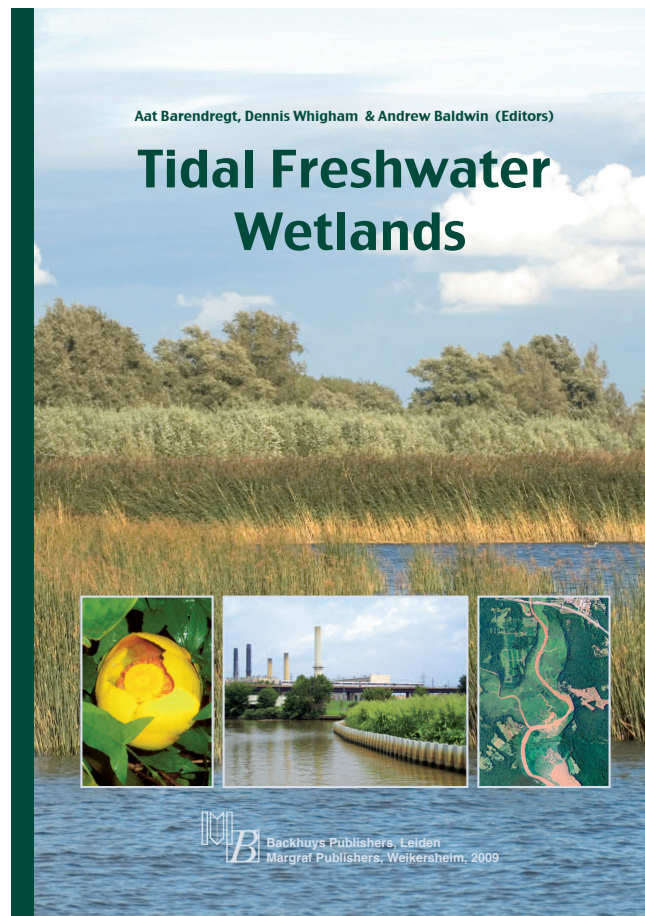


## Chapter 5

# PLANT COMMUNITIES OF TIDAL FRESHWATER WETLANDS OF THE CONTINENTAL USA AND SOUTHEASTERN CANADA


*Mary Alessio Leck, Andrew H. Baldwin, V. Thomas Parker, Lisa Schile  
& Dennis F. Whigham*

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## Chapter 5

# PLANT COMMUNITIES OF TIDAL FRESHWATER WETLANDS OF THE CONTINENTAL USA AND SOUTHEASTERN CANADA

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**Abstract:** Tidal freshwater wetlands (TFW) occur along the Gulf of Mexico, Atlantic, and Pacific coasts of the continental USA and Canada. Plant communities vary spatially across elevation, latitudinal, and disturbance gradients and temporally with season, between years, and over longer time scales. Patterns on a local scale are determined by seed availability, germination requirements, seed bank strategies, and tolerances of seeds and seedlings to stresses. Regional (estuarine) patterns involve tolerances to salinity and sedimentation, as well as hydrologic stresses. Latitudinal patterns may be a response to climatic gradients along the Atlantic coast and rainfall gradients on the Pacific coast. Annual species, which are important vegetation components, vary considerably. Causes of distribution changes or extirpations of rare/threatened species are poorly understood and impact of invasive species varies with location. Comparisons among Atlantic, Gulf, and Pacific coasts are limited by lack of data. Relatively little is known about tidal freshwater swamps or about West coast TFW.

Species names follow a widely used US Department of Agriculture (USDA) web site ([www.its.gov](http://www.its.gov)). In a few cases, a species name or variety is not accepted by ITIS; such taxa are designated as (NA) or not listed.

**Keywords:** annuals, Atlantic coast, seedling establishment, Gulf coast, high marsh, hydrologic gradient, invasive species, low marsh, marsh, marsh types, Pacific coast, precipitation patterns, rare species, salinity gradient, seeds, seed germination, seed banks, seedlings, swamp, tidal patterns, tidal freshwater wetland types

## INTRODUCTION

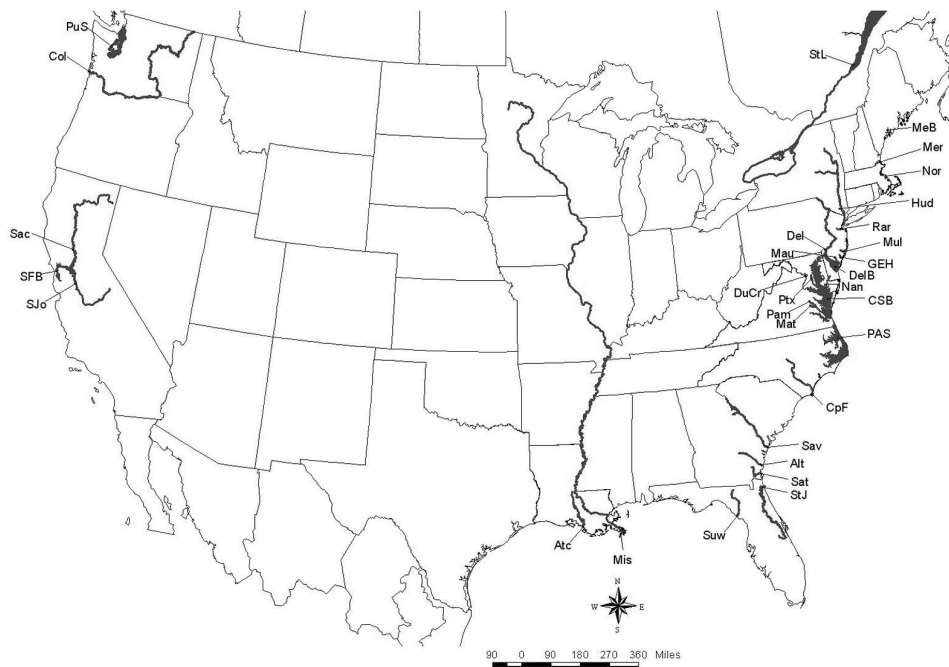
Along tidal rivers of North America, tidal freshwater wetlands (TFW) are dynamic landscape elements. They were used by Indians, European colonists, and later by settlers (see: Chapters 3 and 13). Where they still exist, TFW are vibrant, colorful, diverse, and highly productive (see: Chapter 10). They provide, for example, wildlife habitat and open space in often increasingly urbanized surroundings.

In this chapter, we restrict our discussion to (1) the extent of TFW in the East along the Atlantic coast from the Canadian Border (St. Lawrence River) to the northern Gulf of Mexico, and in the West along the Pacific coast from Washington State south to California (Fig. 1). We also (2) compare three geographical areas, Atlantic, Gulf, and Pacific coasts, and (3) examine plant community dynamics including temporal and spatial patterns. The spatial considerations include local, regional, and geographical comparisons. The importance of disturbance and of seed banks to vegetation dynam-

ics is considered within a local context. These are followed by (4) species of special interest, including annuals, as well as rare and invasive (also see: Chapter 9) species, and (5) conclusions and suggestions for future study.

## GENERAL COMPARISONS

Tidal wetlands of North America are influenced by diverse geology, topography, and climate and experience variable tidal regimes (Odum et al. 1984, Emmett et al. 2000, Mitsch & Gosselink 2000). Brief descriptions of the extent of TFW, habitats and wetland types, climate, and tide characteristics are found in this section (for discussions of sedimentation and geomorphology, see: Chapter 4). Within an estuary, sites typically fresh water (by definition <0.5 parts per thousand (ppt), Odum et al. 1984) may experience periodic influxes of saltier water due either to drought, storms, or



**Figure 1.** TFW found along the Pacific, Atlantic, and Gulf Coasts of North America. Locations are for those rivers (R) reviewed for Chapter 5. River abbreviations are from north to south. (A) Pacific coast: **PuS** - Puget Sound (Washington); **Col** - Columbia R (border Washington, Oregon); **SFB** - San Francisco Bay-Delta Estuary (California); **Sac** - Sacramento R (California); **SJo** - San Joaquin R (California). (B) Atlantic coast: **StL** - St. Lawrence R (Québec, Canada); **MeB** - Merrymaking Bay (Maine); **Mer** - Merrimack R (Massachusetts); **Nor** - North R (Massachusetts); **Hud** - Hudson R (New York); **Del** - Delaware R (New Jersey, Delaware); **DelB** - Delaware Bay; **Mau** - Maurice R (New Jersey); **Rar** - Raritan R (New Jersey); **Mul** - Mullica R (New Jersey); **GEH** - Great Egg Harbor R (New Jersey); **CSB** - Chesapeake Bay; **Nan** - Nanticoke R (Delaware, Maryland); **DuCr** - Dueling Creek (Washington, DC); **Ptx** - Patuxent R (Maryland); **Pam** - Pamunkey R (Virginia); **Mat** - Mattaponi R (Virginia); **PAS** - Pamlico/Albemarle Sound (North Carolina); **CpF** - Cape Fear R (North Carolina); **Alt** - Altamaha R (Georgia); **Sat** - Satilla R (Georgia); **Sav** - Savannah R (Georgia); **StJ** - St. John's R (Florida). (C) Gulf Coast: **Suw** - Suwanee R (Florida); **Mis** - Mississippi R (Louisiana); **Atc** - Atchafalaya R (Louisiana).

other climatic influences. Accordingly, through time, as well as spatially, salinity gradients may exist. These perturbations increase disturbance level and result in increased plant species richness and are important to the vegetation dynamics of TFW, and thus, are included, albeit briefly, in this chapter.

## Extent

TFW occur on the Atlantic, Gulf, and Pacific coasts of North America. They are best developed in the East along the Atlantic coast from New Jersey to Georgia and along the northern Gulf of Mexico coast and in the West in Alaska (Chapters 13-16). These are areas where there is adequate rainfall to maintain freshwater flow in rivers, a flat topography along the river to the ocean that makes possible broad drowned river valleys permitting extensive TFW to develop and have a significant tidal range (Mitsch & Gosselink 2000). Furthermore, extensive development of TFW does not occur along steep and rocky coastlines in eastern Canada (except along the St. Lawrence River) and in northern New England. Similarly, mountains restrict the size and drainage of most estuaries along the Pacific coast and coastal ranges that run parallel to inland ranges further reduce the extent of most watersheds that can reach the coast. Thus, only a few

systems, such as the Puget Sound, Columbia River (Garono et al. 2003), and San Francisco Bay-Delta estuaries, are large enough to support TFW. According to Field et al. (1991), TFW cover an estimated 131,000 ha on the Atlantic coast, mostly in the Mid-Atlantic States, 47,000 ha along the Gulf coast, mostly in Louisiana, and only 14,700 on the Pacific coast (Table 1) where, as indicated, TFW south of Alaska are restricted.

There are, however, considerable discrepancies among the available data on the extent of TFW. For example, estimates range for: New Jersey from 89,000 ha (Odum et al. 1984) to 3,889 ha (Tiner 1985) or 6,195 ha (K. Walz pers. comm.); New York along the Hudson River from 400 ha (Odum et al. 1984) to 715 ha (T. Howard pers. comm.), not including 325 ha of tidal swamps; and for Maryland, where estimates are not so disparate, from 42,361 ha (McCormick & Somes 1982) to 55,659 ha (Tiner & Burke 1995). Published estimates for the Pacific coast are also quite variable; ranging from 14,771 ha (Table 1) to 57,000 ha (Field et al. 1991). Reasons for variable estimates depend on the databases and techniques used to make the estimates. For some basins, underestimates of the actual coverage occur because TFW dominated by trees and shrubs (i.e., swamps) are not included, yet TFW swamp habitats may be quite extensive. Along the Atlantic coast, for example, substantial tidal

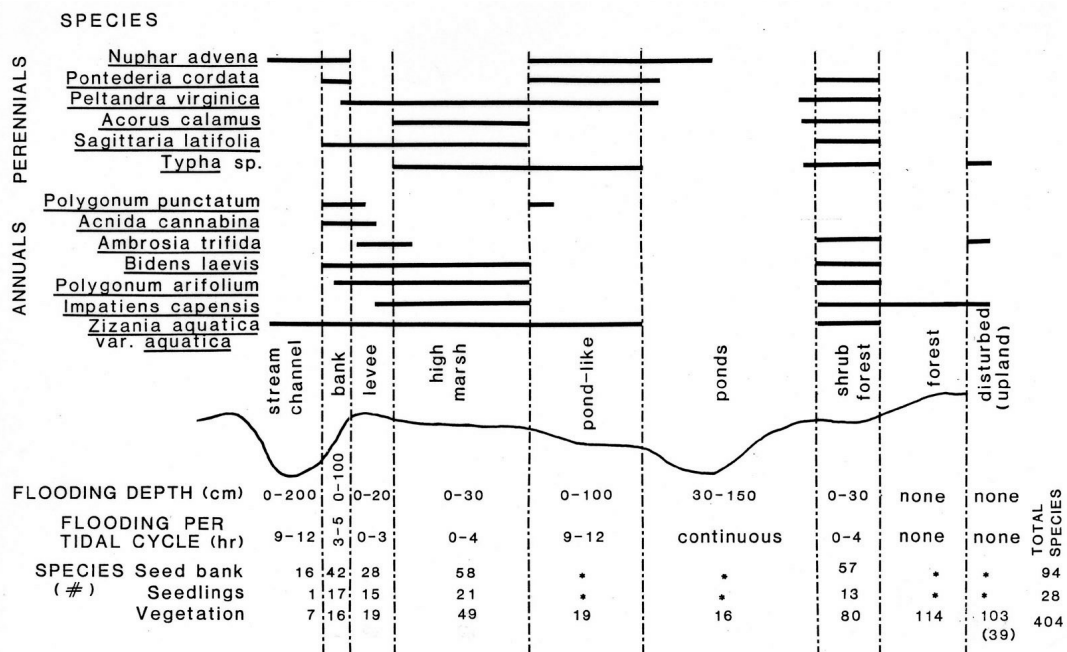


swamps occur along the St. Lawrence River, Connecticut River (R. Tiner pers. comm.), in Delaware Bay (G. Moore, D. Snyder pers. comm.), Chesapeake Bay (McCormick & Somes 1982, Peterson & Baldwin 2004a), and the St. John’s River in Florida (R. Virnstein pers. comm.).

Present-day estimates do not represent the historical extent of TFW. As much as 20% of the original TFW have been lost to development on the Atlantic coast (Mitsch & Gosselink 2000). Likewise, extensive development of wetlands along the Pacific coast, recent compared to the Atlantic

**Table 1.** Area (ha) of coastal freshwater wetlands by region (USA), including tidal marshes and swamps, and non-tidal and non-specified areas; also given are regional percentages. Data are from Field et al. (1991).

| Region             | MARSHEs       |                  |                | SWAMPs         |                  |                  |
|--------------------|---------------|------------------|----------------|----------------|------------------|------------------|
|                    | Tidal         | Non-tidal        | Not Specified  | Tidal          | Non-tidal        | Not Specified    |
| New England        | 728           | 4,856            | 18,009         | 567            | 93,604           | 281,135          |
| Mid Atlantic       | 14,326        | 18,251           | 17,604         | 24,767         | 294,166          | 244,673          |
| South Atlantic     | 24,929        | 240,667          | 7,284          | 65,761         | 1,484,792        | 222,577          |
| Gulf of Mexico     | 36,219        | 698,852          | 146,820        | 10,805         | 2,214,480        | 161,834          |
| Pacific            | 5,706         | 72,196           | 931            | 9,065          | 66,004           | 155,035          |
| Atlantic coast     | 39,983        | 263,774          | 42,897         | 91,095         | 1,872,561        | 748,385          |
| Gulf of Mexico     | 36,219        | 698,852          | 146,820        | 10,805         | 2,214,480        | 161,834          |
| Pacific coast      | 5,706         | 72,196           | 931            | 9,065          | 66,004           | 155,035          |
| <b>Total</b>       | <b>81,908</b> | <b>1,034,822</b> | <b>190,647</b> | <b>110,965</b> | <b>4,153,046</b> | <b>1,065,254</b> |
| <b>Percentages</b> |               |                  |                |                |                  |                  |
| Atlantic coast     | 49            | 25               | 23             | 82             | 45               | 70               |
| Gulf of Mexico     | 44            | 68               | 77             | 10             | 53               | 15               |
| Pacific coast      | 7             | 7                | 1              | 8              | 2                | 15               |



**Figure 2.** Diagrammatic representation of major habitats along an elevation gradient and distribution patterns for dominant tidal species in a Delaware River TFW (*Nuphar advena* = *N. lutea*) (From Leck et al. 1988; reproduced with permission).

coast, has resulted in the loss of >70% of the tidal wetlands in Puget Sound (Washington) and >95% in the San Francisco Bay-Delta (California) (Atwater et al. 1979, Levings & Thom 1994). However, in some estuaries where not impeded by surrounding development or geomorphology, wetland area has expanded related to increase in tide range caused by river channelization and sea level rise (e.g., upper Delaware River; see Chapter 13).

**Table 2.** Characteristic plant species of tidal freshwater marshes along the Atlantic and Gulf of Mexico coasts. Species listed are those that occurred at three or more\* representative sites. Representative sites are in Canada (Québec) and in USA (Massachusetts, Connecticut, New York, New Jersey, Maryland, Virginia, Delaware, Washington, DC, Georgia, and Louisiana). Life forms are annual (A) and perennial (P). The total number of species reported averaged 45 per study and ranged from 9-101 species (N = 11). The percentage of all species that were annual averaged 30% and ranged from 11-50% (N = 10).

Sources: Chabreck 1972, Whigham & Simpson 1975, Tiner 1977, Baillargeon 1981 cited in NWWG 1988, Doumlele 1981, Birch & Cooley 1982, Bowden 1984a, Couillard & Grandin 1986, Leck et al. 1988, Caldwell & Crow 1992, Barrett 1994, Bélanger & Bédard 1994, Tiner & Burke 1995, Baldwin & DeRico 1999, Perry & Hershner 1999, Baldwin et al. 2001, Edinger et al. 2002, Neff 2002, Baldwin & Pendleton 2003, Leck & Leck 2005, MANHP 2005, A. Baldwin (pers. obs.).

| Species                               | Life form |
|---------------------------------------|-----------|
| <i>Acorus calamus</i>                 | P         |
| <i>Amaranthus cannabinus</i>          | A         |
| <i>Bidens laevis</i>                  | A         |
| <i>Calamagrostis canadensis</i>       | P         |
| <i>Carex lacustris</i>                | P         |
| <i>Cuscuta gronovii</i>               | A         |
| <i>Hibiscus moscheutos</i>            | P         |
| <i>Impatiens capensis</i>             | A         |
| <i>Leersia oryzoides</i>              | P         |
| <i>Lythrum salicaria</i>              | P         |
| <i>Mikania scandens</i>               | P         |
| <i>Nuphar lutea</i>                   | P         |
| <i>Peltandra virginica</i>            | P         |
| <i>Pilea pumila</i>                   | A         |
| <i>Polygonum arifolium</i>            | A         |
| <i>Polygonum punctatum</i>            | A         |
| <i>Polygonum sagittatum</i>           | A         |
| <i>Pontederia cordata</i>             | P         |
| <i>Sagittaria graminea</i>            | P         |
| <i>Sagittaria latifolia</i>           | P         |
| <i>Sagittaria rigida</i>              | P         |
| <i>Schoenoplectus fluviatilis</i>     | P         |
| <i>Schoenoplectus tabernaemontani</i> | P         |
| <i>Sium suave</i>                     | P         |
| <i>Spartina cynosuroides</i>          | P         |
| <i>Typha angustifolia</i>             | P         |
| <i>Typha latifolia</i>                | P         |
| <i>Typha</i> spp.                     | P         |
| <i>Zizania aquatica</i>               | A         |
| <i>Zizaniopsis miliacea</i> +         | P         |

\* *Alternanthera philoxeroides* was important in wetlands of the southeast Atlantic and Gulf of Mexico coasts, but reported at only two reviewed sites.

+ Important only in southeast Atlantic and Gulf of Mexico coasts.

## Habitats and types of TFW

There are two broad categories of TFW. Those dominated by herbaceous species are “marshes”, while those dominated by woody species are “swamps” (Tables 2-4). Swamps may be dominated by shrub (scrub-shrub swamps) or tree (swamps) species, but they also have many of the herbaceous species that occur in marsh habitats (Table 4). In swamps, the areas between woody plants are called ‘hollows’ and are topographically lower than the ‘hummocks’ on which woody species and a variety of additional herbs and vines occur (Rheinhardt & Hershner 1992). Distribution of marshes and swamps across elevation gradients is associated with decreasing hydroperiod (i.e., frequency, depth, and duration of flooding). Typically, there are three or four, fairly distinct, habitats based on hydroperiod (Fig. 2). Nearest the tidal streams are “low marsh” habitats, which grade into “high marsh”, and then scrub-shrub swamp and swamp. However, in some locations, low to high marsh patterns are not obvious, and instead there is an elevation-dependent vegetation mosaic (Darke & Megonigal 2003). Mosaic vegetation, even in a limited area, may be due to multiple causes, with constraints related to habitat, geography (resulting, e.g., in species isolation where TFW are discontinuous), and vegetation history (Barrett 1994). Varied and complementary life forms and varied survival value of alternate regeneration modes (seed bank vs. buds), influenced differentially by hydrologic processes, allow for coexistence (Barrett 1994).

An interesting feature of TFW along the Gulf of Mexico is the imperceptible change from low marsh to high marsh and random appearance of plant associations (see: Chapter 15). In still other places, there can be a sharp change from low to high marsh, from marsh to swamp, or from wetland to terrestrial vegetation. Small-scale variation within any one habitat can be dramatic and simple designation, as low and high marsh, does not accurately reflect the complexity of TFW (Simpson et al. 1983a, Pasternack et al. 2000).

Additional TFW habitats may be distinguished, the extent of which is not well documented. Pond and pond-like areas are found in areas diked or otherwise altered by humans (Simpson et al. 1983a) or beaver (*Castor canadensis*) (M. Leck pers. obs.) and have floras dominated by floating (Lemnaceae), submerged (e.g., *Ceratophyllum demersum*), or emergent (e.g., *Zizania aquatica*) macrophytes. Along the Hudson River (New York) (also observed elsewhere) are freshwater intertidal mudflats, exposed at low tide and completely inundated at high tide by 0.9-1.2 m of water, and intertidal rocky or gravelly shores (Tiner 1985, Barrett 1994, Edinger et al. 2002, Kiviat & Stevens 2002). Characteristic species of the mudflats include *Heteranthera reniformis*, *Orontium aquaticum*, *Sagittaria graminea*, *S. rigida*, *S. subulata*, *Schoenoplectus americanus*, and *Zizania aquatica*. Characteristic species of the rocky or gravelly shores are *Amaranthus cannabinus*, *Bidens bidentoides*, *Brassica nigra* (an exotic), *Cardamine pensylvanica*, *Orontium aquaticum*, *Plantago cordata*, and *Polygonum hydropiperoides*. Rocky shores along the Merrimack River (Massachusetts) are

**Table 3.** Species of freshwater tidal swamps occurring at three or more representative Atlantic and Gulf of Mexico sites. Life forms are annual (A), perennial (P), and woody (W). Representative sites are in Canada (Québec) and USA (New York, New Jersey, Maryland, Delaware, Virginia, North Carolina Florida, and Louisiana). The total number of species reported per study averaged 45 species and ranged from 21-78 total species (N = 8). Within a single river system the average number of species was 13 and ranged from 1-39 species (N = 8). Soil organic matter content ranged from 10-80% (N = 4) and salinity ranged from 0-21 ppt (N = 8).

Sources: Penfound & Hathaway 1938, Cauboue 1972, Whigham & Simpson 1975, Conner & Day 1976, Hoffnagle 1980, Conner et al. 1981, Doumlele et al. 1985, Couillard & Grandin 1986, Leck et al. 1988, NWWG 1988, Rheinhardt 1991, 1992, CZR Inc. 1999, Darst et al. 2002, Edinger et al. 2002, Light et al. 2002, Peterson 2003, Leck & Leck 2005, A. Baldwin (pers. obs.), M. Leck (pers. obs.).

| Type                         | Species                            | Life form |
|------------------------------|------------------------------------|-----------|
| Trees                        | <i>Acer rubrum</i>                 | W         |
|                              | <i>Carpinus caroliniana</i>        | W         |
|                              | <i>Fraxinus pennsylvanica</i>      | W         |
|                              | <i>Fraxinus profunda</i>           | W         |
|                              | <i>Liquidambar styraciflua</i>     | W         |
|                              | <i>Magnolia virginiana</i>         | W         |
|                              | <i>Nyssa aquatica</i>              | W         |
|                              | <i>Nyssa biflora</i>               | W         |
|                              | <i>Pinus taeda</i>                 | W         |
|                              | <i>Taxodium distichum</i>          | W         |
| <i>Ulmus rubra</i>           | W                                  |           |
| Shrubs                       | <i>Alnus rugosa</i>                | W         |
|                              | <i>Alnus serrulata</i>             | W         |
|                              | <i>Cephalanthus occidentalis</i>   | W         |
|                              | <i>Cornus amomum</i>               | W         |
|                              | <i>Cornus foemina</i>              | W         |
|                              | <i>Ilex verticillata</i>           | W         |
|                              | <i>Ilex vomitoria</i>              | W         |
|                              | <i>Lindera benzoin</i>             | W         |
|                              | <i>Rosa palustris</i>              | W         |
|                              | <i>Viburnum dentatum</i>           | W         |
| <i>Viburnum nudum</i>        | W                                  |           |
| Vines                        | <i>Amphicarpaea bracteata</i>      | P         |
|                              | <i>Apios americana</i>             | P         |
|                              | <i>Dioscorea villosa</i>           | P         |
|                              | <i>Parthenocissus quinquefolia</i> | W         |
|                              | <i>Smilax laurifolia</i>           | W         |
|                              | <i>Smilax rotundifolia</i>         | W         |
| Herbs                        | <i>Toxicodendron radicans</i>      | W         |
|                              | <i>Boehmeria cylindrica</i>        | P         |
|                              | <i>Cicuta maculata</i>             | P         |
|                              | <i>Impatiens capensis</i>          | A         |
|                              | <i>Leersia oryzoides</i>           | P         |
|                              | <i>Onoclea sensibilis</i>          | P         |
|                              | <i>Osmunda cinnamomea</i>          | P         |
|                              | <i>Osmunda regalis</i>             | P         |
|                              | <i>Peltandra virginica</i>         | P         |
|                              | <i>Pilea pumila</i>                | A         |
|                              | <i>Polygonum arifolium</i>         | A         |
|                              | <i>Polygonum punctatum</i>         | A         |
|                              | <i>Polygonum sagittatum</i>        | A         |
|                              | <i>Saururus cernuus</i>            | P         |
|                              | <i>Sium suave</i>                  | P         |
| <i>Symplocarpus foetidus</i> | P                                  |           |
| <i>Thalictrum pubescens</i>  | P                                  |           |
| <i>Zizania aquatica</i>      | A                                  |           |

dominated by *Amaranthus cannabinus*, *Schoenoplectus pungens*, or *Spartina pectinata* (Caldwell & Crow 1992), while along the Delaware River (New Jersey) *Symphotrichum puniceum*, *Lythrum salicaria*, *Polygonum punctatum*, and *Veronica noveboracensis* are common and *Bidens bidentoides*, a rare species, is predictable (M. Leck pers. obs.).

TFW may be broadly categorized into three types (Mitsch & Gosselink 2000). Along the Atlantic and Gulf coasts most TFW are ‘mature marshes’ that are approximately 500 years old and have a well-developed substrate with 10-15% to 30-40% organic matter. Such TFW are typically dominated by diverse annual and perennial herbaceous species (Table 2; Simpson et al. 1983a, Odum et al. 1984) that vary spatially (Fig. 2) and temporally (Whigham & Simpson 1992). TFW along the East coast are likely quite recent, less than 300 years, with probably most of them originating and growing with soil erosion associated with deforestation and agriculture (Orson et al. 1992, Hilgartner & Brush 2006). Until colonial times, areas now TFW in the Chesapeake estuary, for example, were open water (Pasternack & Brush 1998 and references cited, G. Brush pers. comm.).

On the Pacific coast, most TFW are also of the mature type (Table 4). In the Pacific Northwest, the older TFW are approximately 300 years old because of large Holocene earthquakes and tectonic land subsidence (Atwater 1987), while some deeper sediments in the San Francisco Bay-Delta date to approximately 6000 years (Atwater et al. 1977, 1979, Fairbanks 1989, Malamud-Roam & Ingram 2004). The amount of soil organic matter varies greatly, depending on location and salinity influences, with reported ranges between 5-25% (Thom et al. 2002), 9-60% (Josselyn 1983), or around 50% (Atwater et al. 1979).

The second type of TFW is referred to as ‘floating marshes’ that occur along the Gulf coast. These have a diverse flora that may be dominated by *Panicum hemitomon*, *Sagittaria lancifolia*, or *Eleocharis baldwinii* and *E. parvula* (Mitsch & Gosselink 2000; see also Sasser & Gosselink 1984, Swarzenski et al. 1991). The substrate, a thick organic mat with living roots, rises and falls with the tide and thus, floating marshes are not affected by hydroperiod or by sedimentation.

‘Active marshes’, the third type, are also located along the Gulf coast. These have formed in the past 25 years on emerging islands in the active deltas of the Mississippi and Atchafalaya Rivers and have a number of colonizing species that occupy specific niches. At the water edge *Colocasia esculenta* dominates, with *Salix nigra* on the levees; on extensive back-island mud flats are *Schoenoplectus deltarum* or *Sagittaria latifolia*, and in between occur *Typha latifolia* and a seasonally varied mix of annual and perennial species (Mitsch & Gosselink 2000; see also White 1993).

## Climate

A major factor contributing to differences between Atlantic and Gulf coasts and the Pacific Coast is rainfall pattern. On the Atlantic coast, precipitation is fairly evenly distrib-



**Table 4.** Plant species occurring at two or more representative sites on the Pacific coast of North America. Representative sites are from Skagit Estuary in Puget Sound (Washington), the Columbia River (Washington and Oregon), and the San Francisco Bay Delta region (California). Life forms are annual (A), perennial (P) and woody plants (W). For San Francisco Bay TFW, approximately 20 of 90 total species are annuals (22%); data are unavailable for Puget Sound and Columbia River wetlands.

Sources: Nomenclature is based on Hickman (1993) and ITIS; NA: see abstract. Some older names are listed in parentheses. Other sources are Atwater et al. (1979), Burg et al. (1980), Christy & Putera (1992), and V. Parker, L. Schile, J. Callaway & M. Vasey (pers. obs.).

| Species  | Life form |
|--|-----------|
| <i>Agrostis alba</i> (NA)                                | P         |
| <i>Aster douglasii</i> (NA)                              | A         |
| <i>Aster subspicatus</i> (NA)                            | A         |
| <i>Atherium filix-femina</i>                             | P         |
| <i>Bolboschoenus maritimus</i> (NA)                      | P         |
| <i>Calystegia sepium</i>                                 | A         |
| <i>Carex lanuginosa</i>                                  | P         |
| <i>Carex lyngbyei</i>                                    | P         |
| <i>Carex obnupta</i>                                     | P         |
| <i>Cephalanthus occidentalis</i>                         | W         |
| <i>Cornus sericea</i>                                    | W         |
| <i>Deschampsia cespitosa</i>                             | P         |
| <i>Eleocharis macrostachya</i> ( <i>palustris</i> )      | P         |
| <i>Euthamia occidentalis</i>                             | A         |
| <i>Juncus balticus</i>                                   | P         |
| <i>Phragmites australis</i>                              | P         |
| <i>Rubus discolor</i>                                    | W         |
| <i>Polygonum persicaria</i>                              | A         |
| <i>Polygonum punctata</i>                                | A         |
| <i>Potentilla egedii</i> ssp. <i>egedii</i>              | P         |
| <i>Sagittaria latifolia</i>                              | P         |
| <i>Salix lasiolepis</i>                                  | W         |
| <i>Schoenoplectus acutus</i>                             | P         |
| <i>Schoenoplectus americanus</i> ( <i>olneyi</i> ) (NA)  | P         |
| <i>Schoenoplectus californicus</i> (NA)                  | P         |
| <i>Schoenoplectus tabernaemontani</i> ( <i>validus</i> ) | P         |
| <i>Sparganium eurycarpum</i>                             | P         |
| <i>Stachys albens</i>                                    | P         |
| <i>Typha domingensis</i>                                 | P         |
| <i>Typha latifolia</i>                                   | P         |

uted throughout the year, but on the Pacific coast, especially areas of California with Mediterranean climate, rainfall occurs primarily during the winter (Table 5), permitting considerable swings in salinity. Pacific coast estuaries large enough to maintain tidal conditions can shift from relatively freshwater conditions in winter to well-mixed estuaries and more saline conditions (e.g., from 4-30 ppt) during summer months in northern San Francisco Bay; Conomos et al. 1985), thereby creating wetlands with mixtures of freshwater and halophytic species. Regionally, in the Mediterranean-climate part of the Pacific Coast, these salinity influences result from reduced river flow permitting salinity to move farther upriver, combined with a lack of summer rainfall to remove it from the soil.

Local Pacific coast climates are strongly influenced by the California Current System that is structured by strong temporal variability, with a cold year-round strong south-

ward current and a northward undercurrent (Hickey & Banas 2003) and by the north Pacific High Pressure System. Nutrients, temperature, and salinity are also influenced, resulting in nutrient-rich, wind-driven upwelling near the coast and a general trend of increasing salinity and temperature southward along the coast (Hickey & Banas 2003). Seattle, Washington, for example, averages 975 mm precipitation, with about 9% of that falling in the summer months (Table 5), while San Francisco averages less than 500 mm with only 1.6% falling in the summer. The cold ocean moderates maritime conditions further by generating coastal fog or low clouds, which can be a critical source of moisture during the summer months. Furthermore, along the northern Pacific coast, the slight influence of salinity can be ameliorated by summer rainfall, creating tidal high marshes dominated by freshwater species like *Typha latifolia* and *Schoenoplectus acutus*, and low marshes dominated by species like *Carex lyngbyei*, that can tolerate some salinity. Farther south, the dry Mediterranean-climate summers in California can result in some salt accumulation in high marsh areas. The salinity results from evaporative concentration when high tides and summer rainfall are insufficient to remove the salts from the wetland soils. Where marshes may receive rare tides with low salinity, conditions create mixed marshes with freshwater species, like *Schoenoplectus acutus* and *S. californicus*, dominating low marshes where more tidal flushing occurs, and high marshes often grade into saltier habitats that are dominated by halophytes, like *Distichlis spicata* and *Jaumea carnosa*. Farther upriver, high marsh areas remain fresh and are often invaded by shrubby woody species like *Salix lasiolepis*, *Cornus sericea*, and *Cephalanthus occidentalis* var. *californicus*.

Water flow in streams and rivers peaks in late winter and spring because of winter rains and snowmelt from the surrounding mountains. Climatic influences on regional and restricted watersheds can shift the magnitude and location of oligohaline-freshwater boundaries as the water level in rivers drops. In California, the combined summer flows of the Sacramento and San Joaquin Rivers drop to roughly 13% of average peak winter rates (Conomos 1979). These conditions are aggravated in systems like the San Francisco Bay-Delta, where over 80% of freshwater inflows are diverted for urban and agricultural uses (Monroe & Kelly 1992) and the patterns and magnitude of flow have been drastically changed (Arthur et al. 1996).

In the East, precipitation exceeds 1000 mm (Table 5), with more than 25% falling during the summer. However, periods of persistent drought result in variable salinity, especially where rivers have smaller watersheds with little freshwater input to the estuary. Along the Merrimack River, the limit of salt may vary 10 km (Caldwell & Crow 1992) with drought and along the Hudson River the salt line can shift >23 km (T. Howard pers. comm.). In addition, large storms (e.g., hurricanes and northeasters) can push brackish water into TFW (e.g., Cape Fear River estuary, Hackney & Yelverton 1990). Near the freshwater-oligohaline transition zone in the Mattaponi River (Virginia), for example, the long-term



**Table 5.** Precipitation averages (mm) for representative Atlantic, Gulf, and Pacific coast locations. Shown are total precipitation, months having the highest and lowest values, and the percent of the yearly total that falls during the summer (JJA = June, July, and August). Data are from Williams (1994).

| <i>Location</i>                 | <b>Annual total</b> | <b>Highest</b> |           | <b>Lowest</b> |           | <b>J J A</b> |
|---------------------------------|---------------------|----------------|-----------|---------------|-----------|--------------|
|                                 | <b>mm</b>           | <b>Month</b>   | <b>mm</b> | <b>Month</b>  | <b>mm</b> | <b>%</b>     |
| <b>Atlantic coast</b>           |                     |                |           |               |           |              |
| Montreal (Canada)               | 1036                | Jan            | 97        | April         | 66        | 25.2         |
| New York, New York (USA)        | 1095                | Aug            | 107       | Feb           | 76        | 26.7         |
| <b>Gulf coast</b>               |                     |                |           |               |           |              |
| New Orleans, Louisiana (USA)    | 1539                | Jul            | 163       | Oct           | 71        | 29.2         |
| <b>Pacific coast</b>            |                     |                |           |               |           |              |
| Seattle, Washington (USA)       | 975                 | Nov/Dec        | 150       | Jul           | 20        | 8.6          |
| San Francisco, California (USA) | 483                 | Jan            | 114       | Jul           | 0         | 1.6          |

average was 0.5 ppt, but salinity averaged 2.8 in 1999, ranging from 0.0-15.9 ppt (Darke & Megonigal 2003).

The impact of hurricanes (e.g., Katrina in August 2005 and Rita in September 2005) on TFW, where violent wave action and salinity surges occurred, was considerable (see e.g., Neyland 2007 and websites<sup>1,2</sup>).

### Tidal cycles

Tides and tidal cycles vary considerably (Odum et al. 1984, Mitsch & Gosselink 2000) and where tidal water is constricted due to river morphology (broad at the mouth), tidal amplification occurs upstream. Amplification may not be obvious from tide charts; e.g., along the Hudson River at New York City (East River location, at sea level, tide is 1.2 m, while at Albany 217 km upriver, at 83.8 m above sea level, tide is 1.5 m). In addition, presence of barrier islands, such as the Outer Banks, prevents tidal influence up rivers in North Carolina causing a gap in TFW along the Atlantic coast (except the Cape Fear River system). Similarly, along the California coast, due to insufficient freshwater flow during summer, many rivers form sand bars that block tidal flow (Gordon 1979).

Tides are semi-diurnal on the Atlantic coast and diurnal along much of the Gulf coast. Amplitude varies along the Atlantic coast: 1-5 m - St. Lawrence River (NWWG 1988); 1.5 m - Hudson River (Troy, NY); 2.6 m - Delaware River (Trenton, New Jersey/Crosswicks Creek); 0.85 m - Nanticoke River (Sharptown, Delaware); and 1.35 m - Cape Fear River (North Carolina). On the Gulf coast, e.g., Louisiana /Atchafalaya Delta, where lunar impact is small, tides are irregular, of low amplitude (<0.5 m), and wind-driven (Mitsch & Gosselink 2000). In addition to Louisiana, wind tides influence extensive areas of the Pamlico/Albemarle Sound of North Carolina (R. Rheinhardt pers. comm.) and even in other areas where tides are lunar there may be an important wind compo-

nent. Lunar tide effect, especially where impact is small and irregular, may be eliminated by storm runoff and/or winds.

Along the Pacific coast, the tidal cycle is mixed semi-diurnal, with two high and two low tides a day (24.84 hr), with a significant disparity in the heights of each high tide and each low tide (Conomos 1979, Emmett et al. 2000). The smallest fluctuations are in southern California (1.75 m) while the largest occur in the Puget Sound (3.45 m) (Emmett et al. 2000).

## TEMPORAL PATTERNS IN PLANT COMMUNITIES

Tidal freshwater plant communities vary seasonally, between years, and over longer temporal scales. They also change spatially, locally across elevation gradients, as well as regionally and geographically.

### Within-year variation

Remarkable seasonal changes occur in Atlantic coast TFW over the course of a year, as well as through the growing season, dependent on the diverse plant species found within them (Tables 2, 3, 6). Many TFW herbaceous species die back to the soil surface during winter, so that the wetland has a flat, barren appearance, with a layer of decomposing plant material that decreases in thickness as spring approaches. Also during winter, channel edges are scoured clear of litter. Beginning in March or April, the high marsh gradually becomes green as seeds of annual species (e.g., *Impatiens capensis*, *Polygonum arifolium*) germinate in response to warming temperatures, often yielding high densities of seedlings, which grow quickly in the high light environment with increasing photoperiod (Parker & Leck 1985, Leck 2003). At the same time, perenni-

<sup>1</sup> <http://www.nature.org/wherewework/northamerica/states/louisiana/press/press2133.html>

<sup>2</sup> <http://www.usgs.gov/newsroom/article.asp?ID=997>.

als (e.g., *Acorus calamus*, *Peltandra virginica*) begin growth. Vegetation development takes longer in low marsh locations that are inundated for longer periods of time and have lower densities of seeds in the seed bank.

Canopy development in the high marsh is dynamic. Leaves and shoots of perennials (e.g., *Acorus calamus*, *Leersia oryzoides*, *Peltandra virginica*, *Phalaris arundinacea*) typically grow more rapidly than the seedlings of annuals and reach maximum height and biomass to form a canopy early in the summer (e.g., June in the mid-Atlantic region) (Odum 1988, Whigham & Simpson 1992). By mid to late summer, the stems of many annual species emerge above the perennials to form a canopy often >1 m tall, with certain species (*Amaranthus cannabinus*, *Ambrosia trifida*, *Zizania aquatica*) exceeding 2 m. Some perennials die back as they are overtopped by annuals that continue to grow, experience thinning, and eventually reach maximum biomass later in the season (e.g., September). As autumn approaches, annuals cease growth, set seed, and senesce, resulting in increased light closer to the soil surface, and permitting a second growth period for perennials, such as *Peltandra virginica*,

that had died back earlier in the growing season. Swamps similarly display seasonal changes with herbaceous species beginning to grow before leaves of trees and shrubs emerge.

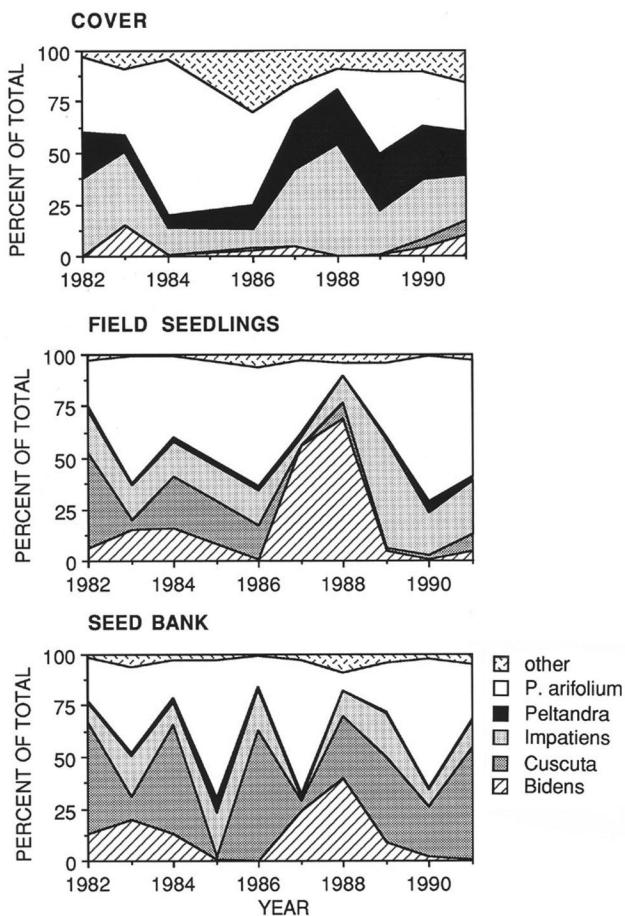
The seasonal changes in canopy and species are also seen in a changing palette of colors. Most early flowering plants have green flowers (e.g., *Acorus calamus*, *Peltandra virginica*, *Phalaris arundinacea*), but as the season progresses, there can be impressive floral displays, pink or white of *Hibiscus moscheutos*, magenta of *Lythrum salicaria*, orange of *Impatiens capensis*, and light yellow of *Zizania aquatica* in anthesis. Growth of the orange stems of the parasitic vine, *Cuscuta gronovii*, can be extensive in mid to late summer. In autumn, the TFW turn yellow- or red-brown, studded with yellow flowers of *Bidens laevis* and *Helenium autumnale* or the lavender of *Symphytotrichum puniceum*. In swamps, there are also senescing leaves of woody species that provide reds (*Acer rubrum*, *Nyssa sylvatica*), yellows (*Alnus*, *Fraxinus* spp.), and purples (*Liquidambar styraciflua*). During winter, the high marsh turns brown following the first killing frosts. In swamps, browns are often brightened by the lingering red fruits of *Ilex verticillata*, a shrub.

Many TFW species in the Northeast flower and/or disperse seed in late summer or autumn, including *Impatiens capensis*, which occurs in a variety of moist habitats, but has delayed seed production in a TFW (Simpson et al. 1985). Some exceptions flower early, including *Phalaris arundinacea* whose non-dormant seeds are shed in late June (Leck 1996) and low-growing, early-flowering annual species like *Gratiola neglecta*, *Lindernia dubia*, or *Ludwigia palustris*.

In Pacific coast TFW, dominants are typically perennial graminoids or species with grass-like shoots (Table 4). Most of these are of large stature (e.g., *Schoenoplectus acutus*, *S. americanus*, *S. californicus*, *S. tabernaemontani*, *Phragmites australis*, and *Typha latifolia*; 2-3 m) that emerge early in the spring at around the same time deciduous woody dominants begin to flower or leaf out (*Cephalanthus occidentalis*, *Cornus sericea*, *Salix lasiolepis*). Although annuals and perennials of smaller stature make up a majority of the species richness of these TFW, for the most part they remain in the understory. Accordingly, seasonal changes mostly reflect growth periods with the wetland greening up in spring and turning brown during autumn.

