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Introduction: big is beautiful

P. A. KEDDY
Southeastern Louisiana University

L. H. FRASER
Thompson Rivers University

This book actually requires no introduction. The title says it all. You may therefore safely turn to the chapters dealing with each wetland. If you are curious about the tale behind the title, and wish to read further here, the tale is largely the search for scientific and conservation priorities. To succeed at scientific research or conservation action, clear priorities must be set – there are always vastly more scientific questions, and vastly more conservation problems, than humans can solve. One way to prioritize is by size: if we can identify the big scientific problems or the big conservation issues, we can address them first. This may appear self-evident, but often it seems that it is not.

No two editors can restructure conservation bureaucracies or scientific communities. However, a clear snapshot of the state of global wetlands, could, we believe, have such an effect. By highlighting all the world's largest wetlands in one book – wetlands that range across ecosystem types, international boundaries, and styles of research – we aspire to nudge all areas of wetland ecology and conservation biology back towards a common view and a common purpose. This purpose would include documenting the patterns in wetlands, unraveling the mechanisms behind these patterns, describing functions that extend beyond the borders of wetlands, predicting future consequences of human manipulation, and ensuring that the world's wetlands are protected and managed within a global context.

When we held our first symposium in Quebec City in 2000 (with start-up funds courtesy of the US Department of Agriculture (USDA) and the Society of Wetland Scientists), there was standing room only, suggesting that our fellow

The World's Largest Wetlands: Ecology and Conservation, eds. L. H. Fraser and P. A. Keddy.

professionals recognized the need for such an overview. Five years later, there is this book. We hope that it will further encourage and inspire those individuals who share our view, and that it will prove useful in guiding global conservation activities. Large wetlands deserve equivalent global status with frontier forests (Bryant *et al.* 1997) and biodiversity hotspots (Myers 1988, Myers *et al.* 2000).

This volume is not intended to be a book on the principles of wetland ecology. Such books already exist. They provide the context for this book on large wetlands. Some existing books focus on general principles, and explore how these recur in different types of wetlands (Keddy 2000). Some focus on a specified region, like North America, and address the major wetland types in turn (Mitsch & Gosselink 2000). Some global compendia strive for comprehensiveness (Whigham *et al.* 1992). Other books use a single issue, such as function, as a theme for exploring many habitats, including wetlands (de Groot 1992). All of these approaches have value. We do not intend to repeat them. Nor will we use this introduction to review wetland ecology; that is the purpose of the preceding books. In this volume we want to focus on size, function, and conservation significance.

Why size matters

Why does size matter? Schumacher (1973) entitled his now classic book *Small is Beautiful*. He was examining economic development, "economics as if people mattered." In the realm of ecology, we beg to differ with Schumacher's title; here *large* is beautiful. Most wetland functions (Table 1.1) increase with area. Some, such as oxygen production or fish production (Fig. 1.1), may be directly proportional to area. Another, such as carbon sequestration, will be a function of area times depth. Other functions have more-complex relationships – species richness ("biodiversity") generally increases with area as c(area)^z where z is an exponent usually less than 3.0 and c is a constant (Fig. 1.2). Whatever the research and conservation goal, be it basic understanding of global carbon cycles or the design of global nature reserve systems, area therefore demands attention. Functions will then further vary locally with climate, biogeographic realm, topographic heterogeneity, substrate type, and season.

A provisional list of the world's largest wetlands was compiled in the late 1990s and was published in Keddy (2000). Then, as now, we have accepted credibly published estimates of area, recognizing that such published estimates include different kinds of assumptions, techniques, and accuracy. Although there is room for debate about what kinds of plant communities belong in the category of wetland, we suspect that problems of definition were not a serious source of error,

Table 1.1 *Functions that may be performed by natural environments including wetlands (from de Groot 1992).*

