002-2020 Hangzhou West Lake Scenic and Historic Area Master Plan basic data*, 2002.
- 4 . Local Chronicle Office of Hangzhou Municipal Government, *Hangzhou yearbook (1987-2020)*: <http://hzzsfzg.wf.sh.cn/yearbook/init.html#content> (accessed 10 March 2022).
- 5 . Shi, *Chronicle of West Lake*. Shanghai: 1995.
- 6 . State Administration of Cultural Heritage of People's Republic of China, *West Lake Cultural Landscape of Hangzhou*, Beijing, 2008.
- 7 . Wang (Eds) , *West Lake Literature Collection (volume 12)*, Hangzhou, 2004.
- 8 . Xu, Zhao, Wu, Li, and Wu, *Evaluation on ecosystem service value of West Lake in Hangzhou*, 2013, 24(03):436-441.
- 9 . Zheng, *Research on the governance history of West Lake in Hangzhou*, Hangzhou2010..
- 10 .Zhou (Eds), *Ancient Hangzhou before Southern and Northern Dynasties*, Hangzhou,1997a.
- 11 .Zhou (Eds), *Famous county Hangzhou in Sui and Tang Dynasties*, Hangzhou, 1997b.
- 12 .Zhu, *Fishes of the West Lake*, Hangzhou, 1932.