### Inter-annual variation

In addition to the seasonal patterns of flowering and seed dispersal, species composition has been found to vary between years in Mid-Atlantic TFW (Fig. 3), usually due to variations in abundance of annual species that often comprise half or more of the species and account for the greatest number of individuals (Fig. 4; Parker & Leck 1985, Leck & Simpson 1987, 1995, Whigham & Simpson 1992). Inter-annual variation of annual species occurs, in part, because of differences in seed production, variable germination of microsites due to spatial variation in litter, surface topography, and to variations in local climatic conditions. Because



**Figure 3.** Comparisons of species importance among three life history stages (seed bank from greenhouse emergence and field seedlings and cover). Shown are data (% of totals) for *Bidens laevis*, *Cuscuta gronovii*, *Impatiens capensis*, *Peltandra virginica*, *Polygonum arifolium* and other species for a Delaware River high marsh site (From Leck & Simpson 1995; reproduced with permission).

annuals must be recruited each year, conditions that alter germination, seedling establishment, or growth of a species result in varied abundances and fluctuations in vegetation composition (Leck & Simpson 1995, Baldwin et al. 2001). On the Pacific coast, inter-annual variation in annuals and smaller statured perennials may reflect habitat disturbance, such as woody detritus in the Pacific Northwest (Maser & Sedell 1994) and fire in California (M. Vasey, L. Schile, V. Parker & J. Callaway pers. obs.).

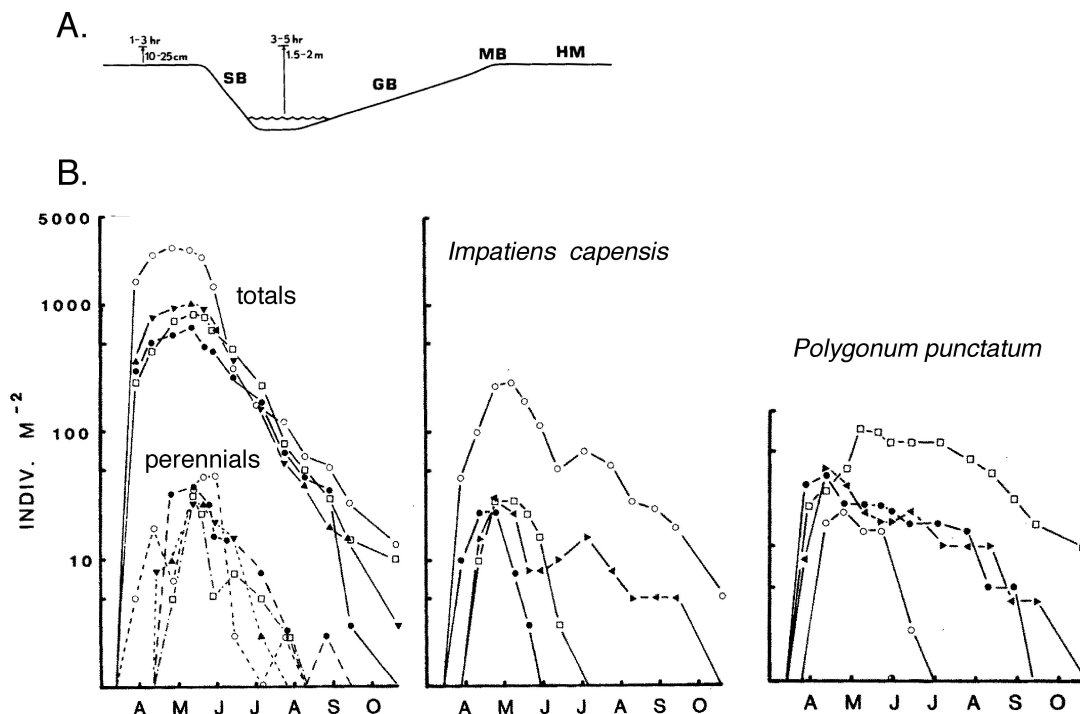
### Long-term variation

Vegetation of TFW also changes over longer periods (see: Chapter 13). Field and Phillip (2000) reported that the overall percentage of low marsh habitats along the Delaware River increased from 9% in 1977/78 to 34% in 1997/98 while high marsh habitats decreased in area. They attributed changes to sea level rise and lack of sediment accretion. In another Delaware River study, vestiges of former sedge-swamp vegetation occurred in seed bank samples at a depth of 30-32 cm (Leck & Simpson 1987, Leck & Leck 2005), attributed to tide level rise and sedimentation that caused the loss of an alder-sedge-dominated community. The dynamic nature of estuaries may also be seen in data from the Altamaha and Satilla estuaries in Georgia. Along the Altamaha, the acreage of TFW changed from 808 ha in 1953 to 626 in 1974 and 793 in 1993. Along the Satilla, TFW occupied 232 ha in 1953, 114 in 1974 and 147 in 1993 (Smith et al. 2001). In southern Maine in Merrymaking Bay, stabilization of tidal wetlands during the past 50 years is related to forest recovery within the watershed (Lichter et al. 2006).

Long-term changes can also occur in response to the intrusion of brackish water into fresh water portions of tidal rivers. Perry and Hershner (1999) documented an increase in the abundance of *Spartina cynosuroides*, an oligohaline species, from 1974 to 1987, possibly due to an increase in salinity resulting from ground water removal by a nearby paper mill (R. Rheinhardt pers. comm.). Changes are not uniform along the Atlantic coast, however, and Higinbotham et al. (2004) found no evidence of brackish intrusion along the Altamaha and Satilla Rivers in coastal Georgia between 1953 and 1993.

Anthropogenic effects on TFW have been substantial (see: Chapters 13, 14). During colonial times, TFW in North and South Carolina were diked and used for growing rice (Prevost 1986) and are now managed for duck habitat. In New England, losses occurred following dam construction that eliminated tides, and elsewhere wetlands were used for many purposes, including landfills, roads, and industrial sites. These impacts substantially reduced the extent of TFW and also altered plant composition (Leck et al. 1988, McKee & Baldwin 1999, Crain et al. 2004).

In San Francisco Bay-Delta, the remaining TFW are generally island remnants within larger shipping channels, adjacent to diked former wetlands that are managed for agriculture or duck habitat. Diversion of water for agriculture or to cities farther south in California threatens the dynamics of the remaining wetlands. Low water flow and levee breaks bring brackish water into areas formerly exclusively fresh.



**Figure 4.** Channel cross-section (A) with inundation zones noted and seasonal patterns (B) in numbers of individuals ( $m^{-2}$ ) found in steep bank (●, SB), gentle bank (□, GB), midbank (▲, MB), and high marsh (○, HM) zones ( $n=10$ ). Field data shown are for site totals and numbers of perennials, *Impatiens capensis*, and *Polygonum punctatum* (From Parker & Leck 1985; reproduced with permission).



## SPATIAL VEGETATION PATTERNS AND FACTORS RESPONSIBLE FOR THEM

Vegetation patterns of TFW can be examined over spatial and temporal scales. At the local scale the most obvious differentiation occurs across elevation gradients related to changes in hydrology, but other factors, such as herbivory and substrate, may be locally important. At the regional scale, differences are mostly due to within-estuary variation in hydrology and salinity, especially in the portion of the estuary that is closest to the boundary between fresh and salt water. Latitudinal variations in the characteristics of TFW and differences between Atlantic and Pacific coasts are mostly due to differences in climate.

### Local vegetation patterns

Vegetation patterns at the local scale are influenced by physical and biotic factors to which species have varying tolerances. Accordingly, across an elevation gradient and with disturbance, the relative importance of physical and biotic influences varies. Moreover, environmental cues that vary spatially influence seed germination, seed banks, and seedling establishment and are, therefore, fundamental to understanding vegetation patterns.

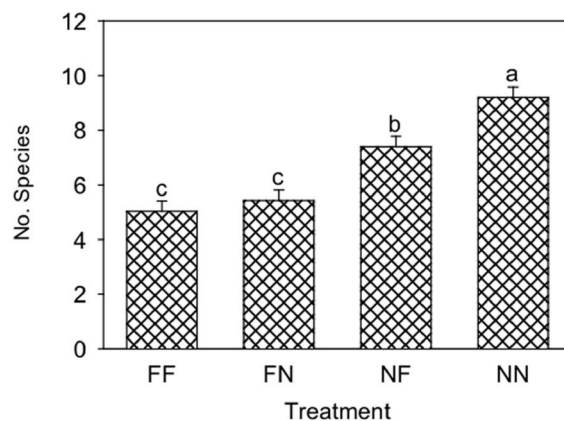
### Elevation gradients

Elevation gradients, which determine inundation regime, occur over varying scales. Gradients can be short (over m) or long (over km); in swamps elevation of hummocks above hollows may be small in scale (cm).

Closest to the subtidal portion of the elevational gradient, low marsh habitats, with longer inundation periods, are dominated by perennials, e.g., *Nuphar lutea* and *Sagittaria subulata* (se: Fig. 2, Leck pers. obs.). Submergent macrophytes, e.g., *Elodea* species, which dominate permanently flooded locations (Capers 2003a), may occasionally be found among these low marsh perennials. Annuals, such as *Polygonum punctatum*, and *Zizania aquatica*, may also occur and dominate locally. In contrast, high marsh at higher elevation usually has a greater number of annual and perennial species. Likewise, swamps, near the upper limit of the inundation gradient, are dominated by hardwood trees and support diverse shrub and herb flora (Table 3). Where there is adequate light, the hollows of swamps and scrub-shrub habitats may have many of the same species that occur in the high marsh (Rheinhardt 1992). Hummocks themselves are habitat for another group of herbs, represented by *Carex* spp., grasses (e.g., *Cinna arundinacea*), ferns (e.g., *Osmunda cinnamomea*, *O. regalis*, and *Thelypteris palustris*), and forbs (e.g., *Viola cucullata*).

Distribution patterns along the tidal gradient are determined by tolerances of individual species to inundation regime (Figs. 2, 4, 5). For example, high marsh species transplanted into low marsh locations did not survive nor did low marsh species transplanted into a high marsh location (Parker & Leck 1985). On the high marsh, biotic stresses (competition) dominate while in low marsh habitats, physical stresses (inundation) are more important and impact species to differing degrees (Fig. 4). Overlap of species distributions is common, however, resulting in the lack of distinct zones in some TFW, especially in swamps. Moreover, diverse communities may be interspersed with extensive almost pure patches of, e.g., *Acorus calamus*, *Ambrosia trifida*, *Schoenoplectus fluviatilis*, *Typha* spp., or *Zizania aquatica*. However, it should be noted that multiple vegetation types may be relics of chance colonization events followed by habitat pre-emption that results in, e.g., mixed dominants and large unexplained variance (Barrett 1994).

Overall, species richness on the Atlantic and Pacific coasts increases from low to the high marsh and swamp habitats, with the highest richness occurring in swamps or scrub-shrub habitats because the hummock and hollow topography provides a greater richness of microhabitats (Rheinhardt 1992, Tanner et al. 2002, Peterson & Baldwin 2004a). In a study that compared responses to hydroperiod (Fig. 5), annuals appeared to have more variable responses while perennials were unaffected or growth was promoted (Baldwin et al. 2001). In upper Chesapeake Bay, the number of species increased with distance inland from one to 14 (Pasternack & Brush 2002). In addition, sandy, dry levee sites had many



**Figure 5.** Effects of hydroperiod on number of plant species. Species richness was determined in marsh sods exposed to four hydrologic regime treatments in the greenhouse. Treatments were: continuously flooded 10 cm for five months (FF); flooded for 35 days followed by a period of four months when not flooded (FN); not flooded for 35 days followed by a flooded period of four months (NF); and not flooded for five consecutive months (NN) (When not flooded, water level was 10 cm below the soil surface). Plotted values are means  $\pm$  SE of number of plant species in experimental units throughout the duration of the study. Means with different letters are significantly different (Tukey-Kramer test). Effect of date and date  $\times$  hydrologic regime were not significant ( $P > 0.05$ ) (From Baldwin et al. 2001; reproduced with permission).



species while frequently flooded sites were usually monospecific.

Low marsh areas in Pacific coast TFW typically have few species, such as *Schoenoplectus acutus*, *S. americanus*, or *Carex lyngbyei*. Often on mudflats, small annual species can be found, like *Lilaeopsis masonii* or *L. occidentalis*. A slight increase in elevation causes a sharp increase in the number of species, including *Ludwigia peploides*, *Mimulus guttatus*, *Polygonum persicaria*, and *P. punctatum*. In shrub or tree swamp habitats, *Alnus rubra*, *Myrica gale*, and *Picea sitchensis* to the north, and *Cephalanthus occidentalis* var. *californicus*, *Cornus sericea*, *Populus fremontii* and *Salix lasiolepis*, to the south, also provide heterogeneous patches that support higher species richness (Tanner et al. 2002). The diverse assemblages of many Pacific coast wetlands reflect rapid shifts from brackish-saline to freshwater conditions, spatially heterogeneous patterns of elevations, seasonal freshwater influences, soil conditions, and disturbance (Simenstad et al. 2000b).

### Disturbance

Various levels and kinds of disturbance produce patches for colonization. These may be caused by death of annuals or by herbivory, scouring due to water and ice, removal or deposition of litter and flotsam, sedimentation, or salt pulses (e.g., Odum et al. 1984). Such patches provide habitat for replacement by annuals or less often by perennials (Parker & Leck 1985). The influences of flood disturbance, which varies both longitudinally and perpendicularly to the channel, are not well appreciated (Barrett 1994). Barrett also distinguishes between flood stress and flood disturbance and suggests that they are more important than gap size. Although no clear pattern of succession has been documented in TFW (Mitsch & Gosselink 2000), if disturbances are sufficiently large as occur in man-made wetlands, directional changes (succession) may occur (Leck 2003).

Of the various agents of disturbance that influence vegetation development, ice appears to have received little attention (exceptions include Bélanger & Bédard (1994) and Ewanchuk & Bertness (2004)). Moving ice may scour litter away from edges of tidal channels and river shores where the most successful plants are annuals or strongly rhizomatous perennials (Caldwell & Crow 1992, M. Leck pers. obs.). Where scouring by ice (and water) is important, annuals, whose seeds can find protection in the micro-relief of the marsh surface or rocky shoreline and strongly rhizomatous perennials, are most successful (Caldwell & Crow 1992). Moreover, along the St. Lawrence River, where ice can remain for five months each year, it plays an important role in sedimentation and may actually serve as a protective agent (Serodes & Troude 1984).

Disturbance by intense herbivory can have significant impact on vegetation. Along the St. Lawrence River, snow geese (*Chen caerulescens atlantica*) lower production of *Schoeno-*

*plectus americanus*, enhance that of *Zizania aquatica*, and have no effect on *Sagittaria* species (Giroux & Bédard 1987), thus altering community composition (M. Jean pers. comm.). Geese grubbing, coupled with ice disturbance, decreased productivity but increased richness in a brackish wetland study (Bélanger & Bédard 1994). In the Delaware and Chesapeake estuaries, grazing by non-migratory Canada geese (*Branta canadensis*) can have a significant detrimental effect on *Zizania aquatica* populations (Baldwin & Pendleton 2003, Nichols 2003). Beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*, nutria (*Myocastor coypus*), and possibly non-native carp (*Cyprinus carpio*) can significantly reduce biomass and richness (Evers et al. 1998, Ford & Grace 1998, Connors et al. 2000, Baldwin & Pendleton 2003).

On the Pacific coast, disturbance results from processes associated with flooding and drought. Major rare floods remove aboveground accumulations of plant debris, open up habitats, shift substrates, and provide establishment opportunities for many species. In the Pacific Northwest, a primary source of disturbance in tidal wetlands is large downed wood, such as tree trunks, brought in by floods (Maser & Sedell 1994). Such detritus modifies local sites in a variety of ways, sometimes creating ponds, other times increasing sedimentation, disturbing sites to form new channels, and serving as a substrate for establishment of woody species (Maser & Sedell 1994, Simenstad et al. 2000b). In California, fire introduced in early spring can provide sites for colonization in wetland habitats by removing dense accumulated litter. Smaller species respond rapidly, increasing in frequency and abundance in the subsequent few years (M. Vasey, L. Schile, V. Parker & J. Callaway pers. obs.).

Large-scale TFW disturbances, including human activities, such as physical alteration of wetlands and wetland creation as part of mitigation activities, create altered habitats for opportunistic species. Vegetation development, and thus succession, in constructed wetlands depends on the availability and dispersability of seeds, sediment quality, hydrologic conditions, growth forms of colonizing plants, water currents, deposition of litter, and the vegetation itself (Neff 2002, Leck 2003, Leck & Leck 2005, Leck & Schütz 2005). Seed banks with very high densities of seeds and species richness develop quickly (Baldwin & DeRico 1999, Leck 2003). Other anthropogenic impacts, such as oil spills, have the potential to affect recruitment of annuals from the seed bank and subsequent community composition (Leck & Simpson 1992).

Additional factors influence TFW vegetation development in disturbances. These include: characteristics of seeds, seed banks, and seedlings (Leck & Simpson 1994, Neff & Baldwin 2005); availability of suitable substrate that can be colonized in, e.g., newly prograding deltas (Gosselink 1996 cited in Mitsch & Gosselink 2000), swamps (Peterson & Baldwin 2004a), or constructed wetlands (Neff 2002, Leck 2003, Leck & Leck 2005); as well as salinity (Baldwin et al. 1996) and other stresses (biotic and physical gradients) (Parker & Leck 1985; Baldwin et al. 2001).

Vegetation patterns in some TFW seem to follow a different trajectory than patterns in terrestrial habitats where annual species are replaced by perennials that are in turn replaced by woody species. In fact, the continuing importance of annuals (60.5% of cover over 10 years in a reference wetland and >50% cover in most channel edge and midpoint locations of a constructed wetland after 10 years; Leck & Simpson 1995, Leck 2003, Leck pers. obs.) indicates the importance of processes like disturbance due to tide rise and sedimentation that have resulted in a habitat unsuitable for establishment of perennials, such as *Carex* species or woody plants. In contrast, along the Connecticut River, Barrett (1994) found annuals to be less important than along the Delaware River and five of eight vegetation types were dominated by perennials. Sedge-dominated communities are also found in Maine (C. Crain pers. comm.). Differences among river systems in the relative importance of annuals suggest differences in substrates, levels of disturbance, or other factors that deserve study. It also appears, if TFW are similar to salt marshes, that plants create a hospitable environment for themselves and that only some dramatic change, such as disturbance, flooding, or salinity, can shift species composition (Hackney et al. 1996, Baldwin & Mendelsohn 1998).

### *Seed banks: strategies, composition, and relationship to vegetation*

Mid-Atlantic and a few Gulf coast studies of seed dispersal, germination, seed bank dynamics, population dynamics of seedlings in the field, and studies of vegetation patterns have provided insights regarding the linkage between the seed bank and extant vegetation on a local scale.

### **Dispersal**

Seed dispersal is mostly by water, but wind and animal dispersal also occur (Middleton 1999, Neff & Baldwin 2005). Distribution can, in part, be explained by buoyancy. For example, *Impatiens capensis* and *Peltandra virginica* have seeds that float for months and are widely dispersed. However, low marsh and stream bank habitats are characterized by species, e.g., *Zizania aquatica*, whose seeds do not float and are adapted to remain in place after falling from the parent plant. *Zizania* seeds sink rapidly and have bristles which secure them in the substrate. In contrast, reduced or no bristles in intertidal varieties of *Eleocharis obtusa* var. *peasei*, *E. olivacea* var. *reductiseta*, and *Schoenoplectus smithii* var. *smithii* are interpreted as reducing the chance of dispersal by epizoochory and of seeds being stranded in litter at the high tide line where it is not continuously wet enough for survival of seedlings (Ferren & Schuyler 1980).

Secondary dispersal of wind-dispersed seeds may also be by water (e.g., *Salix* spp., *Acer saccharinum*; A. Baldwin, M. Brock, M. Leck, pers. obs.) and dispersal of seedlings of some species is exclusively by water (e.g., *Lythrum salicaria*, *Pontederia cordata*; Schulthorpe 1967). Dispersal of seeds (and rhizomes), entrapped and transported by ice (Caldwell

& Crow 1992), appears not to have been studied. However, despite an abundance of propagules, colonization may not be from seeds or seed banks. Capers (2003a) found that for submerged species in channels, 60% of establishment was from plant fragments and 16% from vegetative growth.

### **Germination requirements and seed bank strategies**

Most germination and seedling establishment occur in spring and several factors control the transition from seeds in the seed bank to seedling establishment (Leck 1996). Soil seed banks are of three types: transient, <1 yr; short-term persistent, 1 - 5 yr; and long-term persistent, >5 yr (Thompson et al. 1997). Seed characteristics and germination responses, first reported by Thompson and Grime (1979), are related to seed bank strategies. Our studies similarly found that large-seeded species (*Impatiens capensis*, *Polygonum arifolium*), which did not require light for germination and that germinated at low temperature following stratification (5° C), had transient seed banks (Leck & Simpson 1993, Leck 1996, Leck & Brock 2000). Another transient species, *Peltandra virginica*, also large-seeded, had no seed dormancy but was prevented from germinating until spring by an impermeable fruit coat and a requirement for high (>10° C) germination temperature (Leck 1996). In contrast, species with small seeds that require light and alternating temperatures for germination were persistent in the seed bank (*Bidens laevis*). However, even species with persistent seed banks can have a sizable proportion of a year's seed production germinate the spring following dispersal (Leck & Simpson 1995). Long-term persistent seed banks do occur (e.g., *Dulichium arundinacium*, *Ranunculus sceleratus*) and may contribute to the vegetation when soil disturbance occurs (Leck & Simpson 1987, 1993). Because of the importance of annuals and of species with transient or short-term persistent seed banks, there is considerable depletion of the seed bank during spring germination and seed density can be reduced by as much as 97% in surface samples (Leck & Simpson 1987).

### **Tolerances of seeds and seedlings**

Along elevation/hydrological gradients tolerances to hypoxic conditions vary. Species in low marsh and stream channel locations have seeds that germinate under anoxic conditions (e.g., *Pontederia*, *Zizania*) (Leck 1996). *Peltandra virginica* seeds, in contrast, are able to germinate under both aerobic and anoxic conditions, but buoyancy affects their distribution. *Peltandra virginica* fruits, made buoyant (and drying-resistant) by a layer of mucilage that covers the seed, are dispersed to high marsh locations, away from tidal channels where the large buoyant seedlings are easily dislodged by water movement (Whigham et al. 1979, Leck & Simpson 1993, Leck 1996). Young plants are frequently observed in high marsh locations. Another species capable of germinating under both aerobic and anoxic conditions is *Phalaris arundinacea*, but it does not occur in inundated channel bottoms. Established plants occur along levees and, in constructed

wetlands, along the upland edge and on higher microhabitats (e.g., bases of *Lythrum salicaria* plants) (M. Leck pers. obs.). Although seeds can germinate when inundated, seedlings do not develop roots and, therefore, establishment is deterred. Also, it is possible that, like *Peltandra virginica*, seedlings float, preventing establishment in channels.

In contrast to these species, *Impatiens capensis* seeds cannot tolerate prolonged anoxia (Leck 1996). In the high marsh, seedlings are often found in slightly elevated microhabitats, e.g., at the bases of perennials or where litter has accumulated (M. Leck & R. Simpson pers. obs.). Differences in seedling tolerances along an elevation gradient can be seen in Fig. 4. *Impatiens capensis*, with large seedlings tolerated the biotic competition (max. 4,607 seedlings m<sup>2</sup>) on the high marsh, but not the physical stresses associated with the tidal channel (Parker & Leck 1985, Leck & Simpson 1993). *Polygonum punctatum*, in contrast, did not survive on the high marsh, but dominated along channels. In tidal swamps, shade-tolerant and shade-intolerant species may grow in close proximity (R. Rheinhardt pers. comm.). Varied tolerances of seedlings, together with microsite influences on germination, create the complex vegetation patterns observed.

However, even in a given high marsh location, *Bidens laevis* seedlings did not survive to reproduce during some years (Fig. 3). A requirement for higher alternating temperatures (Leck et al. 1994) means that it may germinate somewhat later than *Impatiens capensis* or *Polygonum arifolium* that germinate at lower temperature, have high densities, and larger seedlings, against which it must compete. *Bidens laevis* seedlings are relatively small (Leck & Simpson 1993). The occurrence of suitable establishment conditions may therefore be more problematic than for other large-seeded annuals.

Germination of annuals from undisturbed soil samples in a greenhouse study was earlier than for perennials (two peaks were at 78 and 83 year days, and 108 and 115 respectively) (Leck et al. 1989). Also in the field, perennials did not persist through the growing season and in the greenhouse *Sagittaria latifolia* germination was 1-1.5 months later than most other species (Parker & Leck 1985, M. Leck pers. obs.).

Other factors affecting germination and establishment include salinity and nutrients. Germination of *Phalaris arundinacea* was reduced ~20% by 50% sea water and increased ~33% by 5 mM KNO<sub>3</sub> (S. Massingill pers. comm.). In a study of oligohaline wetlands in the Mississippi delta, Baldwin et al. (1996) found that salinity did not affect seed viability, but it did inhibit germination. Increased salinity can reduce the abundance of species dependent on seedling recruitment in TFW, but would allow continued growth of species able to grow by vegetative means.

An environmental factor, about which little is known, is the effect of a mud coating on seedlings. This may be a greater problem for smaller seedlings and in areas where there is much sediment carried by tides. It is known, however, that added sediment on the soil surface can reduce germination.

Peterson and Baldwin (2004b) found that density and richness of seedlings emerging from TFW sediments decreased significantly as sediment input increased from 0 to 2 cm depth, with reductions caused by as little as 0.5 cm of sediment.

### Relationship of the seed bank to vegetation

Several studies have examined the relationship between the seed bank and vegetation patterns. Existing vegetation (seedlings and vegetation cover) usually reflects the composition of the seed bank (Leck & Simpson 1995). Species richness was similar in a reference TFW site between seed bank, field seedlings, and vegetation in three habitats (Leck & Simpson 1987), but was greater in seed bank than vegetation in a constructed wetland (Leck 2003).

Annuals accounted for the varied composition of three life history stages over 10 yr at a high marsh site related to year-to-year population fluctuations (Fig. 3). Another study showed that seed rain, seed bank, seedlings, and seed production patterns varied among species, across sites along an elevation gradient for a species, and between years (Leck & Simpson 1994). Relationships between life history stages are complex. For some species, e.g., *Ambrosia trifida*, <1% of seeds survived to seedlings, and even fewer survived to maturity. In contrast, 91% of mature *Polygonum punctatum* plants were recruited from seed rain.

### Regional (estuarine) patterns

Within an estuary, vegetation patterns and species richness also change in response to variation in importance of fluvial and marine effects. At a landscape scale, upstream plant distribution is determined more by competitive ability or tolerance to shading and downstream by tolerance to physiological stress (Crain et al. 2004). This mimics the distribution along elevation gradients described above.

Along the Mattaponi River (Virginia), a tributary of Chesapeake Bay, communities closer to the downstream end of the tidal fresh zone had more species that can also occur in oligohaline habitats, while the dominant species of upriver sites near the upper limit of the tidal effect were almost entirely freshwater species (Darke & Megonigal 2003); the two sites were only 19 km apart. On the nearby Pamunkey River (Virginia), TFW, while sizable, occur on the inside of only a few wide bends in the river, but alternate with tidal swamps that occur within the next upriver bend, and oligohaline wetlands that occur within the next downriver bend, distances of <1 km (R. Rheinhardt pers. comm.). Differences in composition may also be related to salt pulses associated with storm events or periods of drought (Peterson & Baldwin 2004a, b), which are considered below.

In the Nanticoke River watershed (Maryland and Delaware), Peterson and Baldwin (2004a) found that seed banks of marshes and of hummocks and hollows in swamps varied linearly along the river and its tributaries. Specifically, taxa and seedling density decreased with increasing distance up-



stream in swamp hollows and hummocks, but increased or remained constant in marshes. The observed variation across the tidal landscape in swamps may have been due to periodic saltwater pulses in the lower reaches of the tidal fresh water zone that stunted trees and shrubs and created a high light environment capable of supporting a well-developed herbaceous understory and subsequent seed bank. Along the Pamunkey River, however, the stunted nature of trees >35 km upriver appears associated with hydrologic stress (R. Rheinhardt pers. comm.).

The impact of salinity on species richness deserves more attention, given the potential occurrence of salt pulses and to projected estimates of sea level rise. In a study of oligohaline marshes on the Connecticut River, Warren et al. (2001) found that richness was consistently higher in mid-salinity than at either the lowest or highest salinity sites (seven locations ranging from fresh/oligohaline to polyhaline). Similarly, Senerchia-Nardone and Holland (1985) found a greater number of species occurred at the more brackish of two sites, which were located on opposite banks of the river.

Sedimentation regimes may differ within an estuary. In the St. Lawrence Estuary (Canada), upstream TFW receive water with little sediment and do not experience the sediment deposits characteristic of wetlands farther down the estuary (Serodes & Troude 1984). In a Delaware River study, Field and Phillip (2000) reported decreases in high marsh area and increase in low marsh over 20 yr in all sites except the most upstream one. These differences within the estuary were attributed to changes and differences in sedimentation over time and with location.

Other within-estuary effects have been observed in species range changes in the Delaware estuary. More species, both brackish and freshwater, have extended ranges since 1950 while fewer species have reduced ranges, and several intertidal endemics, notably *Amaranthus cannabinus*, *Bidens bidentoides*, and *Sagittaria subulata* have had no range change (Schuyler et al. 1993). Possible reasons for expanded ranges include seasonal shifts in chlorides and dissolved solids, adverse environmental impacts caused by industrial development, increased impact of brackish water, habitat elimination, and introduction of brackish species in ballast dumped in freshwater areas. These explanations are, however, only hypotheses and the causes of range expansion are poorly understood (Schuyler et al. 1993).

In addition to hydrology and sedimentation, species vary in their tolerances to salinity, dependent in part on growth strategies (Howard & Mendelssohn 1999b). In estuaries, TFW in the oligohaline transition boundary may experience periodic salt-water pulses during storms and, over a longer period, during periods of low water flow (e.g., late summer and early autumn). Responses to salinity, and the resultant impact on structure and composition of vegetation, depend on the ability of individual species to recover and the intensity and duration of the stress. Competitive displacement due to physical factors and biotic interactions played important roles in a New England transplantation study that examined

species tolerance of salt and oligohaline species along elevation and salinity gradients (Crain et al. 2004). However, in the absence of competition, the 10 test species grew best in the lowest salinity wetlands.

Thus, the salinity gradient may change spatially and temporally, depending on water flow, wind, and tidal factors. A small increase during drought one summer may alter plant composition for several years (Odum et al. 1984) and in tidal swamps, where trees are already at the edge of their tolerance range, the change may be permanent (R. Rheinhardt pers. comm.). The impact of salinity in systems where freshwater flow is regulated by dams can be seen in the distribution of certain salt-tolerant species (i.e., *Distichlis spicata*, *Spartina patens*) across a salinity gradient (Crain et al. 2004).

On the Pacific coast, fluctuations in seasonal rainfall strongly influence marsh wetlands at oligohaline boundaries. During a severe 2 yr drought, many species responded not only with declines in growth, but also shifts in elevation (Atwater et al. 1979). Similarly, where former wetlands had been reclaimed for agriculture, levee breaks in the California Delta island system further diverted freshwater flow patterns, bringing brackish water farther inland. For example, a break in the Jones Track levee during June 2004 resulted in a 5 ppt salinity increase in the western Delta, a usually freshwater region (S. Siegel pers. comm.).

Crain et al. (2004) note a paradox – the highest species richness occurs where competition is highest. This, too, is observed in TFW along elevation gradients (Fig. 2). In some estuaries, however, the transition zones from fresh to salt water may have the highest plant species richness due to combinations of species overlapping in tolerances (L. Schile, V. Parker, M. Vasey & J. Callaway pers. obs.). Underlying mechanisms have not been studied and comparative data for multiple sites are lacking.

## Geographic effects

On the Atlantic coast from the St. Lawrence River in Canada to Florida, the composition of the vegetation of TFW, not unexpectedly, changes with latitude, but no systematic comparison has been made. Thus, patterns and causes of latitudinal variation are poorly understood. In the north, the presence of ice and scouring by ice influence patterns of sediment distribution that, undoubtedly have profound biological effects (Lavoie et al. 2003). The most widely distributed species appear to be *Zizania aquatica*, an annual distinguished as var. *brevis* in the north and var. *aquatica* in the south, and the perennials *Peltandra virginica*, *Pontederia cordata*, and *Sagittaria latifolia*.

Along the Pacific coast, *Juncus balticus*, *Potentilla anserina* spp. *pacifica*, *Schoenoplectus acutus*, *Typha angustifolia*, and *T. latifolia* are found in all three estuaries that have been examined (Table 5). Other TFW species include *Athyrium filix-femina* var. *cyclosorum*, *Epilobium ciliatum*, *Juncus effusus*, *Oenanthe sarmentosa*, and *Urtica dioica*.



Interestingly, relatively more salt-tolerant species, such as *Carex lyngbyei*, dominate low marshes than high marshes along the Pacific coast. However, as Mediterranean-climate conditions intensify southward along the California coast, freshwater species such as *Schoenoplectus acutus* and *Phragmites australis* dominate low marsh areas where more tidal flushing occurs, while more halophytic species, such as *Distichlis spicata* and *Jaumea carnosa*, dominate the higher portions of marshes that are less frequently flooded and accumulate salt (4-10 ppt). TFW in Washington and Oregon often are dominated by *Carex lyngbyei*, *Eleocharis palustris*, *Schoenoplectus americanus*, and *S. tabernaemontani*. *Carex lyngbyei* frequently forms pure stands in both low and high marsh areas (Eilers 1975, Jefferson 1975, Burg et al. 1980, Ewing 1986). In the Columbia River estuary, TFW can be found as far as 164 km from the mouth of the river and are principally dominated by *Carex lyngbyei*, *S. americanus* and *S. tabernaemontani*, with woody forests or swamps encroaching from higher ground in many sites (Jefferson 1975, Christy & Putera 1992).

Away from the Pacific Maritime climatic influence in the San Francisco Bay-Delta, TFW are dominated by *Schoenoplectus acutus* and *S. californicus*, which often exceed 3 m in height. *Typha* species (*T. angustifolia*, *T. latifolia* and hybrids) are also frequent in freshwater tidal areas, as is *Phragmites australis*. *Schoenoplectus americanus* is abundant in wetlands with a slight saline influence and can range from 30 to 200 cm tall depending on wetland location (L. Schile & V. Parker pers. obs.); however, it is replaced by *Bolboschoenus maritimus* in brackish tidal wetlands. In addition, Pacific coast TFW contain a number of other widespread species, including *Calystegia sepium*, *Epilobium ciliatum*, *Juncus balticus*, *Lythrum californicum*, *Mimulus guttatus*, *Oenanthe sarmentosa*, and *Polygonum punctatum*. In slightly brackish conditions, additional species include *Distichlis spicata*, *Euthamia occidentalis*, *Pluchea odorata*, and *Potentilla anserina* ssp. *pacifica*.

As in Atlantic coast areas, few complete lists of species are available for most of the Pacific coast, making it difficult to compare floristic patterns. The Delta region of California is reported to have over 90 native wetland species, while over 130 have been found on Browns Island, an oligohaline ancient wetland located at the confluence of the San Joaquin and Sacramento Rivers (Knight 1980) (146 species are listed in Mason 1957). Some, like *Bidens laevis*, *Phragmites australis*, *Polygonum punctatum*, *Sagittaria latifolia*, *Typha angustifolia*, and *T. latifolia* are widespread species found across North America. Other species, including dominants, are either restricted to the Pacific coast (e.g., *Potentilla anserina* ssp. *pacifica*) or even more locally restricted (*Lilaeopsis masonii*) (Mason 1957, Hickman 1993).

The prevalence of tidal freshwater swamps in the East appears related to geomorphology and to the presence of coastal plain from New Jersey south. However, they occur along the Connecticut and St. Lawrence Rivers, e.g., but have received little attention (R. Tiner pers. comm.). On the

Pacific coast, swamps are present although their extent is more limited and are primarily located in Oregon and Washington, reflecting rainfall patterns.

Also in the east (New Jersey), certain species (*Aeschynomene virginica*) occur in coastal tidal Pine Barrens rivers (Maurice River), but not along the Delaware River; others are not found along the Maurice River system (e.g., *Gratiola virginiana*, *Elatine americana*), but occur along the Delaware River; while still others occur in both river systems (*Bidens bidentoides*, *Bidens frondosa* var. *anomala* (Ferren 1975/1976). Another floristic study of TFW species (Ferren & Schuyler 1980) found that the Delaware and Raritan River systems were similar, but different from the Mullica and Great Egg Harbor River systems, which originate in the Pine Barrens and were similar to each other. The Delaware and Raritan systems had affinities with both the Hudson system to the north and the Chesapeake to the south. Brackish species, however, were collected in both groups, indicating the importance of salinity in distribution patterns.

## SPECIES OF SPECIAL INTEREST (ANNUALS, RARE, AND INVASIVE SPECIES)

### Annuals

Why are annuals such an important component of TFW in Atlantic coast estuaries? It may be that annuals are maintained by the continuing disturbance caused by sea level rise and sedimentation (Orson et al. 1992; Chapter 13), coupled with frost heaving in winter. Another factor may be the morphology and growth phenology of the dominant perennial species (e.g., *Acorus calamus*, *Peltandra virginica*), which form a relatively open canopy that dies back completely to the ground during the winter. This canopy architecture allows recruitment and growth of annual seedlings. In contrast, seedling recruitment is rare in wetlands dominated by dense perennial grasses, such as *Phragmites* and *Spartina*, or by *Typha* spp. that have a dense canopy that persists through the winter (Baldwin & Mendelsohn 1998).

Along the Pacific coast, TFW are dominated by large herbaceous species (*Schoenoplectus* spp., *Typha* spp. and *Phragmites*), as well as a few shrubs. Annual species do not form dominant patches, but a number of annuals, including *Calystegia sepium*, *Polygonum persicaria*, and *P. punctatum* are prevalent in the community. These species, other annuals, and short-lived perennials all increase in frequency and abundance with disturbance. Interestingly as noted earlier, Barrett (1994) found a “paucity” of annuals in Connecticut River sites compared to the Delaware River, suggesting that this could be related to a delay in the onset of the vegetative season.

**Table 6.** Rare, threatened, and endangered plant species of New Jersey tidal freshwater marshes. Life forms are annual (A) and perennial (P). Also indicated is occurrence in brackish marshes (x). Source: NJ Department of Environmental Protection rare species database, courtesy D. Snyder and E. Williams (pers. comm.).

| Species  | Life Form | Brackish |
|--|-----------|----------|
| <i>Aeschynomene virginica</i>                            | A         | x        |
| <i>Bidens bidentoides</i>                                | A         | x        |
| <i>Bidens eatoni</i>                                     | A         |          |
| <i>Callitriche palustris</i>                             | A         |          |
| <i>Cardamine longii</i>                                  | A?        |          |
| <i>Cuscuta polygonorum</i>                               | A         |          |
| <i>Cyperus engelmannii</i>                               | A         |          |
| <i>Cyperus polystachyos</i>                              | A         |          |
| <i>Elatine americana*</i>                                | A         | x        |
| <i>Eriocaulon parkeri</i>                                | P         |          |
| <i>Eryngium aquaticum</i> var. <i>aquaticum</i>          | P         |          |
| <i>Fuirena squarrosa</i>                                 | P         |          |
| <i>Gratiola virginiana</i>                               | A         | x        |
| <i>Heteranthera multiflora</i>                           | A?        | x        |
| <i>Hydrocotyle verticillata</i> var. <i>verticillata</i> | P         | x        |
| <i>Isoetes riparia</i> var. <i>riparia</i>               | P         | x        |
| <i>Limosella australis</i>                               | A         |          |
| <i>Micranthemum micranthemoides</i>                      | A         | x        |
| <i>Myriophyllum tenellum</i>                             | P         |          |
| <i>Nelumbo lutea</i>                                     | P         |          |
| <i>Sagittaria calcyina</i> var. <i>spongiosa</i>         | P         |          |
| <i>Sagittaria subulata</i>                               | P         | x        |
| <i>Schoenoplectus maritimus</i>                          | P         | x        |
| <i>Schoenoplectus smithii*</i>                           | A         | x        |
| <i>Utricularia biflora</i>                               | P         |          |
| <i>Utricularia gibba</i>                                 | P         |          |
| <i>Wolffiella gladiata</i>                               | P         |          |

\* Species added based on Leck & Leck (2005).

### Rare species

Status and distribution of estuarine endemics and rare species deserves discussion. Limited data, based on dissimilar data sets, suggest an increase in rare species (Federal or state-listed, or species of concern) with decreasing latitude: 0 species along the St. Lawrence River (Québec, Canada), 9 in three Connecticut River sites, and 27 in New Jersey (M. Jean pers. comm., Barrett 1994, see: Table 6). However, perhaps due to relative isolation and more extreme winter climate, a dozen endemic varieties are reported from the St. Lawrence region (*Bidens tripartida* var. *orthocoxa* (not listed by ITIS), *Cicuta maculata* var. *victorinii*, *Deschampsia cespitosa* var. *intercotidalis* (NA by ITIS), *Epilobium ciliatum* var. *ecomosum*, *Gentiana crinita* var. *victorinii* (NA), *Gratiola neglecta* var. *glaberrima* (NA), *Helenium autumnale* var. *fylesii*, *Lycopus americanus* var. *laurentianus*, *Mimulus ringens* var. *colpophilus*, and *Zizania aquatica* var. *brevis*) (Baillargeon 1981 cited in NWWG 1988).

Comparison of tidal rare, endangered, or threatened species in New Jersey found similar numbers in freshwater and

brackish, and fewest in salt marshes. Of the 27 TFW species (Table 6), 11 also occur in brackish tidal wetlands, but none also occur in salt marshes. However, three of the estuarine endemics, *Amaranthus cannabinus*, *Bidens bidentoides* and *Sagittaria subulata* are recorded for the Delaware estuary, none of which have been widely studied (Schuyler et al. 1993). Certain rare species of TFW habitats, such as *Eriocaulon parkeri*, have been extirpated along some rivers (e.g., Delaware River) (Schuyler et al. 1993), but may occur regionally along others (Mullica and Maurice Rivers) (JCN-ERR 1999, M. Leck pers. obs.). Causes of extirpations and distribution changes may be related to habitat loss or degradation, but are not well understood (Schuyler 1986).

Recent studies suggest that many rare species depend on open patches created by disturbances. Griffith and Forseth (2003) found that *Aeschynomene virginica* established and reproduced best in patches where vegetation was removed either experimentally or by muskrats (*Ondatra zibethicus*). Leck and Leck (2005) reported 11 rare/endangered species that found suitable establishment niches during the first 4-5 yr following construction of a created wetland compared to one species in reference sites. Barrett (1994) reported that rare species in Connecticut River sites appeared more often in species-poor vegetation types.

Along the Pacific coast, freshwater and brackish tidal wetlands are typically dominated by only a few species, but may contain a large number of rare or less frequent species. Some species are rare due to habitat loss (e.g., *Hibiscus lasiocarpus*), but others may be of more recent evolutionary origin or restricted to specific habitats (*Lathyrus jepsonii* var. *jepsonii*, *Lilaeopsis masonii*). *Sagittaria sanfordii*, for example, was reported to cover extensive areas in the San Francisco Bay-Delta freshwater tidal areas prior to agricultural development of the region, but now is rare (Mason 1957, CNPS 2001). Other rare species include *Carex interrupta*, *Epipactis gigantea*, *Lindernia dubia*, *Rorippa columbiae*, and *Scirpus cyperinus* in Oregon and Washington, and in transition to brackish wetlands, *Cordylanthus mollis* ssp. *mollis* and *Cirsium hydrophilum* var. *hydrophilum* in California.

### Invasive species

In the East, non-native species (or varieties), including *Phalaris arundinacea* and *Phragmites australis*, may form dense stands that contribute to vegetation changes (see: Chapter 9). The most important invasive in TFW in New England, as well as in mid-Atlantic estuaries, appears to be *P. australis* (Farnsworth & Meyerson 1999, 2003, Rice et al. 2000, Leck 2003). An increase in invasiveness seems likely because McCormick and Ashbaugh (1972), Good and Good (1974/1975), or Whigham and Simpson (1975) did not report it as an important community type in three Delaware River TFW. Moreover, McCormick and Ashbaugh report several other species having high frequency and/or cover in stands with *P. australis*. Evidence suggests that increased invasive-

ness is due to expansion of an introduced genotype because rapid invasion along the lower Connecticut River estuary appeared not to be related to tidal restriction or disturbance (Warren et al. 2001).

In contrast to and despite its reputation, *Lythrum salicaria* in a Delaware River-constructed wetland had no long-term impact on richness (Leck 2003, Leck & Leck 2005). In fact, *L. salicaria* may be uncommon probably because dense colonies decline allowing establishment of native species (Lavoie et al. 2003 and references cited therein). In addition, *Lythrum salicaria* and *Phragmites australis*, as well as *Butomus umbellatus*, are not important in St. Lawrence River TFW, especially in downriver areas, possibly due to the high-amplitude tides and to the species-poor, but dense, populations of native species that resist invasion (Lavoie et al. 2003).

Invasive species represent a considerable problem in many of the Pacific coast wetlands, especially in Oregon and Washington. *Amorpha fruticosa*, *Iris pseudacorus*, *Lythrum salicaria*, and *Phalaris arundinacea* are considered noxious weeds and invade disturbed as well as undisturbed wetlands (Apfelbaum & Sams 1987, Christy & Putera 1992, Glad & Halse 1993). While these species also occur further south in the San Francisco Bay-Delta region (Raven & Thomas 1970, Knight 1980, Grossinger et al. 1998), they are not yet a problem. Moreover although the San Francisco Bay-Delta estuary has been considered one of the most invaded estuaries in the world (Cohen & Carlton 1998), the majority of the invasive species are invertebrates and fish. Invasive vascular plants such as *Lepidium latifolium*, and to a lesser degree, *Arundo donax* and *Eichhornia crassipes*, commonly invade and pose a long-term problem for restoration and management (Young et al. 1997, Grossinger et al. 1998, Renz 2002).