Regulation functions
1. Protection against harmful cosmic influences
2. Regulation of the local and global energy balance
3. Regulation of the chemical composition of the atmosphere
4. Regulation of the chemical composition of the oceans
5. Regulation of the local and global climate (including the hydrological cycle)
6. Regulation of runoff and flood prevention (watershed protection)
7. Water-catchment and groundwater recharge
8. Prevention of soil erosion and sediment control
9. Formation of topsoil and maintenance of soil fertility
10. Fixation of solar energy and biomass production
11. Storage and recycling of organic matter
12. Storage and recycling of nutrients
13. Storage and recycling of human waste
14. Regulation of biological control mechanisms
15. Maintenance of migration and nursery habitats
16. Maintenance of biological (and genetic) diversity
Carrier functions
Providing space and a suitable substrate for:
1. Human habitation and (indigenous) settlements
2. Cultivation (crop growing, animal husbandry, aquaculture)
3. Energy conversion
4. Recreation and tourism
5. Nature protection
Production functions
1. Oxygen
2. Water (for drinking, irrigation, industry, etc.)
3. Food and nutritious drinks
4. Genetic resources
5. Medicinal resources
6. Raw materials for clothing and household fabrics
7. Raw materials for building, construction, and industrial use
8. Biochemicals (other than fuel and medicines)
9. Fuel and energy
10. Fodder and fertilizer
11. Ornamental resources
Information functions
1. Aesthetic information
2. Spiritual and religious information
3. Historic information (heritage value)
4. Cultural and artistic inspiration
5. Scientific and educational information

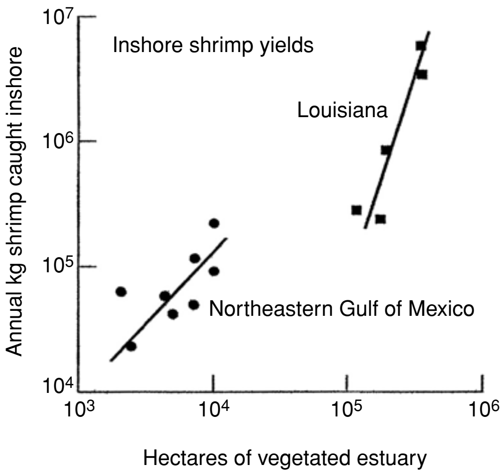


Figure 1.1 There is a linear relationship between the area of wetland in an estuary and the annual catch of inshore shrimp (from Turner 1977).

since there is general agreement among wetland ecologists as to what comprises wetlands (Keddy 2000, Mitsch & Gosselink 2000). One source of uncertainty is estimates of area in wetlands having networks of seasonally flooded channels (such as the Amazon) or having sets of isolated basins (such as the North American prairie potholes). A further difficulty might arise from inconsistencies in the inclusion of areas with heavy human disturbance, such as the vast areas of wetland protected by levees and converted to agriculture in the Mississippi River basin. Some authors may have left out heavily developed or urbanized areas along the borders of wetlands. We neither the resources nor the inclination to impose one standard method upon all participants; given the scale at which we are operating, and other possible sources of error, we suspect that such differences in opinion and methodology would not have a major impact upon the ranking used here. Such issues might, however, become more of a concern at small scales (that is wetlands under 50 000 km^2) where there are many more candidates to evaluate and relatively smaller differences among them. As with all scientific estimates, our estimates of area are certainly provisional and will be subject to eventual revision as better methodologies aries. Table 1.2 and Fig. 1.3 give the latest picture constructed from data in this book.

Two wetlands are in excess of 1 million km^2 in extent: the West Siberian Lowland and the Amazon basin. The West Siberian Lowland is a vast peatland that probably plays a significant role in regulating global climate, both in carbon sequestration and in controlling the flows of northern rivers into the Arctic Ocean. The Amazon River floodplain is a vast alluvial wetland with water-level fluctuations that regularly exceed 5 m in amplitude each year. This floodplain