## CONCLUSIONS AND FUTURE STUDIES

The factors driving the structure of TFW result from a complex and dynamic interplay among abiotic and biotic processes (Pasternack et al. 2000). Elevation, as noted by Pasternack et al. (2000), is not a constant feature, but is variable and changes through time as a function of sedimentation that, in turn, is dependent on plant communities, distance to tidal inlet, distance to stream, elevation, and sea level rise, as well as animal activity. Observations indicate an underlying sensitivity of tidal freshwater plant communities to hydrogeomorphic conditions (Pasternack & Brush 2002). Along Atlantic and Pacific coasts of North America, threats to TFW are similar and include: reclamation for agriculture, filling, erosion, excess nutrients, altered hydrology, invasion of non-native plants, and nuisance animal species (Ehrenfeld 2000, Baldwin 2004) although rates of loss appear to have slowed in recent years in some areas (e.g., St. Lawrence River, M. Jean pers. comm.). Surprisingly little is known about TFW compared to their saline counterparts, particularly on

the Pacific coast (Mitsch & Gosselink 2000). TFW are highly productive and provide refuge for many birds, fish, and invertebrates; however, they have been highly altered and destroyed, and have proven difficult to restore. Restoration efforts along the Pacific coast are increasing because of the recognition of these habitats as critical for salmon and other organisms (Healey 1982, Myers & Horton 1982). Subsidence of diked wetlands is a critical issue for restoration, especially in the freshwater end of the gradient where soils are predominantly organic (Atwater & Belknap 1980, Williams & Orr 2002). In the San Francisco Bay-Delta region, many restoration efforts have created tidal lakes due to high subsidence rates (3-5 m range) that occurred while the areas were diked. Adding material to raise elevations has met with some success in salt marsh areas (e.g., Williams & Faber 2001, Cornu & Sadro 2002), but in the San Francisco Bay-Delta TFW, the low density, high organic soils tend to compact because of their lower bearing capacity (Orr et al. 2003).

Based on data available from Atlantic (AC), Gulf (GC), or Pacific coast (PC) studies, we recognize the following emerging patterns:

- Hydrologic gradients drive horizontal distribution and, thus, zonation of vegetation (AC, PC).
- Sedimentation appears to be a driving force maintaining TFW (AC, GC)
- Seasonal inequalities in precipitation cause salinity impact at oligohaline boundaries (AC, PC).
- Seed banks and establishment vary locally and across the landscape (AC, GC).
- Seasonal and inter-annual variations occur in seed banks and vegetation due to the importance of annual species (AC).
- Dispersability, seed germination requirements, and seedling tolerances drive establishment patterns (AC).
- Animals are important constraints on vegetation structure (AC, GC).

We suggest that future studies of TFW consider the following: (1) The relative importance of stresses, including biotic (competition), physical (inundation, sedimentation), and chemical (salinity, eutrophication), across elevation, regional, and geographic gradients. How these stresses impact life history stages is especially important as TFW continue to be influenced by sea level rise. (2) Comparative ecophysiology studies would shed light on growth strategies and competitive abilities that relate to vegetation patterns. (3) The roles of annual species and mechanisms by which they are sustained. Are generalizations about the importance of annuals, based on Atlantic coast studies, broadly applicable? (4) How do intrinsic factors compare with extrinsic in the distribution of rare and invasive species within and among river systems? (5) Can understanding seed dispersal, as well as seed bank and seedling dynamics, help prevent degradation and further wetland loss, and enhance restoration efforts? (6)

Responses of Pacific coast wetlands, which can be older than Atlantic coast wetlands (1000 vs. 500 yrs), to sea level rise and other perturbations deserve study. (7) More needs to be learned about tidal freshwater swamp distribution and vegetation dynamics.

Finally, the context of future research inevitably will incorporate the changes in global climate (e.g., Day et al. 2005, Osborn & Briffa 2006) and the subsequent rapid sea level rise (Rignot & Kanagaratnam 2006) that will have ongoing impacts on all tidal ecosystems. Future studies need to establish careful baseline information on all aspects of their system to control for or directly study such influences. Sadly, we are just beginning to investigate TFW at a time when global climate and sea level changes cause background manipulation of processes before overall understanding of these systems is possible.

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## REFERENCES

The references in this volume derive from the international literature (e.g., periodicals) and moreover, due to the review of many less-described aspects, also from local periodicals, books and reports from North America and Europe. To assist the reader we incorporated the town and country of publication, except for the well-known cities New York, Washington, London, Amsterdam, Berlin and Paris. Some countries frequently mentioned are indicated by an abbreviation: USA (United States of America; in the reference the town including the state), UK (United Kingdom), DK (Denmark), GER (Germany), NL (The Netherlands), BEL (Belgium), and FR (France). The sequence of the references is alphabetically for the one- and two author publications; the publications with three and more authors (et al.) are arranged by year of publication, eventually followed by the indication a or b. SI = Special Issue.

- Abbott CC (1898) Travels in a tree-top. J.B. Lippincott Co., Philadelphia, PA, USA.
- Able KW, Hagan SM & Brown SA (2003) Mechanisms of marsh habitat alteration due to *Phragmites*: response of young-of-the-year mummichog (*Fundulus heteroclitus*) to treatment for *Phragmites* removal. *Estuaries* 26: 484-494.
- Adams MA & Williams GL (2004) Tidal marshes of the Fraser River estuary: composition, structure, and history of marsh creation efforts to 1997. In: Groulx BJ, Mosher DC, Luternauer JL & Bilderback DE (eds) Fraser River delta, British Columbia: issues of an urban estuary, Geological Survey of Canada Bulletin 567, pp. 147-172. Geological Survey of Canada, Vancouver, BC, Canada.
- Aerts R (1997) Climate, leaf litter chemistry and leaf litter decomposition in terrestrial ecosystems: a triangular relationship. *Oikos* 79: 439-449.
- Ahnert F (1988) Modeling landform change. In: Anderson MG (ed) Modelling geomorphological systems, pp. 375-400. John Wiley and Sons, New York.
- Alaska Department of Fish and Game (2000) Alaska Department of Fish and Game writer's guide. Alaska Department of Fish and Game, Juneau, AK, USA.
- Alaska Department of Fish and Game (2006) Copper River critical habitat area (<http://www.wildlife.alaska.gov>).
- Alexandre A, Meunier J-D, Colin F & Koud J-M (1997) Plant impact on the biogeochemical cycle of silicon and related weathering processes. *Geochimica et Cosmochimica Acta* 61: 677-682.
- Allanson B & Baird D (1999) Estuaries of South Africa. Cambridge University Press, Cambridge, UK.
- Allen JA (1992) Cypress-tupelo swamp restoration in southern Louisiana. *Restoration and Management Notes* 10: 188-189. USA.
- Allen JA, Pezeshki SR & Chambers JL (1996) Interaction of flooding and salinity stress on baldcypress (*Taxodium distichum*). *Tree Physiology* 16: 307-313.
- Allin CC (1993) Mute swan mid-summer survey report for the Atlantic flyway. Rhode Island Department of Environmental Management, Division of Fish and Wildlife, Providence, RI, USA.
- An S & Gardner WS (2002) Dissimilatory nitrate reduction to ammonium (DNRA) as a nitrogen link, versus denitrification as a sink in a shallow estuary (Laguna Madre/Baffin Bay, Texas). *Marine Ecology Progress Series* 237: 41-50.
- Anderson AB & Schmidt RE (1989) Survey of larval and juvenile fish populations in water-chestnut (*Trapa natans*) beds in Tivoli South Bay, a Hudson river tidal marsh. In: Blair EA & Waldman JR (eds) Polgar fellowship reports of the Hudson River National Estuarine Research Reserve Program, pp. vi-1-34. Hudson River Foundation, New York.
- Anderson RR, Brown RG & Rappleye RD (1968) Water quality and plant distribution along the upper Patuxent River, Maryland. *Chesapeake Science* 9: 145-156. USA.
- Ankney CD (1995) An embarrassment of riches: too many geese. *Journal of Wildlife Management* 60: 217-223.
- Antunes C & Costa Dias S (2005) The faunal composition of the euryhaline section of the Lima river estuary. *Journal of Ichthyology* 45 (Suppl. 1): 163-170.
- Antunes C & Weber M (1996) The glass eel fishery and the by-catch in the Rio Minho after one decade (1981-1982 and 1991-1992). *Archives of Polish Fisheries* 4: 131-139.
- AOU (American Ornithologists' Union) (1998) Check list of North American birds. American Ornithologists' Union, Washington, DC, USA.
- Apfelbaum SI & Sams CE (1987) Ecology and control of reed canary grass (*Phalaris arundinacea* L.). *Natural Areas Journal* 7: 69-74. USA.
- Arendse MC & Barendregt A (1981) Magnetic orientation in the semi-terrestrial amphipod *Orchestia cavimana*, and its interrelation with photo-orientation and water loss. *Physiological Entomology* 6: 333-342.
- ARGE Elbe (1991) Das oberflächennahe Zoobenthos der Elbe als Indikator für die Gewässerqualität. Wassergütestelle Elbe. Arbeitsgemeinschaft für die Reinhaltung der Elbe, Hamburg, GER.
- ARGE Elbe (2002) Wassergütedaten der Elbe. Zahlentafel 1999. Arbeitsgemeinschaft für die Reinhaltung der Elbe, Hamburg, GER.
- Arthur JF, Ball MD & Baughman SY (1996) Summary of federal and state water project environmental impacts in the San Francisco Bay-Delta Estuary, California. In: Hollibaugh JT (ed) San Francisco: the ecosystem, pp. 445-495. Pacific Division, AAAS, San Francisco, CA, USA.
- Aschenberg H (1992) Deichschutz und Binnenentwässerung im Stromspaltungsgebiet der Elbe im Raum Hamburg. In: Kramer J & Rohde H (eds) Historischer Küstenschutz – Deichbau, Inseln und Binnenentwässerung an Nord- und Ostsee, pp. 289-318. Verlag Konrad Wittwer, Stuttgart, GER.
- Asselman NEM & Van Wijngaarden M (2002) Development and application of a 1D floodplain sedimentation model for the River Rhine in The Netherlands. *Journal of Hydrology* 268: 127-142.
- Attrill MJ (1998) A rehabilitated estuarine ecosystem: the environment and ecology of the Thames estuary. Kluwer Academic Publishers, Dordrecht, NL.
- Attrill MJ (2002) A testable linear model for diversity trends in estuaries. *Journal of Animal Ecology* 71: 262-269.

- Attrill MJ, Rundle SD & Thomas RM (1996) The influence of drought-induced low freshwater flow on an upper-estuarine macroinvertebrate community. *Water Resources* 30: 261-268.
- Atwater BF & Belknap DF (1980) Tidal-wetland deposits of the Sacramento-San Joaquin Delta, California. In: Douglas RG, Bouma AH, Ingle JC & Colburn IP (eds) Quaternary depositional environments of the Pacific Coast, pp. 89-103. Pacific Coast Paleogeography Symposium 4, Field ME. Pacific Section Society Economic Paleontologists and Mineralogists, Los Angeles, CA, USA.
- Atwater BF (1979) Ancient processes at the site of Southern San Francisco Bay, movement of the crust and changes in sea level. In: Conomos TJ (ed) San Francisco Bay: the urbanized estuary, pp. 31-45. American Association Advancement Science, Pacific Division, San Francisco, CA, USA.
- Atwater BF (1987) Evidence for great Holocene earthquakes along the outer coast of Washington State. *Science* 236: 942-944.
- Atwater BF, Hedel CW & Helley EJ (1977) Late Quaternary depositional history, Holocene sea-level changes, and vertical crustal movement, southern San Francisco Bay, California. Professional Paper 1014. United States Geological Survey, San Francisco, CA, USA.
- Atwater BF, Conrad SG, Dowden JN, Hedel CW, MacDonald RL & Savage W (1979) History, landforms, and vegetation of the estuary's tidal marshes. In: Conomos TJ (ed) San Francisco Bay: the urbanized estuary, pp. 347-385. American Association for the Advancement of Science, Pacific Division, San Francisco, California, USA.
- Aust WM, Mader SF, Mitchell LJ & Lea R (1990) An approach to the inventory of forested wetlands for timber-harvesting impact assessment. *Forest Ecology and Management* 33-34: 215-225.
- Austin K & Findlay S (1989) Benthic bacterial biomass and production in the Hudson River Estuary. *Microbial Ecology* 18: 105-116.
- Avoine J, Allen JP, Nichols M, Salomon JC & Larssonneur C (1981) Suspended-sediment transport in the Seine Estuary, France: effects of man-made modifications on estuary-shelf sedimentology. *Marine Geology* 40: 119-137.
- Baeyens G & Martinez ML (2004) Animal life on coastal dunes: from exploitation and prosecution to protecting and monitoring. In: Martinez ML & Psutty NP (eds) Coastal dunes, Ecology and Conservation, pp. 280-296. Ecological Studies 171, Springer-Verlag, Berlin.
- Baeyens W (2005) Overview of trace metal contamination in the Scheldt estuary and effect of regulatory measures. *Hydrobiologia* 540: 141-154.
- Bailey DE, Perry JE & DeBerry DA (2006) *Aeschynomene virginica* habitat in a tidal freshwater marsh, James City County, Virginia, USA. *Banisteria* 27: 3-9. USA.
- Bakker J & Van Duijn H (1999) Effecten van inundatie op de Mariapolder. MSc Thesis Physical Geography, Utrecht University, Utrecht, NL.
- Baldwin AH (2004) Restoring complex vegetation in urban settings: the case of tidal freshwater marshes. *Urban Ecosystems* 8: 125-137.
- Baldwin AH (2007) Vegetation and seed bank studies of salt-pulsed swamps of the Nanticoke River, Chesapeake Bay. In: Conner W, Doyle T & Krauss K (eds) Ecology of tidal freshwater swamps of the southeastern United States, pp. 139-160. Springer-Verlag, Berlin.
- Baldwin AH & DeRico EF (1999) The seed bank of a restored tidal freshwater marsh in Washington, DC. *Urban Ecosystems* 3: 5-20.
- Baldwin AH & Mendelssohn IA (1998) Response of two oligohaline marsh communities to lethal and nonlethal disturbance. *Oecologia* 116: 543-555.
- Baldwin AH & Pendleton FN (2003) Interactive effects of animal disturbance and elevation on vegetation of a tidal freshwater marsh. *Estuaries* 26: 905-915.
- Baldwin AH, McKee KL & Mendelssohn IA (1996) The influence of vegetation, salinity, and inundation on seed banks of oligohaline coastal marshes. *American Journal of Botany* 83: 470-479.
- Baldwin AH, Egnotovitch MS & Clarke E (2001) Hydrologic change and vegetation of tidal freshwater marshes: field, greenhouse, and seed bank experiments. *Wetlands* 21: 519-531.
- Baldwin AH, Hammerschlag RS & Cahoon DR (2009) Evaluation of restored tidal freshwater wetlands. In: Perillo GME, Wolanski E, Cahoon DR & Brinson MM (eds) Coastal wetlands: an integrated ecosystem approach, pp. 801-831. Elsevier, Oxford, UK.
- Barbour JG & Kiviat E (2007) Middle Ground Island. Hudsonia Ltd., Annandale, NY, USA.
- Barbour S & Kiviat E (1986) A survey of Lepidoptera in Tivoli North Bay (Hudson River Estuary). In: Cooper JC (ed) Polgar Fellowship Reports of the Hudson River National Estuarine Sanctuary Program, 1985, pp. iv-1 to iv-26. New York State Department of Environmental Conservation, Annandale, NY, USA.
- Barendregt A (1980) Vergelijkend onderzoek naar de aktieve bodemfauna van de getijdengrienen langs Oude Maas (Z.H.). MS Thesis, Zoological Museum, Utrecht University, NL.
- Barendregt A (2005) The impact of flooding regime on ecosystems in a freshwater tidal area. *Ecology & Hydrobiology* 5: 95-102.
- Barendregt A, Whigham D, Meire P, Baldwin A & Van Damme S (2006) Wetlands in the tidal freshwater zone. In: Bobbink R, Beltman B, Verhoeven JTA & Whigham DF (eds) Wetlands: function, biodiversity, conservation, and restoration, Ecological Studies - Volume 191, pp. 117-148. Springer-Verlag, Berlin.
- Barras JA, Beville S, Britsch D, Hartley S, Hawes S, Johnston J, Kemp P, Kinler Q, Martucci A, Porthouse J, Reed D, Roy K, Sapkota S & Suhayda J (2003) Historical and projected coastal Louisiana land changes: 1978-2050. USGS Open File Report 03-334, Lafayette, LA, USA.
- Barrett NE (1994) Vegetation patch dynamics in freshwater tidal wetlands. PhD Dissertation, The University of Connecticut. Storrs, CT, USA.
- Bart D & Hartman JM (2003) The role of large rhizome dispersal and low salinity windows in the establishment of common reed, *Phragmites australis*, in salt marshes: new links to human activities. *Estuaries* 26: 436-443.
- Bartlett KB, Bartlett DS, Harriss RC & Sebacher DI (1987) Methane emissions along a salt marsh salinity gradient. *Biogeochemistry* 4: 183-202.
- Bartoldus CC (1990) Revegetation and production in a constructed freshwater tidal marsh. PhD Dissertation, George Mason University, Fairfax, VA, USA.
- Bartoldus CC & Heliotis FD (1989) Factors affecting survival of planted materials in Marley Creek constructed freshwater tidal marsh, Maryland. *Transportation Research Record* 1224: 1-5. USA.

- Bartoli F (1983) The biogeochemical cycle of silicon in two temperate forest ecosystems. *Ecological Bulletin* 35: 469-476.
- Bazzaz FA (1990) The response of natural ecosystems to the rising global CO<sub>2</sub> levels. *Annual Review of Ecology and Systematics* 21: 167-196.
- Bedford BL, Walbridge MR & Aldous A (1999) Patterns in nutrient availability and plant diversity of temperate North American wetlands. *Ecology* 80: 2151-2169.
- Beerling DJ & Perrins JM (1993) Biological flora of the British Isles. *Impatiens glandulifera* Royle (*Impatiens roylei* Walp.). *Journal of Ecology* 81: 367-382.
- Bélanger L & Bédard J (1994) Role of ice scouring and goose grubbing in marsh plant dynamics. *Journal of Ecology* 82: 437-445.
- Bell M (2000) Intertidal peats and the archaeology of coastal change in the Severn Estuary, Bristol Channel and Pembrokeshire. In: Pye K & Allen JRL (eds) Coastal and estuarine environments: sedimentology, geomorphology and geoarchaeology. Special Publications 175: 377-392. Geological Society, London.
- Below H (2006) Das Naturschutzgebiet Heuckenlock und seine Vegetation: Süßwasser-Gezeitenbereich der Elbe (Nachexkursion). In: Härdtle W, Horst K & Prüter J (eds) Jahrbuch des Naturwissenschaftlichen Vereins für das Fürstentum Lüneburg von 1851 e.v.: Flora und Vegetation im Nordöstlichen Niedersachsen, pp. 159-166. GER.
- Bendire C (1895) Life histories of North American birds, from the parrots to the grackles, with special reference to their breeding habits and eggs. *Smithsonian Contributions to Knowledge* 32 (985), Washington, DC.
- Benjamin E (1998) Squatter Shangri-La: Hudson River sites longtime vacation spots for campers without ownership. *Times Union* [Albany, New York] (3 October): D1, D5. USA.
- Benoit LK & Askins RA (1999) Impact of the spread of *Phragmites* on the distribution of birds in Connecticut tidal marshes. *Wetlands* 19: 194-208.
- Bent AC (1963) Life histories of North American marsh birds. Dover Publications, New York. (Originally published 1926 as U.S. National Museum Bulletin 135).
- Berger J & Sinton JW (1985) Water, earth, and fire: land use and environmental planning in the New Jersey Pine Barrens. Johns Hopkins University Press, Baltimore, MD, USA.
- Berggren TJ & Lieberman JT (1977) Relative contributions of Hudson, Chesapeake and Roanoke striped bass, *Morone saxatilis*, to the Atlantic coast fishery. *Fisheries Bulletin* 76: 335-345.
- Bertness MD, Ewanchuk PJ & Silliman BR (2002) Anthropogenic modification of New England salt marsh landscapes. *Proceedings of the National Academy of Sciences* 99: 1395-1398.
- Bevington AE (2007) Environmental factors and *Typha* spp. dominance in created wetlands. MS Thesis, College of William and Mary, Virginia Institute of Marine Science. Gloucester Point, VA, USA.
- Bianchi TS (2007) Biogeochemistry of estuaries. Oxford University Press, New York.
- Bildstein KL, Post W, Johnston J & Frederick P (1990) Freshwater wetlands, rainfall, and the breeding ecology of white ibises in coastal South Carolina. *Wilson Bulletin* 102: 84-98.
- Billen G & Garnier J (1997) The Phison River plume: coastal eutrophication in response to changes in land use and water management in the watershed. *Aquatic Microbial Ecology* 13: 3-17.
- Billen G, Garnier J, Ficht A & Cun C (2001) Modeling the response of water quality in the Seine river estuary to human activity in its watershed over the last 50 years. *Estuaries* 24: 977-993.
- Billen G, Garnier J & Rousseau V (2005) Nutrient fluxes and water quality in the drainage network of the Scheldt basin over the last 50 years. *Hydrobiologia* 540: 47-67.
- Birch JB & Cooley JL (1982) Production and standing crop patterns of giant cutgrass (*Zizaniopsis miliacea*). *Oecologia* 52: 230-235.
- Blagden T Jr (1992) South Carolina's wetland wilderness: the ACE Basin. Westcliffe Publishers, Englewood, CO, USA.
- Blom EAT (1996) King Rail. In: Robbins C (ed) Atlas of the Breeding Birds of Maryland and the District of Columbia, pp. 126. University of Pittsburgh Press, Pittsburgh, PA, USA.
- Blossey B, Schroeder D, Hight SD & Malecki RA (1994) Host specificity and environmental impact of two leaf beetles (*Galerucella calmariensis* and *G. pusilla*) for biological control of purple loosestrife (*Lythrum salicaria*). *Weed Science* 42: 134-140.
- Blum LK & Christian RR (2004) Belowground production and decomposition along a tidal gradient in a Virginia salt marsh. In: Fagherazzi S, Marani M & Blum LK (eds) Ecogeomorphology of tidal marshes, pp. 47-74. Coastal and Estuarine Studies 59. American Geophysical Union, Washington, DC.
- Blum MD & Tornqvist TE (2000) Fluvial responses to climate and sea-level change: a review and look forward. *Sedimentology* 47: 2-48.
- Bobbink R, Beltman B, Verhoeven JTA & Whigham DF (eds) (2008) Wetlands: functioning, biodiversity conservation, and restoration. Springer-Verlag, Berlin.
- Boesveld A (2003) Het getijdenslakje (*Mercuria confusa*) in de Sliedrechtse en Dordtse Biesbosch. Rapport Staatsbosbeheer District De Biesbosch, Werkendam, NL.
- Bonis A, Lepart J & Grillas P (1995) Seed bank dynamics and coexistence of annual macrophytes in a temporary and variable habitat. *Oikos* 74: 81-92.
- Booth PM (1989) Nitrogen and phosphorus cycling strategies in two tidal freshwater macrophytes, *Peltandra virginica* and *Spartina cynosuroides*. PhD Dissertation, The College of William and Mary. Gloucester Point, VA, USA.
- Borawa JC, Kerby JH, Huish MT & Mullis AW (1979) Currituck Sound fish populations before and after infestation by Eurasian water-milfoil. *Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies* 32: 520-528. USA.
- Bordentown Historical Society (1977) Bordentown 1682-1976. Bordentown Historical Society, Bordentown, NJ, USA.
- Boreman J & Klauda RJ (1988) Distribution of early life stages of striped bass in the Hudson River Estuary, 1974-1979. *American Fisheries Society Monograph* 4: 53-58.
- Borum J & Sand-Jensen K (1996) Is total primary production in shallow coastal marine waters stimulated by nitrogen loading? *Oikos* 76: 406-410.
- Bos MG, Repogle JA & Clemmens AJ (1984) Flow measurements flumes for open ditch systems. John Wiley, New York.
- Boshart W (2003) BA-04 West Pointe a la Hache siphon construction summary data and graphics. Coastal Restoration Division, Louisiana Department of Natural Resources, Baton Rouge, LA, USA. Accessed from <http://lacoast.gov>.



- Boudewijn TJ, Veen SM, De Boer EJP & Van der Rijt CWCJ (2001) Getij in de Crezépolder – Een modellenstudie voor mogelijke natuurontwikkeling. Rapport 01-100. Bureau Waardenburg, Culemborg, NL.
- Boudewijn TJ, Van Dam EM & De Ridder RP (2004) Sliedrechtse Biesbosch op de schop! De Levende Natuur 105: 87-92. NL.
- Bouezmarni M & Wollast R (2005) Geochemical composition of sediments in the Scheldt estuary with emphasis on trace metals. *Hydrobiologia* 540: 155-168.
- Boule ME (1981) Tidal wetlands of the Puget Sound region, Washington USA. *Wetlands* 1: 47-60.
- Bouma S, Veen SM & Bonhof GH (2002) Proefgebieden herstel zoet-zout overgangen in het Deltagebied. Rapport 02-158. Bureau Waardenburg, Culemborg, NL.
- Boumans RMJ & Day JW Jr (1993) High precision measurements of sediment elevation in shallow coastal areas using a sedimentation-erosion table. *Estuaries* 16: 375-388.
- Bowden WB (1984a) Nitrogen and phosphorus in the sediments of a tidal, freshwater marsh in Massachusetts. *Estuaries* 7: 108-118.
- Bowden WB (1984b) A nitrogen-15 isotope dilution study of ammonium production and consumption in a marsh sediment. *Limnology and Oceanography* 29: 1004-1015.
- Bowden WB (1986) Nitrification, nitrate reduction, and nitrogen immobilization in a tidal freshwater marsh sediment. *Ecology* 67: 88-99.
- Bowden WB (1987) The biogeochemistry of nitrogen in freshwater wetlands. *Biogeochemistry* 4: 313-348.
- Bowden WB, Vörösmarty CJ, Morris JT, Peterson BJ, Hobbie JE, Stuedler PA & Moore B (1991) Transport and processing of nitrogen in a tidal freshwater wetland. *Water Resources Research* 27: 389-408.
- Bowers JK (1995) Innovations in tidal marsh restoration: the Kenilworth Marsh account. *Restoration and Management Notes* 13: 155-161. USA.
- Boyle RH (1969) *The Hudson River: a natural and unnatural history*. W.W. Norton Co., New York.
- Boynton WR, Setzler EM, Wood KV, Zion HH, Homer M & Mihursky JA (1977) Potomac River fisheries program, ichthyoplankton and juvenile investigations, 1976, draft report, reference No 77-169 Chesapeake Biological Laboratory. Prepared for Power Plant Siting Program, Maryland Department of Natural Resources by University of Maryland, Center for Environmental and Estuarine Studies, Chesapeake Biological Laboratory, Solomons, MD, USA.
- Boynton WR, Polgar TT & Zion HH (1981) Importance of juvenile striped bass food habitat in the Potomac Estuary. *Transactions of the American Fisheries Society* 110: 56-63.
- Brandt R (1937) Verzeichnis der Weichtiere der Hamburgischen Umgebung. *Verhandlungen des Vereins für naturwissenschaftliche Heimatforschung zu Hamburg* 26: 71-84. GER.
- Brasse S, Nellen M, Seifert R & Michaelis W (2002) The carbon dioxide system in the Elbe estuary. *Biogeochemistry* 59: 25-40.
- Bratton JH (ed) (1991) *British Red Data Books (3) – Invertebrates other than insects*. Joint Nature Conservation Committee, Peterborough, UK.
- Breine JJ, Maes J, Quataert P, Van den Bergh E, Simoens I, Van Thuyne G & Belpaire C (2007) A fish-based assessment tool for the ecological quality of the brackish Schelde estuaria in Flanders (Belgium). *Hydrobiologia* 575: 141-159.
- Brinkkemper O & De Ridder T (2001) Het archeobotanisch onderzoek - VLAKE-verslag 2.3; Hoogstad 5.019. Vlaardingen, NL. (available at [www.archeologie.vlaardingen.nl](http://www.archeologie.vlaardingen.nl))
- Brinkkemper O, Weeda EJ, Bohncke SJP & Kuijper WJ (2008) The past and present occurrence of *Elatine* and implications for palaeoenvironmental reconstructions. *Vegetation History and Archaeobotany* 17: 15-24.
- Brinson MM, Lugo AE & Brown S (1981) Primary productivity, decomposition and consumer activity in freshwater wetlands. *Annual Review of Ecology and Systematics* 12: 123-161.
- Brinson MM, Christian RR & Blum LK (1995) Multiple stages in the sea-level induced transition from terrestrial forest to estuary. *Estuaries* 18: 648-659.
- Brion N, Billen G, Guezennec L & Ficht A (2000) Distribution of nitrifying activity in the Seine River (France) from Paris to the estuary. *Estuaries* 23: 669-682.
- Brittingham KD & Hammerschlag RS (2006) Final Report (2002-2004): benthic macroinvertebrate communities of reconstructed freshwater tidal wetlands in the Anacostia River, Washington, DC. U.S. Geological Survey Patuxent Wildlife Research Center, Beltsville, MD, USA. Accessed from <http://www.pwrc.usgs.gov/resshow/hammerschlag/anacostia.cfm>.
- Bromberg KD & Bertness MD (2005) Reconstructing New England salt marsh losses using historical maps. *Estuaries* 28: 823-832.
- Bronsdon RK & Naden PS (2000) Suspended sediment in the Rivers Tweed and Teviot. *The Science of the Total Environment* 252: 95-113.
- Brown CA (1936) The vegetation of the Indian mounds, middens, and marshes in Plaquemines and St. Bernard Parishes. Louisiana Geological Survey, Geological Bulletin 8: 423-440. USA.
- Brown KJ & Pasternack GB (2004) The geomorphic dynamics of an upper deltaic floodplain tract in the Sacramento-San Joaquin Delta, California, USA. *Earth Surface Processes and Landforms* 29: 1235-1258.
- Brown KJ & Pasternack GB (2005) A paleoenvironmental reconstruction to aid in the restoration of floodplain and wetland habitats on an upper deltaic plain, California, USA. *Environmental Conservation* 32: 1-14.
- Brumbach HJ & Bender S (2002) Woodland period settlement and subsistence change in the upper Hudson River Valley. In: Hart JP & Rieth CR (eds) *Northeast subsistence-settlement change A.D. 700-1300*. New York State Museum Bulletin 496: 227-239. USA.
- Brunet RC & Garcia-Gil LJ (1996) Sulfide-induced dissimilatory nitrate reduction to ammonia in anaerobic freshwater sediments. *FEMS Microbiology Ecology* 21: 131-138.
- Bruyndoncx L, Jordaens K & Meire P (2001) De weekdieren van de schorren van het Schelde-estuarium. *De Levende Natuur* 102: 70. NL.
- Bruyndoncx L, Jordaens K, Ysebaert T, Meire P & Backeljau T (2002) Molluscan diversity in tidal marshes along the Scheldt estuary (The Netherlands, Belgium). *Hydrobiologia* 474: 189-196.
- Brys R, Ysebaert T, Escaravage V, Van Damme S, Van Braeckel A, Vandevoorde B & Van den Bergh E (2005) Afstemmen van referentiecondities en evaluatiesystemen in functie van de KRW: afleiden en beschrijven van typespecifieke referentieomstandigheden en/of MEP in elk Vlaams

- overgangswatertype vanuit de – overeenkomstig de KRW – ontwikkelde beoordelingssystemen voor biologische kwaliteitselementen. Report IN.O. 2005.7, Instituut voor Natuurbehoud, Brussels, BEL.
- Buchanan C, Lacouture RV, Marshall HG, Olson M & Johnson JM (2005) Phytoplankton reference communities for Chesapeake Bay and its tidal tributaries. *Estuaries* 28: 138-159.
- Bunt JS, Williams WT & Clay HJ (1982) River water salinity and the distribution of mangrove species along several rivers in North Queensland. *Australian Journal of Botany* 30: 401-412.
- Burchard H & Baumert H (1998) The formation of estuarine turbidity maxima due to density effects in the salt wedge. A hydrodynamic process study. *Journal of Physical Oceanography* 28: 309-321.
- Burg ME, Tripp DR & Rosenberg ES (1980) Plant associations and primary productivity of the Nisqually salt marsh on Southern Puget Sound, Washington. *Northwest Science* 54: 222-236. USA.
- Burger J, Howe MA, Hahn DC & Chase J (1977) Effects of tide cycles on habitat selection and habitat partitioning by migrant shorebirds. *Auk* 94: 743-758. USA.
- Burger MF & Liner JM (2005) Important bird areas of New York: habitats worth protecting. Audubon New York, Albany, NY, USA.
- Burkart M (2001) River corridor plants (Stromtalpflanzen) in central European lowland: a review of a poorly understood plant distribution pattern. *Global Ecology and Biogeography* 10: 449-468.
- Burke JD, Weis JS & Weis P (2000) Release of metals by the leaves of the salt marsh grasses *Spartina alterniflora* and *Phragmites australis*. *Estuarine, Coastal and Shelf Science* 51: 153-159.
- Burns MG (1997) The Goat Island campsite, Tivoli Bays, Hudson River: potential for environmental information from a heavily looted archaeological site. MS Thesis, Bard College, Annandale, NY, USA.
- Burroughs F (2006) Confluence: Merrymeeting Bay. Tilbury House Publishers, Gardiner, ME, USA.
- Burt W (1994) Shadow birds: a quest for rails. Lyons & Burford, New York.
- Byrd GV & Ronsse D (1983) Preliminary classification of plant communities in the vegetated intertidal zone of the central Yukon Delta, Alaska. Unpubl. manuscript on file with: U.S. Fish and Wildlife Service, Anchorage, AK, USA.
- Byrne P, Borengasser M, Drew G, Muller R, Smith BL Jr & Wax C (1976) Barataria Basin: hydrologic and climatologic processes. Center for Wetland Resources, Louisiana State University, Baton Rouge, LA, USA.
- Cahoon DR (1982) Community production and biomass allocation of *Hibiscus moscheutos* L. (Malvaceae), a brackish marsh dominant. PhD Dissertation. University of Maryland, College Park, MD, USA.
- Cahoon DR, Reed DJ & Day JW Jr (1995) Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. *Marine Geology* 128: 1-9.
- Cahoon DR, Lynch JC, Hensel P, Boumans R, Perez BC, Segura B & Day JW (2002) High-precision measurements of wetland sediment elevation: I. Recent improvements to the sedimentation-erosion table. *Journal of Sedimentary Research* 72: 730-733.
- Caldwell FA & Crow GE (1992) A floristic and vegetation analysis of a freshwater tidal marsh on the Merrimack River, West Newbury, Massachusetts. *Rhodora* 94: 63-97. USA.
- Callaway JC (2004) Restoring our national wetlands. In: Spray SL & Mcglathlin KL (eds) *Wetlands (Exploring environmental challenges, a multidisciplinary approach)*, pp. 55-83. Rowman & Littlefield Publishers, Inc., Lanham, MD, USA.
- Callaway JC, Sullivan G & Zedler JB (2003) Species-rich plantings increase biomass and nitrogen accumulation in a wetland restoration experiment. *Ecological Applications* 13: 1626-1639.
- Callender E (1982) Benthic phosphorus regeneration in the Potomac River estuary. *Hydrobiologia* 92: 431-446.
- Callender E & Hammond DE (1982) Nutrient exchange across the sediment-water interface in the Potomac River estuary. *Estuarine, Coastal and Shelf Science* 15: 395-413.
- Campbell R, Rosell F, Nolet BA & Dijkstra VAA (2005) Territory and group sizes in Eurasian beavers (*Castor fiber*): echoes of settlement and reproduction? *Behavioral Ecology and Sociobiology* 58: 597-607.
- Canavan RW, Laverman AM & Slomp CP (2007a) Modeling nitrogen cycling in a coastal fresh water sediment. *Hydrobiologia* 584: 27-36.
- Canavan RW, Van Capellen P, Zwolsman JGG, Van den Berg GA & Slomp CP (2007b) Geochemistry of trace metals in a fresh water sediment: field results and diagenetic modelling. *The Science of the Total Environment* 381: 263-279.
- Capers RS (2003a) Macrophyte colonization in a freshwater tidal wetland (Lyme, CT, USA). *Aquatic Botany* 77: 325-338.
- Capers RS (2003b) Six years of submerged plant community dynamics in a freshwater tidal wetland. *Freshwater Biology* 48: 1640-1651.
- Caraco NF, Cole JJ & Likens GE (1989) Evidence for sulphate-controlled phosphorus release from sediments of aquatic systems. *Nature* 341: 395-413.
- Caraco NF, Cole JJ, Likens GE, Lovett GM & Weathers KC (2003) Variation in NO<sub>3</sub> export from flowing waters of vastly different sizes: does one model fit all? *Ecosystems* 6: 344-352.
- Carney JA (2001) Black rice: The African origins of rice cultivation in the Americas. Harvard University Press, Cambridge, MA, USA.
- Carpenter K, Sasser CE, Visser JM & DeLaune RD (2007) Sediment input into a floating freshwater marsh: effects on soil properties, buoyancy and plant biomass. *Wetlands* 27: 1016-1024.
- Carson MA & Kirkby MJ (1972) Hillslope form and process. Cambridge University Press, New York.
- Carstensen R (2004) GIS mapping for Mendenhall Wetland State Game Refuge: vegetation types, tidal elevations, property boundaries, and their relation to glacial rebound and the conservation of accreted land. *Discovery Southeast for the Southeast Alaska Land Trust*, Juneau, AK, USA.
- Caspers H (1948) Ökologische Untersuchungen über die Wattentierwelt im Elbe-Ästuar. *Verhandlungen der deutschen Zoologischen Gesellschaft (Kiel, 1948)*: 350-359. GER.
- Cauboue M (1972) Étude écologique des forêts ripariennes du Saint-Laurent aux environs de Québec, Thèse de maîtrise, Université Laval, Sainte-Foy, Canada.
- Cebrian J & Lartigue J (2004) Patterns of herbivory and decomposition in aquatic and terrestrial ecosystems. *Ecological Monographs* 74: 237-259.

- Center for Aquatic and Invasive Plants (University of Florida) (2001) *Cyperus difformis*. (Viewed 29 July 2006 at <http://aquat1.ifas.ufl.edu/cypdif.html>).
- Chabreck RH (1970) Marsh zones and vegetative types in the Louisiana coastal marshes. PhD Dissertation, Louisiana State University, Baton Rouge, LA, USA.
- Chabreck RH (1972) Vegetation, water and soil characteristics of the Louisiana coastal region. Louisiana Agricultural Experiment Station Bulletin 664: 1-72. Baton Rouge, LA, USA.
- Chabreck RH & Palmisano AW (1973) The effects of Hurricane Camille on the marshes of the Mississippi River Delta. *Ecology* 54: 1118-1123.
- Chabrierie O, Poudevigne I, Bureau F, Vincelas-Akpa M, Nebbache S, Aubert M, Boarder A & Alard D (2001) Biodiversity and ecosystem functions in wetlands: a case study in the estuary of the Seine river, France. *Estuaries* 24: 1088-1096.
- Chambers RM & Fourqurean JW (1991) Alternative criteria for assessing nutrient limitation of a wetland macrophyte (*Peltandra virginica* (L.) Kunth). *Aquatic Botany* 40: 305-320.
- Chambers RM & Odum WE (1990) Porewater oxidation, dissolved phosphate and the iron curtain: iron-phosphorous relations in tidal freshwater marshes. *Biogeochemistry* 10: 37-52.
- Chambers RM, Meyerson LA & Slatonstall K (1999) Expansion of *Phragmites australis* into tidal wetlands of North America. *Aquatic Botany* 64: 261-273.
- Chambers RM, Osgood DT, Bart DJ & Montalo F (2003) *Phragmites australis* invasion and expansion in tidal wetlands: interactions among salinity, sulfide, and hydrology. *Estuaries* 26: 398-406.
- Chang M, Kennen JG & Corso ED (2005) Evaluating temporal changes in stream condition in three New Jersey river basins by using an index of biotic integrity. *Bulletin New Jersey Academy of Science* 45: 1-12. USA.
- Chen M, Wartel S, Van Eck GTM & Van Maldegem DC (2005) Suspended matter in the Scheldt estuary. *Hydrobiologia* 540: 79-104.
- Chesapeake Bay National Estuarine Research Reserve - Maryland (2004) Bird Checklist of the Patuxent River – Jug Bay Area. Maryland Department of Natural Resources, Annapolis, MD, USA.
- Childers DL & Day Jr JW (1988) A flow-through flume technique for quantifying nutrient and materials fluxes in microtidal estuaries. *Estuarine, Coastal and Shelf Science* 27: 483-494.
- Childers DL, Sklar FH, Drake B & Jordan T (1993) Seasonal measurements of sediment elevation in three mid-Atlantic estuaries. *Journal of Coastal Research* 9: 986-1003.
- Childers DL, Day JW & McKellar HN (2000) Twenty more years of marsh and estuarine flux studies: revisiting Nixon (1980). In: Weinstein MP & Kreeger DA (eds) *Concepts and Controversies in Tidal Marsh Ecology*, pp. 391-424. Kluwer Academic Publishers, Boston, MA, USA.
- Chilton ES (1991) The Goat Island rockshelter: new light from old legacies. MS Thesis, University of Massachusetts, Amherst, MA, USA.
- Christensen JH, Hewitson B, Busuioac A, Chen A, Gao X, Held I, Jones R, Kolli RK, Kwon W-T, Laprise R, Magaña Rueda V, Mearns L, Menéndez CG, Räisänen J, Rinke A, Sarr A & Whetton P (2007) Regional climate projections. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (eds) *Climate change 2007: the physical science basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 847-940. Cambridge University Press, Cambridge, UK, and New York.
- Christmas JF, Bohn RE & Webster DW (1994) Preliminary assessment of the potential for zebra mussel infestation in Maryland. In: Maryland Sea Grant, *Zebra Mussels and the Mid-Atlantic: reports from the Sea Grant Programs of New Jersey, Delaware, Maryland, Virginia, and North Carolina*, pp. 41-54. College Park, MD, USA.
- Christy JA & Putera JA (1992) Lower Columbia River Natural Area Inventory. Report to the Nature Conservancy. Washington Field Office, Seattle, WA, USA.
- Clevering OA (1995) Germination and seedling emergence of *Scirpus lacustris* L. and *Scirpus maritimus* L. with special reference to the restoration of wetlands. *Aquatic Botany* 50: 63-78.
- Clevering OA, Blom CWPM & Van Vierssen W (1996) Growth and morphology of *Scirpus lacustris* and *S. maritimus* seedlings as affected by water level and light availability. *Functional Ecology* 10: 289-296.
- Cleveringa P, Hendriks JPCA, Van Beurden A, Weerts HTJ, Van Smeerdijk DG, Meijer T, De Wolf H & Paalman DBS (2004) "So grot overvlot der watere..." - Een bijdrage aan het moderne interdisciplinaire onderzoek naar de St Elisabethsvloed en de periode die daaraan vooraf ging. *Historische Tijdschrift* 36: 163-180. NL
- Cloern JE (1987) Turbidity as a control on phytoplankton biomass and productivity in estuaries. *Continental Shelf Research* 5: 1367-1381.
- Cloern JE (2001) Our evolving conceptual model of the coastal eutrophication problem. *Marine Ecology Progress Series* 210: 223-253.
- CNPS (California Native Plant Society) (2001) Inventory of Rare and Endangered Plants of California, California Native Plant Society, Sacramento, CA, USA.
- Coen I (1988) Ontstaan en ontwikkeling van de Westerschelde (with summary). *Water* 43: 156-162. BEL.
- Cohen AN & Carlson JT (1998) Accelerating invasion rate in a highly invaded estuary. *Science* 279: 555-558.
- Cohen MR & Poisz HKJ (ed) (2005) Forty years of maritime solutions that changed the world. *Terra et Aqua* nr. 100 (IADC) Sept. 2005. The Hague, NL.
- Cole JJ & Caraco NF (2006) Primary production and its regulation in the tidal-freshwater Hudson River. In: Levinton JS & Waldman JR (eds) *The Hudson River estuary*, pp. 107-120. Cambridge University Press, Boston, MA, USA.
- Cole JJ, Caraco NF & Peierls BL (1992) Can phytoplankton maintain a positive carbon balance in a turbid, fresh-water, tidal estuary? *Limnology and Oceanography* 37: 1608-1617.
- Colijn F, Admiraal W, Baretta WJ & Ruardij P (1987) Primary production in a turbid estuary, the Ems-Dollard - Field and model studies. *Continental Shelf Research* 7: 1405-1409.
- Conley DJ (2002) Terrestrial ecosystems and the global biogeochemical silica cycle. *Global Biogeochemical Cycles* 16: 1121.
- Connecticut Department of Environmental Protection (2004) Connecticut River estuary and tidal wetlands complex (Viewed 30 July 2006 at <http://dep.state.ct.us/olisp/ramsar/changes.htm>).



- Conner WH & Day JW Jr (1976) Productivity and composition of a baldcypress-water tupelo site and a bottomland hardwood site in a Louisiana swamp. *American Journal of Botany* 63: 1354-1364.
- Conner WH, Gosselink JG & Parrondo RT (1981) Comparison of the vegetation of three Louisiana swamp sites with different flooding regimes. *American Journal of Botany* 68: 320-331.
- Conner WH, McLeod KW & McCarron JK (1997) Flooding and salinity effects on growth and survival of four common forested wetland species. *Wetlands Ecology and Management* 5: 99-109.
- Conner WH, Inabinette LW & Ozalp M (2004) Growth and survival of baldcypress planted in an old rice field of coastal South Carolina. In: Connor KF (ed) Proceedings of the 12th Biennial Southern Silvicultural Research Conference, General Technical Report SRS-71, pp. 578-580. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, NC, USA.
- Conner WH, Doyle TW, Krauss KW (eds) (2007) Ecology of tidal freshwater forested wetlands of the Southeastern United States. Springer, Dordrecht, NL.
- Connors LM, Kiviat E, Groffman PM & Ostfeld RS (2000) Muskrat (*Ondatra zibethicus*) disturbance to vegetation and potential net nitrogen mineralization and nitrification rates in a freshwater tidal marsh. *American Midland Naturalist* 143: 53-63.
- Conover MR & Kania GS (1994) Impact of interspecific aggression and herbivory by Mute Swans on native waterfowl and aquatic vegetation in New England. *Auk* 111: 744-748. USA.
- Conomos TJ (1979) Properties and circulation of San Francisco Bay waters. In: Conomos TJ (ed) San Francisco Bay: the urbanized estuary, pp. 47-84. Pacific Division, AAAS, California Academy of Science, San Francisco, CA, USA.
- Conomos TJ, Smith RE & Gartner JW (1985) Environmental setting of San Francisco Bay. *Hydrobiologia* 129: 1-12.
- Constantine JA, Pasternack GB & Johnson ML (2003) Floodplain evolution in a small, tectonically active basin of Northern California. *Earth Surface Processes and Landforms* 28: 869-888.
- Cooper SR (1995) Chesapeake Bay watershed historical land use: impact on water quality and diatom communities. *Ecological Applications* 5: 703-723.
- Cooper SR & Brush GS (1993) A 2,500-year history of anoxia and eutrophication in Chesapeake Bay. *Estuaries* 16: 617-626.
- Coops H & Smit H (1988) Biezen langs de Oude Maas. *De Levende Natuur* 89: 106-110. NL
- Coops H, Geilen N & Van der Velde G (1999) Helophyte zonation in two regulated estuarine areas in the Netherlands: vegetation analysis and relationship with hydrological factors. *Estuaries* 22: 657-668.
- Core EL (1941) *Butomus umbellatus* in America. *Ohio Journal of Science* 41: 79-85. USA.
- Cornu CE & Sadro S (2002) Physical and functional responses to experimental marsh surface elevation manipulation in Coos Bay's South Slough. *Restoration Ecology* 10: 474-486.
- Costanza R, d'Arge R, de Groot R, Farber S, Gasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P & Van den Belt M (1997) The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.
- Couillard L & Grandin P (1986) La végétation des milieux humides du Québec. Les Publications du Québec, Québec, Canada.
- Counts CL III (1986) The zoogeography and history of the invasion of the United States by *Corbicula fluminea* (Bivalvia: Corbiculidae). *American Malacological Bulletin, Special Edition* 2: 7-39.
- Cowardin LM, Carter V, Golet FC & LaRoe ET (1979) Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. U.S. Fish and Wildlife Service, Washington, DC.
- Cox T (2008) Oxygen and planktonic primary production in the freshwater tidal reaches of the Schelde estuary. PhD Dissertation, University of Antwerp, BEL.
- Cox T, Maris T, De Vleeschauwer P, De Mulder T, Soetaert K & Meire P (2006) Flood control areas as an opportunity to restore estuarine habitat. *Ecological Engineering* 28: 55-63.
- CPSL (2001) Final report of the Trilateral Working Group on Coastal Protection and Sea Level Rise. Wadden Sea Ecosystem No. 13. Common Wadden Sea Secretariat, Wilhelmshaven, GER.
- Craft C (2007) Freshwater input structures soil properties, vertical accretion, and nutrient accumulation of Georgia and U.S. tidal marshes. *Limnology and Oceanography* 52: 1220-1230.
- Craft CB & Richardson CJ (1993) Peat accretion, nutrient accumulation, and phosphorus storage efficiency along a eutrophication gradient in the northern Everglades. *Biogeochemistry* 22: 133-156.
- Craft C, Megonigal P, Broome S, Stevenson J, Freese R, Cornell J, Zheng L & Sacco J (2003) The pace of ecosystem development of constructed *Spartina alterniflora* marshes. *Ecological Applications* 13: 1417-1432.
- Craft C, Clough J, Ehman J, Joye S, Park R, Pennings S, Guo S & Machmuller M (2009) Forecasting the effects of accelerated sea level rise on tidal marsh ecosystem services. *Frontiers in Ecology and the Environment* 7: 73-78.
- Crain CM (2007) Shifting nutrient limitation and eutrophication effects in marsh vegetation across estuarine salinity gradients. *Estuaries and Coasts* 30: 26-34.
- Crain CM (2008) Interactions between marsh plant species vary in direction and strength depending on environmental and consumer context. *Journal of Ecology* 96: 166-173.
- Crain CM & Bertness MD (2005) Community impacts of a tussock-forming sedge: is ecosystem engineering important in physically benign habitats? *Ecology* 86: 2695-2704.
- Crain CM, Silliman BR, Bertness SL & Bertness MD (2004) Physical and biotic drivers of plant distribution across estuarine salinity gradients. *Ecology* 85: 2539-2549.
- CRCL (The Coalition to Restore Coastal Louisiana) (1999) No time to lose: facing the future of Louisiana and the crisis of coastal land loss. Baton Rouge, LA, USA.
- Creed RP & Sheldon SP (1995) Weevils and watermilfoil: did a North American herbivore cause the decline of an exotic plant? *Ecological Applications* 5: 1113-1121.
- CREST (2006) Columbia River estuary wetland restoration and monitoring findings report. Columbia River Estuary Study Taskforce, Astoria, Oregon, USA. Accessed from <http://www.columbiaestuary.org>.
- Criel B, Muylaert W, Hoffmann M, De Loose L & Meire P (1999) Vegetatiemodellering van de buitendijkse gebieden langs de Zeeschelde. Rapport Onderzoek Milieu-effecten Sigmaplan (OMES), AMIS DS7.2, deelstudie 8. Gent / Brussel, BEL.
- Crivelli AJ (1983) The destruction of aquatic vegetation by carp. *Hydrobiologia* 106: 37-41.

- Cronk JK & Fennessy MS (2001) Wetland plants: biology and ecology. Lewis Publishers, Washington, DC.
- Crooks S, Schutten J, Sheern GD, Pye K & Davy AJ (2002) Drainage and elevation as factors in the restoration of salt marsh in Britain. *Restoration Ecology* 10: 591-602.
- Crow JH (1968) Plant ecology of the Copper River delta, Alaska. PhD Dissertation, Washington State University, Pullman, WA, USA.
- Crumb SE (1977) Macrobenthos of the tidal Delaware River between Trenton and Burlington, New Jersey. *Chesapeake Science* 18: 253-265. USA.
- Crumrine P (1997) The effects of tides on the feeding patterns of the mummichog (*Fundulus heteroclitus*) in a freshwater tidal wetland. Technical Report of the Jug Bay Wetlands Sanctuary, Lothian, Maryland. MD, USA.
- Cugier P, Billen G, Guillaud JF, Garnier J & Ménesguen A (2005) Modelling the eutrophication of the Seine Bight (France) under historical, present and future riverine nutrient loading. *Journal of Hydrology* 304: 381-396.
- Currin CA & Pearl HW (1998) Epiphytic nitrogen fixation associated with standing dead shoots of smooth cordgrass, *Spartina alterniflora*. *Estuaries* 21: 108-117.
- Curtis PS, Drake BG, Leadley PW, Arp W & Whigham DF (1989) Growth and senescence of plant communities exposed to elevated CO<sub>2</sub> concentrations on an estuarine marsh. *Oecologia* 78: 20-26.
- Cypert E (1972) The origin of houses in the Okefenokee Prairies. *American Midland Naturalist* 87: 448-458.
- CZR Inc. (1999) Location of permanent stations, background stations, and substations for monitoring potential effects of increased tidal range on the Cape Fear River ecosystem due to deepening Wilmington harbor, North Carolina. Report prepared for the U.S. Army Corps of Engineers, Wilmington District, Wilmington, NC, USA.
- Dahl F (1891) Untersuchungen über die Tierwelt der Unterelbe. Sechster Bericht der Kommission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel für die Jahre 1887 bis 1891, 17-21: 150-185. Kiel, GER.
- Dahl TE (2000) Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.
- Dahl TE (2006) Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.
- Dahl TE & Johnson CE (1991) Status and trends of wetlands in the conterminous United States, mid-1970s to mid-1980s. U.S. Fish and Wildlife Service, Washington, DC.
- Dalrymple RW, Zaitlin BA, & Boyd R (1992) Estuarine Facies models: conceptual basis and stratigraphic implications. *Journal of Sedimentary Petrology* 62: 1130-1146.
- Dame RF (1996) Ecology of marine bivalves: an ecosystem approach. CRC Press, Boca Raton, FL, USA.
- Daniel P (1986) Breaking the land: the transformation of cotton, tobacco, and rice cultures since 1880. University of Illinois Press, Urbana, IL, USA.
- D'Antonio C & Meyerson LA (2002) Exotic plant species as problems and solutions in ecological restoration: a synthesis. *Restoration Ecology* 10: 703-713.
- Darke AK & Megonigal JP (2003) Control of sediment deposition rates in two mid-Atlantic Coast tidal freshwater wetlands. *Estuarine, Coastal and Shelf Science* 57: 255-268.
- Darst MR, Light HM & Lewis LJ (2002) Ground-cover vegetation in wetland forests of the Lower Suwannee River floodplain, Florida, and potential impacts of flow reductions. Water Resources Investigations Report 02-4027, U.S. Geological Survey, Tallahassee, FL, USA.
- Dauvin J-C & Desroy N (2005) The food web in the lower part of the Seine estuary: a synthesis of existing knowledge. *Hydrobiologia* 540: 13-27.
- Davidson NC, d'A Laffoley D, Doody JP, Way LS, Gordon J, Key R, Drake CM, Pienkowski MW, Mitchell R & Duff KL (1991) Nature conservation and estuaries of Great Britain. Nature Conservancy Council, Peterborough, UK.
- Davies SB (2004) Vegetation dynamics of a tidal freshwater marsh: long-term and inter-annual variability and their relation to salinity. MS Thesis, College of William and Mary, Virginia Institute of Marine Science. Gloucester Point, VA, USA.
- Davis WM (1909). The geographical cycle. In: Johnson DW (ed) *Geographical Essays*, pp. 249-279. Ginn and Company, Boston, MA, USA.
- Day JW Jr, Barras J, Clairain E, Johnston J, Justic D, Kemp GP, Ko J-Y, Lane R, Mitsch WJ, Steyer G, Templett P & Yañez-Arancibia A (2005) Implications of global climatic change and energy cost and availability for the restoration of the Mississippi delta. In: Mitsch WJ (ed) *Wetland Creation, Restoration and Conservation*, pp. 253-265. Elsevier, Amsterdam.
- Day JW Jr, Boesch DF, Clairain EJ, Kemp GP, Laska SB, Mitsch WJ, Orth K, Mashriqui H, Reed DJ, Shabman L, Simenstad CA, Streever BJ, Twilley RR, Watson CC, Wells JT & Whigham DF (2007) Restoration of the Mississippi Delta: lessons from Hurricanes Katrina and Rita. *Science* 315: 1679-1684.
- De Boois H (1982) Veranderingen in het milieu en de vegetatie in de Biesbosch door de afsluiting van het Haringvliet. PhD Dissertation, Wageningen Agricultural University, NL.
- De Groot SJ (1990) The former allis and twaite shad fisheries of the lower Rhine in the Netherlands. *Journal of Applied Ichthyology* 6: 252-256.
- De Groot SJ (1992) Herstel van trekvis in de Rijn een realiteit? 8. De Fint. *De Levende Natuur* 93: 182-186. NL.
- De Groot SJ (2002) A review of the past and present status of anadromous fish species in the Netherlands: is restocking the Rhine feasible? *Hydrobiologia* 478: 205-218.
- De Jong JW & Everts FH (1995) De vegetatie-ontwikkeling van de Biesbosch 1984-1995. Rapport Everts & de Vries Oecologisch adviesbureau, Groningen, NL.
- De Lange MC & Vriese FT (2006) Visstandbemonstering Benedenrivierengebied 2006. Rapport VA2006\_43, VisAdvies, Utrecht, NL.
- De Nie HW (1996) Atlas van de Nederlandse zoetwatervissen. Stichting Atlas Verspreiding Nederlandse Zoetwater-vissen, Doetinchem. NL.
- De Ridder T (1999) Tweeduizend jaar oude dammen en duikers te Vlaarding. *Tijdschrift voor Waterstaatgeschiedenis* 8: 10-22. NL.
- De Ridder T (2000) Van donk tot stad - Water: vriend en vijand. *Historisch Jaarboek Vlaarding. Historische Vereniging Vlaarding*, NL.

- De Ridder T (2003) Watermanagement rond het begin van de jaartelling (with drawings by B Koster). 33<sup>e</sup> Reuvens-dagen. Samenvattingen lezingen / posters, Vlaardingen, NL.
- De Ridder T (2005) Wassermanagement in Römischer Zeit: die ältesten Deltawerke in Westeuropa. In: Endlich C (ed) Kulturlandschaft Marsch. Natur - Geschichte - Gegenwart, pp. 60-67. Vorträge anlässlich des Symposiums in Oldenburg, 3-5 Juni 2004. Isensee-Verlag, Oldenburg, GER.
- Deaton LE & Greenberg MJ (1986) There is no horohalinicum. *Estuaries* 9: 20-30.
- DeBerry DA & Perry JE (2000a) An introduction to wetland seed banks. Wetlands Program Technical Report No. 00-2. College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA, USA.
- DeBerry DA & Perry JE (2000b) Wetland seed banks: research in natural and created wetlands. Wetlands Program Technical Report No. 00-4. College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA, USA.
- DeBerry DA & Perry JE (2004) Comparison of early successional plant structure and composition in a created and natural non-tidal wetland. *Castanea* 69: 185-193. USA.
- Decler K (1988) Temporary inundation as a determining factor for the spider communities of marshland habitats. XI. Europäisches Arachnologisches Colloquium, Berlin, pp. 161-167. Technische Universität Berlin, GER.
- Decler K (2003) Population dynamics of marshland spiders and carabid beetles due to flooding: about drowning, air bubbling, floating, climbing and recolonisation. Papers conference Towards natural flood reduction strategies, Warsaw, Poland.
- Deegan B, Harrington TJ & Dundon P (2005) Effects of salinity and inundation regime on growth and distribution of *Schoenoplectus triquetus*. *Aquatic Botany* 81: 199-211.
- Deegan LA (2002) Lessons learned: the effects of nutrient enrichment on the support of nekton by seagrass and salt marsh ecosystems. *Estuaries* 25: 727-742.
- DeLaune RD, Smith CJ & Sarafyan MN (1986) Nitrogen cycling in a freshwater marsh of *Panicum hemitomon* on the deltaic plain of the Mississippi River. *Journal of Ecology* 74: 249-256.
- DeLaune RD, Patrick WH Jr & Pezeshki SR (1987) Foreseeable flooding and death of coastal wetland forests. *Environmental Conservation* 14: 129-133.
- DeLaune RD, Jugsujinda A, Peterson GW & Patrick WH Jr (2003) Impact of Mississippi River freshwater reintroduction on enhancing marsh accretionary processes in a Louisiana estuary. *Estuarine, Coastal and Shelf Science* 58: 652-666.
- Den Boer PJ (1990) The survival value of migration in terrestrial arthropods. *Biological Conservation* 54: 175-192.
- Den Hartog C (1963) The amphipods of the deltaic region of the rivers Rhine, Meuse and Scheldt in relation to the hydrography of the area. II. The Talitridae. *Netherlands Journal Sea Research* 2: 40-67.
- Den Hartog C (1971) The border environment between the sea and the fresh water, with special reference to the estuary. *Vie et Milieu, Suppl.* 22: 739-751. FR.
- Denman KL, Brasseur G, Chidthaisong A, Ciais P, Cox PM, Dickinson RE, Hauglustaine D, Heinze C, Holland EA, Jacob D, Lohmann U, Ramachandran S, Da Silva Dias PL, Wofsy SC & Zhang X (2007) Couplings between changes in the climate system and biogeochemistry. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (eds). *Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp. 499-587. Cambridge University Press, Cambridge, UK, and New York.
- Dennis JV (1988) The great cypress swamps. Louisiana University Press, Baton Rouge, LA, USA.
- DeOrsey S & Butler BA (2006) The birds of Dutchess County, New York: today and yesterday, a survey of current status and historical changes since 1870. Ralph T. Waterman Bird Club, Poughkeepsie, NY, USA.
- Desender K & Maelfait JP (1999) Diversity and conservation of terrestrial arthropods in tidal marshes along the River Schelde: a gradient analysis. *Biological Conservation* 87: 221-229.
- Desmit X, Vanderborcht JP, Regnier P & Wollast R (2005) Control of phytoplankton production by physical forcing in a strongly tidal, well-mixed estuary. *Biogeosciences* 2: 205-218.
- DG.Environment (2002) Interpretation note on 'estuaries' (habitat type 1130), with a view to aiding the selection, delimitation and management of sites of community interest hosting this habitat type. Brussels, BEL
- Diaz RJ (1974) Asiatic clam, *Corbicula manilensis* (Philippi), in the tidal James River, Virginia. *Chesapeake Science* 15: 118-120.
- Diaz RJ (1978) Ecology of tidal freshwater and estuarine Tubificidae (Oligochaeta). In: Brinkhurst R & Cook D (eds) *Aquatic Oligochaete Biology*, pp. 319-330. Plenum Press, New York.
- Diaz RJ (1989) Pollution and tidal benthic communities of the James River estuary, Virginia. *Hydrobiologia* 180: 195-211.
- Diaz RJ (1994) Responses of tidal freshwater macrobenthos to sediment disturbance. *Hydrobiologia* 278: 201-212.
- Diaz RJ & Schaffner LC (1990) The functional role of estuarine benthos. In: Haire M & Krome EC (eds) *Perspectives on the Chesapeake Bay, 1990 - Advances in estuarine sciences*, pp. 25-56. Chesapeake Research Consortium, report No. CBP/TRS41/90, Gloucester Point, VA, USA.
- Diaz RJ, Boesch DF, Haver JL, Stone CA & Munson K (1978) Part II: Aquatic biology - benthos. In: Adams DD, Darby DA & Young RJ (eds) *Habitat development field investigations Windmill Point marsh development site, James River, Virginia*, pp. 18-54. U.S. Army Waterways Experiment Station Technical report D-77-23, Vicksburg, MS, USA.
- Dippner JW (1998) Competition between different groups of phytoplankton for nutrients in the southern North Sea. *Journal of Marine Systems* 4: 181-198.
- Disraeli DJ & Fonda RW (1979) Gradient analysis of the vegetation in a brackish marsh in Bellingham Bay, Washington. *Canadian Journal of Botany* 57: 465-475.
- Doody JP (1987) The impact of 'reclamation' on the natural environment of the Wash. In: Doody JP & Barnet B (eds) *The Wash and its environment*, pp. 165-172. Research and Survey in nature conservation No 7. Nature Conservancy Council, Peterborough, UK
- Doody JP (2001) Coastal conservation and management: an ecological perspective. *Conservation Biology Series* 13. Kluwer Academic Publisher, Boston, USA.
- Doody JP (2004) 'Coastal squeeze' - an historical perspective. *Journal of Coastal Conservation* 10: 129-138.
- Doumlele DG (1981) Primary production and seasonal aspects of emergent plants in a tidal freshwater marsh. *Estuaries* 4: 139-142.



- Doumlele DG, Fowler KB & Silberhorn GM (1985) Vegetative community structure of a tidal freshwater swamp in Virginia. *Wetlands* 4: 129-145.
- Dovel WL (1981) Ichthyoplankton of the lower Hudson Estuary, N.Y. *New York Fish and Game Journal* 28: 21-39. USA.
- Drake BG, Peresta G, Beugeling E & Matamala R (1996) Long-term elevated CO<sub>2</sub> exposure in a Chesapeake Bay wetland: ecosystem gas exchange, primary production, and tissue nitrogen. In: Koch GW & Hooney HA (eds). *Carbon dioxide and terrestrial ecosystems*, pp. 197-214. Academic Press, San Diego, CA, USA.
- Dresler PV & Cory RL (1980) The Asiatic clam, *Corbicula fluminea*, in the tidal Potomac River. *Estuaries* 3: 150-151.
- Dubisch J (1985) Low country fevers: cultural adaptations to malaria in antebellum South Carolina. *Social Science and Medicine* 21: 641-649.
- Duke N (2006) Australia's mangroves. University of Queensland, Brisbane, Australia.
- Dunbar JB (1990) Land loss rates, Report 2, Louisiana Chenier Plain. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, USA.
- Dunbar JB, Britsch LD & Kemp EB (1992) Land loss rates, Report 3, Louisiana coastal plain. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS, USA.
- Dunn C & Sharitz R (1990) History of *Murdannia keisak* (Commelinaceae) in the southeastern United States. *Castanea* 55: 122-129. USA.
- Dunn ML (1978) Studies on the breakdown of freshwater tidal marsh plants. MS Thesis, University of Virginia. Charlottesville, VA, USA.
- Dupre WR (1978) Annual report: young delta coastal processes study. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Boulder, CO, USA.
- Duryea M & R Schmidt (1986) Feeding biology of tessellated darter (*Etheostoma olmstedi atromaculatum*) at Tivoli North Bay, Hudson River, New York. In: Blair EA & Cooper J (eds) *Reports of the Hudson River National Estuarine Research Reserve, 1985*, pp iii-1 to iii-19. New York State Department of Environmental Conservation, Annandale, NY, USA.
- Dyer KR (ed) (1979) *Estuarine hydrography and sedimentation - a handbook*. Cambridge University Press, Cambridge, UK.
- Dyer KR (1986) *Coastal and estuarine sediment dynamics*. John Wiley and Sons, New York.
- Dyer KR (1989) Sediment processes in estuaries: future research requirements. *Journal of Geophysical Research* 94: 14327-14339.
- Edinger GJ, Evans DJ, Gebauer S, Howard TJ, Hunt DM & Olivero AM (eds) (2002) *Ecological communities of New York State*. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY, USA.
- Edwards AMC & Winn PSJ (2006) The Humber Estuary, eastern England: strategic planning of flood defences and habitats. *Marine Pollution Bulletin* 53: 165-174.
- Egan M (1881) A day in the Ma'sh. *Scribner's* 22: 343-351. USA.
- Ehrenfeld JG (2000) Evaluating wetlands within an urban context. *Urban Ecosystems* 4: 69-85.
- Eilers HP (1975) Plants, plant communities, net production and tide levels: the ecological biogeography of the Nehalem salt marshes, Tillamook Country, Oregon. PhD Dissertation, Oregon State University, Corvallis, OR, USA.
- Eisma D (1986) Flocculation and de-flocculation of suspended matter in estuaries. *Netherlands Journal of Sea Research* 20: 183-199.
- Eisma D (1998) Intertidal deposits: river mouths, tidal flats, and coastal lagoons. CRC Press, Boca Raton, LA, USA.
- Eisma D, Chen S & Li A (1994) Tidal variations in suspended matter floc size in the Elbe river and Dollard estuaries. *Netherlands Journal of Aquatic Ecology* 28: 267-274.
- Ellenberg H (1963) *Vegetation Mitteleuropas mit den Alpen*. E. Ulmer Verlag, Stuttgart, GER.
- Elliot T (1986) Deltas. In: Reading HG (ed) *Sedimentary environments and facies*, pp. 113-154. Backwell Scientific Publications, Oxford, UK.
- Elliott M & Dewailly F (1995) The structure and components of European estuarine fish assemblages. *Netherlands Journal of Aquatic Ecology* 29: 397-417.
- Elliott M & Hemingway K (eds) (2002) *Fishes in estuaries*. Blackwell Science, London, UK.
- Elliott M & McLusky DS (2002) The need for definitions in understanding estuaries. *Estuarine, Coastal and Shelf Science* 55: 815-827.
- Elliott M, Hemingway KL, Cutts ND, Burdon DB, Allen JH, Thomson SM, Murby P Breine J, Van den Bergh E, Stevens M, Simoens I & Jager Z (2008) *Estuarine ecosystem functioning and health*. Harbasins WP2 report., IECS, Hull, UK.
- Ellison RL & Nichols MM (1976) Modern and Holocene foraminifera in the Chesapeake Bay Region. *Marine Sedimentation Special Publication No 1*: 131-151. USA.
- Emery KO (1980) Relative sea levels from tide-gauge records. *Proceedings of the National Academy of Sciences* 77: 6968-6972.
- Emmett R, Llanso R, Newton J, Thom R, Hornberger M, Morgan C, Levings C, Copping A & Fishman P (2000) Geographic signatures of North American West Coast estuaries. *Estuaries* 23: 765-792.
- English Nature (2002) *Boundaries of proposed sites of community importance for estuaries in the Atlantic biogeographic region - Project 1130*. Maritime Team English Nature Northminster House, Peterborough, UK.
- Enklaar PTh (1924) De verovering van het Merwedegedebied door graaf Dirk III in 1018. *Tijdschrift voor Geschiedenis* 39: 180-187. NL.
- Enriquez S, Duarte CM & Sand-Jensen K (1993) Patterns in decomposition rates among photosynthetic organisms: the importance of detritus C:N:P content. *Oecologia* 94: 457-471.
- Erickson JE, Megonigal JP, Peresta G & Drake BG (2007) Salinity and sea level mediate elevated CO<sub>2</sub> effects on C<sub>3</sub>-C<sub>4</sub> plant interactions and tissue nitrogen in a Chesapeake Bay tidal wetland. *Global Change Biology* 13: 202-215.
- Ernst CH & Ernst EM (2003) *Snakes of the United States*. Smithsonian Institution Press, Washington, DC.
- Ernst CH, Lovich JE & Barbour RW (1994) *Turtles of the United States and Canada*. Smithsonian Institution Press, Washington, DC.
- Escaravage V & Prins TC (2002) Silicate availability, vertical mixing and grazing control of phytoplankton blooms in mesocosms. *Hydrobiologia* 484: 33-48.

- Eschenburg H (1928) Gemarkungsflora von Holm. Aus den Schriften des Naturwissenschaftlichen Vereinigung für Schleswig-Holstein. GER.
- Eschenburg H & Schulz A (1927) Gemarkungsflora von Holm und Plön. Aus den Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein 18: 62-161. GER.
- Ettinger WS (1982) Macrobenthos of the freshwater tidal Schuylkill River at Philadelphia, Pennsylvania. *Journal of Freshwater Ecology* 1: 599-606.
- European Commission (2003) Common implementation strategy for the Water Framework Directive (2000/60/EC) guidance document number 5. Transitional and coastal waters. Typology, reference conditions and classification systems. Office for Official Publications of the European Communities, LUX.
- European Commission (2005) Commission Decision of 17 August 2005 on the establishment of a register of sites to form the intercalibration network in accordance with Directive 2000/60/EC of the European Parliament and of the Council. *Official Journal of the European Union* L 243/1-48 (September 2005).
- European Commission (2007) Interpretation Manual of European Union Habitats, Eur 27 (July 2007). <http://www.europa.eu.int/comm/environment/nature>
- European Communities (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities* 43 (L327).
- Evans DL (1982) Status reports on twelve raptors. Special Scientific Report No. 238. U.S. Department of the Interior. Fish and Wildlife Service, Washington, DC.
- Evans J (1970) About nutria and their control. U.S. Department of Interior Bureau of Sport Fisheries and Wildlife. Denver, CO, USA.
- Evans J (1983) Nutria. In: Timm RM (ed) Prevention and control of wildlife damage, pp. B-61 to B-70. Cooperative Extension Service, University of Nebraska, Lincoln, NB, USA.
- Evers DE, Holm GO & Sasser CE (1996) Digitization of the floating marsh maps in the Barataria and Terrebonne basins, Louisiana. Barataria-Terrebonne National Estuary Program, Thibodaux, LA, USA.
- Evers DE, Sasser CE, Gosselink JG, Fuller DA & Visser JM (1998) The impact of vertebrate herbivores on wetland vegetation in Atchafalaya Bay, Louisiana. *Estuaries* 21: 1-13.
- Ewanchuk PJ & Bertness MD (2004) Structure and organization of a northern New England salt marsh plant community. *Journal of Ecology* 92: 72-85.
- Ewing K (1986) Plant growth and productivity along complex gradients in a Pacific northwest brackish intertidal marsh. *Estuaries* 9: 49-62.
- Fairbanks, RG (1989) A 17,000-year glacio-eustatic sea level record; influence of glacial melting rates on the Younger Dryas event and deep ocean circulation. *Nature* 342: 637-642.
- Fairbridge RW (1980) The estuary: its definition and geochemical role. In: Olausson E & Cato I (eds) Chemistry and geochemistry of estuaries, pp. 1-35. John Wiley, New York.
- Farnsworth EJ & Ellis DR (2001) Is purple loosestrife (*Lythrum salicaria*) an invasive threat to freshwater wetlands? Conflicting evidence from several ecological metrics. *Wetlands* 21: 199-209.
- Farnsworth EJ & Meyerson LA (1999) Species composition and inter-annual dynamics of a freshwater tidal plant community following removal of the invasive grass, *Phragmites australis*. *Biological Invasions* 1: 115-127.
- Farnsworth EJ & Meyerson LA (2003) Comparative ecophysiology of four wetland plant species along a continuum of invasiveness. *Wetlands* 23: 750-762.
- Faulhaber P (2000) Veränderung hydraulisch-morphologischer Parameter der Elbe. *Mitteilungsblatt der Bundesanstalt für Wasserbau* 82: 97-117. Wedel, GER.
- Fenner M (1985) Seed ecology. Chapman and Hall, London.
- Ferguson HA & Wolff WJ (1983) The Haringvliet-project: the development of the Rhine-Meuse estuary from tidal inlet to stagnant freshwater lake. *Water Science and Technology* 16: 11-26.
- Fernald ML, Kinsey AC & Rollins RC (1958) Edible wild plants of eastern North America. Harper & Row, New York.
- Ferren R Jr (1975-1976) Aspects of the intertidal zones, vegetation, and flora of the Maurice River system, New Jersey. *Bartonia* 44: 58-67. USA.
- Ferren WR Jr & Schuyler AE (1980) Intertidal vascular plants of river systems near Philadelphia. *Proceedings of the Academy of Natural Science of Philadelphia* 132: 86-120. USA
- Ferren WR Jr, Good RE, Walker R & Arsenault J (1981) Vegetation and flora of Hog Island, a brackish wetland in the Mullica River, New Jersey. *Bartonia* 48: 1-10. USA.
- Field DW, Reyer AJ, Genovese PV & Shearer BD (1991) Coastal wetlands of the United States. A special NOAA 20<sup>th</sup> Anniversary Report. Strategic Assessment Branch. Ocean Assessments Division. Office of Oceanography and Marine Assessment. National Ocean Service. National Oceanic and Atmospheric Administration and U.S. Fish and Wildlife Service, USDI, Washington, DC.
- Field RT & Phillip KR (2000) Vegetation changes in the freshwater tidal marshes of the Delaware estuary. *Wetlands Ecology and Management* 8: 79-88.
- Findlay SEG, Schoeberl K & Wagner B (1989) Abundance, composition, and dynamics of the invertebrate fauna of a tidal freshwater wetland. *Journal of the North American Benthological Society* 8: 140-148.
- Findlay SEG, Howe K & Austin HK (1990) Comparison of detritus dynamics in two tidal freshwater wetlands. *Ecology* 71: 288-295.
- Findlay S, Pace ML & Lints D (1991) Variability and transport of suspended sediment, particulate and dissolved organic carbon in the tidal freshwater Hudson River. *Biogeochemistry* 12: 149-169.
- Findlay SEG, Pace ML & Fischer DT (1996) Spatial and temporal variability in the lower food web of the tidal freshwater Hudson River. *Estuaries* 19: 866-873.
- Findlay SEG, Pace ML & Fischer DT (1998a) Response of heterotrophic planktonic bacteria to the Zebra Mussel invasion of the tidal freshwater Hudson River. *Microbial Ecology* 36: 131-140.
- Findlay SEG, Sinsabaugh RL, Fischer DT & Franchini P (1998b) Sources of dissolved organic carbon supporting planktonic bacterial production in the tidal freshwater Hudson River. *Ecosystems* 1: 227-239.
- Findlay SEG, Dye S & Kuehn KA (2002a) Microbial growth and nitrogen retention in litter of *Phragmites australis* compared to *Typha angustifolia*. *Wetlands* 22: 616-625.

- Findlay SEG, Tank J, Dye S, Valett HM, Mulholland PJ, McDowell WH, Johnson SL, Hamilton SK, Edmonds J, Dodds WK & Bowden WB (2002b) A cross-system comparison of bacterial and fungal biomass in detritus pools of headwater streams. *Microbial Ecology* 43: 55-66.
- Findlay SEG, Groffman P & Dye S (2003) Effects of *Phragmites australis* removal on marsh nutrient cycling. *Wetland Ecology and Management* 11: 157-165.
- Findlay SEG, Wigand C & Nieder WC (2006) Submersed macrophyte distribution and function in the tidal freshwater Hudson River. In: Levinton JS & Waldman JR (eds) *The Hudson River estuary*, pp. 230-241. Cambridge University Press, New York.
- Firth A (2000) Development-led archaeology in coastal environments: investigations at Queenborough, Motney Hill and Gravesend in Kent, UK. In: Pye K & Allen JRL (eds) *Coastal and estuarine environments: sedimentology, geomorphology and geoarchaeology*. Special Publications 175: 403-417. Geological Society, London.
- Fisher TR, Hagy JD III, Boynton WR & Williams MR (2006) Cultural eutrophication in the Choptank and Patuxent estuaries of Chesapeake Bay. *Limnology and Oceanography* 51: 435-447.
- Flemer DA, Heinle DR, Keefe CW & Hamilton DH (1978) Standing crops of marsh vegetation of two tributaries of Chesapeake Bay. *Estuaries* 1: 157-163.
- Flynn KJ (2005) Castles built on sand: dysfunctionality in plankton models and the inadequacy of dialogue between biologists and modellers. *Journal of Plankton Research* 27: 1205-1210.
- Flynn KM, McKee KL & Mendelsohn IA (1995) Recovery of freshwater marsh vegetation after a saltwater intrusion event. *Oecologia* 103: 63-72.
- Fockema Andreae GJ (1950) *Studies over waterschapsgeschiedenis III, De Grote of Zuidhollandse Waard*. Brill, Leiden, NL.
- Fogel ML & Tuross N (1999) Transformation of plant biochemicals to geological macromolecules during early diagenesis. *Oecologia* 120: 336-346.
- Folker RV (1987) An ecological study of *Hydrilla* in the Potomac River; waterfowl segment. Technical Report A-87-1. United States Army Corps of Engineers, Washington, DC.
- Foppen R & Deuzeman S (2007) De Grote karekiet in de noordelijke randmeren; een dilemma voor natuurontwikkelingsplannen!?. *De Levende Natuur* 108: 20-26. NL.
- Ford MA & Grace JB (1998) Effects of vertebrate herbivores on soil processes, plant biomass, litter accumulation and soil elevation changes in a coastal marsh. *Journal of Ecology* 86: 974-982.
- Ford MA, Cahoon DR & Lynch JC (1999) Restoring marsh elevation in a rapidly-subsiding salt marsh by thin-layer deposition of dredge material. *Ecological Engineering* 12: 189-205.
- Forrest J (1988) *Lord I'm coming home: everyday aesthetics in Tidewater North Carolina*. Cornell University Press, Ithaca, NY, USA.
- Fowler BK & Hershner C (1989) Primary production in Cohoke Swamp; a tidal freshwater wetland in Virginia. In: Sharitz RR & Gibbone JW (eds) *Freshwater wetlands and wildlife symposium: perspectives on natural, managed and degraded ecosystems*, pp. 365-374. U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, TN, USA.
- Frankignoulle M, Abril G, Borges A, Bourge I, Canon C, Delille B, Libert E & Theate J-M (1998) Carbon dioxide emission from European estuaries. *Science* 282: 434-436.
- Frazier DE (1967) Recent deltaic deposits of the Mississippi River, their development and chronology. *Gulf Coast Association of Geological Societies Transactions* 17: 287-315. USA.
- Friebele E & Zambo J (2004) *A guide to the amphibians and reptiles of Jug Bay*. Publication of the Chesapeake Bay National Estuarine Research Reserve, Department of Natural Resources, Annapolis, MD, USA.
- Friebele E, Swarth CW & Stafford K (2001) *The ecology and history of Jug Bay: a volunteer's guide*. Chesapeake Bay National Estuarine Research Reserve - Maryland, Maryland Department of Natural Resources, Annapolis, MD, USA.
- Friedrichs CT & Perry JE (2001) Tidal salt marsh morphodynamics: a synthesis. *Journal of Coastal Research - Special Issue* 27: 7-37.
- Frings, RM & Kleinhans MG (2008) Complex variations in sediment transport at three large river bifurcations during discharge waves in the river Rhine. *Sedimentology* 55: 1145-1171.
- Froomer NL (1980) Sea-level changes in the Chesapeake Bay during historic times. *Marine Geology* 36: 289-305.
- Frost JW, Schleicher T & Craft CB (2009) Effects of nitrogen and phosphorus additions on primary production and invertebrate densities in a Georgia (USA) tidal freshwater marsh. *Wetlands* 29: 196-203.
- Fuller DA, Sasser CE, Johnson WB & Gosselink JG (1985) The effects of herbivory on vegetation on islands in Atchafalaya Bay, Louisiana. *Wetlands* 4: 105-114.
- Fuller DA, Peterson GW, Abernethy RK & LeBlanc MA (1988) The distribution and habitat use of waterfowl in Atchafalaya Bay, Louisiana. In: Sasser CE & Fuller DA (eds) *Vegetation and waterfowl use of islands in Atchafalaya Bay*, pp. 73-103. Coastal Ecology Institute, Louisiana State University, Baton Rouge, LA, USA.
- Funk RE (1976) *Recent contributions to Hudson Valley prehistory*. New York State Museum Memoir 22, USA.
- Furumai H, Kawasaki T, Futuwatari T & Kusuda T (1988) Effect of salinity on nitrification in a tidal river. *Water Science and Technology* 20: 165-174.
- Galatowitsch SM, Anderson NO & Ascher PD (1999) Invasiveness in wetland plants in North America. *Wetlands* 19: 733-755.
- Gannett Fleming (2001) *Plans of Route 29 - Open water mitigation, Township of Hamilton, County of Mercer*. Gannett Fleming, Inc., Hammonton, NJ, USA.
- Garniel A & Mierwald U (1996) Changes in the morphology and vegetation along the human-altered shoreline of the Lower Elbe. In: Nordstrom KF & Roman CT (eds) *Estuarine shores: evolution, environments and human alterations*, pp. 375-396. John Wiley & Sons, Chichester, UK.
- Garniel A & Mierwald U (2005) *Konventionsvorschlag für eine länderübergreifend angestimmte Meldepraxis des Lebesraumtyps [1130] [Ästuarien] an der Unterelbe*. Kieler Institut für Landschaftsökologie. Kiel, GER.
- Garnier J, Billen G & Coste M (1995) Seasonal succession of diatoms and Chlorophyceae in the drainage network of the Seine River: Observations and modelling. *Limnology and Oceanography* 40: 750-765.
- Garnier J, Servais P, Billen G, Akopian M & Brion N (2001) Lower Seine river and estuary (France) carbon and oxygen budgets during low flow. *Estuaries* 24: 964-976.



- Garnier J, Cebren A, Tallee G, Billen G, Sebilo M & Martinez A (2006) Nitrogen behaviour and nitrous oxide emission in the tidal Seine River estuary (France) as influenced by human activities in the upstream watershed. *Biogeochemistry* 77: 305-326.
- Garono RJ, Robinson R & Simenstad C (2003) Estuarine and tidal freshwater habitat cover types along the lower Columbia River estuary determined from Landsat 7 ETM + Imagery. Wetlands and Watershed Assessment Group. Corvallis, OR, USA.
- Gaudet JJ (1977) Uptake, accumulation, and loss of nutrients by papyrus on tropical swamps. *Ecology* 58: 415-422.
- Gaumert Th (1982) 100 Jahre Elbe-Forschung. Hydrobiologische Situation und Fischbestand 1842-1943 unter dem Einfluß von Stromverbau und Sieleinleitungen. *Archiv für Hydrobiologie, Suppl.* 61: 317-376.
- George M (1992) The land use, ecology and conservation of Broadland. Packard Publishing Limited, Chichester, UK.
- Gerkens M & Thiel R (2001) Habitat use of age-0 twaite shad (*Alosa fallax* Lacepede, 1803) in the tidal freshwater region of the Elbe River, Germany. *Bulletin Francais de la Peche et de la Pisciculture* 362-263: 773-784. FR.
- Gertler E (1992) Garden State canoeing: a paddler's guide to New Jersey. Seneca Press, Silver Spring, MD, USA.
- Gibbs RJ (1970) Circulation in the Amazon River estuary and adjacent Atlantic Ocean. *Journal of Marine Research* 28: 113-123.
- Giddy IH (2003) The Hudson River water trail guide. River Water Trail Association, New York.
- Gilbert H (1990) Productivité végétale dans un marais intertidal d'eau douce, Québec (Québec). *Canadian Journal of Botany* 68: 825-856.
- Giroux J & Bédard J (1987) The effects of grazing by greater snow geese on the vegetation of tidal marshes in the St. Lawrence Estuary. *Journal of Applied Ecology* 24: 773-788.
- Giroux J & Bédard J (1995) Seed production, germination rate, and seedling establishment of *Scirpus pungens* in tidal brackish marshes. *Wetlands* 15: 290-297.
- Gittenberger E, Backhuys W & Ripken ThEJ (1970) De landslakken van Nederland. Bibliotheek KNNV no. 17, Amsterdam, NL.
- Gittenberger E, Janssen AW, Kuijper WJ, Kuiper JG, Meijer T, Van de Velde G & De Vries JN (1999) De Nederlandse zoetwatermollusken. *Nederlandse Fauna* 2. Nationaal Natuurhistorisch Museum Naturalis, KNNV Uitgeverij & EIS-Nederland, Leiden, NL.
- Glad JB & Halse RR (1993) Invasion of *Amorpha fruticosa* L. (Leguminosae) along the Columbia and Snake Rivers in Oregon and Washington. *Madroño* 40: 62-63. USA.
- Gleason HA & Cronquist A (1991) Manual of vascular plants of the northeastern United States and adjacent Canada. The New York Botanical Garden, Bronx, NY, USA.
- Glöer P (2002a) Die Süßwassergastropoden Nord- und Mitteleuropas. Conchbooks, Hackenheim, GER.
- Glöer P (2002b) Die Molluskenfauna der Elbe bei Hamburg und angrenzender Gewässer vor 100 Jahren und heute. Ein vorläufiger Bericht. *Collectanea Malacologica – Festschrift für Gerhard Falkner*: 479-517. Conchbooks, Hackenheim, GER.
- Glunt RR (ca. 1969) The old lighthouses of the Hudson River. Moran Printing Company, Grove, PA, USA.
- Glunt RR (1975) Lighthouses and legends of the Hudson. Library Research Associates, Monroe, NY, USA.
- Gocke K & Lenz J (2004) A new 'turbulence incubator' for measuring primary production in non-stratified waters. *Journal of Plankton Research* 26: 357-369.
- Godfrey RK & Wooten JW (1979) Aquatic and wetland plants of the southeastern United States: Monocotyledons. University of Georgia Press, Athens, GA, USA.
- Godfrey RK & Wooten JW (1981) Aquatic and wetland plants of the southeastern United States: Dicotyledons. University of Georgia Press, Athens, GA, USA.
- Godin G (1999) The propagation of tides up rivers with special considerations on the Upper Saint Lawrence river. *Estuarine, Coastal and Shelf Science* 48: 307-324.
- Goldblatt LA (2004) Purple loosestrife (*Lythrum salicaria*) in the Chesapeake Bay watershed: a regional management plan. Regional *Lythrum salicaria* Working Group, Chesapeake Bay, USA. (Viewed 25 Febr. 2008 at <http://www.anstaskforce.gov/>).
- Gomez M & Day F (1982) Litter nutrient content and production in the Great Dismal Swamp. *American Journal of Botany* 69: 1314-1321.
- Good P & Lowe J (2006) Emergent behavior and uncertainty in multi-model climate projections of precipitation trends at small spatial scales. *Journal of Climatology* 27: 357-375.
- Good RE & Good NF (1974-1975) Vegetation and production of the Woodbury Creek-Hessian Run freshwater tidal marshes. *Bartonia* 43: 38-45. USA.
- Good RE, Whigham DF & Simpson RL (eds) (1978) Freshwater wetlands, ecological processes and management potential. Academic Press, New York, USA.
- Goosen NK, Kromkamp J, Peene J, Van Rijswijk P & Van Breugel P (1999) Bacterial and phytoplankton production in the maximum turbidity zone of three European estuaries: the Elbe, Westerschelde and Gironde. *Journal of Marine Systems* 22: 151-171.
- Gordon BL (1979) Monterey Bay area: natural history and cultural imprints. The Boxwood Press, Pacific Grove, CA, USA.
- Gosselink JG (1984) The ecology of delta marshes of coastal Louisiana: a community profile, U.S. Fish Wildlife Service. Washington, DC.
- Gosselink JG, Coleman JM & Stewart RE Jr (1998) Coastal Louisiana. In: Mac MG, Opler PA, Puckett-Haecher CE & Doran PD (eds) Status and trends of the nation's biological resources, Volume 1, pp. 386-436. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, USA.
- Gottschalk LC (1945) Effects of soil erosion on navigation in upper Chesapeake Bay. *Geographical Review* 35: 219-238.
- Grabemann I & Krause G (2001) On different time scales of suspended matter dynamics in the Weser estuary. *Estuaries* 24: 688-698.
- Grabemann I, Uncles RJ, Krause G & Stephens JA (1997) Behaviour of turbidity maxima in the Tamar (U.K.) and Weser (F.R.G.) estuaries. *Estuarine, Coastal and Shelf Science* 45: 235-246.
- Grant A & Middleton R (1993) Trace metals in sediments from Humber estuary: a statistical analysis of spatial uniformity. *Netherlands Journal of Aquatic Ecology* 27: 111-120.
- Gratton C & Denno RF (2003) Inter-year carryover effects of a nutrient pulse on *Spartina* plants, herbivores, and natural enemies. *Ecology* 84: 2692-2707.