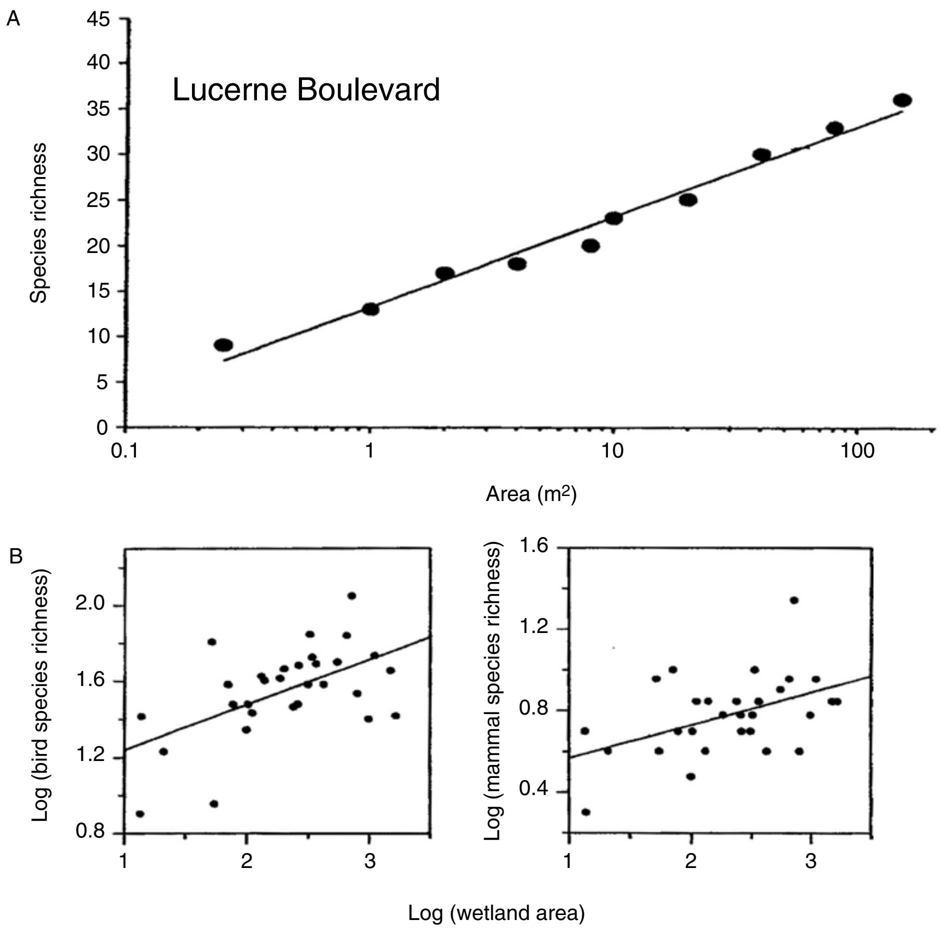


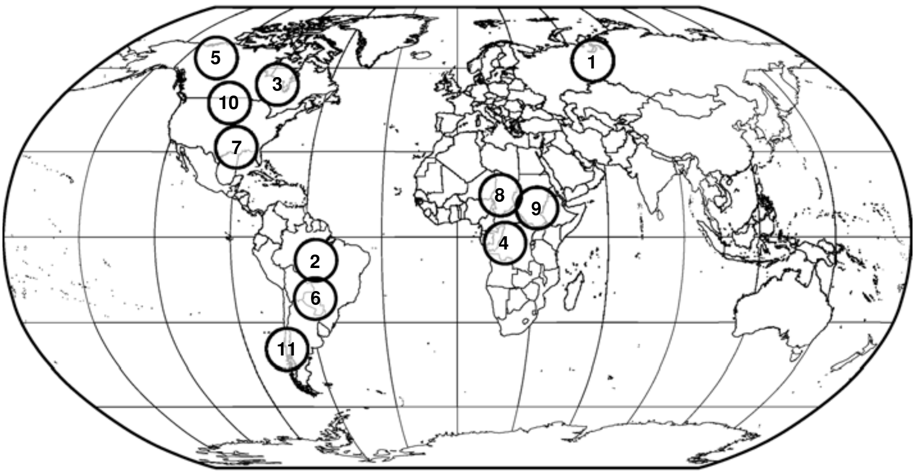
Figure 1.2 The number of species in a habitat increases with area. At the small scale, less than a hectare (A), there is a linear relationship between the number of plant species and log wetland area (Weiher 1999). At the larger scale, over hundreds of hectares (B), the log of the number species increases linearly with the log of area (Findlay & Houlahan 1997).

is one of the world's major repositories of biological diversity, particularly for fish and trees. Given the volume of sediment transported by the river, the delta may also be an important locale for carbon sequestration. These two wetlands comprise Chapters 2 and 3 of this book.