- Graveland J (1998) Reed die-back, water level management and the decline of the Great Reed Warbler *Acrocephalus arundinaceus* in the Netherlands. *Ardea* 86: 187-201. NL.
- Gray A, Simenstad CA, Bottom DL & Cornwell TJ (2002) Contrasting functional performance of juvenile salmon habitat in recovering wetlands of the Salmon River estuary, Oregon, USA. *Restoration Ecology* 10: 514-526.
- Greenway D & R (1999) Hamilton/Trenton Marsh management plan. D & R Greenway, One Preservation Place, Princeton, NJ, USA.
- Gribsholt B, Boschker HTS, Struyf E, Andersson M, Tramper A, De Brabandere L, Van Damme S, Brion N, Meire P, Dehairs F, Middelburg JJ & Heip C (2005) Nitrogen processing in a tidal freshwater marsh: a whole ecosystem <sup>15</sup>N labeling study. *Limnology & Oceanography* 50: 1945-1959.
- Gribsholt B, Struyf E, Tramper A, Andersson MGI, Brion N, De Brabandere L, Van Damme S, Meire P, Middelburg JJ, Dehairs F & Boschker HTS (2006) Ammonium transformation in a nitrogen-rich tidal freshwater marsh. *Biogeochemistry* 80: 289-298.
- Gribsholt B, Struyf E, Tramper A, De Brabandere L, Brion N, Van Damme S, Meire P, Dehairs F, Middelburg JJ & Boschker HTS (2007) Nitrogen assimilation and short term retention in a nutrient-rich tidal freshwater marsh – a whole ecosystem <sup>15</sup>N enrichment study. *Biogeosciences* 4: 11-26
- Grieser KA & Dalton SE (2006) Quantification and characterization of recreational paddling on Tivoli Bays and Constitution Marsh. In: Nieder WC & Waldman JR (eds) Final reports of the Tibor T. Polgar Fellowship Program 2005, pp. vii-1 to viii-36. Hudson River Foundation, New York.
- Griffith AB & Forseth IN (2003) Establishment and reproduction of *Aeschynomene virginica* (L.) (Fabaceae), a rare, annual wetland species in relation to vegetation removal and water level. *Plant Ecology* 167: 117-125.
- Grobbelaar JU (1990) Modelling phytoplankton productivity in turbid waters with small euphotic to mixing depth ratios. *Journal of Plankton Research* 12: 923-931.
- Grossinger R, Alexander J, Cohen AN & Collins JN (1998) Introduced tidal marsh plants in the San Francisco Estuary. San Francisco Estuary Institute, Oakland, CA, USA.
- Guézennec L, Lafite R, Dupont JP, Meyer R & Boust D (1999) Hydrodynamics of suspended particulate matter in the tidal freshwater zone of a macrotidal estuary (the Seine estuary, France). *Estuaries* 22: 717-727.
- Hack JT (1960) Interpretation of erosional topography in humid temperate regions. *American Journal of Science* 258A: 80-97.
- Hackney CT & Yelverton GF (1990) Effects of human activities and sea level rise on wetland ecosystems in the Cape Fear River estuary, North Carolina, USA. In: Whigham DF, Good RE & Kvet J (eds) Wetland ecology and management: case studies, pp. 55-61. Kluwer Academic Publishers, Dordrecht, NL.
- Hackney CT, Brady S, Stemmy L, Boris M, Dennis C, Hancock T, O'Brian M, Tilton C & Barbee E (1996) Does intertidal vegetation indicate specific soil and hydrologic conditions? *Wetlands* 16: 89-94.
- Haecher CE & Doran PD (eds) Status and trends of the nation's biological resources, Volume 1, pp. 386-436. U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, USA.
- Hall D, Evans C, Hodder I & Pryor F (1987) The fenlands of East Anglia, England: survey and excavation. In: Coles JM & Lawson AJ (eds) European wetlands in prehistory, pp. 169-201. Clarendon Press, Oxford, UK.
- Hall JV (1988) Alaska coastal wetland survey. National Wetlands Inventory, U.S. Fish and Wildlife Service, Anchorage, AK, USA.
- Hall JV, Frayer WE & Wilen BO (1994) Status of Alaska wetlands. U.S. Fish and Wildlife Service, Washington, DC.
- Hamerlynck O, Hostens K, Arellano RV, Mees J & Van Damme PA (1993) The mobile epibenthic fauna of soft bottoms in the Dutch Delta (south-west Netherlands): spatial structure. *Netherlands Journal of Aquatic Ecology* 27: 343-358.
- Hammerschlag RS, Baldwin AH, Krafft CC, Neff KP, Paul MM, Brittingham KD, Rusello K & Hatfield JS (2006) Five years of monitoring reconstructed freshwater tidal wetlands in the urban Anacostia River (2000-2004). Technical Reports of the US Geological Survey, Patuxent Wildlife Research Center and University of Maryland Department of Biological Resources Engineering. College Park, MD, USA.
- Hansen WR & Eckel EB (1971) Setting and effects of the earthquake. In: National Research Council, Committee on the Alaska Earthquake. The great Alaska earthquake of 1964: geology, pp. 5-43. National Academy of Sciences, Washington, DC.
- Hanson HC (1951) Characteristics of some grassland, marsh and other plant communities in western Alaska. *Ecological Monographs* 21: 317-378.
- Haramis GM & Colona R (1998) The effect of nutria (*Myocastor coypus*) on marsh loss on the Eastern Shore. <http://www.pwrc.usgs.gov/resshow/nutria.htm> (Viewed January 2008).
- Haramis GM & Kearns GD (2007a) Herbivory by resident geese: The loss and recovery of wild rice along the tidal Patuxent River. *Journal of Wildlife Management* 71: 788-794.
- Haramis GM & Kearns GD (2007b) Soras in tidal marsh: banding and telemetry studies on the Patuxent River. *Waterbirds* 30 (Special Publication 1): 105-121.
- Harbasins (2008) Steps towards a harmonized transnational management strategy for coastal and transitional waters. Overall final report of Harbasins. Rijkswaterstaat, Lelystad, NL.
- Hardell L & Eriksson M (1999) A case-control study of non-Hodgkin lymphoma and exposure to pesticides. *Cancer* 85: 1353-1360.
- Harding JJ & Harding JJ (1980) Birding the Delaware Valley region: a comprehensive guide to bird watching in southeastern Pennsylvania, central and southern New Jersey, and north central Delaware. Temple University Press, Philadelphia, PA, USA.
- Hare JA & Able KW (2007) Mechanistic links between climate and fisheries along the east coast of the United States: explaining population outbursts of Atlantic croaker (*Micropogonias undulatus*). *Fisheries Oceanography* 16: 31-45.
- Harris LD & Cropper WP Jr (1992) Between the devil and the deep blue sea: implications of climate change for Florida's fauna. In: Peters RL & Lovejoy TE (eds) Global warming and biological diversity, pp. 309-324. Yale University Press, New Haven, CT, USA.
- Harvey JW, Chambers RM & Hoelscher JR (1995) Preferential flow and segregation of porewater solutes in wetland sediment. *Estuaries* 18: 568-578.

- Haslam SM (1972) *Phragmites communis*. Journal of Ecology 60: 585-610.
- Hastings RW & Good RE (1977) Population analysis of the fishes of a freshwater tidal tributary of the lower Delaware River. Bulletin of the New Jersey Academy of Sciences 22: 13-20. USA.
- Hauber DP, White DA, Powers SP & DeFrancesch FR (1991) Isozyme variation and correspondence with unusual infrared reflectance patterns in *Phragmites australis* (Poaceae). Plant Systematics and Evolution 178: 1-8.
- Hawkins P & Leck CF (1977) Breeding bird communities in a tidal freshwater marsh. Bulletin of the New Jersey Academy of Science 22: 13-20. USA.
- Healey MC (1982) Juvenile Pacific salmon in estuaries: the life support system. In: Kennedy VS (ed) Estuarine Comparisons, pp. 315-341. Academic Press, New York.
- Healy MG & Hickey KR (2002) Historic land reclamation in the intertidal wetlands of the Shannon estuary, western Ireland. Journal of Coastal Research 36: 365-373.
- Heemken OP, Stachel B, Theobald N & Wenclawiak BW (2000) Temporal variability of organic micropollutants in suspended particulate matter of the river Elbe at Hamburg and the river Mulde at Dressau, Germany. Archives of Environmental Contamination and Toxicology 38: 11-31.
- Heij CJ & De Jong HF (1970) De mollusken van de "Esscheplaat" en een in de nabijheid gelegen afgedamde kreek, in relatie tot hun milieu. MSc Thesis, Zoologisch Museum, Utrecht University, NL.
- Heinle DR & Flemer DA (1976) Flows of materials between poorly flooded tidal marshes and an estuary. Marine Biology 35: 359-373.
- Heip C, Goosen N, Herman PMJ, Kromkamp J, Middelburg J & Soetaert K (1995) Production and consumption of biological particles in temperate tidal estuaries. Oceanography and Marine Biology: an Annual Review 33: 1-149.
- Heise S, Calmano W, Ahlf W, Leal W & Krahn D (2005) Environmental challenges for the amburg stretch of the River Elbe and its catchment with regard to the Water Framework Directive. Watersketch study Elbe. Hamburg, GER.
- Hejda M & Pysek P (2006) What is the impact of *Impatiens glandulifera* on species diversity of invaded riparian vegetation? Biological Conservation 132: 143-152.
- Hellings L, Dehairs F, Van Damme S & Baeyens W (2001) Dissolved inorganic carbon in a highly polluted estuary (the Scheldt). Limnology and Oceanography 46: 1406-1414.
- Hendrickx F (1996) Ecologische aspecten van enkele arthropodengroepen van de schorren langs het Schelde-estuarium. Licentiaatsthesis Universiteit Gent, BEL.
- Hendriks JPC, Van Beurden A, Weerts HTJ, Meijer T, Van Smeerdijk DG & Paalman DBS (2004) "Dar vordrunken 167 schone kerspele..." - Introductie op het moderne interdisciplinaire onderzoek naar de St. Elisabethsvloeden, 1421-1424. Westerheem, tijdschrift voor de Nederlandse archeologie 53: 94-111. NL.
- Hepp GR & Bellrose FC (1995) Wood Duck (*Aix sponsa*). In: Poole A (ed) The birds of North America online. Cornell Lab of Ornithology, Ithaca, NY, USA. <http://bna.birds.cornell.edu/bna/species/169>, doi:bna.169 (Viewed Jan. 2008).
- Herman PMJ, Middelburg JJ, Van de Koppel J & Heip CHR (1999) Ecology of estuarine macrobenthos. Advances in Ecological Research 29: 195-240.
- Herschey RW (1995) Streamflow measurement. E & FN Spon, Londen.
- Hesse ID, Day JW Jr & Doyle TW (1998) Long-term growth enhancement of baldcypress (*Taxodium distichum*) from municipal wastewater application. Environmental Management 22: 119-127.
- Heyligers PC (1961) De bodemfauna van de grienden. In: Verwey et al. (eds) De Biesbosch, land van het levende water, pp. 85-117. Thieme, Zutphen, NL.
- Heyligers PC (1965) The soil fauna of the osierbeds of the Brabantse Biesbosch. In: Tüxen R (ed) Biosoziologie, pp. 199-210. Junk, Den Haag, NL.
- Hickey BM & Banas NS (2003) Oceanography of the U.S. Pacific Northwest coastal ocean and estuaries with application to coastal ecology. Estuaries 26: 1010-1031.
- Hickman JC (1993) The Jepson manual: higher plants of California. University of California Press, Berkeley, CA, USA.
- Hight SD, Blossey B, Laing J & DeClerck-Floate R (1995) Establishment of insect biocontrol agents from Europe against *Lythrum salicaria* in North America. Environmental Entomology 24: 967-977.
- Higinbotham CB, Alber M & Chalmers AG (2004) Analysis of tidal marsh vegetation patterns in two Georgia estuaries using aerial photography and GIS. Estuaries 27: 670-683.
- Hilgartner WB (1995) Habitat development in a freshwater tidal wetland: a paleoecological study of human and natural influences. PhD Dissertation, The Johns Hopkins University, Baltimore, MD, USA.
- Hilgartner WB & Brush GS (2006) Prehistoric habitat stability and post-settlement habitat change in a Chesapeake Bay freshwater tidal wetland, USA. The Holocene 16: 479-494.
- Hindman LJ, Dickson KM, Harvey WF & Serie JR (2003) Atlantic flyway Canada geese: New perspectives in goose management. In: Moser TJ, Vercauteren KC, Lien RD, Abraham KF, Andersen DE, Bruggink JG, Coluccy JM, Graber DA, Leafloor JO, Luukonen DR & Trost RE (eds) Proceedings of the 2003 International Canada Goose Symposium, pp. 12-21. Madison, WI, USA.
- Hobbie JS (ed) (2000) Estuarine science: a synthetic approach to research and practice. Island Press, Washington, DC.
- Hoek PPC (1910) De achteruitgang van de steurvisscherij onzer Benedenrivieren. Mededelingen Visscherij 17: 103. NL.
- Hofer B (1913) Bericht über die Ergebnisse einer Untersuchung der Unterelbe von der Elbemündung bis Hamburg. Anlage zum Protokoll der Dradenau-Kommission vom 6.12.1913: 8. [cited after Gaumert 1982] GER.
- Hoffnagle JR (1980) Estimates of vascular plant primary production in a west coast saltmarsh-estuary ecosystem. Northwest Science 54: 68-79. USA.
- Hogg EH & Wein RW (1988a) The contribution of *Typha* components to floating mat buoyancy. Ecology 69: 1025-1031.
- Hogg EH & Wein RW (1988b) Seasonal change in gas content and buoyancy of floating *Typha* mats. Journal of Ecology 76: 1055-1068.
- Holdahl SA & Morrison NL (1974) Regional investigations of vertical crustal movements in the U.S., using precise relevelings and mareographic data. Tectonophysics 23: 373-390.
- Holm GO Jr & Sasser CE (2001) Differential salinity response between two Mississippi River subdeltas: implications for changes in plant composition. Estuaries 24: 78-89.



- Holm GO Jr, Sasser CE, Peterson GW & Swenson EM (2000) Vertical movement and substrate characteristics of oligohaline marshes near a high-sediment, riverine system. *Journal of Coastal Research* 16: 164-171.
- Hopkinson CS, Giblin AE, Tucker J & Garritt RH (1999) Benthic metabolism and nutrient cycling along an estuarine salinity gradient. *Estuaries* 22: 863-881.
- Hopley D (1978) Sea level changes on the Great Barrier Reef. *Philosophical Transactions of the Royal Society of London, Series A Mathematical and Physical Sciences* 291: 159-166.
- Horrevoets AC, Savenije HHG, Schuurman JN & Graas S (2004) The influence of river discharge on tidal damping in alluvial estuaries. *Journal of Hydrology* 294: 213-228.
- Howard RJ & Mendelssohn IA (1999a) Salinity as a constraint on growth of oligohaline marsh macrophytes. I. Species variation in stress tolerance. *American Journal of Botany* 86: 785-794.
- Howard RJ & Mendelssohn IA (1999b) Salinity as a constraint on growth of oligohaline marsh macrophytes. II. Salt pulses and recovery potential. *American Journal of Botany* 86: 795-806.
- Howarth R (1984) The ecological significance of sulfur in the energy dynamics of salt marsh and coastal marine sediments. *Biogeochemistry* 1: 5-27.
- Howarth RW (1988) Nutrient limitation of net primary production in marine ecosystems. *Annual Review of Ecology and Systematics* 19: 89-110.
- Howarth RW, Marine R & Cole JJ (1988) Nitrogen-fixation in freshwater, estuarine, and marine ecosystems. 2. Biogeochemical controls. *Limnology and Oceanography* 33: 688-701.
- Howarth RW, Schneider R & Swaney D (1996) Metabolism and organic carbon fluxes in the tidal freshwater Hudson River. *Estuaries* 19: 846-665.
- Howarth RW, Sharpley A & Walker D (2002) Sources of nutrient pollution to coastal waters in the United States: Implications for achieving coastal water quality goals. *Estuaries* 25: 656-676.
- Howat JK (1972) *The Hudson River and its painters*. Viking Press, New York.
- Howe CM, Berrill M, Pauli BC, Helbing CC, Werry K & Veldhoen N (2004) Toxicity of glyphosate-based pesticides to four North American frog species. *Environmental Toxicology and Chemistry* 23: 1928-1938.
- Huang X & Morris JT (2003) Trends in phosphatase activity along a successional gradient of tidal freshwater marshes on the Cooper River, South Carolina. *Estuaries* 26: 1281-1290.
- Hull CHJ & Titus JT (1986) Greenhouse effect, sea level rise, and salinity in the Delaware estuary. U.S. Environmental Protection Agency, Washington, DC.
- Hume IN (1994) *The Virginia adventure: Roanoke to James Towne: an archaeological and historical odyssey*. Alfred A. Knopf, New York.
- Hummel M & Findlay S (2006) Effects of water chestnut (*Trapa natans*) beds on water chemistry in the tidal freshwater Hudson River. *Hydrobiologia* 559: 169-181.
- Hummel M & Kiviat E (2004) Review of world literature on water-chestnut (*Trapa natans*) with implications for management in North America. *Journal of Aquatic Plant Management* 42: 17-28.
- Hutchinson I (1986) Primary production functions of wetlands in the Pacific northwest. In: Strickland R (ed) *Wetland Functions, Rehabilitation, and Creation in the Pacific Northwest*, pp. 73-91. Washington State Department of Ecology, Olympia, WA, USA.
- Immeyer J (1996) Untersuchungen zur Veränderung der ökologischen Bedingungen der Tideröhrichte an der Unterelbe zwischen den Kartierungen von Kötter und heute (1961-1995). Diplomarbeit am Institut für Angewandte Botanik, Universität Hamburg, GER.
- Inglett PW, Reddy KR & McCormick PV (2004) Periphyton chemistry and nitrogenase activity in a northern Everglades ecosystem. *Biogeochemistry* 67: 213-233.
- ISCWW (2002) Invasive species in the Chesapeake watershed workshop: Nutria (<http://www.mdsg.umd.edu/exotics/workshop/nutria.html>).
- Iverson LR & Prasad AM (1998) Predicting the abundance of 80 tree species following climate change in the eastern United States. *Ecological Monographs* 68: 465-485.
- Jackson RH, Williams PJ Le B & Joint IR (1987) Freshwater phytoplankton in the low salinity region of the River Tamar estuary. *Estuarine, Coastal and Shelf Science* 25: 299-311.
- Jacobs P, Steenkamp BPC & De Goederen S (2003) Analyse zoutmetingen inlaatproef Haringvliet in maart 1997. RIZA rapport 2003.001. Lelystad, NL.
- Jaekel SGA (1962) Ergänzungen und Berichtigungen zum rezenten und quartären Vorkommen der mitteleuropäischen Mollusken. In: Brohmer P, Ehrmann P & Ulmer G (eds), *Die Tierwelt Mitteleuropas 2 (Lief.1, Erg.)*: 25-294. Quelle & Meyer, Leipzig, GER.
- JBWS (Jug Bay Wetland Sanctuary) (2007a) Wetland plants of the Jug Bay Wetlands Sanctuary (<http://www.jugbay.org/jugbay/wetlandplants.html>).
- JBWS (Jug Bay Wetland Sanctuary) (2007b) Mammals observed at the Jug Bay Wetlands Sanctuary (<http://www.jugbay.org/jugbay/mammallist.html>).
- JBWS (Jug Bay Wetland Sanctuary) (2007c) Checklist of the birds of the Jug Bay Wetlands Sanctuary (<http://www.jugbay.org/jugbay/birdlist.html>).
- JBWS (Jug Bay Wetland Sanctuary) (2007d) Fish occurring in the Patuxent River, wetlands and streams at Jug Bay (<http://www.jugbay.org/jugbay/research/>).
- JBWS (Jug Bay Wetland Sanctuary) (2007e) Fish occurring in the Patuxent River, wetlands and streams at Jug Bay (<http://www.jugbay.org/jugbay/research/herpsearch2001.html>).
- JCNERR (Jacques Cousteau National Estuarine Research Reserve) (1999) Mullica river - Great Bay (MRGB) National Estuarine Research Reserve in New Jersey. Final Management Plan. Institute of Coastal and Marine Science, Rutgers University, New Brunswick, NJ, USA.
- Jefferson CA (1975) Plant communities and succession in Oregon coastal salt marshes. PhD Dissertation. Oregon State University, Corvallis, OR, USA.
- Jensen J, Mudersbach C & Blasi C (2003) Hydrological changes in tidal estuaries due to natural and anthropogenic effects. Proceedings of the 6<sup>th</sup> International MEDCOAST 2003-Conference. Ravenna, Italy.
- Jensen K (2007) Röhrichte in Ästuaren: Verbreitung, Ökosystemfunktion und Gefährdung. BFG Veranstaltungen 2: 5-19. GER.
- Jickells TD & Rae JE (eds) (1997) *Biogeochemistry of intertidal sediments*. Cambridge University Press, Cambridge, UK.
- JNNC (Joint Nature Conservation Committee) (1996). Guidelines for selection of biological SSSIs: intertidal marine habitats and saline lagoons. Peterborough, UK.

- Jochems H, Schneiders A, Denys L & Van den Bergh E (2002) Typologie van de oppervlaktewateren in Vlaanderen. Eindverslag van het project VMM. KRLWtypology 2001 IN.O.2002.27. INBO, Brussels, BEL.
- Johnson AS, Hillestad HO, Shanholtzer SF & Shanholtzer GF (1974) An ecological survey of the coastal region of Georgia. National Park Service Scientific Monograph Series 3, Washington, DC.
- Johnson Randall LA & Foote AL (2005) Effects of managed impoundments and herbivory on wetland plant production and stand structure. *Wetlands* 25: 38-50.
- Johnson WB, Sasser CE & Gosselink JG (1985) Succession of vegetation in an evolving river delta, Atchafalaya Bay, Louisiana. *Journal of Ecology* 73: 973-986.
- Joint Nature Conservation Committee (1996) Guidelines for selection of biological SSSIs: intertidal marine habitats and saline lagoons. Peterborough, UK.
- Jones RC & Kelso DP (2005) An ecological study of Gunston Cove. Final Report to Department of Public Works, Fairfax, VA, USA.
- Jonkers N, Laane RWPM & De Voogt P (2003) Fate of nonylphenol ethoxylates and their metabolites in two Dutch estuaries: evidence of biodegradation in the field. *Environmental Science Technology* 37: 321-327.
- Jordan TE, Correll DL & Whigham DF (1983) Nutrient flux in the Rhode River: Tidal exchange of nutrients by brackish marshes. *Estuarine, Coastal and Shelf Science* 17: 651-667.
- Jordan TE, Corell DL, Miklas J & Weller DE (1991) Nutrients and chlorophyll at the interface of a watershed and an estuary. *Limnology and Oceanography* 36: 251-267.
- Jordan TE, Cornwell JC, Boynton WR & Anderson JT (2008) Changes in phosphorus biogeochemistry along an estuarine salinity gradient: the iron conveyor belt. *Limnology and Oceanography* 53: 172-184.
- Josselyn M (1983) The Ecology of San Francisco Bay tidal marshes: a community profile. Biological Report FWS/OBS-83/23. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, DC.
- Jurik TW, Wang S & Van der Valk AG (1994) Effects of sediment load on seedling emergence from wetland seed banks. *Wetlands* 14: 159-165.
- Junk WJ (1983) Wetlands of tropical South America. In: Whigham D, Dykijováand D & Hejný S (eds). *Wetlands of the World: Inventory, Ecology and Management*. Volume 1, pp. 679-739. Kluwer Academic Publishers, Dordrecht, NL.
- Kadereit G & Kadereit JW (2005) Phylogenetic relationships, evolutionary origin, taxonomic status and genetic structure of the endangered local Lower Elbe river (Germany) endemic *Oenanthe coniooides* (Nolte ex Rchb. f.) Lange (Apiaceae): ITS and AFLP evidence. *Flora: Morphologie, Geobotanik, Oecophysiologie* 200: 15-29. GER.
- Kahn H & Brush GS (1994) Nutrient and metal accumulation in a freshwater tidal marsh. *Estuaries* 17: 345-360.
- Kale HW II (1965) Ecology and bioenergetics of the long-billed marsh wren *Telmatodytes palustris griseus* (Brewster) in Georgia salt marshes. Nuttall Ornithological Club, Cambridge, MA, USA.
- Kaminsky M & Scelsi P (1986) Route 130, Section 9F Rancocas Creek Bridge, Site iii Wetland Replacement. Bureau of Environmental Analysis, New Jersey Department of Transportation, Trenton, NJ, USA.
- Kandus P & Malvárez AI (2004) Vegetation patterns and change analysis in the Lower Delta Islands of the Paraná River (Argentina). *Wetlands* 24: 620-632.
- Kane R (2001a) *Phragmites* use by birds in New Jersey. *Records of New Jersey Birds* 9: 122-124. USA.
- Kane R (2001b) *Phragmites*: a dissenting opinion. *New Jersey Audubon* (Winter 2000-2001): 25-26. USA.
- Karl TR, Knight RW & Plummer N (1995) Trends in high-frequency climate variability in the 20th century. *Nature* 377: 217-220.
- Kay SH (1995) Efficacy of wipe-on applications of glyphosate and imazapyr on common reed in aquatic sites. *Journal of Aquatic Plant Management* 33: 25-26.
- Kays RW & Wilson DE (2002) *Mammals of North America*. Princeton University Press, Princeton, NJ, USA.
- Kearney MS, Grace RE & Stevenson JC (1988) Marsh loss in Nanticoke Estuary, Chesapeake Bay. *Geographical Review* 78: 206-220.
- Kearns GD, Kwartin NB, Brinker DF & Haramis GM (1998) Digital playback and improved trap design enhances capture of migrant soras and Virginia rails. *Journal of Field Ornithology* 69: 466-473. USA.
- Kelley CA, Martens CS & Chanton JP (1990) Variations in sedimentary carbon remineralization rates in the White Oak River Estuary, North Carolina. *Limnology and Oceanography* 35: 372-383.
- Kemble FA (1969) *Journal of a residence on a Georgian plantation in 1838-1839*. Afro-Am Books, Chicago, IL, USA.
- Kerkhofs MJJ, Tiebosch T, Van der Velden JA & Kuijpers JWM (2005) Alternative management of the Haringvliet sluices: first step toward major rehabilitation of the Rhine-Meuse estuary. *Archiv für Hydrobiologie Supplement* 155 (Large Rivers 15): 569-577.
- Kerner M (2007) Effects of deepening the Elbe Estuary on sediment regime and water quality. *Estuarine, Coastal and Shelf Science* 75: 492-500.
- Keup L & Bayliss J (1964) Fish distribution at varying salinities in the Neuse River Basin, North Carolina. *Chesapeake Science* 5: 119-123. USA.
- Khan H (1993) A paleoecological study of a freshwater tidal marsh. PhD Dissertation, The Johns Hopkins University, Baltimore, MD, USA.
- Khan H & Brush GS (1994) Nutrient and metal accumulation in a freshwater tidal marsh. *Estuaries* 17: 345-360.
- Kies L (1997) Distribution, biomass and production of planktonic and benthic algae in the Elbe estuary. *Limnologica* 27: 55-64.
- KIfL (Kieler Institut für Landschaftsökologie) (2007) Ausgleichsmaßnahme Hahnöfer Sand. Monitoring des Schierlings-Wasserfenchels Ergebnisse 2004-2007. Unveröff. Gutachten im Auftrag der ReGe Hamburg. Kiel, GER.
- Killgore KJ, Morgan RP II & Rybicki NB (1989) Distribution and abundance of fishes associated with submersed aquatic plants in the Potomac River. *North American Journal of Fisheries Management* 9: 101-111.
- King R, DeLuca WV, Whigham DF & Marra PP (2007) Threshold effects of coastal urbanization on *Phragmites australis* (Common Reed) abundance and foliar nitrogen in Chesapeake Bay. *Estuaries and Coasts* 30: 469-481.
- Kirchner JW, Finkel RC, Riebe CS, Granger DE, Clayton JL, King JG & Megahan, WF (2001). Mountain erosion over 10 yr, 10 k.y., and 10 m.y. time scales. *Geology* 29: 591-594.

- Kistritz R (1996) Habitat compensation, restoration and creation in the Fraser River estuary: are we achieving a no-net-loss of fish habitat? Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2349. R.U. Kistritz Consultants Ltd., Richmond, BC, Canada.
- Kittel TGF, Steffan WL & Chapin FS (2000) Global and regional modelling of Arctic-boreal vegetation distribution and its sensitivity to altered forcing. *Global Change Biology* 6: 1-18.
- Kiviat E (1974) A fresh-water tidal marsh on the Hudson, Tivoli North Bay. In: Third Symposium on Hudson River Ecology, Paper No. 14. Hudson River Environmental Society, Bronx, NY, USA.
- Kiviat E (1978a) Hudson River east bank natural areas, Clermont to Norrie. Nature Conservancy, Arlington, VA, USA.
- Kiviat E (1978b) Vertebrate use of muskrat lodges and burrows. *Estuaries* 1: 196-200.
- Kiviat E (1980) A Hudson River tidemars snapping turtle population. *Transactions of the Northeast Section of the Wildlife Society* 37: 158-168. USA.
- Kiviat E (1989) The role of wildlife in estuarine ecosystems. In: Day J, Hall CAS, Kemp WM & Yáñez-Arancibia A (eds) *Estuarine ecology*, pp 438-476. John Wiley and Sons, New York.
- Kiviat E (1991) Wetland human ecology. PhD Dissertation, Union Institute, Cincinnati, OH, USA.
- Kiviat E (1994) Muskrat: manager of the marsh. *News from Hudsonia* 10: 1-3. USA.
- Kiviat E (1996) American goldfinch nests in purple loosestrife. *Wilson Bulletin* 108: 182-186. USA.
- Kiviat E (1999) Changing tides: Tivoli Bays: a Hudson River wetland. Purple Mountain Press, Fleischmanns, NY, USA.
- Kiviat E (2004) Occurrence of *Ailanthus altissima* on a Maryland freshwater tidal estuary. *Castanea* 69: 139-142. USA.
- Kiviat E (2006) *Phragmites* management sourcebook for the tidal Hudson River. Report to the Hudson River Foundation, New York, NY, Hudsonia Ltd., Annandale, NY. Available at [www.hudsonia.org](http://www.hudsonia.org)
- Kiviat E & Barbour JG (1996) Wood turtles in fresh-tidal habitats of the Hudson River. *Canadian Field-Naturalist* 110: 341-343.
- Kiviat E & MacDonald K (2004) Biodiversity patterns and conservation in the Hackensack Meadowlands, New Jersey. *Urban Habitats* 2: 28-61. USA.
- Kiviat E & Stevens G (2002) Assessment manual for the Hudson River Estuary corridor. Hudsonia Ltd., New York Department Environmental Conservation, Albany, NY, USA.
- Kiviat E, Findlay SEG & Nieder WC (2006) Tidal wetlands. In: Levinton JS & Waldman JR (eds) *The Hudson River Estuary*, pp. 279-295. Cambridge University Press, New York.
- Klingel GC (1937) The Chesapeake marshes. *Natural History Society of Maryland Bulletin* 7: 30-35. USA
- Knight MA & Pasternack GB (2000) Sources, input pathways, and distributions of Fe, Cu, and Zn in a Chesapeake Bay tidal freshwater marsh. *Environmental Geology* 39: 1359-1371.
- Knight W (1980) The story of Browns Island. *The Four Seasons* 6: 3-10. USA.
- Knights B & Phillips AJ (eds) (1979) *Estuarine and coastal land reclamation and water storage*. Saxon House, Westmead, Farnborough, UK.
- Koch MS & Mendelssohn IA (1989) Sulphide as a soil phytotoxin: differential responses in two marsh species. *Journal of Ecology* 77: 565-578.
- Koch MS, Mendelssohn IA & McKee KL (1990) Mechanism for the hydrogen sulphide-induced growth limitation in wetland macrophytes. *Limnology and Oceanography* 35: 399-408.
- Koerselman W & Meuleman AFM (1996) The vegetation N:P ratio: a new tool to detect the nature of nutrient limitation. *Journal of Applied Ecology* 33: 1441-1450.
- Kolb CR & Van Lopik JR (1958) Geology of the Mississippi deltaic plain - southeastern Louisiana. U.S. Army Corps of Engineers Waterways Experiment Station 482, Vicksburg, MS, USA.
- Kominkova D, Kuehn KN, Busing N & Steiner D (2000) Microbial biomass, growth, and respiration associated with submerged litter of *Phragmites australis* decomposing in a littoral reed stand of a large lake. *Aquatic Microbial Ecology* 22: 271-282.
- Köpcke B (2004) The importance of peripheral areas and mudflats for the maintenance of Eurytemora affinis (Poppe, 1880) (Copepoda; Crustacea) populations in the Elbe Estuary. *Archiv für Hydrobiologie Suppl.* 110: 329-443.
- Kötter F (1961) Die Pflanzengesellschaften der Unterelbe. *Archiv für Hydrobiologie, Suppl.* 26: 106-184.
- Kraft JC (1988) Geology. In: Bryant TK & Pennock JR (eds) *The Delaware Estuary: rediscovering a forgotten resource*, pp. 31-41. University of Delaware Sea Grant Program. Newark, DE, USA.
- Krause LH, Rietsma C & Kiviat E (1997) Terrestrial insects associated with *Phragmites australis*, *Typha angustifolia*, and *Lythrum salicaria* in a Hudson River tidal marsh. In: Nieder WC & Waldman JR (eds) *Reports of the Tibor T. Polgar Fellowship Program 1996*, pp. v-1 to v-35. Hudson River Foundation, New York, USA.
- Krauss KW, Chambers JL, Allen JA, Soileau DM Jr & DeBosier AS (2000) Growth and nutrition of baldcypress families planted under varying salinity regimes in Louisiana. *Journal of Coastal Research* 16: 153-163.
- Kreeger DA & Newell RIE (2000) Trophic complexity between producers and invertebrate consumers in salt marshes. In: Weinstein MP & Kreeger DA (eds) *Concepts and controversies in tidal marsh ecology*, pp. 187-220. Kluwer Academic Publishers, Boston, MA, USA.
- Krieg H-J (2005) Die Entwicklung eines modifizierten Potamon-Typie-Indexes (QK Benthische Wirbellosenfauna) zur Bewertung Okologischen Zustands Tideelbe von Geesthacht bis zur Seegrenze: Methodenbeschreibung AeTI (Aestuar Typie-Index) und Anwendungsbeispiele. Project AeTI V.1.0, ARGE ELBE/FHH WG ELBE 2005. Hamburg, GER.
- Krieg H & Kies L (1989) Artenschutzprogramm Armleuchteralgen (Charophyta) und Süßwasser-Rotalgen (Rhodophyta) im Gebiet der Freien und Hansestadt Hamburg. *Naturschutz und Landschaftspflege in Hamburg, Schriftenreihe der Umweltbehörde* 30: 1-39. GER.
- Kromkamp JC & Peene J (2005) Changes in phytoplankton biomass and primary production between 1991 and 2001 in the Westerschelde estuary (Belgium/The Netherlands). *Hydrobiologia* 540: 117-126.
- Kromkamp JC, Peene J, van Rijswijk P, Sandee A & Goosen N (1995) Nutrients, light and primary production by phytoplankton and microphytobenthos in the eutrophic, turbid Westerschelde estuary (The Netherlands). *Hydrobiologia* 311: 9-19.
- Krueck BL (2004) Use of tidal marsh and upland habitats by the marsh rice rat (*Oryzomys palustris*). *Journal of Mammalogy* 85: 569-575.



- Kuehn KA & Suberkropp K (1998) Diel fluctuations in rates of CO<sub>2</sub> evolution from standing dead leaf litter of the emergent macrophyte *Juncus effusus* L. *Aquatic Microbial Ecology* 14: 171-182.
- Kuijpers JWM (1995) Ecological restoration of the Rhine/Meuse estuary. *Water Science and Technology* 31(8): 187-195.
- Kuiper JGJ & Wolff WJ (1970) The Mollusca of the estuarine region of the rivers Rhine, Meuse and Scheldt in relation to the hydrography of the area. III the genus *Pisidium*. *Basteria* 34: 1-40. NL.
- Kulp MA (2000) Holocene stratigraphy, history, and subsidence: Mississippi River delta region, northcentral Gulf of Mexico. PhD Dissertation, University of Kentucky, Lexington, KY, USA.
- Lamers LPM, Dolle G, Van Den Berg STG, Van Delft SPJ, Sebastiaan PJ & Roelofs JM (2001) Differential responses of freshwater wetland soils to sulphate pollution. *Biogeochemistry* 55: 87-102.
- Lammers I (2005a) Natuurplannen voor Sophiapolder in stroomversnelling. *Zuid-Hollands Landschap* 2005(1): 22-23. NL.
- Lammers I (2005b) Natuurontwikkeling langs de Oude Maas: groot profijt. *Zuid-Hollands Landschap* 2005(2): 4-7. NL.
- Lampman GG, Caraco NF & Cole JJ (1999) Spatial and temporal patterns of nutrient concentration and export in the tidal Hudson River. *Estuaries* 22: 285-296.
- Lancelot C, Billen G, Sournia A, Weisse T, Colijn F, Veldhuis M, Davies A & Wassman P (1987) Phaeocystis blooms and nutrient enrichment in the continental coastal zone of the North Sea. *Ambio* 16: 38-47.
- Land Management Group (2004) McIntyre Tract: year four monitoring report, Brunswick County, North Carolina. Land Management Group, Inc., Wilmington, NC, USA. Accessed from <http://pmu.dot.state.nc.us/doh/preconstruct/pe/NEU/Monitoring>.
- Lane RR, Day JW Jr & Thibodeaux B (1999) Water quality analysis of a freshwater diversion at Caernarvon, Louisiana. *Estuaries* 22: 327-336.
- Lapin B & Nothnagle P (1995) Control of false indigo (*Amorpha fruticosa*), a non-native plant, in riparian areas in Connecticut. *Natural Areas Journal* 15: 279. USA.
- Latham PJ, Pearlstine LG & Kitchens WM (1994) Species association changes across a gradient of fresh-water, oligohaline, and mesohaline tidal marshes along the lower Savannah River. *Wetlands* 14: 174-183.
- Lavoie C, Jean M, Delisle F & Létourneau G (2003) Exotic plant species of the St. Lawrence River wetlands: a spatial and historical analysis. *Journal of Biogeography* 30: 537-549.
- Lawrence S & Gross B (1984) The Audubon Society field guide to the natural places of the Mid-Atlantic States: Inland. Pantheon Books, New York.
- LCWCRTF (Louisiana Coastal Wetlands Conservation and Restoration Task Force) (1998) Coast 2050: toward a sustainable coastal Louisiana, Louisiana Coastal Wetlands Conservation and Restoration Task Force, Baton Rouge, LA, USA.
- LCWCRTF (Louisiana Coastal Wetlands Conservation and Restoration Task Force) (2006) The 2006 evaluation report to the U.S. Congress on the effectiveness of Coastal Wetlands Planning, Protection and Restoration Act projects. Louisiana Coastal Wetlands Conservation and Restoration Task Force, U.S. Army Corps of Engineers, New Orleans, LA, USA.
- Leck MA (1989) Wetland seed banks. In: Leck MA, Parker VT & Simpson RL (eds) *Ecology of soil seed banks*, pp. 283-305. Academic Press, Inc., San Diego, CA, USA.
- Leck MA (1996) Germination of macrophytes from a Delaware River tidal freshwater wetland. *Bulletin of the Torrey Botanical Club* 123: 48-67. USA.
- Leck MA (2003) Seed-bank and vegetation development in a created tidal freshwater wetland on the Delaware River, Trenton, New Jersey, USA. *Wetlands* 23: 310-343.
- Leck MA & Brock MA (2000) Ecological and evolutionary trends in wetlands: evidence from seeds and seed banks in New South Wales, Australia and New Jersey, USA. *Plant Species Biology* 15: 97-112 (Corrigendum 2001 16: 2183-2184).
- Leck MA & Leck CF (2005) Vascular plants of a Delaware River tidal freshwater wetland and adjacent terrestrial areas: seed bank and vegetation comparisons of reference and constructed marshes and annotated species list. *Journal of the Torrey Botanical Society* 132: 323-354. USA.
- Leck MA & Schütz W (2005) Regeneration of Cyperaceae, with particular reference to seed ecology and seed banks. *Perspectives in Plant Ecology, Evolution and Systematics* 7: 95-133.
- Leck MA & Simpson RL (1987) Seed bank of a freshwater tidal wetland: turnover and relationship to vegetation change. *American Journal of Botany* 74: 360-370.
- Leck MA & Simpson RL (1992) Effect of oil on recruitment from the seed bank of two tidal freshwater wetlands. *Wetlands Ecology and Management* 1: 223-231.
- Leck MA & Simpson RL (1993) Seeds and seedlings of the Hamilton Marshes, a Delaware River tidal freshwater wetland. *Proceedings of the Academy of Natural Sciences of Philadelphia* 144: 267-281. USA.
- Leck MA & Simpson RL (1994) Tidal freshwater wetland zonation: seed and seedling dynamics. *Aquatic Botany* 47: 61-75.
- Leck MA & Simpson RL (1995) Ten-year seed bank and vegetation dynamics of a tidal freshwater marsh. *American Journal of Botany* 82: 1547-1557.
- Leck MA, Simpson RL, Whigham DF & Leck CF (1988) Plants of the Hamilton Marshes: a Delaware River freshwater tidal wetland. *Bartonia* 54: 1-17. USA.
- Leck MA, Simpson RL & Parker VT (1989) The seedbank of a freshwater tidal wetland and its relationship to vegetation dynamics. In: Sharitz R & Gibbons JW (eds) *Proceedings symposium on freshwater wetlands and wildlife*, pp. 198-205. USDOE Office of Scientific and Technical Information, Oak Ridge, TN, USA.
- Leck MA, Baskin CC & Baskin JM (1994) Germination ecology of *Bidens laevis* (Asteraceae) from a freshwater tidal wetland. *Bulletin of the Torrey Botanical Club* 121: 230-239. USA.
- Leijs R, Van Apeldoorn RC & R Bijlsma (1999) Low genetic differentiation in north-west European populations of the locally endangered root vole, *Microtus oeconomus*. *Biological Conservation* 87: 39-48.
- Lensink CJ & Rothe TC (1986) Value of Alaskan wetlands for waterfowl. In: *Alaska regional wetland functions – proceedings of a workshop*, pp. 45-84. The Environmental Institute, University of Massachusetts, Amherst, MA, USA.

- Leonard LA, Wren PA & Beavers RL (2002) Flow dynamics and sedimentation in *Spartina alterniflora* and *Phragmites australis* marshes of the Chesapeake Bay. *Wetlands* 22: 415-424.
- Lepage M, Lobry J, Girardin M, Gonthier P (2004) Structure des assemblages ichtyologiques dans les milieux de transition de type estuarien. Contribution à la caractérisation de l'état écologique à partir du cas de la Gironde. Année 2004: typologie, échantillonnage et suivi. Cémagref, Bordeaux, FR.
- Leppaköski E, Gollasch S & Olenin S (eds) (2002) Invasive aquatic species in Europe. Kluwer Academic Publishers, Dordrecht, NL.
- Leschke M (1909) Mollusken. Hamburgische Elb-Untersuchung. Mitteilungen des naturhistorischen Museums Hamburg 26 (2): 250-279. GER.
- Lesourd S, Lesueur P, Brun-Cottan J-C, Auffret J-P, Poupinet N & Laignel B (2001) Morphosedimentary evolution of the macrotidal Seine estuary subjected to human impact. *Estuaries* 24: 940-949.
- Levings CD & Nishimura DJH (1996) Created and restored sedge marshes in the lower Fraser River and estuary: an evaluation of their functioning as fish habitat. Canadian Technical Report of Fisheries and Aquatic Sciences 2126. Department of Fisheries and Oceans, West Vancouver, BC, Canada.
- Levings CD & Nishimura DJH (1997) Created and restored marshes in the lower Fraser River, British Columbia: summary of their functioning as fish habitat. *Water Quality Research Journal of Canada* 32: 599-618.
- Levings CD & Thom RM (1994) Habitat changes in Georgia Basin: implications for resource management and restoration. In: Wilson RCH, Beamish RJ, Aitkens F & Bell J (eds) Review of the marine environments and biota of Strait of Georgia, Puget Sound and Juan de Fuca Strait, pp. 300-351. Proceedings of the British Columbia/Washington Symposium on the Marine Environment. Canadian Technical Report of Fisheries and Aquatic Sciences Number 1948. Victoria, British Columbia, Canada.
- Lichter J, Caron H, Pasakarnis TS, Rodgers SL, Squiers TS Jr & Todd CS (2006) The ecological collapse and partial recovery of a freshwater tidal ecosystem. *Northeastern Naturalist* 13: 153-178. USA.
- Light HM, Darst MR, Lewis LJ & Howell DA (2002) Hydrology, vegetation, and soils of riverine and tidal floodplain forests of the lower Suwannee River, Florida, and potential impacts of flow reductions. Professional Paper 1656A, US Geological Survey, Washington, DC.
- Lindsay P, Balls PW & West JR (1996) Influence of tidal range and river discharge on suspended particulate matter fluxes in the Forth estuary (Scotland). *Estuarine, Coastal and Shelf Science* 42: 63-82.
- Lionard M, Muylaert K, Van Gansbeke D & Vyverman W (2005) Influence of changes in salinity and light intensity on growth of phytoplankton communities from the Schelde river and estuary (Belgium/The Netherlands). *Hydrobiologia* 540: 105-115.
- Lippson AJ & Lippson RL (1997) Life in the Chesapeake Bay. Johns Hopkins University Press, Baltimore, MD, USA.
- Lippson AJ, Haire MS, Holland AF, Jacobs F, Jenson J, Moran-Johnson RL, Polgar TT & Richkus WA (1979) Environmental Atlas of the Potomac Estuary. Williams and Heintz Map Corporation, Washington, DC.
- Lips CJP (1938) Oudheidkundige vondsten in den Biesbosch. Number 3444 in Gemeente Archief Dordrecht, NL.
- Lloyd FE & Tracy SM (1901) The insular flora of Mississippi and Louisiana. *Bulletin of the Torrey Botanical Club* 28: 61-101. USA.
- LMS Engineers (2005) Marsh breeding bird survey in the Hudson River estuary, 2005. Prepared for the New York Department of Environmental Conservation. Lawlor, Matusky & Skelly Engineers, LLP, Pearl River, New York.
- Lobry J, Mourand L, Rochard E & Elie P (2003) Structure of the Gironde estuarine fish assemblages: a comparison of European estuaries perspective. *Aquatic Living Resources* 16: 47-58.
- Long LL & Ralph CJ (2001) Dynamics of habitat use by shorebirds in estuarine and agricultural habitats in northwestern California. *Wilson Bulletin* 113: 41-52. USA.
- Longcore JR, McAuley DG, Hepp GR & Rhymer JM (2000) American Black Duck (*Anas rubripes*). In: Poole A (ed) The birds of North America online, Cornell Lab of Ornithology, Ithaca, NY. <http://bna.birds.cornell.edu/bna/species/481>, doi: bna.481 (Viewed January 2008).
- Lopez GR (1988) Comparative ecology of the macrofauna of freshwater and marine muds. *Limnology and Oceanography* 33: 946-962.
- Lotze HK, Lenihan HS, Bourque BJ, Bradbury RH, Cooke RG, Kay MC, Kidwell SM, Kirby MX, Petersons CH & Jackson JBC (2006) Depletion, degradation, and recovery potential of estuaries and coastal seas. *Science* 312: 1806-1809.
- Louwe Kooijmans LP (1985) Sporen in het land. De Nederlandse Delta in de prehistorie. Meulenhof Informatief, Amsterdam.
- Louwe Kooijmans LP (1987) Neolithic settlement and subsistence in the wetlands of the Rhine/Meuse delta of The Netherlands. In: Coles JM & Lawson AJ (eds) European wetlands in prehistory, pp. 227-251. Clarendon Press, Oxford, UK.
- Louwe Kooijmans LP, Van den Broeke PW, Fokkens H & Van Gijn A (eds) (2005) The prehistory of The Netherlands. Amsterdam University Press, Amsterdam, NL.
- Lucas Y, Luizao FJ, Chauvel A, Rouiller J & Nahon D (1993) The relation between biological activity of the rain forest and mineral composition of soils. *Science* 260: 521-523.
- Luo YQ, Hui DF & Zhang DQ (2006) Elevated CO<sub>2</sub> stimulates net accumulations of carbon and nitrogen in land ecosystems: a meta-analysis. *Ecology* 87: 53-63.
- Lynch JJ, O'Neal T & Lay DW (1947) Management significance of damage by geese and muskrats to gulf coast marshes. *Journal of Wildlife Management* 11: 50-76.
- MacFarlane GT & Hebert RA (1984) Effect of oxygen tension, salinity, temperature, and organic matter concentration on the growth and nitrifying activity of an estuarine strain of *Nitrosomonas*. *FEMS Microbiology Letters* 23: 107-111.
- Maes F & Neumann F (2004) The Habitats Directive and port development in coastal zones: experiences in safeguarding biodiversity. *Journal of Coastal Conservation* 10: 73-80.
- Maes J, Taillieu A, Van Damme PA, Cottenie K & Ollevier F (1998) Seasonal patterns in the fish and crustacean community of a turbid temperate estuary (Zeeschelde estuary, Belgium). *Estuarine, Coastal and Shelf Science* 47: 143-151.
- Maes J, Van Damme S, Meire P & Ollevier F (2004) Statistical modelling of seasonal and environmental influences on the population dynamics of an estuarine fish community. *Marine Biology* 145: 1033-1042.