Of the remaining wetlands, seven are in the order of 100 000 to 400 000 km^2. (Hudson Bay Lowland, Congo River basin, Mackenzie River basin, Pantanal, Mississippi River basin, River Nile basin, Lake Chad basin). The most-heavily

Table 1.2 *The world's largest wetlands (areas rounded to the nearest 1 000 km²).*

Rank	Continent	Wetland	Description	Area (km²)	Source
1	Eurasia	West Siberian Lowland	Bogs, mires fens	2 745 000	Solomeshch, Chapter 2
2	South America	Amazon River basin	Floodplain forest and savanna, marshes, mangrove	1 738 000	Junk and Piedade, Chapter 3
3	North America	Hudson Bay Lowland	Bogs, fens, swamps, marshes	374 000	Abraham and Keddy, Chapter 4
4	Africa	Congo River basin	Swamps, riverine forest, wet prairie	189 000	Campbell, Chapter 5
5	North America	Mackenzie River basin	Bogs, fens, swamps, marshes	166 000	Vitt *et al.*, Chapter 6
6	South America	Pantanal	Savannas, grasslands, riverine forest	138 000	Alho, Chapter 7
7	North America	Mississippi River basin	Bottomland hardwood forest, swamps, marshes	108 000	Shaffer *et al.*, Chapter 8
8	Africa	Lake Chad basin	Grass and shrub savanna, marshes	106 000	Lemoalle, Chapter 9
9	Africa	River Nile basin	Swamps, marshes	92 000	Springuel and Ali, Chapter 10
10	North America	Prairie potholes	Marshes, meadows	63 000	van der Valk, Chapter 11
11	South America	Magellanic moorland	Bogs	44 000	Arroyo *et al.*, Chapter 12



1	West Siberian Lowland	7	Mississippi River basin
2	Amazon River basin	8	Lake Chad basin
3	Hudson Bay Lowland	9	River Nile basin
4	Congo River basin	10	Prairie potholes
5	Mackenzie River basin	11	Magellanic moorland
6	Pantanal		

Figure 1.3 Locations of the world's largest wetlands. The numbers correspond to Table 1.2.

disturbed is probably the Mississippi River where >90% of the floodplain has been deforested and/or obstructed by levees; some might argue that until such areas are restored to wetland, they should be removed from the list. In Chapter 8 on the Mississippi, the prospects for restoration receive particular emphasis. The least well understood of these large wetlands appears to be the Congo River basin (Chapter 5), with most literature (except satellite reconnaissance) now several decades old and much of it inaccessible to those who cannot read French.

At smaller sizes, that is of the order of 50 000 km^2, increasingly larger numbers of wetlands are candidates for consideration. We have included here the North American prairie potholes and the Magellanic moorland complex. We have excluded wetlands on the island of New Guinea (eastern Indonesia and Papua New Guinea) for lack of adequate data, although the maps of active alluvial plains in eastern Indonesia (Löffler 1982) and a map of poorly drained alluvial soils (Wood 1982) suggest that this area deserves further evaluation. Currently, the World Wild Fund for Nature (Olsen *et al.* 2001; World Wide Fund for Nature 2001) classifies this area as "Southern New Guinea freshwater swamp forests," with an area of 99 900 km^2; taking an estimated half of this as wetland would yield an area of 50 000 km^2.

One other big problem in this exercise was psychological rather than technical – the difficulty in finding people willing to contribute, particularly for areas in equatorial Africa and southeast Asia. We hope that this volume will encourage more prioritization for conservation planning for areas including the Congo and New Guinea. We suspect that part of our problem arose from the increasing emphasis upon reductionism in biology today, coupled – in ecology – with replacement of remaining field biologists by laboratory biologists. This may not only have reduced the pool of candidates from whom we could solicit contributions, but also seemed to have made some individuals, even those with established funding, unwilling to take the risk of presuming knowledge of any area larger than their own study sites. If anyone reading this book feels personally left out, or believes that we missed an important area, our apologies – we strongly encourage you to publish a scientific paper in an international journal using a similar format. Your contribution can then easily be included within future global compendia, maybe even within a future edition of this book. We encourage the publication of such work in international journals, because too often we found fine compendia that were out of print and/or otherwise inaccessible; in at least one case, the author had retired and had no forwarding address. Publications in scientific journals, in contrast, will always be available in most libraries.

We are left with the impression that too much activity in wetland conservation occurs at small scales, and that it is geographically localized within the densely industrialized areas of Western Europe and the eastern United States. The publications on the wetlands in the Netherlands, for example, vastly exceed those addressing the Congo or New Guinea. This was understandable back in the days of horse-drawn carriages and sailing ships. In the new global village – linked by airplanes, satellites, and computer networks – such imbalances are inexcusable. We hope that our book will help restore some balance and focus further attention upon large wetlands, their ecological functions, and their conservation.

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