- Maes J, Belpaire C, Breine J & Goeman G (2005) Vissen als gezondheidsindicatoren voor de toestand van het Zeeschelde-ecosysteem. *Water*: 5(5): 1-7. BEL.
- Magalhães CM, Joye SB, Moreira RM, Wiebe WJ & Bordalo AA (2005) Effect of salinity and inorganic nitrogen concentrations on nitrification and denitrification rates in intertidal sediments and rocky biofilms of the Douro River estuary, Portugal. *Water Research* 39: 1783-1794.
- Magee TK, Ernst TL, Kentula ME & Dwire KA (1999) Floristic comparison of freshwater wetlands in an urbanizing environment. *Wetlands* 19: 517-534.
- Magurran AE (1988) *Ecological diversity and its measurement*. Princeton University Press, Princeton, NJ, USA.
- Mahlman JD (1997) Uncertainties in projections of human-caused climate warming. *Science* 278: 1416-1417.
- Maitland PS & Hatton-Ellis TW (2003) Ecology of allis and twaite shad (*Alosa alosa* and *Alosa fallax*). *Conserving Natura 2000 River Ecology Series No. 3*. English Nature, Peterborough, UK.
- Maitland PS, Boon PJ & McLusky DS (eds) (1994) *The freshwaters of Scotland: a national resource of international significance*. John Wiley, Chichester, UK.
- Malamud-Roam FP & Ingram BL (2004) Late Holocene  $\delta^{13}C$  and pollen records of paleosalinity from tidal marshes in the San Francisco Bay estuary, California. *Quaternary Research* 62: 134-145. USA.
- Malecki RA, Blossey B, Hight S, Schroeder D, Kok LT & Coulson JR (1993) Biological control of purple loosestrife. *Bioscience* 43: 680-686.
- Maloney T, Barrett JP, Barrett N, Gephard S, Hammerson GA, Kimball CH, Pfeiffer J, Proctor N & Stone JR (2001) *Tidewaters of the Connecticut River: an explorer's guide to hidden coves and marshes*. River's End Press, Essex, CT, USA.
- MANHP (2005) *Natural Heritage & Endangered Species Program*, Massachusetts Division of Fisheries & Wildlife. <http://www.mass.gov/dfwele/dfw/nhsp/nhcommfact.htm>
- Marble and Company (1998) *Post-construction wetland monitoring report*, Trenton Complex mitigation site, Mercer County, New Jersey. A.D. Marble and Company, Inc., Rosemont, PA, USA.
- Marchand J (1993) The influence of seasonal salinity and turbidity maximum variations on the nursery function of the Loire estuary (France). *Netherlands Journal of Aquatic Ecology* 27: 427-436.
- Marchand M, Quinlan M & Swarth CW (2004) Movement patterns and habitat use of eastern box turtles at the Jug Bay Wetlands Sanctuary, Maryland. In: Swarth CW, Roosenburg WM & Kiviat E (eds) *Conservation and ecology of turtles of the Mid-Atlantic region*, pp 55-62. Bibliomania, Salt Lake City, UT, USA.
- Maris T, Cox T, Temmerman S, De Vleeschauwer P, Van Damme S, De Mulder T, Van den Bergh E & Meire P (2007) Tuning the tide: creating ecological conditions for tidal marsh development in a flood control area. *Hydrobiologia* 588: 31-43.
- Maryland Department of Natural Resources (2003) *Mute swans in Maryland: a statewide management plan*. Maryland Department of Natural Resources, Wildlife and Heritage Service, USA. <http://www.dnr.state.md.us/wildlife/msfinalexec.html> (Viewed January 2008).
- Maryland Sea Grant (2002) *Invasive species in the Chesapeake Bay watershed: a workshop to develop regional invasive species management strategies*. In: Moser FC (ed) *Final report to the Chesapeake Bay Program Invasive Species Working Group*. Sea Grant publication UM-SG-TS-2002-03. Maryland Sea Grant College Program, College Park, MD, USA.
- Maser C & Sedell JR (1994) *From the forest to the sea: the ecology of wood in streams, rivers, estuaries, and oceans*. St. Lucie Press, Delray Beach, FL, USA.
- Mason HL (1957) *A flora of the marshes of California*. University of California Press, Berkeley, CA, USA.
- Massart J (1908) *Essai de géographie botanique des districts littoraux et alluviaux de la Belgique*. Recueil de l'Institut Botanique Léo Errera VII: 1g - 121e. Brussel, BEL.
- Maurizi S & Puillon F (eds) (1992) *Restoration of aquatic ecosystems*. National Academy Press, Washington, DC.
- McClelland JW & Valiela I (1998) Linking nitrogen in estuarine producers to land-derived sources. *Limnology and Oceanography* 43: 577-585.
- McCormick J & Ashbaugh T (1972) *Vegetation of a section of Oldmans Creek tidal marsh and related areas in Salem and Gloucester Counties, New Jersey*. Bulletin of the New Jersey Academy of Science 17 (2): 31-37. USA.
- McCormick J & Somes HA Jr (1982) *The coastal wetlands of Maryland*. Jack McCormick & Associates, Ind, Chevy Chase, MD, USA.
- McGlynn CA (2006) *The effects of two invasive plants on native communities in Hudson River freshwater tidal wetlands*. PhD Dissertation. Stony Brook University, Stony Brook, New York, USA.
- McGlynn CA & Ostfeld RS (2000) *A study of the effects of invasive plant species on small mammals in Hudson River freshwater marshes*. In: Waldman JR & Nieder WC (eds) *Reports of the Tibor T. Polgar Fellowship Program 1999*, pp. viii-1 to viii-21. Hudson River Foundation, New York, USA.
- McIvor CC & Odum WE (1988) Food, predation risk, and microhabitat selection in a marsh fish assemblage. *Ecology* 69: 1341-1351.
- McKee KL & Baldwin AH (1999) *Disturbance regimes in North American wetlands*. In: Walker LR (ed) *Ecosystems of the world (16): ecosystems of disturbed ground*, pp. 331-361. Elsevier, Amsterdam.
- McKee KL & Mendelssohn IA (1989) Response of a freshwater marsh plant community to increased salinity and increased water level. *Aquatic Botany* 34: 301-316.
- McKee KL & Patrick WH Jr (1988) The relationship of smooth cordgrass (*Spartina alterniflora*) to tide datums: a review. *Estuaries* 11: 143-151.
- McKellar HN, Tufford DL, Alford MC, Saroprayogi P, Kelley BJ & Morris JT (2008) Tidal nitrogen exchanges across a freshwater wetland succession gradient in the upper Cooper River, South Carolina. *Estuaries* 30: 989-1006.
- McKenzie MC, Miglarese JV, Anderson BS & Barclay LA (1980) *Ecological characterization of the Sea Island coastal region of South Carolina and Georgia. Volume 2: Socioeconomic features of the characterization area*, U.S. Fish and Wildlife Service FWS/OBS-79/41, Washington, DC.
- McLusky DS (1987) *Intertidal habitats and benthic macrofauna of the Forth estuary, Scotland*. Proceedings Royal Society Edinburgh B 93: 389-400. UK.
- McLusky DS (1993) *Marine and estuarine gradients - an overview*. *Netherlands Journal of Aquatic Ecology* 27: 489-493.



- McLusky DS & Elliott M (2004) The estuarine ecosystem: ecology, threats and management. Oxford University Press, Oxford, UK.
- McLusky DS & Elliott M (2007) Transitional waters: a new approach, semantics or just muddying the waters? *Estuarine and Coastal Shelf Science* 71: 359-363.
- McLusky DS, Hull SC & Elliott M (1993) Variations in the intertidal and subtidal macrofauna and sediments along a salinity gradient in the upper Forth estuary. *Netherlands Journal of Aquatic Ecology* 27: 101-109.
- McLusky DS, Deprez M, Elkaim B & Duhamel S (1994) The inner estuary of the Baie de Somme. *Estuarine, Coastal and Shelf Science* 38: 313-318.
- McManus J (2005) Salinity and suspended matter variations in the Tay estuary. *Continental Shelf Research* 25: 729-747.
- McVaugh R (1958) Flora of the Columbia County area, New York. *New York State Museum Bulletins* 360 & 360A. Albany, NY, USA.
- Meade RH (1972) Transport and deposition of sediments in estuaries. *The Geological Society of America - Memoir* 133: 91-120.
- Meador MR (1996) South Carolina wetland resources. In: Fretwell JD, Williams JS & Redman PJ (compilers) National water summary on wetland resources, pp. 345-349. United States Geological Survey Water-Supply Paper 2425, Washington, DC.
- Meanley B (1965) Early-fall food and habitat of the sora in the Patuxent River Marsh, Maryland. *Chesapeake Science* 6: 235-237. USA.
- Meanley B (1969) Natural history of the king rail. *North American Fauna*, No. 67, pp. 1-116. Bureau of Sports Fisheries and Wildlife, Washington, DC.
- Meanley B (1993) The Patuxent River wildrice marsh. Privately published, USA.
- Meanley B (1996) The Patuxent River wildrice marsh. Maryland National Capital Park and Planning Commission, Montgomery and Prince George's Counties, Maryland, Riverdale, MD, USA.
- Meehl GA, Stocker TF, Collins WD, Friedlingstein P, Gaye AT, Gregory JM, Kitoh A, Knutti R, Murphy JM, Noda A, Raper SCB, Watterson IG, Weaver AJ & Zhao Z-C (2007) Global climate projections. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M & Miller HL (eds) *Climate change 2007: the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp. 747-845. Cambridge University Press, Cambridge, UK, and New York.
- Megonigal JP (1996) Methane production and oxidation in future climate. PhD Dissertation, Duke University, Durham, NC, USA.
- Megonigal JP & Schlesinger WH (1997) Enhanced CH<sub>4</sub> emissions from a wetland soil exposed to elevated CO<sub>2</sub>. *Biogeochemistry* 37:
- Megonigal JP & Schlesinger WH (2002) Methane-limited methanotrophy in tidal freshwater swamps. *Global Biogeochemical Cycles* 16: 1088.
- Megonigal JP, Hines ME & Visscher PT (2004) Anaerobic metabolism: linkages to trace gases and aerobic metabolism. In: Schlesinger WH (ed) *Biogeochemistry*, pp. 317-424. Elsevier-Pergamon, Oxford, UK.
- Megonigal JP, Vann CD & Wolf AA (2005) Flooding constraints on tree (*Taxodium distichum*) and herb growth responses to elevated CO<sub>2</sub>. *Wetlands* 25: 430-438.
- Meijer R & Van der Nat J (1989) Bluethroat *Cyanosylvia svecica* saved by the Biesbosch? *Limosa* 62: 67-74. NL.
- Meijer R & Weel B (2007) Profiteren de vogels van de Rode Lijst van de nieuwe Biesbosch? *De Levende Natuur* 108: 185-192. NL.
- Meire P & Vincx M (eds) (1993) Marine and estuarine gradients. *Netherlands Journal of Aquatic Ecology* 27: 41-496.
- Meire P & Van Damme S (eds) (2005) Special issue: Ecological structures and functions in the Scheldt estuary: from past to future. *Hydrobiologia* 540: 1-278.
- Meire P, Rossaert G, De Regge N, Ysebaert T & Kuijken E (1992) Het Schelde-estuarium: ecologische beschrijving en een visie op de toekomst. Rapport RUG-WWE 28, IN nr. A. 92.57. Gent, Brussel, BEL.
- Meire P, Kuijken E & Ysebaert T (1993) The Zeeschelde an ecological impulse area? (in Dutch with English summary) *HZ-gazet* 6: 10-12. BEL.
- Meire P, Van den Bergh E, Ysebaert T & Nijssen D (2002) Nature development along the river Scheldt: combining ecosystem functions in the Kruibeke-Bazel-Rupelmonde polder. In: Redecker B, Finck P, Härdtle W, Riecken U & Schröder E (eds) *Pasture landscapes and nature conservation*, pp. 173-185. Springer-Verlag, Berlin.
- Meire P, Ysebaert T, Van Damme S, Van den Bergh E, Maris T & Struyf E (2005) The Scheldt estuary: a description of a changing ecosystem. *Hydrobiologia* 540: 1-11.
- Melvin SM & Gibbs JP (1996) Sora *Porzana carolina*. *Birds of North America* 250: 1-20.
- Menge BA & Olson AM (1990) Role of scale and environmental factors in regulation of community structure. *Trends in Ecology and Evolution* 5: 52-57.
- Mennema J (1963) De Oude Maas – landschap, vegetatie en avifauna van een getijdenrivier. *Natuur en Landschap* 17: 66-84.
- Mennema J (1967) *Leucojum aestivum* L. in België teruggevonden. *Gorteria* 3: 108. NL.
- Merrill JZ (1999) Tidal freshwater marshes as nutrient sinks: particulate nutrient burial and denitrification. PhD Dissertation, University of Maryland. Cambridge, MD, USA.
- Merrill JZ & Cornwell JC (2000) The role of oligohaline marshes in estuarine nutrient cycling. In: Weinstein MP & Kreeger DA (eds) *Concepts and controversies in tidal marsh ecology*, pp. 425-442. Kluwer Academic Publishers, Boston, MA, USA and Dordrecht, NL.
- Meschkat A (1937) Abwasserbiologische Untersuchungen in einem Bühnenfeld unterhalb Hamburgs. *Archiv für Hydrobiologie* 31: 399-432.
- Mesnager V, Bonneville S, Laignel B, Lefebvre D, Dupont JP & Mikes D (2002) Filling of a wetland (Seine estuary, France): natural eutrophication or anthropogenic process? A sedimentological and geochemical study of wetland organic sediments. *Hydrobiologia* 475/476: 423-435.
- Mettam C (1994) Intertidal zonation of animals and plants on rocky shores in the Bristol Channel and Severn Estuary – the northern shores. *Biological Journal of the Linnean Society* 51: 123-147.
- Michaelis H, Fock H, Grothahn M & Post D (1992) The status of the intertidal zoobenthic brackish-water species in the estuarine of the German Bight. *Netherlands Journal of Aquatic Ecology* 27: 71-496.

- Michels FW (1973) De Brabantsche Biesbosch tussen Nieuwe Merwede en het Land van Heusden & Altena (schaal 1: 20 000). NV Waterwinningsbedrijf Brabantse Biesbosch, Rotterdam, NL.
- Michener WK, Blood ER, Bildstein KL, Brinson MM & Gardner LR (1997) Climate change, hurricanes and tropical storms, and rising sea level in coastal wetlands. *Ecological Applications* 7: 770-801.
- Middelburg JJ, Klaver G, Nieuwenhuize J, Markuse RM, Vlug T & Van Der Nat FJWA (1995) Nitrous oxide emissions from estuarine intertidal sediments. *Hydrobiologia* 311: 43-55.
- Middelkoop H (2000) Heavy-metal pollution of the river Rhine and Meuse floodplains in the Netherlands. *Netherlands Journal of Geosciences* 79: 411-428.
- Middleton AP (1984) Tobacco Coast: A maritime history of Chesapeake Bay in the colonial era. The Johns Hopkins University Press, Baltimore, MD, USA.
- Middleton B (1999) Wetland restoration, flood pulsing, and disturbance dynamics. John Wiley and Sons, New York.
- Mihocko G, Kiviat E, Schmidt RE, Findlay SEG, Nieder WC & Blair E (2003) Assessing ecological functions of Hudson River fresh-tidal marshes: reference data and a modified hydrogeomorphic (HGM) approach. New York State Department of Environmental Conservation, Hudson River Estuary Program, New Paltz, NY, USA.
- Miller DE, Ladd J & Nieder WC (2006) Channel morphology in the Hudson River estuary: historical changes and opportunities for restoration. In: Waldman JR, Limburg KE & Strayer DL (eds) Hudson river fishes and their environment, pp. 29-37. American Fisheries Society Symposium No. 51. Bethesda, MD, USA.
- Milliman JD & Meade RH (1983) World-wide delivery of river sediment to the oceans. *Journal of Geology* 91: 1-21.
- Mills EL, Scheuerell MD, Carlton JT, Strayer DL (1997) Biological invasions in the Hudson River basin: an inventory and historical analysis. New York State Museum Circular 57: 1-51. USA.
- Minchinton TE & Bertness MD (2003) Disturbance-mediated competition and the spread of *Phragmites australis* in a coastal marsh. *Ecological Applications* 13: 1400-1416.
- Mitchell JC & Reay KK (1999) Atlas of Amphibians and Reptiles of Virginia. Special pub. no. 1, Virginia Department of Game and Inland Fisheries, Richmond, VA, USA.
- Mitsch WJ & Gosselink JG (1993) Wetlands. Van Nostrand Reinhold, New York.
- Mitsch WJ & Gosselink JG (2000) Wetlands. John Wiley & Sons Inc., New York.
- Mitsch WJ & Gosselink JG (2007) Wetlands. John Wiley and Sons, Inc. Hoboken, NJ, USA.
- Mitsch WJ, Day JW Jr, Gilliam JW, Groffman PM, Hey DL, Randall GW & Wang N (2001) Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River basin: strategies to counter a persistent ecological problem. *Bioscience* 51: 373-388.
- Modderman PJR (1953) Een neolithische woonplaats in de polder Vriesland onder Hekelingen (Eiland Putten, Zuid-Holland). *Berichten R.O.B. (Proceedings State Service for Archeological Investigations in The Netherlands)* 4(2): 1-26.
- Mohd-Lokman H & Pethick JS (2001) Seasonality of sediment skewness as a geochronological tool for the Humber salt marshes, U.K. *Wetlands Ecology and Management* 9: 1-12.
- Momber G (2000) Drowned and deserted: a submerged prehistoric landscape in the Solent, England. *The International Journal of Nautical Archaeology* 29: 86-99.
- Momber G & Campbell C (2005) Stone Age stove under the Solent. *International Journal of Nautical Archaeology* 34: 148.
- Monbet Y (1992) Control of phytoplankton biomass in estuaries: A comparative analysis of microtidal and macrotidal estuaries. *Estuaries* 15: 563-571.
- Monroe MW & Kelly J (1992) State of the estuary: a report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Bay Estuary Project, Oakland, CA, USA.
- Montz GN (1978) Vegetational characteristics of the Atchafalaya River delta. *Louisiana Academy of Sciences* 41: 71-84. USA.
- Moon C & Dunstan WM (1990) Hydrodynamic trapping and the formation of the chlorophyll *a* peak in the turbid, very low salinity waters of estuaries. *Journal of Plankton Research* 12: 323-336.
- Moonsammy RZ, Cohen DS & Hufford MT (1987) Living with the landscape. In: Moonsammy RZ, Cohen DS & Williams LE (eds) Pinelands folklife, pp. 65-230. Rutgers University Press, New Brunswick, NJ, USA.
- Moorhead KK & Brinson MM (1995) Response of wetlands to rising sea level in the lower coastal plain of North Carolina. *Ecological Applications* 5: 261-271.
- Mörner NA (1987) Models of global sea-level changes. In: Tooley M & Shennan I (eds) Sea-Level Changes, pp 332-355. Blackwell, Oxford, UK.
- Morris JT (1986) Decomposition and nutrient dynamics of litter from four species of freshwater emergent macrophytes. *Hydrobiologia* 131: 215-224.
- Morris JT & Bradley PM (1999) Effects of nutrient loading on carbon balance of coastal wetland sediments. *Limnology and Oceanography* 44: 699-702.
- Morris JT, Sundareshwar PV, Nietch CT, Kjerfve B & Cahoon DR (2002) Responses of coastal wetlands to rising sea level. *Ecology* 83: 2869-2877.
- Morris RKA (2007) English Nature's Estuaries Initiative: a review of its contribution to ICZM. *Ocean & Coastal Management* 51: 25-42.
- Morse JL, Megonigal JP & Walbridge MR (2004) Sediment nutrient accumulation and nutrient availability in two tidal freshwater marshes along the Mattaponi River, Virginia, USA. *Biogeochemistry* 69: 175-206.
- Morton JM, Kirkpatrick RL, Vaughan MR & Stauffer DF (1989) Habitat use and movements of American black ducks in winter. *Journal of Wildlife Management* 53: 390-400.
- Mörzer-Bruijns MF, Regteren-Altena CO & Butot LJM (1959) The Netherlands as an environment for land Mollusca. *Basteria* 23. NL.
- Moser J (1981) The steel shot program in New York, 1976-1980: results of a four-year gizzard collection. Federal Aid in Fish and Wildlife Restoration Project W-39-R, Job X-2 New York State Department of Environmental Conservation, Albany, NY, USA.
- Mounier RA (2003) Looking beneath the surface: the story of archaeology in New Jersey. Rutgers University Press, New Brunswick, NJ, USA.
- Mouthon J (1999) Longitudinal organisation of the mollusc species in a theoretical French river. *Hydrobiologia* 390: 117-128.
- Müller-Schwarze D & Sun L (2003) The beaver: natural history of a wetlands engineer. Cornell University Press, Ithaca, NY, USA.

- Muller-Solger AB, Jassby AD & Muller-Navarra DC (2002) Nutritional quality of food resources for zooplankton (*Daphnia*) in a tidal freshwater system (Sacramento-San Joaquin River Delta). *Limnology and Oceanography* 47: 1468-1476.
- Musick JA (1972) Herpetiles of the Maryland and Virginia coastal plain. In: Wass ML (ed) A checklist of the biota of lower Chesapeake Bay, pp. 213-223. Virginia Institute of Marine Science, Gloucester Point, VA, USA.
- Muyllaert K & Sabbe K (1999) Spring phytoplankton assemblages in and around the maximum turbidity zone of the estuaries of the Elbe (Germany), the Schelde (Belgium/The Netherlands) and the Gironde (France). *Journal of Marine Systems* 22: 133-149.
- Muyllaert K & Vyverman W (2006) Impact of a flood event on the planktonic food web of the Schelde estuary (Belgium) in spring 1998. *Hydrobiologia* 559: 385-394.
- Muyllaert K, Van Kerkvoorde A, Vyverman W & Sabbe K (1997) Structural characteristics of phytoplankton assemblages in tidal and non-tidal freshwater systems: a case-study from the Schelde basin. *Freshwater Biology* 38: 263-276.
- Muyllaert K, Sabbe K & Vyverman W (2000) Spatial and temporal dynamics of phytoplankton communities in a freshwater tidal estuary (Schelde, Belgium). *Estuarine, Coastal and Shelf Science* 50: 673-687.
- Muyllaert K, Van Wichelen J, Sabbe K & Vyverman W (2001) Short-term phytoplankton dynamics in a freshwater tidal estuary. *Archiv für Hydrobiologie* 150: 269-288. GER.
- Muyllaert K, Van Nieuwerburg L, Sabbe K & Vyverman W (2002) Microphytobenthos communities in the freshwater tidal brackish reaches of the Schelde estuary (Belgium). *Belgian Journal of Botany* 135: 15-26.
- Muyllaert K, Tackx M & Vyverman W (2005) Phytoplankton growth rates in the freshwater tidal reaches of the Schelde estuary (Belgium) estimated using a simple light-limited primary production model. *Hydrobiologia* 540: 127-140.
- Myers KW & Horton HF (1982) Temporal use of an Oregon estuary by hatchery and wild juvenile salmon. In: Kennedy VS (ed) *Estuarine comparisons*, pp. 377-391. Academic Press, New York.
- Myrick RM & Leopold LB (1963) Hydraulic geometry of a small tidal estuary: physiographic and hydraulic studies of rivers. B1-B18. U.S. Geologic Survey, Washington, DC.
- Najjar RG, Walker HA, Anderson PJ, Barron EJ, Bord RJ, Gibson JR, Kennedy VS, Knight CG, Megonigal JP, O'Connor RE, Polsky CD, Psuty NP, Richards BA, Sorenson LG, Steele EM & Swanson RS (2000) The potential impacts of climate change on the mid-Atlantic coastal region. *Climate Research* 14: 219-233.
- NCDC (2004) Climate of 2003: 2003 in historical perspective. National Climate Data Center (<http://www.ncdc.noaa.gov/oa/climate/research/2003/ann/ann03.html>).
- Nedwell DB & Raffaelli DG (eds) (1999) *Estuaries*. Advances in Ecological Research 29. Academic Press, London.
- Neff KP (2002) Plant colonization and vegetation change in a restored tidal freshwater wetland in Washington, DC. MS Thesis, University of Maryland, College Park, MD, USA.
- Neff KP & Baldwin AH (2005) Seed dispersal into wetlands: techniques and results for a restored tidal freshwater marsh. *Wetlands* 25: 392-404.
- Neff KP, Rusello K & Baldwin AH (2009) Rapid seed bank development in restored tidal freshwater wetlands. *Restoration Ecology* 17, DOI: 10.1111/j.1526-100X.2008.00415.x.
- NEMESIS (National Exotic Marine and Estuarine Species Information System) (2005) *Hydrilla verticillata*. (Viewed 30 July 2006 at <http://invasions.si.edu/nemesis/>)
- Neubauer SC (2008) Contributions of mineral and organic components to tidal freshwater marsh accretion. *Estuarine, Coastal and Shelf Science* 78: 78-88.
- Neubauer SC & Anderson IC (2003) Transport of dissolved inorganic carbon from a tidal freshwater marsh to the York River estuary. *Limnology and Oceanography* 48: 299-307.
- Neubauer SC, Miller WD & Anderson IC (2000) Carbon cycling in a tidal freshwater marsh ecosystem: a carbon gas flux study. *Marine Ecology Progress Series* 199: 13-30.
- Neubauer SC, Anderson IC, Constantine JA & Kuehl SA (2002) Sediment deposition and accretion in a mid-Atlantic (U.S.A.) tidal freshwater marsh. *Estuarine, Coastal and Shelf Science* 54: 713-727.
- Neubauer SC, Anderson IC & Neikirk BB (2005a) Nitrogen cycling and ecosystem exchanges in a Virginia tidal freshwater marsh. *Estuaries* 28: 909-922.
- Neubauer SC, Givler K, Valentine S & Megonigal JP (2005b) Seasonal patterns and plant-mediated controls of subsurface wetland biogeochemistry. *Ecology* 86: 3334-3344.
- Neubecker J, Kohler S, Obst G & Jensen K (2005) Der Schierlings-Wasserfenchel – erfolgreiche Ansiedlung einer prioritären FFH-Art an der Elbe. *Naturschutz und Landschaftsplanung* 37: 248-255. GER.
- New York Natural Heritage Program (1996) Stockport Flats: biodiversity inventory final report. New York Natural Heritage Program, Latham, NY, USA.
- New!Delta (2007) Ports and nature, striking a new balance. Province of South Holland, The Hague, NL.
- Newell SY & Porter D (2000) Microbial secondary production from salt marsh grass shoots, and its known and potential fates. In: Weinstein MP & Kreeger DA (eds) *Concepts and controversies in tidal marsh ecology*, pp. 159-186. Kluwer Academic Publishers, Boston, MA.
- Newell SY, Arsuffi TL & Palm LA (1996) Misting and nitrogen fertilization of shoots of a saltmarsh grass: effects upon fungal decay of leaf blades. *Oecologia* 108: 495-502.
- Newell SY, Blum LK, Crawford RE, Dai T & Dionne M (2000) Autumnal biomass and potential productivity of salt marsh fungi from 29 degrees to 43 degrees North latitude along the United States Atlantic coast. *Applied and Environmental Microbiology* 66: 180-185.
- Neyland R (2007) The effects of Hurricane Rita on the aquatic vascular flora in a large fresh-water marsh in Cameron Parish, Louisiana. *Castanea* 72: 1-7. USA.
- Ngai JT & Jefferies RL (2004) Nutrient limitation of plant growth and forage quality in Arctic coastal marshes. *Journal of Ecology* 92: 1001-1010.
- Nichols TC (2003) Integrated damage management program reduces grazing impacts by resident Canada geese on wild rice. Proceedings 2003 International Canada Goose Symposium. Madison, WI, USA.
- Nieder WC, Barnaba E, Findlay SEG, Hoskins S, Holochuck N & Blair EA (2004) Distribution and abundance of submerged aquatic vegetation and *Trapa natans* in the Hudson River estuary. *Journal of Coastal Research* 45: 150-161.



- Nienhuis PH, Bakker JP, Grootjans AP, Gulati RD & De Jonge VN (2002) The state of the art of aquatic and semi-aquatic ecological restoration projects in the Netherlands. *Hydrobiologia* 478: 219-233.
- Niering WA (1997) Tidal wetlands restoration and creation along the east coast of North America. In: Urbanska KM, Webb NR & Edwards PJ (eds) *Restoration ecology and sustainable development*, pp. 259-285. Cambridge University Press, Cambridge, UK.
- Nietch CT (2000) Carbon biogeochemistry in tidal marshes of South Carolina: the effect of salinity and nutrient availability on marsh metabolism in estuaries with contrasting histories of disturbance and river influence. PhD Dissertation, University of South Carolina, Columbia, SC, USA.
- NISIC (National Invasive Species Information Center) (2006) <http://www.invasivespeciesinfo.gov> (Viewed January 2008).
- NOAA (1975) The coastline of the United States. Publication NOAA/PA 71046. U.S. Government Printing Office, Washington, DC.
- NOAA (1988) Tide tables: high and low water predictions, west coast of North and South America. U.S. Dept of Commerce, Washington, DC.
- NOAA (2007) NOAA Tides and currents: tide station locations and ranges (<http://tidesandcurrents.noaa.gov/tides08/tab2ec2c.html#57>).
- Nolet BA & Rosell F (1998) Comeback of the beaver *Castor fiber*: An overview of old and new conservation problems. *Biological Conservation* 83: 165-173.
- Nolet BA, Hoekstra A & Ottenheim MM (1994) Selective foraging on woody species by the beaver *Castor fiber*, and its impact on a riparian willow forest. *Biological Conservation* 70: 117-128.
- Nolet B, Spitzen A, Van Leijssen J & Dijkstra V (2006) Bevers in de Biesbosch - Griendwerkers van de toekomst? *Landschap* 23: 171-180. NL.
- Nordstrom KF & Roman CT (eds) (1996) *Estuarine shores - evolution, environments and human alterations*. John Wiley & Sons, Chichester, UK.
- NWWG (National Wetlands Working Group) (1988) *Wetlands of Canada ecological land classification series*. No 24. Environment Canada, Ottawa, Ontario, and Polyscience Publications, Inc., Montreal, Quebec, Canada.
- O'Shea ML & Brosnan TM (2000) Trends in indicators of eutrophication in Western Long Island Sound and the Hudson-Raritan Estuary. *Estuaries* 23: 877-901.
- Odum EP (2000) Tidal Marshes as outwelling/pulsing systems. In: Weinstein MP & Kreeger DA (eds) *Concepts and controversies in tidal marsh ecology*, pp. 3-8. Kluwer Academic Publishers, Boston, MA, USA.
- Odum EP, Birch JB & Cooley JL (1983) Comparison of giant cutgrass productivity in tidal and impounded marshes with special reference to tidal subsidy and waste assimilation. *Estuaries* 6: 88-94.
- Odum WE (1988) Comparative ecology of tidal freshwater and salt marshes. *Annual Review of Ecology and Systematics* 19: 147-176.
- Odum WE & Heywood MA (1978) Decomposition of intertidal freshwater marsh plants. In: Good RE, Whigham DF & Simpson RL (eds) *Freshwater wetlands: ecological processes and management potential*, pp. 89-98. Academic Press, New York.
- Odum WE, Smith TJ III, Hoover JK & McIvor CC (1984) The ecology of tidal freshwater marshes of the United States east coast: a community profile. U.S. Fish and Wildlife Service, FWS/OBS-83/17, Washington, DC.
- Odum WE, Rozas LP & McIvor CC (1987) A comparison of fish and invertebrate community composition in tidal freshwater and oligohaline marsh systems. In: Hook DD, McKee Jr WH, Smith HK, Gregory J, Burrell VG, DeVoe MR, Sojka RE, Gilbert S, Banks R, Stolzy LG, Brooks C, Matthews TD & Shear TH (eds) *Ecology and management of wetlands*, pp. 112-132. Croom Helm, London.
- Odum WE, Odum EP & Odum HT (1995) Nature's pulsing paradigm. *Estuaries* 18: 547-555.
- Oertling W (1992) Profil-Typen der Ufer-Vegetation der Unterelbe im Bereich und unterhalb der Mitteltidehochwasser-Linie. Institut für Angewandte Botanik der Universität Hamburg, Beiheft 3: 37-74. GER.
- Officer CB (1976) *Physical oceanography of estuaries (and associated coastal waters)*. John Wiley & Sons, New York.
- Officer CB (1981) Physical dynamics of estuarine suspended sediments. *Marine Geology* 40: 1-14.
- Officer CB & Ryther JH (1980) The possible importance of silicon in marine eutrophication. *Marine Ecology Progress Series* 3: 83-91.
- O'Neil T (1949) *The muskrat in the Louisiana coastal marshes*. Wildlife and Fisheries Commission, New Orleans, LA, USA.
- Orr M, Crooks S & Williams PB (2003) Will restored tidal marshes be sustainable? In: Brown LR (ed) *Issues in San Francisco Estuary tidal wetlands restoration*. San Francisco Estuary and Watershed Science 1(1), Article 1. Oakland, CA, USA. Electronic journal available at <http://repositories.cdlib.org/jmie/sfews/vol1/iss1/art5>.
- Orson RA, Simpson RL & Good RE (1990) Rates of sediment accumulation in a tidal freshwater marsh. *Journal of Sedimentary Petrology* 60: 859-869.
- Orson RA, Simpson RL & Good RE (1992) The paleoecological development of a late Holocene, tidal freshwater marsh of the upper Delaware River Estuary. *Estuaries* 15: 130-146.
- Orson RA, Warren RS, Niering WN & Patten PV (eds) (1998) *Research in New England marsh-estuarine ecosystems: directions and priorities into the next millennium*. The Connecticut Sea Grant College Program. Groton, CT, USA.
- Orth DJ (1967) *Dictionary of Alaska place names*. U.S. Geological Survey Paper 567. U.S. Government Printing Office, Washington, DC.
- Orth RJ, Nowak JF, Anderson GF & Whiting JR (1996) Distribution of submerged aquatic vegetation in the Chesapeake Bay and tributaries and Chincoteague Bay - 1995. U.S. Environmental Protection Agency, Annapolis, MD, USA.
- Orton GJ & Reading HG (1993) Variability of deltaic processes in terms of sediment supply, with particular emphasis on grain-size. *Sedimentology* 40: 475-512.
- Osborn TJ & Briffa KR (2006) The spatial extent of 20<sup>th</sup>-century warmth in the context of the past 1200 years. *Science* 311: 841-844.
- Osgood DT, Yozzo DJ, Chambers RM, Jacobson D, Hoffman T & Wnek J (2003) Tidal hydrology and habitat utilization by resident nekton in *Phragmites* and non-*Phragmites* wetlands. *Estuaries* 26: 522-533.

- Osgood DT, Yozzo DJ, Chambers RM, Pianka S, Lewis J & LePage C (2007) Patterns of habitat utilization by resident nekton in *Phragmites* and *Typha* marshes on the Hudson River estuary, New York. In: Waldman J, Limburg K & Strayer D (eds) Hudson River fishes and their environment 51: 151-173. American Fisheries Society Symposium, Bethesda, MD, USA.
- O'Sullivan A (2001) Archaeology, foragers, farmers and fishers in a coastal landscape; an intertidal archaeological survey of the Shannon estuary. Discovery Programme Monograph 5, Royal Irish Academy Publication.
- Otto S, Groffman PM, Findlay SEG & Arreola AE (1999) Invasive plant species and microbial processes in a tidal freshwater marsh. *Journal Environmental Quality* 28: 1252-1257.
- Paavola M, Olenin S & Leppaköski E (2005) Are invasive species most successful in habitats of low native species richness across European brackish water seas? *Estuarine, Coastal and Shelf Science* 64: 738-750.
- Page GW, Stenzel LE & Wolfe CM (1979) Aspects of the occurrence of shorebirds on a central California estuary. *Studies in Avian Biology* 2: 15-32. USA.
- Pahl JW (2002) The combined effects of salinity and sulfide on the growth and physiology of the freshwater marsh plant *Panicum hemitomon* J.A. Schultes. PhD Dissertation, Louisiana State University, Baton Rouge, LA, USA.
- Paludan C & Morris JT (1999) Distribution and speciation of phosphorus along a salinity gradient in intertidal marsh sediments. *Biogeochemistry* 45: 197-221.
- Parfitt SA, Barendregt RW, Breda M, Candy I, Collins MJ, Coope GR, Durbidge P, Field MH, Lee JR, Lister M, Mutch R, Penkman KEH, Preece RC, Rose J, Stringer CB, Symmons R, Whittaker JE, Wymer JJ & Stuart AJ (2005). The earliest record of human activity in northern Europe. *Nature* 438: 1008-1012.
- Park RA, Armentano TV & Cloonan CL (1986) Predicting the effects of sea level rise on coastal wetlands. In: Titus JG (ed) Effects of changes in stratospheric ozone and global climate, Vol. 4: Sea level rise, pp. 129-152. U.S. Environmental Protection Agency, Washington, DC.
- Park RA, Trehan MS, Mausel PW & Howe RC (1989) Coastal wetlands in the twenty first century: profound alterations due to rising sea level. In: Wetlands, concerns and successes, pp. 71-80. Proceedings of symposium sponsored by American Water Resources Association, Bethesda, MD.
- Park RA, Lee JK, Mausel PW & Howe RC (1991) Using remote sensing for modeling the impacts of sea level rise. *World Resources Review* 3: 184-220.
- Parker VT & Leck MA (1985) Relationships of seed banks to plant distribution patterns in a freshwater tidal wetland. *American Journal of Botany* 72: 161-174.
- Pasternack GB (1998) Physical dynamics of tidal freshwater delta evolution. PhD Dissertation, The Johns Hopkins University, Baltimore, MD, USA.
- Pasternack GB (2001) Animal response to river evolution in the tidal freshwater zone. In: Dorava JM, Montgomery DR, Palsak BB & Fitzpatrick FA (eds) Geomorphic processes and riverine habitat, pp.139-157. American Geophysical Union, Washington, DC.
- Pasternack GB & Brush GS (1998). Sedimentation cycles in a river-mouth tidal freshwater marsh. *Estuaries* 21: 407-415.
- Pasternack GB & Brush GS (2001) Seasonal variations in sedimentation and organic content in five plant associations on a Chesapeake Bay tidal freshwater delta. *Estuarine, Coastal and Shelf Science* 53: 93-106.
- Pasternack GB & Brush GS (2002) Biogeomorphic controls on sedimentation and substrate on a vegetated tidal freshwater delta in upper Chesapeake Bay. *Geomorphology* 43: 293-311.
- Pasternack GB & Hinnov LA (2003) Hydrometeorological controls on water level in a vegetated Chesapeake Bay tidal freshwater delta. *Estuarine, Coastal and Shelf Science* 58: 373-393.
- Pasternack GB, Hilgartner WB & Brush GS (2000) Biogeomorphology of an upper Chesapeake Bay river-mouth tidal freshwater marsh. *Wetlands* 20: 520-537.
- Pasternack GB, Brush GS & Hilgartner WB (2001) Impact of historic land-use change on sediment delivery to an estuarine delta. *Earth Surface Processes and Landforms* 26: 409-427.
- Paul MM, Krafft CC & Hammerschlag RS (2006) Avian comparisons between Kingman and Kenilworth Marshes, Final Report 2001-2004. U.S. Geological Survey Patuxent Wildlife Research Center, Beltsville, MD, USA.
- Pearlstone LG, Kitchens WM, Latham PJ & Bartleson RD (1993) Tide gate influences on a tidal marsh. *Water Resources Bulletin* 29: 1009-1019.
- Pelegri SP & Blackburn TH (1995) Effects of *Tubifex tubifex* (Oligochaeta: Tubificidae) on N-mineralisation in freshwater sediments, measured with <sup>15</sup>N isotopes. *Aquatic Microbial Ecology* 9: 289-294.
- Peluso M, Munnia A, Bolognesi C & Parodi S (1998) <sup>32</sup>P-postlabeling detection of DNA adducts in mice treated with the herbicide Roundup. *Environmental and Molecular Mutagenesis* 31: 55-59.
- Penfound WT & Hathaway ES (1938) Plant communities in the marshlands of southeastern Louisiana. *Ecological Monographs* 8: 1-56.
- Perham C (1980) The long tidal river. *EPA Journal* 6: 11-15. USA.
- Perillo GME, Piccolo MC & Pino-Quivira M (eds) (1999) Estuaries of South America, their geomorphology and dynamics. SpringerVerlag, Berlin, GER.
- Perls J (1999) Paths along the Hudson: a guide to walking and biking. Rutgers University Press, New Brunswick, NJ, USA.
- Perry JE (1994) Temporal and spatial changes in plant diversity in Chesapeake Bay tidal wetlands: management implications. In: Lynch MP & Crowder B (eds) Organizing for the coast: proceedings of the 13<sup>th</sup> International Conference of the Coastal Society, pp. 619-625. Gloucester, MA, USA.
- Perry JE (1997) Natural heritage resources fact sheet: tidal freshwater marshes. Department Conservation & Recreation, Richmond, VA, USA.
- Perry JE (2005) Vegetation assessments of a created forested tidal wetland mitigation site in Charles City, Virginia. Annual Report, Virginia Polytechnic Institute and University, Blacksburg, VA, USA.
- Perry JE & Atkinson RA (1997). Plant diversity along a salinity gradient of four marshes on the York and Pamunkey rivers in Virginia. *Castanea* 62: 112-118. USA.
- Perry JE & Atkinson RA (2007) York River tidal marshes. In: Moore KA & Reay WG (eds) A site profile of the Chesapeake Bay National Estuarine Research Reserve, Virginia. VIMS Special Scientific Report No. 149. The Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, USA.
- Perry JE & Hershner CH (1999) Temporal changes in the vegetation pattern in a tidal freshwater marsh. *Wetlands* 19: 90-99.

- Perry MC & Deller AS (1996) Review of factors affecting the distribution and abundance of waterfowl in shallow-water habitats of Chesapeake Bay. *Estuaries* 19: 272-278.
- Perry MC & Uhler FM (1981) Asiatic clam (*Corbicula manilensis*) and other foods used by waterfowl in the James River, Virginia. *Estuaries* 4: 229-233.
- Petermeier A, Schöll F & Tittizer Th (1994) Historische Entwicklung der aquatischen Lebensgemeinschaft (Zoobenthos und Fischfauna) im deutschen Abschnitt der Elbe. Bundesanstalt für Gewässerkunde. 0832. Koblenz [unveröffentlichtes Gutachten], GER.
- Petermeier A, Schöll F & Tittizer Th (1996) Die ökologische und biologische Entwicklung der deutschen Elbe. Ein Literaturbericht. *Lauterbornia* 24: 1-95. Dinkelscherben, GER.
- Peterson JE (2003) Factors regulating expression of seed banks in vegetation of tidal freshwater wetlands. MS Thesis, University of Maryland, College Park, MD, USA.
- Peterson JE & Baldwin AH (2004a) Variation in wetland seed banks across a tidal freshwater landscape. *American Journal of Botany* 91: 1251-1259.
- Peterson JE & Baldwin AH (2004b) Seedling emergence from seed banks of tidal freshwater wetlands: response to inundation and sedimentation. *Aquatic Botany* 78: 243-254.
- Pethick J (2002) Estuarine and tidal wetland restoration in the United Kingdom: policy versus practice. *Restoration Ecology* 10: 431-437.
- Petzlberger BEM (2000) Coastal development and human activities in NW Germany. In: Pye K & Allen JRL (eds) Coastal and estuarine environments: sedimentology, geomorphology and geoaerchaeology. Special Publications 175: 365-376. Geological Society, London.
- Pezechki SR, DeLaune RD & Patrick WH Jr (1990) Flooding and salt water intrusion: Potential effects on survival and productivity of wetland forests along the U.S. Gulf Coast. *Forest Ecology and Management* 33/34: 287-301.
- Pezechki SR, DeLaune RD & Pan SZ (1991) Relationship of soil hydrogen sulfide level to net carbon assimilation of *Panicum hemitomon* and *Spartina patens*. *Vegetatio* 95: 156-166.
- Pfannkuche O, Jelinek H & Hartwig E (1975) Zur Fauna eines Süßwasserwattes im Elbe-Aestuar. *Archiv für Hydrobiologie* 76: 475-498. GER.
- Phelps HL (1994) The Asiatic clam (*Corbicula fluminea*) invasion and system-level ecological change in the Potomac River estuary near Washington, DC. *Estuaries* 17: 614-621.
- Philipp KR & Field RT (2005) *Phragmites australis* expansion in Delaware Bay salt marshes. *Ecological Engineering* 25: 275-291.
- Phillip M (2005) Decker Island wildlife area: enhancing delta wetlands one phase at a time. *Outdoor California*, March-April 2005: 4-8. USA. Accessed from <http://www.dfg.ca.gov/ocal>.
- Piavis PG (1991) Yellow perch. In: Funderbunk SL, Jordan SJ, Mihursky JA & Riley D (eds) Habitat requirements for Chesapeake Bay living resources, pp 14-1 to 14-15. National Oceanic and Atmospheric Administration, Annapolis, MD, USA.
- Piccolo MC & Perillo GME (1999) The Argentina estuaries: a review. In: Perillo GME, Piccolo MC & Pino-Quivira M (eds) Estuaries of South America: their geomorphology and dynamics, pp. 101-132. SpringerVerlag, Berlin.
- Pickett J, McKellar H & Kelley J (1989) Plant community composition, leaf mortality, and aboveground production in a tidal freshwater marsh. In: Sharitz RR & Gibbons JW (eds) *Freshwater Wetlands and Wildlife*, pp. 351-364. Proceedings of symposium at Charlestown, South Carolina, 24-27 March 1986. U.S. Department of Energy, National Technical Information Service. Springfield, VA, USA.
- Pimentel D, Lach L, Zuniga R & Morrison D (2000) Environmental and economic costs of nonindigenous species in the United States. *BioScience* 50: 53-65.
- Pinder DA & Witherick ME (1990) Port industrialization, urbanization and wetland loss. In: Williams M (ed) *Wetlands - a threatened landscape*, pp. 234-266. Basil Blackwell, Oxford, UK.
- Platt T, Lewis M & Geider R (1984) Thermodynamics of the pelagic ecosystem: elementary closure conditions for biological production in the open ocean. In: Fasham MJR (ed) *Flows of energy and materials in marine ecosystems*, pp. 48-84. Plenum Press, New York.
- Platvoet D & Pinkster S (1995) Changes in the Amphipod fauna (Crustacea) of the Rhine, Meuse and Scheldt estuary due to the 'Delta Plan' coastal engineering works. *Netherlands Journal of Aquatic Ecology* 29: 5-30.
- Pleijte M & During R (2006) Ruimte voor alternatieven? - Ruimte voor de rivier in de Noordwaard. *Landschap* 23: 187-191. NL.
- Pomfret JR, Elliott M, O'Reilly MG & Phillips S (1991) Spatial and temporal patterns in the fish communities in two UK North Sea estuaries. In: Elliott M & Ducrottoy JP (eds) *Estuaries and coasts: spatial and temporal intercomparisons*, pp. 277-284. Olson & Olson, Fredensborg, DK.
- Pons LJ & Zonneveld IS (1965) Soil ripening and soil classification, initial soil formation in alluvial deposits and a classification of the resulting soils. Publication No. 13 of International Institute for Land reclamation and Improvement. Veenman & Zonen, Wageningen, NL.
- Poorter H (1993) Interspecific variation in the growth-response of plants to an elevated ambient CO<sub>2</sub> concentration. *Vegetatio* 104: 77-97.
- Posey MH, Wigand C & Stevenson JC (1993) Effects of an introduced plant, *Hydrilla verticillata*, on benthic communities in the upper Chesapeake Bay. *Estuarine, Coastal and Shelf Science* 37: 539-555.
- Post RA (1996) Functional profile of black spruce wetlands in Alaska. Alaska Department of Fish and Game, Fairbanks, AK, USA.
- Posthoorn R (ed) (2000) *Ontwikkelingsvisie Tiengemetten – eiland van wildernis, weelde en weemoed*. RIZA rapport 2000.041. Lelystad, NL.
- Postma H & Kalle K (1955) Die Entstehung von Trübungszonen im Unterlauf der Flüsse, speziell im Hinblick auf die Verhältnisse in der Unterelbe. *Deutsche Hydrographische Zeitschrift* 8: 138-144. GER.
- Pratolongo P, Kandus P & Brinson MM (2007) Net aboveground primary production and soil properties of floating and attached freshwater tidal marshes in the Rio del al Plata estuary, Argentina. *Estuaries and Coasts* 30: 618-626.
- Preisinger H (1991) *Strukturanalyse und Zeigerwert der Auen- und Ufervegetation im Hamburger Hafen- und Hafenrandgebiet*. Dissertationes Botanicae Band 174. Cramer, Berlin.



- Prevost MB (1986) Management of plant communities for waterfowl in coastal South Carolina. Symposium on waterfowl and wetlands management in the coastal zone of the Atlantic flyway. Wilmington, Delaware, Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife and Delaware Coastal Management Program. Dover, DE, USA.
- Pritchard DW (1967) What is an estuary: a physical viewpoint. *American Association for the Advancement of Science* 83: 3-5.
- Puterbaugh P (1997) Southeastern wetlands: a guide to selected sites in Georgia, North Carolina, South Carolina, Tennessee, and Kentucky. Terrene Institute, Alexandria, VA, USA.
- PWA (2006) Dutch Slough tidal marsh restoration conceptual plan and feasibility report. PWA Ref. No. 1714. Phillip Williams and Associates, Ltd., San Francisco, CA, USA. Accessed from <http://www.dutchslough.org/Documents>.
- Quigley DTG, Igoe F & O'Connor W (2004) The European smelt *Osmerus eperlanus* L. in Ireland: general biology, ecology, distribution and status with conservation recommendations. *Biology and Environment: Proceedings of the Royal Irish Academy* 104B (3): 57-66.
- Quigley PA (2001) Wetlands monitoring report, Henderson freshwater tidal wetland restoration, John Heinz National Wildlife Refuge, Monitoring Year 2000. Patricia Ann Quigley, Inc., Norristown, PA, USA.
- Quinn JR (1997) Fields of sun and grass: an artist's journal of the New Jersey Meadowlands. Rutgers University Press, New Brunswick, NJ, USA.
- Raabe EW (1986) Die Gliederung der Ufervegetation der Elbe unterhalb Hamburg. *Mitteilungen Natur- und Umweltschutz Hamburg* 2: 117-141. GER.
- Rabalais NN, Turner RE, Justice D, Dortsch Q, Wiseman Jr. WJ & Sen Gupta B (1996) Nutrient changes in the Mississippi River and system responses on the adjacent continental shelf. *Estuaries* 19: 386-407.
- Raichel DL, Able KW & Hartman JM (2003) The influence of *Phragmites* (common reed) on the distribution, abundance, and potential prey of a resident marsh fish in the Hackensack Meadowlands, New Jersey. *Estuaries* 26: 511-521.
- Rapp JM, Fugler M, Armbruster CK & Clark NS (2001) Atchafalaya sediment delivery AT-02 progress report No. 1. Monitoring Series No. AT-02-MSPR-0599-1. Coastal Restoration Division, Louisiana Department of Natural Resources, Baton Rouge, LA, USA. Accessed from <http://lacoast.gov>.
- Raven PH & Thomas JH (1970) *Iris pseudacorus* in western North America. *Madroño* 20: 390-391. USA.
- Raynie RC & Visser JM (2002) CWPPRA adaptive management review final report. Coastal Restoration Division, Louisiana Department of Natural Resources, Baton Rouge, LA, USA.
- Redeke HC (1941) *De visschen van Nederland*. Sijthoff, Leiden, NL.
- Reed DJ (1989) Patterns of sediment deposition in subsiding coastal salt marshes, Terrebonne Bay, Louisiana: the role of winter storms. *Estuaries* 12: 222-227.
- Reed DJ (ed) (1995) Status and historical trends of hydrologic modification, reduction in sediment availability, and habitat loss/modification in the Barataria and Terrebonne estuarine system. Barataria-Terrebonne National Estuary Program, Thibodaux, LA, USA.
- Reed DJ (2002) Understanding tidal marsh sedimentation in the Sacramento-San Joaquin Delta, California. *Journal of Coastal Research (Special Issue)* 36: 605-611.
- Rehbehn R, Schuchardt B, Schirmer M & Kirst GO (1993) The distribution of *Actinocyclus normanii* (Bacillariophyceae) in estuaries: field observations and laboratory investigations. *Netherlands Journal of Aquatic Ecology* 27: 205-214.
- Rejmanek M, Sasser CE & Peterson GW (1988) Hurricane-induced sediment deposition in a Gulf coast Marsh. *Estuarine, Coastal and Shelf Science* 27: 217-222.
- Remane A (1934) Die Brackwasserfauna. *Zoologischer Anzeiger (Supplement)* 7: 34-74. GER.
- Renz MJ (2002) Biology, ecology and control of perennial pepperweed (*Lepidium latifolium* L.). PhD Dissertation, University of California, Davis, CA, USA.
- Retière C (1994) Tidal power and the aquatic environment of La Rance. *Biological Journal of the Linnean Society* 51: 25-36.
- Reynolds M (1991) Ecology of the marsh snail, *Oxyloma effusa*. Technical report of the Jug Bay Wetlands Sanctuary, Lothian, MD, USA.
- Rheinhardt RD (1991) Vegetation ecology of tidal freshwater swamps in lower Chesapeake Bay, USA. PhD Dissertation, School of Marine Science, College of William and Mary, Gloucester Point, VA, USA.
- Rheinhardt RD (1992) Multivariate analysis of vegetation patterns in tidal freshwater swamps of lower Chesapeake Bay, USA. *Bulletin of the Torrey Botanical Club* 119: 193-208. USA.
- Rheinhardt RD & Hershner C (1992) The relationship of below-ground hydrology to canopy composition in five tidal freshwater swamps. *Wetlands* 12: 208-216.
- Rhyne N (1994) Touring the coastal Georgia back roads. John F. Blair Publisher, Winston-Salem, NC, USA.
- Rice D, Rooth J & Stevenson JC (2000) Colonization and expansion of *Phragmites australis* in upper Chesapeake Bay tidal marshes. *Wetlands* 20: 280-299.
- Rich FJ (1984) The development of three tree islands in the Okefenokee Swamp as determined by palynostratigraphy and peat petrography. In: Cohen AD, Casagrande DJ, Andrejko MJ & Best GR (eds) *The Okefenokee Swamp: its natural history, geology, and geochemistry*, pp. 444-455. Wetland Surveys, Los Alamos, NM, USA.
- Richard E & Schmidt RE (1987) Feeding ecology of the banded killifish (*Fundulus diaphanus*) at Tivoli North Bay, Hudson River, New York. In: Blair EA & Cooper JC (eds) *Polgar Fellowship Reports of the Hudson River National Estuarine Research Reserve, 1986*, pp ii-1-20. New York State Department of Environmental Conservation, Annandale, NY, USA.
- Richard S, Moslemi S, Sipahutar H, Benachour N & Seralini GE (2005) Differential effects of glyphosate and Roundup on human placental cells and aromatase. *Environmental Health Perspectives* 113: 716-720.
- Richardson K (1997) Harmful or exceptional phytoplankton blooms in the marine ecosystem. *Advances in Marine Biology* 31: 301-385.
- Richardson K, Beardall J & Raven JA (1983) Adaptation of unicellular algae to irradiance- an analysis of strategies. *New Phytologist* 93: 157-191.

- Ridgley MA & Rijsberman FR (1994) Multicriterion analysis and the evaluation of restoration policies for a Rhine estuary. *Socio-Economic Planning Science* 28: 19-32.
- Riedel-Lorjé JC & Gaumert T (1982) A century of Elbe research – Hydrobiological conditions and fish populations from 1842 to 1943 under the influence of construction projects and sewage discharge (in German). *Archiv für Hydrobiologie, Suppl.* 61: 317-376.
- Rignot E & Kanagaratnam P (2006) Changes in velocity structure of the Greenland Ice Sheet. *Science* 311: 986-990.
- Ritter DF (1986) *Process geomorphology*. Wm. C. Brown Publishers, Dubuque, IA, USA.
- Rolinski S (1999) On the dynamics of suspended matter transport in the tidal river Elbe: description and results of a Lagrangian model. *Journal of Geophysical Research* 104: 26.043-26.057.
- Rolinski S & Eichweber G (2000) Deformations of the tidal wave in the Elbe estuary and their effect on suspended particulate matter dynamics. *Physical Chemistry of the Earth* 25: 355-358.
- Rooth JE & Stevenson JC (2000) Sediment deposition patterns in *Phragmites australis* communities: implications for coastal areas threatened by rising sea-level. *Wetland Ecology and Management* 8: 173-183.
- Rooth JE, Stevenson JC & Cornwell JC (2003) Increased sediment accretion rates following invasion by *Phragmites australis*: the role of litter. *Estuaries* 26: 475-483.
- Rose PM & Scott DA (1997) *Waterfowl Population Estimates*. Wetlands International Publication 44. Wageningen, NL.
- Roßbach B, Sievers H, Hammen A & Doerffer R (1997) Luftbildauswertung "Tideröhrichte an der Unterelbe". Report GKSS, Geesthacht, GER.
- Rozas LP & Odum WE (1987a) Fish and macrocrustacean use of submerged plant beds in tidal freshwater marsh creeks. *Marine Ecology-Progress Series* 38: 101-108.
- Rozas LP & Odum WE (1987b) Use of tidal freshwater marshes by fishes and macrofaunal crustaceans along a marsh stream-order gradient. *Estuaries* 10: 36-43.
- Rozycki C & Kiviat E (1996) A low density, tidal marsh, painted turtle population. In: Waldman JR, Nieder WC & Blair EA (eds) *Reports of the Tibor T. Polgar Fellowship Program, 1995*, pp. v-1 to v-35. Hudson River Foundation, New York.
- Rusch DH, Malecki RA & Trost RE (1995) Canada Geese in North America. In: Laroe ET, Farris GS, Puckett CE, Doran PD & Mae MJ (eds) *Our living resources*, pp. 26-28. US Department of the Interior, National Biological Survey, Washington, DC.
- Russell EWB (1986) Interpretation of a palynological core from the floodplain of the Abbott Farm National Historic Landmark. *Trenton Complex Archaeology: report B. Archaeological data recovery I-295, and wetlands area interchange area B (28 Me 1-B)*, pp. A1-6. Louis Berger & Associates, Inc., The Cultural Resource Group. Trenton, NJ, USA.
- Russell RJ (1942) Flotant. *Geographical Review* 32: 74-98. USA.
- RWS-ZL (1998) Hoofdrapport MER Beheer Haringvlietsluizen – over de grens van zout naar zoet. Report RWS apv 98/102. Rijkswaterstaat Directie Zuid-Holland, Rotterdam, NL.
- Rybicki NB & Landwehr JM (2007) Long-term changes in abundance and diversity of macrophyte and waterfowl populations in an estuary with exotic macrophytes and improving water quality. *Limnology and Oceanography* 52: 1195-1207.
- Rysgaard S, Thastum P, Dalsgaard T, Christensen PB & Sloth NP (1999) Effects of salinity on  $\text{NH}_4^+$  adsorption capacity, nitrification, and denitrification in Danish estuarine sediments. *Estuaries* 22: 21-31.
- Ryther JH & Dunstan WM (1971) Nitrogen, phosphorus, and eutrophication in the coastal environment. *Science* 171: 1008-1013.
- Sager LL (1993) A recreational development site plan for the Tivoli Bays Hudson River National Estuarine Research Reserve. MS Thesis, State University of New York College of Environmental Science and Forestry, Syracuse, NY, USA.
- Salomone P, Morstad S, Sands T, Westing C, Baker T & Brazil C (2007) 2006 Bristol Bay area annual management report. Fishery Management Report No. 07-22. Alaska Department of Fish and Game, Anchorage, AK, USA.
- Salomons W, Schwedhelm E, Schoer J & Knauth H-D (1988) Natural tracers to determine the origin of sediments and suspended matter from the Elbe estuary. *Water Science and Technology* 20: 89-102.
- Saltonstall K (2002) Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. *Proceedings of the National Academy of Sciences USA* 99: 2445-2449.
- Saltonstall K (2003) Genetic variation among North American populations of *Phragmites australis*: implications for management. *Estuaries* 26: 444-451.
- Sanderson GC & Bellrose FC (1986) A review of the problem of lead poisoning in waterfowl. Illinois Natural History Survey, Champaign, Illinois. Special Publication 4. Jamestown ND: Northern Prairie Wildlife Research Center Online, USA. <http://www.npwrc.usgs.gov/resource/birds/pbpoison/index.htm> (Viewed January 2008).
- Sandifer PA, Miglarese JV, Calder DR, Manzi JJ & Barclay LA (1980) Ecological characterization of the Sea Island coastal region of South Carolina and Georgia. Vol. iii: Biological features of the characterization area. US Fish Wildlife Biological Service Program, FWS/OBS-79/42. Washington, DC.
- Santín C, Otero XL, Fernández S, González-Pérez M & Alvarez MA (2007) Variations of organic carbon stock in reclaimed estuarine soils (Villaviciosa estuary, NW Spain). *Science of the Total Environment* 378: 138-142.
- Saris F (1987) *Patroon en proces in een zoetwater(getijden)delta*. Rapport SCMO, Delft, NL.
- Saris F & Sierdsema H (1987) *Avifauna van de Biesbosch - Een beschrijving van de veranderingen en de dynamiek van een unieke vogelgemeenschap*. Rapport SBB, Tilburg, NL.
- Sasser CE & Gosselink JG (1984) Vegetation and primary production in a floating freshwater marsh in Louisiana. *Aquatic Botany* 20: 245-255.
- Sasser CE, Gosselink JG & Shaffer GP (1991) Distribution of nitrogen and phosphorus in a Louisiana freshwater floating marsh. *Aquatic Botany* 41: 317-331.
- Sasser CE, Swenson EM, Evers DE, Visser JM, Holm GO Jr & Gosselink JG (1994) Floating marshes in the Barataria and Terrebonne basins, Louisiana. Louisiana State University, Coastal Ecology Institute, Baton Rouge, prepared for U.S. Environmental Protection Agency, Dallas, TX, USA.
- Sasser CE, Gosselink JG, Swenson EM & Evers DE (1995a) Hydrologic, vegetation, and substrate characteristics of floating

- marshes in sediment-rich wetlands of the Mississippi River delta plain, Louisiana, USA. *Wetlands Ecology and Management* 3: 171-187.
- Sasser CE, Visser JM, Evers DE & Gosselink JG (1995b) The role of environmental variables in interannual variation in species composition and biomass in a sub-tropical minerotrophic floating marsh. *Canadian Journal of Botany* 73: 413-424.
- Sasser CE, Gosselink JG, Swenson EM, Swarzenski CM & Leibowitz NC (1996) Vegetation, substrate and hydrology in floating marshes in the Mississippi river delta plain wetlands, USA. *Vegetatio* 122: 129-142.
- Sasser CE, Holm GO Jr, Visser JM & Swenson EM (2004) Thin-mat floating marsh enhancement demonstration project TE-36. School of the Coast and Environment, Louisiana State University. Baton Rouge, LA, USA.
- Saunders CJ, Megonigal JP & Reynolds JF (2006) Comparison of belowground biomass in C<sub>3</sub>- and C<sub>4</sub>-dominated mixed communities in a Chesapeake Bay brackish marsh. *Plant and Soil* 280: 305-322.
- Savenije HHG (2005) Salinity and tides in alluvial estuaries. Elsevier, Amsterdam.
- Schaminee JHJ, Weeda EJ & Westhoff V (1995) De Vegetatie van Nederland – deel 2 – Plantengemeenschappen van wateren, moerassen en natte heiden. Opulus Press, Uppsala, Sweden.
- Schindler PW (1983) Metal ions in natural aquatic systems. *Inorganica Chimica Acta* 79: 32-33.
- Schlekat CE, McGee BL, Boward DM, Reinharz E, Velinsky DJ & Wade TI (1994) Tidal river sediments in the Washington, DC. area. III. Biological effects associated with sediment contamination. *Estuaries* 17: 334-344.
- Schlesinger WH (1978) Community structure, dynamics, and nutrient cycling in the Okefenokee cypress swamp-forest. *Ecological Monographs* 48: 43-56.
- Schlesinger WH (1997) Biogeochemistry: an analysis of global change. Academic Press, San Diego, CA, USA.
- Schmidt KA (1986) The life history of the chrysomelid beetle *Pyrhhalta nymphaeae* (Galerucinae) on water chestnut, *Trapa natans* (Hydrocharitaceae), in Tivoli South Bay, Hudson River, NY. In: Blair EA & Waldman JR (eds) Polgar Fellowship Reports of the Hudson River National Estuarine Sanctuary Program, 1985, pp. v-1 to v-32. New York State Department of Environmental Conservation, Annandale, NY, USA.
- Schmidt RE & Cooper S (1996) A catalog of barriers to upstream movement of migratory fishes in Hudson River tributaries. Report to the Hudson River Foundation, New York, Hudsonia Ltd., Annandale, NY, USA.
- Schneider DW (1996) Effects of European settlement and land use on regional patterns of similarity among Chesapeake forests. *Bulletin of the Torrey Botanical Club* 123: 233-239. USA.
- Schoellhamer DH (2001) Influence of salinity, bottom topography, and tides on locations of estuarine turbidity maxima in northern San Francisco Bay. In: McAnally WH & Mehta AJ (eds) Coastal and estuarine fine sediment transport processes, pp. 343-357. Elsevier Science, Amsterdam, NL.
- Scholle J, Schuchardt B, Schulze S & Veckenstedt V (2007) Situation of the smelt (*Osmerus eperlanus*) in the Ems estuary with regard to the aspects of spawning grounds and recruitment. Bioconsult, Bremen, GER.
- Schröder U (2007) Aktuelle und historische Röhrlichtentwicklung an Unter- und Außenelbe. BFG Veranstaltungen 2: 20-30. GER.
- Schubel J & Carter HH (1984) The estuary as a filter for fine grained, suspended sediment. In: Kennedy VS (ed) The estuary as a filter, pp. 81-105. Academic Press Inc., New York.
- Schuchardt B (1995) Die Veränderung des Tidehubs in den inneren Ästuaren von Eider, Elbe, Weser und Ems. Indikator für die ökologische Verformung der Gewässer. *Naturschutz und Landschaftsplanung* 27: 211-217. GER.
- Schuchardt B & Schirmer M (1991) Phytoplankton maxima in the tidal freshwater reaches of two coastal plain estuaries. *Estuarine, Coastal and Shelf Science* 32: 187-206.
- Schuchardt B, Haesloop U & Schirmer M (1993) The tidal freshwater reach of the Weser estuary: riverine or estuarine? *Netherlands Journal of Aquatic Ecology* 27: 215-226.
- Schubel JR, Shen H & Park M (1986) Comparative analysis of estuaries bordering the Yellow Sea. In: Wolfe DA (ed) Estuarine variability, pp 43-62. Academic Press, San Diego, CA, USA.
- Schumacher A (1957) Untersuchungen über die makroskopische Bodentierwelt der Pagensander Nebenelbe. Hamburg. [cited after Petermeier et al. 1996], GER.
- Schumann EH & Pearce MW (1997) Freshwater inflow and estuarine variability in the Gamtoos estuary, South Africa. *Estuaries* 20: 124-133.
- Schuyler AE (1986) Rare plants of the Delaware Estuary in Pennsylvania. In: Majumdar SK, Brenner FJ & Rhoads AF (eds) Endangered and threatened species programs in Pennsylvania and other states: causes, issues and management, pp. 156-162. The Pennsylvania Academy of Science, Harrisburg, PA, USA.
- Schuyler AE, Anderson AB & Kolaga VJ (1993) Plant zonation changes in the tidal portion of the Delaware River. *Proceedings of the Academy of Natural Sciences of Philadelphia* 144: 263-266. USA.
- Schwartz FJ (1967) Maryland turtles. University of Maryland, College Park, MD, USA.
- Sculthorpe, CD (1967) The biology of aquatic vascular plants. Edward Arnold Ltd London, Reprint 1985 Koeltz Scientific Books, Königstein, GER.
- Sebilo M, Billen G, Mayer B, Billiou D, Grably M, Garnier J & Mariotti A (2006) Assessing nitrification and denitrification in the Seine river and estuary using chemical and isotopic techniques. *Ecosystems* 9: 564-577.
- Sebold KR (1992) From marsh to farm: the landscape transformation of coastal New Jersey. National Park Service, U.S. Department of Interior, Cultural Resources, Washington, DC.
- Seelig A (1992) Profil-Typen und Standorte der Elbufer-Vegetation zwischen Staustufe Geesthacht und Bunthäuser Spitze im Bereich der Mitteltidehochwasserlinie. *Institut für Angewandte Botanik der Universität Hamburg, Beiheft* 3: 5-36. GER.
- Segers R (1998) Methane production and methane consumption: a review of processes underlying wetland methane fluxes. *Biogeochemistry* 41: 23-51.
- Sehlinger B & Otey D (1980) Southern Georgia canoeing: a canoeing and kayaking guide to the streams of the western Piedmont, Coastal Plain, Georgia coast and Okefenokee Swamp. Menasha Ridge Press, Birmingham, AL, USA.
- Seine-Aval (2006) North-Atlantic Estuaries: Problems and perspectives. GIP Seine-Aval, Rouen, FR.
- Seitzinger SP (1988) Denitrification in freshwater and coastal marine ecosystems: ecological and geochemical significance. *Limnology and Oceanography* 33: 702-724.



- Seitzinger SP, Gardner WS & Spratt AK (1991) The effect of salinity on ammonium sorption in aquatic sediments - implications for benthic nutrient recycling. *Estuaries* 14: 167-174.
- Seitzinger SP, Kroeze C, Bouwman AF, Caraco NF, Dentener F & Styles RV (2002) Global patterns of dissolved inorganic and particulate nitrogen inputs to coastal systems: recent conditions and future projections. *Estuaries* 25: 640-655.
- Senerchia-Nardone P & Holland MM (1985) Floristic comparison of two tidal wetlands in the Connecticut River estuary. *Newsletter Connecticut Botanical Society* 13: 1-5. USA.
- SERC (Smithsonian Environmental Research Center) (2006) NEMESIS program (National Exotic Marine and Estuarine Species Information System). <http://www.invasive-speciesinfo.gov>.
- SERC Marine Invasions Research Lab (2006) <http://invasions.si.edu/nemesis/index.html> (Viewed January 2008).
- Serodes J-B & Troude J-P (1984) Sedimentation cycle of a freshwater tidal flat in the St. Lawrence estuary. *Estuaries* 7: 119-127.
- Servais P & Garnier J (2006) Organic carbon and bacterial heterotrophic activity in the maximum turbidity zone of the Seine estuary (France). *Aquatic Sciences* 68: 78-85.
- Setzler-Hamilton EM (1991) White Perch. In: Funderbunk SL, Jordan SJ, Mihursky JA & Riley D (eds) *Habitat requirements for Chesapeake Bay living resources*, pp 12-1 to 12-20. National Oceanic and Atmospheric Administration. Annapolis, MD, USA.
- Setzler-Hamilton EM & Hall L Jr (1991) Striped Bass. In: Funderbunk SL, Jordan SJ, Mihursky JA & Riley D (eds) *Habitat requirements for Chesapeake Bay living resources*, pp 13-1 to 13-31. National Oceanic and Atmospheric Administration. Annapolis, MD, USA.
- Setzler-Hamilton EM, Boynton WR, Mihursky JA, Polgar TT & Wood KV (1981) Spatial and temporal distribution of striped bass eggs, larvae and juveniles in the Potomac Estuary. *Transactions of the American Fisheries Society* 110: 121-136.
- Seys J, Vincx M & Meire P (1999) Spatial distribution of oligochaetes (*Clitellata*) in the tidal freshwater and brackish parts of the Schelde estuary (Belgium). *Hydrobiologia* 406: 119-132.
- Shaffer GW, Sasser CE, Gosselink JG & Rejmanek M (1992) Vegetation dynamics in the emerging Atchafalaya Delta, Louisiana, USA. *Journal of Ecology* 80: 677-687.
- Shamsi SRA & Whitehead FH (1977) Comparative eco-physiology of *Epilobium hirsutum* L. and *Lythrum salicaria* L. iv.: effects of temperature and inter-specific competition and concluding discussion. *Journal of Ecology* 65: 71-84.
- Sheail J (1998) The Tweed fisheries: an historical perspective. *The Science of the Total Environment* 210/211: 469-482.
- Shumway SW & Bertness MD (1992) Salt stress limitation of seedling recruitment in a salt marsh plant community. *Oecologia* 92: 490-497.
- Sibylle O, Groffman PM, Findlay SEG & Arreola AE (1999) Invasive plant species and microbial processes in a tidal freshwater marsh. *Journal of Environmental Quality* 28: 1252-1257.
- Sickels FA & Simpson RL (1985) Growth and survival of Giant Ragweed (*Ambrosia trifida*) in a Delaware River USA freshwater tidal wetland. *Bulletin of the Torrey Botanical Club* 112: 368-375. USA.
- Sikora JP, Sikora WB, Erkenbrecher CW & Coull BC (1977) Significance of ATP, carbon and caloric content of meiobenthic nematodes in partitioning benthic biomass. *Marine Biology* 44: 7-14.
- Silliman BR & Bertness MD (2004) Shoreline development drives invasion of *Phragmites australis* and loss of plant diversity on New England salt marshes. *Conservation Biology* 18: 1424-1434.
- Silliman BR & Newell SY (2003) Fungal farming in a snail. *Proceedings of the National Academy of Sciences of the United States of America* 100: 15643-15648.
- Silliman BR & Zieman JC (2001) Top-down control of *Spartina alterniflora* production by periwinkle grazing in a Virginia salt marsh. *Ecology* 82: 2830-2845.
- Simenstad CA & Thom RM (1996) Functional equivalency trajectories of the restored Gog-Le-Hi-Te estuarine wetland. *Ecological Applications* 6: 38-56.
- Simenstad C, Toft J, Higgins H, Cordell J, Orr M, Williams P, Grimaldo L, Hymanson Z & Reed D (2000a) Sacramento/San Joaquin Delta breached levee wetland study (BREACH). School of Fisheries, University of Washington, Seattle, WA, USA.
- Simenstad CA, Hood WG, Thom RM, Levy DA & Bottom DL (2000b) Landscape structure and scale constraints on restoring estuarine wetlands for Pacific Coast juvenile fishes. In: Weinstein MP & Kreeger DA (eds) *Concepts and controversies in tidal marsh ecology*, pp. 597-630. Kluwer Academic Publ., Dordrecht, NL.
- Simpson RL, Whigham DF & Walker R (1978) Seasonal patterns of nutrient movement in a freshwater tidal marsh. In: Good RE, Whigham DF & Simpson RL (eds) *Freshwater wetlands. Ecological processes and management potential*, pp. 259-263. Academic Press, New York.
- Simpson RL, Whigham DF & Brannigan K (1979) The midsummer insect communities of freshwater tidal wetland macrophytes. Delaware River estuary, New Jersey. *Bulletin of the New Jersey Academy of Sciences* 24: 22-28. USA.
- Simpson RL, Good RE, Leck MA & Whigham DF (1983a) The ecology of freshwater tidal wetlands. *BioScience* 34: 255-259.
- Simpson RL, Good RE, Walker R & Frasco BR (1983b) The role of Delaware river freshwater tidal wetlands in the retention of nutrients and heavy metals. *Journal of Environmental Quality* 12: 41-48.
- Simpson RL, Leck MA & Parker VT (1985) The comparative ecology of *Impatiens capensis* Meerb. (Balsaminaceae) in Central New Jersey. *Bulletin of the Torrey Botanical Club* 112: 295-311. USA.
- Sin Y, Wetzel RL & Anderson IC (1999) Spatial and temporal characteristics of nutrient and phytoplankton dynamics in the York River estuary, Virginia: analysis of long term data. *Estuaries* 22: 260-275.
- Sinsabaugh RL & Findlay S (1995) Microbial production, enzyme activity, and carbon turnover in surface sediments of the Hudson River estuary. *Microbial Ecology* 30: 127-141.
- Sipple WS (1991) *Through the eyes of a young naturalist*. Gateway Press, Baltimore, MD, USA.
- Smit H & Coops H (1991) Ecological, economic and social aspects of natural and man-made bulrush (*Scirpus lacustris* L.) wetlands in The Netherlands. *Landscape and Urban Planning* 20: 33-40.
- Smit H, Smits R, Van der Velde G & Coops H (1997) Ecosystem responses in the Rhine-Meuse delta during two decades after

- enclosure and steps toward estuary restoration. *Estuaries* 20: 504-520.
- Smith C, Alber M & Chalmers A (2001) Linking shifts in historic estuarine vegetation to salinity changes using a GIS. In: Hatcher KJ (ed) *Proceedings 2001 Georgia Water Resources Conference*, University of Georgia. Athens, GA, USA.
- Smith HR & Jordan PA (1976) The effect of increased trapping pressure on the age structure and stability of an estuarine muskrat population. *Transactions of the Northeast Section the Wildlife Society* 33: 119-124. USA.
- Smith SG (2000) Typhaceae. In: *Flora of North America* Editorial Committee (eds) 22. (Viewed 30 June 2007 at <http://www.efloras.org/>).
- Smith SV, Swaney DP, Talaue-McManus L, Bartley JD, Sandhei PT, McLaughlin CJ, Dupra VC, Crossland CJ, Buddemeier RW, Maxwell BA & Wulff F (2003) Humans, hydrology, and the distribution of inorganic nutrient loading to the ocean. *Bioscience* 53: 235-245.
- Smith TR & Bretherton FP (1972) Stability and the conservation of mass in drainage basin evolution. *Water Resources Research* 8: 1506-1529.
- Smith VH (1998) Cultural eutrophication of inland, estuarine, and coastal waters. In: Pace ML & Groffman PM (eds) *Successes, limitations, and frontiers in ecosystem science*, pp. 7-49. Springer, New York.
- Smithberger S & Swarth CW (1993) Reptiles and amphibians of the Jug Bay Wetlands Sanctuary. *Maryland Naturalist* 37: 28-46. USA.
- Sobczak WV, Cloern JE, Jassby AD & Muller-Solger AB (2002) Bioavailability of organic matter in a highly disturbed estuary: the role of detrital and algal resources. *Proceedings of the National Academy of Sciences of the United States of America* 99: 8101-8105.
- Sobczak WV, Cloern JE, Jassby AD, Cole BE, Schraga TS & Arnsberg A (2005) Detritus fuels ecosystem metabolism but not metazoan food webs in San Francisco estuary's freshwater Delta. *Estuaries* 28: 124-137.
- Soetaert K & Herman P (1995a) Carbon flows in the Westerschelde estuary (The Netherlands) evaluated by means of an ecosystem model (MOSES). *Hydrobiologia* 311: 247-266.
- Soetaert K & Herman P (1995b) Nitrogen dynamics in the Westerschelde estuary (SW-Netherlands) estimated by means of an ecosystem model (MOSES). *Hydrobiologia* 311: 225-246.
- Soetaert K, Hoffman M, Meire P, Starink M, Van Oevelen D, Van Regenmortel S & Cox T (2004) Modeling growth and carbon allocation in two reed beds (*Phragmites australis*) in the Scheldt estuary. *Aquatic Botany* 79: 211-234.
- Soetaert K, Middelburg JJ, Heip C, Meire P, Van Damme S & Maris T (2006) Long-term change in dissolved inorganic nutrients in the heterotrophic Scheldt estuary (Belgium, the Netherlands). *Limnology and Oceanography* 51: 409-423.
- Sonneveld F (1958) Bodemkartering en daarop afgestemde landbouwkundige onderzoekingen (soil survey and attuned agricultural investigations of) van het Land van Heusden en Altena. PhD Dissertation Wageningen. Verslagen Landbouwkundig onderzoek 64.4. Staatsdrukkerij, The Hague, NL.
- Sousa R, Guilhermino L & Antunes C (2005) Molluscan fauna in the freshwater tidal area of the River Minho estuary, NW of Iberian Peninsula. *Annales de Limnologie – International Journal of Limnology* 41: 141-147.
- Sousa R, Antunes C & Guilhermino L (2007) Species composition and monthly variation of the Molluscan fauna in the freshwater subtidal area of the River Minho estuary. *Estuarine, Coastal and Shelf Science* 75: 90-100
- Southern, WE (1987) Gull research in the 1980s: symposium overview. In: Hand JL, Southern WE & Vermeer K (eds) *Ecology and behavior of gulls*, pp. 1-7. *Studies in Avian Biology* No. 10. Cooper Ornithological Society. Allen Press, Lawrence, KS, USA.
- Spalding EA & Hester MW (2007) Interactive effects of hydrology and salinity on oligohaline plant species productivity: implications of relative sea-level rise. *Estuaries and Coasts* 30: 214-225.
- Spray SL & McGlothlin KL (2004) The challenge of preserving wetlands: concluding thoughts. In: Spray SL & McGlothlin KL (eds) *Wetlands - Exploring environmental challenges, a multidisciplinary approach*, pp. 157-166. Rowman & Littlefield Publishers, Inc, Lanham, MD, USA.
- Stalter R & Baden J (1994) A twenty year comparison of vegetation of three abandoned rice fields, Georgetown County, South Carolina. *Castanea* 59: 66-77. USA
- Stansfield CA Jr (1998) *A geography of New Jersey: the city in the garden*. Rutgers University Press, New Brunswick, NJ, USA.
- Stapleton J & Kiviat E (1979) Rights of birds and rights of way: Vegetation management on a railroad causeway and its effect on breeding birds. *American Birds* 33: 7-10.
- Steege V (2007) Die Entwicklung der Tide-Röhrliche an der Weser und ihr Leitbild. *BFG Veranstaltungen* 2: 31-45. GER.
- Steen RICA, Evers EHG, Van Hattum B, Cofino WP & Brinkman UATh (2002) Net fluxes of pesticides from the Scheldt Estuary into the North Sea: a model approach. *Environmental Pollution* 116: 75-84.
- Stehr G, Böttcher B, Dittberner P, Rath G & Koops H-P (1995) The ammonia-oxidizing, nitrifying population of the River Elbe estuary. *FEMS Microbiology Ecology* 17: 177-186.
- Stein BA & Flack SR (eds) (1996) *America's least wanted: alien species invasions of U.S. ecosystems*. The Nature Conservancy, Arlington, VA, USA.
- Stevens G (ed) (2001) *Natural resource / human use inventory of various Hudson River estuary lands*. Report to New York State Department of Environmental Conservation, New Paltz, NY, USA.
- Stevenson JS, Heinle DR, Flemer DA, Small RJ, Rowland RA & Ustach JF (1985) Nutrient exchanges between brackish water marshes and the estuary. In: Wiley M (ed) *Estuarine Processes Vol II*, pp. 219-240. Academic Press, New York.
- Stewart MA (1991) Rice, water, and power: landscapes of domination and resistance in the Lowcountry, 1790-1880. *Environmental History Review* 15: 47-64. USA.
- Stewart MA (2002) "What nature suffers to groe": life, labor, and landscape on the Georgia coast, 1680-1920. University of Georgia Press, Athens, GA, USA.
- Stiller G (2007) Vorgezogene überblicksweise Überwachung der Qualitätskomponenten Makrophyten und Angiospermen in der Tideelbe gemäß EG-Wasserrahmenrichtlinie. Gutachten im Auftrag von Sonderaufgabenbereich Tideelbe der ARGE ELBE, Wassergütestelle Elbe, Hamburg, GER.

- Stillwater Environmental Services (2003) Decker Island Phase ii habitat development and levee rehabilitation project, initial study/mitigated negative declaration public review draft. Stillwater Environmental Services, Davis, CA, USA. Accessed from [http://www.dfm.water.ca.gov/dsmo/levees/decker\\_ceqa.html](http://www.dfm.water.ca.gov/dsmo/levees/decker_ceqa.html).
- Stone GW, Grymes III JM, Dingler JR & Pepper DA (1997) Overview and significance of hurricanes on the Louisiana coast, U.S.A. *Journal of Coastal Research* 13: 656-669.
- Stone W (1965) *Bird studies at Old Cape May: an ornithology of coastal New Jersey*. Dover Publications, New York. (Originally published 1937 by the Delaware Valley Ornithological Club.)
- Stone WB, Kiviat E & Butkas SA (1980) Toxicants in snapping turtles. *New York Fish and Game Journal* 27: 39-50. USA
- Storm C, Van der Velden JA & Kuijpers JWM (2005) From nature conservation towards restoration of estuarine dynamics in the heavily modified Rhine-Meuse estuary, The Netherlands. *Archiv für Hydrobiologie Suppl.* 155 (Large Rivers 15): 305-318.
- Storm C, Kuijpers J & Harmsen C (2006) Eb... en weer vloed in het Haringvliet. *Landschap* 23: 199-207. NL.
- Stortelder AHF, Schaminee JHJ & Hommel PWF (1999) *De Vegetatie van Nederland – deel 5 – Plantengemeenschappen van ruigten, struwelen en bossen*. Opulus Press, Uppsala, Sweden.
- Strayer DL (2006) The benthic animal communities of the tidal-freshwater Hudson River estuary. In: Levinton JS & Waldman JR (eds) *The Hudson River estuary*, pp. 266-278. Cambridge University Press, Boston, MA, USA.
- Strayer DL & Jirka KJ (1997) The pearly mussels of New York state. *Memoirs of the New York State Museum* 26: 1-113. University of the State of New York, Albany, NY, USA.
- Strayer DL & Smith LC (1996) Relationships between zebra mussels (*Dreissena polymorpha*) and unionid clams during early stages of the zebra mussel invasion of the Hudson river. *Freshwater Biology* 36: 771-779.
- Strayer DL, Hunter DC, Smith LC & Borg CK (1994) Distribution, abundance and roles of freshwater clams (Bivalvia, Unionidae) in the freshwater tidal Hudson River. *Freshwater Biology* 31: 239-248.
- Strayer DL, Lutz C, Malcom HM, Munger K & Shaw WH (2003) Invertebrate communities associated with a native (*Vallisneria americana*) and an alien (*Trapa natans*) macrophyte in a large river. *Freshwater Biology* 48: 1938-1949.
- Stroud PT (2000) *The emperor of nature, Charles-Lucien Bonaparte and his world*. University of Pennsylvania Press, Philadelphia, PA, USA.
- Stroud PT (2005) *Joseph Bonaparte, the man who once was king*. University of Pennsylvania Press, Philadelphia, PA, USA.
- Strucker RCW (1992) *De Oude Maas, laatste zoetwatergetijdenrivier in Nederland*. *Het Vogeljaar* 40: 105-109. NL.
- Strucker RCW (1996) *Vogels van de zoetwatergetijdenrivier de Oude Maas*. Maasdam. Haveka, Alblasserdam, NL.
- Strucker RCW, Preesman LC & Verkerk J (1994) *Watervogels van het zoetwater-getijdegebied de Oude Maas*. *Limosa* 67: 45-52. NL.
- Struyf E (2005) *The role of freshwater marshes in estuarine silica cycling (Scheldt estuary)*. PhD Dissertation, University of Antwerp, BEL.
- Struyf E, Van Damme S & Meire P (2004) Possible effects of climate change on estuarine nutrient fluxes: a case study in the highly nutrified Schelde estuary (Belgium, The Netherlands). *Estuarine, Coastal and Shelf Science* 60: 649-661.
- Struyf E, Van Damme S, Gribsholt B & Meire P (2005a) Freshwater marshes as dissolved silica recyclers in an estuarine environment (Schelde estuary, Belgium). *Hydrobiologia* 540: 69-77.
- Struyf E, Van Damme S, Gribsholt B, Middelburg JJ & Meire P (2005b) Biogenic silica in freshwater marsh sediments and vegetation. *Marine Ecology Progress Series* 303: 51-60.
- Struyf E, Dausse A, Van Damme S, Bal K, Gribsholt B, Boschker HTS, Middelburg JJ & Meire P (2006) Tidal marshes and biogenic silica recycling at the land-sea interface. *Limnology and Oceanography* 51: 838-846.
- Struyf E, Van Damme S, Gribsholt B, Middelburg JJ & Meire P (2007) *Phragmites australis* and Si recycling in freshwater tidal marshes (Schelde estuary, Belgium). *Aquatic Botany* 87: 134-140.
- Stutz B (1992) *Natural lives modern times: people and places of the Delaware River*. Crown Publishers, New York.
- Sundareshwar PV & Morris JT (1999) Phosphorus sorption characteristics of intertidal marsh sediments along an estuarine salinity gradient. *Limnology and Oceanography* 44: 1693-1701.
- Sundareshwar PV, Morris JT, Koepfler EK & Fornwalt B (2003) Phosphorus limitation of coastal ecosystem processes. *Science* 299: 563-565.
- Swarth CW (1998) *The ecology and population status of turtles at Jug Bay, Patuxent River, Maryland*. Technical report of the Jug Bay Wetlands Sanctuary, Lothian, MD, USA.
- Swarth CW (2004) *Natural history and reproductive biology of the red-bellied turtle (Pseudemys rubriventris)*. In: Swarth CW, Roosenburg WM & Kiviat E (eds) *Conservation and ecology of turtles of the Mid-Atlantic Region*, pp. 73-84. Bibliomania, Salt Lake City, UT, USA.
- Swarth CW & Burke J (2000) *Waterbirds in freshwater tidal wetlands: population trends and habitat use in the non-breeding season*. Technical Report of the Jug Bay Wetlands Sanctuary, Lothian, MD, USA.
- Swarth CW & Burke J (2002) *Seasonal dynamics of waterbirds using freshwater tidal wetlands*. In: Perry MC (ed) *Black ducks and their Chesapeake Bay habitats: proceedings of a symposium*, pp. 39. USGS, Biological Resources Discipline Information and Technology Report USGS/BRD/ITR-2002-2005. Annapolis, MD, USA.
- Swarzenski CM, Swenson EM, Sasser CE & Gosselink JG (1991) Marsh mat flotation in the Louisiana Delta Plain. *Journal of Ecology* 79: 999-1011.
- Swift B (1989) *Avian breeding habitats in Hudson River tidal marshes*. Final Report to the Hudson River Foundation. New York State Department of Environmental Conservation, Albany, NY, USA.
- Syphard AD & Garcia MW (2001) *Human- and beaver-induced wetland changes in the Chickahominy River watershed from 1953 to 1994*. *Wetlands* 21: 342-353.
- Syphax SW & Hammerschlag RS (1995) *The reconstruction of Kenilworth Marsh, the last tidal marsh in Washington, DC*. *Park Science* 15: 15-19. USA.
- Tande GF & Jennings TW (1986) *Classification and mapping of tundra near Hazen Bay, Yukon Delta National Wildlife Refuge*. U.S. Fish and Wildlife Service, Anchorage, AK, USA.



- Tangley L (1988) Preparing for climate change. *BioScience* 38: 14-18.
- Tanner CD, Cordell JR, Rubey J & Tear LM (2002) Restoration of freshwater intertidal habitat functions at Spencer Island, Everett, Washington. *Restoration Ecology* 10: 564-576.
- Taylor RT (1981) Shoreline vegetation of the arctic Alaska coast. *Arctic* 34: 37-42.
- Taylor RW & Counts III CL (1977) The Asiatic clam, *Corbicula manilensis*, as a food of the northern raccoon, *Procyon lotor*. *Nautilus* 91: 34. USA.
- Temmerman S (2003) Sedimentation on tidal marshes in the Scheldt estuary. A field and numerical modelling study. PhD Dissertation, KU Leuven, BEL.
- Temmerman S, Govers G, Meire P & Wartel S (2003a) Modelling long-term tidal marsh growth under changing tidal conditions and suspended sediment concentrations, Scheldt estuary, Belgium. *Marine Geology* 193: 151-169.
- Temmerman S, Govers G, Wartel S & Meire P (2003b) Spatial and temporal factors controlling short-term sedimentation in a salt and freshwater tidal marsh, Scheldt estuary, Belgium, SW Netherlands. *Earth Surface Processes and Landforms* 28: 739-755.
- Temmerman S, Govers G, Wartel S & Meire P (2004) Modelling estuarine variations in tidal marsh sedimentation: response to changing sea level and suspended sediment concentrations. *Marine Geology* 212: 1-19.
- Templer P, Findlay S & Wigand C (1998) Sediment chemistry associated with native and non-native emergent macrophytes of a Hudson River marsh ecosystem. *Wetlands* 18: 70-78.
- Tenore K, Cammen L, Findlay S & Phillips N (1982) Perspectives of research on detritus: do factors controlling the availability of detritus to macroconsumers depend on its source. *Journal of Marine Research* 40: 473-490.
- Thiel R & Potter IC (2001) The ichthyofaunal composition of the Elbe Estuary: an analysis in space and time. *Marine Biology* 138: 603-616.
- Thiele H-U (1977) Carabid beetles in their environments – a study on habitat selection by adaptations in physiology and behaviour. Springer-Verlag, Berlin, GER.
- Thilenius TF (1995) Phytosociology and succession on earthquake-uplifted coastal wetlands, Copper River Delta, Alaska. General Technical Report PNW-GTR-346. U.S. Forest Service, Portland, OR, USA.
- Thom RM, Blanton SL, Borde AB, Williams GD, Woodruff DL & Huesemann MH (2002) Investigations into wetland carbon sequestration as remediation for global warming. In: Nehring KW & Brauning SE (eds) International conference on wetlands and remediation; wetlands and remediation II, pp. 311-320. Battelle Press, Columbus, OH, USA.
- Thomas LK Jr (1980) The impact of three exotic plant species on a Potomac island. National Park Service Scientific Monograph Series 13, U.S. Department of the Interior, Washington, DC.
- Thompson K & Grime JP (1979) Seasonal variation in the seed banks of herbaceous species in ten contrasting habitats. *Journal of Ecology* 67: 893-921.
- Thompson, K (1976) Swamp development in the headwaters of the White Nile. In: Rzoska J (ed) The Nile, Biology of an Ancient River, pp. 177-196. Junk Publishers, The Hague, NL.
- Thompson K, Bakker J & Bekker R (1997) The soil seed banks of North West Europe: methodology, density and longevity. Cambridge University Press, Cambridge, UK.
- Thompson SA (2000) Acoraceae. In: Flora of North America Editorial Committee (eds) Flora of North America 22. (Viewed 30 June 2007 at <http://www.efloras.org/>).
- Thonon I (2006) Deposition of sediment and associated heavy metals on floodplains. Netherlands Geographical Studies 337. Utrecht, NL.
- Thorbahn PT & Cox DC (1988) The effect of estuary formation on prehistoric settlement in southern Rhode Island. In: Nicholas GP (ed) Holocene human ecology in Northeastern North America, pp. 167-182. Plenum Press, New York.
- Tiner RW Jr (1977) An inventory of South Carolina's coastal marshes. South Carolina Marine Resources Center Technical Report Number 23, South Carolina Wildlife and Marine Resources Department, Charleston, SC, USA.
- Tiner RW Jr (1985) Wetlands of New Jersey. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Corner, MA, USA.
- Tiner RW (2005) Assessing cumulative loss of wetland functions in the Nanticoke river watershed using enhanced National Wetlands Inventory data. *Wetlands* 25: 405-419.
- Tiner RW Jr & Burke DG (1995) Wetlands of Maryland. U.S. Fish and Wildlife Service, Ecological Services, Region 5, Hadley, MA and Maryland Department of Natural Resources, Annapolis, MD, USA.
- Titus JG & Narayanan VK (1995) The probability of sea level rise. EPA 230-R-95-008. U.S. Environmental Protection Agency, Washington, DC.
- Tobias CR, Macko SA, Anderson IC, Canuel EA & Harvey JW (2001) Tracking the fate of a high concentration groundwater nitrate plume through a fringing marsh: a combined groundwater tracer and in situ isotope enrichment study. *Limnology and Oceanography* 46: 1977-1989.
- Tomlinson PB (1986) The botany of mangroves. Cambridge University Press, Cambridge, UK.
- Townsend JF (2007) Natural heritage resources of Virginia: rare plants. Natural Heritage Technical Report 07-13. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA, USA.
- Tuckerman S (ed) (1990) Appalachian Mountain Club river guide: Massachusetts, Connecticut, Rhode Island. Appalachian Mountain Club, Boston, MA, USA.
- Tufford DL (2005) State of knowledge: South Carolina coastal wetland impoundments. South Carolina Sea Grant Consortium, Charleston, SC, USA.
- Turin H (2000) De Nederlandse loopkevers: verspreiding en ecologie (Coleoptera: Carabidae). Nationaal Natuurhistorisch Museum Naturalis, Leiden, NL.
- Tyler AC, Mastronicola TA & McGlathery KJ (2003a) Nitrogen fixation and nitrogen limitation of primary production along a natural marsh chronosequence. *Oecologia* 136: 431-438.
- Tyler AC, McGlathery KJ & Anderson IC (2003b) Benthic algae control sediment-water column fluxes of organic and inorganic nitrogen compounds in a temperate lagoon. *Limnology and Oceanography* 48: 2125-2137.
- Uncles RJ & Smith RE (2005) A note on the comparative turbidity of some estuaries of the Americas. *Journal of Coastal Research* 21: 845-852.

- Uncles RJ & Stephens JA (1993) The freshwater-saltwater interface and its relationship to the turbidity maximum in the Tamar estuary, United Kingdom. *Estuaries* 16: 126-141.
- Uncles RJ & Stephens JA (1997) Dynamics of turbidity in the Tweed estuary. *Estuarine, Coastal and Shelf Science* 45: 745-758.
- Uncles RJ, Howland RJM, Aeston AE, Griffiths ML, Harris C, King RS, Morris AW, Plummer DH & Woodward EMS (1998) Concentrations of dissolved nutrients in the tidal Yorkshire Ouse River and Humber Estuary. *Science of the Total Environment* 210-211: 377-388.
- Uncles RJ, Stephens JA & Smith RE (2002) The dependence of estuarine turbidity on tidal intrusion length, tidal range and residence time. *Continental Shelf Research* 22: 1835-1856.
- US Fish and Wildlife Service (2006) <http://www.fws.gov/chesapeakebay/baldeagl.htm> (Viewed January 2008).
- USACE (1971) National shoreline study, inventory report – Alaska region. U.S. Army Corps of Engineers, North Pacific Division, Portland, OR, USA.
- USDA (2007) The plants database (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA, USA.
- USDI (2007) Bald eagle soars off Endangered Species List. U.S. Department of the Interior. ([http://www.doi.gov/news/07\\_News\\_Releases/070628.html](http://www.doi.gov/news/07_News_Releases/070628.html)).
- USFS (2006) Species at Stikine flats wildlife viewing area. U.S. Forest Service. [http://www.fs.fed.us/r10/ro/naturewatch/southeast/stikine\\_flats/stikine\\_species.htm](http://www.fs.fed.us/r10/ro/naturewatch/southeast/stikine_flats/stikine_species.htm)
- USFWS (1982) National Wetland Inventory maps, Petersburg C-1 and C-2 quadrangles. U.S. Fish and Wildlife Service, Washington, DC.
- USFWS (1985) National Wetland Inventory maps, Cordova A-2, B-2, B-3, B-4, B-5, and C-5 quadrangles. U.S. Fish and Wildlife Service, Washington, DC.
- USFWS (1995) Sensitive joint-vetch (*Aeschynomene virginica*) recovery plan. U.S. Fish and Wildlife Service, Hadley, MA, USA.
- USFWS (2006a) National Wetlands Inventory wetlands online mapper (<http://www.fws.gov/nwi>). U.S. Fish and Wildlife Service, Washington, DC.
- USFWS (2006b) U.S. Fish and Wildlife Service: Chesapeake Bay nutria control. (<http://www.fws.gov/invasives/Indexhottop.NU.html>)
- Vader W (1977) Habitat and distribution of *Perforatella rubiginosa* (Gastropoda, Pulmonata) in the freshwater tidal region of the Scheldt estuary, Belgium. *Hydrobiologia* 52: 23-28.
- Van Allemeersch R, Hoffmann M & Meire P (1999) Ontwerpbeheersplan voor het Vlaams natuurreserveaat slikken en schorren van Schelde en Durme. University of Gent / Institute for Nature Conservation, Brussel, BEL.
- Van Benthem Jutting T (1933) Mollusca (1), A. Gastropoda Prosobranchia et Pulmonata. Fauna van Nederland, 7. Leiden, NL.
- Van Beusekom JEE & Brockmann UH (1998) Transformation of phosphorus in the Elbe estuary. *Estuaries* 21: 518-526.
- Van Beusekom JEE & De Jonge VNN (2002) Long-term changes in Wadden-Sea nutrient cycles: importance of organic matter import from the North Sea. *Hydrobiologia* 475/476: 185-194.
- Van Braeckel A, Piesschaert F & Van den Bergh E (2006) Historical analysis of the Zeeschelde and tidal tributaries, 19th century till present. (In Dutch with English summary) INBO.2006.29. Research Institute for Nature and Forest, Brussels, BEL.
- Van Cappellen P (2003) Biomineralisation and global biogeochemical cycles. *Reviews in Mineralogy and Geochemistry* 54: 357-381.
- Van Damme S, Ysebaert T, Meire P & Van den Bergh E (1999) Habitatstructuren, waterkwaliteit en leefgemeenschappen in het Schelde-estuarium. Rapport Instituut voor Natuurbehoud 99/24, Brussel, BEL.
- Van Damme S, Struyf E, Maris T, Ysebaert T, Dehairs F, Tackx M, Heip C & Meire P (2005) Spatial and temporal patterns of water quality along the estuarine salinity gradient of the Scheldt estuary (Belgium and The Netherlands): results of an integrated monitoring approach. *Hydrobiologia* 540: 29-45.
- Van de Noort R (2004) The Humber wetlands, the archaeology of a dynamic landscape. Windgather Press, Macclesfield, UK.
- Van de Noort R & Ellis S (2000) The Humber estuary: managing the archaeological resource in a dynamic environment. In: Pye K & Allen JRL (eds) Coastal and estuarine environments: sedimentology, geomorphology and geoarchaeology. Special Publications 175: 419-427. Geological Society, London, UK.
- Van de Rijjt CWCJ, Hazelhoff L & Blom CWPM (1996) Vegetation zonation in a former tidal area: a vegetation-type response model based on CDA logistic regression using GIS. *Journal of Vegetation Science* 7: 505-518.
- Van den Berg GA, Loch JPG, Van der Heijdt LM & Zwolsman JJG (1998) Mobilisation of heavy metals in contaminated sediments in the river Meuse, The Netherlands. *Water, Air and Soil Pollution* 116: 567-586.
- Van den Berg JH, Jeuken CJL & Van der Spek AJF (1996). Hydraulic processes affecting the morphology and evolution of the Westerschelde estuary. In: Nordstrom KF & Roman CT (eds) Estuarine shores – evolution, environments and human alterations, pp. 157-184. John Wiley & Sons, Chichester, UK.
- Van den Bergh E, Van Damme S, Graveland J, De Jong D, Baten I & Meire P (2005a) Ecological rehabilitation of the Schelde estuary (The Netherlands-Belgium; Northwest Europe): linking ecology, safety against floods, and accessibility for port development. *Restoration Ecology* 13: 204-214
- Van den Bergh E, Ysebaert T & Meire P (2005b) Water bird communities in the Lower Zeeschelde: long-term changes near an expanding harbour. *Hydrobiologia* 540: 237-258.
- Van den Broeke PW (1996) A crowded peat area: observations in Vlaardingenvest and the Iron Age habitation of southern Midden-Delfland. *Analecta Praehistorica Leidensia* 26: 59-82. NL.
- Van den Wyngaert I (2001) Grazing of extensive reed beds by moulting Greylag geese: effects on nutrient dynamics and growth of the *Phragmites australis* vegetation and consequences for the lake ecosystem. PhD Dissertation, Utrecht University, Utrecht, NL.
- Van der Esch C (1985) Houweningen onder de loep. Vondsten van een voormalig dorp in de polder Ruytgen bezuiden den Peereboom. *Westerheem A.W.N.* XXXIV pp. 245-258. NL.
- Van der Heide GD & Lebrecht T (1944) Achter de schermen - een boek over eendenkooien. Kinheim-Uitgeverij, Heiloo, NL.
- Van der Meijden R (1996) Heukels' Flora van Nederland. Wolters-Noordhoff, Groningen, NL.
- Van der Molen DT (ed) (2004) Referenties en concept-maatlatten voor de rivieren voor de Kaderrichtlijn Water. STOWA Rapport 2004.43, Utrecht, NL.

- Van der Pluijm A (1995) De mos- en korstmossen van de Biesbosch. Report Staatsbosbeheer regio Brabant-West, Biesbosch, Werkendam, NL.
- Van der Spek AJF (1997) Tidal asymmetry and long-term evolution of Holocene tidal basins in the Netherlands: simulations of paleo-tides in the Schelde estuary. *Marine Geology* 141: 71-90.
- Van der Zee C, Roelvros N & Chou L (2007) Phosphorus speciation, transformation and retention in the Scheldt estuary (Belgium/The Netherlands) from the freshwater tidal limits to the North Sea. *Marine Chemistry* 106: 76-91.
- Van Dijk GL, Van Liere L, Admiraal W, Bannink BA & Cappon JJ (1994) Present state of the water quality of European rivers and implications for management. *The Science of the Total Environment* 145: 187-195.
- Van Engle WA & Joseph EB (1968) Characterization of coastal and estuarine fish nursery grounds as natural communities. Final Report to Bureau of Commercial Fisheries, Virginia Institute of Marine Science, Gloucester Point, VA, USA.
- Van Gelder RG (1984) The mammals of the State of New Jersey: a preliminary annotated list. New Jersey Audubon Society, occasional paper no. 143, Department of Natural History, Bernardsville, NJ, USA.
- Van Ginkel E (2002) Dam in de Rotte, het begin van Rotterdam. Flyer with text, maps, colored photographs, painting. Gemeentewerken Rotterdam, NL.
- Van Heerden IL & HH Roberts (1980) The Atchafalaya delta: rapid progradation along a traditionally retreating coast (southcentral Louisiana). *Zeitschrift für Geomorphologie* 34: 188-201. GER.
- Van Oord familie (1999) Familie album, Fotoboek. Van Oord Vereniging, Werkendam, NL.
- Van Oord JG (2001) Een gedurfde onderneming, de geschiedenis van de van Oord Groep 1948 – 1998. Walburg Pers, Zutphen, NL.
- Van Oost K, Govers G & Desmet P (2000) Evaluating the effects of changes in landscape structure on soil erosion by water and tillage. *Landscape Ecology* 15: 577-589.
- Van Regteren Altena CO (1958) Faunistische aantekeningen 5. *Pseudammicola confusa* (Frauenfeld, 1863) nieuw voor de Nederlandse fauna. *Basteria* 22: 66. NL.
- Van Regteren Altena JF, Bakker JA, Clason AT, Glasbergen W, Groenman - van Wateringe W & Pons LJ (1962/1963) The Vlaarding culture. *Helinium* II 3-35, 97-103, 215-243; III 39-54, 97-120. NL.
- Van Rijckegem G, De Regge N & Van den Bergh E (2006) Voedsel ecologie en gedrag van overwinterende watervogels langs de Zeeschelde: een methodologische studie. INBO.R. 2006.28. Instituut voor Natuur- en Bosonderzoek, Brussels, BEL.
- Van Rompaey AJJ, Verstraeten G, Van Oost K, Govers G & Poesen J (2001) Modelling mean annual sediment yield using a distributed approach. *Earth Surface Processes and Landforms* 26: 1221-1236.
- Van Someren RH (1841) St Elizabeths nacht. A° 1421, Dichtstuk in drie zangen, incl. historische aantekeningen en kaarten. Bosch en Zoon, Utrecht, NL.
- Van Spaendonck JCM, Kromkamp JC & De Visscher PRM (1993) Primary production in a turbid coastal plain estuary, the Westerschelde (The Netherlands). *Netherlands Journal of Sea Research* 31: 267-279.
- Van Steenis CGGJ (1971). De zoetwatergetijdedotter van de Biesbosch en de Oude Maas, *Caltha palustris* L. var. *araneosa*, var.nov. *Gorteria* 5: 213-219. NL.
- Van Waeyenberge J, Anselin A & Meire P (1999) Aantallen, verspreiding en ecologie van de broedvogels in de buitendijkse gebieden langs de Zeeschelde. Rapport 99/16, Instituut voor Natuurbehoud, Brussels, BEL.
- Van Wijk W & Van der Neut J (2003) De Biesbosch na de Don-Boscovloed. Aprilis, Zaltbommel, NL.
- Van Wirdum G (1972) Rapport over vegetatie-onderzoek langs de Oude Maas, 1969-1971. Archives Rijnmond, Rotterdam, NL.
- Vanderweijden CH & Middelburg JJ (1989) Hydrogeochemistry of the river Rhine - long-term and seasonal variability, elemental budgets, base levels and pollution. *Water Research* 23: 1247-1266.
- VanGessel MJ (2001) Glyphosate-resistant horseweed from Delaware. *Weed Science* 49: 703-705. USA.
- Vann CD & Megonigal JP (2002) Productivity responses of *Acer rubrum* and *Taxodium distichum* seedlings to elevated CO<sub>2</sub> and flooding. *Environmental Pollution* 116: S31-S36.
- Vann CD & Megonigal JP (2003) Elevated CO<sub>2</sub> and water depth regulation of methane emissions: comparison of woody and non-woody wetland plant species. *Biogeochemistry* 63: 117-134.
- Vasquez EA, Glenn EP, Brown JJ, Guntenspergen GR & Nelson SG (2005) Salt tolerance underlies the cryptic invasion of North American salt marshes by an introduced haplotype of the common reed *Phragmites australis* (Poaceae). *Marine Ecology Progress Series* 298: 1-8.
- Vaughn CC & Hakenkamp CC (2001) The functional role of burrowing bivalves in freshwater ecosystems. *Freshwater Biology* 46: 1431-1446.
- VDEQ (2007) Drought status report July 19, 2002. Drought Monitoring Task Force, Virginia Department of Environmental Quality (<http://www.deq.virginia.gov/export/sites/default/waterresources/pdf/drought19july2002.pdf>).
- Velinsky DJ, Wade TI, Schlekert CE, McGee BL & Presley BJ (1994) Tidal river sediments in the Washington, D.C. area. II. Distribution and sources of trace metals. *Estuaries* 17: 305-320.
- Vennum T Jr (1988) Wild rice and the Ojibway people. Minnesota Historical Society Press, St. Paul, MN, USA.
- Verdonschot PFM (1980) Aquatische Oligochaeta III. Het Deltagebied. Delta Instituut voor Hydrobiologisch Onderzoek, Rapporten en verslagen 1980-9. Yerseke, NL.
- Verger F (2005) Marais maritimes et estuaires du littoral français. Belin, Paris.
- Verhey CJ, Heyligers PC, Leuret T & Zonneveld IS (1961) De Biesbosch, land van het levende water. Thieme, Zutphen, NL.
- Verhoeven JTA, Whigham DF, Van Logtestijn R & O'Neill J (2001) A comparative study of nitrogen and phosphorus cycling in tidal and non-tidal riverine wetlands. *Wetlands* 21: 210-222.
- Verhoeven JTA, Beltman B, Bobbink R & Whigham DF (eds) (2006) Wetlands and natural resource management. Springer, Berlin.
- Verity PG (2002) A decade of change in the Skidaway River Estuary. I. Hydrography and nutrients. *Estuaries* 25: 944-960.
- Verner J & Engelsens GH (1970) Territories, multiple nest building, and polygyny in the Long-billed Marsh Wren. *Auk* 87: 557-567. USA.



- Viereck LA, Dryness CT, Batten AR & Wenzlick KJ (1992) The Alaska vegetation classification. General Technical Report PNW-GTR-286. U.S. Forest Service, Portland, OR, USA.
- Vincent KA, Aucoin LT & Clark NS (2000) Freshwater bayou wetlands ME-04 (XME-21), Progress Report No. 5. Monitoring Series No. ME-04-MSPR-1099-5. Coastal Restoration Division, Louisiana Department of Natural Resources, Abbeville, LA, USA. Accessed from <http://lacoast.gov>.
- Visser JM (1989) The impact of vertebrate herbivores on primary production of *Sagittaria* marshes in the Wax Lake Delta, Atchafalaya Bay, Louisiana. PhD Dissertation, Louisiana State University, Baton Rouge, LA, USA.
- Visser JM, Sasser CE, Chabreck RH & Linscombe RG (1999) Long-term vegetation change in Louisiana tidal marshes. *Wetlands* 19: 168-175.
- Vitousek PM, Mooney HM, Lubchenco J & Melillo JM (1997) Human domination of earth's ecosystems. *Science* 277: 494-499.
- Von Weihe K & Reese G (1968) *Deschampsia wibeliana* Sonder (Parl.) – Beiträge zur Monographie einer Art des Tidegebietes. *Botanische Jahrbücher* 88: 1-48. GER.
- Votteler TH & Muir TA (1996) Wetland management and research: wetland protection legislation. In: Fretwell JD, Williams JS & Redman PJ (compilers) National Water Summary on Wetland Resources, pp. 57-64. United States Geological Survey Water-Supply paper 2425, Washington, DC.
- Wacker PO & Clemens PGE (1995) Land use in early New Jersey, a historical geography. New Jersey Historical Society, Newark, NJ, USA.
- Wade TI, Velinsky DJ, Reinharz E & Schlekot CE (1994) Tidal river sediments in the Washington, D.C. area. II. Distribution and sources of organic contaminants. *Estuaries* 17: 321-333.
- Wainwright SC, Weinstein MP, Able KW & Currin CA (2000) Relative importance of benthic microalgae, phytoplankton and detritus of smooth cordgrass *Spartina alterniflora* and the common reed *Phragmites australis* to brackish-marsh food webs. *Marine Ecology Progress Series* 200: 77-91.
- Walker R (1981) Nitrogen, phosphorus and production dynamics for *Peltandra virginica* (L.) Kunth in a southern New Jersey freshwater tidal marsh. PhD Dissertation, Rutgers University. New Brunswick, NJ, USA.
- Wall RD, Stewart RM, Cavallo J, McLearn D, Foss R, Perazio P & Dumont J (1996) Prehistoric archaeological synthesis. Trenton complex archaeology: report 15. The Cultural Resource Group, Louis Berger & Associates, Inc., Trenton, NJ, USA.
- Walling DE, Owens PN, Carter J, Leeks GJL, Lewis S, Meharg AA & Wright J (2003) Storage of sediment-associated nutrients and contaminants in river channel and floodplain systems. *Applied Geochemistry* 18: 195-220.
- Walsh LP, McCormick C, Martin C & Stocco DM (2000) Roundup inhibits steroidogenesis by disrupting steroidogenic acute regulatory (StAR) protein expression. *Environmental Health Perspectives* 108: 769-776. USA.
- Walter R & Merritts D (2008) Natural streams and the legacy of water-powered milling. *Science* 319: 299-304.
- Walton WC (1996) Occurrence of zebra mussel (*Dreissena polymorpha*) in the oligohaline Hudson River, New York. *Estuaries* 19: 612-618.
- Wang B (2006) Cultural eutrophication in the Changjiang (Yangtze River) plume: history and perspective. *Estuarine, Coastal and Shelf Science* 69: 471-477.
- Wang ZB, Jeuken MCJL, Gerritsen H, De Vriend HJ & Kornman BA (2002) Morphology and asymmetry of the vertical tide in the Westerschelde estuary. *Continental Shelf Science* 22: 2599-2609.
- Ware DME (1991) Northern Joint-vetch, *Aeschynomene virginica* (L.) B.S.P. In: Terwilliger K (ed) Virginia's endangered species, pp. 119-121. McDonald & Woodward Publishing Company, Blacksburg, VA, USA.
- Warren RS & Niering WA (1993) Vegetation changes on a northeast tidal marsh: interactions of sea level rise and marsh accretion. *Ecology* 74: 76-103.
- Warren RS, Fell PE, Grimsby JL, Buck EL, Rilling GC & Fertik RA (2001) Rates, patterns, and impacts of *Phragmites australis* expansion and effects of experimental *Phragmites* control on vegetation, macroinvertebrates, and fish within tidelands of the lower Connecticut River. *Estuaries* 24: 90-107.
- Warrick RA, Barrow EM & Wigley TML (1993) Climate and sea level change: observations, projections and implications. Cambridge University Press, New York.
- Wassergütestelle Elbe (2008) Steckbrief Typ 20 - Subtyp Tideelbe, Steckbrief Typ 22.3 - Subtyp Tideelbe. Im Auftrag des Koordinierungsraums Tideelbe (Kor Tel). Entwurf. Hamburg, GER.
- Watts BD, Markham AC & Byrd MA (2006) Salinity and population parameters of Bald Eagles (*Haliaeetus leucocephalus*) in the lower Chesapeake Bay. *Auk* 123: 393-404. USA.
- Webster CG (1964) Fall foods of Soras from two habitats in Connecticut. *Journal of Wildlife Management* 28: 163-165.
- Webster WD, Parnell JF & Biggs WC Jr (1985) Mammals of the Carolinas, Virginia, and Maryland. University of North Carolina Press, Chapel Hill, NC, USA.
- Weeda EJ (2006) Crisis in de boomlaag, feest in de kruidlgaag: *Carex strigosa* Huds. terug langs de benedenrivieren. *Stratiotes* 32: 31-50. NL.
- Weeda EJ, Westra R, Westra C & Westra T (1987) Nederlandse ecologische flora. Wilde planten en hun relaties 2. IVN, Amsterdam, NL.
- Weeda EJ, Van der Neut JJM, Boesveld AAM & Weel BAM (2003) Nationaal Park De Biesbosch: schatkamer van de wilde flora. Een overzicht van zeldzame en bedreigde vaatplanten. Alterra / Staatsbosbeheer. Wageningen, NL.
- Weeda EJ, Schaminee JHJ & Van Duuren L (2005) Atlas van plantengemeenschappen in Nederland – deel 4 – Bossen, struwelen en ruigten. KNNV Uitgeverij, Utrecht, NL.
- Weiner J & Whigham DF (1988) Size variability and self-thinning in wild rice (*Zizania aquatica*). *American Journal of Botany* 75: 445-448.
- Weinstein MP, Litvin SY, Bosley KL, Fuller CM & Wainwright SC (2000) The role of tidal salt marsh as an energy source for marine transient and resident fin-fishes: a stable isotope approach. *Transactions of the American Fisheries Society* 129: 797-810.
- Weir DJ & McManus J (1987) The role of wind in generating turbidity maxima in the Tay estuary. *Continental Shelf Research* 7: 1315-1318.

- Weis JS & Weis P (2003) Is the invasion of the common reed, *Phragmites australis*, into tidal marshes of the eastern US an ecological disaster? *Marine Pollution Bulletin* 46: 816-820.
- Weisberg SB, Whalen R & Lotrich VA (1981) Tidal and diurnal influence on food consumption of a salt marsh killifish *Fundulus heteroclitus*. *Marine Biology* 61: 243-246.
- Weller MW (1981) *Freshwater marshes: ecology and wildlife management*. University of Minnesota Press, Minneapolis, MN, USA.
- Weller MW (1999) *Wetland birds: habitat resources and conservation implications*. Cambridge University Press, Cambridge, UK.
- Wells JT, Chinburg SJ & Coleman JM (1982) Development of the Atchafalaya River deltas: generic analysis. Center of Wetland Resources, Louisiana State University, Baton Rouge, LA, USA.
- West RJ & Walford TR (2000) Estuarine fishes in two large eastern Australian coastal rivers – does prawn trawling influence fish community structure? *Fisheries Management and Ecology* 7: 523-536.
- Weston NB & Joye SB (2005) Temperature-driven decoupling of key phases of organic matter degradation in marine sediments. *Proceedings of the National Academy of Sciences* 102: 17036-17040.
- Weston NB, Dixon RE & Joye SB (2006) Ramifications of increased salinity in tidal freshwater sediments: geochemistry and microbial pathways of organic matter mineralization. *Journal of Geophysical Research-Biogeosciences* 111: Art. No. G01009 FEB 7 2006.
- Wetzel PR, Kitchens WM, Brush JM & Dusek ML (2004) Use of a reciprocal transplant study to measure the rate of plant community change in a tidal marsh along a salinity gradient. *Wetlands* 24: 879-890.
- Whigham DF & Simpson RL (1975) Ecological studies of the Hamilton Marshes, progress report for the period June 1974 - January 1975. Biology Department, Rider University, Trenton, NJ, USA.
- Whigham DF & Simpson RL (1976a) The potential use of freshwater tidal marshes in the management of water quality in the Delaware River. In: Tourbier J & Pierson RW Jr (eds) *Biological control of water pollution*, pp. 173-186. University of Pennsylvania Press, Philadelphia, PA, USA.
- Whigham DF & Simpson RL (1976b) Sewage spray irrigation in a Delaware River freshwater tidal marsh. In: Tilton D, Kadlec J & Richardson CJ (eds) *Freshwater wetlands and sewage effluent disposal*, pp. 119-144. School of Natural Resources. University of Michigan, Ann Arbor, Michigan, USA.
- Whigham DF & Simpson RL (1977) Growth, mortality, and biomass partitioning in freshwater tidal wetland populations of wild rice (*Zizania aquatica* var. *aquatica*). *Bulletin of the Torrey Botanical Club* 104: 347-351. USA.
- Whigham DF & Simpson RL (1978a) The relationship between above ground and below ground biomass of freshwater tidal macrophytes. *Aquatic Botany* 5: 355-364.
- Whigham DF & Simpson RL (1978b) Nitrogen and phosphorus movement in a freshwater tidal wetland receiving sewage effluent. *Proceedings of Coastal Zone '78: Symposium on Technological, Environmental, Socioeconomic, and Regulatory Aspects of Coastal Zone Management*. pp. 2189-2203. American Society of Civil Engineers, San Francisco, CA, USA.
- Whigham DF & Simpson RL (1992) Annual variation in biomass and production of a tidal freshwater wetland and comparison with other wetland systems. *Virginia Journal of Science* 43: 5-14. USA.
- Whigham DF, McCormick J, Good RE & Simpson RL (1978) Biomass and primary production in freshwater tidal wetlands of the middle Atlantic coast. In: Good RE, Whigham DF & Simpson RL (eds) *Freshwater wetlands: ecological processes and management potential*, pp. 3-20. Academic Press, New York.
- Whigham DF, Simpson RL & Leck MA (1979) The distribution of seeds, seedlings, and established plants of arrow arum (*Peltandra virginica* (L.) Kunth) in a freshwater tidal wetland. *Bulletin of the Torrey Botanical Club* 106: 193-199. USA.
- Whigham DF, Simpson RL, Good RE & Sickels FA (1989) Decomposition and nutrient-metal dynamics of litter in freshwater tidal wetlands. In: Sharitz RR & Gibbons JW (eds) *Freshwater wetlands and wildlife*, pp. 167-188. USDOE Office of Science and Technology Information, Oak Ridge, TN, USA.
- Whigham DF, Baldwin AH & Barendregt A (2009) Tidal freshwater wetlands. In: Perillo GME, Wolanski E, Cahoon DR & Brinson MM (eds) *Coastal wetlands: an integrated ecosystem approach*, pp. 515-533. Elsevier Earth Sciences, Amsterdam.
- Whitaker JO Jr & Hamilton WJ Jr (1998) *Mammals of the eastern United States*. Cornell University Press, Ithaca, NY, USA.
- White DA (1989) Accreting mudflats at the Mississippi River delta: sedimentation rates and vascular plant succession. In: Duffy WG & Clark D (eds) *Marsh management in coastal Louisiana: effects and issues*, pp. 49-57. US Fish and Wildlife Service Biological Report 89, US Fish and Wildlife Service/Louisiana Department Natural Resources, Slidell, LA, USA.
- White DA (1993) Vascular plant community development on mudflats in the Mississippi River delta, Louisiana, USA. *Aquatic Botany* 45: 171-194.
- White JR & Reddy KR (1999) Influence of nitrate and phosphorus loading on denitrifying enzyme activity in Everglades wetland soils. *Soil Science Society of America Journal* 63: 1945-1954.
- Whitehead FH (1971) Comparative autecology as a guide to plant distribution. In: Duffey E & Watt AS (eds) *The scientific management of plant and animal communities for conservation*, pp. 167-176. Blackwell Scientific Publications, London.
- Whiting GJ & Chanton JP (1993) Primary production control of methane emission from wetlands. *Nature* 364: 794-795.
- Whiting GJ & Chanton JP (1996) Control of the diurnal pattern of methane emission from emergent aquatic macrophytes by gas transport mechanisms. *Aquatic Botany* 54: 237-253.
- Wicker AM & Endres KM (1995) Relationship between waterfowl and American coot abundance with submersed macrophytic vegetation in Currituck Sound, North Carolina. *Estuaries* 18: 428-431.
- Wigand C, McKinney RA, Charpentier MA, Chintala MM & Thursby GB (2003) Relationships of nitrogen loadings, residential development, and physical characteristics with plant structure in New England salt marshes. *Estuaries* 26: 1494-1504.
- Willebrand E, Ledin S & Verwijst T (1993) Willow coppice systems in short rotation forestry: effects of plant spacing, rotation length and clonal composition on biomass production. *Biomass and Bioenergy* 4: 323-331.
- Williams J (1994) *USA TODAY weather almanac 1995*. Vintage Books, New York.
- Williams JP (1982) Exploring the Chesapeake fringe. *Small Boat Journal* (June-July 1982): 39-44. USA.

- Williams PB & Faber PM (2001) Salt marsh restoration experience in the San Francisco Bay Estuary. *Journal of Coastal Research (Special Issue) 27*: 203-211.
- Williams PB & Orr MK (2002) Physical evolution of restored breached levee salt marshes in the San Francisco Bay Estuary. *Restoration Ecology 10*: 527-542.
- Willis JM & Hester MW (2004) Interactive effects of salinity, flooding, and soil type on *Panicum hemitomon*. *Wetlands 24*: 43-50.
- Willner GR, Chapman JA & Pursley D (1979) Reproduction, physiological responses, food habitats and abundance of nutria on Maryland marshes. *Wildlife Monographs 65*: 3-43.
- Windham L & Ehrenfeld JG (2003) Net impact of a plant invasion on nitrogen-cycling processes within a brackish tidal marsh. *Ecological Applications 13*: 883-897.
- Windham L & Lathrop RG Jr (1999) Effects of *Phragmites australis* (common reed) invasion on above ground biomass and soil properties in brackish tidal marsh of the Mullica River, New Jersey. *Estuaries 22*: 927-935.
- Windham L, Weis JS & Weis P (2001a) Patterns and processes of mercury release from leaves of two dominant salt marsh macrophytes, *Phragmites australis* and *Spartina alterniflora*. *Estuaries 24*: 787-795.
- Windham L, Weis JS & Weis P (2001b) Lead uptake, distribution, and effects in two dominant salt marsh macrophytes, *Spartina alterniflora* (cordgrass) and *Phragmites australis* (common reed). *Marine Pollution Bulletin 42*: 811-816.
- Winkels HJ & Vink JPM (1993) Bodemopbouw, bodemkwaliteit en hoogteligging van de Biesboschpolders Mariapolder, Plattehoek en Vijf Ambachten. Flevovericht nr. 344. Directoraat-Generaal Rijkswaterstaat, Lelystad, NL.
- Winn PJS, Young RM & Edwards AMC (2003) Planning for the rising tides: the Humber Estuary Shoreline Management Plan. *The Science of the Total Environment 314-316*: 13-30.
- Winogrand HG & Kiviat E (1997) Invasion of *Phragmites australis* in the tidal wetlands of the Hudson River. In: Nieder WC & Waldman JR (eds) Final Reports of the Tibor T. Polgar Fellowship Program 1996, pp. vi-1 to vi-29. Hudson River Foundation, New York.
- Winterwerp JC, Manning AJ, Martens C, De Mulder T & Vanlede J (2006) A heuristic formula for turbulence-induced flocculation of cohesive sediment. *Estuarine, Coastal and Shelf Science 68*: 195-207.
- Wise CL & Fletcher CH (1986) Archaeology in the wetlands: managing an invisible resource. Proceedings of a Symposium on Waterfowl & Wetlands Management in the Coastal Zone of the Atlantic Flyway, Wilmington, Delaware, Delaware Department of Natural Resources & Environmental Control, Division of Fish & Wildlife, and the Delaware Coastal Management Program, USA.
- Wittfogel KA (1957) Oriental despotism. Yale University Press, New Haven, CT, USA.
- Wolanski E (2007) Estuarine ecohydrology. Elsevier, Amsterdam.
- Wolf A (1988) Röhrichte und Rieder des holsteinischen Elbufers unterhalb Hamburgs. *Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein 58*: 55-68. GER.
- WolfRJAM, Vrieling JG & De Waal RW (1997) Riverine woodlands in the Netherlands. *Global Ecology and Biodiversity Letters 6*: 287-295.
- Wolfe DAE (ed) (1986) Estuarine variability. Academic Press, San Diego, CA, USA.
- Wolff WJ (1968) The Mollusca of the estuarine region of the rivers Rhine, Meuse and Scheldt in relation to the hydrography of the area. I. The Unionidae. *Basteria 32*: 13-47. NL.
- Wolff WJ (1969a) The Mollusca of the estuarine region of the rivers Rhine, Meuse and Scheldt in relation to the hydrography of the area. II. The Dreissenidae. *Basteria 33*: 93-103. NL.
- Wolff WJ (1969b) Distribution of non-breeding waders in an estuarine area in relation to the distribution of their food organisms. *Ardea 57*: 1-28. NL.
- Wolff WJ (1970). The Mollusca of the estuarine region of the rivers Rhine, Meuse and Scheldt in relation to the hydrography of the area. IV. The genus *Sphaerium*. *Basteria 34*: 75-90. NL.
- Wolff WJ (1973) The estuary as a habitat – an analysis of the soft-bottom macrofauna of the estuarine area of the rivers Rhine, Meuse, and Scheldt. *Zoölogische Verhandelingen, Leiden 126*: 1-242. NL.
- Wolff WJ (1999). Exotic invaders of the meso-oligohaline zone of estuaries in the Netherlands: why are there so many? *Helgoländer Meeresuntersuchungen 52*: 393-400. GER.
- Wolman MG & Gerson R (1978) Relative scales of time and effectiveness of climate in watershed geomorphology. *Earth Surface Processes and Landforms 3*: 189-208.
- Wondolowski L (2001) Diurnal activity patterns of wintering gulls at Jug Bay Wetlands Sanctuary, Maryland. MS Thesis, Bard College, Annandale-on-Hudson, New York.
- Wright AL & Reddy KR (2001) Heterotrophic microbial activity in northern Everglades wetland soils. *Soil Science Society of America Journal 65*: 1856-1864.
- Young JA, Palmquist DE & Wotring SO (1997) The invasive nature of *Lepidium latifolium*: a review. In: Brock JH, Wade M, Pysek P & Green D (eds) Plant invasions: studies from North America and Europe, pp. 59-68. Backhuys Publishers, Leiden, NL.
- Yozzo DJ & Diaz RJ (1999) Tidal freshwater wetlands: invertebrate diversity, ecology, and functional significance. In: Batzer DB, Rader RB & Wissinger SA (eds) Invertebrates in freshwater wetlands of North America: ecology and management, pp. 889-918. John Wiley and Sons Inc, New York.
- Yozzo DJ & Odum WE (1993) Fish predation on epiphytic microcrustacea in Tivoli South Bay, a Hudson River tidal freshwater wetland. *Hydrobiologia 257*: 37-46.
- Yozzo DJ & Smith DE (1995) Seasonality, abundance, and microhabitat distribution of meiofauna from a Chickahominy River, Virginia tidal freshwater marsh. *Hydrobiologia 310*: 197-206.
- Yozzo DJ & Smith DE (1998) Composition and abundance of resident marsh-surface nekton: comparison between tidal freshwater and salt marshes in Virginia, USA. *Hydrobiologia 362*: 9-19.
- Yozzo DJ & Steineck PL (1994) Ostracoda from tidal freshwater wetlands at Stockport, Hudson River estuary: Abundance, distribution and composition. *Estuaries 17*: 680-684.
- Yozzo DJ, Smith DE & Lewis ML (1994) Tidal freshwater ecosystems. Bibliography. Virginia Institute of Marine Sciences, Contribution No.1880. Gloucester Point, VA, USA.
- Yozzo DJ, Anderson JL, Cianciola MM, Nieder WC, Miller DE, Ciparis S & McAvoy J (2005) Ecological profile of the Hudson River National Estuarine Research Reserve. National Oceanic and Atmospheric Administration. Annandale, NY, USA.



- Ysebaert T, Meire P, Maes D & Buijs J (1993) The benthic macrofauna along the estuarine gradient of the Schelde estuary. *Netherlands Journal of Aquatic Ecology* 27: 327-341.
- Ysebaert T, Meire P, Coosen J & Essink K (1998) Zonation of intertidal macrobenthos in the estuaries of Schelde and Ems. *Aquatic Ecology* 32: 53-71.
- Ysebaert T, De Neve L & Meire P (2000a) The subtidal macrobenthos in the mesohaline part of the Schelde estuary (Belgium): influenced by man? *Journal Marine Biological Association UK*, 80: 587-597.
- Ysebaert T, Meininger PL, Meire P, Devos K, Berrevoets CM, Strucker RCW & Kuijken E (2000b) Waterbird communities along the estuarine salinity gradient of the Schelde estuary, NW-Europe. *Biodiversity and Conservation* 9: 1275-1296.
- Ysebaert T, Herman PMJ, Meire P, Craeymeersch J, Verbeek H & Heip CHR (2003) Large-scale spatial patterns in estuaries: estuarine macrobenthic communities in the Schelde estuary, NW-Europe. *Estuarine, Coastal and Shelf Science* 57: 335-355.
- Zedler JB (ed) (2001). *Handbook for restoring tidal wetlands*. CRC Press, Boca Raton, FL, USA.
- Zedler JB & Kercher S (2004) Causes and consequences of invasive plants in wetlands: opportunities, opportunists, and outcomes. *Critical Reviews in Plant Sciences* 23: 431-452.
- Zettler ML & Glöer P (2006) Zur Ökologie und Morphologie der Sphaeriidae der Norddeutschen Tiefebene. *Heldia* 6 (Sonderheft 8): 1-61. München, GER.
- Ziegler SE & Fogel ML (2003) Seasonal and diel relationships between the isotopic compositions of dissolved and particulate organic matter in freshwater ecosystems. *Biogeochemistry* 64: 25-52.
- Zonneveld IS (1960) *The Brabantsche Biesbosch. A study of soil and vegetation of a fresh water tidal delta*. PhD Dissertation, Wageningen, NL.
- Zonneveld IS (1999) *De Biesbosch een halve eeuw gevolgd*. Staatsbosbeheer / Uitgeverij Uniepers, Abcoude, NL.
- Zwolsman JGG (1994) Seasonal variability and biogeochemistry of phosphorus in the Scheldt estuary, South-West Netherlands. *Estuarine, Coastal and Shelf Science* 39: 227-248.